Appendices

Appendix A
Notice of Preparation

ROSEDALE - RIO BRAVO
WATER STORAGE DISTRICT

849 Allen Road • P. O. Box 867 • Bakersfield, California 93302-0867 • (661) 589-6045 • FAX (661) 589-1867

Notice of Preparation

Date April 18, 2007

To: Responsible and Trustee Agencies and Interested Parties

Subject: Notice of Preparation of an Environmental Impact Report for the Strand Ranch Integrated Banking Project

This Notice of Preparation (NOP) has been prepared to notify agencies and interested parties that the Rosedale-Rio Bravo Water Storage District (Rosedale) as the Lead Agency is beginning preparation of an Environmental Impact Report (EIR) pursuant to the California Environmental Quality Act (CEQA) for the proposed Strand Ranch Integrated Banking Project. The Strand Ranch is located adjacent to the Rosedale district boundary in Kern County and is owned by the Irvine Ranch Water District (IRWD). IRWD has entered into an agreement with Rosedale to participate in their Conjunctive Use Program. The proposed project would integrate the Strand Ranch into Rosedale's existing Conjunctive Use Program, augmenting Rosedale's existing groundwater storage, recharge, and extraction capabilities. IRWD would be a Responsible Agency for the project. The proposed project would increase water supply reliability for both Rosedale and IRWD customers and would increase groundwater recharge capabilities for Rosedale.

Rosedale is soliciting the views of interested persons and agencies as to the scope and content of the environmental information to be studied in the EIR. In accordance with CEQA, agencies are requested to review the project description provided in this NOP and provide comments on environmental issues related to the statutory responsibilities of the agency. The EIR will be used by Rosedale and IRWD when considering approval of the Strand Ranch Integrated Banking Project.

In accordance with the time limits mandated by CEQA, comments to the NOP must be received by Rosedale no later than 30 days after publication of this notice. We request that comments to this NOP be received no later than May 18, 2007. Please send your comments to the address shown below. Please include a return address and contact name with your comments.

Two public meetings will be held to receive public comments and suggestions on the project, one in Orange County and one in Kern County. The scoping meetings will be open to the public on:

	ORANGE COUNTY	KERN COUNTY
DATE:	Tuesday, April 24, 2007	Tuesday, May 8, 2007
TIME:	5:30 PM	11:00 AM
LOCATION:	Irvine Ranch Water District 15600 Sand Canyon Avenue Irvine, California	Rosedale-Rio Bravo Water Storage District 849 Allen Road Bakersfield, California

Project Title:	Strand Ranch Integrated Banking Project EIR
Signature:	Hal Crossley
Title:	General Manager
Address:	Rosedale-Rio Bravo Water Storage District Attn: Hal Crossley, General Manager 849 Allen Road P.O. Box 867 Bakersfield, CA 93302
Telephone:	(661) 589-6045

INTRODUCTION

Rosedale-Rio Bravo Water Storage District (Rosedale) manages the portion of the regional Kern County groundwater basin that is within its boundaries. Rosedale operates groundwater recharge and banking programs, and is developing recovery programs for its landowners and for other districts within and outside of Kern County, California. Rosedale and Irvine Ranch Water District (IRWD) are proposing the Strand Ranch Integrated Banking Project (proposed project) to augment Rosedale’s groundwater banking program by integrating Strand Ranch into Rosedale’s existing Conjunctive Use Program. Strand Ranch consists of approximately 600 acres of agricultural land owned by IRWD adjacent to the Rosedale district boundary in Kern County. As part of the proposed project, Strand Ranch would be annexed into Rosedale’s boundaries. Rosedale and IRWD propose to develop facilities on this property capable of recharging an average of approximately 17,500 acre-feet per year (AFY) to and from the underlying aquifer. Rosedale and IRWD also propose to develop facilities on or near Strand Ranch to recover approximately 17,500 AFY of water from the aquifer. Rosedale would operate these facilities to optimize the use of the groundwater storage and recovery capacity of the aquifer and to provide a reliable source of water for Rosedale and IRWD customers.

PROJECT BACKGROUND

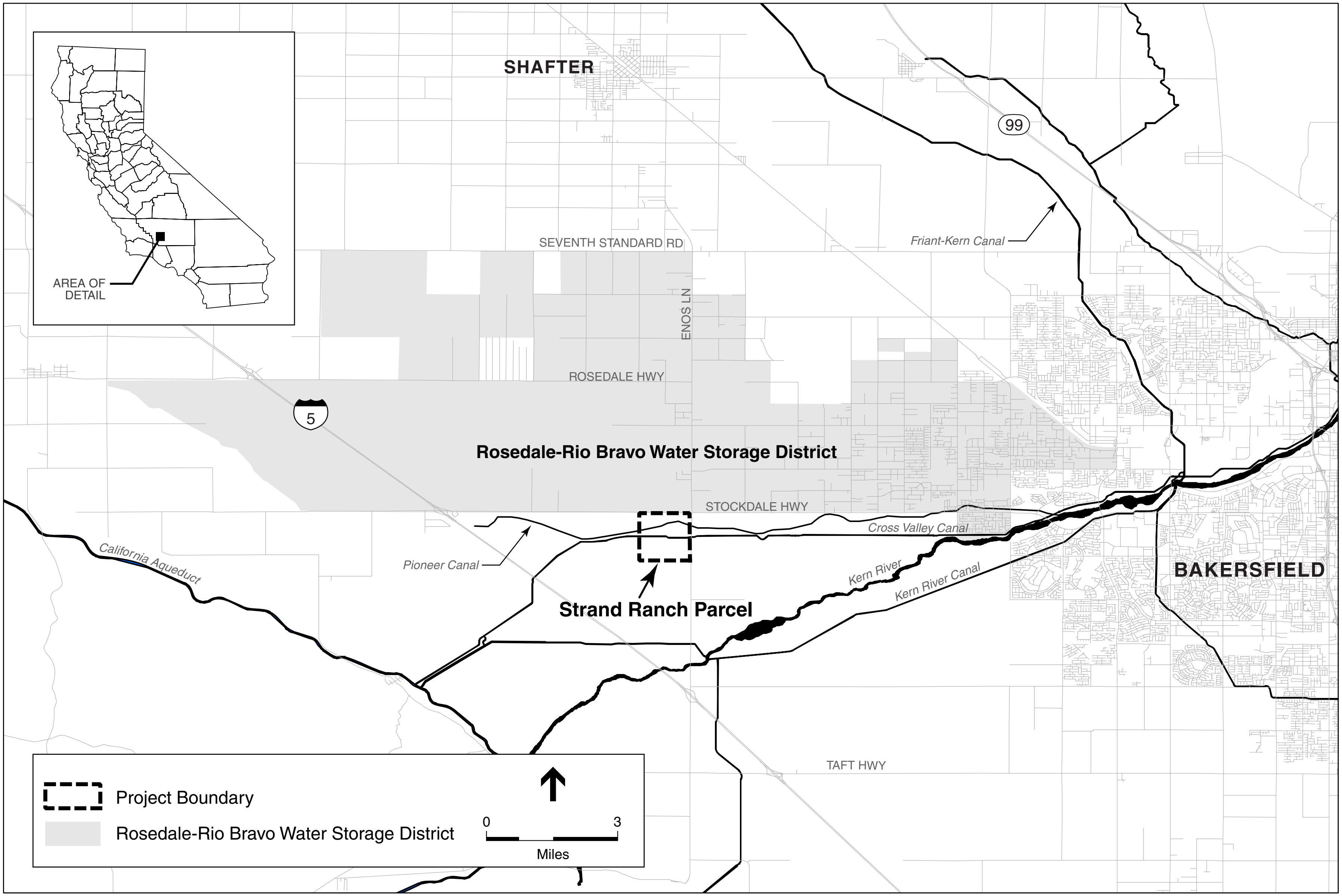
Rosedale-Rio Bravo Water Storage District

Rosedale was established in 1959 to develop a groundwater recharge program to offset overdraft conditions in the regional Kern County aquifer. Rosedale, located west of Bakersfield, encompasses approximately 43,000 acres in Kern County (**Figure 1**), with 28,500 acres developed as irrigated agriculture and about 6,000 acres developed for urban uses.

Rosedale’s Groundwater Storage, Banking, Exchange, Extraction & Conjunctive Use Program (Conjunctive Use Program) currently manages approximately 300,000 acre feet (AF) of stored groundwater in the underlying aquifer, which has an estimated total storage capacity in excess of 930,000 AF. Rosedale acquires water for its Conjunctive Use Program from the Kern River, the Friant-Kern Canal of the Central Valley Project (CVP), and the State Water Project (SWP) through water supply contracts with the Kern County Water Agency (KCWA). Rosedale certified a Final Master EIR covering the Conjunctive Use Program in July 2001.

Irvine Ranch Water District

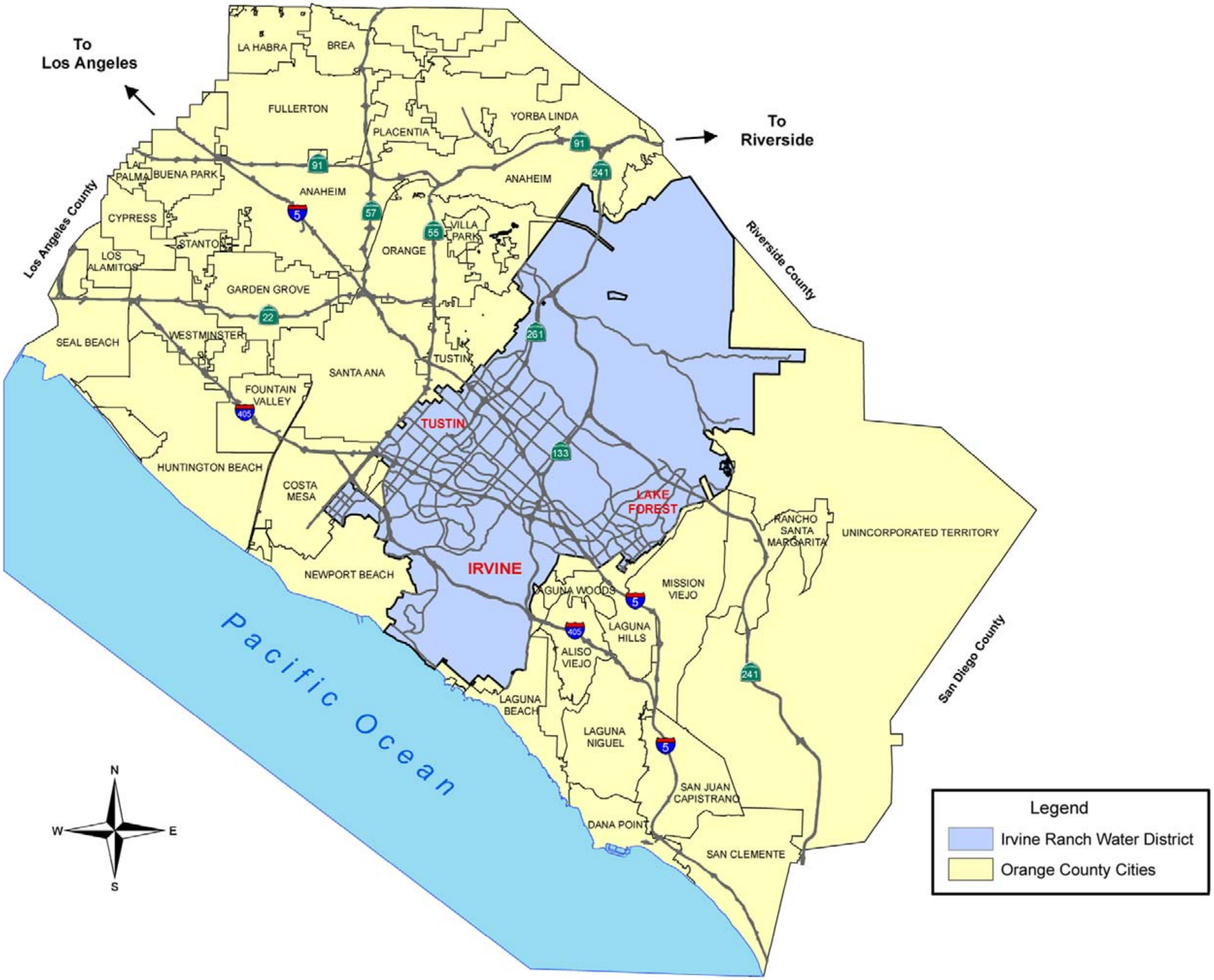
IRWD was established in 1961 as a California Water District pursuant to the California Water District Law (California Water Code, Division 13). IRWD provides potable and recycled water, sewage collection and treatment, and urban runoff treatment to municipal and industrial (M&I), and agricultural customers within an 114,560-acre service area in Orange County, California (**Figure 2**). Currently, 60 percent of the water IRWD provides for its customers comes from local sources, including groundwater (produced from the groundwater basin managed by Orange County Water District), surface water, and reclaimed water.



SOURCE: Kern County, 2007; ESA, 2007.

IRWD . 205426

Figure 1
Project Location
Strand Ranch



SOURCE: Thomas Brothers, 2007; IRWD, 2007.

IRWD . 205426

Figure 2
IRWD Service Area

The remaining 40 percent of IRWD's water supply is imported by the Metropolitan Water District of Southern California (Metropolitan) and purchased from the Municipal Water District of Orange County (MWDOC). IRWD purchased the 611-acre Strand Ranch in Kern County for the purpose of developing a program to bank water to increase the reliability of water supplies to its customers.

Strand Ranch

The 611-acre Strand Ranch property is located in unincorporated Kern County in the northern Kern River Fan area south of Stockdale Highway (Figure 1). Strand Ranch is adjacent to Rosedale's existing boundary and to portions of the Kern Water Bank. Strand Ranch currently is used for agriculture and interim recharge ponds. Two existing water conveyance facilities bisect the property: the Pioneer Canal and the Cross Valley Canal.

PROJECT OBJECTIVES

The objectives of the proposed project are as follows:

- Provide additional groundwater recharge, storage, and recovery capacity in the regional Kern County area to augment Rosedale's existing and future programs;
- Integrate IRWD's participation in Rosedale's Conjunctive Use Program through the use of Strand Ranch;
- Increase the use of the aquifer underlying Rosedale by annexing and developing the Strand Ranch property for recharge and recovery purposes;
- Allow the storage of water during wet hydrologic periods for recovery and use during dry periods to provide IRWD customers with increased water supply reliability through redundancy and diversification.

PROJECT DESCRIPTION

As described below, the proposed project includes the development of facilities for groundwater recharge, recovery, and conveyance at Strand Ranch and the operation of such facilities to provide groundwater storage for use by Rosedale and IRWD. As a part of the proposed project, Strand Ranch would be annexed into Rosedale's boundaries and assimilated into its Conjunctive Use Program, and IRWD would acquire rights to recharge, store, and recover water from the underlying aquifer, thereby improving water supply reliability for its customers.

Recharge Facilities

Rosedale and IRWD would construct facilities on Strand Ranch capable of directly recharging approximately 17,500 AFY. The recharge facilities may occupy the entire Strand Ranch property, less portions used for recovery. Recharge facilities would consist of recharge basins formed from earthen berms made from on-site soils. Any acreage not used for recharge or recovery could be used for continued agricultural operations or fallowed. The recharge facilities would be operated by Rosedale as a component of its Conjunctive Use Program.

Recharge Water

Recharge water for the proposed project would be secured and acquired by IRWD from various sources, potentially including federal, state, and local supplies. Possible sources have not been identified but could include State Water Project water and Kern River water depending on annual availability. IRWD would have rights to a maximum cumulative storage of 50,000 AF.

Conveyance Facilities

New and existing facilities would be used to convey surface water to and from Strand Ranch. Existing conveyances include the Cross Valley Canal (CVC) (operated by KCWA), Pioneer Canal, farm piping and ditches. New conveyance facilities would include turnouts, onsite channels, pipelines, and pumping facilities. Water recovered from the Strand Ranch for IRWD would be conveyed via the CVC to the California Aqueduct where it would flow south to Metropolitan's facilities for distribution to IRWD customers.

Recovery Facilities

Production wells would be constructed on or near Strand Ranch, designed to pump groundwater at a rate to recover approximately 36 cubic feet per second, considering peak delivery needs, facility redundancy, and other operational criteria. Recovery facilities would include recovery wells and piping. Rosedale would use Strand Ranch facilities and its other Conjunctive Use Program facilities to provide IRWD up to 17,500 AFY of recovered water.

DISCUSSION OF IMPACTS

The EIR will assess the physical changes to the environment that would likely result from construction and operation of the Strand Ranch Integrated Banking Project, including direct, indirect and cumulative impacts. Potential impacts of the proposed project are summarized below. The EIR will identify mitigation measures if necessary to minimize potentially significant impacts of the proposed project.

Aesthetics

The existing aesthetic quality of the project area is dominated by rural agriculture. The proposed project would alter the character and visual conditions of the project site by constructing recharge basins and wellheads. The EIR will evaluate the proposed project for impacts related to aesthetic resources, including consistency of the proposed project with the Kern County General Plan and local ordinances.

Agricultural Resources

The proposed project would convert up to 611 acres of agricultural land to groundwater recharge facilities. Strand Ranch is covered under a Williamson Act contract. Some agriculture may remain active on the property. The EIR will identify land uses allowed by Kern County and the Department of Conservation on Williamson Act lands.

Air Quality

Construction of the proposed project would generate emissions from construction equipment exhaust, earth movement, construction workers' commute, and material hauling. The EIR will evaluate the effects of construction activities on air quality and will develop mitigation measures if necessary to reduce the level of impact.

Biological Resources

The proposed project is located on and surrounded by productive agricultural lands. Natural habitat on the Strand Ranch is limited. The EIR will evaluate the potential for the proposed project to impact biological resources, such as sensitive species and critical habitats, including the consistency of the proposed project with the Kern County General Plan, Metropolitan Bakersfield Habitat Conservation Plan (HCP), Kern Water Bank HCP, local ordinances, and state and federal regulations.

Cultural Resources

Although the parcels are productive agricultural lands, excavation below the top soil could uncover previously unknown archaeological or paleontological resources. Historic resources may exist in the area. The EIR will assess the potential effects of the proposed project on cultural resources at Strand Ranch. Mitigation measures will be developed if necessary to reduce the level of impact where possible.

Geology and Soils

The proposed project is located in a seismically active region. The construction of recharge basins could be subject to potential seismic hazards including ground shaking and surface rupture. In addition, construction activities could expose soils to storm water erosion. The EIR will summarize previous geologic studies conducted for Strand Ranch to evaluate percolation capacities of the underlying soils. The EIR will evaluate geologic hazards in the region and will develop mitigation measures if necessary to reduce potential effects from the proposed project.

Hazards and Hazardous Materials

Excavation activities could uncover contaminated soils or hazardous substances that pose a substantial hazard to human health or the environment. The EIR will assess the potential for encountering such hazards at Strand Ranch and will develop mitigation measures if necessary to ensure that any hazards encountered during construction would be handled in accordance with applicable regulations.

Hydrology and Water Quality

The EIR will summarize the water quality at Strand Ranch using existing available data. Monitoring requirements will be identified to determine water quality impacts due to groundwater recharge and pump back operations. The EIR will evaluate the potential for surface contamination to be transported by percolating water into the groundwater table, and the potential effects of the proposed project on neighboring water banking operations. Rosedale has entered into a Memorandum of Understanding (MOU) with neighboring districts that outlines mitigation measures and commitments necessary to ensure that water banking activities do not impact neighboring water quality, agricultural operations, or pumping levels. The EIR will consider these mitigation measures to reduce potential water quality impacts.

Land Use

Strand Ranch is located in a rural area of Kern County. The proposed project would convert up to 611 acres of productive agricultural land into recharge basins. The EIR will evaluate the compatibility of the proposed project with existing and planned land uses.

Noise

Construction of the proposed project would generate noise that could affect residences, businesses, and other sensitive receptors near the project site. The EIR will evaluate the proximity of sensitive receptors to the project site and recommend mitigation measures if necessary to ensure that the proposed project complies with local policies and ordinances to minimize noise impacts.

Population and Housing

Implementation of the proposed project would enhance reliability of the water supply for agricultural and urban use within Rosedale’s service area and for IRWD customers during drought conditions. The EIR will describe growth trends in the Rosedale and IRWD service areas.

Traffic and Transportation

Construction of the proposed project would temporarily add additional trips to the local transportation corridors. The EIR will evaluate the impact of the proposed project on traffic and circulation at the project site. The EIR will develop mitigation measures if necessary to minimize any potential effects.

Appendix B

Scoping Comment Letters

Rosedale-Rio Bravo Water Storage District
Strand Ranch Integrated Banking Project
Irvine Ranch Water District
Scoping Meeting Notes
April 24, 2007
5:30 pm

<u>Present</u>:
Tom Barnes – ESA

<u>Oral Comments</u>:

1) What will be the water source be?

2) What is the expiration of the Williamson Act Contract?

Rosedale-Rio Bravo Water Storage District
Strand Ranch Integrated Banking Project
Rosedale-Rio Bravo Water Storage District
Scoping Meeting Notes
May 8, 2007
11:00 am

Present:
Tom Barnes – ESA

Oral Comments:

Kern Water Agency

1) Generally support banking.
2) When will Strand Ranch be annexed?
3) Will turnouts be covered and documented in this EIR or KWA EIR?
4) Recovery facilities? Where will wells be located in order to assess water quality issues.
5) How many wells, seven or eight? (36 cfs)
6) 36 cfs is high per sq/m?? than KWB
7) The EIR needs to evaluate whether the 17,500 would be produced in consecutive years
8) Is 50,000 af of storage cumulative?
9) Is there a maximum for the life of the project?
10) Biological resources (not in Metro HCP)
11) Kern County floor HCP in progress needs to be addressed.
12) Make sure that hydrology section does what NOP says it will. Add tech data depth
13) Population: housing – how is Rosedale urbanizing and how it fits with water use. Show that water is available.

14) Identify water sources
15) Recovery plan will be scrutinized
16) May be overly optimistic
17) Cumulative ?? analysis
18) Will GW balance method be used?
19) How will MOU fit in? Existing or new MOU? Will there be any mods? Stand alone?
20) Loss factors in MOU will be of concern to KWB

21) Is this EIR mean to be a Master EIR?
22) Cumulative – look at potential future ????
23) KWA – will this evaluate whole Rosedale?
24) Document that evaluates all of Rosedale operations if they are part of project
25) How does IRWD fit in?
26) UWMP could be appended to EIT to see how this fits into their portfolio

27) Tax situation? County tax on land – how is that handled?

Dan Burtwell BV Water

1) Cumulative impacts of partnership will they doc talk about contractual commitments to BV Water
2) How does pump cease from MOU ??? ? Who gets shut down first?

KERN WATER BANK AUTHORITY

ENGINEERING AND PLANNING
MAY 21 2007
IRVINE RANCH
WATER DISTRICT

May 16, 2007

Mr. Hal Crossley
Rosedale – Rio Bravo Water Storage District
849 Allen Road
Bakersfield, CA 93302

Subject: Notice of Preparation of an Environmental Impact Report for the Strand Ranch Integrated Banking Project

Dear Mr. Crossley:

The Kern Water Bank Authority (KWBA) appreciates the opportunity to provide comments on the Notice of Preparation (NOP) of an Environmental Impact Report (EIR) for the Strand Ranch Integrated Banking Project (Project). The documentation attached to the NOP indicates Rosedale – Rio Bravo Water Storage District (Rosedale) and Irvine Ranch Water District (IRWD) plan to develop a project capable of recharging and recovering 17,500 acre-feet/year of water. Recovery would utilize wells expected to extract 36 cfs of water, both on the Strand Ranch and elsewhere on District lands. The maximum storage allocated to IRWD at any time would not exceed 50,000 acre-feet.

Some of the information that will be necessary for us to evaluate the project will include:

- A cumulative analysis of all of Rosedale's banking and sales programs. We are very pleased to hear that you intend to provide this type of comprehensive analysis. In previous CEQA analyses, Rosedale provided historical balance data illustrating how each of the District's programs fits into its operations (e.g. see Table 5 and supporting tables in the MEIR). Such analysis is particularly important given Rosedale's sales programs. We recommend that the DEIR utilize the methodology developed through the groundwater mediation process to document the District's balance for this analysis. This analysis should also evaluate a worst-case scenario wherein Rosedale has to meet all of its current and expected obligations during a prolonged drought.
- Detailed analysis of the project's expected impacts to water levels and quality. This analysis should consider the worst-case scenario wherein Rosedale needs to return all of IRWD's 50,000 acre-feet of storage in consecutive years.
- Discussions at the public hearing seemed to indicate Rosedale has an obligation to provide the 17,500 acre-feet of capacity to IRWD on a first priority. If Rosedale intends

5500 Ming Avenue | Suite 490 | Bakersfield, California 93309 | Phone 661-398-4900 | Fax 661-398-4959

to utilize the Project for itself or others above this capacity, the DEIR should analyze potential impacts from these additional uses.
- Information on proposed well locations, screened intervals, expected recovery rates and recovery rate declines. The recovery rate declines will be important in evaluating the programs worst-case recovery scenarios mentioned above.
- Detailed information on water sources for the program, particularly with respect to water that will be sold or otherwise provided to IRWD by Rosedale.

Thank you for the opportunity to provide input for your proposed EIR. Please call if you have any questions.

Sincerely,
Kern Water Bank Authority,

Jonathan D. Parker,
General Manager

cc: KWBA Board of Directors
Dick Diamond, Irvine Ranch Water District

Directors
CLAUDIA ALVAREZ
PHILIP L. ANTHONY
WES BANNISTER
KATHRYN L. BARR
DENIS R. BILODEAU
JAN DEBAY
SHAWN NELSON
IRV PICKLER
STEPHEN R. SHELDON
ROGER C. YOH

ORANGE COUNTY WATER DISTRICT
Orange County's Groundwater Authority

Officers
PHILIP L. ANTHONY
President
JAN DEBAY
First Vice President
KATHRYN L. BARR
Second Vice President
—
MICHAEL R. WEHNER
Acting General Manager

May 3, 2007

Hal Crossley
General Manager
Rosedale-Rio Bravo Water Storage District
849 Allen Road
Bakersfield, CA 93302

Subject: **Notice of Preparation of Environmental Impact Report Strand Ranch Integrated Banking Project**

Dear Mr. Crossley:

The Orange County Water District (OCWD) appreciates the opportunity to review the Notice of Preparation (NOP) for the Strand Ranch Integrated Banking Project. At this time we have no specific comments on the NOP. However, we would like to receive a copy of the Draft Environmental Impact Report when it becomes available. Please feel free to call me at (714) 378-3256, if you have any questions concerning our request. Once again, thank you for the opportunity for allowing OCWD to be part of the environmental review process for the project.

Sincerely,

Dan Bott

Dan Bott
Senior Planner
Planning & Watershed Management

PLANNING DEPARTMENT

TED JAMES, AICP, Director
2700 "M" STREET, SUITE 100
BAKERSFIELD, CA 93301-2323
Phone: (661) 862-8600
FAX: (661) 862-8601 TTY Relay 1-800-735-2929
E-Mail: planning@co.kern.ca.us
Web Address: www.co.kern.ca.us/planning

RESOURCE MANAGEMENT AGENCY

DAVID PRICE III, RMA DIRECTOR
Community & Economic Development Department
Engineering & Survey Services Department
Environmental Health Services Department
Planning Department
Roads Department

File: Rosedale Rio Bravo
Strand Ranch – NOP

November 12, 2007

Rosedale-Rio Bravo Water Storage District
Attn: Hal Crossley, General Manager
P.O Box 867
Bakersfield, California 93302

RE: **Late Comments – Notice of Preparation**
Strand Ranch Integrated Banking Project

Dear Mr.Crossley,

Kern County Planning has reviewed the Notice of Preparation for the proposed Strand Ranch Integrated Banking Project EIR. This proposed project on 600 acres of land owned by the Irvine Ranch Water District will construct facilities capable of recharging an average of 17,500 AFY of water. The project site, south of Stockdale Highway at Enos Lane is designated R-IA (Resource- Intensive Agriculture) by the Metropolitan Bakersfield's General Plan and 8.1 (Intensive Agriculture) by the Kern County General Plan. It is zoned A (Agriculture) and is subject to a Williamson Act Land Use Contract. Staff has met with the project applicants and consultants and appreciates your consideration of these late comments.

This department has determined that a Williamson Act Contract is compatible with water banking if the qualifying agricultural use would occur approximately 8 to 10 months of the year, compared with year-round—or nearly year-round—cultivation of the site. The DEIR should detail what the qualifying agricultural uses and how they are compatible with the water recharge activities.

The property is currently under the land use jurisdiction of Kern County and encumbered by a Williamson Act Land Use Contract. If the cancellation of the Williamson Act Contract is proposed then the following comments are provided as a Responsible Agency under Section 15381 of the revised CEQA guidelines, as any proposed cancellation of the Williamson Act Contract will require Kern County Board of Supervisors approval and use the FEIR for compliance with CEQA as a Responsible Agency.

The preferred method for removing property from the Williamson Act Contract is nonrenewal. After a notice of nonrenewal is filed on the property with Kern County, a cancellation could be considered. The Agricultural Resources section of the DEIR requires the following discussion to meet the requirements of Kern County Planning for use in any request for cancellation, which is a discretionary action that can be denied, conditionally approved or approved. Provide a clear and complete description of the process for submittal and processing of a cancellation request including details on the required findings under 51282 of the Government Code. A copy of the required findings have been attached for your use.

As noted clearly on Zone Map 121, a Specific Plan line has been adopted for the Kern River Freeway ending at the center of Section 2. Potential compatibility issues and impacts need to be included in the DEIR.

Please provide this office with notifications and documents related to this matter including, but not limited to the Draft EIR, Response to Comments, all hearing notices, staff reports and Notice of Determination.

If you have any questions regarding this matter, please contact me at (661) 862-8866 or Loreleio@co.kern.ca.us. Thank you.

Sincerely,

Lorelei H. Oviatt A.I.C.P
Division Chief

Appendix C

RRBWSD Summary of CEQA Documentation

Summary of RRBWSD Banking Program CEQA Documents

Master EIR for Groundwater Storage, Banking, Exchange, Extraction and Conjunctive Use Program

- Up to 100,000 AF/year recharge.
- Over 300,000 AF of groundwater storage volume used for programs.
- Construction of 15 to 20 wells, extraction capacity of 35,000 to 45,000 AF/year
- Recharge in advance of extraction.
- Water supplies from SWP, Kern River, Friant-Kern Canal, or other sources.
- Overall program goal that for each acre foot of water extracted, one acre foot would remain in District (2:1 program).
- Expects that a MOU will be entered into and a monitoring committee will be established.
- States that as details of each project are defined, site specific environmental reviews per CEQA will be conducted.

Addendum No. 1 to Master EIR

- States that groundwater storage capacity under District is 930,000 AF (per "Determination of Aquifer Storage Capacity" by Sierra Scientific Services, January 20, 2003).

EIR for BVWSD/RRBWSD Water Banking and Recovery Program

- 25% of groundwater banking from existing accounts in BVWSD, 75% from accounts developed primarily from recharge of BVWSD Kern River high flow water in RRBWSD.
- 100% of recovery for first two years will be from previously banked waters in BVWSD.
- Thereafter, recovery will be made jointly by RRBWSD and BVWSD from the previously banked accounts and the accounts to be developed through recharge within RRBWSD.
- More than 80,000 AF/year could be recharged in RRBWSD.
- Recovery/delivery may be more than 20,000 AF/year.
- Primary method of recovery/delivery will be via SWP exchange.
- RRBWSD to construct three additional extraction wells, and possibly replace two existing wells (Westside Well Field).
- Offers to enter into MOU's setting provisions for monitoring program.
- Maximum program storage of 200,000 AF in RRBWSD.
- New recharge basins to be constructed for 200-300 cfs additional capacity (includes Paul Enns and Fanucchi basins).

Negative Declaration for GLC Banking and Recovery Program

- Development of recharge areas for a total District capacity of 600 cfs (includes Sec. 25).
- Sale of a total of 220,000 AF to GLC according to buildup schedule, max. delivery of 9,500 AF/yr.
- 60,000 AF of storage for MWD exchange portion of project.
- Max. delivery of 20,000 AF/yr with MWD exchange.
- 10 additional extraction wells to be constructed (8 new and 2 replacement, Westside Well Field).

Addendum No. 1 to Negative Declaration for GLC Program

- Increases the total sale quantity to 262,500 AF if sufficient water supplies are available.

Negative Declarations for Kern Tulare and Groundwater Banking – Allen Road Wellfield (AEWSD)

- Construction of a total of 7 extraction wells, extraction capacity of 20,500 AF/year.
- 2:1 Groundwater Banking Programs.
- Provides for the construction of a monitoring well.

Appendix D

RRBWSD Conjunctive Use Program Banking Program Operations

Rosedale Rio-Bravo Water Storage District Water Balance, 2006

Source: Balance_c RRBWSD rev 2006.xls, RRBWSD Programs worksheet.

AEWSD 2:1 Program (from 2004 on)

	For AEWSD				For RRBWSD		
Year	Total Delivered	Gross	Total Returned	Bank Balance	Gross	Losses	Net after Losses
				38453			
2004	0	0	17938	20515	0	0	21018
2005	86046	43023	3948	59590	43023	1506	41517
2006	0	0	417	59173	0	0	0
2007	0	0	0	59173	0	0	0
2008	0	0	0	59173	0	0	0
2009	0	0	0	59173	0	0	0
2010	0	0	0	59173	0	0	0
2011	0	0	0	59173	0	0	0
2012	0	0	0	59173	0	0	0
2013	0	0	0	59173	0	0	0
2014	0	0	0	59173	0	0	0
2015	0	0	0	59173	0	0	0
2016	0	0	0	59173	0	0	0

KT&RG 2:1 Program (from 2004 on)

		For KT & RG					For RRBWSD		
				Total to					
Year	Total Delivered	Gross	Banking Losses	Bank (net)	Total Returned	Bank Balance	Gross	Losses	Net after Losses
						1318			
2004	0	0	0	0	0	1318	0	0	0
2005	49747	24874	1492.41	23381	0	24699	24874	249	24625
2006	10000	5000	300	4700	0	29399	5000	50	4950
2007	0	0	0	0	0	29399	0	0	0
2008	0	0	0	0	0	29399	0	0	0
2009	0	0	0	0	0	29399	0	0	0
2010	0	0	0	0	0	29399	0	0	0
2011	0	0	0	0	0	29399	0	0	0
2012	0	0	0	0	0	29399	0	0	0
2013	0	0	0	0	0	29399	0	0	0
2014	0	0	0	0	0	29399	0	0	0
2015	0	0	0	0	0	29399	0	0	0
2016	0	0	0	0	0	29399	0	0	0

BVWSD Banking Program
No net water to RRBWSD

Year	Total Delivered	For BVWSD Gross	Banking Losses	Total to Bank (net)	Total Returned	Bank Balance
2004	313	313	34	279	0	279
2005	58210	58210	6403	51807	0	52085
2006	38352	38352	4219	34133	0	86219
2007	0	0	0	0	0	86219
2008	0	0	0	0	0	86219
2009	0	0	0	0	0	86219
2010	0	0	0	0	0	86219
2011	0	0	0	0	0	86219
2012	0	0	0	0	0	86219
2013	0	0	0	0	0	86219
2014	0	0	0	0	0	86219
2015	0	0	0	0	0	86219
2016	0	0	0	0	0	86219

CLWA Banking Program
No net water to RRBWSD

Year	Total Delivered	For CLWA Gross	Banking Losses	Total to Bank (net)	Total Returned	Bank Balance
2004	0	0	0	0	0	0
2005	20000	20000	2200	17800	0	17800
2006	20000	20000	2200	17800	0	35600
2007	0	0	0	0	0	35600
2008	0	0	0	0	0	35600
2009	0	0	0	0	0	35600
2010	0	0	0	0	0	35600
2011	0	0	0	0	0	35600
2012	0	0	0	0	0	35600
2013	0	0	0	0	0	35600
2014	0	0	0	0	0	35600
2015	0	0	0	0	0	35600
2016	0	0	0	0	0	35600

Total All Programs (from 2004 on)

		For Partners			For RRBWSD		
Year	Total Delivered	Total to Bank	Total Returned	Bank Balance	Gross	Losses	After Losses
				39771			
2004	313	279	17938	22112	0	0	21018
2005	214003	136011	3929	154175	67897	1755	66142
2006	68352	56633	417	210391	5000	50	4950
2007	0	0	0	210391	0	0	0
2008	0	0	0	210391	0	0	0
2009	0	0	0	210391	0	0	0
2010	0	0	0	210391	0	0	0
2011	0	0	0	210391	0	0	0
2012	0	0	0	210391	0	0	0
2013	0	0	0	210391	0	0	0
2014	0	0	0	210391	0	0	0
2015	0	0	0	210391	0	0	0
2016	0	0	0	210391	0	0	0

Notes: Losses for banked water assessed as 5%. The additional 1% loss is taken off the return water (SWP exchange booked to RRB when water is returned to banking partners).

Appendix E

Memorandum of Understanding Groundwater Banking and Sale Program

Directors:

Fred L. Starrh
Division 1

Terry Rogers
Vice President
Division 2

Peter Frick
Division 3

Michael Radon
Division 4

Adrienne J. Mathews
Division 5

Lawrence P. Gallagher
Division 6

ene A. Lundquist
President
Division 7

Thomas N. Clark
General Manager

John F. Stovall
General Counsel

661/634-1400

ailing Address
P.O. Box 58
B ield, CA 93302-0058

Street Address
3200 Rio Mirada Dr.
Bakersfield, CA 93308

April 30, 2004

Mr. Hal Crossley, General Manager
Rosedale-Rio Bravo Water Storage District
P.O. Box 867
Bakersfield, CA 93302

Re: Memorandum of Understanding, Rosedale-Rio Bravo Water Storage District Groundwater Banking and Sale Program

Dear Mr. Crossley:

Enclosed please find executed copies of the above-referenced Memorandum of Understanding. It is our understanding that this MOU does not in any way modify or amend our letter agreement regarding the banking and sales programs dated December 1, 2003. Please acknowledge that this is also your understanding by signing the acknowledgement below and returning a copy of this letter.

Sincerely,

Thomas N. Clark
General Manager

Being authorized by the district, we agree to the foregoing.

Hal Crossley
Rosedale-Rio Bravo Water Storage District
By Hal Crossley, General Manager
Dated: May 10, 2004

MEMORANDUM OF UNDERSTANDING

REGARDING OPERATION AND MONITORING OF THE ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT GROUNDWATER BANKING AND SALE PROGRAM

This Memorandum of Understanding is entered into the Effective Date hereof by and among **ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT**, hereinafter referred to as "Rosedale", and **ROSEDALE RANCH I.D. OF NORTH KERN WATER STORAGE DISTRICT, SEMITROPIC WATER STORAGE DISTRICT, BUENA VISTA WATER STORAGE DISTRICT, HENRY MILLER WATER DISTRICT, BERRENDA MESA WATER DISTRICT, KERN COUNTY WATER AGENCY, KERN WATER BANK AUTHORITY, IMPROVEMENT DISTRICT NO. 4 KERN COUNTY WATER AGENCY, and WEST KERN WATER DISTRICT**, collectively referred to as "Adjoining Entities."

RECITALS

WHEREAS, Rosedale expects that certain real property more particularly shown on the map attached hereto as Exhibit A and incorporated herein by this reference ("Project Site"), or portions thereof, will be used in connection with the Project; and

WHEREAS, Rosedale intends to develop and improve the Project Site as necessary to permit the importation, percolation and storage of water in underground aquifers for later recovery, transportation and use for the benefit of Rosedale, all as more fully described in Exhibit B attached hereto and incorporated herein by this reference ("Project"); and

WHEREAS, Adjoining Entities encompass lands and/or operate existing projects lying adjacent to the Project Site as shown on said Exhibit A; and

WHEREAS, in recent years, water banking, recovery and transfer programs in Kern County have become increasingly numerous and complex; and

WHEREAS, it is appropriate and desirable to mitigate or eliminate any short-term and long-term significant adverse impacts of new programs upon potentially affected projects and landowners within the boundaries of Adjoining Entities; and

WHEREAS, Adjoining Entities and Rosedale desire that the design, operation and monitoring of the Project be conducted and coordinated in a manner to insure that the beneficial effects of the Project to Rosedale are maximized but that the Project does not result in significant adverse impacts to water levels, water quality or land subsidence within the boundaries of Adjoining Entities, or otherwise interfere with the existing and ongoing programs of Adjoining Entities; and

WHEREAS, on October 26, 1995, the Kern Water Bank Authority and its Member Entities, as the "Project Participants," and Buena Vista Water Storage District, Rosedale-Rio Bravo Water Storage District, Kern Delta Water District, Henry Miller Water District and West Kern Water District, as the "Adjoining Entities," entered into a Memorandum of Understanding, similar to this Memorandum of Understanding, which provided among other things at Paragraph 8 that for "any future project within the Kern Fan Area, the Parties hereto shall use good faith efforts to negotiate an agreement substantially similar in substance to this MOU," and by entering into this MOU the Adjoining Entities find that this MOU satisfies such requirement for the Project; and

WHEREAS, Rosedale intends to operate its Project such that the same does not cause or contribute to overdraft of the groundwater basin; and

WHEREAS, in connection with its environmental review for the Project, Rosedale commissioned a hydrologic balance study for a period of years, which study shows that the District is not currently operating in a state of overdraft, and, further, Rosedale has projected said hydrologic balance study into the future, assuming completion of the Project, and said projection demonstrates that the District is not expected to operate in state of overdraft following implementation of the Project, which studies have not been independently verified by the Adjoining Entities; and

WHEREAS, in the hydrologic balance studies conducted by Rosedale in connection with the Project, the annual safe yield from the groundwater basin is assumed to be .3 acre-feet per acre times the gross developed acres in the District and no assumption is included with respect to groundwater inflow or outflow; and

WHEREAS, this MOU affects the Project and other similar banking programs operated for the benefit of third parties.

NOW, THEREFORE, BE IT RESOLVED that, based upon the mutual covenants contained herein, the parties hereto agree as follows:

1. Project Design and Construction. Rosedale has completed a preliminary Project Description of the Project described in Exhibit B hereto representing the contemplated facilities for the Project. Said preliminary description has been reviewed by the parties hereto. The foregoing shall not be interpreted to imply consent to any aspect of any future project not described in existing approved environmental documentation. Rosedale will construct the Project consistent with such preliminary description. Any major modifications of the facilities and/or significant changes from that described in Exhibit B and in the environmental documentation for the Project will be subject to

additional environmental review pursuant to CEQA and will be subject to review ~~of the~~ Monitoring Committee prior to implementation.

2. Project Operation. The Project shall be operated to achieve the maximum water storage and withdrawal benefits for Rosedale consistent with avoiding, mitigating or eliminating to the greatest extent practicable, significant adverse impacts resulting from the Project. To that end, the Project shall be operated in accordance with the following Project Objectives and Minimum Operating Criteria:

a. Project Objectives. Consistent with the Project description, Rosedale will make a good faith effort to meet the following objectives, which may or may not be met:

(1) The parties should operate their projects in such manner as to maintain and, when possible, enhance the quality of groundwater within the Project Site and the Kern Fan Area as shown in Exhibit C.

(2) If supplies of acceptable recharge water exceed recharge capacity, all other things being equal, recharge priority should be given to the purest or best quality water.

(3) Each project within the Kern Fan Area should be operated with the objective that the average concentration of total dissolved salts in the recovered water will exceed the average concentration of total dissolved salts in the recharged water, at a minimum, by a percentage equal to or greater than the percentage of surface recharge losses. The average shall be calculated from the start of each project.

(4) To maintain or improve groundwater quality, recovery operations should extract poorer quality groundwater where practicable. Blending may be used to increase recovery of lesser quality groundwater unless doing so will exacerbate problems by generating

unfavorable movement of lesser quality groundwater. It is recognized that the extent ~~to~~ which blending can help to resolve groundwater quality problems is limited by regulatory agency rules regarding discharges into conveyance systems used for municipal supplies, which may be changed from time to time.

(5) All groundwater pumpers should attempt to control the migration of poor quality water. Extensive monitoring will be used to identify the migration of poor quality water and give advance notice of developing problems. Problem areas may be dealt with by actions including, but not limited to:

(a) limiting or terminating extractions that tend to draw lesser quality water toward or into the usable water areas;

(b) increasing extractions in areas that might generate a beneficial, reverse gradient;

(c) increasing recharge within the usable water area to promote favorable groundwater gradients.

(6) It is intended that all recovery of recharged water be subject to the so-called "golden rule." In the context of a banking project, the "golden rule" means that, unless acceptable mitigation is provided, the banker may not operate so as to create conditions that are worse than would have prevailed absent the project giving due recognition to the benefits that may result from the project, all as more fully described at paragraph 2(b)12 below.

(7) The Project shall be developed and operated so as to prevent, eliminate or mitigate significant adverse impacts. Thus, the Project shall incorporate mitigation measures as necessary. Mitigation measures to prevent significant adverse impacts from occurring include but

are not limited to the following: (i) spread out recovery area; (ii) provide buffer areas between recovery wells and neighboring overlying users; (iii) limit the monthly, seasonal, and/or annual recovery rate; (iv) provide sufficient recovery wells to allow rotation of recovery wells or the use of alternate wells; (v) provide adequate well spacing; (vi) adjust pumping rates or terminate pumping to reduce impacts, if necessary; (vii) impose time restrictions between recharge and recovery to allow for downward percolation of water to the aquifer; and (viii) provide recharge of water that would otherwise not recharge the Kern Fan Basin. Mitigation measures that compensate for unavoidable adverse impacts include but are not limited to the following: (i) with the consent of the affected groundwater pumper, lower the pump bowls or deepen wells as necessary to restore groundwater extraction capability to such pumper; (ii) with the consent of the affected groundwater pumper, provide alternative water supplies to such pumper; and (iii) with the consent of the affected groundwater pumper, provide financial compensation to such pumper.

b. Minimum Operating Criteria.

(1) The Monitoring Committee shall be notified prior to the recharge of potentially unacceptable water, such as "produced water" from oilfield operations, reclaimed water, or the like. The Monitoring Committee shall review the proposed recharge and make recommendations respecting the same as it deems appropriate. Where approval by the Regional Water Quality Control Board is required, the issuance of such approval by said Board shall satisfy this requirement.

(2) Recharge may not occur in, on or near contaminated areas, nor may anyone spread in, on or near an adjoining area if the effect will be to mound water near enough to the contaminated area that the contaminants will be picked up and carried into the uncontaminated

groundwater supply. When contaminated areas are identified within or adjacent to ~~the~~ Project, Rosedale shall also:

(a) participate with other groundwater pumpers to investigate the source of the contamination;

(b) work with appropriate authorities to ensure that the entity or individual, if any, responsible for the contamination meets its responsibilities to remove the contamination and thereby return the Project Site to its full recharge and storage capacity;

(c) operate the Project in cooperation with other groundwater pumpers to attempt to eliminate the migration of contaminated water toward or into usable water quality areas.

(3) Operators of projects within the Kern Fan Area will avoid operating such projects in a fashion so as to significantly diminish the natural, normal and unavoidable recharge of water native to the Kern Fan Area as it existed in pre-project condition. If and to the extent this occurs as determined by the Monitoring Committee, the parties will cooperate to provide equivalent recharge capacity to offset such impact.

(4) The mitigation credit for fallowed Project land shall be .3 acre-feet per acre per year times the amount of fallowed land included in the Project Site in the year of calculation.

(5) The lands shown in Exhibit A may be utilized for any purpose provided, however, the use of said property by Rosedale for the Project shall not cause or contribute to overdraft of the groundwater basin.

(6) Each device proposed to measure recharge water to be subsequently recovered and/or recovery of such water will be initially evaluated and periodically reviewed by the

Monitoring Committee. Each measuring device shall be properly installed, calibra~~ted,~~ rated, monitored and maintained by and at the expense of the owner of the measuring device.

(7) It shall be the responsibility of the user to insure that all measuring devices are accurate and that the measurements are provided to the Monitoring Committee at the time and in the manner required by the Monitoring Committee.

(8) A producer's flow deposited into another facility, such as a transportation canal, shall be measured into such facility by the operator thereof and the measurement reported to the Monitoring Committee at the time and in the manner required by such Monitoring Committee.

(9) The Monitoring Committee or its designee 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., P.G.&E. bills). The Monitoring Committee will publish or cause to be published annual reports of operations.

(10) Losses shall be assessed as follows:

(a) Surface recharge losses shall be fixed and assessed at a rate of 3%, which includes a "safety factor" of 1% of water diverted for direct recharge. An additional surface recharge loss of 3% shall be fixed and assessed against water directly recharged which is subsequently extracted for out-of-district use. Such initial 3% loss may be modified in the future if studies acceptable to the parties demonstrate that such modification is appropriate, providing that a 1% "safety factor" shall be maintained and the total loss when directly recharged water is subsequently extracted for out-of-district use shall not exceed 6%. Notwithstanding anything to the contrary provided herein, water banked in Rosedale for or on behalf of third parties~~ (i.e~~., creating a third party bank account) shall be subject to surface recharge losses calculated at 6% of water diverted for direct recharge.

(b) To account for all other actual or potential losses (including migration losses), a rate of 4% of water placed in a bank account shall be deducted to the extent that Rosedale has been compensated within three (3) years following the end of the calendar year in which the water was designated as banked at the SWP Delta Water Rate charged by DWR at the time of payment; provided further, however, that the water purchased and subtracted from a groundwater bank account pursuant to this provision shall only be used for overdraft correction within the District purchasing the water.

(c) An additional 5% loss shall be assessed against any water diverted to the Project Site for banking by, for, or on behalf of any out-of-County person, entity or organization (except current SWP Agricultural Contractors).

(d) All losses provided for herein represent amounts of water that are non-bankable and non-recoverable by Rosedale.

(11) Recovery of banked water shall be from the Project Site and recovery facilities shall be located therein. Recovery from outside the Project Site may be allowed with the consent of the District or entity having jurisdiction over the area from which the recovery will occur and upon review by the Monitoring Committee.

(12) Recovery of banked water may not be allowed if not otherwise mitigated if it will result in significant adverse impacts to surrounding overlying users. "Adverse impacts" will be evaluated using data applicable in zones including the area which may be affected

by the Project of approximately five miles in width from the boundaries of the Project as designated by the Monitoring Committee. In determining "adverse impacts," as provided at this paragraph and elsewhere in this MOU, consideration will be given to the benefits accrued over time during operation of the Project to landowners surrounding the Project Site including higher groundwater levels as a result of operation of the Project. In determining non-Project conditions vs. Project conditions, credit toward mitigation of any otherwise adverse impacts shall be recognized to the extent of the 4% loss and 5% losses recognized under paragraphs 2.b.(10)(b) and (c), for the mitigation credit recognized under paragraph 2.b.(4), if any, and to the extent of recharge on the Project Site for overdraft correction.

(13) To the extent that interference, other than insignificant interference, with the pumping lift of any existing active well as compared to non-Project conditions, is attributable to pumping of any wells on the Project Site, Rosedale will either stop pumping as necessary to mitigate the interference or compensate the owner for such interference, or any combination thereof. The Monitoring Committee will establish the criteria necessary to determine if well interference, other than insignificant interference, is attributable to pumping of Project wells by conducting pumping tests of Project wells following the installation of monitoring wells (if not already completed) and considering hydrogeologic information.

(14) The Kern Fan Element Groundwater Model, with input from Rosedale and the Adjoining Entities, and utilizing data from a comprehensive groundwater monitoring program, may be used by the Monitoring Committee as appropriate to estimate groundwater impacts of the Project.

(15) The parties recognize that the Project shall be operated with a positive balance, i.e., there shall be no "borrowing" of water for recovery from the basin.

3. Project Monitoring. Adjoining Entities agree to participate in a comprehensive monitoring program and as members of a Monitoring Committee, as hereinafter more particularly described, in order to reasonably determine groundwater level and water quality information under Project and non-Project conditions. The monitoring program will more particularly require the following:

a. Monitoring Committee: Rosedale and the Adjoining Entities shall form a Monitoring Committee for the Project upon terms and conditions acceptable to the participants. The Monitoring Committee shall:

(1) Engage the services of a suitable independent professional groundwater specialist who shall, at the direction of the Committee, provide assistance in the performance of the tasks identified below;

(2) Meet and confer monthly or at other intervals deemed to be appropriate in furtherance of the monitoring program;

(3) Establish a groundwater evaluation methodology or methodologies;

(4) Prepare a monitoring plan and two associated maps, "Well Location, Water Quality Network," and "Well Location, Water Level Network," which plan and maps depict the location and types of wells anticipated to be used in the initial phase of groundwater monitoring (said plan and maps are expected to be modified from time to time as the monitoring program is developed and operated);

(5) Specify such additional monitoring wells and ancillary equipment as are deemed to be necessary or desirable for the purposes hereof;

(6) Prepare annual water balance studies and other interpretive studies, which will designate all sources of water and the use thereof within the study area;

(7) Develop criteria for determining whether excessive mounding or withdrawal is occurring or is likely to occur in an area of interest;

(8) Annually or as otherwise needed determine the impacts of the Project on each of the Adjoining Entities by evaluating with and without Project conditions; and

(9) Develop procedures, review data, and recommend Project operational criteria for the purpose of identifying, verifying, avoiding, eliminating or mitigating, to the extent practicable, the creation of significant imbalances or significant adverse impacts.

b. <u>Collection and Sharing of Data</u>. The Adjoining Entities will make available to the Monitoring Committee copies of all relevant groundwater level, groundwater quality, and other monitoring data currently collected and prepared by each. Rosedale shall annually report, by areas of interest, water deliveries for banking and other purposes, groundwater withdrawals from bank accounts, transfers and other changes in account balances.

c. <u>Monitoring Costs</u>.

(1) The cost of constructing monitoring wells and ancillary equipment within Rosedale shall be borne by Rosedale. The cost of any new or additional monitoring wells and ancillary equipment outside the boundaries of Rosedale shall be borne as may be determined by separate agreement of Rosedale and Adjoining Entities.

(2) Each of the parties shall be responsible for the personnel costs of its representative on the Monitoring Committee. In addition, the Adjoining Entities shall be responsible for all costs of monitoring operations and facilities within their respective boundaries and Rosedale shall be responsible for all costs of monitoring operations and facilities within the Project Site.

(3) All other groundwater monitoring costs, including employment of the professional groundwater specialist, collection, evaluation and analyses of data as adopted by the Monitoring Committee, shall be allocated among and borne by the parties as they shall agree among themselves. Cost sharing among Adjoining Entities shall be as agreed by them. Any additional monitoring costs shall be determined and allocated by separate agreement of those parties requesting such additional monitoring.

4. Modification of Project Operations. The Monitoring Committee may make recommendations to Rosedale, including without limitation recommendations for modifications in Project operations based upon evaluation(s) of data which indicate that excessive mounding or withdrawal is occurring or is likely to occur in an area of interest. The Monitoring Committee and its members shall not act in an arbitrary, capricious or unreasonable manner.

5. Dispute Resolution.

a. Submission to Monitoring Committee. All disputes regarding the operation of the Project or the application of this MOU, or any provision hereof, shall first be submitted to the Monitoring Committee for review and analysis. The Monitoring Committee shall meet and review all relevant data and facts regarding the dispute and, if possible, recommend a fair and equitable resolution of the dispute. The Monitoring Committee and its members shall not act in an arbitrary, capricious or unreasonable manner. In the event that (1) the Monitoring Committee fails to act as herein provided, (2) any party disputes the Monitoring Committee's recommended resolution or (3) any party fails to implement the Monitoring Committee's recommended resolution within the time allowed, any party to this MOU may seek any legal or equitable remedy available as hereinafter provided.

b. Arbitration. If all of the parties agree that a factual dispute exists regarding any recommendation of the Monitoring Committee made pursuant hereto, or implementation thereof, such dispute shall, be submitted to binding arbitration before a single neutral arbitrator appointed by unanimous consent and, in the absence of such consent, appointed by the presiding judge of the Kern County Superior Court. The neutral arbitrator shall be a registered civil engineer, registered geologist, or other person agreeable to the parties, preferably with a background in groundwater hydrology. The arbitration shall be called and conducted in accordance with such rules as the contestants shall agree upon, and, in the absence of such agreement, in accordance with the procedures set forth in California Code of Civil Procedure section 1282, et seq. Any other dispute may be pursued through a court of competent jurisdiction as otherwise provided by law.

c. Burden of Proof. In the event of arbitration or litigation under this MOU, all parties shall enjoy the benefit of such presumptions as are provided by law but, in the absence thereof, neither party shall bear the burden of proof on any contested legal or factual issue.

d. Landowner Remedies. Nothing in this MOU shall prevent any landowner within the boundaries of any party from pursuing any remedy at law or in equity in the event such landowner is damaged as a result of projects within the Kern Fan Area.

6. Term. The Effective Date of this MOU shall be January 1, 2003 regardless of the date of actual execution. This MOU shall continue in force and effect from and after the Effective Date

until terminated by (1) operation of law, (2) unanimous consent of the parties, or (3) abandonment of the Project and a determination by the Monitoring Committee that all adverse impacts have been fully eliminated or mitigated as provided in this MOU.

7. Complete Agreement/Incorporation Into Banking Agreements. This MOU constitutes the whole and complete agreement of the parties regarding Project operation, maintenance and monitoring. Rosedale shall incorporate this MOU by reference into any further agreement it enters into respecting banking of water in or withdrawal of water from the Project Site.

8. Future Projects. With respect to any future project within the Kern Fan Area, the Parties hereto shall use good faith efforts to negotiate an agreement substantially similar in substance to this MOU.

9. Notice Clause. All notices required by this MOU shall be sent via first class United States mail to the addresses shown on the signature page of this agreement and shall be deemed delivered three days after deposited in the mail. Notice of changes in the representative or address of a party shall be given in the same manner.

10. California Law Clause. All provisions of this MOU and all rights and obligations of the parties hereto shall be interpreted and construed according to the laws of the State of California.

11. Amendments. This MOU may be amended by written instrument executed by all of the parties. In addition, recognizing that the parties may not now be able to contemplate all the implications of the Project, the parties agree that on the tenth anniversary of implementation of the Project, if facts and conditions not envisioned at the time of entering into this MOU are present, the parties will negotiate in good faith amendments to this MOU. If the parties cannot agree on whether conditions have changed necessitating an amendment and/or upon appropriate amendments to the

MOU, such limited issues shall be submitted to an arbitrator or court, as the case may be, as provided above.

12. Successors and Assigns. This MOU shall bind and inure to the benefit of the successors and assigns of the parties.

13. Severability. The rights and privileges set forth in this MOU are severable and the failure or invalidity of any particular provision of this MOU shall not invalidate the other provisions of this MOU; rather all other provisions of this MOU shall continue and remain in full force and effect notwithstanding such partial failure or invalidity.

14. Force Majeure. All obligations of the parties shall be suspended for so long as and to the extent the performance thereof is prevented, directly or indirectly, by earthquakes, fires, tornadoes, facility failures, floods, drownings, strikes, other casualties, acts of God, orders of court or governmental agencies having competent jurisdiction, or other events or causes beyond the control of the parties. In no event shall any liability accrue against a party, or its officers, agents or employees, for any damage arising out of or connected with a suspension of performance pursuant to this paragraph.

15. Counterparts. This MOU, and any amendment or supplement thereto, may be executed in two or more counterparts, and by each party on a separate counterpart, each of which, when executed and delivered, shall be an original and all of which together shall constitute one instrument, with the same force and effect as though all signatures appeared on a single document. In proving this MOU or any such amendment, supplement, document or instrument, it shall not be necessary to produce or account for more than one counterpart thereof signed by the party against whom enforcement is sought.

IN WITNESS WHEREOF the parties have executed this MOU as of ______________, 2004 (Effective Date) at Bakersfield, California.

ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT
P. O. Box 867
Bakersfield, CA 93302-0867

By: Hal Crossley

By:

ROSEDALE RANCH I.D.
NORTH KERN WATER STORAGE DISTRICT
P. O. Box 81435
Bakersfield, CA 93380-1435

By:______________________________

By:______________________________

SEMITROPIC WATER STORAGE DISTRICT
P. O. Box Z
Wasco, CA 93280-0877

By:______________________________

By:______________________________

BUENA VISTA WATER STORAGE DISTRICT
P. O. Box 756
Buttonwillow, CA

By:______________________________

By:______________________________

HENRY MILLER WATER DISTRICT
P. O. Box 9759
Bakersfield, CA 93389-9759

By:______________________________

By:______________________________

BERRENDA MESA WATER DISTRICT
2100 F Street, Suite 100
Bakersfield, CA 93301

By:______________________________

By:______________________________

KERN COUNTY WATER AGENCY
P. O. Box 58
Bakersfield, CA 93302-0058

By: Gene A. Lundquist

By: President

KERN WATER BANK AUTHORITY
P. O. Box 80607
Bakersfield, CA 93380-0607

By:______________________________

By:______________________________

IMPROVEMENT DISTRICT NO. 4
KERN COUNTY WATER AGENCY
P. O. Box 58
Bakersfield, CA 93302-0058

By: Gene A. Lundquist

By: President

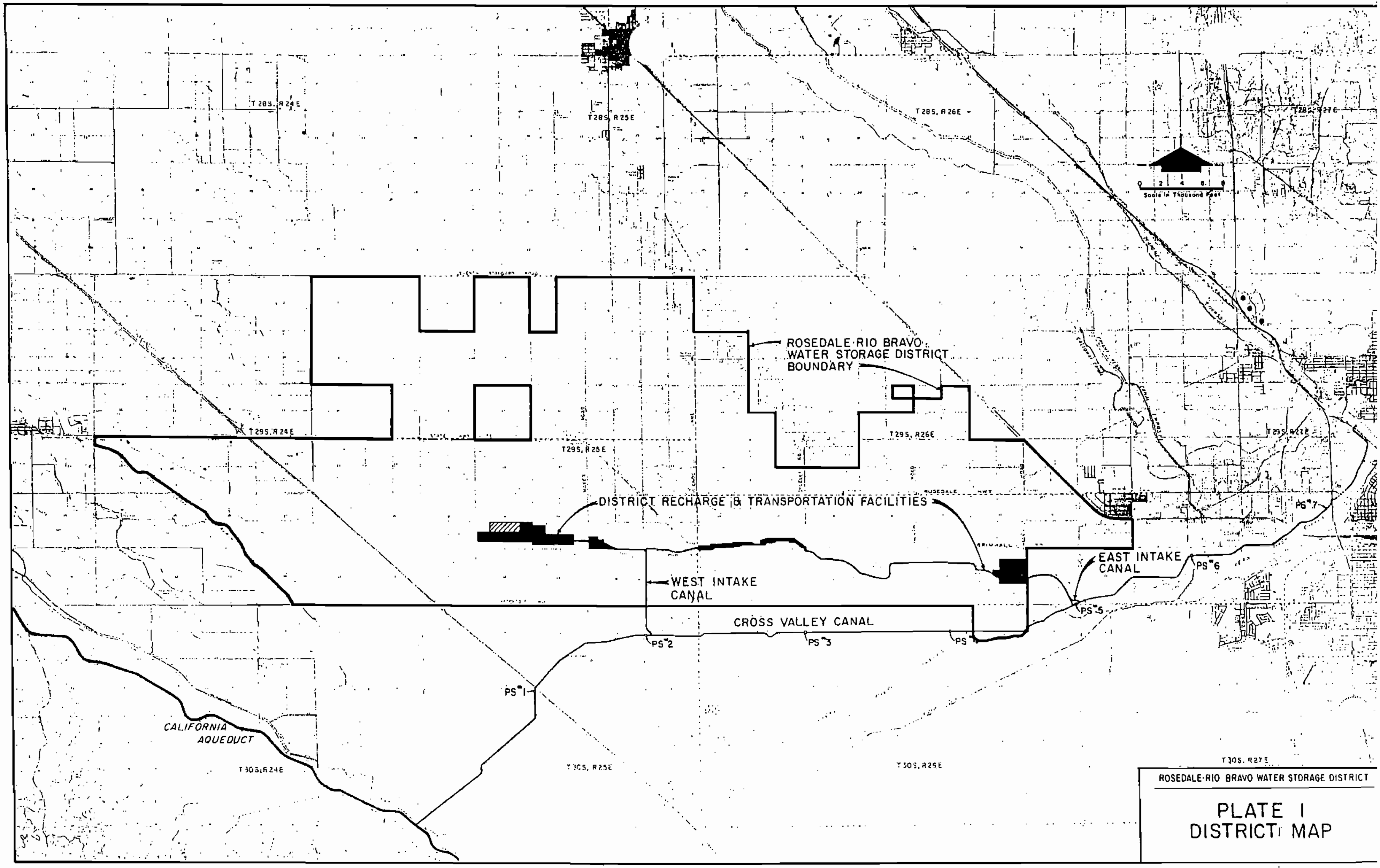
WEST KERN WATER DISTRICT
P. O. Box 1105
Taft, CA 93268-1105

By:__________________________________

By:__________________________________

RRB banking MOU - sales included - final.wpd

EXHIBIT ‘A’



ROSEDALE-RIO BRAVO WATER STORAGE DISTRICT

PLATE I
DISTRICT MAP

EXHIBIT ‘B’

Appendix F

Strand Ranch Well Placement and Drawdown Analysis

Sierra Scientific Services

An Evaluation of Well Placements and Potential Impacts of the Proposed Strand Ranch Well Field, Kern County, California.

20 December, 2007

prepared for:
Irvine Ranch Water District
P. O. Box 57000
15600 Sand Canyon Avenue.
Irvine, Ca 92619 - 7000
Attn: Mr. Paul Weghorst,
Principal Water Resources Manager
(949) 453 - 5632

prepared by:
Sierra Scientific Services
1800 30th Street, Suite 400
Bakersfield, CA 93301-1932
Attn: Robert A. Crewdson, Ph.D.
(661) 377 - 0123

Table of Contents

List of Figures.

List of Tables.

List of Exhibits.

Note: The Exhibit 5 Catalog is presented in a large, separately-bound volume which is available at the main office of the Irvine Ranch Water District in Irvine, Ca, or the main office of the Rosedale - Rio Bravo Water Storage District in Bakersfield, Ca. A table of contents of the Exhibit 5 Catalog is presented at the end of this Report in place of the complete Catalog.

Sierra Scientific Services

An Evaluation of Well Placements and Potential Impacts
of the Proposed Strand Ranch Well Field, Kern County, California.

1. Summary of Findings

The purpose of this Report is to present the findings of a water-level-drawdown impact evaluation for a proposed well field which is a part of the Strand Ranch aquifer storage and recovery (ASR) project. The study includes the computer simulation of predicted water level drawdowns in the local aquifer due to project pumping and the evaluation of the predicted impacts within the area of influence. The study also includes the computer simulation and evaluation of predicted water table mounding due to project recharge as part of a total-project-impact analysis. The Strand Ranch project area covers nearly a full section of land, a square area of approximately 611 acres. The study area includes the project site plus the eight (8) contiguous adjoining sections, i.e., a square study area covering a total of nine (9) square miles. The Strand Ranch project site is surrounded by other existing ASR projects which overlie the prolific fresh water aquifer referred to locally as the Kern Fan in Kern County, California.

We calculated and summarized the drawdowns and mounding in several ways by mapping the actual drawdown as a function of location and distance from the operating wells, by calculating the average drawdown within the well field and within each of the eight adjacent sections, and by calculating the specific drawdowns at selected locations of interest in the surrounding sections.

Well Field and Aquifer Model.

For this study, we calculated the water level drawdowns for three hypothetical well-field operating scenarios of 9-, 7-, or 5- wells. Each scenario is designed to recover 17,500 af of ground water from the underlying aquifer in a year, with all wells pumped at a nominal 5 cfs. The criteria which we used for well placements serve to: 1. minimize well interference, 2. distribute the drawdown impacts as uniformly as possible across the largest possible area, and 3. minimize the drawdown impacts to non-project wells in the surrounding area. Based on these criteria, we used a uniform square grid of 9 possible well locations with a well spacing of

1/3-mile (1,760 ft) and a property line setback of 1/6-mile (880 ft). These dimensions are consistent with existing well-field practices in other ASR projects located in the local area.

The Kern Fan aquifer behaves and is modeled as a 3-layer, semi-confined, i.e. "leaky", aquifer in which the shallow zone is unconfined, the deep zone is semi-confined, and the intermediate zone acts as a leaky aquitard between the other two. The base case aquifer parameters were the same for each case, i.e., a 300-ft thick, semi-confined aquifer with T = 17,100 ft^2/d, S = 0.02, and porosity = 30%; an overlying aquitard with L' = 0.000475 d^{-1} which is gives a Hantush leakage factor of B = 6,000 ft; and an overlying unconfined aquifer with a specific yield of Sy = 21%.

The unimpacted, natural groundwater gradient was assumed to be zero unless otherwise specified. For capture zone and particle trajectory calculation we used a groundwater gradient of -25 ft/mi to the northwest (-0.0048 at a left aximuth of 135 degrees from east) and we assumed a corresponding reference groundwater elevation at 100 ft below GL at the southeast corner of the project area (i.e., the SE cor Sec 02, T30s, R25e). We calibrated the results by varying selected parameters to provide a sensitivity analysis to estimate the effects of parameter uncertainty. The modeling parameters have been summarized in Table 1 and described in detail in the text and Exhibit 2.

Calculated Drawdowns.

We calculated the leaky- aquifer, transient and steady-state (maximum) water level drawdowns, capture zones, and particle trajectories using the commercially-available analytic computer model "WinFlow" by Environmental Solutions, Inc. We present a discussion of computer models in Exhibit 1, aquifer parameters and parameter values in Table 1 and Exhibit 2, limitations of the analysis in Exhibit 3, and a catalog of all model outputs in Exhibit 5. We present the primary results of interest below.

Nine- well scenario: q = 90 af/d, pumping t = 194 d, V = 17,500 af/yr.

The hypothetical steady-state drawdowns created by the Strand Ranch, *9-well, 194-day*, pumping scenario are presented on the map in Figure 5 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 43 ft and the average drawdowns in the surrounding 8 sections are in the range of 12 - 20 ft. The drawdowns along the perimeter of the study area are in the range of 5 - 9 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter. The drawdowns for the 9-well case superimposed on a northwesterly groundwater gradient are shown on the map in Figure 9.

Under these assumptions, the area will achieve steady-state within about 100 days after pumping begins and the water levels will begin to recover after 194 days when pumping ceases. As long as the leaky-aquifer assumptions continue to be met, the water levels in the study area will recover to pre-pumping levels in another 100 days or less, in the absence of other influences.

<u>Seven - well scenario:</u> q = 70 af/d, pumping t = 250-day, V = 17,500 af/yr.

The hypothetical steady-state drawdowns created by the Strand Ranch, *7-well, 250-day*, pumping scenario are presented on the map in Figure 6 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 34 ft and the average drawdowns in the surrounding 8 sections are in the range of 9 - 14 ft. The drawdowns along the perimeter of the study area are in the range of 3 - 8 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter.

Under these well field assumptions, the area will achieve steady-state within about 100 days after pumping begins and the water levels will begin to recover after 350 days when pumping ceases. As long as the leaky-aquifer assumptions continue to be met, the water levels in the study area will recover to pre-pumping levels in another 100 days or less, in the absence of other influences.

The hypothetical drawdowns created by the Strand Ranch *7-well, 250-day scenario* are approximately 78% of the hypothetical drawdowns for the 9- well scenario but the duration of impact lasts about 56 days longer because the wells must operate longer to recover the same total volume of water (17,500 af/yr) at the lower recovery rate (70af/d vs. 90 af/d).

<u>Five - well scenario:</u> q = 50 af/d, pumping t = 350-day, V = 17,500 af/yr.

The hypothetical steady-state drawdowns created by the Strand Ranch, *5-well, 350-day*, pumping scenario (wells 1, 3, 5, 7, 9) are presented on the map in Figure 7 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 24 ft and the average drawdowns in the surrounding 8 sections are in the range of 7 - 11 ft. The drawdowns along the perimeter of the study area are in the range of 2 - 6 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter.

Under these well field assumptions, the area will achieve steady-state within about 100 days after pumping begins and the water levels will begin to recover after 350 days when pumping ceases. As long as the leaky-aquifer assumptions continue to be met, the water levels in the study area will recover to pre-pumping levels in another 100 days or less, in the absence of other influences.

The hypothetical drawdowns created by the Strand Ranch *5-well, 350-day scenario* are approximately 56% of the hypothetical drawdowns for the 9- well scenario but the duration of impact lasts about 156 days longer because the wells must operate longer to re-cover the same total volume of water (17,500 af/yr) at the lower recovery rate (50 vs 90 af/d).

We have also calculated the hypothetical, steady-state drawdowns for an alternate Strand Ranch, *5-well, 350-day*, pumping scenario the same as above except using wells at locations 1,2,3,4,5 instead of 1,3,5,7,9. The drawdowns for this case are presented on the map in Figure 8 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 24 ft and the average drawdowns in the surrounding 8 sections are in the range of 7 - 11 ft. The drawdowns along the perimeter of the study area are in the range of 2 - 6 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter.

The project has considerable flexibility in delivering less than the full recovery rate of 45 cfs and/or the annual recovery volume of 17,500 af. The project may meet reduced delivery rates and volumes by choosing to pump for less time, and/or at lower pumping rates, and/or using fewer wells. Each of these possible alternatives provides reduced drawdowns, somewhat smaller areal distributions, and faster aquifer- recovery times.

Capture Zone.

For 300 days of pumping, the hypothetical capture perimeter surrounding the entire well field extends only a few hundred ft outward from the individual wells and remains entirely within the property boundary of the Strand Ranch. For a hypothetical 1000 days (approx. 3 yr) of continuous pumping, the hypothetical capture perimeter extends about 1,800 ft from the individual wells. For a hypothetical 3650 days (10 yr) of continuous pumping, the capture zone would extend about 2,300 ft down-gradient to the northwest and would extend about 4,500 ft up-gradient to the southeast under conditions of long-term groundwater gradient of 25 ft/mi to the northwest. Pumping by non-project wells in the surrounding areas will change the shape and extent of this capture zone, as shown in the various model runs.

A capture zone analysis requires that we model the aquifer behavior as realistically as possible, since true particle trajectories will respond to all influences on the potentiometric pressure field and not just those generated by the Strand Ranch wells. Therefore, the most realistic scenario assumes that the Strand Ranch wells will most likely be pumping in a dry year when all of the neighboring wells are pumping as well. The combined pumping effects of these wells superimposed on the natural groundwater gradient will determine the locations of capture zone and particle trajectories with time.

The water level elevation map in Figure 10 shows the steady-state impacts of the nine Strand Ranch wells and eleven Kern Water Bank wells superimposed on the local groundwater gradient. The five wells located at the center and corners of the Strand Ranch well field (wells 1, 3, 5, 7, 9) have 1,000-day reverse particle trajectories attached to them which define the shape and areal extents of the “3-year” capture zones for continuous pumping at these locations. For reference purposes, the section corners have been labeled on the map. We have mapped the locations of the capture zone perimeter for pumping times of 300-, 1000-, 1825-, and 3650-days superimposed on 10-year continuous particle trajectories in Figure 11.

We have also mapped (Figure 12) the 10-year forward particle trajectories of a hypothetical line source located in the southwest quarter of section 12, T30s, R25e under conditions of continuous pumping of both the Strand Ranch and Kern Water Bank wells. Any groundwater contamination which comes from a source located on or near this line will follow the same trajectories. A slug or plume of contamination will eventually be captured by wells located on the Kern Water Bank and/or Strand Ranch depending on the particular location of the source and its downgradient trajectories.

Based on available existing water quality data, the shallow aquifer under the project site (compared to the nearby, unimpacted shallow aquifer) has elevated concentrations of total dissolved solids and several constituents of concern due to the inflow of a brine plume from an unspecified, up-gradient source or sources in or near the southwest quarter of Section 12, T30s/25e. This brine plume represents a source of water quality degradation that falls within the predicted capture zone of the well field under conditions of natural groundwater gradient and under conditions of pumping. There is no recognized way of positioning the proposed Strand Ranch wells to avoid the water quality impacts of this brine plume. The quantitative analysis of the potential impacts of this brine plume on the Strand Ranch well field is outside the scope of this study.

Calculated Recharge Mounding.

We calculated the unconfined- aquifer, transient, water table drawdowns using the commercially-available analytic computer model "WinFlow" by Environmental Solutions, Inc. We calculated the transient water level rises due to mounding assuming that the project recharges 17,500 af in a single episode using 450 acres of ponds. For the range of expected infiltration rates of 0.20, 0.25, and 0.30 ft/d, a recharge episode will last 129 - 194 days. We present the primary results of interest below.

For the three recharge scenarios, the calculated maximum mound heights under the project range from 32 - 40 ft and the maximum water level rises in the surrounding 8 sections ranges from 6 - 14 ft.

As discussed in the Report, the positive impact of recharge mounding fully compensates for recovery drawdown in all except the "least-favorable" case of a recharge/recovery cycle at minimum recharge rates and maximum recovery rates. In this one case, the maximum uncompensated net temporary drawdown in the surrounding eight sections is in the range of -6 to -7 ft. All other, more-favorable, scenarios result smaller net water level declines and/or net water level rises at all locations surrounding the project site for comparable time periods.

Project Impact.

The proposed Strand Ranch ASR project operation is designed to always maintain a positive project balance, i.e., a volume of water must always be stored in the aquifer prior to removing a like volume from the aquifer. ASR projects usually operate by putting water into the ground in a wet year and then recovering it as needed in some future dry year, so there is little likelihood of recharge and recovery happening simultaneously. As long as the project puts as much water in the ground as it takes out, the net basin impact from water level drawdown will be pre-compensated for by the water-level rise due to recharge mounding, so there will be no net long term effect on the basin no matter how far apart recharge and recovery are separated in time.

In the case of the proposed Strand Ranch project, both recharge and recovery facilities will be co-located on the project site such that the approximately equal and opposite impacts of both recharge and recovery will be superimposed on the same area and same aquifer zones.

The Project operators have voluntarily established operating limits which preclude the occurrence of an unacceptable, unbalanced recharge/recovery cycle. The project is voluntarily designed so that 1. the Strand Ranch project will not have more than 50,000 af of water in basin storage, and 2. the project will not recharge or recover more than a maximum of 17,500 af of groundwater per year during normal operations. The computer models of both recharge and recovery have demonstrated that by capping the maximum inflow/outflow at 17,500 af/yr, that 1. the beneficial impacts of recharge are approximately equal to the potentially detrimental impacts of recovery, and 2. by spreading the recovery of the maximum allowable volume of water in storage over a 3-year period the individual and combined net impacts of the total operation avoids and prevents unacceptable impacts to the aquifer and the basin.

Conclusions and Recommendations.

We conclude that the Strand Ranch well-field scenarios minimize the respective predicted drawdown impacts by putting the maximum available distances between wells over the widest available area by using well spacings and property line setbacks which are no less than those being used successfully in other ASR projects in the Kern Fan project area. We conclude that the project design results in approximately balanced recharge/recovery cycles so that the transient water level rises due to recharge mounding episodes are approximately equal and opposite to the transient water level declines due to recovery drawdown episodes.

We conclude that for this project to operate as predicted and desired, the total recharge to this area must start out and remain in long term balance with total recovery in this area, as the project is designed to do.

We conclude that under existing and foreseeable circumstances, the Strand Ranch, 9-well, 45 cfs, maximum-recovery scenario is an acceptable short-term and long-term operating scenario which does not create a net impact on the basin if recharge precedes recovery, as proposed. All other Strand Ranch scenarios using fewer wells, and/or lower total recovery rates, and/or lower total recovery volumes are also acceptable by the same criteria.

We conclude that the brine plume which is flowing under the Strand Ranch from an unspecified upgradient source or sources is a cause for concern which cannot be mitigated through well placements within the project area. However, the plume is a residual effect from oilfield-brine discharge sources which are no longer active and both periodic recharge and periodic shallow groundwater extraction by the Kern Water Bank on adjacent lands is remediating the plume by diluting and permanently removing groundwater with elevated TDS content from within the plume perimeter. We note that the Kern Water Bank's operation of these wells is voluntary; the KWB was not responsible for the brine discharge nor are they being held responsible for its cleanup. Future Strand Ranch project operations will have the same beneficial impacts on the brine plume.

We recommend that the project test each new water well individually with a testing program which will provide for aquifer parameter measurement as well as pump parameter measurement. Such data will be useful and essential for a future aquifer model calibration. We recommend that the project partners consider contracting with SSS to help design, observe, and interpret the well tests.

We recommend that the project impacts be carefully monitored from startup so that we can calibrate and verify the results of this work program and then make refinements in our model of the aquifer behavior for future use.

We recommend installing monitoring wells to satisfy four different purposes, including well testing, model calibration and verification, long- term operational water level monitoring, and contaminant- detection monitoring. We recommend as many monitoring well installations as are necessary to cover all of these functions at all important locations and in all necessary aquifer zones. It may be necessary to install some monitoring wells which are useful for only one of these functions, since a single well placement may not be effective for all purposes. We recommend that the project consider designing the completion depth interval of each monitoring well depending on the intended purpose for the well. We also recommend that the project be willing to use multiple monitoring wells which are completed in different depth intervals where potentially effective or necessary.

We recommend that the project consider using the drawdown maps from this study to locate the placement of monitoring wells for water level monitoring especially in and around the recharge/recovery zones. We recommend that the project consider using the particle trajectory and capture zone maps from this study to locate the placement of monitoring wells for contaminant detection monitoring, especially to the east of the well field. We again recommend that the project consider restricting the completion depth interval of each monitoring well depending on the intended purpose for the well.

Crewdson, Robert, A., 20 December, 2007, An Evaluation of Well Placements and Potential Impacts of the proposed Strand Ranch Well Field, Kern County, California., Sierra Scientific Services, Bakersfield, CA.

2. Introduction

Purpose.

The main purpose of this Report is to describe the water level drawdown impacts which are expected to occur as a result of the operation of the Strand Ranch Aquifer Storage and Recovery Project. The potential drawdown impacts of interest are the impacts created by pumping the proposed Strand Ranch recovery wells. The locations of interest include the project site and the eight sections adjacent to the project and more specifically any existing water wells in those sections. We have evaluated and summarized these drawdowns in several ways by mapping the actual drawdown as a function of location and distance from the operating wells, by calculating the average drawdown within the well field and within each of the eight adjacent sections, and by calculating the specific drawdowns at selected locations in the surrounding sections.

The findings of this study may be used to 1. evaluate the alternatives for numbers and locations of water recovery wells in the future Strand Ranch well field, 2. evaluate the numbers and locations of monitoring wells which are desired or required for purposes of water level and water quality monitoring, and 3. evaluate the potential interactions and impacts between the Strand Ranch project and adjacent entities.

Project Scope - Aquifer Storage and Recovery.

Aquifer storage and recovery (ASR) is the generic term which describes the practice of deliberately putting surface water into a groundwater aquifer through infiltration basins with the intention of recovering a like volume of water from the aquifer at a later date. Such a practice presents a great opportunity to increase the local and statewide capacity to store water. ASR projects help regulate the water supply and demand over time by storing excess water when it is available in wet years for future recovery when water is needed in dry years.

In Kern County, California, there are 3 main components to every ASR facility: infiltration basins, water wells, and a conveyance system. The infiltration basins, also referred to as recharge basins[1], are ponds which are constructed to allow ponded water to infiltrate into the groundwater basin. The water wells, also referred to as recovery wells[2], are conventional high-flow water wells used to pump water out of the underlying aquifer. The project conveyance system consists of one or more canals, ditches, or pipelines used to deliver water between the ASR facility and the local or regional water conveyance infrastructure.

The Kern County water community generally refers to ASR projects as "banking" projects. According the Kern County Water Agency, "These banking programs are essential to Kern County's water management and future growth"[3] and this is broadly true of the entire State of California water infrastructure. As used in Kern County, the term "banking" is loosely used to describe the act of physically putting water into the underlying aquifer and crediting the owner with the right to remove a like volume of water from the aquifer at a later date. This credit allows the owner to show such a volume of banked water as part of its current water

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[1] We prefer the terms "infiltration basin" or "percolation basin" rather than "recharge basin" since the former terms are neutral and descriptive while the latter term needlessly implies, contrary to intent, that we are putting water back into the aquifer ***after*** it has been taken out, as has historically been the case in some conjunctive-use projects in Kern County, Ca. The primary distinction, in our opinion, is that the concept of "recharge" might be appropriate in a conjunctive-use context where water borrowed from the basin must subsequently be replaced, i.e., the aquifer must be replenished or recharged as a means of overdraft correction whereas "groundwater banking", by definition, requires storing water prior to removing it. Nevertheless, we recognize the common local use of "recharge" to mean any addition of water to an aquifer.

[2] We prefer the term "water well" rather than "recovery well" since the former term is neutral and descriptive while the latter term needlessly suggests, contrary to intent, that such a "recovery" well may be different than other water wells and perhaps restricted to the extraction of some particular water or water for some particular use.

[3] Lloyd Fryer, 2005, Kern County Groundwater Banking Projects, KCWA brochure.

supply. If such water has been "banked" on behalf of another party, then it is considered to be real water held in trust for that party who has an absolute right of recovery.

Local Operating Rules. The local water community in Kern County has established certain conventions regarding the design, operation, and monitoring of aquifer storage and recovery projects, i.e., "water banking" operations. The rules are the guiding principles which are contained in the Memorandums of Understanding (MOUs) between Kern County project operators and adjacent entities. The rules provide for creating intended project benefits while eliminating or minimizing potentially significant adverse impacts. The MOUs elaborate on these principles which are paraphrased below (the numbers below are for reference for our convenience only):

1. A project should not degrade the basin and should enhance it when possible;
2. A project should minimize the impacts on the environment and adjacent entities;
3. A project should provide mitigation for unavoidable adverse impacts;
4. A project mitigation can give consideration to the compensating aspects of recharge and recovery operations;
5. A project site should be monitored for water levels and water quality;
6. A project should take water out where it puts water in;
7. A project should account for losses to the basin.

Project Background.

Location. The Irvine Ranch Water District (IRWD) is currently in the process of developing a ±600 acre parcel in Kern County, California, as an Aquifer Storage and Recovery (ASR) Project. The parcel of interest is located in Section 2, Township 30s, Range 25e, MDBM, located at the southwest corner of Stockdale Highway and Enos Lane, several miles west of the City of Bakersfield. The ±600-acre Strand Ranch ASR project will be the latest among several existing ASR projects in the area which currently cover approximately 20,000+ acres and include more than 120 wells. The project site is surrounded in all four compass directions by existing ASR facilities belonging to the Kern Water Bank Authority or to the Rosedale - Rio Bravo Water Storage District. The parcel has been known historically as the Strand Ranch, so-named for the sand fairways crossing the property, so the project is informally referred to as the Strand Ranch ASR project.

Facilities. For this study we have assumed that the proposed project is designed to include approximately 450 acres of recharge ponds at full build-out which are expected to be able to recharge as much as 150 af per day. The estimated maximum site recharge capacity is 57,500 af per year, assuming a 365-day, wet-year, water supply and an average infiltration rate of 0.35 ft/d. The project site currently has approximately 117 ac of existing recharge ponds which were operated in 2006 on a pilot-study basis.

The Strand Ranch project plans to deliver water to and from the project site through the Cross Valley Canal which runs through the Strand Ranch property. The project owner is currently cooperating with the Kern County Water Agency for the installation of a CVC turnout to service the project site. During the 2006 pilot phase, the project received water deliveries through a cooperative agreement with the Kern Water Bank.

The site currently contains five or more irrigation wells which were installed by the previous owners of the Strand Ranch and are capable of recovering groundwater at this time. The project owner proposes to recondition or replace existing wells, and/or install recovery wells, as necessary or as beneficial, to meet their proposed operating parameters. To date, no recovery wells or pipelines have been installed on the property but the operational objective of the Strand Ranch ASR well field is to recover water which has been previously stored in the underlying groundwater aquifer. The project design objective is to store a sufficient volume of water in the aquifer over the long term to be able to recover a maximum 17,500 af/yr with a total in-ground storage limit of 50,000 af.

Aquifer. The site is flat at an elevation of about 320 ft above msl. The site overlies the prolific aquifers which comprise the so-called Kern Fan which, geologically speaking, is a thick pile of interbedded, fine- to coarse- grained, fluvial/alluvial sediments. The shallow aquifer is recharged by natural and manmade percolation of (mostly) Kern River water. Recharge occurs in the river bottom and nearby recharge ponds which form a 15-mile long, linear recharge axis trending southwest across the southern San Joaquin Valley starting in the city limits of Bakersfield, Ca. When we refer to the Kern Fan in this Report we will generally be referring to the ±15- mile wide elongate area which straddles the recharge axis and includes the river channel, ASR project sites, and related surface infrastructures.

The Strand Ranch ASR Project is near, but northwest of, the recharge axis of the Kern Fan recharge mound. The depths to groundwater under the Project site fluctuate significantly due to the rise and fall of the Kern Fan recharge mound under the influence of the regional climatic wet/dry cycle. During consecutive dry years the groundwater may be 150 - 170 ft deep such as in 1990 - 1994, whereas during consecutive wet years the groundwater under the site may be 20 - 70 ft deep such as in 1995 - 1998. The unimpacted, natural groundwater gradient under the Project site in dry years trends northwesterly at -10 to -15 ft/mi WNW and in wet years trends northwesterly at -20 to -30 ft/mi NW.

Surface Water Supply. The three potential sources of surface water which might be brought to the property include high-flow water from the Kern River, water from the Federal Central Valley Project (CVP) via the Friant- Kern Canal, and/or water from the California State Water Project (SWP) via the California Aqueduct, etc. The source of both the Kern River water and CVP water is runoff from the winter snowpack from the highlands of the southern Sierra Nevada mountain range. The primary water source for the SWP is runoff from the greater volcanic highlands surrounding Mt Shasta in northern California. The waters from all three sources are very good quality when they reach their intended points of use within Kern County.

Work Program.

The components of the work program for this study included designing realistic well-field alternatives based on the well-field spacing and operating practices within existing local ASR projects, determining the aquifer parameters for the study area, calculating the water level drawdowns and particle flow-trajectories for base case and non-base case scenarios, and evaluating the project water level impacts, including consideration of the beneficial impacts of project recharge operations. This Report presents the findings of the work program.

Personnel.

Dr. Robert A. Crewdson is a Bakersfield, California consultant doing business as Sierra Scientific Services (SSS). SSS specializes in quantitative ground water hydrology, applied potential theory and time series analysis, quantitative ground water flow analysis, water quality geochemistry, well testing and monitoring, contaminant transport modeling, and aquifer properties testing. Dr. Crewdson is a research associate and adjunct professor at California

State University Bakersfield where he has taught hydrology, contaminant transport, geochemistry and geophysics in upper division and graduate level courses.

SSS would like to thank Kellie Welch of the Irvine Ranch Water District and Jennifer Jacobus of ESA, Inc. for their help preparing several maps and figures in this Report.

Methodology.

SSS obtained and reviewed well field data, historical recharge, pumping volume and recovery rate data, and water level hydrographs for the ASR projects located on the Kern Fan supplied by IRWD and as published in the KCWA 2001Kern Fan Area Operations and Monitoring Report, April, 2005 and from other data sources generated for the bimonthly Kern Fan Monitoring Committee. SSS used these data to define alternative hypothetical well-field scenarios for the Strand Ranch ASR project which would be consistent with existing well field practices in these other ASR projects. SSS obtained and reviewed the available sources of aquifer parameter data which are referenced in this Report and selected a suite of aquifer parameter values for use in the drawdown calculations. SSS used the "WinFlow" digital computer program by Environmental Simulations, Inc. to model the two dimensional groundwater flow, including the calculation of transient and steady-state water level drawdowns and the calculation of particle flow trajectories for all of the cases of interest.

3. Discussion

Section I - Project and Study Area.

The Strand Ranch (SR) project covers essentially all of Section 02, T30s, R25e. The drawdown- impact study area covers a 3x3 sq. mi area which is centered on the project site in section 02 and includes the surrounding eight contiguous sections, 34, 35, 36 (T29s,R25e) and 1, 3, 10, 11, 12 (T30s, R25e). The three sections to the north (34, 35, 36) are part of the Rosedale - Rio Bravo Water Storage District (RRB). These sections include 3 existing farm irrigation wells but no RRB district project wells. Parts or all of the other five sections to the east, south, and west (1, 3, 10, 11, 12) are part of the Kern Water Bank (KWB). These sections contain eleven (11) operable banking project recovery wells.

For this study, one hypothetical project well-field alternative is 90 af/d (approx. 45cfs) which includes nine wells each pumping water at a nominal rate of at 5 cfs. The proposed maximum annual recovery of 17,500 af/yr requires pumping for 194 days. The two other hypothetical well-field alternatives we considered are 7 wells pumping at 70 af/d for 250 days or 5 wells pumping at 50 af/d for 350 days. The final number and locations of wells in the proposed Strand Ranch well field have not yet been determined.

The surrounding area contains three known private irrigation or domestic water wells within the Rosedale - Rio Bravo Water Storage (RRBWSD) district approximately ½ - 1 mile from the project site and eleven known banking project recovery wells which belong to the Kern Water Bank Authority, two of which are located very close to the property boundary between the Strand Ranch and the Kern Water Bank. The three private wells have an estimated pumping capacity of 10 cfs and the eleven KWBA wells have a published average pumping capacity of 62 cfs. Under the Strand Ranch (SR) hypothetical operating scenario of 45 cfs, the total recovery capacity in the 9 sq. mi. study area is 117 cfs, equivalent to 232 af/d. This maximum recovery scenario represents 38% of the total recovery capacity in the study area.

Under the hypothetical 5-well and 7-well operating scenarios of 25 and 35 cfs each, the project recovery would represent 26% or 33%, respectively, of the total recovery capacity in the study area.

Water level changes in the study area can be potentially effected by any or all of these wells. We also note, based on historical data, that the basinwide water level response to the climatic wet/dry cycle alone can be larger than the pumping drawdowns and may dominate the water level fluctuations in some years, independent of the project operations. Since project impacts may well occur at the same time as the water level impacts from other causes, the combined year-to-year water level declines due to both climate and non-project pumping may be significantly greater than the declines we have projected due to project pumping alone.

The potential drawdown impacts of interest are the impacts created by pumping the Strand Ranch recovery wells. These impacts include both permanent, basinwide impacts and local, temporary impacts and, according to the local MOU, the analysis of total net project impact may also consider the compensating, beneficial impacts of water level rises due to recharge mounding. The locations of interest include the eight sections adjacent to the project. We have evaluated and summarized these drawdowns in several ways by mapping the predicted drawdowns within the well field, by calculating the average drawdown within the well field and within each of the adjacent eight sections, and by calculating the drawdowns at specific locations of interest within the study area. We have evaluated water level rises due to recharge mounding in the same way as a part of a total net project impact analysis.

Apart from selecting the proposed well locations, the drawdown impact analysis is the main objective of this evaluation. This analysis assumes that the wells are drilled, completed, and developed properly so that they are efficient and productive water wells, limited only by the delivery capacity of the aquifer. The drawdown impact analysis requires several types of essential information including operating parameters, well parameters, aquifer model and aquifer parameters. We describe each of these parameter sets below.

Section II - Well Placement Analysis.

Placement criteria. The three primary criteria for locating the Strand Ranch water recovery wells are to meet project objectives and to 1. minimize well interference, 2. minimize the magnitude of the water level drawdown at all locations by distributing the drawdown impacts as uniformly as possible across the largest possible area, and 3. minimize the drawdown impacts to non-project wells in the surrounding area. The first two criteria are best met by placing the wells on the nodes of a uniform grid at the largest possible spacing and operating all wells simultaneously at the same flow rate. The third is best met by orienting and sizing the grid so that every possible well node is no closer to the nearest surrounding well of concern than a minimum specified property-line setback distance.

There are several secondary constraints and operating criteria which limit the selection of the proposed project well locations including: well spacing, voluntary property line setback distance, water quality issues, and accommodating the existing and proposed surface facilities including the CVC and the project recharge ponds and levees.

Based on our review of the well fields in other nearby ASR projects, we can achieve acceptable well spacings for purposes of meeting the primary criteria and be consistent with existing well placement practices, by using well spacings of 1/4 to 1/3-mile (1,320 to 1,760 ft) and a property-line setback distance of 1/8 to 1/6-mile (660 to 880 ft). Based on our review of these other fields, existing well placements in certain locations have ignored primary spacing and/or setback criteria in favor of optimizing the placement with respect to secondary criteria such as proximity to conveyance systems, total gathering system pipeline length, and/or drainage of otherwise inaccessible areas, all of which are related to capital and operating costs, and other factors. Therefore, all proposed well-field designs are based on 9 possible well locations on an equi-spaced 3x3 grid (i.e., a 9-spot pattern) with 1/3-mile spacings and 1/6-mile property line setbacks.

Proposed Water Recovery Operations. For the purposes of this study, we have selected three hypothetical well-field configurations for impact analysis on the Strand Ranch project site. All three well-field patterns are based on the positions of an equi-spaced "9-spot" pattern of NS/EW rows of wells centered on the project site. The first well-field scenario is 9 wells fully occupying the "9-spot" pattern. An alternate, 5-well field uses 5 wells located at the corner- and center- locations of the 9-spot pattern, and an alternate 7-well field uses 7 wells located at all locations except the southwest and south-central positions.

The proposed wells are designed to be 1,760 ft away from each other and 1,760 ft or more away from the nearest non- project wells based on a voluntarily 880-ft setback from the Strand Ranch property line. The projected recovery capacities of the three hypothetical well fields are 90af/d, 70 af/d, and 50 af/d for 9, 7, and 5 wells operating at a nominal 5 cfs each. The operating scenarios involve continuous pumping to recover a maximum 17,500 af/yr from the groundwater aquifer. This represents projected pumping durations of 194 days, 250 days, and 350 days for the 9, 7, and 5-well scenarios respectively.

The project has considerable flexibility in delivering less than the full recovery rate of 45 cfs and/or the annual recovery volume of 17,500 af. The project may meet reduced delivery rates and volumes by choosing to pump for less time, and/or at lower pumping rates, and/or using fewer wells. Each of these possible alternatives provides reduced drawdowns, somewhat smaller-, or differently located-, areas of impact, and faster aquifer- recovery times.

The project may have the operational flexibility to operate in cooperation with nearby project operators so as to mitigate, minimize or eliminate the mutual impacts and interactions between parties. One additional potential mitigation measure may include exercising an opportunity to recover project water from up to three wells located in a proposed Rosedale - Rio Bravo WSD well field about 1.4 miles north-northwest of the Strand Ranch well field. The hypothetical impacts of such recovery pumping are substantially removed from the Strand Ranch project site and adjacent properties; nevertheless, we have modeled the drawdown from four such scenarios and have included that analysis in Exhibit 4. The water level impact analysis for all on-site operations are presented in subsequent sections of this Report.

Total Study-area Recovery Capacity. The total recovery capacity in the 9-sq.mi. study area due to the proposed SR wells and the other existing wells is an estimated 117 cfs, which includes 45 cfs for the Strand Ranch 9-well maximum- recovery scenario, 62 cfs from the 11 surrounding KWB wells, and 10 cfs from the three RRB irrigation wells. The hypothetical future SR maximum recovery scenario represents 38% of the total recovery capacity in the study area . Alternately, the hypothetical 7-well and 5-well SR scenarios, at 25 and 35 cfs respectively, would represent 26% or 33% of the total recovery capacity in the study area.

The final numbers and locations of wells in the proposed Strand Ranch well field have not been determined as of this Study. But the new wells will represent only about 5% of the more than 120 existing or currently planned project recovery wells in the ASR projects on the overall Kern Fan.

Well Placement and Water Quality. Based on available existing water quality data, the shallow aquifer under the project site (compared to the nearby, unimpacted shallow aquifer) has residual, elevated concentrations of total dissolved solids and several constituents of concern due to the inflow of an old brine plume from an unspecified, historic, up-gradient source or sources in or near Section 12, T30s/25e. This brine plume represents a source of water quality degradation that falls within the predicted capture zone of the well field under conditions of natural groundwater gradient and under conditions of pumping. There is no recognized way of positioning the proposed Strand Ranch wells to avoid the water quality impacts of this brine plume. The quantitative analysis of the potential impacts of this brine plume on the Strand Ranch well field is outside the scope of this study.

Section III - Aquifer Model and Parameter Selection.

There are several different computation methods for predicting water-level drawdown from a pumping well in space and time and every method requires that the user select the equations which are most appropriate for the user's preferred model of the aquifer. In essence, the user must try to select the set of mathematical expressions which best represent the user's physical model of the aquifer. The calculated results, if done correctly, always represent the mathematical model and also represent the real aquifer behavior to the extent that the parameters, simplifications and assumptions of the mathematical model reflect the true workings of nature. The selection of the mathematical model and the equations, the accuracy of the parameter values, and the representativeness of the calculated output all reflect the correctness of- and uncertainty in- the judgments of the user. These judgments cannot be made by the computer and the two critical judgments include the choice of mathematical model and the choice of aquifer parameters.

The Real Aquifer. Based on our analysis of the local hydrogeology in the Strand Ranch project area, the local aquifer is a semi-confined (leaky) aquifer which is recharged from the sides and from the overlying layers. For a very small area such as the Strand Ranch project site, it is relatively easy to define a constant-property aquifer model which is representative of the entire area of interest. Our interpretations and our choices of model and parameter values differ from those of Schmidt in 1997 & 1998 and of the Department of Water Resources (DWR) in 1995, which we discuss in Exhibits 2 and 3. The aquifer consists of a sequence of nearly- horizontal, laterally discontinuous, interbedded, unconsolidated, sandy and silty sediments but there is no widespread, laterally continuous impermeable confining layer anywhere under the area of interest. Horizontal ground water flow occurs almost entirely within the sandy units. The shallow sands behave as an unconfined aquifer, but deeper sands show increasing amounts of delayed yield and confinement, according to KCWA hydrographs.

The total thickness of the commonly-used part of the aquifer is approximately 700 ft and, for modeling purposes, assumed to consist of shallow, intermediate, and deep producing zones. The shallow zone exhibits unconfined-aquifer behavior and is approximately 250 ft thick. The middle zone which exhibits intermediate behavior is considered to be the retarding layer and is approximately 100 ft thick. The deep zone exhibits short-term confined behavior and long-term semi-confined behavior and is approximately 300 ft thick. Essentially all of the existing recovery wells on the Kern Fan are completed across the intermediate and deep zones and exhibit semi-confined, aka "leaky", aquifer water-level behaviors. We have tabulated the aquifer properties which we have used in our modeling in Table 1 and discussed them in Exhibit 2.

Because the inter-bedded silts have some permeability of their own, and because pumping in the deeper zones causes significant downward vertical gradients, the deeper sands obtain a significant fraction of their recharge from the overlying layers. This "leakage recharge" through the permeable silts is augmented by higher- speed, vertical flow at the lateral margins of the silty layers through the more permeable sand facies between layers. The multi-zone hydrographs which are prepared and presented by the Kern County Water Agency on a monthly basis corroborate the widespread and persistent presence of downward vertical gradients between successively deeper depth intervals which are indicative of leaky aquifers.

We also note, based on historical data, that the basinwide water level response to the climatic wet/dry cycle alone can be larger than the pumping drawdowns and may dominate the water level fluctuations in some years, independent of the project operations. Since project impacts may well occur at the same time as impacts from other causes, the combined year- to-year water level declines due to both climate and non- project pumping may be significantly greater than the declines we have predicted due to project pumping alone.

The Model Aquifer. For this scope of work, we have a choice of computational method (analytical or numerical) and a choice of three mathematical aquifer models, i.e., a confined aquifer, an unconfined aquifer, or a semi-confined, or "leaky", aquifer. We chose to use "Winflow", a commercially-available analytical computational model written by ESI, as discussed in Exhibit 1.

Based on the observed stratigraphy and aquifer hydrology, the aquifer underlying the project site and study we chose to use a semi-confined-aquifer model. For the purpose of computer modeling, we represented the local aquifer as three zones; a shallow, 250-ft thick, unconfined aquifer, an intermediate, 100-ft thick "leaky" aquitard, and a deep, 300-ft thick semi-confined aquifer. We assume in the computer model that all project water recovery wells are completed across the full 300-ft thickness of the semi-confined zone. We have summarized the relevant aquifer parameters in the next section of this report and have discussed them in more detail in Exhibit 2.

There are other modeling variables besides the physical aquifer parameters which affect, and could perhaps even dominate, the water levels under the site, and which are easy to calculate but difficult to forecast in advance. The natural factors include the depth to the water table at project startup, the magnitude and direction of the ground water gradient, and the large water level fluctuations within the recharge area due to the climatic wet/dry cycle. The manmade variables include non-project impacts caused by other recharge or pumping operations in the surrounding area. The evaluation of these variables is outside the scope of work, however, they are not relevant to the basic determination of water level drawdown impacts due to Project well field operations. We have included a general discussion of the limitations of computer modeling in Exhibit 3.

Aquifer Parameters. For the leaky aquifer model, we must specify the aquifer dimensions, regional gradient, aquifer storage properties, and aquifer flow properties in both the horizontal and vertical directions. There is a scarcity of reliable parameter data in the Kern Fan area. We have reviewed all of the available data and have found just enough data to make an estimate of every required parameter. Because of the lack of replicate data, there is an unknown amount of uncertainty in the representativeness of these single parameter values, which is in addition to the uncertainty in the accuracy of these measurements themselves. We have accommodated the recognized uncertainty by repeatedly running the computer model with different sets of aquifer parameter values to generate sets of predicted drawdowns for the full range of possible parameter values in the Kern Fan area. We have discussed the aquifer parameters in more detail in Exhibit 2 and elements of the concept of uncertainty in the Exhibits 1 - 3.

From top to bottom, the shallow, unconfined zone is 250-ft thick, the middle "leaky" zone is 100-ft thick, and the deep semi-confined zone is 300 ft thick. All wells are assumed to be completed across the full 300-ft thickness of the bottom, semi-confined zone. All zones are assumed to have an average porosity of 30%.

The base case parameter values for the deep, semi-confined zone are as follows: the value of horizontal hydraulic conductivity is $K_h = 57$ ft/day, and the sensitivity analysis was run for $40 < K < 100$ ft/day; the value of specific storage is $S_s = 6.67\text{x}10^{-5}\ \text{ft}^{-1}$ and was not re-calculated in the sensitivity analysis although the range of possible values could be half to twice the selected value. These valuers of K_h and S_s give equivalent values of semi-confined aquifer transmissivity and storativity of $T = 17{,}100\ \text{ft}^2/\text{day}$ and $S = 0.02$.

The base case parameter values for the middle, "leaky" zone are as follows: the value of leakance is assumed to be $L' = 0.000475\ \text{d}^{-1}$ which yields a Hantush leakage factor of B = 6,000 ft, and the sensitivity analysis was run for B = 3200, 6000, 10,000 ft. These values of B are equivalent to values of weighted-average vertical hydraulic conductivities (K_v') in the 100-ft thick aquitard of $K_v' =$ 0.17, 0.0475, and 0.017 ft/day. However, for reasons of equivalence, we place little significance in these specific values of K_v' and prefer to limit the discussion of aquitard behavior to expected leakance in the range $0.00017 < L' < 0.0017$.

The base case value of average specific yield for the shallow unconfined zone is 21%. This parameter is not actually involved in the drawdown models of this study since none of the calculated cases actually dewaters the shallow aquifer.

For the calculation of drawdown impacts, we have initially assumed that the regional gradient in the test area is zero so that all model impacts are superimposed on an initially flat water table. We set our reference elevation to be zero at the initial water table rather than at ground level or at mean sea level so that all calculated drawdowns are relative to the initial water table. This device allows us to easily observe just the predicted pumping- induced drawdown at any location without the complicating effects of the natural gradient.

However, in order to perform particle trajectory and capture zone analyses, we must superimpose the calculated pumping- induced drawdowns on a realistic approximation of the natural water table gradient. We have based our approximations on observed historical water table behavior in the study area. We assume a groundwater gradient of -0.0048 at a left azimuth angle of 135 degrees from east which is equivalent to a water table slope of 25 ft per mile to the northwest. We set our reference water level elevation at a depth of 100 ft at the southeast corner of section 02, T30s, R25e, which is the southeast corner of the Strand Ranch project site.

Section IV - Drawdown Analysis.

When we speak of *water level*, we are always referring to the water level which would be observed in a hypothetical monitoring well which is completed in the aquifer at the specified location and depth interval of interest. The water level in such a monitoring well represents the elevation of the potentiometric surface, sometimes referred to as the pressure head, in the aquifer at that location. A map of such water levels represents the distribution of pressure head in the aquifer. When we speak of *drawdown*, we are always referring to a decline in potentiometric water level caused by one or more pumping wells.

When an episode of groundwater pumping removes water from the underlying aquifer the potentiometric water level changes in response to the decreasing volume of water in aquifer storage. This water level behavior has both transient and permanent components, including the temporary creation and then dissipation of a local cone of depression ending with a permanent, small, net drop in the basinwide water table. We can predict the height, areal extent, and rate of change of this falling, rising, and then re-equilibrating water table if we know the aquifer properties and the location, volumetric rate, and duration of pumping.

Expected Results. The drawdowns related to the proposed Strand Ranch pumping operations are temporary rather than permanent water level impacts. We expect at any moment after pumping has begun that a cone of depression will form around each well and that the cone of depression will deepen and expand outward with time, subject to certain limits. This depression is a drop in the pressure levels (equivalent to potentiometric water levels in properly-placed monitoring wells) within the aquifer but there is no corresponding creation of an actual physical void space of the same shape within the aquifer under semi-confined (or confined) conditions. The drop in pressure within this cone of depression is what causes groundwater to flow along inward radial paths to the well. The actual region of the aquifer from which water is removed by pumping is called the "capture zone". The shape of the capture zone is a vertical cylinder centered on the well and the radius of the capture zone is much smaller than the radius of the cone of depression. As steady pumping continues, the capture zone increases in radius, albeit at a continuously decreasing rate of expansion since the radius is a function of the square root of pumping time and not directly of time itself. When pumping ceases, the cone of depression immediately begins to shrink inward toward the central well until the pressure levels have recovered to their pre-pumping state and the cone of depression is gone.

A cone of depression in a semi-confined aquifer is a temporary condition in which the depression deepens and widens only as long as the total well-field pumping rate exceeds the downward vertical recharge from the overlying layers. Once those rates are equal (vertical recharge rate increases as the size of the depression increases), the depression stops growing. Then when pumping ceases, vertical recharge continues, causing the depression to shrink until gone and the water levels are indistinguishable from the background water table behavior. Since there is now less water in the basin than before pumping, all else equal, the average water level in the basin is slightly lower than before pumping took place.

We expect at any moment, that the drawdowns will be larger close to the wells and smaller farther away from the wells. We expect at any location that pressure drawdown increases as the duration of pumping increases. We also expect for any specified time and location, that the drawdown will be larger for higher pumping rates and smaller for lower pumping rates. We also expect that for any location that is within the radii of influence of more than one pumping well, that the observed drawdown will be the sum of the individual drawdowns caused by every pumping well superimposed at that location.

What may not be as intuitive is the expected drawdown behavior depending on the choice of aquifer model. If the aquifer is fully confined or fully unconfined, the drawdowns will continue to decline indefinitely and the radius of the capture zone expands indefinitely. If the aquifer is semi-confined with leakage recharge from the overlying layers as we expect in this area, then the observed qualitative behavior will be more complicated. For a short period of time, the aquifer will behave as a confined aquifer, meaning that the observed drawdowns near each of the wells will decline quickly and with the same time - distance relationship as is predicted for a confined aquifer with the same values of T & S. Thereafter, the piezometric water levels will decline at a decreasingly slower rate than predicted by the confined- aquifer model until the water levels stop falling altogether. Once the water levels quit falling, the capture zone will have reached its maximum radius and will quit expanding. At this time, all recharge will flow vertically downward into the top surface of the cylindrical capture zone and no flow will come from inward radial flow through its sides, i.e., there is no mining of water from the adjacent areas outside the capture zone.

After an undetermined time period of leaky behavior during which there is little or no observed drawdown despite continued pumping, we expect that the water table will once again start to decline at a rate which is consistent with the de-watering of the overlying unconfined aquifer. The durations of each of these behavioral phases may be estimated but the calculated times of transition are not particularly precise because of the inability to predict future recharge. This project can be in leaky steady state for a very long time if the shallow aquifer is consistently recharged. Once this program has begun, a properly designed well- testing and monitoring program will provide a wealth of new understanding of the aquifer, well beyond what we are able to model with the small parameter set which is available at this time. We such a program, we will be able to perform aquifer parameter test within the project area to verify ad improve our current, limited knowledge of the aquifer.

The predicted drawdowns from this work program are significantly different than the predicted drawdowns from three other recent impact analyses for entities on the Kern Fan by other workers in five respects. First, SSS modeled the aquifer as a leaky aquifer rather than as a confined aquifer. Second, SSS used the superposition method versus the so-called centroid method used in the other studies. Third, SSS's parameter values are different than those of the other studies, and incidentally are different in such a way as to increase the calculated drawdowns, all else being equal. Fourth, the leaky aquifer model which SSS used predicts that the water levels will decline and then stabilize at a static, steady- state drawdown at least for a while, compared to the other forecasts which predict that water levels will continue to decline as long as pumping is continued. Fifth, for SSS's choices of aquifer model and aquifer parameters, the predicted drawdowns are significantly less than the predicted drawdowns from these other studies.

Modeling Scenarios. The first hypothetical operating scenario is to pump 9 wells at a combined rate of 90 af/d (based on a nominal rate of 5 cfs per well) for 194 days to recover a total 17,500 af per year. For a given well-field configuration, the project has considerable flexibility in delivering less than the hypothetical full 9-well, recovery rate of 45 cfs and/or the annual recovery volume of 17,500 af. The project may also meet reduced delivery rates or volumes by choosing to pump for less time, and/or at lower pumping rates, and/or using fewer wells. Each of these possible alternatives provides reduced drawdowns, somewhat different drawdown distributions, and faster aquifer- recovery times. The two alternate scenarios of primary interest in this study are: pumping 7 wells at a combined rate of 70 af/d for 250 days to recover a total 17,500 af in a year, or pumping 5 wells at a combined rate of 50 af/d for 350 days to recover a total 17,500 in a year.

In each case, the operating well field establishes a steady-state condition of no further drawdown between 30 and 100 days of pumping due to leaky recharge. Therefore, pumping more than 100 days and even multi- year continuous pumping will not increase the drawdown as long as the project maintains its recharge commitment and the immediate area also continues to receive sufficient total recharge to re-supply all non-project wells in the area. The key to moderating the aquifer behavior is to keep the local area adequately recharged over time. If recharge does not match recovery, then the predicted drawdowns within the aquifer after 300 days of pumping may be as much as twice as much as predicted or more, depending on the rate of depletion of the shallow, unconfined aquifer. However, by design and by requirement, this project will always recharge prior to recovery.

For 300 days of pumping, the hypothetical capture perimeter surrounding the entire well field extends only a few hundred ft outward from the individual wells and remains entirely within the property boundary of the Strand Ranch. For a hypothetical 1000 days (approx. 3 yr) of continuous pumping, the hypothetical capture perimeter extends about 1,800 ft from the individual wells. For a hypothetical 3650 days (10 yr) of continuous pumping, the capture zone would extend about 2,300 ft down-gradient to the northwest and would extend about 4,500 ft up-gradient to the southeast under conditions of dry-year groundwater gradient of 25 ft/mi to the northwest.

For the given set of aquifer conditions, the water-level drawdowns caused by the Strand Ranch recovery well operations vary with our choices aquifer parameters, well parameters, pumping duration, and location. Therefore, there is no way to represent the multiple potential impacts with a single number unless we specify a single set of aquifer and well parameters, a single pumping duration, and a single location.

We can reduce the number of possible operating scenarios by using a single "base case" operating scenario. We can reduce the time variable by using a single pumping duration, and we have chosen to compute drawdown for a time after which the drawdowns at all locations have reached "steady-state", i.e., maximum drawdown. At this point, the evaluation of impacts is reduced to observing the predicted drawdowns simply as a function of location.

The three main cases of interest include the 9-well scenario, the 7-well scenario, and the 5-well scenario, each of which is evaluated with and without the presence of a superimposed natural groundwater gradient. All drawdowns for all cases and all locations within the study area are presented in a Catalog of Drawdown Maps in Exhibit 5, one case at a time.

Computed Results. The basic output from each drawdown analysis is a contour map of the predicted water levels in and around the area of the well field. Each map shows the well locations, the contours representing the water levels for a specified set of pumping parameters, and flowpath particle trajectories, if included, for a specified duration of pumping. The computer-generated maps cover a square, 3x3- mile area centered on the project area. Using local (east, north) coordinates in units of feet, the local origin (0,0) is at the intersection of Stockdale Hwy and Enos Lane, the southwest map corner is located at (-10,600, -10,600), and the northeast corner (+5,400, +5,400) since the model uses an 80x80- cell model space with each cell representing 200x200 ft in real space. The map scale of the computer printouts is approximately 1 inch = 2290 ft. Additional map information is included at the beginning of Exhibit 5 where we have compiled a catalog of all maps for all scenarios in a catalog of results. The Catalog includes more modeling scenarios than were necessary for this study. They were run as a diligent effort to investigate transient conditions, non-base case parameter impacts, sensitivity analysis, comparisons with alternate aquifer models, etc. The maps which are included as Figures in this Report cover everything discussed in the text and are derived from the model runs in the Catalog.

For this study, we have calculated the water level drawdowns for the three main hypothetical well-field operating scenarios of 9-, 7-, or 5- wells each, each of which is designed to recover 17,500 af of ground water from the underlying aquifer in a year. All three scenarios used the same set of aquifer parameters. We calculated additional results by varying selected parameters to provide a sensitivity analysis.

The base case aquifer parameters were the same for every case, i.e., a 300-ft thick, semi-confined aquifer with T = 17,100 ft^2/d, S = 0.02, and porosity = 30%; an overlying aquitard with L' = 0.000475 d^{-1} which is gives a Hantush leakage factor of B = 6,000 ft; and an overlying unconfined aquifer with Sy = 15%. The unimpacted, natural groundwater gradient was assumed to be zero unless otherwise specified. For capture zone and particle trajectory calculation we used a groundwater gradient of -25 ft/mi to the northwest (-0.0048 at a left aximuth of 135 degrees from east) and we assumed a corresponding reference groundwater elevation at 100 ft below GL at the southeast corner of the project area (i.e., the SE cor Sec 02, T30s, R25e). All of the modeling parameters have been summarized in Table 1 and are discussed in detail in Exhibit 2..

We present the calculated drawdown results for the three hypothetical operating scenarios in the next three sections below.

<u>Nine- well scenario:</u> q = 90 af/d, pumping t = 194 d, V = 17,500 af/yr.

The hypothetical steady-state drawdowns created by the Strand Ranch, *9-well, 194-day*, pumping scenario are presented on the map in Figure 5 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 43 ft and the average drawdowns in the surrounding 8 sections are in the range of 12 - 20 ft. The drawdowns along the perimeter of the study area are in the range of 5 - 10 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter. The drawdowns for the 9-well case superimposed on a northwesterly groundwater gradient are shown on the map in Figure 9.

Under the base case assumptions, the area will achieve steady-state within about 100 days after pumping begins and the water levels will begin to recover after 194 days when pumping ceases. As long as the leaky-aquifer assumptions continue to be met, the water levels in the study area will recover to pre-pumping levels in another 100 days or less, in the absence of other influences.

Seven - well scenario: q = 70 af/d, pumping t = 250-day, V = 17,500 af/yr.

The hypothetical steady-state drawdowns created by the Strand Ranch, *7-well, 250-day*, pumping scenario are presented on the map in Figure 6 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 34 ft and the average drawdowns in the surrounding 8 sections are in the range of 9 - 17 ft. The drawdowns along the perimeter of the study area are in the range of 3 - 8 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter.

Under the modified well field assumptions, the area will achieve steady-state within about 100 days after pumping begins and the water levels will begin to recover after 350 days when pumping ceases. As long as the leaky-aquifer assumptions continue to be met, the water levels in the study area will recover to pre-pumping levels in another 100 days or less, in the absence of other influences.

The hypothetical drawdowns created by the Strand Ranch *7-well, 250-day scenario* are approximately 78% of the hypothetical drawdowns for the 9- well scenario but the duration of impact lasts about 56 days longer because the wells must operate longer to recover the same total volume of water (17,500 af/yr) at the lower recovery rate (70af/d vs. 90 af/d).

Five - well scenario: q = 50 af/d, pumping t = 350-day, V = 17,500 af/yr.

The hypothetical steady-state drawdowns created by the Strand Ranch, *5-well, 350-day*, pumping scenario (wells 1, 3, 5, 7, 9) are presented on the map in Figure 7 and summarized in Tables 2 & 3. At steady-state, the average drawdown under the project site is 24 ft and the average drawdowns in the surrounding 8 sections are in the range of 7 - 11 ft. The drawdowns along the perimeter of the study area are in the range of 2 - 6 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter.

Under the modified well field assumptions, the area will achieve steady-state within about 100 days after pumping begins and the water levels will begin to recover after 350 days when pumping ceases. As long as the leaky-aquifer assumptions continue to be met, the water levels in the study area will recover to pre-pumping levels in another 100 days or less, in the absence of other influences.

The hypothetical drawdowns created by the Strand Ranch *5-well, 350-day scenario* are approximately 56% of the hypothetical drawdowns for the 9- well scenario but the duration of impact lasts about 156 days longer because the wells must operate longer to recover the same total volume of water (17,500 af/yr) at the lower recovery rate (50 vs. 90af/d).

Base Case Specific Capacity of the Pumped Wells. Specific capacity (SC) is defined as the ratio of pumping rate to drawdown within a pumping well and is used by local engineers as a measure of well performance from which other parameters are calculated. Unfortunately SC is not a constant and varies with pumping time, length of completion interval, hole diameter, and well efficiency, so it is not an effective measure of anything without making the corrections for each of these factors. We can calculate the theoretical specific capacity (SC) of the project wells for the steady- state leaky aquifer condition from the selected base case parameters for purposes of preliminary pump parameter selection. Normally for pump design purposes, we would recommend using actual drawdown data from nearby pumping wells as the best predictor of well performance, but we can calculate a value as well.

For the base case semi-confined aquifer parameters, we estimate the expected *steady-state* project- well specific capacity to be about SC = 0.14 cfs/ft, which is equivalent to 63 gpm/ft, for a 100% efficient well. For all pumping times less than the time required to reach steady- state, the observed SC will appear to be larger and, in the first few hours and days, perhaps much larger than this predicted final value.

Sensitivity Analysis. Because of the uncertainties in the actual aquifer conditions, the actual operating drawdowns when the well field is finally installed and operated may be different than the calculated base case values. We have already acknowledged that there is considerable uncertainty in the few data available to us. Since the accuracy of the impact calculations for the leaky aquifer model depends primarily on the values of T and B, we have varied the base case parameters within the credible ranges of possible values and have re-calculated the drawdowns for these other parameter values (Figure 13 and Table 4). We used the Hantush & Jacob, 1955 formula to calculate the steady-state drawdowns for various T & B for leaky-aquifer conditions.

We selected a base case value of aquifer transmissivity T = 17,100 ft^2/d for the computer modeling based on a hydraulic conductivity of 57 ft/d and an aquifer thickness of h = 300 ft. This T-value is at the lower end of the reported range of possible T-values in the Kern Fan area. If the true aquifer transmissivity (T) is higher than our base case value, then the actual observed drawdowns will be less than predicted drawdowns, all else equal. We have calculated the hypothetical steady-state drawdowns for the 9-well, 194-day scenario using T-values ranging from 12,000 ft^2/d to 30,000 ft^2/d. If the true transmissivity is15,000 ft^2/d rather than 17,100 ft^2/d, then the actual drawodows across the study area will be about 15% higher than predicted but if the actual transmissivity is 24,000 - 30,000 ft^2/d, then the actual drawdowns across the study area will be only 72% - 58%, respectively, of the predicted drawdowns. Since the sensitivity to T is a multiplicative effect, the greatest differences will tend to occur in the areas of greatest drawdown and vice versa, that is, an error in T-value make the biggest difference in and near the well field, and have a decreasing difference between predicted and corrected drawdowns with distance away from the project area.

We selected a base case value of aquitard leakage factor B = 6,000 ft for the computer modeling based on an aquitard leakance of L' = 0.000474 d^{-1}. This mid-range L- value is consistent with the expected vertical hydraulic conductivities for sandy silts and/or silty sands of the Kern Fan area. If the true aquitard leakage factor (B) is lower than our base case value, then the real aquifer is less-confined than calculated which would cause smaller drawdowns than calculated for B = 6,000. If the true aquitard leakage factor (B) is higher than our base case value, then the real aquifer is more-confined than calculated which would cause larger drawdowns than calculated for B = 6,000. If the actual leakage factor is B = 3,200 ft (L' = 0.0017 d^{-1}), then the actual drawdowns across the study area will be about 2.5 ft less than predicted and if the actual leakage factor is B = 10,000 ft (L' = 0.00017 d^{-1}), then the actual drawdowns across the study area will be about 2.1 ft more than predicted. Since the sensitivity to B is an additive effect, the same differences will tend to occur across the entire area of interest, that is, an error in B-value makes the same difference in and near the well field as it does between predicted and corrected drawdowns in the surrounding sections.

Section V - Flow Trajectory and Capture Analysis.

Particle trajectories. A particle trajectory represents the hypothetical flowpath of a water molecule under ideal flow behavior, i.e., ignoring the effects of dispersion, flowpath tortuosity, heterogeneity, etc. We can calculate particle trajectories in downgradient or upgradient directions, which we refer to as forward or reverse particle tracking, respectively. In our computational models we assume that the aquifer is horizontally isotropic so that particle trajectories are always perpendicular to water level contours. For this project we used reverse particle trajectories to determine the shapes and extents of the capture zones for each of the pumping wells in the well field for different pumping durations. We also used one forward-particle tracking model to the general pathway of contaminant flow from the southwest quarter of section 12, T30s, R25e. An important use of particle trajectory mapping is for designing contaminant- detection monitoring programs so that the operator can place the monitoring wells in the likely flowpaths from known or suspected contaminant sources.

Capture zones. A capture zone is the enclosing perimeter of the actual bulk volume of the aquifer from which a pumping well extracts water over a specified time period. The shape and lateral extent of a capture zone is very different than that of the cone of depression. For a confined or semi- confined aquifer, the capture zone is a vertical cylinder centered on the well and bounded by the confining layers at the top and bottom of the aquifer. The radius of the capture zone increases as long as pumping continues. The shape of the capture zone will be distorted by the presence of other wells and/or recharge boundaries but it will always have a fully enclosing perimeter. The method of reverse particle tracking will always provide a means to map the shape and extent of the capture zone for a specified pumping duration.

Mapping a capture zone analysis requires that we model the aquifer behavior as realistically as possible, since true particle trajectories will respond to all influences on the real potentiometric pressure field and not just those generated by the Strand Ranch wells. Therefore, we assume that the most realistic scenario will occur in a dry year when the Strand Ranch wells will most likely be pumping and all of the neighboring wells are pumping as well. The combined pumping effects of these wells superimposed on the natural groundwater gradient will determine the locations of capture zone and particle trajectories with time.

The water level elevation map in Figure 10 shows the steady-state impacts of the nine Strand Ranch wells and eleven Kern Water Bank wells superimposed on the local groundwater gradient. The five wells located at the center and corners of the Strand Ranch well field (wells 1, 3, 5, 7, 9) have 1,000-day reverse particle trajectories attached to them which define the shape and areal extents of the “3-year” capture zones for continuous pumping at these locations.

For reference purposes, the section corners have been labeled on the map. We have mapped the locations of the capture zone perimeter for pumping times of 300-, 1000-, 1825-, and 3650-days superimposed on 10-year continuous particle trajectories in Figure 11.

The individual capture zones of widely-spaced wells, such as in the Strand Ranch project, do not merge unless pumping continues for a relatively long time . The importance of mapping the capture zone is for purposes of evaluating water quality, particularly the potential for contaminant capture. We have mapped (Figure 11) the approximate locations of the particle trajectories and expanding capture zone for continuous pumping of both the Strand Ranch and Kern Water Bank wells for pumping times of 300-, 1000-, 1825-, and 3650- days for an aquifer with a northwesterly water table gradient, as described below.

For 300 days of pumping, the hypothetical capture perimeter surrounding the entire well field extends only a few hundred ft outward from the individual wells and remains entirely within the property boundary of the Strand Ranch. For shorter pumping durations, such as our hypothetical 9- and 7-well operating scenarios, the capture zones around each well would be proportionately smaller. For a hypothetical 1000 days (approx. 3 yr) of continuous pumping, the hypothetical capture perimeter extends about 1,800 ft from the individual wells. For a hypothetical 3650 days (10 yr) of continuous pumping, the capture zone would extend about 2,300 ft down-gradient to the northwest and would extend about 4,500 ft up-gradient to the southeast under conditions of groundwater gradient of 25 ft/mi to the northwest. Pumping by non-project wells in the surrounding areas will change the shape and extent of this capture zone, as shown in the various model runs.

We have also mapped (Figure 12) the 10-year forward particle trajectories of a hypothetical line source located in the southwest quarter of section 12, T30s, R25e under conditions of continuous pumping of both the Strand Ranch and Kern Water Bank wells. Any groundwater contamination which comes from a source located on or near this line will follow the same trajectories. A slug or plume of contamination will eventually be captured by wells located on the Kern Water Bank and/or Strand Ranch depending on the particular location of the source and its downgradient trajectories.

The time it takes contaminants to flow from the source to the well field perimeter will be approximately equal to the capture-zone time-radius (approx. 8 years under continuous pumping of all wells) that crosses the source area assuming that the contaminant moves at the same speed as the groundwater. For many contaminant constituents, this assumption is false, since the processes of dispersion, retardation, and attenuation slow the flow velocity of contaminants in ground water. There are no rules of thumb in this regard without specifying the contaminant of concern, but the capture zones which are based on the flow velocity of the ground water form the base case of any contaminant capture analysis. Sierra Scientific Services has performed contaminant transport modeling for other clients, but it is outside this scope of work.

Section VI - Recharge Mound Analysis.

When an episode of groundwater recharge adds water to the underlying unconfined aquifer the water table changes in response to the increasing volume of water in aquifer storage. This water level behavior has both transient and permanent components, including the temporary rise and fall of a local water mound ending with a permanent, small, net rise in the basinwide water table. We can predict the height, areal extent, and rate of change of this rising, falling, and then re-equilibrating water table if we know the aquifer properties and the location, volumetric rate, and duration of recharge.

Expected Results.

The initial recharge will create a fully-saturated, vertical column of water through the vadose zone from the base of the recharge pond to the top of the water table. This column of “falling” water is not part of a recharge mound per se. Once the flow front reaches the water table, a water mound will begin to develop above the water table as downward-moving water spreads out laterally into available space. The mound will continue to rise and widen as recharge progresses until the rate of lateral mound outflow matches the rate of downward vertical recharge.

The mound is a temporary condition in which the mound rises and widens only as long as the continuing downward vertical flow of water into the mound exceeds the lateral flow out of the mound. Once those rates are equal, the mound stops rising but continues to widen. Then when recharge ceases, lateral outflow continues, causing the mound to flatten and widen until the mound is indistinguishable from the background water table. Since there is now more water in the basin than before recharge, all else equal, the average water level in the basin is slightly higher than before recharge took place.

The pond infiltration rate will be a maximum at the beginning of recharge and will decrease continuously and perhaps quickly (perhaps over a few days or a couple of weeks) until the pond infiltration rate is numerically equal to the vertical hydraulic conductivity of the underlying flow path. The infiltration rate will remain steady at this value as long as the water table (and associated capillary fringe) is far below the base of the infiltration pond. As the water table rises during the time of recharge, the infiltration rate will also decrease accordingly as the volume of available, unsaturated storage space decreases. If and when the rising water table approaches the ground surface, the infiltration rate will be a minimum equal to some fraction of the value of the hydraulic conductivity of the underlying flow path.

Modeling Scenarios.

The hypothetical base case recharge scenario is to maintain water in approximately 450 acres of recharge ponds on the Strand Ranch at an overall average infiltration rate (IR) estimated to be between 0.2 - 0.4 ft/d. The duration of recharge will depend on the availability of a surface water supply. In a maximum recharge scenario, recharge ceases when the cumulative recharge volume equals 17,500 af in a given year, which requires recharge durations in the range of 100 - 200 days for the reported range of parameter values. We assume in our model for convenience and without a loss of generality that the recharge pond is circular with a radius of 2,500 ft and centered in the Project site.

The key parameter controlling pond recharge is the long term infiltration rate which we have estimated to be in the range from 0.2 - 0.4 ft/d on the Strand Ranch property, assuming that the ponds are maintained in a clog-free state. The lowest recharge rate will occur when the water table is very shallow and highest recharge rate will occur when the water table is very deep. With respect to design, operations, and impact issues the critical project recharge performance is the recharge which occurs at the lowest infiltration rate.

During 2006, the project operated a pilot recharge test which consisted of filling a 117-acre pond from mid-July to mid-December. By September, the pond inflow had stabilized at a steady recharge rate of 12 cfs, meaning that 23.8 af of water per day infiltrated from the 117 ac pond, giving a computed infiltration rate of IR = 0.20 ft/d. Since the water table for the entire duration of the pilot test was very shallow (less than a few feet deep) we conclude that the observed infiltration rate of 0.2 ft/d was a minimum rate and that future operations with a deeper water table will experience higher infiltration rates, perhaps as high as 0.40 ft/d. For modeling purposes, we made mound calculations for infiltrations rates of 0.20, 0.25, and 0.30 ft/d since all critical issues are related to mounding in the lower range of possible infiltration rates.

For this study, we calculated the water level rises for a 450-acre recharge pond which is designed to put 17,500 af of ground water into the underlying aquifer in a single recharge episode per year. All three scenarios used the same set of aquifer parameters. We calculated additional results by varying selected parameters to provide a sensitivity analysis.

Except for the infiltration rate, the base case aquifer parameters were the same for every case, i.e., a 300-ft thick, unconfined aquifer with K = 57 ft/d, Sy = 0.21, and porosity = 30%. The unimpacted, natural groundwater gradient was assumed to be zero and we assumed a corresponding reference groundwater elevation at 100 ft below GL at the southeast corner of the project area (i.e., the SE cor Sec 02, T30s, R25e). The modeling parameters have been summarized in Table 1.

Computed Recharge Results.

The basic output from each mound analysis is a contour map of the predicted water levels in and around the area of the recharge pond. Each map shows the pond location, the recovery well locations for convenience, and contours representing the water levels for a specified set of recharge parameters. The computer-generated maps cover the same square, 3x3- mile area as used for the drawdown analyses. The map scale of the computer printouts is approximately 1 inch = 2290 ft. Additional map information is included at the beginning of Exhibit 5 where we have compiled all maps for all scenarios in a catalog of results.

Pond recharge at IR = 0.20 ft/d: q = 90 af/d, recharge t = 194 d, V = 17,460 af/yr.

The maximum water level rises created by the Strand Ranch, *90-af/d, 194-day*, recharge scenario are presented on the map in Figure 14 and summarized in Tables 5 & 6. The average water level rise under the project site is 32 ft and the average rises in the surrounding 8 sections are in the range of 6 - 13 ft. The drawdowns along the perimeter of the study area are in the range of 1 - 5 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter. These water level rises are within a few percent of the maximum, steady-state mounding rises which are predicted for this scenario under infinite recharge duration. However, the mound in this scenario will begin to decline as soon as recharge has stopped at t = 194 days.

<u>Pond recharge at IR = 0.25 ft/d:</u> q = 112.5 af/d, recharge t = 155 d, V = 17,438 af/yr.

The maximum water level rises created by the Strand Ranch, *112.5-af/d, 155-day* recharge scenario are presented on the map in Figure 15 and summarized in Tables 5 & 6. The average water level rise under the project site is 36 ft and the average rises in the surrounding 8 sections are also in the range of 6 - 13 ft. The drawdowns along the perimeter of the study area are in the range of 1 - 5 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter. These water level rises would continue to rise if recharge continued after t = 155 days, and are not close to the steady-state mound heights which are predicted for this scenario under infinite recharge duration. However, the mound will begin to decline as soon as recharge has stopped at t = 155 days.

<u>Pond recharge at IR = 0.30 ft/d:</u> q = 135 af/d, recharge t = 129 d, V = 17,444 af/yr.

The maximum water level rises created by the Strand Ranch, *135-af/d, 129-day*, recharge scenario are presented on the map in Figure 16 and summarized in Tables 5 & 6. The average water level rise under the project site is 40 ft and the average rises in the surrounding 8 sections are in the range of 6 - 14 ft. The drawdowns along the perimeter of the study area are in the range of 1 - 5 ft and drawdowns decrease to negligible levels with increasing distance from the perimeter. These water level rises would continue to rise if recharge continued after t = 129 days, and are not close to the steady-state mound heights which are predicted for this scenario under infinite recharge duration. However, the mound will begin to decline as soon as recharge has stopped at t = 129 days.

We also note that if the actual infiltration rate is higher than IR = 0.30 ft/d, then the project will be able to recharge water at a higher volumetric rate than we have modeled here (135 af/d at IR = 0.30 ft/d) and the time needed to recharge 17,500 af/yr will be less than t = 129 days.

Based on the results of modeling, we observe that the water level rises in the 8 sections surrounding the project site project area for all 3 scenarios are almost identical, i.e., in the range of 6 - 13 ft, even though the recharge occurs at different rates for different durations for the three scenarios. We note that the predicted maximum water level rises from recharge mounding under the adjacent lands are essentially the same regardless of the infiltration rate, for these cases where the total recharge volume is the same.

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Maximum Recharge.

The 30-year period from 1969 - 1998, was a period of above-average high flows and floods on the Kern River and CVP Friant-Kern systems. There were nine such high-flow episodes during that time period in which Kern County suffered damages and/or water left the county and was lost to local beneficial use[4]. Based on the experiences of this period, Kern County has placed a high priority on using all available facilities to minimize the potential impacts of high-flow/flood conditions and minimize the amount of water which is lost to beneficial use by diverting as much water as possible from the Kern river channel under such conditions. The capacity to divert water from the Kern River channel has substantially increased since 1990 by the development of recharge facilities for district water banking programs. The benefits of diverting high-flow water to recharge ponds include lowering the threat of flooding, improving the in-ground water supplies for districts which rely on conjunctive use programs to deliver water to their farmers, reducing overdraft through losses to the basin paid by project operators, and capturing water for unrestricted local use, water which might otherwise have left the county.

In the case of the proposed Strand Ranch project, the addition of 450 acres of recharge ponds represents a significant increase in potential local flood mitigation by high-flow capture and recharge. To our knowledge, Kern County has never restricted or prevented the use of any recharge pond for the unrestricted capture of high-flow water. The benefits to the County and the basin are large, obvious, but relatively infrequent. Nevertheless, we include here a water level impact analysis for a maximum recharge scenario in which 450 acres of recharge ponds are kept full for a period of 365 days at maximum recharge rates. Since we do not yet know what the maximum recharge rate might be on the Strand Ranch project site, we have done four such analyses for infiltration rates of IR = 0.20, 0.30, 0.35, and 0.40 ft/d.

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[4] KCWA, August 27,2001, Initial Water Management Plan, Public Review Draft, p. T26.

<u>Maximum recharge-1:</u> IR= 0.20 ft/d, q= 90 af/d, recharge t= 365 d, V= 32,850 af/yr.

<u>Maximum recharge-2:</u> IR= 0.30 ft/d, q= 135 af/d, recharge t= 365 d, V= 49,275 af/yr.

<u>Maximum recharge-3:</u> IR= 0.40 ft/d, q= 180 af/d, recharge t= 365 d, V= 65,700 af/yr.

The water level rises created by the preceding three hypothetical maximum recharge scenarios are presented on the maps in Figures 17 - 19 and in Tables 9 - 10. The average water level rise after 365 days of recharge under the project site for each IR scenario is 39-, 58-, or 76-ft, respectively. The average rises in the surrounding 8 sections are in the range of 11 to 19-, 18 to 28-, or 23 to 36-ft, respectively. These full-year water-level rises are approximately 6-, 13-, or 18- ft higher in the surrounding 8 sections than would be encountered for recharge at the same infiltration rates (Figures 20 - 22), respectively, except that each scenario had stopped after 17,500 af had been recharged (as presented in earlier in this report).

A natural, high-flow event of sufficient magnitude to generate a 365-day capture and recharge episode may have a recurrence probability of only once-per-century, more or less, so any such event is unlikely to occur over a given 30-year project forecast. Nevertheless, given the reduced storage capacity in the Lake Isabella reservoir due to engineering issues, the lower Kern River may experience more-frequent, higher-volume releases of water during a multiple wet-year period than might otherwise be the case. These mounding calculations demonstrate that the range of water level impacts from any realizable 365-day recharge scenario are not objectionably different than other, smaller-recharge scenarios of the same rate but of shorter duration currently under consideration.

Section VII - Total Project Water Level Impact Analysis.

The following analysis assumes that all of the proposed operational design recharge- and recovery- rates and caps apply to the project operation except that there is no cap on the capture and recharge of high-flow water, such as is discussed in the preceding section.

The essence of full ASR project operation is the ongoing cycle of adding water to- and subsequently removing water from- aquifer storage. These processes have both local and basinwide impacts. The basinwide impact is a small, widespread, cumulative, and permanent, water level rise. The magnitude of the basinwide water level rise is proportional to the cumulative net volume of water which is left in the basin over time and is insensitive to the number, frequency, or size of the many individual project recharge and recovery episodes. The basinwide project impact is positive meaning that the project permanently adds water to the basin and that a water level rise is considered to be beneficial.

In contrast, the local impacts are larger, localized, and temporary but recurring. Adding water to the local aquifer causes a temporary water level mound and removing water from the local aquifer causes a temporary water level depression. Such a mound or depression only lasts as long as a recharge or recovery operation takes place, respectively, plus a re-equilibration time during which the mound or depression dissipates. The magnitude of an individual local mound or depression is proportional to the *rate* at which water is added to or removed from the local aquifer, i.e., the higher the volumetric flow rate in or out of the aquifer (in acre-feet per day) the greater the temporary water level impact, all else equal. A water level mound or depression may be seen as either a beneficial or detrimental impact depending on whether the operations would be seen as improving or worsening some pre-existing condition, such as water levels being already too high or too low to begin with.

In Kern County, there are three potential water level impacts of concern, one of which is a long-term, basinwide impact and two of which are short-term, local impacts. The long-term basinwide impact of concern is a dewatering of the aquifer. The short-term local impacts of concern include raising the water table close to the ground surface such that crops or manmade structures may be threatened, or lowering the aquifer water levels such that local water wells go dry and/or it costs more to pump water from the greater depths. The most frequent and greatest single impact of concern to landowners in Kern County is the increased cost to pump water wells due to manmade water level declines.

Permanent Water Level Impacts. By design and by requirement, the Strand Ranch Project must first put water into aquifer storage before it can recover any groundwater from storage. Moreover, since the Project is not allowed to borrow water from the basin, i.e., the project may not remove more water than its net current balance, the project will start with and always maintain a positive balance[5] relative to the basin. If we were to look only at the impact of

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[5] Strictly speaking, the Project must maintain a non-negative balance, locally referred to as a “positive balance”, a condition

groundwater pumping, we would only see the impacts due to the extraction of groundwater. But in the context of the total project, it is clear that the project will only take water out of the basin that will have been previously put in so that the basin never has less water in storage than would have been there in the absence of the project.

According to the local MOUs, a project which directly recharges water for an out-of-county entity must permanently leave 5% of all such water in the ground. This volume of water is referred to as a *"loss to the basin"* and is a form of in-kind usage tax paid by all banking projects on all out-of-county water as a component of basinwide overdraft correction. For the Strand Ranch project it is likely that the great majority of all future stored and recovered water will be for the Irvine Ranch Water District which is an out-of-county entity. Therefore, this 5% loss to the basin may represent a significant volume of water. For example, if IRWD were to store and recover an average of 50,000 af every decade, then the cumulative losses paid to the basin would amount to 2,500 af per decade. This water is non-bankable and non-recoverable by IRWD. This "loss to the basin" represents a real, beneficial, cumulative, and permanent addition of water to the basin by the proposed Strand Ranch ASR project.

The permanent water level impacts are related to the project volumetrics. Over the long term, the addition and removal of like volumes of project water from the basin would result in no net cumulative change in basinwide water levels. However, as a result of the 5% losses paid to the basin, there will be a small, permanent rise in basinwide water levels. In the hypothetical case of adding an average 2,500 af per decade, the average long-term water level rise under the Kern Fan recharge area would be about 0.10 ft. This permanent water level rise is so small only because of the great size of the basin. Still, we conclude that even with the addition of significant amounts of water (2500 af/decade) to the basin, there is only a negligibly small but positive long term water level impact of the project on the basin.

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which is assumed to also include or allow the condition of zero balance.

Aquifer Dewatering. Since the proposed Strand Ranch project and other existing ASR projects must always maintain a positive balance relative to the basin, overall basin overdraft simply cannot occur as a result of direct-recharge ASR project operations. Never-theless, the potential still exists for an ASR project to dewater a portion of the aquifer if the location of groundwater recovery is in a completely different location and/or is completely isolated from the location of groundwater recharge. Such a condition might also exist if an ASR project includes in-lieu banking[6] operations which may have the effect of changing the time and location of recharge and/or recovery from when or where it would otherwise have occurred, perhaps causing an unbalanced groundwater extraction and local dewatering.

In the case of the proposed Strand Ranch project, both recharge and recovery facilities will be co-located on the project site such that the approximately equal and opposite impacts of both recharge and recovery will be superimposed on the same area and same aquifer zones. The requirement that the Strand Ranch project always maintain a positive balance relative to the basin precludes the potential dewatering impacts of in-lieu banking from occurring. Therefore, we conclude that conditions do not exist at the Strand Ranch site which could permit dewatering of the aquifer by these mechanisms.

The potential also exists for an ASR project to dewater a portion of the aquifer if the climatic wet/dry cycle causes, or if the ASR project operator chooses to operate, a severely unbalanced recharge and recovery cycle. For example, consider a hypothetical scenario in which an ASR project stored 50,000 af of water in the aquifer and then removed 47,500 af (50kaf net of 2.5 kaf losses to the basin) under the following conditions. Let us suppose that over a 7-year period, the Project stored, on average,10,000 af per year in each of five years for a total of 50,000 af of water in storage. For the duration of the wet period, the impact on the basin would be as if the project recharged at an average rate of 7,100 af per year. The

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[6] In-lieu banking, as practiced in Kern County, includes the act of consuming bankable surface water instead of (in-lieu of) delivering it to ASR ponds for recharge and/or the act of delivering surface water from some alternate source to an end-user instead of (in-lieu of) pumping it out of groundwater storage. With these types of physical water movements it is possible to operate a banking program in which storage and/or recovery may occur without any water actually entering or leaving the aquifer, and such operations must be associated with bookkeeping transactions which move water credits between different accounts.

accumulation of a cumulative water supply in periodic, small increments is typical of the Kern County climatic cycle.

However, let us also suppose that after 3 critically dry years during which water levels declined and during which the water owners used up all of their other available sources of water, the project then extracted all 47,500 af in storage in a single year. This recovery rate is over 6 times higher than the average recharge rate and since impacts are proportional to rates, recovery may be expected to produce drawdown impacts that may be six times greater in magnitude than the beneficial impacts of recharge. We call this an unbalanced recharge/ recovery cycle because the rate of recharge and the rate of recovery are so different.

The impacts of such an unbalanced recharge/recovery cycle cannot be fully evaluated without specifying all of the actual aquifer parameters, but for the aquifer underlying the Kern Fan, there is every likelihood that the unbalanced groundwater extraction could dewater at least the shallow zone of the aquifer. This water level drawdown, like other drawdowns, is local and temporary and will re-equilibrate with time. In this hypothetical case, however, the magnitude of this individual drawdown episode is of sufficient magnitude to temporarily dewater the aquifer which might be of sufficient concern to establish other limiting criteria on an individual impact event.

The foregoing hypothetical example of multi-year climatic wet or dry cycles is based on the actual wet/dry cycles that Kern County has experienced since 1960, and particularly since 1995 when major water-banking operations began in Kern County. In the future, if such a climatic wet/dry cycle causes several ASR projects on the Kern Fan to operate unbalanced recharge and recovery cycles at the same time, then the composite impacts of all such operations may dewater much of the Aquifer under the Kern Fan for a considerable time period until an equilibration of basinwide proportions can take place.

In the case of the proposed Strand Ranch project, the operators have voluntarily established operating limits which preclude the occurrence of an unacceptable, unbalanced recharge/recovery cycle. The project is voluntarily designed so that 1. the Strand Ranch project will not have more than 50,000 af of water in basin storage, and 2. the project will not recharge or recover more than a maximum of 17,500 af of groundwater per year during normal operations. The computer models of both recharge and recovery have demonstrated that by capping the maximum inflow/outflow at 17,500 af/yr, that 1. the beneficial impacts of recharge are approximately equal to the potentially detrimental impacts of recovery, and 2. by spreading the recovery of the maximum allowable volume of water in storage over a 3-year period the individual and combined net impacts of the total operation avoids and prevents unacceptable extreme impacts to the aquifer and the basin.

Temporary Water Level Impacts. The impact of recharge is a temporary, local rise in water levels and the impact of recovery is a temporary, local drop in water levels. ASR projects usually operate by putting water into the ground in a wet year and then recovering it as needed in some future dry year, so there is little likelihood of recharge and recovery happening simultaneously. The two potential temporary impacts of concern include the decline in water levels due to project pumping and a rise in the water table up to the ground surface due to project recharge. A manmade water level drawdown increases the vertical distance that groundwater must be lifted and therefore increases the cost to pump a well over what would otherwise have occurred. A standing water table within a few feet of the ground surface creates potentially adverse impacts to many types of crops and to the foundations of manmade structures including building and/or tower foundations, roads, and lined and unlined canals, ponds, and ditches.

Water Level Declines. Since the Strand Ranch project is fundamentally designed to store and recover like volumes of water within the same project area, at similar rates, and at different times but over periods of similar duration, the expected impacts from recharge and then recovery are approximately equal and opposite. This is not to say that the recharge impacts and recovery impacts therefore “cancel” each other out, especially since they impact somewhat different aquifer zones, occur separately in time and not simultaneously, and perhaps under different types of pre-existing conditions. Nevertheless, the local MOUs have made a provision (rule 4) that the beneficial impacts from recharge may be taken into consideration if and when it is necessary to consider mitigating the detrimental drawdown impacts of pumping. To the extent that this is an agreed-upon local principle which has been established among the participants of the banking project MOUs, then we can evaluate the potential drawdown impact by evaluating the cumulative net impact within the context of the total Strand Ranch project impact.

As previously discussed, the project has been designed so that the maximum expected recharge or recovery volumes are both equal to 17,500 af/yr and the total volume might be 50,000 af every decade. The expected project recharge rates range from 90 - 150 af/d and the expected recovery rates range from 50 - 90 af/d. Since the expected recharge rates are slightly higher than the expected recovery rates, the project will be in recharge 10 - 15% of the time, in recovery 15 - 20% of the time, and idle 65 - 75% of the time. Since we do not know in advance what the actual aquifer parameters will be, we can predict a least-favorable impact scenario by assuming minimum recharge rates and maximum recovery rates. For the Strand Ranch project, this would be a recharge scenario of storing 17,500 af in the aquifer at a rate of 90 af/d for 194 days (194.4 days to be exact) and a recovery scenario of pumping 17,500 af from the aquifer, coincidentally, also at a rate of 90 af/d for 194 days.

Based on the computer modeling, the transient water table mound is comparable in shape, magnitude, and duration to the cone of depression due to pumping but of opposite sense, i.e., rising-then-falling water levels rather than falling-then-rising water levels. All else, equal, if we consider a drop in water levels due to pumping to be a negative impact then we may consider a rise in water levels due to recharge to be a positive impact. The question is therefore, If the cycle of recharge and recovery operations causes both positive and negative water level changes of comparable size and duration, then can we say that there is little or no net impact on water wells in the area?

The local MOU provides for such consideration. Based on one possible interpretation of “rule 4" of the MOU, one foot of daily water level rise due to project recharge may be considered as a possible mitigation of one foot of daily water level decline due to project pumping. If we apply such an interpretation to the total net impact from the Strand Ranch “least-favorable” hypothetical scenario, then there may be a near-project, maximum overall -6 to -7 ft temporary decline in water levels which remains uncompensated by any equivalent water level rise. Such an uncompensated, temporary water level decline might exist in 2 years out of ten in each of the eight sections surrounding the project. In all more-favorable, hypothetical, scenarios (with higher-than-minimum recharge rates and/or lower-than-maximum recovery rates) the total net impact from project recharge and recovery operations is calculated to be nearly completely balanced or actually to have created a net positive mitigation in excess of the total temporary drawdown at all locations in all surrounding sections, depending on the specific scenario (Tables 7, 8).

Near-surface Water Levels. A hypothetical standing water table within a few feet of the ground surface creates potentially adverse impacts to many types of crops and to the foundations of manmade structures including building and/or tower foundations, roads, and lined and unlined canals, ponds, and ditches. Within a year or two, row crops and almond trees will no longer exist on the Strand Ranch so there will be no possible agricultural impact from a shallow water table under the Strand Ranch. The only structure of concern which will remain on or near the Strand Ranch project site is the KCWA Cross Valley Canal that might be impacted by a shallow water table. The KCWA operates a monitoring program using an array of shallow piezometers along the Cross Valley Canal (CVC) to monitor water levels for potential conditions of concern.

In 2006, the Strand Ranch constructed and operated a pilot recharge facility on the site. As it so happened, the water table in 2006 was already within 1 - 2 ft of the ground surface on the Strand Ranch due to extended, large-volume, recharge operations on the Kern Fan by other project operators. This very shallow standing water table was already being monitored for potential impacts to the CVC. The constructors of the pilot-test recharge ponds encountered the water table when they excavated about 3 ft deep into the shallow sediment to make the ponds. When excavation was completed, the site had standing water along the new pond levees[7] from the presence of the very shallow water table. The pilot recharge test lasted about 5 months (mid-July - mid-December, 2006) and stored approximately 3,000 af in the ground. This recharge did not serve to raise the pre-existing water table since it was already at the ground surface but it extended by some undetermined amount, the length of time required for the shallow strata to dewater after recharge on the Kern Fan stopped. During this entire period, the KCWA did not issue any requests for mitigation or notices of observed impacts to the CVC, as far as we know.

The proposed operation of the Strand Ranch project is of sufficiently small recharge volume that it cannot threaten to create such a shallow water table unless a project recharge episode between about 10 - 17.5 kaf occurs at a time when the pre-existing water table is already less than about 30 ft deep due to other causes. Such a pre-existing, shallow water table

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[7] Robert Coffee, RRBWSD operations manager, verbal communication, November, 2007.

has only occurred twice since 1960 (1999 and 2006) and will not recur unless and until a multi-year climatic wet period creates sufficient surface water supplies to re-fill the Kern Fan recharge mound. Based on the experience of 2006, we conclude that a shallow water table can exist under the Strand Ranch property without necessarily observing any adverse impacts, at least not necessarily regarding mitigation for the durations of shallow table table of a year or less. Nevertheless, a monitoring program is already in place which specifically tests for conditions which might have a potentially adverse impact on the Cross Valley Canal.

Summary of Project Impact Findings.

Basinwide, Permanent Impact. The proposed Strand Ranch ASR project operation is designed to always maintain a positive project balance, i.e., a volume of water must always be stored in the aquifer prior to removing a like volume from the aquifer. The long-term basinwide water level impact from the project is a negligibly small rise in overall water levels due to the MOU-required permanent addition of a few thousand acre-feet of overdraft correction water to the basin over the project life. There is no possibility of overdraft or aquifer dewatering under any proposed Strand Ranch scenario.

Local, Temporary Mounding Impact. The project has the potential to temporarily raise the local water table a maximum of 30 to 40 ft under the project site and 6 to 14 ft in the surrounding eight sections due to project recharge operations. The water level rise only lasts for the duration of recharge and begins to re-equilibrate to its previous level when recharge ceases. Such a rise in water levels is considered to be beneficial except, perhaps, if the water table rises so high that it rises up to or close to the ground surface under the project site only if the pre-existing water table is already very shallow due to non-project causes. This condition is unlikely and mitigation monitoring already exists on the project site. One such episode occurred during a pilot recharge test in 2006 and no adverse impacts were observed or reported in the area.

Local, Temporary Drawdown Impact. The project has the potential to temporarily lower the local water levels a maximum of -24 to -43 ft under the project site and a maximum of -7 to -20 ft at operating non-project water well locations in the vicinity of the project. These temporary, localized impacts can occur even though there is a continuous, permanent, long-term, net increase in the total amount of water left in the basin. Such a temporary lowering of water levels lasts only as long as pumping lasts plus a recovery period. Such a drawdown is considered to be an undesirable impact because a non-project operating well would experience a higher lifting cost to pump water than would be the case in the absence of project pumping. However, this impact may be mitigated by the beneficial impacts of mounding as summarized below.

Compensated Net Local, Temporary Project Impacts. As previously discussed, the positive impact of recharge mounding fully compensates for recovery drawdown in all except the "least-favorable" case of a recharge/recovery cycle at minimum recharge rates and maximum recovery rates. In this one case, the maximum uncompensated net temporary drawdown in the surrounding eight sections is in the range of -6 to -7 ft. All other, more-favorable, scenarios result smaller net water level declines and/or net water level rises at all locations surrounding the project site for comparable time periods.

Comparative Project Impacts. The local project mounding and drawdown water-level impacts are small, local, and temporary relative to the 100+ ft magnitude of the historically observed water level fluctuations due to the climatic wet/dry cycle. The impacts of the proposed Strand Ranch Project are also small relative to the scale of impacts due to some other banking project and district operations on the Kern Fan and in Kern County which store and recover larger water volumes at higher rates. The project mounding and drawdown impacts are temporary; for example, the drawdown impacts from one seasonal pumping cycle will fully equilibrate prior to the beginning of the next seasonal pumping cycle. The project impacts are local in the sense that there is no significant water-level impact beyond 1 - 1.5 miles from the project site.

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4. References.

<u>local work products</u>

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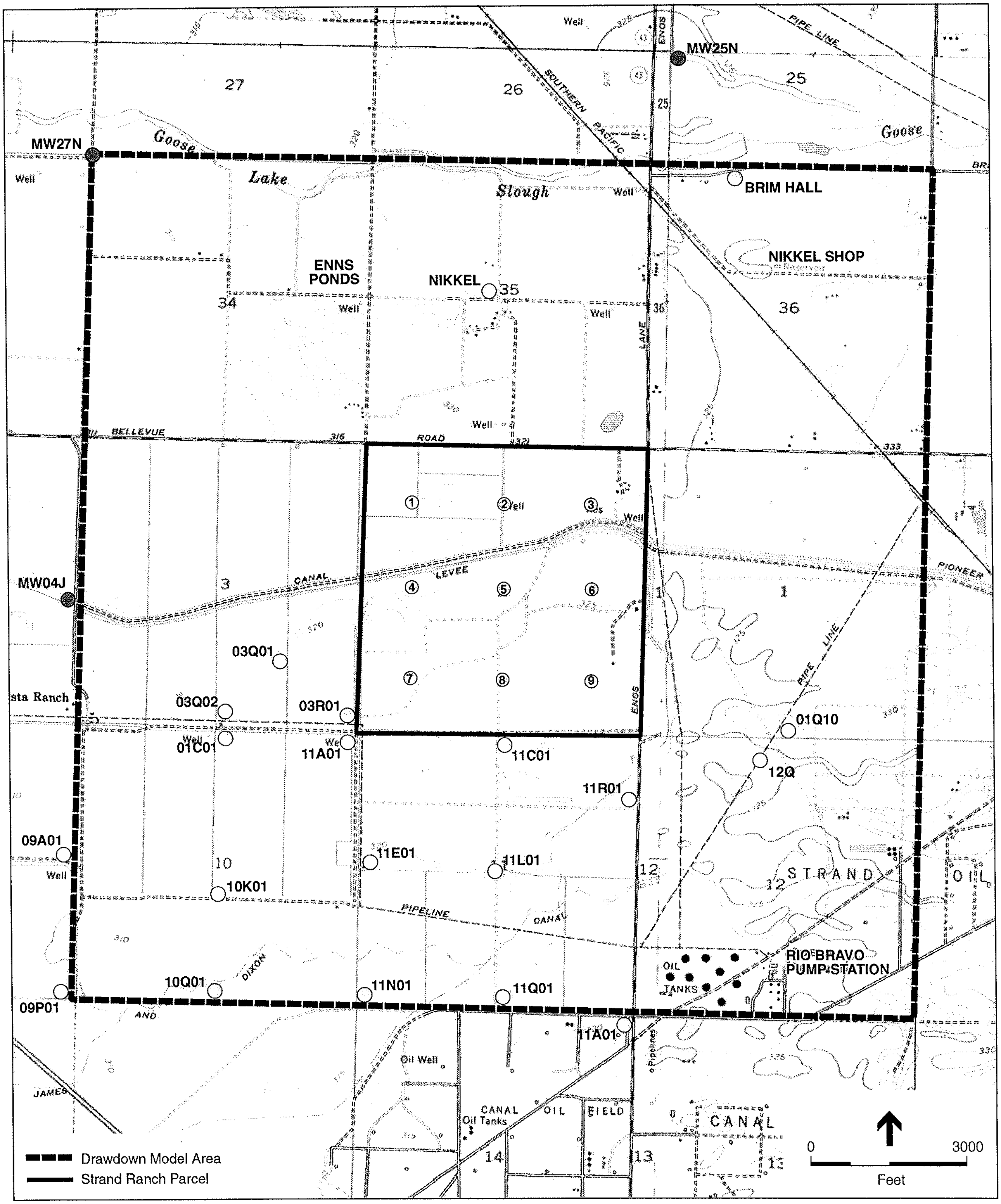
Bird, R. Byron , Stewart, W. E., and Lightfoot, E. N., 1960, Transport Phenomena, John Wiley

Fetter, Charles W., 1994, Applied Hydrogeology, Prentice Hall.

Domenico, Patrick A., and Schwartz, Franklin W., 1990, Physical and Chemical Hydrogeology, John Wiley & Sons.

Bouwer, Herman, 1978, Groundwater Hydrology, McGraw - Hill.

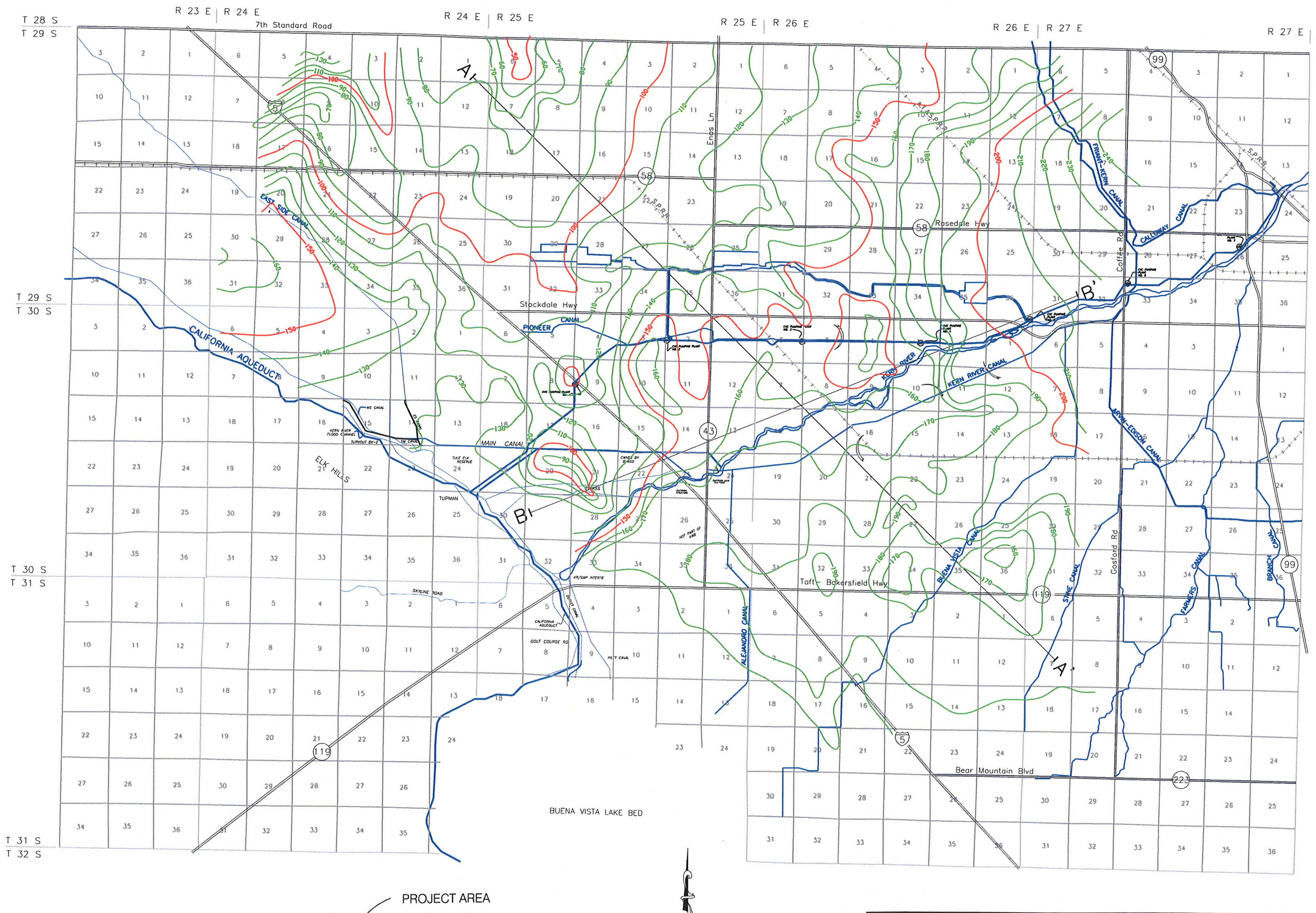
Figures.

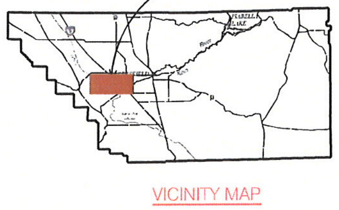


SOURCE: USGS; ESA, 2007.

Irvine Ranch Water District . 205426

Figure 1
Project Location





PROJECT AREA

VICINITY MAP

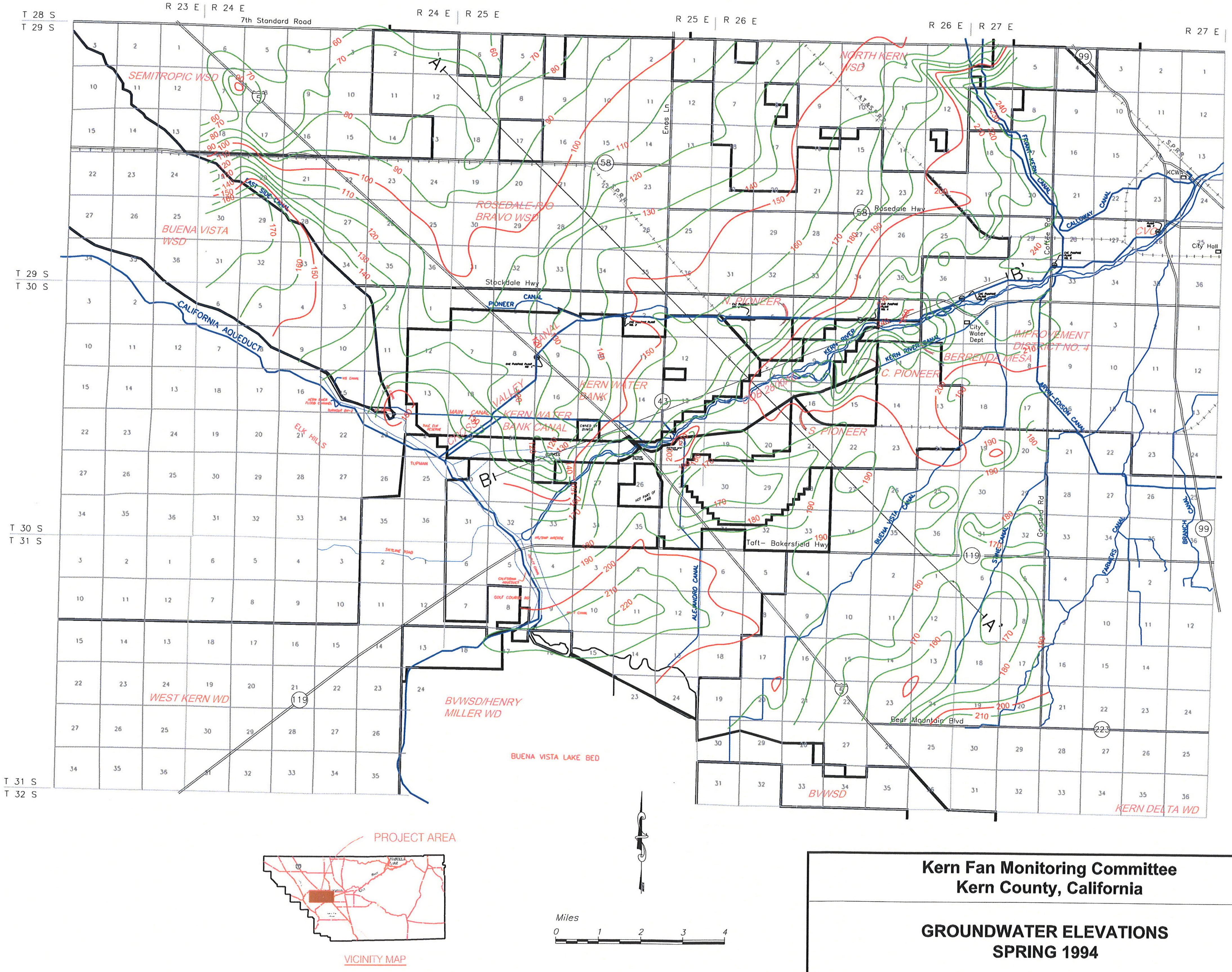
Kern Fan Monitoring Committee
Kern County, California

Kern Fan Monitoring Committee
GROUNDWATER SURFACE ELEVATION
SPRING 1993

T. HASLEBACHER

APRIL, 1993

FIG 2



Kern Fan Monitoring Committee
Kern County, California

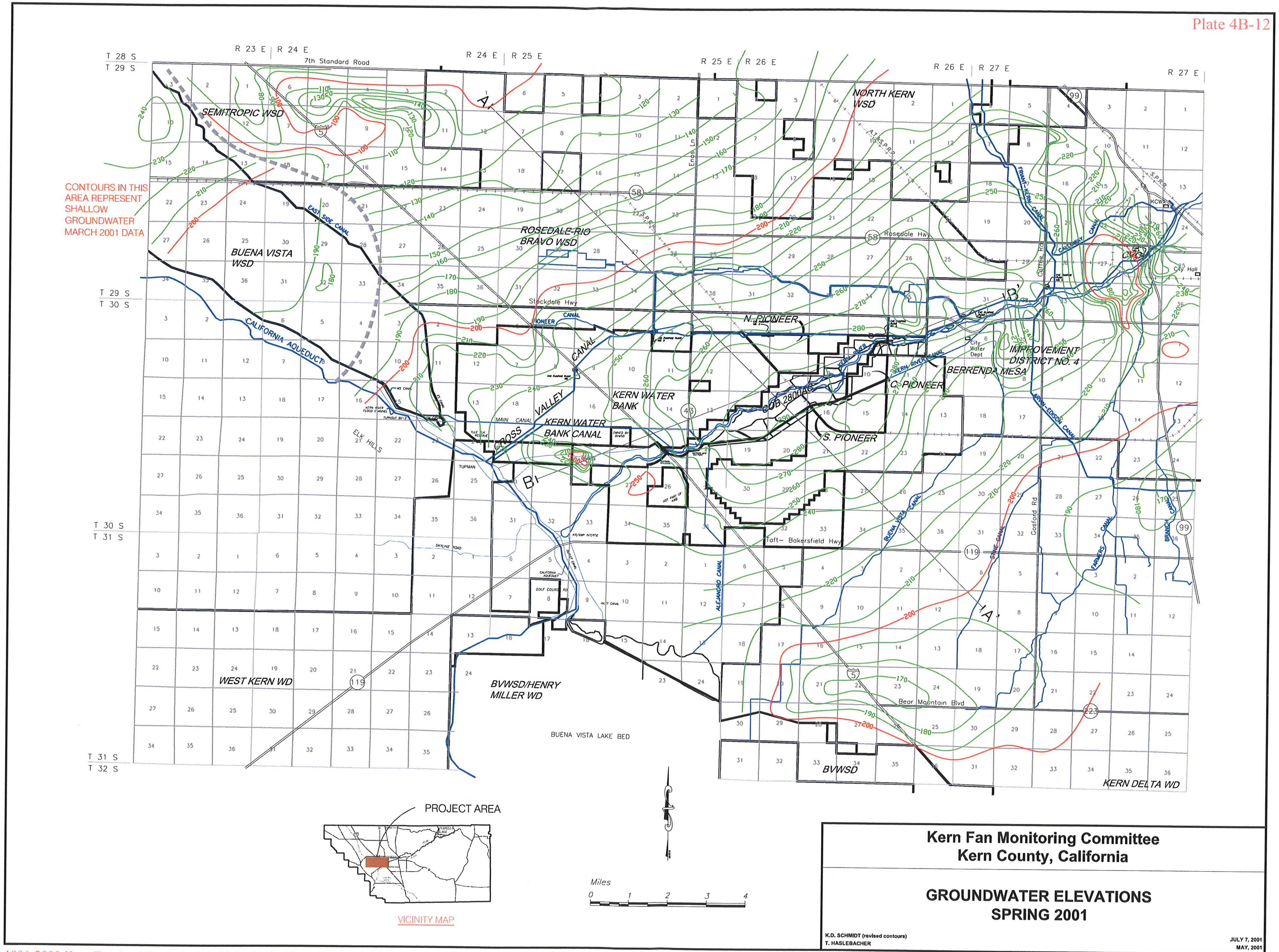
GROUNDWATER ELEVATIONS
SPRING 1994

T. HASLEBACHER

DECEMBER 1996

FIG 3

Plate 4B-12



CONTOURS IN THIS AREA REPRESENT SHALLOW GROUNDWATER MARCH 2001 DATA

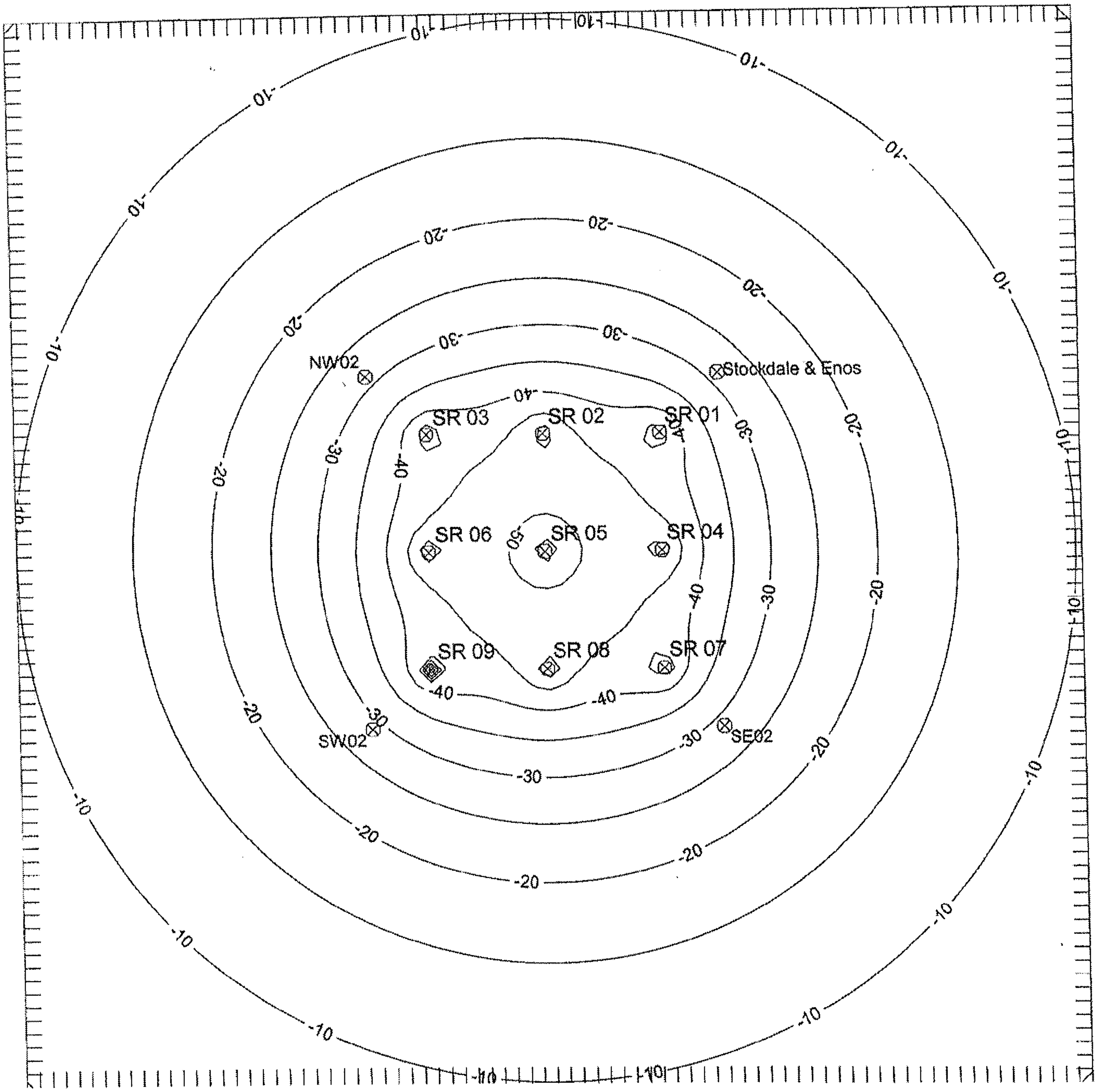
Kern Fan Monitoring Committee
Kern County, California

GROUNDWATER ELEVATIONS
SPRING 2001

K.D. SCHMIDT (revised contours)
T. HASLEBACHER

JULY 7, 2001
MAY, 2001

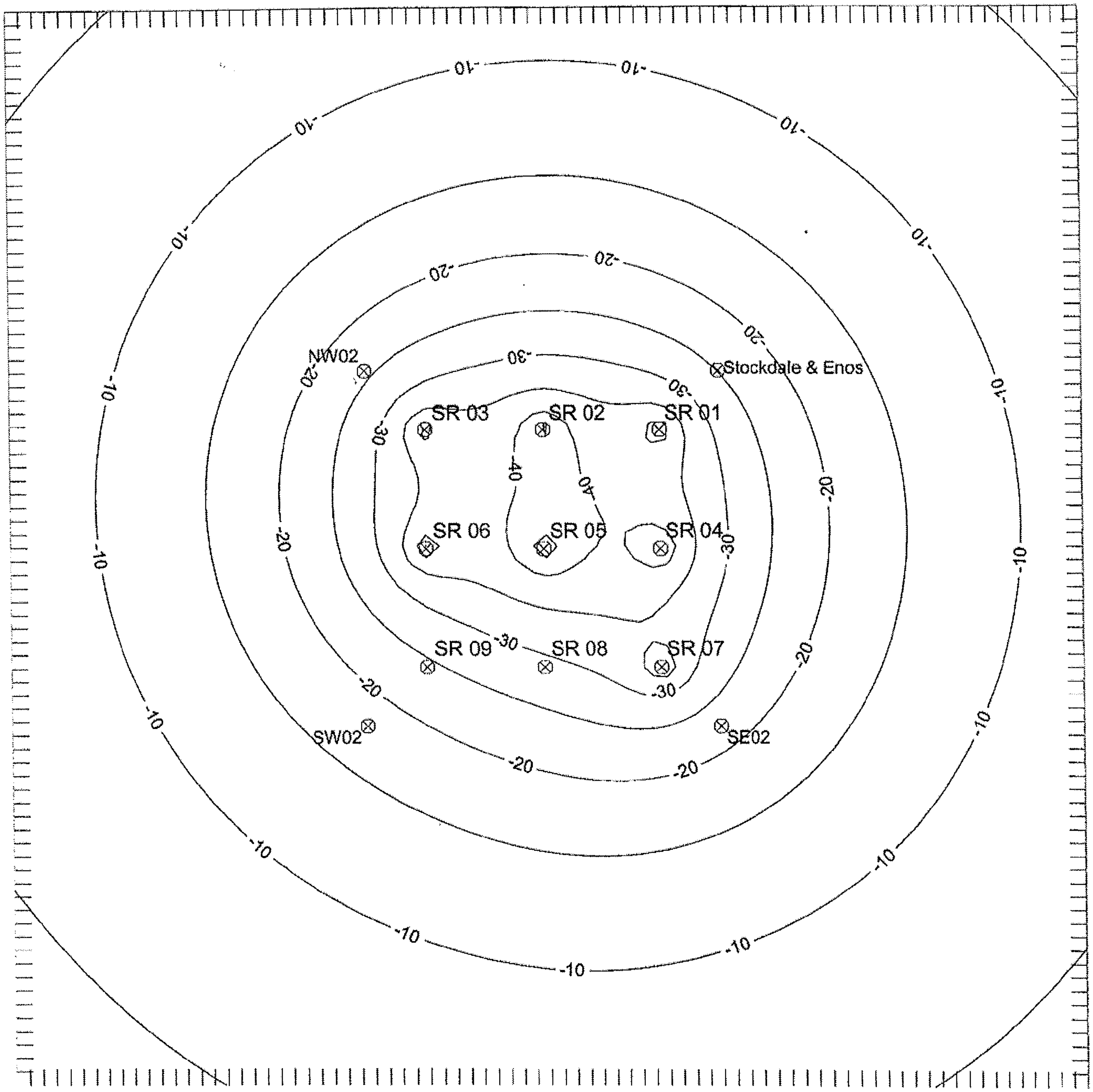
FIG 4



SOURCE: Geomatrix, 2007.

Figure 5

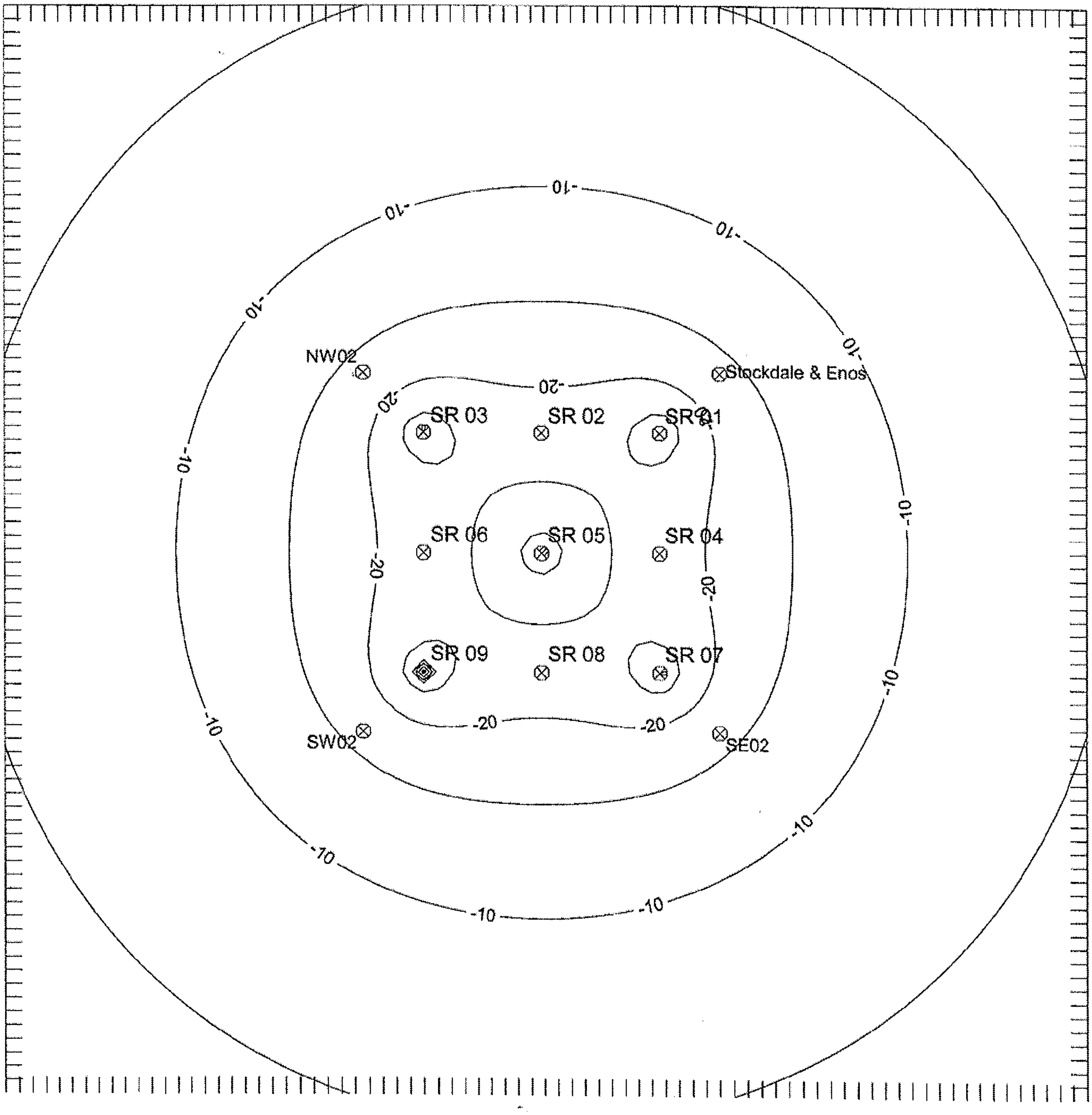
Predicted Water Level Drawdown Map,
9-Well Scenario (Wells 1-9),
Base Case Aquifer Parameters



SOURCE: Geomatrix, 2007.

Irvine Ranch Water District . 205426

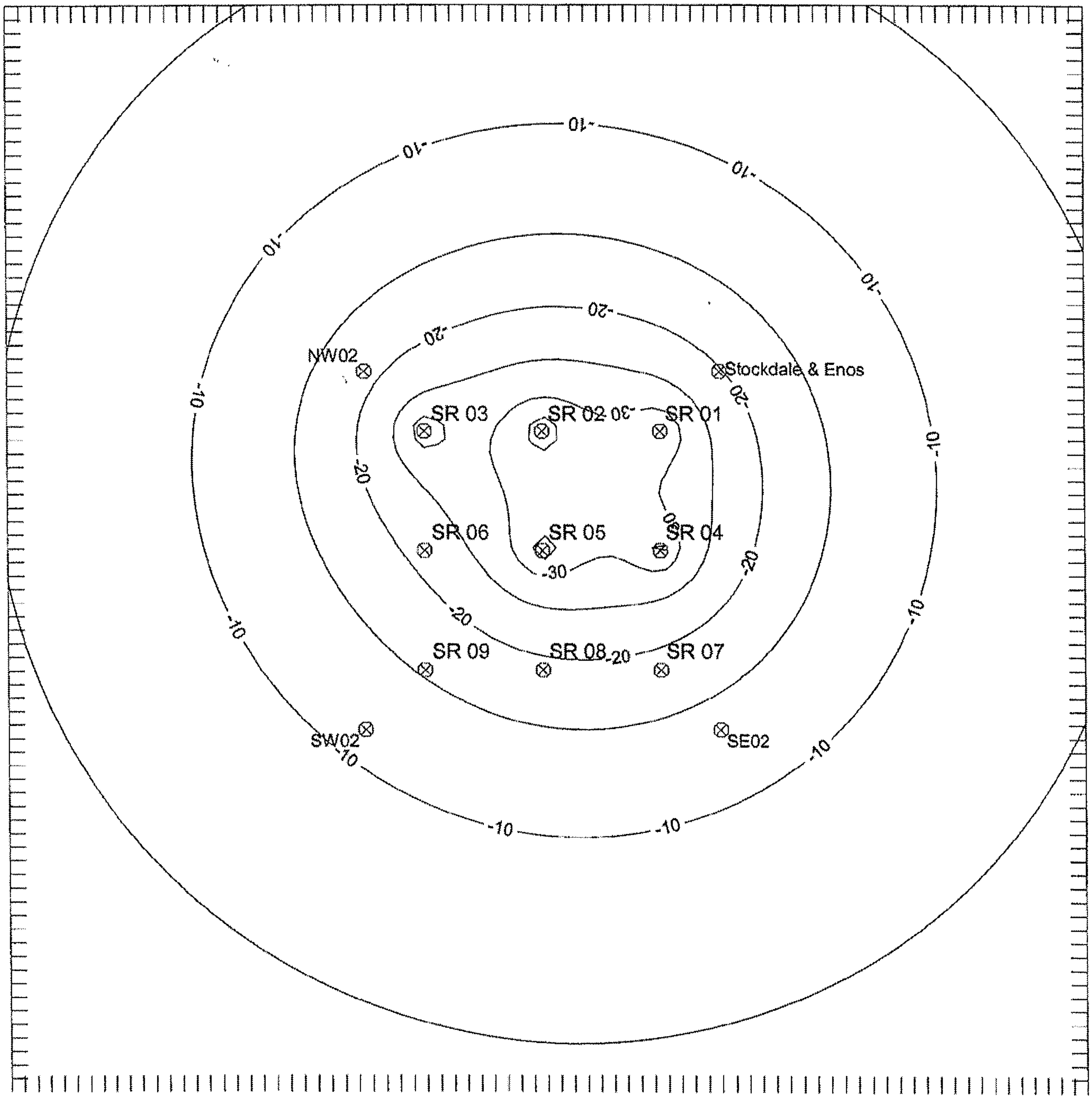
Figure 6
Predicted Water Level Drawdown Map,
7-Well Scenario (Wells 1-7),
Base Case Aquifer Parameters



SOURCE: Geomatrix, 2007.

Irvine Ranch Water District . 205426

Figure 7
Predicted Water Level Drawdown Map, 5-Well Scenario (Wells 13579), Base Case Aquifer Parameters

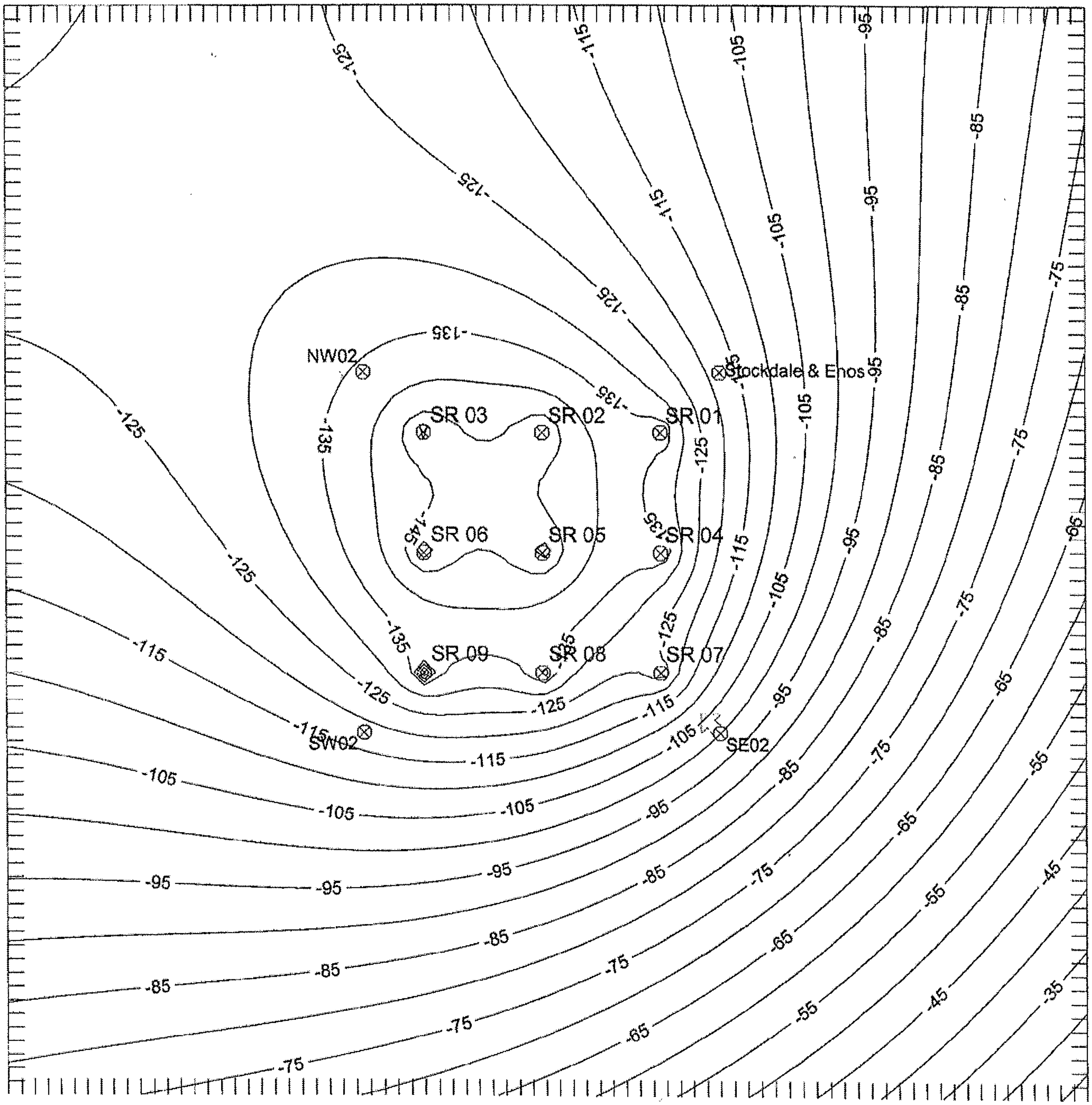


SOURCE: Geomatrix, 2007.

Irvine Ranch Water District . 205426

Figure 8

Predicted Water Level Drawdown Map,
5-Well Scenario (Wells 12345),
Base Case Aquifer Parameters

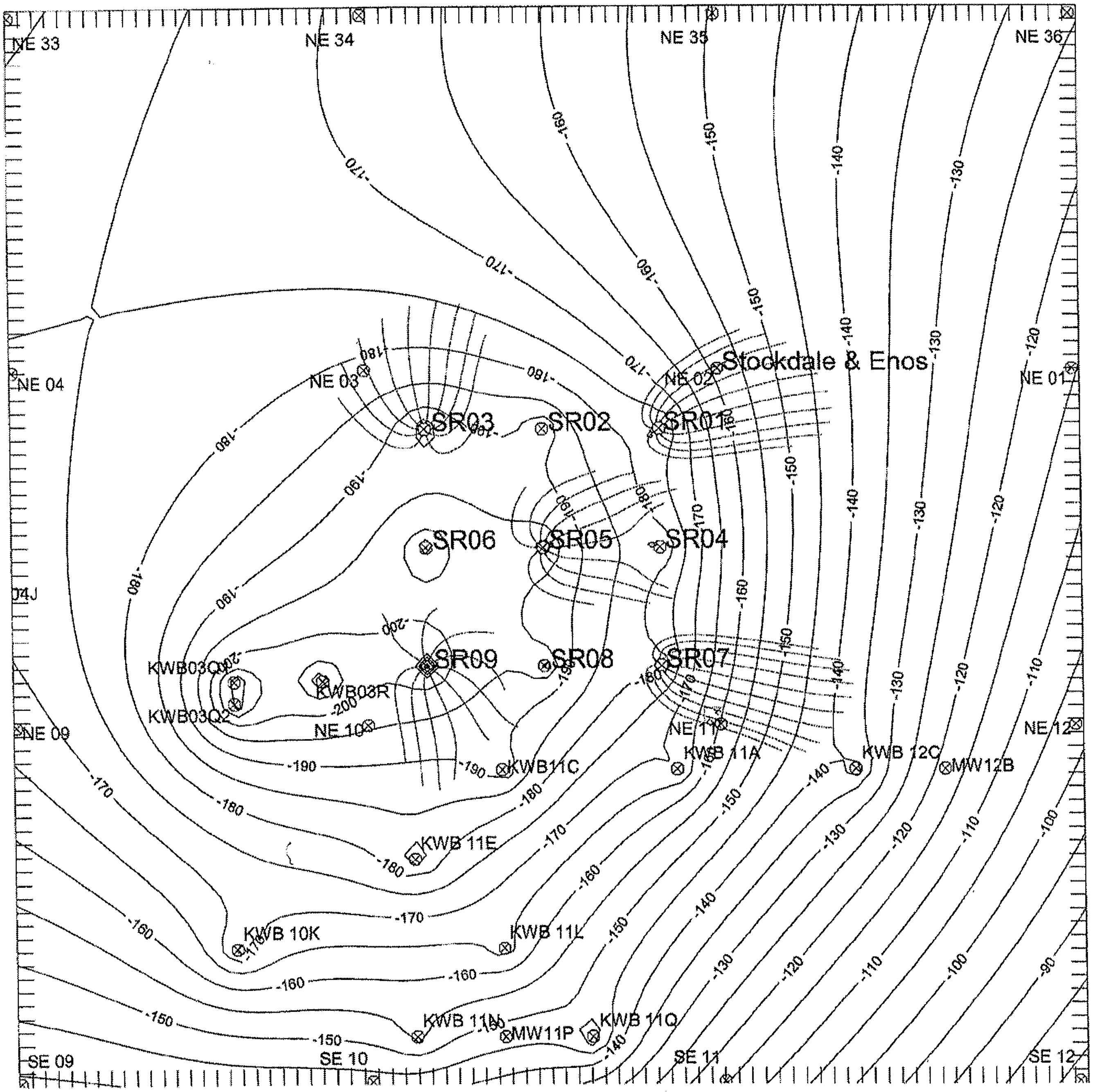


SOURCE: Geomatrix, 2007.

Irvine Ranch Water District . 205426

Figure 9

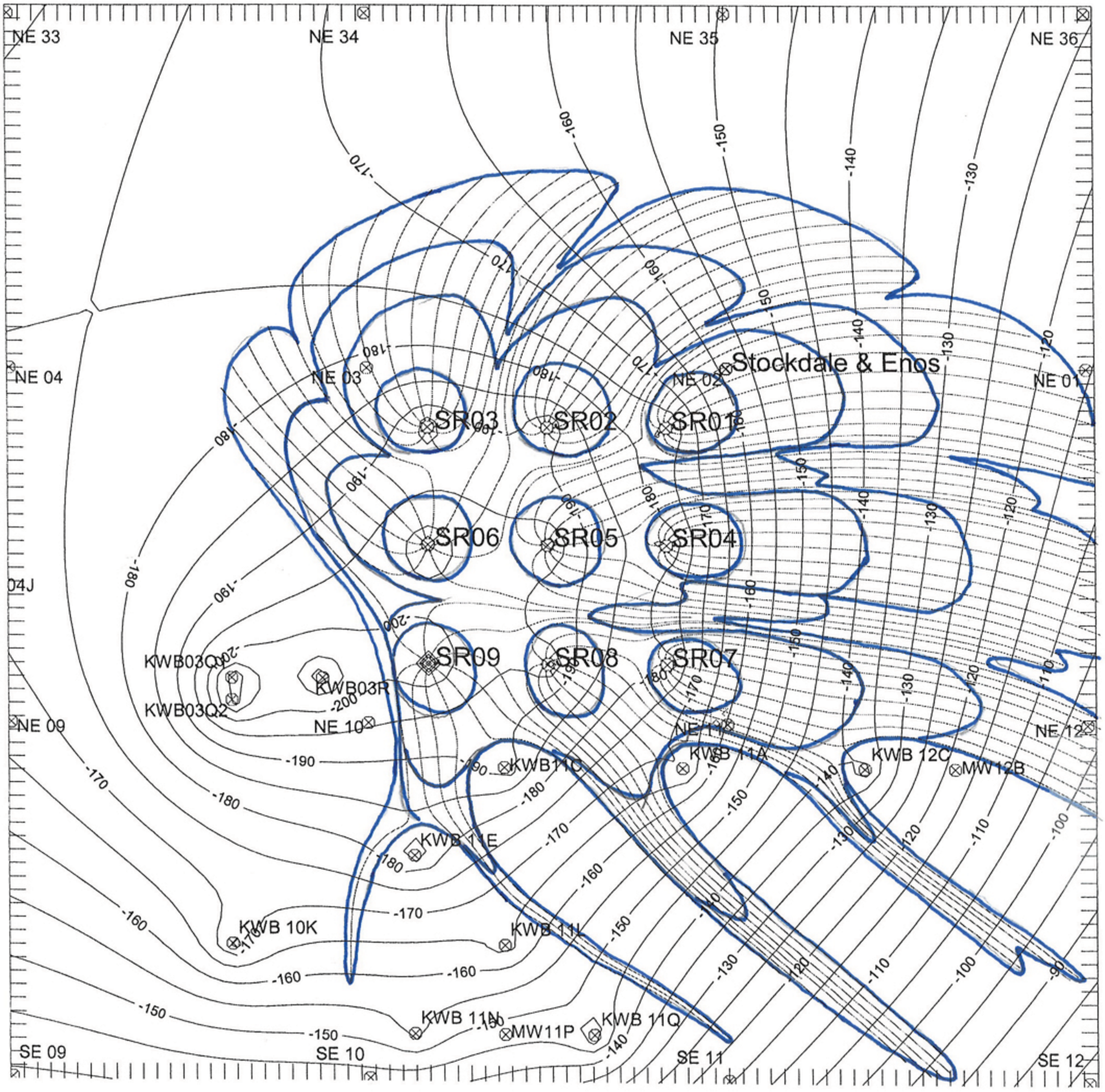
Predicted Water Level Elevation Map,
9-Well Scenario (Wells 1-9),
Base Case Aquifer Parameters with Wet-Year Groundwater Gradient



SOURCE: Geomatrix, 2007.

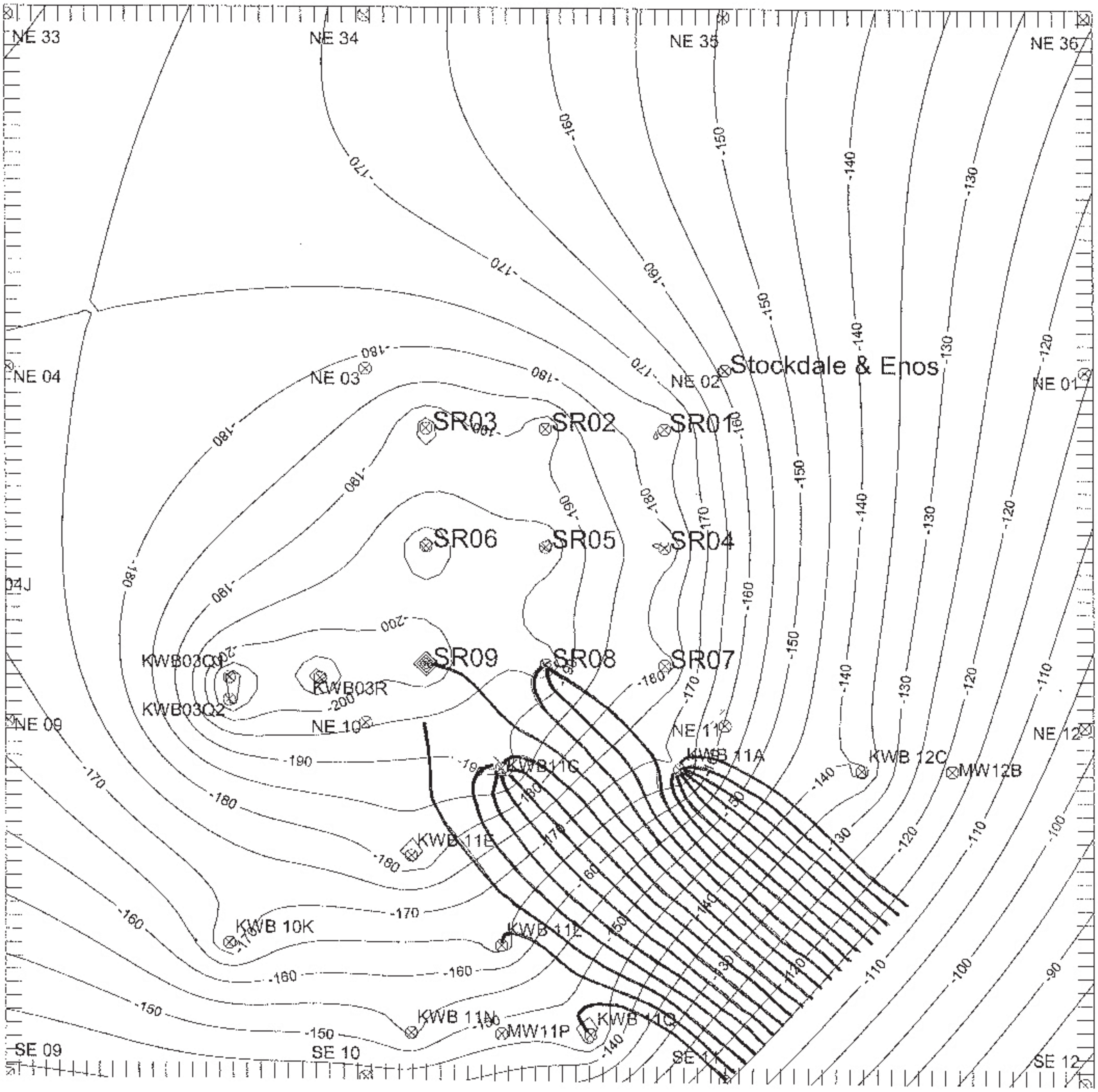
Irvine Ranch Water District . 205426

Figure 10
Predicted Water Level Elevation Map,
20-Well Scenario (Wells 1-9 and KWB Wells 1-11),
Base Case Aquifer Parameters with Wet-Year Groundwater Gradient



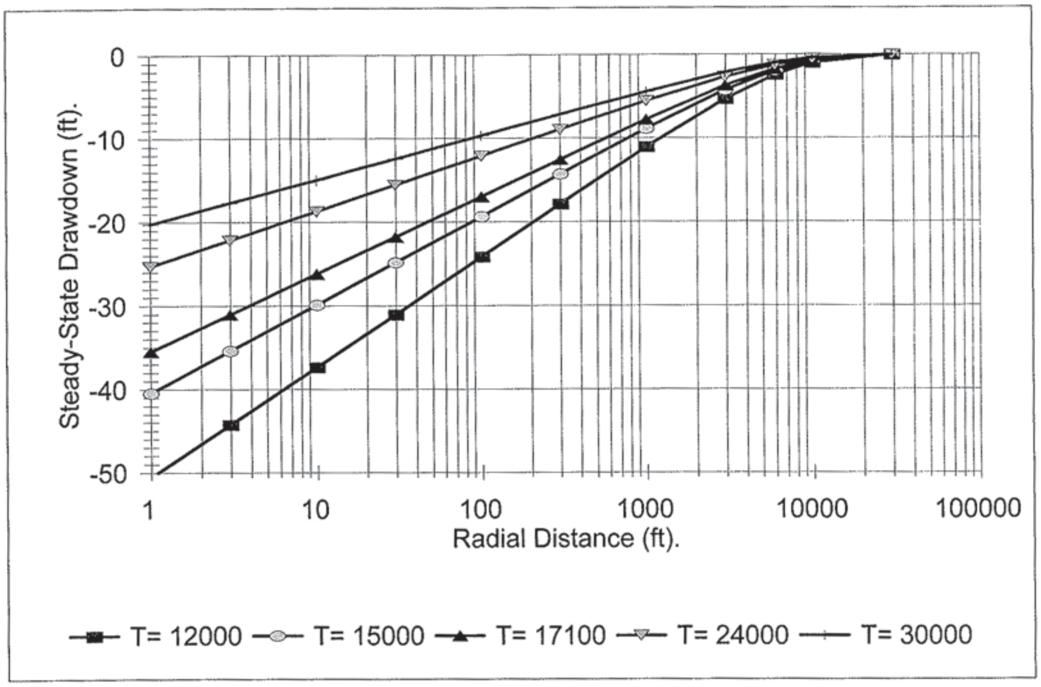
SOURCE: Sierra Scientific Services, 2007

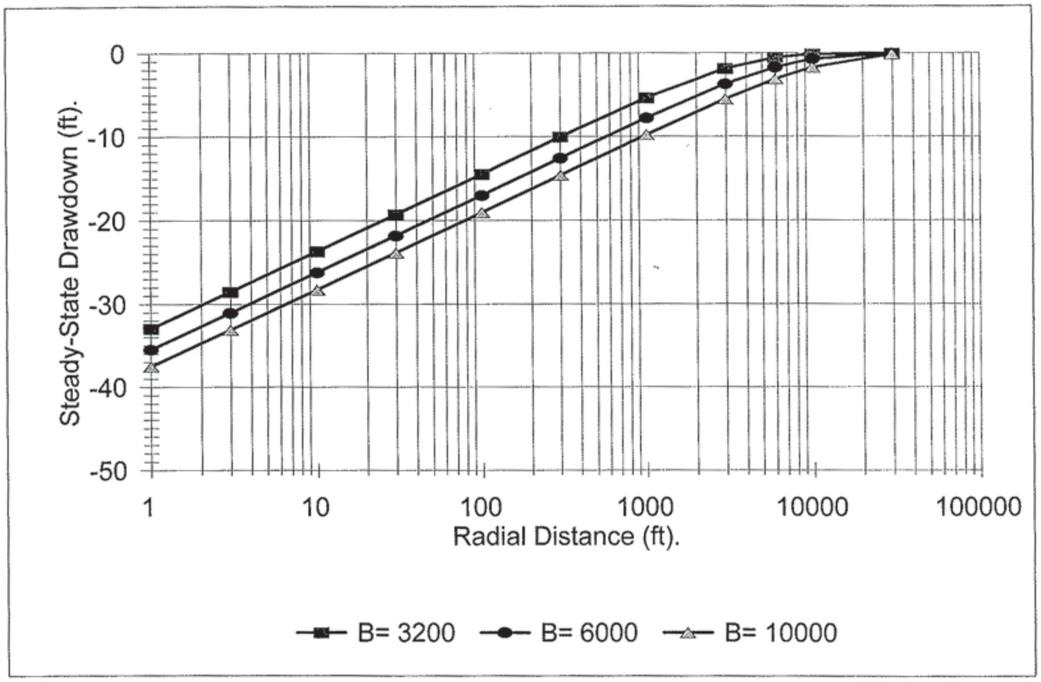
Figure 11
Particle Trajectory and Capture Zone Perimeter Map;
t = 300, 1000, 1825, and 3650d



SOURCE: Sierra Scientific Services, 2007

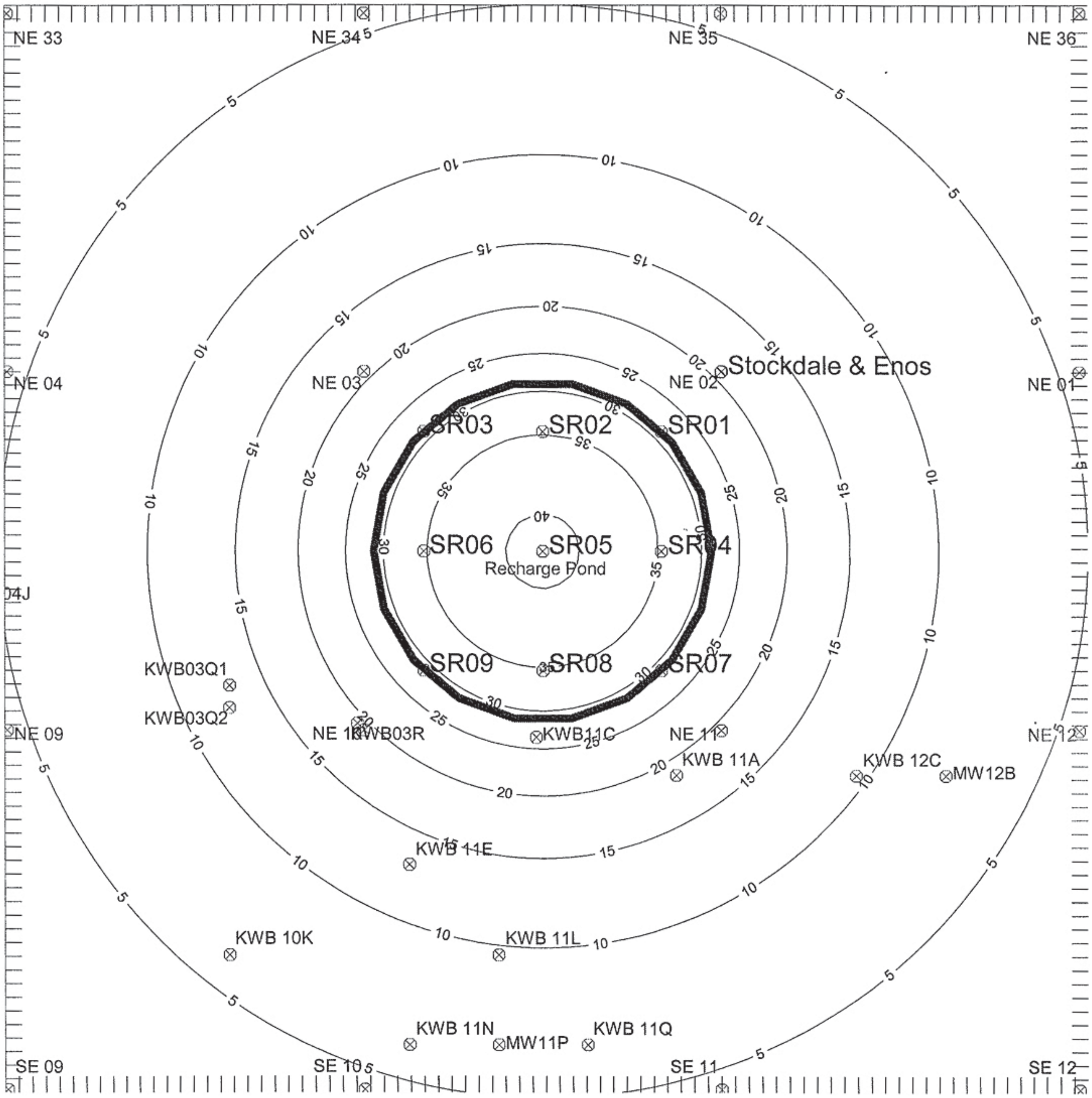
Figure 12
Particle Trajectory Map;
Hypothetical Contaminant Source in
Sec 02, T30s, R25e





SOURCE: Sierra Scientific Services, 2007

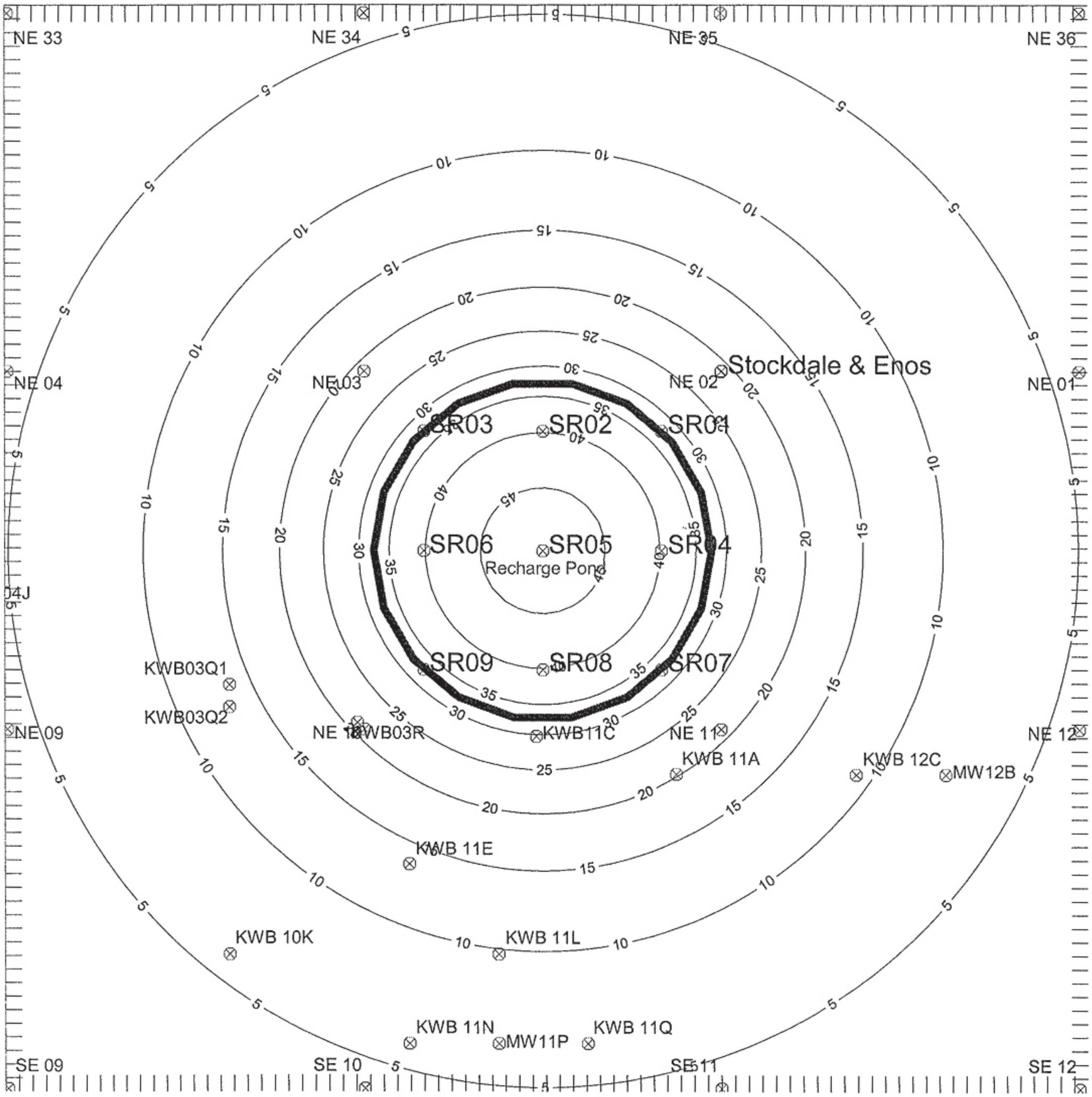
Figure 13
Strand Ranch Base Case Sensitivity Analysis
Steady-State Drawdowns for
Variations in T or B



SOURCE: Sierra Scientific Services, 2007

Irvine Ranch Water District . 205426

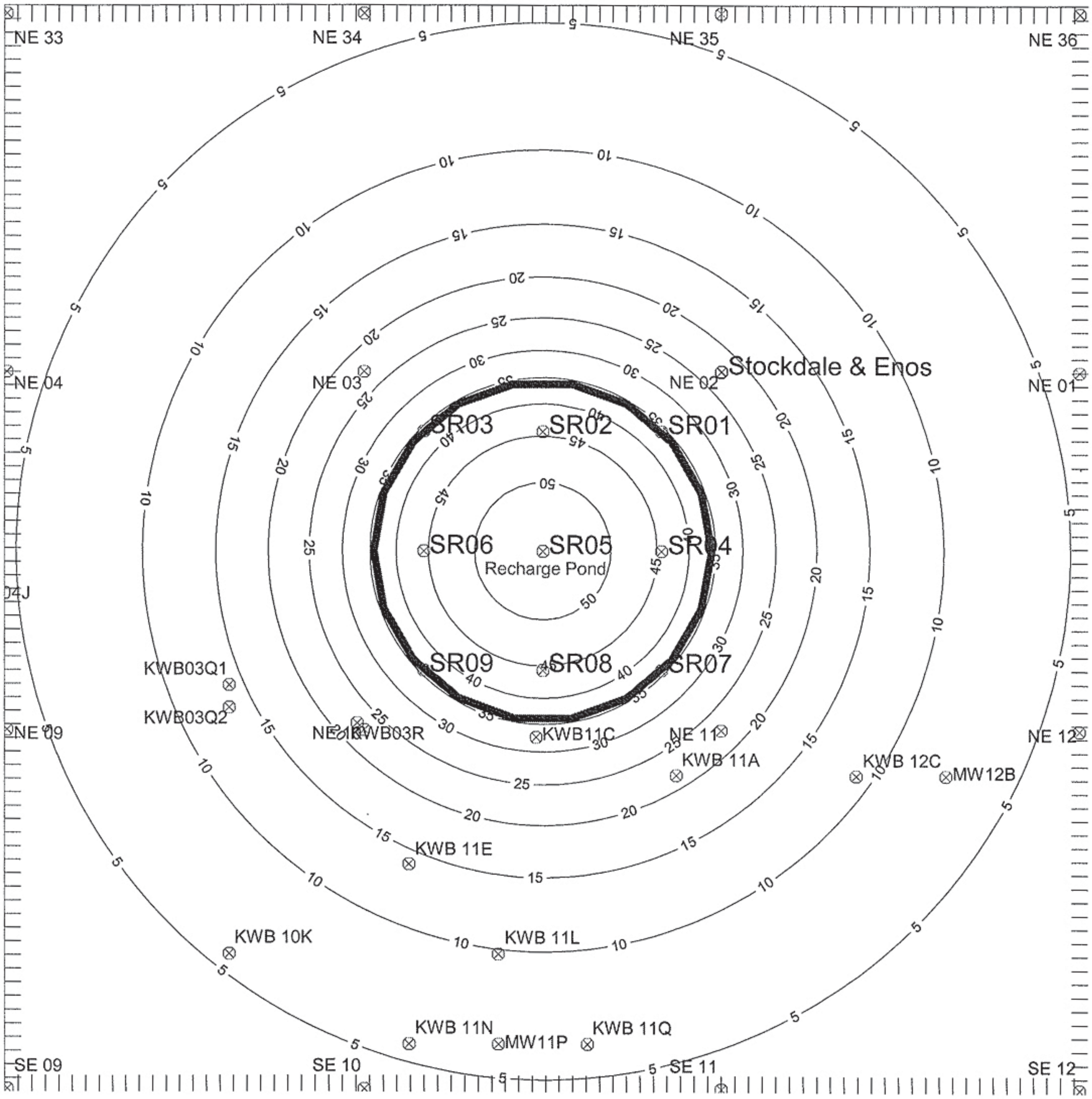
Figure 14
Water Level Rise Map,
Pond Recharge at IR = 0.20,
Base Case Aquifer Parameters



SOURCE: Sierra Scientific Services, 2007

Irvine Ranch Water District . 205426

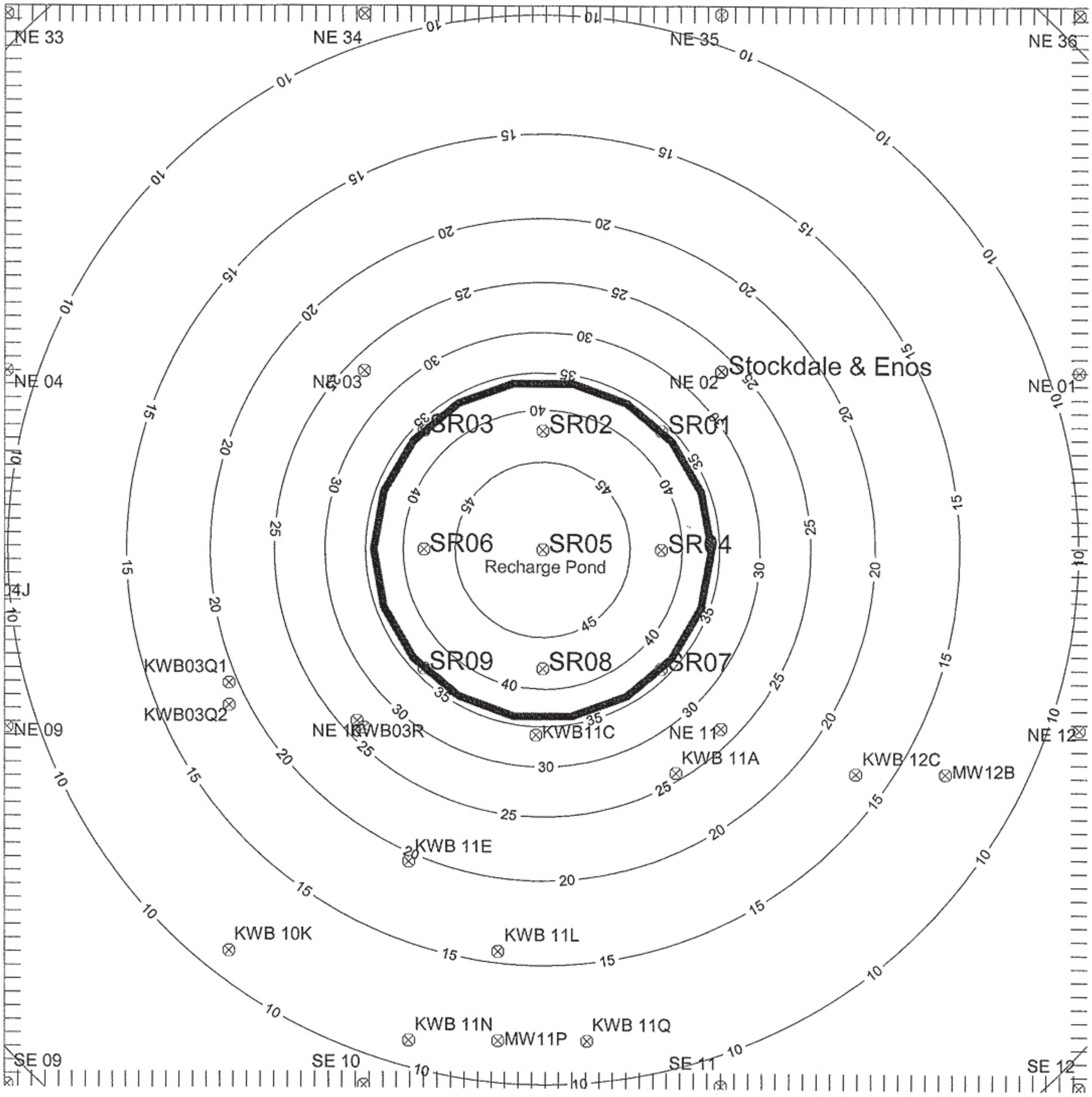
Figure 15
Water Level Rise Map,
Pond Recharge at IR = 0.25,
Base Case Aquifer Parameters



SOURCE: Sierra Scientific Services, 2007

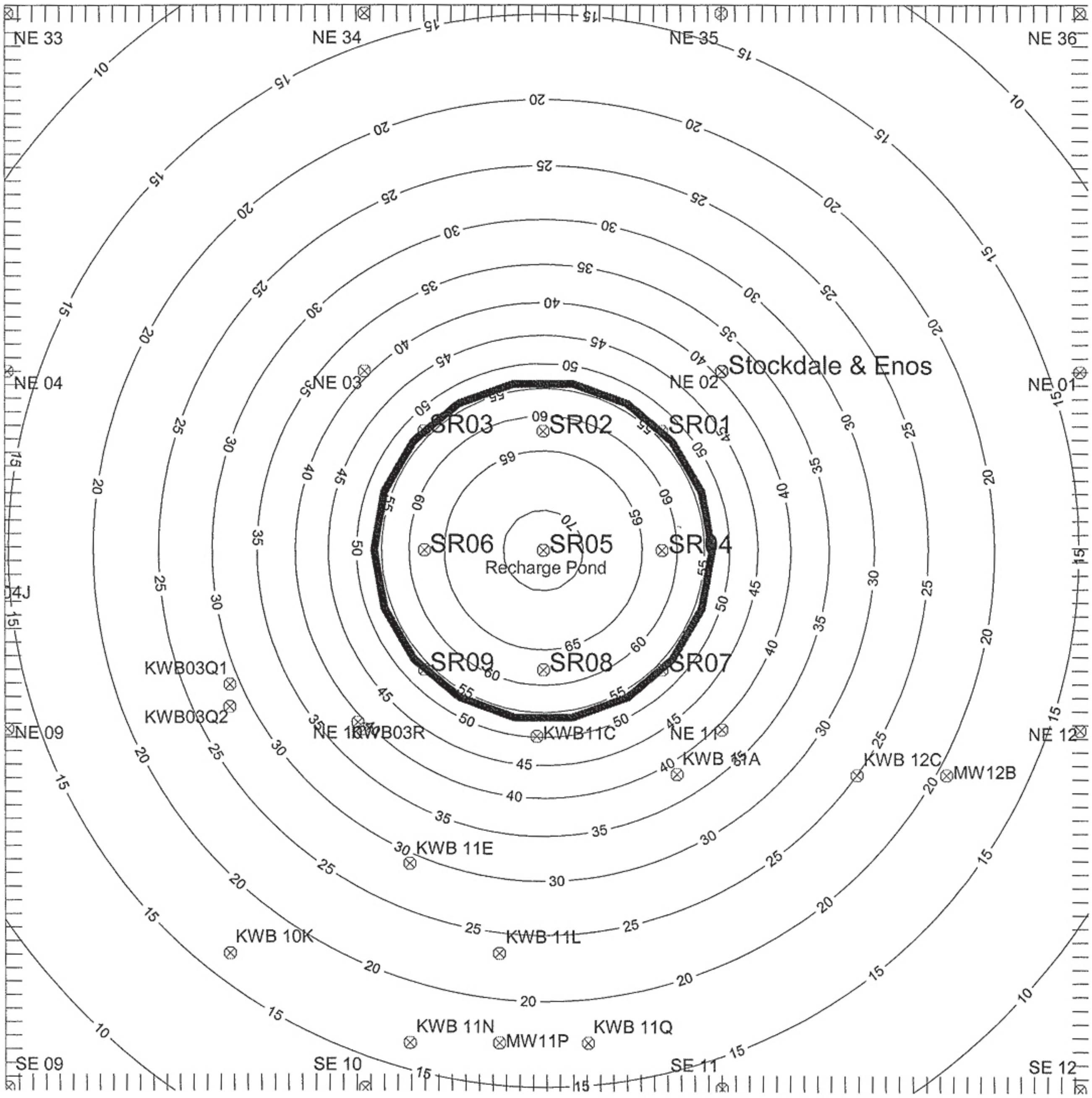
Irvine Ranch Water District . 205426

Figure 16
Water Level Rise Map,
Pond Recharge at IR = 0.30,
Base Case Aquifer Parameters



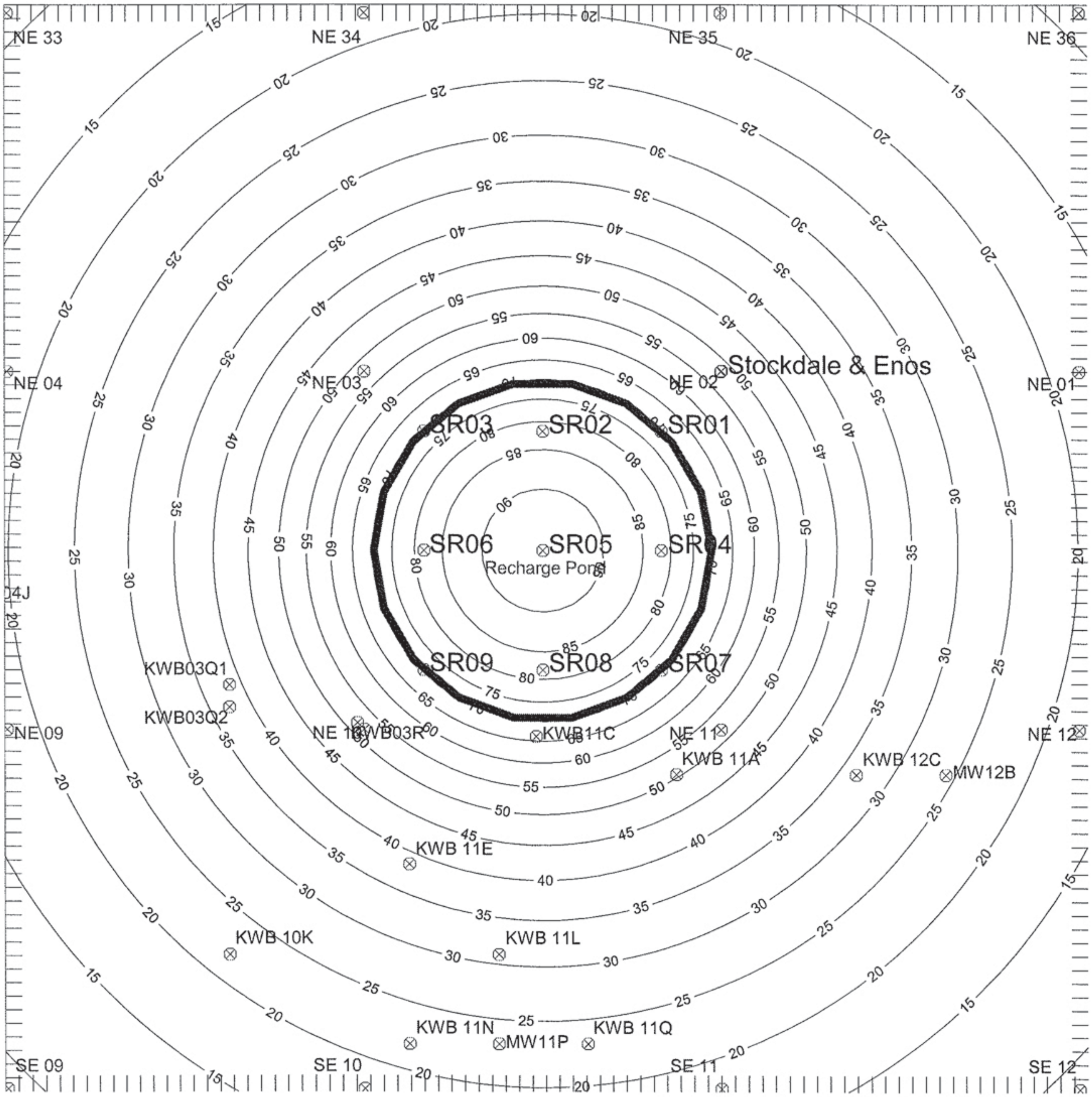
SOURCE: Sierra Scientific Services, 2007

Figure 17
Water Level Rise Map,
Maximum Recharge at IR = 0.20,
Base Case Aquifer Parameters



SOURCE: Sierra Scientific Services, 2007

Figure 18
Water Level Rise Map,
Maximum Recharge at IR = 0.30,
Base Case Aquifer Parameters



SOURCE: Sierra Scientific Services, 2007

Irvine Ranch Water District . 205426

Figure 19
Water Level Rise Map,
Maximum Recharge at IR = 0.40,
Base Case Aquifer Parameters

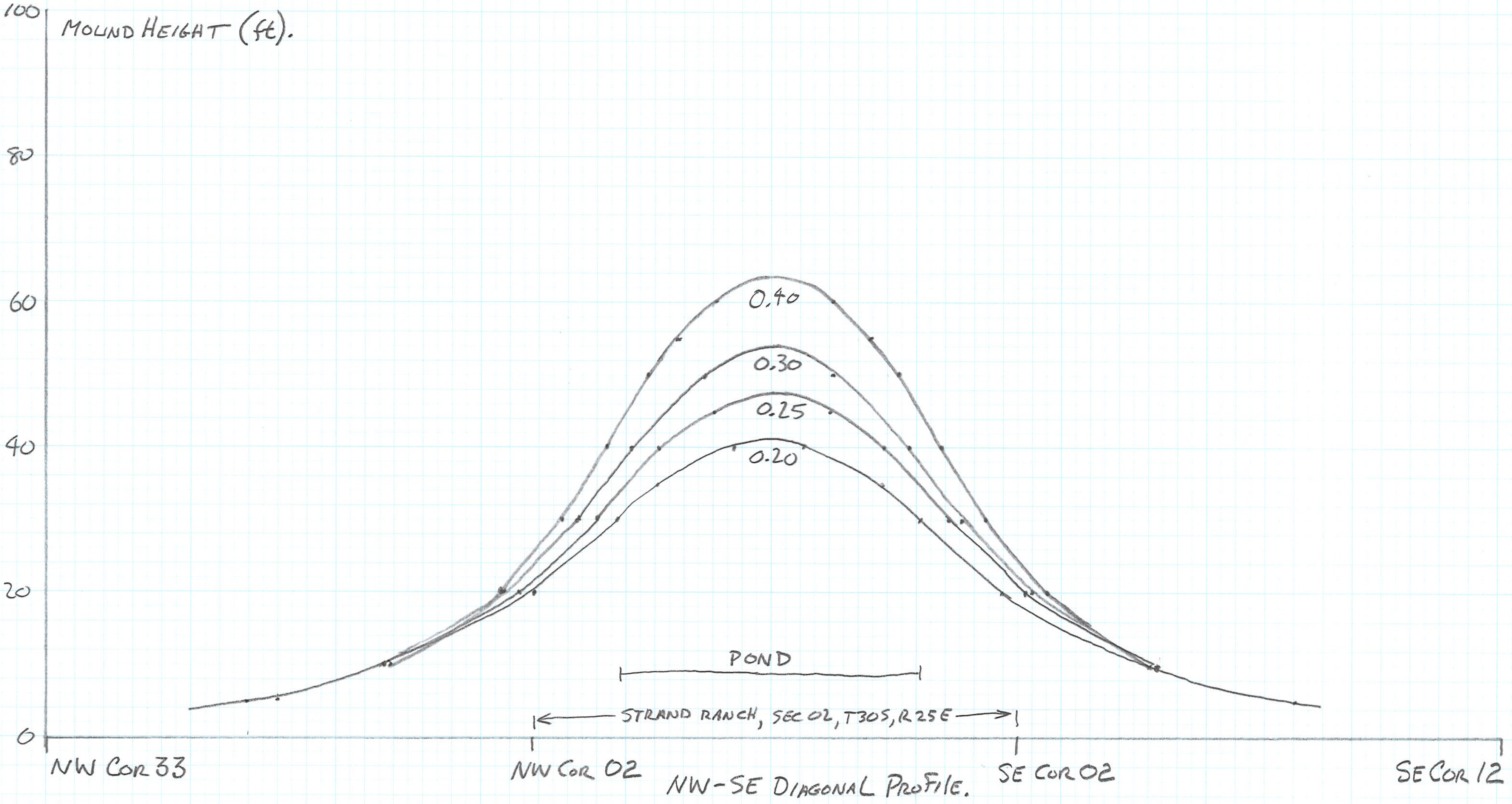


FIGURE 20. WATER LEVEL PROFILES, POND RECHARGE AT IR = 0.20, 0.25, 0.30, 0.40 ft/d; TOTAL VOLUME = 17,500 af, ALL CASES.

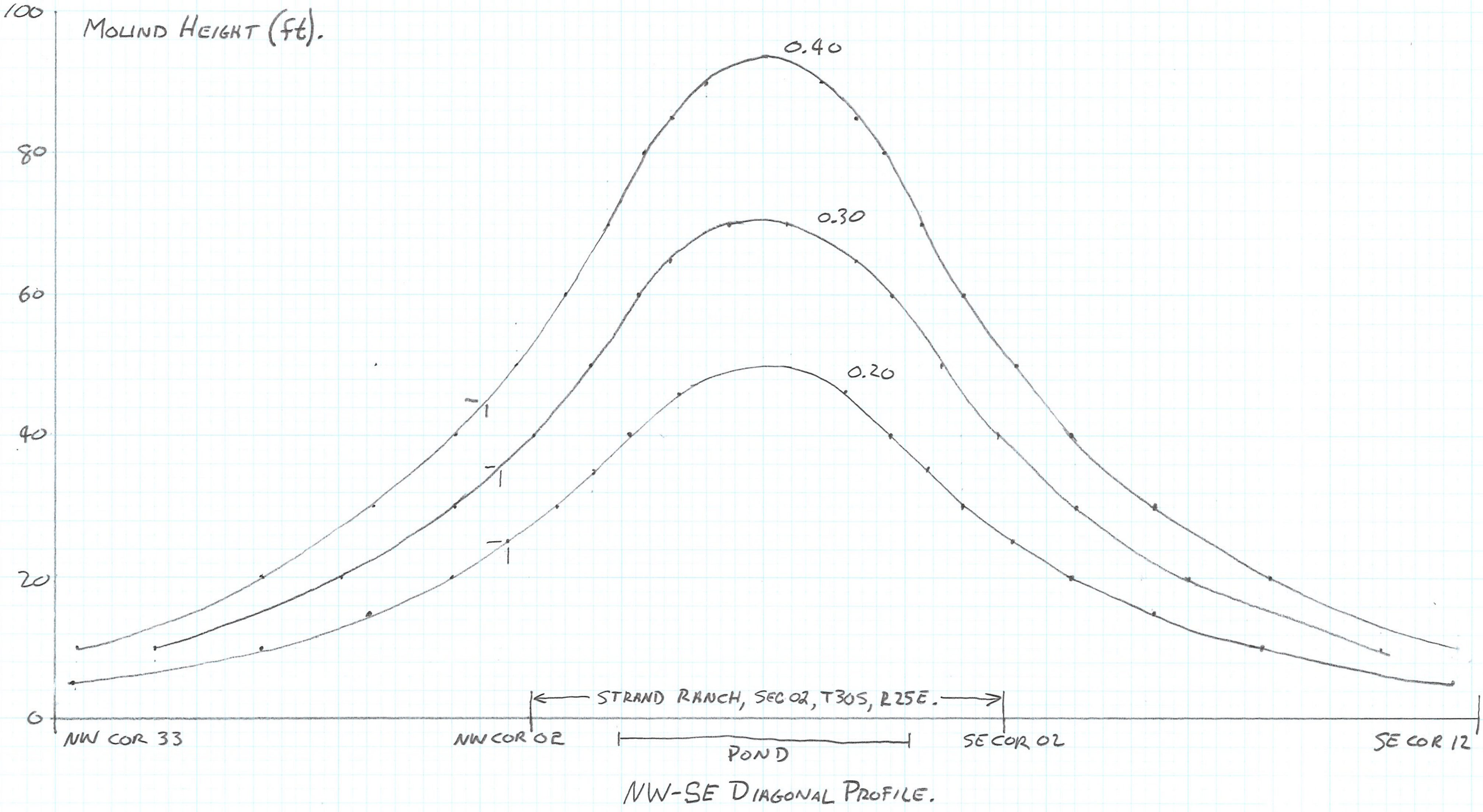


FIGURE 21. WATER LEVEL PROFILES, POND RECHARGE AT IR = 0.20, 0.30, 0.40 ft/d; TOTAL TIME = 365 dAYS, ALL CASES.

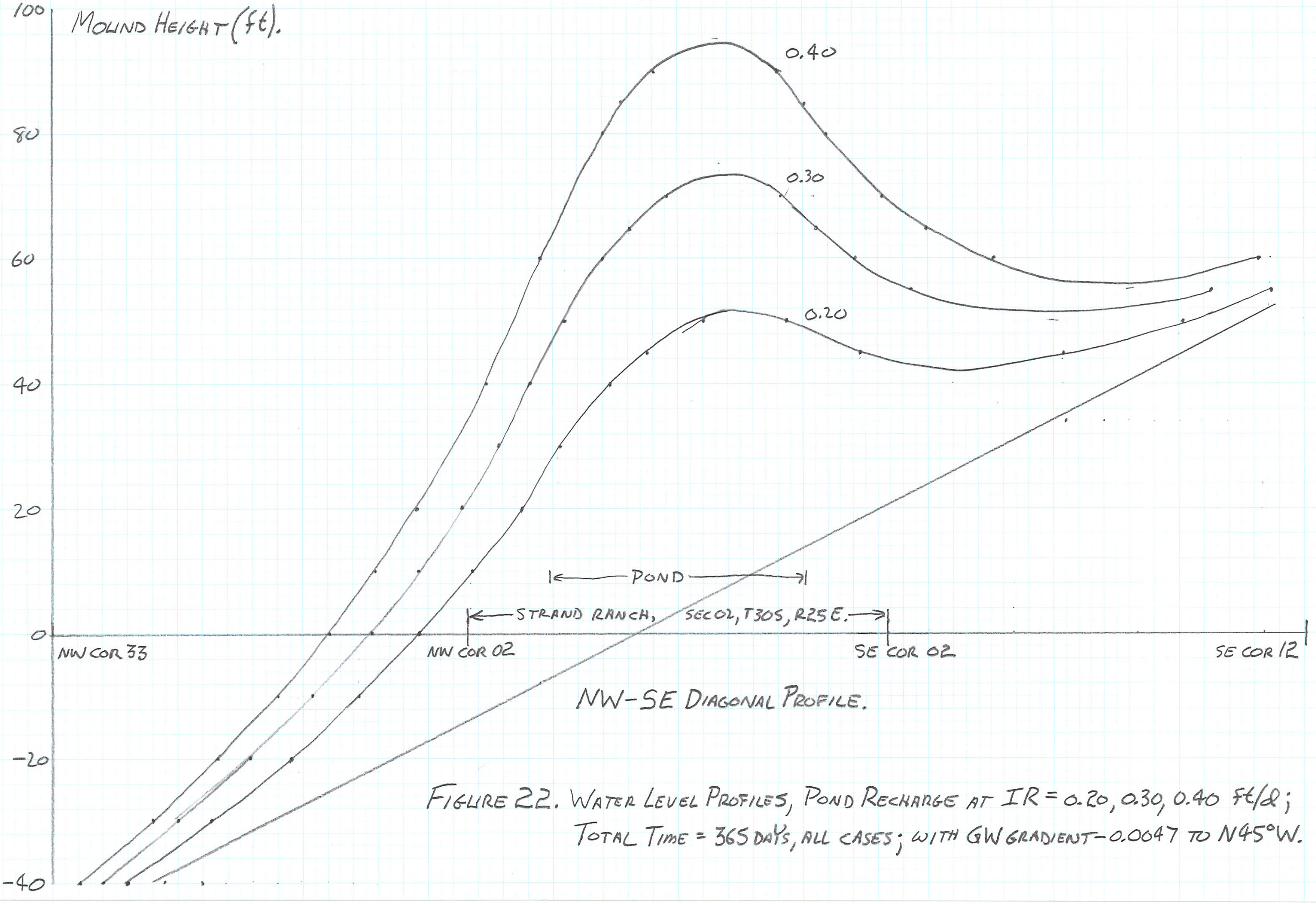


Figure 22. Water Level Profiles, Pond Recharge at IR = 0.20, 0.30, 0.40 ft/d; Total Time = 365 days, all cases; with GW gradient-0.0047 to N45°W.

Tables.

Table 1. IRWD Strand Ranch Drawdown Model Parameters.

Property	Sym.	Value	Units
Aquifer Parameters			
Aquifer Hy. Conductivity (Hor)	K(h)	57	ft/d
Aquifer Hy. Conductivity (Vert)	K(v)	n/d	ft/d
Aquifer Thickness	H	300	ft
Aquifer Transmissivity	T	17100	ft^2/d
Aquifer Specific Yield	Sy	0.15	v/v
Aquifer Specific Storage	Ss	0.000067	ft^-1
Aquifer Storativity	S	0.02	v/v
Aquifer Porosity	phi	0.3	v/v
Aquitard Hy. Conductivity (Vert)	Kv'	0.0475	ft/d
Aquitard Thickness	H'	100	ft
Aquitard Leakance	L'	0.000475	d^-1
Hantush Factor	B	6000	ft
GW gradient	G	0.0048	N 45 W
SR Well Recovery Rate	Q	432000	cf/d

Well Parameters (X, Y) coordinates in feet wrt local origin (0,0) at NE cor Sec 02, T30s, R25e.

Well	Q (cfs)	Q (cf/d)	Q (af/d)	X (ft)	Y (ft)
SR 01	5	432000	9.9	-880	-880
SR 02	5	432000	9.9	-2640	-880
SR 03	5	432000	9.9	-4400	-880
SR 04	5	432000	9.9	-880	-2640
SR 05	5	432000	9.9	-2640	-2640
SR 06	5	432000	9.9	-4400	-2640
SR 07	5	432000	9.9	-880	-4400
SR 08	5	432000	9.9	-2640	-4400
SR 09	5	432000	9.9	-4400	-4400
Nikkel (RRB)	3.3	285120	6.5	-3300	3300
Nikkerl Shop (RRB)	3.3	285120	6.5	1980	4620
Brimhall (RRB)	3.4	293760	6.7	3300	5940
KWB 03Q1	6.3	544320	12.5	-7260	-4620
KWB 03Q2	7.0	604800	13.9	-7260	-4950
KWB 03R	7.1	613440	14.1	-5940	-4620
KWB 10K	6.6	570240	13.1	-7260	-8580
KWB 11A	4.7	406080	9.3	-660	-5940
KWB 11C	5.3	457920	10.5	-3300	-5940
KWB 11E	5.4	466560	10.7	-4620	-7260
KWB 11L	3.7	319680	7.3	-3300	-8580
KWB 11N	3.7	319680	7.3	-4620	-9900
KWB 11Q	7.2	622080	14.3	-1980	-9900
KWB 12C	4.5	388800	8.9	1980	-5940

Note: KWB includes all 11 listed wells, each centered on their respective 40-acre designations.
Note: KWB well flow rates (Q, cfs) taken from KWBA production data; Jan - Apr, 2003, 4-mo avg flow rate.
Note: RRB irrigation wells centered on their 40-acre designations.
Note: SR well flow rates assumed to be 5 cfs, according to proposed project design specification.

Table 2. Strand Ranch Calculated Water Level Drawdown Summary.

3x3-mi Project Study Area centered on Sec 02, T30s, R25e.

9-well Scenario, Wells 1-9.
Average Drawdown per Section (ft).

12	20	12
20	43	20
12	20	12

9-well Scenario, Wells 1-9.
Range of Drawdowns per Section (ft).

5 to 28	9 to 36	5 to 28
9 to 36	29 to 55	9 to 36
5 to 28	9 to 36	5 to 28

7-well Scenario, Wells 1-7.
Average Drawdown per Section (ft).

9	21	10
14	34	17
8	13	9

7-well Scenario, Wells 1-7.
Range of Drawdowns per Section (ft).

3 to 23	8 to 31	3 to 24
8 to 29	17 to 45	8 to 30
7 to 18	7 to 25	3 to 23

5-well Scenario, Wells 13579.
Average Drawdown per Section (ft).

7	11	7
11	24	11
7	11	7

5-well Scenario, Wells 13579.
Range of Drawdowns per Section (ft).

2 to 16	6 to 19	2 to 16
6 to 19	17 to 30	6 to 19
2 to 16	6 to 19	2 to 16

Sierra Scientific Services, 2007. (661) 477 - 0767.

Table 3. Strand Ranch Calculated Water Level Drawdowns at Selected Locations.

WELL GROUP:	9 wells	7 wells	5 wells-A	5 wells-B	4 wells
Well numbers:	SR 1-9	SR 1-7	SR 13579	SR 12345	SR 2468
see map =	F2	F3	F4	F5	B20
Total Drawdown at:	(ft)	(ft)	(ft)	(ft)	(ft)
well SR 01	-45	-40	-25	-30	-17
well SR 02	-50	-40	-22	-35	-25
well SR 03	-45	-40	-25	-35	-17
well SR 04	-50	-40	-22	-22	-25
well SR 05	-55	-45	-30	-35	-20
well SR 06	-50	-40	-22	-35	-25
well SR 07	-45	-35	-25	-16	-17
well SR 08	-50	-29	-22	-19	-25
well SR 09	-45	-24	-25	-18	-17
well Nikkel (RRB)	17	14	9	12	8
well Nikkel Shop (RRB)	9	8	5	7	4
well Brimhall (RRB)	7	6	3	4	2
well KWB 03Q1	-20	-14	-12	-11	-9
well KWB 03Q2	-19	-14	-11	-10	-9
well KWB 03R	-27	-18	-15	-14	-12
well KWB 10K	-12	-8	-7	-5	-5
well KWB 11A	-28	-20	-15	-12	-12
well KWB 11C	-30	-20	-16	-13	-15
well KWB 11E	-20	-13	-12	-9	-9
well KWB 11L	-16	-11	-8	-7	-8
well KWB 11N	-11	-7	-6	-5	-5
well KWB 11Q	-12	-8	-7	-5	-5
well KWB 12C	-17	-13	-10	-8	-8
NE cor study area (NE sec 36)	5	4	2	3	1
SE cor study area (SE sec 12)	5	3	2	2	1
SW cor study area (SW sec 10)	5	2	2	2	1
NW cor study area (NW sec 34)	5	3	2	3	1
Center, north side study area	10	8	6	7	4
Center, east side study area	10	8	6	7	4
Center, south side study area	10	5	6	4	4
Center, west side study area	10	7	6	5	4

Table 4. Strand Ranch Water Level Drawdown Sensitivity Analysis.

Table 4a. Base case Drawdowns with Variations in Aquifer Model.
(base case in **bold**.)

Aquifer Model =	**Semi-confined**	Confined	Unconfined
see Map =	**B0**	B11	B12
			(only wells 13579)
Drawdown at:	**(ft)**	(ft)	(ft)
within the SR well field	**-40 to -55**	-85 to -100	-100 to -115
within the SR property (sec 02)	**-30 to -55**	-70 to -100	-87 to -115
within 1 mile of SR (adj. sections)	**-10 to -30**	-40 to -70	-65 to -87
beyond 1 mile from SR	**0 to -10**	0 to -40	0 to -65

Table 4b. Base case Drawdowns with Variations in degree of Confinement.
(base case in **bold**.)

confinement:	less	**base case**	more
Variation in confinement: B = ft	3200	**6000**	10000
see Map =	B1	**B0**	B2
Drawdown at:	(ft)	**(ft)**	(ft)
within the SR property (sec 02)	-15 to -35	**-30 to -55**	-45 to -70
within 1 mile of SR (adj. sections)	0 to -10	**-10 to -30**	-20 to -45
beyond 1 mile from SR	0	**0 to -10**	0 to -20

Table 4c. Base case Drawdowns with Variations in Aquifer Permeability.
(base case in **bold**.)

permeability:	more	more	**base case**	less	less
Variation in conductivity: K = ft/d	100	80	**57**	50	40
see Map =	B3	B4	**B0**	B5	B6
Drawdown at:	(ft)	(ft)	**(ft)**	(ft)	(ft)
within the SR property (sec 02)	-15 to -30	-20 to -40	**-30 to -55**	-35 to -60	-45 to -75
within 1 mile of SR (adj. sections)	-5 to -15	-7 to -20	**-10 to -30**	-12 to -35	-15 to -45
beyond 1 mile from SR	0 to -5	0 to -7	**0 to -10**	0 to -12	0 to -15

Table 4d. Base case Drawdowns with Variations in Pumping Duration.
(base case in **bold**.)

duration:	less	less	less	**base case**	more
Pumping Duration, t = days	10	30	100	**300**	1000
see Map =	B7	B8	B9	**B0**	B10
Drawdown at:	(ft)	(ft)	(ft)	**(ft)**	(ft)
within the SR property (sec 02)	-15 to -35	-25 to -50	-30 to -55	**-30 to -55**	-30 to -55
within 1 mile of SR (adj. sections)	-1 to -15	-5 to -25	-10 to -30	**-10 to -30**	-10 to -30
beyond 1 mile from SR	0 to -1	0 to -5	0 to -10	**0 to -10**	0 to -10

Table 5. Strand Ranch Calculated Water Level Mounding Summary.

3x3-mi Project Study Area centered on Sec 02, T30s, R25e.

Recharge 17,500 af in 194 days (IR=0.20)
Average WL Rise per Section (ft).

6	13	6
13	32	13
6	13	6

Recharge 17,500 af in 194 days (IR=0.20)
Range of WL Rise per Section (ft).

1 to 18	5 to 27	1 to 18
5 to 27	20 to 43	5 to 27
1 to 18	5 to 27	1 to 18

Recharge 17,500 af in 155 days (IR=0.25)
Average WL Rise per Section (ft).

6	13	6
13	36	13
6	13	6

Recharge 17,500 af in 155 days (IR=0.25)
Range of WL Rise per Section (ft).

1 to 21	4 to 30	1 to 21
4 to 30	22 to 48	4 to 30
1 to 21	4 to 30	1 to 21

Recharge 17,500 af in 129 days (IR=0.30)
Average WL Rise per Section (ft).

6	14	6
14	40	14
6	14	6

Recharge 17,500 af in 129 days (IR=0.30)
Range of WL Rise per Section (ft).

1 to 22	4 to 33	1 to 22
4 to 33	23 to 53	4 to 33
1 to 22	4 to 33	1 to 22

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Table 6. Strand Ranch Calculated Water Level Mounding Rise at Selected Locations.

Recharge Case	base	alt 1	alt 2
recharge rate (ft/d) =	0.20	0.25	0.30
recharge duration (d) =	194	155	129
recharge volume (af) =	17489	17467	17444
Total Water Level Rise at:	(ft)	(ft)	(ft)
well SR 01	28	32	35
well SR 02	35	40	44
well SR 03	28	32	35
well SR 04	35	40	44
well SR 05	43	48	53
well SR 06	35	40	44
well SR 07	28	32	35
well SR 08	35	40	44
well SR 09	28	32	35
well Nikkel (RRB)	12	12	12
well Nikkel Shop (RRB)	3	3	3
well Brimhall (RRB)	2	2	2
well KWB 03Q1	13	14	14
well KWB 03Q2	13	13	13
well KWB 03R	19	21	22
well KWB 10K	6	6	6
well KWB 11A	18	20	22
well KWB 11C	27	30	33
well KWB 11E	13	14	14
well KWB 11L	9	10	10
well KWB 11N	6	6	6
well KWB 11Q	7	7	7
well KWB 12C	11	11	11
NE cor study area (NE sec 36)	1	1	1
SE cor study area (SE sec 12)	1	1	1
SW cor study area (SW sec 10)	1	1	1
NW cor study area (NW sec 34)	1	1	1
Center, north side study area	5	5	5
Center, east side study area	5	5	5
Center, south side study area	5	5	5
Center, west side study area	5	5	5

Table 7. Strand Ranch Calculated Net Water Level Impact Summary.

3x3-mi Project Study Area centered on Sec 02, T30s, R25e.

Recharge: 90 af/d x 194 d.
Recovery: 9-wells @ 90 af/d.
Avg Net Impact per Section (ft).

-6	-7	-6
-7	-11	-7
-6	-7	-6

Recharge: 90 af/d x 194 d.
Recovery: 7-wells @ 70 af/d (1-7).
Avg Net Impact per Section (ft).

-3	-8	-4
-1	2	-4
-2	0	-3

Recharge: 90 af/d x 194 d.
Recovery: 5-wells @ 50 af/d (13579).
Avg Net Impact per Section (ft).

-1	3	-1
3	16	3
-1	3	-1

Table 8. Strand Ranch Calculated Net Water Level Impact at Selected Locations.

Recharge Case	base	base	base		= 194 d @ 90 af/d.
Recovery Case	9-well	7-well	5-well		= #wells @10 af/d/w.
Nominal Rcharge/Recovery Volume	17500	17500	17500	af	
Net Water Level Impact at:	(ft)	(ft)	(ft)		
well SR 01	-17	-12	3		
well SR 02	-15	-5	13		
well SR 03	-17	-12	3		
well SR 04	-15	-5	13		
well SR 05	-12	-2	13		
well SR 06	-15	-5	13		
well SR 07	-17	-7	3		
well SR 08	-15	6	13		
well SR 09	-17	4	3		
well Nikkel (RRB)	29	26	21		
well Nikkel Shop (RRB)	12	11	8		
well Brimhall (RRB)	9	8	5		
well KWB 03Q1	-7	-1	1		
well KWB 03Q2	-6	-1	2		
well KWB 03R	-8	1	4		
well KWB 10K	-6	-2	-1		
well KWB 11A	-10	-2	3		
well KWB 11C	-3	7	11		
well KWB 11E	-7	0	1		
well KWB 11L	-7	-2	1		
well KWB 11N	-5	-1	0		
well KWB 11Q	-5	-1	0		
well KWB 12C	-6	-2	1		
NE cor study area (NE sec 36)	6	5	3		
SE cor study area (SE sec 12)	6	4	3		
SW cor study area (SW sec 10)	6	3	3		
NW cor study area (NW sec 34)	6	4	3		
Center, north side study area	15	13	11		
Center, east side study area	15	13	11		
Center, south side study area	15	10	11		
Center, west side study area	15	12	11		

Table 9. Strand Ranch Maximum Water Level Mounding Summary.

3x3-mi Project Study Area centered on Sec 02, T30s, R25e.

Recharge 32,850 af in 365 days (IR=0.20)
Average WL Rise per Section (ft).

12	19	11
19	39	19
11	19	12

Extra Recharge = 15,350 af.
Extra Rise from 194 to 365 days (IR=0.20)
Average WL Rise per Section = 5 - 6 ft.

6 to 12	13 to 19	6 to 11
13 to 19	32 to 39	13 to 19
6 to 11	13 to 19	6 to 12

Recharge 49,275 af in 365 days (IR=0.30)
Average WL Rise per Section (ft).

18	28	18
28	58	28
18	28	18

Extra Recharge = 31,775 af.
Extra Rise from 129 to 365 days (IR=0.30)
Average WL Rise per Section = 12 - 14 ft.

6 to 18	14 to 28	6 to 18
14 to 28	40 to 58	14 to 28
6 to 18	14 to 28	6 to 18

Recharge 65,700 af in 365 days (IR=0.40)
Average WL Rise per Section (ft).

23	36	23
36	76	36
23	36	23

Extra Recharge = 48,200 af.
Extra Rise from 97 to 365 days (IR=0.40)
Average WL Rise per Section = 16 - 20 ft.

7 to 23	16 to 36	7 to 23
16 to 36	40 to 76	16 to 36
7 to 23	16 to 36	7 to 23

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Table 10. Strand Ranch Maximum Water Level Mounding Rise at Selected Locations.

365-day Recharge Case	IR = 0.20	IR = 0.30	IR = 0.40
pond acreage (ac) =	450	450	450
recharge rate (ft/d) =	0.20	0.30	0.40
recharge duration (d) =	365	365	365
recharge volume (af) =	32850	49275	65700
Total Water Level Rise at:	(ft)	(ft)	(ft)
well SR 01	36	54	70
well SR 02	42	62	82
well SR 03	36	54	70
well SR 04	42	62	82
well SR 05	48	71	93
well SR 06	42	62	82
well SR 07	36	54	70
well SR 08	42	62	82
well SR 09	36	54	70
well Nikkel (RRB)	19	27	36
well Nikkel Shop (RRB)	7	10	13
well Brimhall (RRB)	6	9	12
well KWB 03Q1	19	29	38
well KWB 03Q2	18	28	37
well KWB 03R	26	39	52
well KWB 10K	11	17	22
well KWB 11A	26	38	50
well KWB 11C	34	50	66
well KWB 11E	19	29	38
well KWB 11L	16	23	31
well KWB 11N	11	17	22
well KWB 11Q	12	18	23
well KWB 12C	17	19	26
NE cor study area (NE sec 36)	4	6	9
SE cor study area (SE sec 12)	4	6	9
SW cor study area (SW sec 10)	4	6	9
NW cor study area (NW sec 34)	4	6	9
Center, north side study area	10	15	20
Center, east side study area	10	15	20
Center, south side study area	10	15	20
Center, west side study area	10	15	20

Exhibits.

Exhibit 1.

Mathematical Aquifer Models.

Exhibit 1.
Mathematical Aquifer Models.

Aquifer behavior.

An aquifer is a porous medium consisting of one or more layers of rock or sediment which can store and transmit water in useful quantities. In the simplest terms, ground water aquifers function in two ways: an aquifer functions as a reservoir to store water and an aquifer functions as a pathway for ground water flow. Changes in aquifer storage or aquifer flow are caused by either gains or losses of water from the aquifer due to any of several natural or manmade actions. These changes are always manifested as changes in the elevation, orientation, and/or gradient of the potentiometric surface (i.e, water levels) in the aquifer.

In the case of aquifer storage, hydrologists evaluate ground water storage with a map of the water level elevation which basically represents how “full” the aquifer is at any particular location and time. If a hydrologist wants to determine the hypothetical impacts of gaining or losing water from the aquifer due to, for example, recharge ponds or pumping wells, then the impacts would be represented by changes in the configuration of the water table as presented in one or more maps or cross sections. All estimates of the change in aquifer storage use the area-weighted vertical changes in this water surface to calculate the volumetric change in storage.

In the case of aquifer flow, hydrologists evaluate ground water flow in the aquifer by determining the flow paths (which we call particle trajectories) and flow rates (particle velocities) that describe the movement of water molecules in the aquifer. If a hydrologist wants to determine the hypothetical impacts of changing the aquifer dynamics due to, for example, recharge ponds or pumping wells, then the impacts would be represented by changes in the lengths and directions of the flow paths as presented in one or more maps or cross sections.

Computer Modeling.

Hydrologists use mathematical aquifer models (sets of equations including sets of conditions and parameters) to calculate the hypothetical water level elevation maps and the ground water flow velocities and flow path maps which are predicted to result from the aquifer dynamics related to recharge ponds, pumping wells, streams, springs, and/or any other natural inflow/outflow or manmade action of interest. Since many aquifers and types of aquifer dynamics have been thoroughly studied and modeled, many computer models exist which can be used to model many classes of aquifer behaviors. Many such aquifer behaviors may be easily, quickly, and reliably studied with the right choices of model and parameters.

Modeling is an exercise in cause-and-effect. In modeling, we consider the natural or manmade flows of water into and out of an aquifer to be “causes” and the resulting water level behaviors observable in the aquifer to be “effects”. Causes are the inputs to a model and the effects are the intended output of the model. The model itself is our mathematical representation of the real aquifer and we will consider a model to be a good model if a set of model inputs and outputs satisfactorily resembles a set of known cause-and-effect flows and water level behaviors actually observed in the aquifer.

Water Level Drawdown Analysis.

Let us consider the special case of potential water table drawdown and inward radial flow of ground water due to installing and then pumping a new water well. Hydrologists often refer to this type of evaluation as a drawdown analysis or impact analysis. Our desired output is a map which shows the hypothetical water table drawdown and ground water flow paths within the capture zone surrounding one or more wells. We can calculate a predicted aquifer behavior for one or as many wells as we are interested in, since the mathematics of modeling provides for an unlimited number of causes and effects, depending only on computer memory and processing speed.

There are many computation methods for predicting drawdown from a pumping well in space and time and every method requires that the user select the equations which are most appropriate for the user’s preferred model of the aquifer. In essence, the user must try to select the set of mathematical expressions which best represents the user’s physical model of the aquifer. The hydrologist’s physical model of the aquifer includes knowledge of the geology and hydrology including the layering, structure, depths, dimensions and physical properties of the aquifer as well as the locations and flow rates of all sources of inflow and outflow to the aquifer such as wells, streams, ponds, etc.

The calculated result, if done correctly, always represents the workings of the mathematical equations but only represents the behavior of the real aquifer to the extent that the parameters, simplifications and assumptions of the mathematical model reflect the true workings of nature. The selection of the mathematical model, the equations, the accuracy of the parameter values, and the representativeness of the calculated output all reflect the experience, expertise, correctness of- and uncertainty in- the judgments of the hydrologist. These judgments cannot be made by the computer and the two main judgments include the choice of mathematical model and the choice of a set of aquifer parameters.

There is no such thing as a simple calculation. A good impact analysis rests at least as much on a hydrologist's competence in understanding equations, validity tests, boundary conditions, and model parameterization as it does on the determination of aquifer properties. In our opinion, many hydrologists and engineers who use mathematical models to compute aquifer impacts would benefit from a better background and understanding of the proper use and pitfalls of such models because, from experience, we have observed the results of many aquifer modeling efforts which are unusable because they demonstrably fall into one or more of the obvious and avoidable pitfalls of the method.

Analytical Models.

For any scope of work, there are two basic choices of mathematical model. The first choice is to select a "canned" analytical computer model which best approximates the interpreted aquifer conditions and then supply the user's best estimates of the required aquifer parameter values. The great advantage to this alternative is that the models are fast, convergent, easy to customize and operate, and the models result in a *unique* set of solutions because the degrees of freedom in the model are the same as the number of available parameters. SSS selected an analytical model since it was very well suited to the aquifer characteristics for this particular project scope of work.

The general disadvantage of an analytic computer model is that the mathematical model may not represent all of the known or suspected complexities of the real aquifer and the user must evaluate the relevance and magnitude of the possible errors in the results due to the simplifications in the mathematical model. The analytical models which are frequently used today include the familiar equations attributed to Theis, Cooper - Jacob, Hantush, Hantush - Jacob, Neuman, Strack, etc., for all of the useful recharge and recovery interactions (wells, ponds, rivers, surface recharge, etc) for transient and steady- state conditions in unconfined, confined, and leaky aquifers. Analytical models are particularly well-suited to the prediction and simulation of water levels and flow trajectories related to recharge mounds and water level depressions due to the operations of aquifer storage and recovery (ASR) projects.

Numerical Models.

The second choice, which SSS did not choose for this project, is to design and program a numerical computer model which best approximates the interpreted aquifer conditions in all its 3-dimensional detail and then supply the user's best estimates of the required aquifer parameter values. The only advantage to this alternative is that the model may be designed to any degree of complexity in order to approximate the true aquifer structure and dynamic inflow/outflow elements.

The disadvantages of numerical modeling are numerous and punishing. The models are tedious and difficult to build and verify; the models require an impossibly vast knowledge of the aquifer properties because the user must define the value of every aquifer parameter at every depth at every location; the hundreds or thousands of degrees of freedom always outnumber the amount of real data which causes non-uniqueness[8] and equivalence[9] in the model outputs; and there is a significant likelihood that numerical complexity does nothing to improve the quality or accuracy of the output of the calculation compared to analytical models while giving a false sense of precision in the effort.

One of the most popular numerical models is actually a number of programs which are all referred to by the name *Modflow* (a trademark of the United States Geological Survey), which are based on a publicly- available computer code developed by the U.S.G.S. and commercialized in several proprietary forms by different scientific software companies. Sierra Scientific Services owns a complete set of Modflow simulators for groundwater flow, contaminant transport modeling, and parameter estimation but SSS favored the analytic model to be better suited to this particular project scope of work.

Model Calibration.

Modeling is commonly thought of as specifying a set of inflows and/or outflows to a parameterized aquifer model and then calculating the predicted water level fluctuations which are expected at various locations over time. The locations, magnitudes, and durations of the calculated water levels depend on the choices of the numerical values of the various aquifer

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[8] Uniqueness is a computational condition in which a given set of inputs can result in only a single, fully determined output. Non-uniqueness is a computational condition in which a given set of inputs can result in two or more different, fully- determined possible outputs.

[9] Equivalence is a computational condition in which two or more different set of inputs can result in exactly the same, fully determined output.

properties that govern such behavior. Calibration is commonly thought of as tweaking the model parameters until the predicted water levels match the actual, observed water levels for the case being simulated.

The study of the movement of water through permeable aquifers is referred to as ground water hydraulics and *"the principle method of analysis in ground water hydraulics is the application ... of equations derived for particular ... conditions."*[10] *"The flow of fluids through porous media ... can be described by differential equations."*[11] *"These mathematical ideas are among the most abstract that we will encounter in hydrogeology."*[12] Groundwater modeling, therefore, is a process which requires expertise in mathematics as well as expertise in hydrogeology.

The use of computers and computer models has vastly revolutionized groundwater hydraulics by speeding up calculations, by improving computational accuracy, and providing for models that would have been impossibly complex to calculate by non-computer methods. This level of automation has *not* reduced the need for human judgment; rather, it has *increased* the need for operator education and expertise to correctly match the computational systems to the real-earth counterparts. The fact that nearly every model run by nearly every consultant still needs to be "calibrated" suggests that the models and/or the operators have not yet succeeded in correctly matching the computational systems to the real-earth counterparts.

"Model calibration" is a popular catch phrase which implies that there exists some special method of post-processing which can be used to independently verify, improve, or optimize the computational results of a modeling effort after a computer model has been "run". Let us consider what workers commonly mean by calibration.

Groundwater modeling is an exercise in simulating the connection between cause-and-effect in a natural aquifer system. For example, we know that pumping a water well causes water levels in an aquifer to decline. We can select one of many available commercial computer models and "parameterize" it to represent the aquifer of interest. If we use this

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[10] Lohman, S.W., 1972, Ground-water Hydraulics, USGS Professional Paper 708, Washington, D.C., p. 1.

[11] Fetter, C.W., 1994, Applied Hydrogeology, 3rd Ed., Prentice-Hall, p. 146.

[12] Domenico, Patrick, A., and Schwartz, F. W., 1990, Physical and Chemical Hydrogeology, John Wiley & Sons, p. 104.

computer model to predict the water level declines for a certain water well and then measure the actual water level behavior for that well under the same conditions, and if the predicted and actual water level behaviors are the same to within some acceptably small margin of error, then we might say that the model is correctly parameterized.

If the predicted and actual water level behaviors do not agree, then we assume that one or more of the model parameters may be incorrect. The process of calibration serves to adjust the model parameterization and we "calibrate" the model by changing selected parameter values until the predicted and actual behaviors agree for a specified calibration event. We then say that the model has been calibrated and we are thereby implying that the model now is an accurate representation of the aquifer. We are also implying that if we model and then observe a different set of cause-and-effect conditions, then the new set of predicted and observed results would agree since the model had been correctly parameterized through the process of calibration. We are further implying that, if we choose to model another set of cause-and-effect conditions which we are unable to verify by direct experiment or observation, we can place high confidence in the accuracy of the calculated results since the model has been calibrated. The real importance is not whether a model has been "calibrated" but whether some set of measures has been used to support an acceptable level of confidence in the accuracy of the predicted results.

In this study we used a computer model to calculate the hypothetical water level declines under the area of interest that would accompany a proposed project water well pumping scenario involving multiple operating wells. We cannot calibrate our computer model at this time with predicted and actual drawdowns because the well field doesn't actually exist so we have no actual cause-and-effect scenario.

Instead, we have used another set of measures to support an acceptable level of confidence in the accuracy of the predicted results. The actual area of interest is small enough that, based on experience and theoretical considerations, we expect each aquifer parameter to be constant across the entire "model space". Therefore, by eliminating spatial heterogeneity as a model factor, we have reduced the potential uncertainties to just a few degrees of freedom. Those degrees of freedom are the few aquifer parameter values which we need to perform our water level calculations.

We put a large effort into determining good values for the required aquifer parameters. We only have one aquifer parameter value which was measured within the actual area of interest but we can assign each of the other parameters to its own limited range of possible values based on our study of reported parameter data from similar geology in the surrounding area. We selected a single set of parameter values from these ranges of values to be used as a base case scenario and we analyzed the sensitivity of the calculated water level drawdowns to variations in each of the parameters. Since we conclude that it is very unlikely that any actual parameter value lies outside its specified range of possible values, we can calculate a limited range of possible water level drawdowns such that the true, but unobserved, drawdowns will most likely be within that range.

For the purpose of this study, we are primarily interested in whether or not the predicted water level drawdowns will be acceptable or mitigate-able according to some set of criteria. It may not be so important to accurately know the exact water level drawdowns if we can determine that the entire range of calculated water level impacts are acceptable by the relevant criteria.

Exhibit 2.

Aquifer Parameters and Parameter Values.

Exhibit 2.

Aquifer Parameters and Parameter Values.

The aquifer parameters of interest for mathematical modeling include those *intrinsic* physical properties of the porous media which determine the volume- specific storage and unit flow properties of the aquifer. These intrinsic properties are then combined with the physical dimensions (depths, thicknesses, boundaries, inflows, outflows, and gradients) of the aquifer media to determine the full- aquifer behavior. The storage properties include the specific storage (S_s) and specific yield (S_y) of each of the porous media. The required flow properties include the hydraulic conductivity (K), porosity (φ), and dispersivity (α) of each of the porous media. The hydraulic conductivity is required for volumetric flux and flow rate in directions of interest (K_h for horizontal flow and K_v for vertical flow), the porosity is required for particle tracking, and dispersivity (both longitudinal α_L and transverse α_T) is required for contaminant transport.

These properties are normally determined either by physical properties measurements on actual rock or sediment samples or by special types of pumping tests on water wells which have been completed across the thickness of the aquifer. Some of these properties vary by several orders of magnitude for common aquifer rock- and sediment- types, so for aquifer materials which have not been measured or tested, there is little likelihood that a best- guess “textbook” value which is based on rock type or another index property will be very close to the actual value. We recommend that the careful determination of the relevant physical properties be an essential and early part of any groundwater program.

It is important to emphasize that the values of these physical properties are all constants for each of the respective aquifer media and that they do not vary with changes in either the water table, or in the pump rate or completion interval of a well, or with any other observed variable, apart from the natural variability of the property within the porous medium itself. It is good practice to measure these properties as many times as possible to determine the average value and range of natural variability for each. And since hydrologists recognize that the natural variability of these parameters may be large, it is best to obtain measured values which are representative of the aquifer under the entire area of interest for which impact analyses are desired, and measured in ways which minimize the unassociated variance in the determination. It is also important to emphasize that few of these properties can be determined directly from well tests and must instead be derived indirectly from well test data by also using other information. The ability to do this is governed by cost, access to wells, and the expertise of the hydrologist to perform the right test and to make the necessary corrections for factors and interferences which otherwise cause errors in the values.

Aquifer storage properties.

Water is stored in an aquifer by occupying the intergranular void spaces of the porous aquifer material. The physical amount of water which can be stored in and recovered from a porous medium is the sum of two components; the fillable void space remaining in a rock or sediment which is at residual saturation, and a very much smaller component which is a result of the minute elastic dilation of this void space when the water in the aquifer is under pressure combined with the slight compression of the water itself.

When water is released or recovered from an aquifer, the first water recovered is always that which is released due to the elastic rebound of the pore space and the water. The last water recovered is always that which drains from the pore space and dewaters the aquifer. When water is stored in the aquifer, the reverse actions occur, i.e., water first fills the void spaces and then dilates the void space as the fluid pressure increases.

Specific yield. The first component is termed the *specific yield* (S_y) and is the amount of water produced by "de-watering" the aquifer void space as the water table falls within the aquifer. This term effectively determines the amount of water which is gained or lost under the project area or some specific area due to the rising or falling water table. The values for well sorted sandy sediments[13], such as in the area of interest may range from $0.10 \leq S_y \leq 0.35$. The formula for calculating the volume of water released by dewatering is $V_w = A \cdot S_y \cdot \_h$ for a drop in water table of _h. The aquifer thickness is not a term in this calculation.

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[13] Fetter, C. W., 1994, Applied Hydrogeology, 3rd ed., Prentice - Hall, Inc., Table 4.4, p.91.

<u>Specific storage and Storativity.</u> The second component is termed the *specific storage* (S_s) and is the much smaller amount of water produced by contraction of the dilated pore space and expansion of the water as the pressure drops within the aquifer. The values for loose- to well-packed silty or sandy sediments[14], such as in the area of interest may range from $0.00017 \leq S_s \leq 0.0032\ ft^{-1}$. This property is related to the in situ bulk compressibility of the aquifer media and the water itself. The compressibility of water is known and we can measure the compressibility of sediment samples, as SSS has done for RRBWSD on another project.

The formula for calculating the volume of water released from the aquifer by de-pressuring is $V_w = A\cdot H\cdot S_s\cdot$_h for a drop in head of _h in an aquifer of thickness H. The product of aquifer thickness and specific storage in this equation is defined as *storativity*, $S = H\cdot S_s$, and it is obvious that if the thickness of an aquifer changes, then the value of S will change, even though the intrinsic property of the porous medium, i.e., the specific storage, remains constant. It should also be noted that if only a portion of the full thickness of an aquifer is relevant to a particular problem, then the appropriate value of S to be used in any calculation is the value for the interval of interest.

The specific storage term is also an essential term in the flow equations which describe transient, i.e. non steady- state, aquifer flow. The ratio of hydraulic conductivity to specific storage is defined as the hydraulic diffusivity and this ratio explicitly occurs in all non steady-state equations of flow. Therefore, while it is tempting to dismiss the need for an accurate value of S_s because it is negligible for the calculation of aquifer storage, it is important to obtain as good a value as is possible because it occurs directly in the flow equations along with conductivity. For example, the 20-fold difference between low and high values of S_s will make only a negligible difference in the calculated storage capacity of the aquifer, but will significantly alter the calculated results of the flow equations.

<u>Available storage capacity (SC).</u> The available storage capacity, which is not relevant to this particular scope of work, is defined as the volume of water that could be stored in the unsaturated zone above the water table within the boundaries of the project area up to within a few feet of the ground surface. This working definition is usually used to calculate a change in aquifer storage due to a rise or fall of the water table over some time period, and is not an important or even relevant part of many types of aquifer modeling. In practice, the specific

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[14] Domenico, P.A. and Schwatrz, F.W., 1990, Physical and Chemical Hydrogeology, John Wiley, Inc, Table 4.1, p.111.

storage (S_s) is negligible compared to the specific yield (S_y) ($0.0005 < S_s/S_y < 0.00005$) so, unless an aquifer is very thick, we do not consider the specific storage in the calculation of storage capacity and just use the specific yield formula.

Layered- aquifer storage properties. For aquifers which are either heterogeneous or layered, we must determine the storage properties of each type of sediment within the aquifer and the proportions of each, and perhaps even the sequence in which they are successively filled and/or dewatered. For a layered aquifer, the volumetric storage capacity under an area (A) is defined as being equal to the volumetric integral: $SC = \int^A\int \varphi(1- S_r)dAdh$, which simplifies to a summation which looks like: $SC = A\Sigma(h_i \cdot Sy_i)$, that is, the total Project area times the sum of products of the individual layer thicknesses and specific yields which, finally, is often more- conventionally written as: $SC = A \cdot H \cdot Sy_{eq}$, the product of total Project area area times total aquifer thickness times the “average” or equivalent specific yield. We must always remember that the correct values for determining an actual change in storage must be those values of $h_i \cdot Sy_i$ which represent the actual interval being filled or dewatered, and not the “full- aquifer” average value. Any modeling effort which simplifies the aquifer stratigraphy by reducing the number of layers must address the issue of determining the equivalent parameters of each layer model relative to the actual parameters of the actual stratigraphy.

The same additive property is true of storativity (S) for a sequence of layers in an aquifer. The value of storativity is a summation which looks like: $S = \Sigma(h_i \cdot Ss_i) = \Sigma(S_i)$, that is, the storativity of any depth interval is the sum of the individual- layer storativities for all layers within the interval. This additive property is important to consider when interpreting well tests which are not completed across the full layered- aquifer thickness.

Aquifer flow properties.

Water flows down-gradient in an aquifer from higher to lower potential. Groundwater flow may be horizontal or vertical or have components of both. The externally applied forces which cause water to move come primarily from gravity and secondarily from manmade actions. In other words, left to itself, the groundwater in aquifers and in basins “seeks its own level” and always prefers the path of least resistance. Water will stop moving when there is no change in potential along a pathway. Otherwise, water is moving in one of two type of conditions, either steady- state flow or transient flow. In steady state flow, water passing any location continues to flow in the same direction at the same flow rate and at the same head without any change over time. In transient flow, water passing any location will not be steady in direction, flow rate, or head because of dis-equilibrium somewhere in the system. Transient flow may be non-Darcy flow and this is the condition of the aquifer in the project area most of the time.

The persistent re-equilibration of a groundwater system toward a no-flow condition takes time. Often the cycle of recharge to- and recovery of- water from the system is faster than the ability of the groundwater system to either re-balance or even achieve a steady- state. As in most cases, the groundwater system is always dynamic and in a transient state, even if it appears to respond slowly and steadily by human perception.

The groundwater flow behaviors of interest include flow direction and flow rate. Flow direction may be visualized as an arrow pointing in the down- direction of the potential gradient, since water moves in the direction of the applied force. Flow direction may also be visualized as a hypothetical flowline that a single water molecule would follow under steady-state. A contour map of the water table or piezometric surface is a map of the groundwater potential in the aquifer, and the direction of flow at any location will be perpendicular to the contours and pointing in the direction of lower potential.

Flow rate can be described as the average flow speed of a water molecule at a specified place and time or as the “instantaneous” volumetric flux of a volume of water through a specified cross sectional area (W·H) of the aquifer over a short period of time. Apart from the externally applied driving forces and the physical dimensions of the aquifer, these measures of ground water flow depend only on the hydraulic conductivity and porosity of the porous medium.

Hydraulic conductivity. The *hydraulic conductivity (K)* is a measure of the ease with which *water* flows through an aquifer. In general, the natural flow of a fluid through a porous medium depends on the density (ρ) and viscosity (μ) of the fluid, the intrinsic *permeability (k)* of the porous medium, and the driving force of gravity (g) which causes fluid to move. Since the value of gravity and the values of density and viscosity of water are nearly constant for the usual range of aquifer conditions, the only variable property which controls the fluid flow in an aquifer is the permeability. So, for mathematical convenience hydrologists have combined the value of gravity, the properties of water, and the measure of aquifer permeability into a single, new property which is defined as the hydraulic conductivity, where $K = k(\rho g)/\mu$. The units of this “aquifer” property are length per time, i.e., units of velocity such as ft/day.

This term effectively determines the flow rate or volumetric flux of water through the aquifer under whatever potential gradient exists at the time and place of interest. The K values for silty and sandy sediments, such as occur in the area of interest may range from $0.001 \leq K \leq 300$ ft/d, a range covering more than five orders of magnitude. The formula for calculating the steady- state volumetric flux of water (Q_w) in an aquifer is $Q_w = W \cdot H \cdot K \cdot G$ for a groundwater potential gradient G = _h/_x, through an aquifer cross sectional area of width W and thickness H. If the aquifer is not in steady- state, then the calculation represents only the “instantaneous” flow at that moment at that location under those conditions and the full equation of flow must instead be used to describe the transient flow behavior over time.

The steady- state flux equation applies to both horizontal and vertical groundwater flow with the condition that the values of K and G are the values of hydraulic conductivity and gradient in the direction of flow. Most aquifer materials, whether unconsolidated sediments or sedimentary rocks, are anisotropic and are commonly 5 - 20 times more permeable in flow directions parallel to the bedding planes than in flow directions perpendicular to the bedding planes. Thus, in order to quantify or model aquifer flow with both horizontal and vertical components, it is necessary to specify both the horizontal and vertical hydraulic conductivities of relevant aquifer materials.

Transmissivity. A term representing hydraulic conductivity occurs in all groundwater flow equations. This term also occurs in the solutions to many flow problems as the product of conductivity (K) times aquifer thickness (h) which we define as transmissivity, $T = Kh$. The significance to the hydrologist is that an aquifer pump test often results in providing a value for the thickness-conductivity product Kh, which we’ve defined as transmissivity T, but the aquifer test does not provide a means of separately determining the values of K or h alone. We normally measure the aquifer thickness (h) directly in a well, on an outcrop, or from geophysical data, and then obtain a calculated value of $K = T/h$ from the independently measured values of T and h.

We point out that aquifer transmissivity is not an intrinsic property of an aquifer or aquifer material since its value depends on the saturated vertical thickness of the aquifer, i.e., transmissivity will vary from place to place as the saturated aquifer thickness varies, even where the intrinsic permeability of the aquifer remains constant. We strongly prefer and recommend that it is better to specify the aquifer properties of K and h separately rather than specifying only a value of transmissivity.

Leakance. The *leakance (L′)* is a property which determines the rate of downward vertical flow of water from a water table aquifer, through a somewhat-permeable aquitard, and into an underlying semi-confined aquifer due to head differences across the aquitard. Such head differences are common in many aquifer systems. The value of L′ is determined as the ratio of vertical hydraulic conductivity to the thickness of the aquitard, $L' = K_v'/h'$. (The prime (′) in the abbreviations symbolize that these are properties of the *aquitard* and not of the underlying aquifer). We refer to aquifers which show this type of recharge behavior as semi-confined or “leaky” aquifers and one flow equation which describes this type of flow behavior is the Hantush - Jacob equation, named after its authors.

The mathematics of leakage occurs in the flow equation in the form of what is referred to as the Hantush leakage factor (B) and B is related to known parameter values according to the formula $B = (T/L')^{½}$. In the project area, the high- permeability zones of the aquifer are sandy sediments and the low-permeability zones are silty sediments. These silty sediments are the aquitards which retard the vertical flow of water between the sandy layers of the aquifer. Based on our measurements and estimates of the relevant properties, we estimate that the value of B varies in the range of about $3200 \le B \le 10000$ and we have used a value of B = 6000 as our base case value.

Porosity. The *porosity* (φ) is the dimensionless ratio specifying the fraction of void space to total space in a unit volume of a porous medium. As a flow property, it determines the amount of intergranular flowpath within the porous medium that is available to the water. The formula for calculating the steady- state flow velocity of water (v_w) in an aquifer is $v_w = K \cdot G/\varphi$. If the aquifer is not in steady- state, then the calculation represents only the “instantaneous” flow speed at that moment at that location under those conditions and the full equation of flow must instead be used to describe the transient flow behavior over time. Well-sorted, unconsolidated, sands and silts commonly have porosities ranging from 10 - 30%. Porosity decreases as the degree of sorting decreases, i.e., as the range of grain sizes increases in the stratum.

Layered- aquifer flow properties. For aquifers which are either heterogeneous or layered, we must determine the hydraulic conductivity and porosity of each type of sediment within the aquifer and the proportions of each. For a layered aquifer, the total average horizontal hydraulic conductivity of the full saturated aquifer thickness is defined as being equal to a summation which looks like: $K_{avg} = \Sigma(h_i \cdot K_i)/H$, that is, the sum of products of the individual layer thicknesses and hydraulic conductivities divided by the total aquifer thickness. Since the product of thickness and conductivity in this equation is defined as transmissivity (T), this is often more-conventionally written as: $T_{eq} = H \cdot K_{avg} = \Sigma(h_i \cdot K_i) = \Sigma(T_i)$, i.e., the equivalent aquifer transmissivity is the sum of the individual layer transmissivities.

The average conductivity and equivalent aquifer transmissivity refer to a hypothetical, homogenous aquifer which would deliver the same total volumetric flux as the specified layered aquifer. However, it must be remembered that the true flow behavior and volumetric fluxes are different in the individual layers of the actual aquifer than in the hypothetical equivalent- layer model and that the average or equivalent properties represent a mathematical fiction which is usable only in certain specific ways.

Aquifer Transport properties.

Transport in this context refers to the motion of constituents which are dissolved and/or suspended in ground water, especially the movement of unregulated contaminant releases which propagate as slugs or plumes within the aquifer. The important transport processes are advection, dispersion, retardation, and attenuation which might be defined as follows. Advection is the physical transport of a constituent by the flow of water within a porous medium. Retardation includes all processes which cause a plume or constituents to move slower than the ground water. Dispersion includes all processes which re-distribute constituents away, i.e., spreads them out, from the center of mass of a plume. Attenuation includes all processes which permanently remove constituent mass from a ground water plume.

These processes affect contaminant transport and plume behavior in specific ways. Mathematically, they may all be represented by terms in the transport equation which describes the location, speed, amount and distribution of contamination within a plume in space and time. Advection refers to groundwater flow which we have already discussed. Both retardation and attenuation may be thought of as properties related to the type of constituent rather than as properties of the aquifer. Dispersion is related to dispersivity which is strictly an aquifer property which can be measured with special types of well test or estimated from theoretical considerations. Since the treatment of transport is outside this project scope of work, we omit the discussion of these processes from this report. However, it is important to note that most contaminants travel at different flow speeds and different particle trajectories than the ground water and must be modeled in different ways.

Sources of data.

Sierra Scientific Services (SSS) used four sources of information for the aquifer properties within the area of interest (AOI) including:

1. SSS physical property data (S_y, S_s, φ, K, H, F_{sd}) measured on surface and borehole samples or determined from electric logs from locations within the Rosedale - rio Bravo Water Storage District,
2. ID4 December, 2001, well test data (T & S) from wells near the intersection of Stockdale Hwy and Allen Rd at the northeast end of the Kern Fan,
3. C.o.B. infiltration test data (Kv) for large test ponds also near the intersection of Stockdale Hwy and Allen Rd at the northeast end of the Kern Fan,
4. KCWA water table elevation maps covering the Kern Fan area of interest.

SSS carefully reviewed and chose not to use the data from two other sources including:

5. DWR aquifer model data (Sy, S, K & T) for the Kern Fan area,
6. KWBA and Pioneer Project pump test data from various reports by Kenneth Schmidt and Associates (KDSA) of Fresno, Ca.

SSS did not use the data from these two sources for several reasons, chief among them is that we obtained a minimum but sufficient amount of well- documented, actual measurements for the necessary parameters of interest from the first four sources. However, with all due respect, we also consider the data from both of these other two sources to be questionable because of a lack of data, poor documentation, questionable or incorrect calculation methodologies, lack of corroboration, supporting discussions which are inconsistent with basic principles of hydrology, and/or internal inconsistencies. We recommend that readers carefully evaluate the data from these sources against their own technical and theoretical criteria before they use them in their own analyses. We offer some of our observations regarding the data from these two sources below, for purposes of clarification since we consider the selection (or rejection) of parameter values to be an important, documentable, exercise of judgment in a modeling program.

The DWR parameter data[15]. In 1988, the California Department of Water Resources (DWR) purchased approximately 20,000 acres of land in Kern County for an aquifer storage and recovery (ASR) program. The area has since changed ownership and is now known as the Kern Water Bank. In the early 1990's, the DWR attempted to develop a numerical computer model to simulate the aquifer behavior and evaluate various aspects of their project. The modeling effort concluded in early 1996 with the publication of the footnoted DWR memorandum which summarized the work. The memorandum included a discussion and summary of all the aquifer parameter values that the DWR used, and these parameter values have been referenced and used by some workers in the local water community.

In the process of parameterizing their computer model of the Kern Fan area, the DWR never actually measured a single value of any parameter in preparation for what became a massive modeling effort. The DWR assigned "textbook" values of specific yield obtained from the general literature (but not specific to the study area) to each of 55 different types of drill cuttings reported in driller's reports. Then, after blundering through a simplistic and erroneous application of trend analysis in which they assigned book values of K_h, K_v and S to these same drill cuttings and then numerically correlated to the assigned textbook values of specific yield, they proceeded to put these values into their computer model.

For example, the DWR assigned values of Sy ranging from 12 - 27% to drill cuttings described as water gravel, dry gravel, heavy gravel, heaving gravel, hard gravel, dead gravel, and cemented gravel. The DWR assigned values of Sy ranging from 12 - 20% to drill cuttings described as hard sand, heaving sand, dirty pack sand, tight sand, and quick sand. The DWR assigned values of Sy ranging from 3 - 6% to drill cuttings described as sediment, soil, loam, hard clay, cemented clay, adobe, and muck.

The DWR then used driller's logs and electric logs to basically assign all of the Kern County geology to one of the 3 previously-described sediment groupings, i.e., gravel, sand, or

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[15] Swartz, Robert, 1995, Development and Calibration of the Kern Fan Ground Water Model, DWR San Joaquin District Report, July, 1995.

silt/clay and then proceeded to apply their fabricated numerical parameter values to their geological model.

Apart from the aquifer parameter values, the DWR approach to developing the basic computer model appears to be consistent with many of their model simplifications which were required in order to approximate the true physical aquifer behaviors within the constraints of the model. However, in our opinion, their treatment of aquifer parameters shows poor judgment perhaps stemming from an insufficient understanding of the physical properties and property interrelationships of porous media and geological materials and, in our opinion, their poor parameterization showed up in their modeling as poor results.

DWR reported that the model calibration results were unsatisfactory based on their initial parameter values so they arbitrarily changed the parameter values around their control points to improve the outcome. Unfortunately, the DWR computer model never provided good results, which we attribute to incorrect parameter values, poor assumptions and poor choices of free parameters in the "calibration" tests.

Since the initial parameter values were questionable on petrophysical and theoretical grounds, since their choices of driller's explanations of the geological materials are unrepresentative of the local stratigraphy, and since the model results were unsatisfactory, we conclude that there is very little credibility in the representativeness of any of the DWR parameter values except to the extent that they fall within the wide ranges of published values for generic geological materials. We therefore, place no credibility whatsoever in any of the initial or subsequent textbook parameter values that the DWR assigned to any aquifer layer at any location as have chosen to not use their data or modeling results.

Kern Water Bank and Pioneer Project well test data[16]. The operators of these two sites have conducted a number of pump tests on wells in these areas over the years, and the test data have been interpreted and reported by Kenneth Schmidt and Associates (KDSA) of Fresno, Ca

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[16] Schmidt, Kenneth D., November 27, 1997, Hydrogeologic Conditions for Development of the Maximum Recovery Plan for the Kern Water Bank Authority, revised report, Kenneth D. Schmidt & Associates, Fresno, CA.

Schmidt, Kenneth D., September 22, 1998, Maximum Recovery Plan for the Pioneer Kern Fan Project, draft report, Kenneth D. Schmidt & Associates, Fresno, CA.

on behalf of and under contract to the Kern County Water Agency to provide estimates of the aquifer parameters T & S. Part of the issue with these well tests as a source of aquifer parameters is that the test operations and test data are only poorly documented in these reports. But based on our review of the scant information in these reports, we can make the following observations.

The pump tests appear to have been designed and operated by engineers in order to determine pump-parameter values rather than aquifer parameter values. Many of these tests had multiple wells pumping simultaneously and most tests lasted for only short durations (as little as 20 minutes or 1 - 2 hours), both of which make it difficult to determine aquifer properties. Moreover, all of the reported drawdowns were measured in the pumping wells and not in adjacent monitoring wells, so none of the data meet the standard validity criteria for aquifer analysis.

Our main objections to the findings of the two KDSA reports include: no presentation of test data or calculations, no discussion of where the data came from, no discussion of the assumptions or the methods of calculation of T or S, the acknowledged dependence on uncorrected discharge/drawdown ratios for a number of pumping wells to estimate values of T without providing calculations or making corrections for even the most basic and most obvious variations in well conditions, many explanatory statements that are inconsistent with fundamental principles of hydrology, a heavy reliance on the DWR parameter values which we have reviewed, criticized, and rejected (see previous section) and, finally, an unexpectedly large range of reported values for T which is inconsistent with our own independent data. We therefore give very little credibility to the KDSA parameter data for these reasons.

Aquifer Parameter Values used in this Study.

Aquifer Dimensions. The aquifer model includes a 300-ft thick shallow unconfined zone, a 50-ft thick middle aquitard zone, and a 300-ft thick deep semi-confined zone. All wells are assumed to be completed across the full aquifer thickness of the deep zone, i.e., a producing interval 300-ft long.

Porosity (φ). The source of porosity values for this scope of work is the field work that SSS[17] completed for the Rosedale - Rio Bravo Water Storage District (RRBWSD) and reported in 2003. RRBWSD contracted SSS to drill coreholes, collect sediment samples and obtain laboratory analyses for specific yield and a set of other useful physical properties. One suite of samples came from the RRBWSD recharge pond area less than 1 mile north of the Strand Ranch project site. Based on those samples, the measured average porosity of well sorted sandy sediments is 37% and the measured average porosity of the silty sediments is 34% and give a weighted average porosity for the aquifer media of 30% for this project.

Specific yield (S_y). Specific yield is a function of the porosity and grain surface area of porous media and is a property which varies over only a limited range of values for the few aquifer materials of interest. The source of specific yield values for this scope of work is also from the 2003 field work that SSS completed for the Rosedale - Rio Bravo WSD.

Based on the RRB study, the average specific yield of the sandy and silty sediments in the area of interest are 33% and 8.6%, respectively. Based on the relative fractions of each in the upper aquifer, the average specific yield of the interval is about 21%.

In contrast, KDSA (1998, p. 15) reported that:

> *"The average specific yield of Layer 1 is estimated to be about 17%, based on DWR groundwater modeling. The best specific yield value that can be used ... is 10%. This is thus considered to be an appropriate value to use to estimate future water level declines due to recovery pumpage..."*

And in contradiction, KDSA (1997, p. 11) reported that:

> *"... long term tests in [the KWB] area in 1990 - 1991... generally indicated that [the] unconfined aquifer could be assumed with a storage coefficient of about 0.01 to 0.02 .."*

Our measured values are considerably different than the fabricated DWR values and the KDSA values of unknown origin. We therefore, have rejected the DWR and KDSA values in favor of our own data. In the case of specific yield (Sy), this has no impact on the drawdown analysis since dewatering of the aquifer does not enter into the calculation and therefore the value of Sy is not used in the determination.

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[17] Crewdson, Robert A., 20 January, 2003, Determination of Aquifer Storage Capacity for the Rosedale - Rio Bravo Water Storage District, Bakersfield, California., Sierra Scientific Services, Bakersfield, Ca.

Specific storage (S_s) and Storativity (S). Specific storage is a function of the porosity and bulk compressibility of porous media and is a property which varies over only a limited range of values for the packed, unconsolidated sandy and silty media of interest. The source of specific storage values for this scope of work is from the 2003 field work that SSS completed for the Rosedale - Rio Bravo WSD. Based on compressive stress tests on samples of poorly sorted sand and silty sand, the bulk compressibilities of these samples range from 4.5 - 7.9 x 10^{-8} m^2/N from which we have derived the values for the dense, compacted equivalents of these sediments as 1 - 1.8 x 10^{-8} m^2/N which are in the expected range of compressibilities for dense sands. From these values we have calculated the corresponding values of S_s ranging from 0.000030 to 0.000053 ft^{-1} and averaging 0.000041 ft^{-1}. This range of S_s values is entirely consistent with the range of published values expected for dense sands and silts.

Based on these values of S_s, the equivalent values of storativity for a 300-ft thick aquifer range from 0.009 to 0.016 and if we add a factor for water released from storage in the overlying aquitard, the expected value of aquifer storativity is expected to be in the range from 0.012 to 0.021. Based on this analysis, we would have chosen to use an average value of S = 0.016 for our modeling but, as presented in the following discussion, we have used a value of S = 0.020 as our base case value of storativity.

We have reviewed the available published sources of parameter values and we consider the ID4 well test of December, 2002 to be the best available source of a verifiable T & S value from an actual aquifer pump test for the Kern Fan area of interest. KDSA[18] originally interpreted the data and reported a transmissivity T = 476,000 gpd/ft [equivalent to 63,600 ft^2/d] and a storage coefficient S = 0.0008. However, based on our own independent analysis, we found that the KDSA calculations were incorrect due to a failure to meet the validity criteria of the method and, after our own reformulation, the corrected aquifer test yielded values of T = 20,000 ft^2/d and a storage coefficient S = 0.00056. We also disagreed with the entire KDSA distance - drawdown interpretation presented in the same report because of an incorrect application of the Cooper - Jacob (single-well) method to a cluster of several pumping wells. As a result, we have chosen not to use the KDSA reported values of T & S, in favor of our own reinterpretation of the data.

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[18] Schmidt, Kenneth D., February 28, 2003, Supplement to the Groundwater Conditions and Potential Impacts of Pumping for the ID-4 Kern Parkway and Rosedale - Rio Bravo WSD Projects, aka Allen Road Well Field December 2002 Pump Test, Kenneth D. Schmidt & Associates, Fresno, CA.

Despite the calculation error, the original KDSA values and our recalculated values of T & S from the 2002 ID4 well test differ significantly from those values published in the KDSA report of 1997 (KDSA did not report values of storativity in their 1998 report). With respect to storativity, KDSA (1997, p. 20) reported:

> *"Past pumping in the COB 2,800-area and the Kern Water Bank area indicate a value for storage coefficient of 0.02, which is considered applicable for most of the existing recovery wells. With continued pumping, (i.e. greater than six months), the storage coefficient is expected to gradually increase, to about 0.05, and to possibly as high as 0.10."* (Curiously, KDSA does not report any S values in their 1998 study, stating that (p. 15) *"The storage coefficient can't be readily determined from the available pump tests, mainly because the tests could not be run for long enough periods in the absence of interference.."*)

On the one hand, we are prepared to accept a reported value of S = 0.02 as being close to our expected range of values (0.009 to 0.016) for the deep aquifer zone except that the KDSA value was intended to represent the entire aquifer across all three zones, so there is less agreement here than it appears. We would expect a deep zone value, based on the KDSA full-aquifer number, to be more in the range of 0.001 to 0.01. However, the value of S = 0.02 is completely uncorroborated since KDSA did not provide any data, calculations, or discussions so we are unable to place any credibility in the value. Moreover, their claim that the value of S will increase with time due to continued pumping is not only unsupported with any discussions or calculations, it is contrary to expectation and incorrect based on the most fundamental theoretical considerations. We therefore reject the credibility of the KDSA parameter values as being questionable or at least unverifiable.

Nevertheless, since the KDSA 1997 Report was written for and presented to the Kern Water Bank Authority, we assume that the KWBA is using these parameter data for their own modeling calculations. Lacking any corroborating data to improve the reliability in the parameter value, we have chosen to use the KDSA reported value of S = 0.02 anyway as our base case value for storativity because it was close to our expected range of values and it was also the value reported and used by the Kern Water Bank, the nearest neighbor to the Strand Ranch project Our use of the 1997 KWB storativity value of S = 0.02 is for attempted consistency with previous work for-, and for general acceptability to-, the Kern Water Bank and is neither intended to be construed as our acceptance nor our verification that these values represent the true values within the aquifer.

Transmissivity (T) and Conductivity (K). One T-value for this scope of work is based on our re-interpretation[19] of the ID4 well test of December, 2002. As previously mentioned, we reviewed the KDSA report, disagreed with the KDSA findings, and re-calculated the T & S values using the correct theoretical assumptions and validity conditions for the method.

Based on our re-analysis, the correctly determined value of transmissivity is T = 20,000 ft^2/d. The chief concern is that the test well covers a different completion interval and is about 6 miles from our current area of interest so that the T & S values may not be representative of the conditions near the Strand Ranch. Based on an unpublished, proprietary study by SSS, we have data which tentatively suggests that the average aquifer transmissivity under the Rosedale - Rio Bravo Water Storage District under the east half of township 29s/25e and the west half of 29s/25e is in the range of 18,000 - 24,000 ft^2/d. This large area is immediately north of the current project site and suggest that perhaps an aquifer transmissivity around 18,000 - 20,000 ft^2/d within ± 20% may be representative of the producing zone in the study area as well.

We also reviewed the 1997 KDSA Report and focused on the T and K data which they attributed specifically to the areas of the Kern Water Bank immediately adjacent to the Strand Ranch project site, i.e., KWB Area 3, Area E, and Area S. The reported K values for the three surrounding areas (1997, Table 1, p. 14) have an average value of K = 57 ft/d which is the same as the KDSA reported K-value for the shallow aquifer under Area E alone (1997, p. 13, HCvert = 430 gpd/ft). The values are reportedly calculated from the observed rise in water levels under recharge ponds in 1995 - 1996, using the 1978 Bouwer formula. Unfortunately, KDSA provided no data, formulas, or calculations so these findings are completely uncorroborated. Based on our familiarity with the Bouwer method (Bouwer, 1978, section 8.3.1, pp. 279-288) we observe that such a calculation would be very much more complex than the otherwise simplistic handling of data presented in the rest of the KDSA report. Nevertheless, if these findings were to be accepted as is, they would appear to be unique in that they represent a departure from using the DWR computer model data that is the basis for all of the other reported parameters (1997, p.12).

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[19] Crewdson, robert, A., 20 July, 2004, An Evaluation of Well Placements and Potential Impacts of the ID4 / Kern Tulare / Rosedale - Rio Bravo Aquifer Storage and Recovery Project, Bakersfield, California, Sierra Scientific Services, Bakersfield, Ca.

In our attempt to use aquifer parameter values that will be found acceptable by the Kern Water Bank Authority, we chose to use this reported value of K = 57 ft/d and have calculated an aquifer transmissivity for the 300 ft thickness of the producing zone of T = 17,100 ft^2/d. This value is close to, but less than our range of expected values of T for the same interval. Given the complete lack of verifiable data in the area, we have no basis to prefer one set of parameter values over another. If this T-value proves to be too low in subsequent testing, then the predicted hypothetical drawdowns will have been too large. For all T-values in the real aquifer that are larger than our assumed base case value of 17,100 ft^2/d, the actual drawdowns will be less than those we have calculated in this study. Since there is a body of other data, even though of questionable value in our opinion, which reports a wide range of possible and particularly much higher values of T, we have treated T as one of our free parameters which we vary in our modeling sensitivity analysis. The sensitivity analysis was based on a range of hydraulic conductivity values of $40 < K < 100$ ft/d.

Aquitard leakage factor (B). The mathematics of leakage occurs in the flow equation in the form of what is referred to as the Hantush leakage factor (B) and B is related to known parameter values according to the formula $B = (T/L')^{1/2}$. In the project area, the high-permeability zones of the aquifer are sandy sediments and the low-permeability zones are silty sediments. These silty sediments are the aquitards which retard the vertical flow of water between the sandy layers of the aquifer. Based on our measurements and estimates of the relevant properties, we estimate that the value of B varies in the range of about $3200 \leq B \leq 10{,}000$ and we have used a value of B = 6000 as our base case value.

Both Swartz (1995) and Schmidt (1997) quote generic values for vertical hydraulic conductivity (K_v)for the Kern Water Bank area (see Exhibit 2) ranging from .0004 - .0027 ft/d which are within the two orders of magnitude of typical textbook values for silty sediments. Swartz (1995, p.116) indicated that the selected DWR values were guessed at and did not work very well in their computer models and had to be changed to other, unreported values. Schmidt reported (1997, p.11) that their K_v values were determined from long- term well tests performed in the KWB area in 1990 - 1991 but we do not know how this might have been done, since Kv cannot normally be determined from a well test. Moreover, Schmidt did not present either the well locations, test methods, test data, or calculations so we cannot independently verify the reported values or their relevance to the project area. Except that these reported values fall within the range of expected textbook values for silty sediments, we place no particular credibility in the representativeness of these particular values of K_v. We do not know of any other reported pump test data which provide a determination of the vertical hydraulic conductivity of the local sediments.

There are several reported measured values of vertical hydraulic conductivity Kv_{sand} for both sand and silt samples collected in the area of interest. RRB (Crewdson, 2003) and the City of Bakersfield (COB, 2000) separately reported independent sediment permeability data which are based on laboratory core analyses of shallow unconsolidated sediments which have been retrieved from boreholes down to 120 ft deep. The RRB sand samples had a $Kv_{sand} = 18$ ft/d and the COB sand samples had a $Kv_{sand} = 112$ ft/d. The RRB silt samples had a $Kv_{silt} = 0.038$ ft/d and the COB silt samples had bimodally distributed values of $Kv_{silt} = 0.3$ and $Kv_{silt} = 0.03$ ft/d. Based on these core- sample data, we observe that the local silty sediments are about 500 - 1000 times less permeable than the local sandy sediments.

Based on the Kv/Kh ratio for these sediment analyses and the well-test value of $K_{Hsand} = 80$ ft/d, we estimate that the range of vertical hydraulic conductivity of the silty intervals is about $0.04 < K_{Vsilt} < 0.16$ ft/d with an average estimated value of $K_{Vsilt} = 0.08$ ft/d . Finally, we have estimated the aquitard thickness (b′) based on E-logs and dimensional considerations to be 50 - 100 ft thick and have calculated a range of values of leakance (L′) and Hantush leakage factor (B) accordingly. We have selected an average value of B = 6000 ft for base case drawdown calculations and a range of $3200 \le B \le 10{,}000$ for sensitivity analyses.

Water Levels and Groundwater Gradients. For the calculation of drawdown impacts, we have initially assumed that the regional gradient in the test area is zero so that all model impacts are superimposed on an initially flat water table. We set our reference elevation to be zero at the initial water table rather than at ground level or at mean sea level so that all calculated drawdowns are relative to the initial water table. This device allows us to easily observe just the predicted pumping- induced drawdown at any location without the complicating effects of the natural gradient.

However, in order to perform particle trajectory and capture zone analyses, we must superimpose the calculated pumping- induced drawdowns on a realistic approximation of the natural water table gradient. We based our approximations on observed historical water table behavior for wet and dry climatic conditions in which the unimpacted natural groundwater gradient is northwesterly at -10 to -30 ft/mile. The greater impact during dry conditions is the distortions in the water levels due to pumping of non-project wells in the immediate area so we have prepared one scenario in which the impacts of the local Kern Water Bank wells were included in the drawdown model. The pumping rates for the KWB wells were obtained from KWB published data.

Exhibit 3.

Limitations of the Analyses.

Exhibit 3.

Limitations of the Analyses.

SSS has evaluated several sets of base case and non- base case operating scenarios and aquifer conditions to determine the predicted impacts of a hypothetical Strand Ranch pumping program. The uncertainties in the calculated results are due to several factors which we briefly summarize in this Exhibit.

Non - project wells.

There are three issues related to the impact of non- project wells in the local area. The first issue is the effect of water table decline due to the pumping of these non- project wells which is in addition to, and superimposed upon, the drawdown caused by the project wells. We have not included any hypothetical scenarios which takes this into consideration.

The second issue is that these non- project wells are removing water from aquifer storage which is not included in the project water balance. Even though the project, by design, will remain in balance, the local area may still suffer a net shortage of recharge depending on the operations of other parties which may create a net decline in water levels, which will ultimately change the aquifer behavior from semi-confined to unconfined. We have already recognized this hypothetical condition in our general analysis, and it is important to recognize the potential for shallow aquifer dewatering by the pumping of non-project wells.

The third issue is that non- project wells create capture zones of their own which extend outward into surrounding areas which are outside of the capture zone limit of just the project well field alone. It is possible that these surrounding wells may draw contamination into the project area that would not have arrived here otherwise. Such a capture analysis is outside the scope of this analysis. While there are limits to the possible magnitude of this potential impact, the wells of greatest potential concern would be wells which are close to the project well field and those which are to the east or south of the well field.

Changes in the groundwater gradient.

The Strand Ranch ASR Project is near, but northwest of, the recharge axis of the Kern Fan recharge mound. Based on KCWA groundwater elevation maps for the area, we have observed historical changes in overall water levels and changes in the groundwater gradients as the climate swings from wet to dry conditions.

The depths to groundwater under the Project site fluctuate significantly due to the rise and fall of the Kern Fan recharge mound under the influence of the regional climatic wet/dry cycle. During consecutive dry years the groundwater may be 150 - 170 ft deep such as in 1990 - 1994, whereas during consecutive wet years the groundwater under the site may be 20 - 70 ft deep such as in 1995 - 1998. The unimpacted, natural groundwater gradient under the Project site in dry years trends northwesterly at -10 to -15 ft/mi WNW and in wet years trends northwesterly at -20 to -30 ft/mi NW.

The unimpacted, natural groundwater gradient under the Project site in wet years trends -20 to -30 ft/mi NW'ly (for example, see KCWA groundwater elevation map for Spring, 2001.) During a dry cycle, the absence of recharge in this stretch causes a shallower, more westerly -10 to -15 ft/mi WNW unimpacted, natural gradient to dominate. However, dry years are also characterized by heavy pumping in the Kern Fan banking projects. The groundwater pumping within the Kern Water Bank in the areas adjacent to the Strand Ranch project site has historically been observed to cause reversals, depressions, and/or other complexities in the groundwater gradient under the Strand Ranch project site (for example, see KCWA groundwater elevation maps for Spring, 1993 or Spring, 1994).

Similar large water level fluctuations in the future will create potential design and operating challenges for the placement and operation of downhole pumps in the Strand Ranch water recovery wells. The evaluation of such potential factors is entirely outside the scope of this work program.

We also recognize that such historical water level fluctuations and gradient changes have already affected the downgradient location of the observed shallow-aquifer brine plume which has migrated under the project site from an unspecified off-site, upgradient location. We expect that future gradient changes will continue to impact the known plume and may cause potential but as-yet unrecognized contaminant plumes located outside of, but close to, the long term project well-field capture zone limit to move into the capture zone. The reverse is not really possible, i.e., contaminant plumes leaving the capture zone, because even though particle trajectories say it is possible, actual contaminant migration invariably leaves in situ residues behind in its pathway which linger as continuing in situ sources of low- grade contamination for many years thereafter. We have not included the unknown future fluctuations in water levels or ground water gradient in our analysis.

Uncertainty in predictive modeling.

There are several causes of uncertainty in the outcome of a predictive forecast and it is useful to keep the relative importance of these causes in perspective.

Natural variability. The single most significant cause of uncertainty is natural variability, i.e., the complexity, heterogeneity, and randomness in the real world which are impossible to fully identify or evaluate at relevant scales of measure. In this project, we know that the aquifer is more complex in ways which we may or may not recognize but can't model because of insufficient data. For example, we know that the silty layers seen in the E-log of one well rarely correlate with the silty layers seen in adjacent wells. But we can't model all of these individual layers because we don't actually know where they start and end in the unobserved spaces between wells. The same is true for boundaries which are there but have not yet been detected by the existing investigations.

We must therefore try to represent the known or suspected complexity with a simpler component within our model which best approximates the expected behavior of the real earth by lumping the complex properties together in the form of a simpler analog. The practice of "lumped parameter" modeling is a simplification of choice as well as necessity. Even if it were possible to represent every sand grain and every pore space in the aquifer, the increase in microscopically detailed complexity may not contribute anything to improve the accuracy or reliability of the results. It is one of the hard-won skills of good modeling to know when and where a simpler approximation will be an effective and accurate representation of the real system.

A corollary effect of natural variability is that the true aquifer parameters will always be somewhat different than those in the model at some place or at some time. Even if we could precisely determine the true average value for every parameter, those local parts of the aquifer which are higher or lower than the average value and have observation wells located in them, will be observed to behave differently than predicted by the model. Since predictive modeling is often used *before* projects have begun, it is often true that a sufficient amount of good data doesn't even exist to estimate the average properties of the aquifer let alone map the full range of variability at all locations. Often a sufficiency of data doesn't exist until such a project has operated for many years. So, when comparing a predicted behavior to a subsequently observed behavior, it would be a mistake to treat point- by- point differences as a parameter error when those differences can be adequately explained as being caused by simple, undeterminable, natural variability about an average value.

Another effect of natural variability applies to the inability to predict future naturally-occurring or manmade events or behaviors, in addition to the variability in physical properties. For example, highly variable weather conditions can deviate significantly from average behavior without being considered anomalous, so that any *particular* predicted event has a significant chance of being different than the actual occurrence even though the prediction is a "correct" one. For these types of conditions, the correct prediction is actually a set of predictions covering the full range of possible values, with a probability of occurrence attached to each one. So in this project, we predict aquifer drawdowns due to pumping and our model stipulates that the actual future drawdown behavior will be controlled in part by the amount and timing of recharge which is controlled by the climatic weather cycle.

Judgment. The second significant cause of uncertainty is errors in judgment by the modeler, including such mistakes as selecting an inapplicable model or poor model parameters, doing the work incorrectly, or failing to recognize and correct "catchable" mistakes. These errors in judgment range from making an informed choice under difficult conditions or with very little data to blatant mistakes. There is probably little chance of a non- expert catching errors in judgment other than, perhaps, blatant mistakes.

In our opinion, there are three ways for a client to try to minimize judgment errors. The first is to use a modeler who clearly has the education, the background, and the experience to do the job correctly to begin with. The second is to get a thorough presentation of the work (model and results) and, if necessary, get second opinion from a qualified expert. The third is to take the time to learn enough basics to make a critical review of the work. After all, the accuracy of your own work may depend on these results. And then, require clear, complete, and verifiable documentation beyond simple numerical QA/QC with any modeling project and simply evaluate the work product for logic, consistency, clarity, and credibility.

Expectation. A third cause of uncertainty is errors of expectation on the part of an inexperienced modeler or the final user of the predictive output. Errors of expectation can include expecting too much and expecting too little. Unreasonably high expectations often come from a lack of understanding of the issues of natural variability. Examples of such errors of expectation include the assumption that there is only a single possible answer or that it is single- valued; that the answer is precise and accurate and, if correct, will be verified to a high degree by the actual observed outcomes; that the answer must be right because modeling is a numerical procedure and computational accuracy is mistaken as being the same as representational accuracy; or that the modeling procedure is wrong or useless or that mistakes must have been made if the predicted results and actual results disagree in some way.

Low expectations often come from a lack of understanding of how powerful and sophisticated predictive modeling can be in the hands of a competent expert. Many business people, policymakers, engineers, and consultants go about their particular business unaware that predictive modeling tools exist for almost every type of process or system including groundwater phenomena such as the flow behavior of rivers, water supply reliability, weather patterns, basin analysis, flow behaviors, and contaminant plume migration.

Unlike errors of judgment by a trained practitioner, errors of expectation are not a matter of right or wrong. Getting it wrong while learning what to expect is the normal process for all of us. The lesson is that if modeling is not part of one's expertise, then 1. hire an expert rather than trying to do it yourself, 2. talk to your expert about reasonable expectations, and 3. learn something about the required inputs, the process itself, and the form of the expected output so you can bring some critical review to the results.

Exhibit 4.

Drawdown Analysis of Proposed Wells Located Within the RRBWSD Service Area.

Exhibit 4.

Drawdown Analysis of Proposed Wells Located Within the RRBWSD Service Area.

One of the design objectives of the proposed Strand Ranch Aquifer Storage and Recovery Project is to provide all of the project benefits to the project participants while minimizing the potential, adverse, impacts on the environment, the project itself, and on adjacent entities. The adverse impacts of primary concern include well interference within the project well field and drawdown impacts to non-project wells in the surrounding area.

We have already discussed the proposed design practices for the Strand Ranch well field to minimize these impacts in the main text of the Report. The project also proposes to use an additional, available, alternate mitigation measure as necessary or as beneficial which is to reduce the rate and/or duration of pumping from the Strand Ranch onsite project wells which would otherwise be necessary by recovering water, by mutual agreement, from up to three wells located off the project site and within the adjacent Rosedale - Rio Bravo Water Storage District serv ice area.

As part of a pre-existing proposed well field program, RRBWSD agrees to provide a priority right of use to up to three wells located on or near the existing Paul Enns Recharge Ponds Facility (in Sec 34, T29s/R25e) or along the Goose Lake Slough upstream of the Enns Facility (on or near the north section lines of Sec 35 or 36, T29s/R25e).

We have modeled the predicted recovery-well drawdowns for four hypothetical well scenarios on the RRBWSD property. All scenarios assume that every well pumps at a nominal rate of 10 af/d (5 cfs). The four scenarios include: 1. five wells (5-spot pattern in a 160-acre area) in the Enns Recharge Pond Facility; 2. three wells (3 in-line at 1/3-mile spacing) just south of the north section line of Sec 35; 3. three wells (3 in-line at 1/3-mile spacing) just north of the north section line of Sec 36; or 4. All eleven wells operating simultaneously.

The drawdowns have been calculated and plotted on a rectangular base map covering a 2-mile N/S by 5-mile E/W area centered on the 11-well array (see, at the end of this text, Maps 4-1, 4-2, 4-3, & 4-4, for the pumping scenarios 1 - 4, respectively). This study area is bounded on the north side by Rosedale Highway and on the south side by Stockdale Highway. The main impact-areas-of-concern include the northernmost portions of the Kern Water Bank which lie to the south of the proposed RRBWSD well field. The northernmost boundary of the Kern Water Bank in Twp 25E runs E/W parallel to- and ½-mile south of- Stockdale Highway.

In all well-field pumping scenarios, the maximum predicted drawdown at or just south of Stockdale Highway is 5 ft and by easy extrapolation, the maximum predicted drawdown ½-mile south of Stockdale Highway is less than 2 ft (Maps A01, A14, A15, and A21, included in this Exhibit). The northernmost three KWB wells are all 3/4 to 1-mile south of Stockdale Highway where we predict that the maximum drawdown (from the 11-well scenario) would be less than 1 ft, and for any three-well scenario, the maximum predicted drawdown at the closest KWB wells is a fraction of 1 ft. We conclude that there will be no significant adverse impact to any non-project wells outside of the District due to the hypothetical case of pumping of all eleven wells in the proposed RRBWSD well field.

We also conclude that the expected impacts due to pumping of any three wells at any three locations within the proposed RRBWSD well field, whether clustered or separated, will have maximum drawdown impacts of less than 2 ft south of Stockdale Highway, and less than 1 ft at locations within the boundary of the Kern Water Bank.

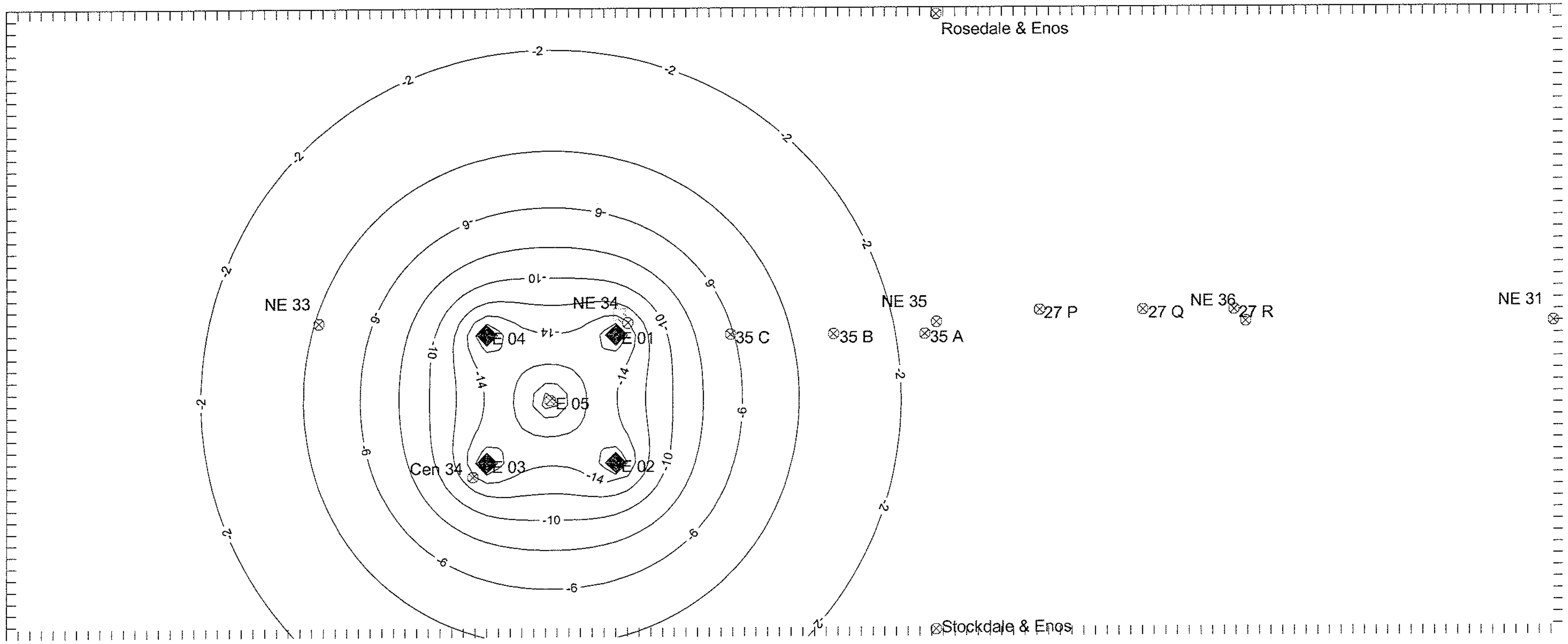

EXHIBIT 4. MAP 4-1.

A01

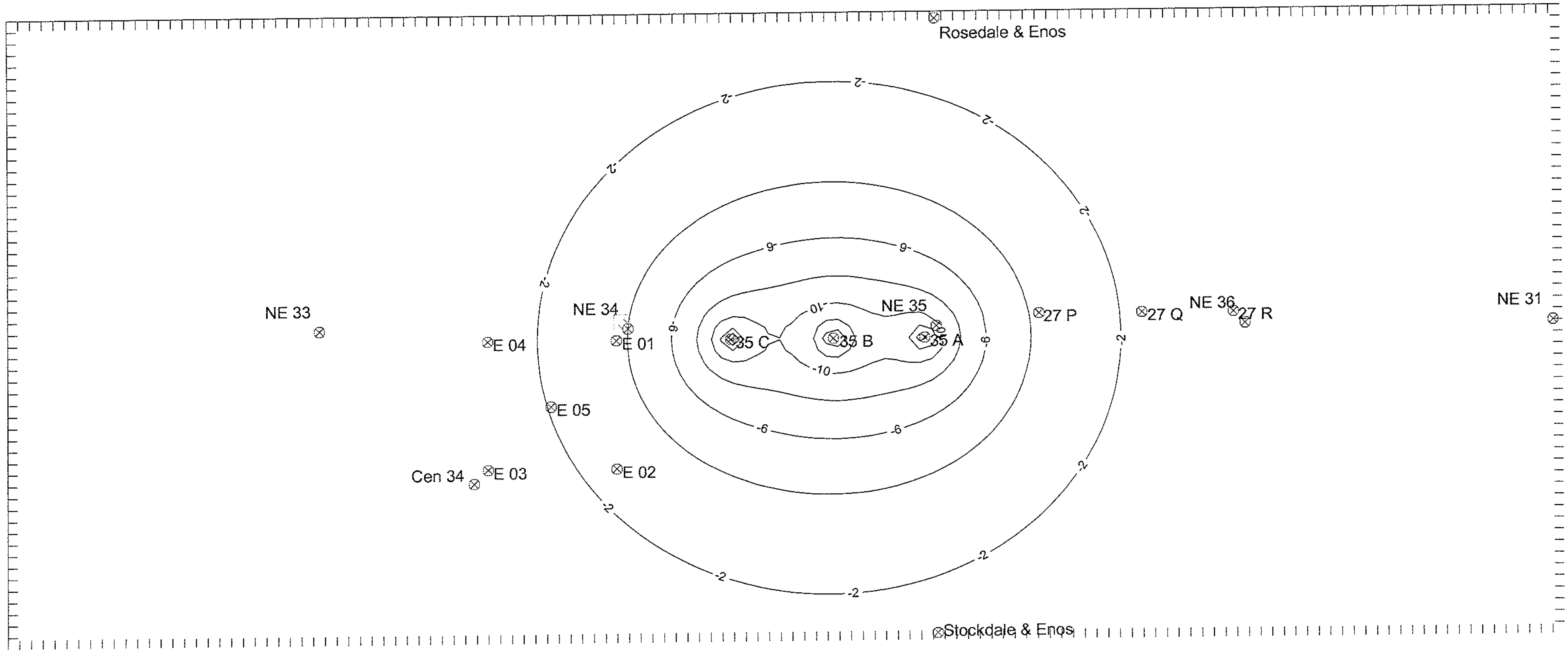

EXHIBIT 4. MAP 4-2.

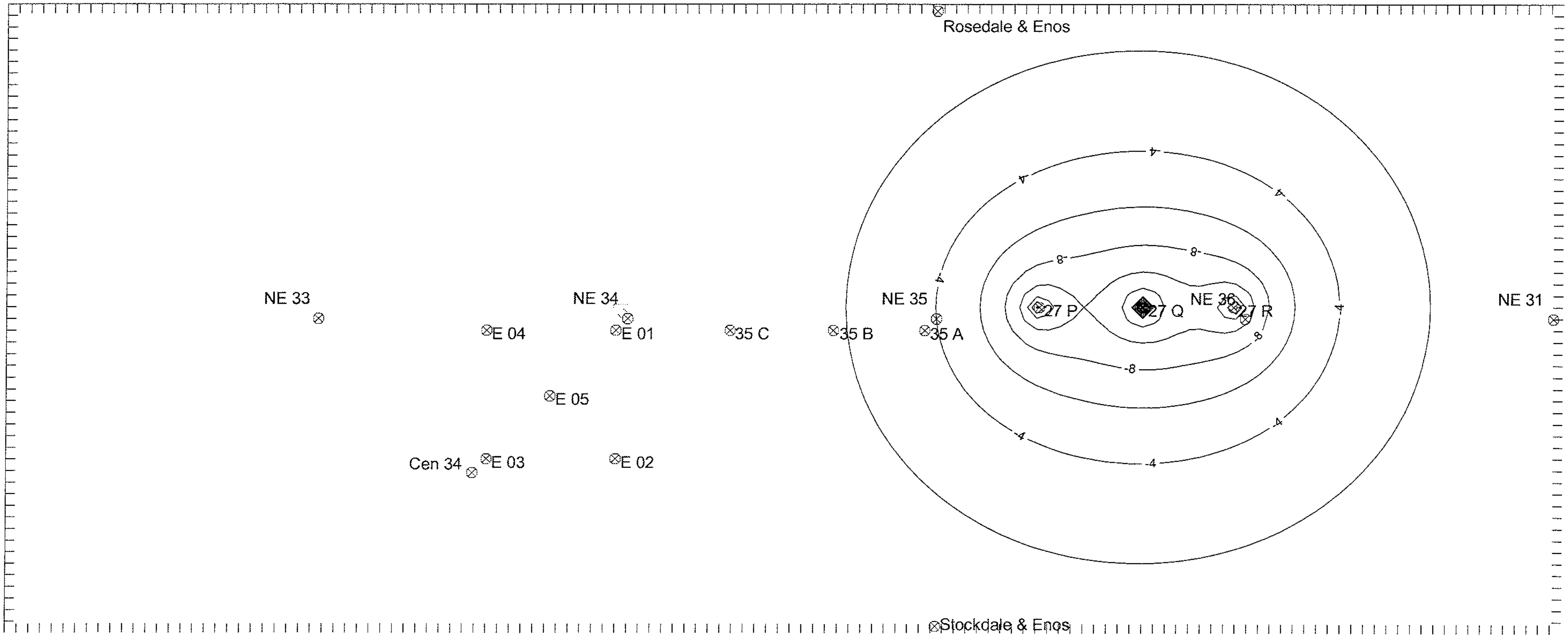

EXHIBIT 4. MAP 4-3.

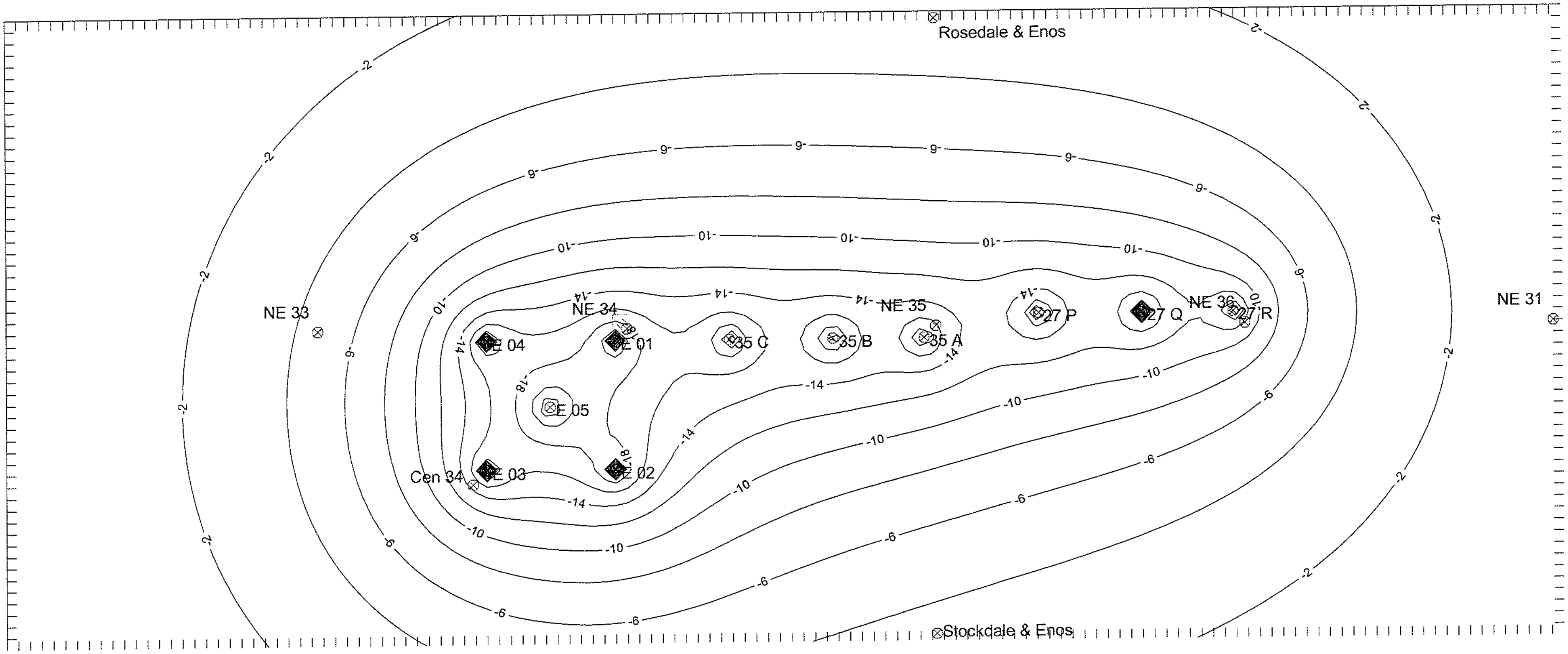

EXHIBIT 4. MAP 4-4.

Exhibit 5.

Catalog of Drawdown and Mound Analyses.

Exhibit 5.

Catalog of Drawdown and Mound Analyses.

SSS evaluated several sets of base case and non- base case conditions to illustrate the calculated drawdowns for purposes of comparison and evaluation. The best way to compare variations is to look at the maps to observe the changes in drawdown at locations of interest with respect to the changes in the free parameters and remember that the parameter changes are intended to reflect hypothetical changes in the real aquifer properties which affect the groundwater behavior. All maps cover nine sections centered on sec 02, T30s, R25e at a scale of approximately 1inch = 2290 ft. The model space is an 80x80-cell grid which is marked on the map margins; each cell represents 200x200 ft in real space. All maps include reference markers at the NE, SE, SW, and NW corners of section 02.

We have compiled a set of introductory maps (Set 0) showing the well locations, groundwater gradient scenarios, and parameter sensitivity variations in the absence of project pumping. We have compiled the data sets into groups of drawdown analyses (Sets 1 - 3) with or without particle trajectories, and a group of other special-case analyses (Sets 4 - 7) which are illustrative of other issues but not necessary to the basic drawdown impact scope of work. From the drawdown analyses, we have tabulated the observed drawdowns within the Strand Ranch well field, within the overall Strand Ranch project site, within the surrounding eight sections which comprise the study area, and outside the study area perimeter.

We list the complete set of drawdown analyses in the catalog below.

Set 0. Basic model data.

- Map B40 - B43, well location maps.
- Map B0, B22, base case drawdown, w/o and w/ GW gradient.
- Map B39, GW gradient (GWG) only.

Set 1. Variations in aquifer model.

- Map B0 - B2; B = 3200, 6000, 10,000.
- Map B0, B3 - B6; K = 57, 100, 80, 50, 40 ft/d.
- Map B0, B7 - B10; t = 300, 10, 30, 100, 1000 days.
- Map B0, B11 - B12; leaky, confined, unconfined.

Set 2. A. Variations in well operation *without* GW gradient.

- Map B0, B14, B16, B18, B20, D1; wells 1-9, 12356, 4789, 13579, 2468, 1-7.

B. Variations in well operation *with* GW gradient.

- Map B22, B15, B17, B19, B21, D2; wells 1-9, 12356, 4789, 13579, 2468, 1-7.

Set 3. Variations in particle tracking.

- Map B23 - B25; steady-state 10 & 5-yr, transient 10-yr.

Set 4. Special cases comparing 1760-ft and 1320-ft Strand Ranch well spacing.

- Map B26, B38; WL diff between SR 1-9 (1760-ft) and SR 11-19 (1320-ft).
- Map B27 - B28; wells SR 11 - 19, 1320-ft spacing, w/o and with GW gradient.

Set 5. Special cases comparing Strand Ranch drawdowns with Kern Water Bank drawdowns.

- Map C1-C3; SR only, SR & KWB1, KWB1 only,
- Map C4 - C6; KWB1 w/GWG, SR & KWB1 w/GWG, SR only w/GWG
- Map B29 - B31; KWB1 no GWG, ref change, KWB1 w/GWG
- note: KWB1 - 03R and 11C at setback locations.

Set 6. Special cases comparing Strand Ranch drawdowns with Kern Water Bank drawdowns.

- Map B33; KWB2 drawdown. (KWB2 - 03R & 11C on property boundary).
- Map B34 - B35; diff calc shows net areas of SR or KWB drawdowns.
- Map B36 - B37; SR & KWB2 total drawdown, with & w/o GWG.

Set 7. Drawdown impacts on Strand Ranch related to KWB wells 11C and 03R.

- Map E1 - E2; old locations, setback locations.
- Map E3 - E4; net diff calc, transient & steady-state.
- Map E5 - E6; same except for 11C only.

Set 8. Re-run of key models.

- Map F1 - F15; 9-,7-, & 5-well cases w/wo GWG & particle trajectories.

Appendix G

Strand Ranch Water Quality Report

Sierra Scientific Services

A Water Quality Evaluation of the Strand Ranch Aquifer Storage and Recovery Project, Kern County, Ca.

19 December, 2007

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Sierra Scientific Services

A Water Quality Evaluation of the Strand Ranch Aquifer Storage and Recovery Project, Kern County, Ca.

1. Summary of Findings

The proposed Strand Ranch Aquifer Storage and Recovery Project is designed to receive surface waters from the State Water Project, the Federal Central Valley Project, and the Kern River and store these waters in the available dewatered storage space of the underlying unconfined aquifer. At some later time, the Project will use high-flow water wells to recover a like volume of groundwater from the underlying aquifer.

All three surface waters are considered to be low-TDS, high-quality water which is acceptable for all uses in Kern County with little or no pre-treatment. The existing groundwater banking projects in the area have been storing these same three surface waters in the aquifer since about 1980. Since these three surface waters have lower TDS concentrations and lower constituent-of-concern concentrations than the groundwaters in the aquifer zones under the Project site, the historical data record shows that all recharge-then-recovery operations in all such projects have a beneficial salt balance impact and a beneficial COC balance impact on the basin.

Based on calculated hypothetical stoichiometry on the proposed Project recharge and recovery (predicted -118 mg/l net loss of salt from the basin), and based on the observed positive impacts from existing projects, we conclude that the water quality impacts from this Project will be significantly positive for the basin as well.

We have observed in the groundwater data that there is a shallow-aquifer brine plume which is migrating under the Project site from an unspecified, upgradient, off-site, source or sources, which is causing a ± 400 mg/l rise in TDS under the site relative to the unimpacted adjacent aquifer water. The suspected sources of the plume are oilfield wastewater disposal ponds which have not been active for more than 30 years, as qualified in this Report.

The plume has been degrading due to natural dispersion and active removal by local water wells. The residual concentrations at all locations in the plume have been declining and are expected to continue to do so, subject to verification of actual conditions over time. The project recharge and recovery operations will both have the immediate, beneficial impacts of remediating the plume in two ways: 1. the addition of lower-TDS surface water to the shallow aquifer during recharge will decrease the in-situ TDS by dilution and 2. the recovery operations will decrease the plume volume by permanently extracting plume water from the aquifer. The basin will benefit from the direct remediation of this plume as an incidental positive impact of Project recharge and recovery operations.

However, as long as the elevated-TDS plume exists and is not fully mitigated, the plume will have an impact on the Project by making it somewhat more difficult for the Project to meet the pump-in criteria for the Cross Valley Canal and the California Aqueduct when they need to recover and return water to end-users. The KWB continues to operate nearby plume-impacted water wells by blending the recovered plume water with other, lower-TDS recovered waters as necessary for their purposes and the same operational mitigation is available to the Strand Ranch Project as well.

We conclude that:

1. The conversion of agricultural land to an aquifer storage and recovery project eliminates the potential future use of Ag chemicals on the property which has been generally recognized in Kern County as a potential source of shallow-aquifer degradation;

2. The surface water sources available to the Project are free of constituents of concern (COCs) and are of lower total dissolved solids (TDS) content than the existing groundwater directly underneath the project site;

3. The recharge cycle will add lower-TDS surface water to the shallow aquifer where it will have the beneficial effect of diluting down the higher-TDS, plume-impacted groundwater;

4. The recovery cycle will remove groundwater which has a higher TDS and COC content than was originally put into the aquifer during recharge;

5. The positive water quality benefits of a full recharge/recovery cycle include a net removal of salt from the basin under the unimpacted natural water quality conditions of the aquifer, as well as an additional net reduction in COCs, and an ongoing dilution and extraction of the migrating brine plume as long as it continues to exist.

Note: Sierra Scientific Services reserves the copyright to this report. We request that all references to this report or to material within it be referenced as:

Crewdson, Robert, A., 19 December, 2007, A Water Quality Evaluation of the Strand Ranch Aquifer Storage and Recovery Project, Kern County, Ca., Sierra Scientific Services, Bakersfield, Ca.

A Water Quality Evaluation of the
Strand Ranch Aquifer Storage and Recovery Project,
Kern County, Ca.

2. Introduction

Section I - Purpose.

The purpose of this Report is to describe the water quality interactions and impacts which are expected to occur as a result of the operation of the Strand Ranch Aquifer Storage and Recovery Project.

An operational objective of the Strand Ranch ASR Project is to protect and preserve the water quality of the underlying groundwater aquifer while meeting the applicable regulatory and contractual standards of ASR operation. These standards may include the “pump-in criteria” for transporting project water in the Cross Valley Canal and California Aqueduct, the terms of the Memorandums of Understanding (MOUs) with adjacent entities, terms established by contract or other agreement, or the concepts of sustainable groundwater management.

The initial findings of this study may be used as a baseline to begin a voluntary water quality monitoring and reporting program (MRP) for future ongoing water quality evaluations. The purpose of this study and the MRP is to provide a permanent water quality database related to the Project operations which can be used for demonstrating and verifying compliance with the water quality objectives.

Section II - Project Scope - Aquifer Storage and Recovery.

Aquifer storage and recovery (ASR) is the generic term which describes the practice of deliberately putting surface water into a groundwater aquifer through infiltration basins with the intention of recovering a like volume of water from the aquifer at a later date. Such a practice presents a great opportunity to increase the local and statewide capacity to store water. ASR projects help regulate the water supply and demand over time by storing excess water when it is available in wet years for future recovery when water is needed in dry years.

In Kern County, California, there are 3 main components to every ASR facility: recharge basins, water wells, and a conveyance system. The recharge basins are ponds which are constructed to allow ponded water to infiltrate into the groundwater basin. The water wells are conventional high-flow water wells used to pump water out of the underlying aquifer. The project conveyance system consists of one or more canals, ditches, or pipelines used to deliver water to or from the ASR facility by connecting it with the local and regional water conveyance infrastructure.

The Kern County water community generally refers to ASR projects as "banking" projects. According the Kern County Water Agency, "These banking programs are essential to Kern County's water management and future growth[1]" and this is broadly true of the entire State of California water infrastructure. As used in Kern County, the term "banking" is loosely used to describe the act of physically putting water into the underlying aquifer and crediting the owner with the right to remove a like volume of water from the aquifer at a later date. This credit allows the owner to show such a volume of banked water as part of its current water supply. If such water has been "banked" on behalf of another party, then it is considered to be real water held in trust for that party who has an absolute right of recovery.

Section III - Background.

The Irvine Ranch Water District (IRWD) is currently in the process of developing a ±600 acre parcel in Kern County, California, as an Aquifer Storage and Recovery (ASR) Project (Figure 1). The parcel of interest is located in Section 2, Township 30s, Range 25e, MDBM, located at the southwest corner of Stockdale Highway and Enos Lane, several miles west of the City of Bakersfield. The ±600-acre Strand Ranch ASR project will be the latest among several existing ASR projects in the area which currently cover approximately 20,000+ acres and include more than 120 wells. The project site is surrounded in all four compass directions by existing ASR facilities belonging to the Kern Water Bank Authority or to the

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[1] Lloyd Fryer, 2005, Kern County Groundwater Banking Projects, KCWA brochure.

Rosedale - Rio Bravo Water Storage District. The parcel has been known historically as the Strand Ranch, so- named for the sand fairways crossing the property, so the project is informally referred to as the Strand Ranch ASR project.

The proposed project is designed to include 450+ acres of recharge ponds and 6 to 8 water recovery wells. The project site currently has approximately 120 ac of existing recharge ponds which were operated in 2006 on a pilot-study basis. The Cross Valley Canal runs through the Strand Ranch parcel which provides potential conveyance capacity to move surface water to and from the Project site. The site currently contains five or more irrigation wells which were installed by the previous owners of the Strand Ranch and are capable of recovering groundwater at this time. The project operator proposes to recondition or replace existing wells, and/or install recovery wells, as necessary or as beneficial, to meet their proposed operating parameters.

The site is flat at an elevation of about 320 ft above msl. The site overlies the prolific aquifers which comprise the so-called Kern Fan which, geologically speaking, is a thick pile of interbedded, fine- to coarse- grained, fluvial/alluvial sediments. The shallow aquifer is recharged by natural and manmade percolation of (mostly) Kern River water. Recharge occurs in the river bottom and nearby recharge ponds which form a 15-mile long, linear recharge axis starting in the city limits of Bakersfield and trending southwest across the southern San Joaquin Valley. When we refer to the Kern Fan in this Report we will generally be referring to the ±12-mile wide elongate area which straddles the recharge axis and includes the river channel, ASR project sites, and related surface infrastructures.

The Strand Ranch ASR Project is near, but northwest of, the recharge axis of the Kern Fan recharge mound. The depths to groundwater under the Project site fluctuate significantly due to the rise and fall of the Kern Fan recharge mound under the influence of the regional climatic wet/dry cycle. During consecutive dry years the groundwater may be 150 - 180 ft deep such as in 1990 - 1995, whereas during consecutive wet years the groundwater under the site may be 20 - 80 ft deep such as in 1995 - 1998. The unimpacted natural groundwater gradients under the Project site consistently trend northwesterly at -10 to -20 ft/mi WNW in dry years and -20 to -30 ft/mi NW in wet years.

The three potential sources of surface water which might be brought to the property include water from the Kern River, water from the Federal Central Valley Project (CVP) via the Friant- Kern Canal, and/or water from the California State Water Project (SWP) via the California Aqueduct. The source of both the Kern River water and CVP water is runoff from the winter snowpack from the highlands of the southern Sierra Nevada mountain range. The primary water source for the SWP is runoff from the greater volcanic highlands surrounding Mt Shasta in northern California. The waters from all three sources are very good quality when they reach their intended points of use within Kern County.

The water chemistries[2] of the surface waters differ somewhat from each other and they differ from the water chemistry of the groundwater. When surface water is stored in the aquifer and commingles with groundwater, the volume of water in the aquifer increases and the water chemistry of the augmented, commingled groundwater changes. The water chemistry of the commingled groundwater is intermediate between the water chemistries of the recharged water and the pre-existing groundwater in the zone of commingling. When groundwater is removed (recovered) from the aquifer, the water chemistry of the recovered water is the intermediate chemistry of the commingled water. For this study, the waters of interest include the following: the shallow, intermediate, and deep groundwaters; the three potential surface-water sources; and a brine plume flowing in the shallow aquifer under the site.

Section IV - Work Program.

Some of the data and findings in this Report have been excerpted and modified from another ongoing water quality study being prepared for the Rosedale - Rio Bravo Water Study District, with their permission. That study is a baseline water quality (BWQ) analysis of the groundwater aquifer in the RRBWSD area of interest, which happens to include the Strand Ranch Project area because of proximity. The RRBWSD baseline water quality analysis will be completed and presented in report form in the Fall, 2007.

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[2] By “water chemistry”we mean all of the individual constituent concentrations of the various dissolved solids, whether natural or manmade, which are of interest for the intended uses of the water.

The ongoing BWQ work program includes groundwater data collection, basic data analysis, and preliminary interpretation. The sources of data include: the Kern County Water Agency water quality database (courtesy of Tom Haslebacher, KCWA Senior Hydrogeologist), Vaughan Water Company water well analyses (courtesy of Mike Huhn, manager, VWC), and the Rosedale - Rio Bravo Water Storage District (courtesy of Robert Coffee, RRBWSD operations manager). Sierra Scientific Services specified the data screening criteria and the methods of data analysis according to accepted standards and practices.

For this study, we have added water sample analyses provided by IRWD collected from the accessible irrigation wells on the Strand Ranch property and analyses obtained by IRWD for other wells located on adjacent property.

Section V - Personnel.

Dr. Robert A. Crewdson is a Bakersfield, California consultant doing business as Sierra Scientific Services (SSS). SSS specializes in quantitative ground water hydrology, applied potential theory and time series analysis, quantitative ground water flow analysis, water quality geochemistry, well testing and monitoring, contaminant transport modeling, and aquifer properties testing. Dr. Crewdson is a research associate and adjunct professor at California State University Bakersfield where he has taught hydrology, contaminant transport, geochemistry and geophysics in upper division and graduate level courses.

Section VI - Methodology.

The primary task of this study was to collect the available data and determine the observed, historical water quality trends in the surface waters and groundwaters which flow into and out of the Kern Fan aquifer system as it relates to the Strand Ranch Project. The complete methodology will be presented in the forthcoming RRBWSD Baseline Water Quality report, but we present a summary in Exhibit 1. We present a tabulation of the surface water and ground water geochemical analyses in Exhibit 2.

Section VII - Water Quality.

There is no single, universal standard for *"water quality"*. But for the purposes of this study, we only need to establish the criteria which are relevant to the Strand Ranch Project. For our purposes, when we refer to "water quality" we really mean "water chemistry", since we are not so much applying criteria of acceptability (good for irrigation, residential, etc) as we are simply referring to the numerical values of the measured constituents. The constituents which we consider sufficient to be broadly representative of the water chemistry in the project area include: total dissolved solids content (TDS), hardness (Hd), hydrogen ion concentration (pH), arsenic concentration (As), alpha-emission radioactivity (α), and nitrate concentration (NO3).

In general, fresh water with a TDS content of 500 mg/l or less is considered to be good or excellent for domestic use and considered to be unacceptable over 1,200 - 1,500 mg/l, depending of course on the specific constituents. Water with a hardness less than 60 mg/l is considered to be "soft" and more than 120 mg/l is considered to be "hard" (120 - 180 mg/l) or "very hard" (>180 mg/l). Hardness is generally considered to be objectionable if it exceeds 100 mg/l. Water with a pH in the range from 5 to 9.0 is considered to be in the acceptable range for a public water supply.

Two naturally-occurring constituents of concern, arsenic and alpha radioactivity, exist in most natural waters at or above trace concentrations. The current federal regulatory maximum concentration limit (MCL) in water for each is 10 ug/l and 15pCi/l, respectively. These standards are set to achieve the following hypothetical objective: that if every person in a community were to drink 2 liters of water with these MCL concentrations daily for 30 years, there would be no more than one additional cancer death from arsenic poisoning and no more than one from alpha radiation poisoning per 10,000 people, on average, than would otherwise be expected in the community population.

The third constituent of concern, nitrate, is manmade in the sense that it occurs significantly in surface water and groundwater only because of manmade activities, i.e., it comes from agricultural use of fertilizers, from wastewater treatment plant effluent, and from stockyards. The federal MCL for nitrate is 10 mg/l.

In the Discussion section of this Report, we present the water chemistry of the surface waters, the ground waters, and the interactions and impacts related to the Strand Ranch Aquifer Storage and Recovery Project.

A Water Quality Evaluation of the Strand Ranch Aquifer Storage and Recovery Project, Kern County, Ca.

3. Discussion

The expected water quality interactions and impacts related to the Strand Ranch Project come from the developments and operations which are common to all aquifer storage and recovery (i.e. water banking) projects as designed and operated in Kern County, California. The following discussion includes the relevant surface water and ground water data and parameters which are specific to the Strand Ranch ASR Project.

Section I - Basic Project Development and Operation.

The Strand Ranch ASR Project development involves: 1. converting agricultural land which previously supported almond trees and row crops into infiltration ponds for the purpose of percolating surface water into the underlying aquifer, 2. Maintaining existing water wells and/or installing new water wells for the purpose removing water from the underlying aquifer, 3. installing ditches and/or pipelines to convey water between the Project facilities and the local conveyance infrastructure which, for the Strand Ranch Project, is the Cross Valley Canal, and 4. Installing monitoring wells for the purpose of monitoring water levels and water chemistry in the underlying aquifers.

The Strand Ranch ASR Project physical operation involves: 1. diverting a quantity of water from the local conveyance infrastructure into the Project recharge ponds, 2. maintaining the water depth in the active recharge ponds for maximum infiltration, 3. maintaining the empty and unused ponds when recharge is not occurring, 4. operating the recovery wells and delivering this water back to the local conveyance infrastructure. The maximum rates at which water can be diverted and recharged or recovered and re-conveyed are limited by the maximum physical operating capacities of the particular facilities which are in use. The actual rates and the actual scheduling of these water inflows or outflows may also depend on operating preferences, 3rd party requirements, contractual limits, uncontrollable circumstances, availability of water, and/or limitations due to capacities or priorities in the Cross Valley Canal.

For our purposes, we will assume that any expected interactions or impacts will be maximum when the recharge inflows or the recovery outflows are also at a maximum. This "maximum" scenario is defined by the maximum physical operating capacities of the hypothetical future facilities under consideration. This "maximum' scenario is not necessarily the most- likely scenario, nor should it be assumed that it is a "best-or-worst-case" scenario. The future Project operation currently under consideration in this water quality evaluation is based on hypothetical maximum recharge rates of 80 - 240 af/d (± 400 ac of ponds w/ IR = 0.2 - 0.6 ft/d) and maximum recovery rates of up to 45 cfs (90 af/d).

Section II - Water Chemistry of the Kern County Surface Waters.

All of the existing ASR (banking) projects on the Kern Fan have received their surface waters since 1995 from one of three sources: the Kern River (KR), the Federal Central Valley Project (CVP) via the Friant - Kern canal (FK), and the California State Water Project (SWP) via the California Aqueduct (AQ). The Strand Ranch ASR Project will receive all of its surface water from one or more of these same three sources. We have chosen to report the baseline water quality of each of these surface water sources according to the analyses reported by the KCWA Improvement District No. 4 (ID4) at the inlet to their water treatment plant (data obtained from the KCWA water quality database). We present all analyses from all sources in Exhibit 2.

The Kern River brings an average 772,800[3] af/yr of Sierran snowmelt runoff water into Kern County. Kern River water has an average TDS = 88 mg/l, an average Hd = 39 mg/l, and an average pH = 7.9. The three COCs (As = 5.9ug/l, α = 3.2 pCi/l, NO3 = 1.0 mg/l) are all present at low levels and less than their respective MCL concentrations.

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[3] Source of inflow volumes: KCWA, August 27, 2001, Initial Water Management Plan, Public Review Draft, p. ES-13.

The Friant-Kern Canal brings an average 395,000 af/yr of Sierran snowmelt runoff water from the Federal CVP into Kern County. FK water has an average TDS = 41 mg/l, an average Hd = 22 mg/l, and an average pH = 7.5. The three COCs (As = 2.9ug/l, α = 2.9 pCi/l, NO3 = 1.4 mg/l) are all present at low levels and less than their respective MCL concentrations.

The California Aqueduct brings an average 807,500 af/yr of Northern California snowmelt runoff water from the State SWP into Kern County. SWP water has an average TDS = 334 mg/l, an average Hd = 115 mg/l, and an average pH = 8.3. The three COCs (As = 7.0 ug/l, α = 1.9 pCi/l, NO3 = 2.4 mg/l) are all present at low levels and less than their respective MCL concentrations.

The water chemistry of the SWP water which arrives in Kern County via the aqueduct varies significantly but predictably (Table 1). During climatic dry cycles such as the years 1991 - 1995, the average annual TDS (344 mg/l) is approximately 170% higher than the TDS during climatic wet cycles (208 mg/l) such as the years 1996 - 2000 (Table 1). Within any given year, the average monthly TDS in the winter months is consistently 150% - 190% higher than the TDS in the summer months (Table 1). We do not see a comparable variability in the FK or KR waters. The seasonal and climatic variability of the SWP water chemistry is significant enough that, to the extent possible, the Project can benefit from scheduling its water deliveries to minimize the salt-load impacts on the aquifer and scheduling its returns to maximize the Project's ability to qualify for Tier-1 pump-in to the Aqueduct.

By these measures, the overall Kern County surface water supply is very good quality, even during periods of elevated TDS in the aqueduct. The total dissolved solids contents are quite low, the physical properties are acceptable, suspended solids, if present, can be eliminated by settling or filtration, and the trace occurrences of constituents of concern (COCs) are below MCLs and, so far, of minor concern. As a result, there is a general consensus in the local water community that a source of Kern County surface water and/or ground water is most likely OK as long as does not contain any of the few recognized constituents that locally make the water *unacceptable* for its intended use.

Section III - Water Chemistry of the Kern Fan Aquifer Waters.

The project site overlies a prolific fresh water aquifer which is a 700-ft thick, stratified sequence of interbedded, unconsolidated, sandy and silty alluvial and fluvial sediments. Most groundwater in the basin today originated as Kern River water which infiltrated into the aquifers from areas of natural recharge through a number of different pathways in times past. Today, we recognize that the groundwater is of poorer water quality than the Kern River water from which it comes. Part of the difference comes from a simple increase in the total amount of dissolved solids in the groundwater as a result of passing through the soils and sediments along the groundwater flowpath. Much of this increased “mineralization” of the water is of no consequence for its consumptive use, but some of this mineralization may include naturally-occurring constituents of concern. The main naturally- occurring constituents of concern in the project area have been elevated but non-toxic levels of naturally- occurring arsenic and radioactivity. Both constituents are commonly associated with sediments which have been derived from the erosion of granitic-type rocks, as is the case in the study area. The process of mineralization of percolating water is considered to be a natural and inevitable process and there is currently no known way to prevent this process of mineralization from occurring. The standard measure of this effect is to calculate a “salt balance” for storing and recovering a unit volume of water of known water chemistry in the aquifer.

In the project area, as on adjacent lands and elsewhere, the potential for an additional decrease in aquifer water quality includes the introduction of non-native constituents due to manmade activities and practices. The recognized, potential sources of manmade COCs in and around the Project site may include agriculture, oilfield operations, accidental spills on the nearby highways, and groundwater inflows of COCs from up-gradient sources. The main manmade constituents of concern include nitrates, pesticides, fertilizers, and common mineral salts.

The water chemistry in the groundwater aquifer varies with location and with depth. The total saturated thickness of the commonly-used part of the aquifer is approximately 500 - 700 ft (dry or wet conditions, respectively) and is often described as consisting of shallow, intermediate, and deep producing zones. These three zones cannot be clearly defined based on stratigraphy alone but can be differentiated based on both water chemistry and hydraulic behavior.

Shallow aquifer water chemistry. The shallow aquifer zone (approx. 0 - 300ft deep) contains a vadose (unsaturated) zone overlying an unconfined water table which varies in depth from 10 - 200 ft below ground level depending on the climatic wet/dry cycle. In the project area which is, more specifically, part of the Kern Fan recharge area, the shallow aquifer contains groundwater which comes primarily from downward vertical recharge from overlying surficial sources. Since the source of most of this recharge water is the Kern River through natural and manmade recharge, the water chemistry of the shallow aquifer resembles that of the Kern River except modified by processes of dissolution and reaction accompanying the percolation of this water through the vadose zone. The water chemistry of the unimpacted shallow groundwater zone may be summarized as having moderate TDS (229 mg/l), moderately hard Hd (122 mg/l), somewhat basic pH (7.8), low As (0.7 ug/l), elevated alpha (5.5 pCi/l), and elevated NO3 (9.9 mg/l). These data are presented in Tables 2 & 3 and on maps in Figures 2 - 7.

Brine plume. The shallow aquifer zone in the project area is being impacted by a brine plume which appears to be migrating from an unidentified, off-property, source or sources which are upgradient of- and unrelated to- the Stand Ranch Project site. The source[4] is upgradient to the southeast of the project site, perhaps in section 12 and/or somewhat farther to

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[4] One possible plume source is the so-called Rio Bravo Pump Station which is located in the central-southern portion of Sec 12, T30s/R25e, approximately one mile SE of the SE corner of the project site. The following entry was printed in the Kern Water Bank Authority Monthly Status Report of August 15, 2007: The following item occurs under the heading "Third Parties and Environmental Cleanup" and under the sub-heading "Chevron": *"Rio Bravo Pump Station: Historic use of this facility resulted in the pollution of groundwater with salts. TDS in recent samples have been as high as 1500 mg/l. In correspondence dated November 28, 2006, the RWQCB requested that a groundwater monitoring program be implemented."*

Mr. Jon Parker, KWB Operations Manager, reports that the suspected source of the brine plume is a system of oilfield-wastewater disposal ponds in section 12 that are no longer active. The original plume reportedly never came under regulatory control because the groundwater impact was not considered to be serious enough. The KWB groundwater pumping operations since 1995 have removed a large volume of groundwater with elevated TDS content from within the plume zone of impact, resulting in an improvement to the local water quality of the shallow aquifer. (verbal comm. December, 2007) the southeast. The water chemistry of the shallow groundwater brine plume may be summarized as having elevated levels of most or all constituents relative to the unimpacted shallow groundwater, with moderate to very high TDS (385 - 2380 mg/l), hard to very hard hardness (163 - 991 mg/l), near-neutral, slightly basic pH (7.2 - 7.9), undetermined levels of As and alpha, and elevated NO3 (19 - 28 mg/l). These data are presented in Tables 2 & 3.

The brine plume at MW 12B, the monitoring well closest to the source area, has a TDS content which is approximately 11 times higher than the surrounding shallow aquifer water (2380 mg/l vs. 225 mg/l) and has a clear "fingerprint" indicated by a chloride (Cl) content that is 44 times greater than the chloride content of the surrounding shallow aquifer water. The chloride ion is useful because we can map the presence of excess chloride ion in the aquifer as an indicator of the migrating plume. We have also used the presence of excess calcium to independently map the plume location with similar results (see maps in Figures 8 - 10). Based on this analysis, the brine source appears to be located at or sufficiently close to the axis of recharge that it is actually causing plumes to migrate downgradient into both flanks of the recharge mound. A plume of elevated TDS is migrating to the northwest under the Strand Ranch project site (Figure 10) and a plume of elevated TDS is also migrating southeast away from the same source area. Based on the data in both plume-flow directions, the source(s) of the twin plumes must be located in or near sec 12, T30s/R25e and/or sec 07, T30s, R26e.

In our opinion, based on our own analyses and on credible local sources, the present plume has been in existence for more than 30 years. At an estimated average flow velocity of 1 ft/d, this plume has propagated more than 2 miles downgradient from the source location. However, the oilfield wastewater disposal ponds which were the suspected original sources of the groundwater brine plume are no longer active[5]. Based on theoretical considerations, we conclude that the plume has reached its maximum concentration at all points within its existing perimeter and these concentrations are actively decreasing. We expect that the natural processes of advection and dispersion will cause the perimeter of the remaining residual plume to steadily lengthen and widen and the TDS constituent concentrations to steadily decrease through dilution. The existing KWB operations and the proposed Strand Ranch operations will

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[5] Mr. Royce Fast, a long-time local resident farmer, reports that these oilfield wastewater disposal ponds have been inactive for as long as he can remember, and specifically, that he has no recollection of the ponds being active at least as far back as the early 1970s and perhaps earlier. (verbal comm. December, 2007)

continue to remediate the plume with accelerated dilution through surface water recharge and accelerated TDS content removal by groundwater recovery within the plume zone of influence.

It is possible and likely, in our opinion and subject to verification, that low-grade, residual, in-situ salt deposits might still exist within the sediments of the vadose zone underlying the locations of the former disposal ponds. Such a residual, in-situ, source of salts may explain why the tail of the plume has not "disconnected" and migrated downgradient from the source area during the time since the pond use was discontinued, why elevated TDS concentrations still exist in monitoring wells close to the suspected source area, and why the plume has not been completely remediated by local groundwater extraction over the last 30+ years. Nevertheless, the ongoing processes of dilution and extraction will continue to remediate this pre-existing, residual, shallow-aquifer, brine plume.

<u>Deep aquifer water chemistry.</u> The deep zone (approx. 400 - 800 ft deep) contains a semi-confined aquifer which shows hydraulic connection with the overlying zones but with delayed pressure response and little inter-zonal flow in the unimpacted areas with few water wells. In the project area, the unimpacted deep aquifer contains groundwater which comes primarily from lateral recharge from sources of deep infiltration near the upgradient limits of the Kern Fan far to the east, rather than from downward vertical recharge. Since the deep groundwater has traveled a long flowpath with a long subsurface residence time, the water chemistry of the deep aquifer is different than the shallow water as we would expect from geochemical considerations. The water chemistry of the unimpacted deep groundwater may be summarized as having low TDS (119 mg/l), very soft Hd (6 mg/l), basic, elevated pH (9.4), elevated As (10 - 139 ug/l), low alpha (0.8), and low NO3 (± 0.8 mg/l). These data are presented in Tables 2 & 3 and on maps in Figures 11 - 16. According to available data, the brine plume does not currently extend into the deep zone of the aquifer.

<u>Middle aquifer water chemistry.</u> The middle zone (approx. 300 - 500 ft deep) is transitional between the shallow and deep zones in both hydraulic behavior and water chemistry and varies depending on location. The middle zone has a water chemistry which appears to be a stoichiometric blend of the shallow and deep waters. The water chemistry of the upper middle zone looks somewhat more like that of the shallow aquifer water and the water chemistry of the deeper middle zone looks somewhat more like that of the deeper aquifer water. We are limited by the spatial distribution of data points but the middle zone appears to be a

thin, unimpacted, transitional zone between the shallow and deep aquifers on the northwest and southeast margins of the Kern Fan whereas the middle zone appears to be a thick zone of manmade blending underneath a contiguous area centered on the fan which includes the Pioneer North Project and the central portion of the Kern Water Bank which is north of the Kern River channel and east of Bussell Road.

Section IV - Water Chemistry of Local Water Wells.

According to public records, there have been eleven (11) water wells drilled or re-drilled between 1950 and 1976 on the Strand Ranch property. The wells were either irrigation wells or shallow domestic water wells which were completed across the shallow zone (5 wells) or both shallow and intermediate aquifer zones (6 wells). None of these wells were completed in the deep zone of the aquifer. IRWD sampled the five currently-existing, accessible wells (W1, W2, W3, W4, and W6) in December, 2003 (Figure 10). As we would expect, the water chemistries in each of the five wells is a plume-impacted blend of shallow and intermediate zone water chemistries (Exhibit 2).

All five wells clearly show the impacts of the brine plume migrating under the Strand Ranch project site. The waters in all five wells have elevated TDS ranging from 410 - 800 mg/l (avg 618 mg/l) and elevated shallow-zone COCs (alpha = 11 pCi/l and NO3 = 24 mg/l) relative to the unimpacted shallow aquifer (TDS = 229 mg/l) which we have mapped in the study area. Based on a simple blending calculation, the waters from these five wells are about two-thirds plume water and one-third non-plume aquifer water. In our opinion, these well-water analyses are representative of the plume-impacted waters in the shallow and upper-intermediate aquifer zones under the Project site.

The water wells in the surrounding sections to the north include 3 irrigation wells in the Rosedale - Rio Bravo Water Storage District (Figure 10), all of which are downgradient from the Project site, approximately ½ - 1 mile NNW of the north Project boundary. We do not know the depth intervals of these three wells (Enns-N, Enns-S, and Nikkel) but all three wells have water chemistries which are typical of a somewhat plume-impacted shallow aquifer: elevated TDS (312 - 448 mg/l), slightly basic pH (7.5 - 7.8), hard to very hard Hd (174 - 236 mg/l), low As (<1 ug/l), elevated alpha (>10 pCi/l), and moderate NO3 (6-7 mg/l). In our opinion, these three well analyses are representative of the plume-impacted shallow aquifer in this area (Exhibit 2).

The water wells in the surrounding sections to the south and west include banking project recovery wells which belong to the Kern Water Bank (Figure 10). The four wells for which we have data are all within ½ -mile of the south or west Strand Ranch property line. Wells 11A and 11C are upgradient from the Project site and wells 03Q and 03R are lateral to the Project site. We do not know the depth intervals of these four KWB wells but based on the reported water chemistries, well 11A appears to produce water from the deep aquifer zone (low TDS, high pH, elevated As, low alpha, and low NO3) and wells 11C, 03Q, and 03R all produce water from the plume-impacted shallow or shallow and intermediate zones (moderate TDS, lower pH, low As; unreported alpha and nitrate). Although well 11A is located substantially inside the recognized plume perimeter, it shows no constituent evidence of plume impacts and therefore, we conclude that it must be completed in a depth interval which is below the depth of recognizable plume impact. The TDS values at the other three locations are elevated with respect to the unimpacted shallow aquifer and therefore are useful in mapping the lateral and downgradient extents of the migrating brine plume. These data have been combined with the monitoring well data and the data from the Strand Ranch and Rosedale irrigation wells and are included in the shallow- aquifer TDS contour map shown in Figure 10.

The KCWA Improvement District No. 4 water treatment plant has historically received inlet water from recovery wells on the Kern Water Bank. The KWB source water (11 analyses over several years) came from unspecified wells but we assume that it was a blend from conveniently-located wells with “acceptable” water quality. This KWB water at the inlet to the ID4 treatment plant had a water chemistry which was consistent with a blend of 17% shallow aquifer water and 83% deep aquifer water: avg TDS (143 mg/l), slightly basic pH (7.6), very hard Hd (445 mg/l), elevated As (9.9 ug/l), low alpha (3.7 pCi/l), and low NO3 (2.7 mg/l). We consider this to be consistent with the KWB preference for deep wells in their project area.

Aqueduct and Cross Valley Canal Pump-in Criteria.

The California Department of Water Resources (DWR) requires that all waters which enter the California Aqueduct must meet their water quality criteria, i.e., that the water is of "consistent, predictable, and acceptable quality"[6]. The Kern County Water Agency has incorporated those same standards for all waters which enter the Cross Valley Canal which serves several member districts within Kern County and connects to the Aqueduct. The DWR water quality criteria establish two levels of acceptable water quality as follows: Tier 2 water is of lesser quality with respect to the DWR standards[7] such that water from a specific source can only be pumped into the aqueduct after the *DWR facilitation group* has reviewed the water quality and approved it on a specific case-by-case basis; Tier 1 water is of better quality with respect to the DWR standards and water *"meeting Tier 1 water quality standards shall be approved* [for delivery into the Aqueduct] *by DWR without further review..."*.

It is very desirable for a water source to have a Tier 1 designation because it creates tremendous flexibility in conveyance scheduling which is not subject to review, delay, or perhaps disapproval by the facilitation group. Kern River water meets Tier 1 criteria and Kern Fan groundwater, perhaps with minor blending, can meet Tier 1 criteria as well.

Some of the plume-impacted, shallow aquifer water under the Strand Ranch Project site exceeds the DWR constituent concentration limits and would not meet the Tier 1 water quality criteria unless it was blended with "better quality" water to dilute the objectionable constituents down to acceptable levels. The unimpacted shallow groundwater adjacent to the site is at or near-Tier 1 water quality, so at such time as the brine plume has been fully remediated by natural and/or project operations, the shallow aquifer under the Project will be at or near Tier 1 water quality, all else equal.

Section V - Water Chemistry Interactions and Impacts.

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[6] Interim Department of Water Resources Water Quality Criteria for Acceptance of Non-Project Water into the State Water Project, March 1, 2001.

[7] The March 1, 2001 Interim DWR water quality standards are presented on pp. D-4 through D-7 of the KCWA 2001 Kern Fan Operations and Monitoring Report. Examples of Kern County pump-in water quality from seven different sources is presented on p. E-6 of the same Report.

Land Conversion Impact. The potential water quality impacts from converting the site from agricultural use to an ASR site has two recognized elements. The first element is that by eliminating the Ag use of the land, the site has been eliminated as a potential source of allowable, but potentially undesirable low-grade, agriculture-related, shallow-aquifer degradation. We have no data on what agricultural products may or may not have been used on the property in the past. If such products had been used, then the conversion to project operations represents a cessation of such product use. And the conversion to an ASR project eliminates the potential future use of pesticides, fertilizers, sulfur compounds, and other Ag products from potential use. In our opinion, this element of site conversion is a neutral or positive impact on the aquifer.

The second element is that the future, initial episode of large-volume recharge which will occur as each new recharge pond is put into operation may be the first re-saturation of the underlying sedimentary column from the ground surface to the water table in several years, depending on the climate. Such a re-saturation may result in a short-term flushing of accumulated salts from the shallow strata which will enter the shallow aquifer. We are not aware of any data or any estimates of such impacts for any other ponds in any other projects in Kern County that such impacts exist or have been observed. In our opinion, we do not expect that such re-wetting events will have any significant, long-term impacts.

Moreover, the area experienced two consecutive years of major recharge since 2003 which raised the shallow water table on the entire Kern Fan and to within 5 ft of the ground surface within much of the Strand Ranch site. This major rise in the shallow water table was subsequently followed by the current drought and water levels have since dropped by 100 ft. The point is that this water table fluctuation has thoroughly purged the shallow strata of soluble salts in the recent past, so we conclude that there will be no significant future buildup of shallow salts between now and the start of the project since most of the acreage has already been fallowed.

Recharge and Recovery Salt Balance Impact.

Based on reported historical data, every existing ASR banking project on the Kern Fan (Pioneer, Berrenda Mesa, 2800 acres, and Kern Water Bank) has a positive impact on the basin by removing more dissolved salts in their recovery water than is put into the basin in their stored surface water (Table 4). This is true on a volume-for-volume basis because the average

TDS concentration is lower in the stored surface water and higher in the recovered water. For example, for the 2001 operating year, the reported average TDS of surface waters stored in the basin was 121 mg/l and the average TDS of ground waters removed from the basin was 218 mg/l, and therefore there was an average decrease in basin salt load of -97 mg for every liter of water. That is equivalent to a net removal of 264 lb of salt for every acre-foot of stored-then-recovered water (data from KCWA 2001 Kern Fan Monitoring Report, Figure 5D-1).

Based on the same source of reported historical data (KCWA 2001 KFMR, Tables 5D- to 5D-8), the incoming salt load varies significantly depending on the source of surface water which is stored in the projects. For example, for the reporting period from 1995 through 2001, 29% of all stored water came from the SWP via the Aqueduct, 28% came from the CVP via the FK canal, and 43% came from the Kern River. However, 57% of the total salt load came from the SWP water, only 11% came from the CVP water, and 32% came from the Kern River. Despite the nearly equal surface water volumes coming from the SWP and CVP, the salt load from the SWP was five times higher than that from the CVP because of the 5-fold difference in average TDS contents (227 mg/l vs 43 mg/l) of the respective waters over this time period. The salt load from the imported SWP water for the period was 180% greater than that of the Kern River even though the volume of SWP water was only 67% of the volume of KR water because of the difference in respective TDS contents. It is clear that SWP surface water is the least desirable source of surface water from a TDS salt balance perspective because it brings in the highest concentration of dissolved salts of the three potential sources.

For the Strand Ranch Project, the basic hypothetical salt balance data are as follows. The historical average TDS contents of the three potential sources of surface water are SWP TDS = 227 mg/l, KR TDS = 88 mg/l, and FK TDS = 41 mg/l. The average TDS contents of the local aquifer waters in the study area are: unimpacted shallow TDS = 229 mg/l, plume-impacted area-weighted shallow TDS = 559 mg/l, and unimpacted deep TDS = 119 mg/l.

Based on these data, all of the surface waters have TDS concentrations which are less than the plume-impacted shallow aquifer waters near and under the Project site and both the KR and FK have TDS contents that are less than that in any part of the underlying aquifer. If we look at the historical SWP data for the project operating period from 1995 - 2001, it is clear that the SWP water actually delivered to Kern County with an average TDS = 227 mg/l is much less than the unweighted, long-term, historical average of 334 mg/l (measured at the inlet to the ID4 water treatment plant) so it is possible to obtain large volumes of SWP surface water for banking programs at much less than the historical average TDS.

We have calculated a number of recharge/recovery salt balances for the project and for the wide range of all realistic assumptions, the hypothetical Project salt balances are all positive, i.e., there is a net loss of salt from the groundwater basin because of project recharge and recovery. The calculations yield a base case salt load balance of -118 mg/l (net loss of salt from the basin, equivalent to a loss of -332 lb per acre-foot).

We note that the predicted Strand Ranch Project positive impact (-118 mg/l salt loss) is in the same range as the 2001 reported project impacts from the existing Kern Fan banking projects which ranged from -72 mg/l at the Berrenda Mesa project to -129 mg/l at the Pioneer project. The 2001 Kern Water Bank salt balance was -99 mg/l. And we also point out that since the Strand Ranch Project has the elevated-TDS brine plume to deal with, the predicted Strand Ranch salt balance beneficial impact may be greater depending on the fraction of shallow-aquifer water which is captured in total recovery volume.

The salt balance calculations are included in tables 3.1 - 3.3 of Exhibit 3. Table 3.1 presents the hypothetical long-term average recharge TDS based on various relative mixes of SWP, KR, and FK source waters. Hypothetical inflow blends 11-16 and 21-26 are for assumed SWP TDS conditions of 334 and 227 mg/l, respectively as previously described. We have assumed In-Blend 26 to be our hypothetical base case and an long-term average inflow TDS of 111 mg/l.

Table 3.2 presents the hypothetical long-term average recovery TDS based on various relative mixes of shallow and deep aquifer waters. Hypothetical outflow blends 31-38 and 41-48 are for assumed shallow aquifer TDSD conditions of 559 and 237 mg/l, respectively for brine-plume and non-plume conditions. We have assumed Out-Blend 36 to be our hypothetical base case and a long-term average outflow TDS of 229 mg/l.

Table 3.3 presents a matrix of hypothetical long-term net aquifer salt balance outcomes for the various in-flow conditions listed across the top of the table and the various outflow conditions listed down the left side of the table. The base case conditions (in bold) assume long-term average inflows at +111 mg/l TDS and long-term average outflows at -229 mg/l TDS resulting in a net loss of salt from the basin at a rate of -118 mg/l. The base case assumes that the long-term average surface water inflow to the project is 20% SWP, 70% KR, and 10% FK at TDS contents of 227, 88, and 41 mg/l, respectively. The base case assumes that the long-term average recovered water outflow from the project is 25% shallow aquifer and 75% deep aquifer at TDS contents of 559 and 119 mg/l, respectively. Other possible scenarios may be read directly from the table.

Recharge and Recovery Constituent-of-Concern (COC) Impact.

Based on reported geochemical data, all COC concentrations in the three potential sources of surface water are significantly below the respective MCLs and are at lower concentrations than in the ground waters in the study area. Therefore, we conclude that the COC balance for all species of interest is favorable to the basin, without the need to perform the calculations to demonstrate this.

Crewdson, Robert, A., 19 December, 2007, A Water Quality Evaluation of the Strand Ranch Aquifer Storage and Recovery Project, Kern County, Ca., Sierra Scientific Services, Bakersfield, Ca.

Figures

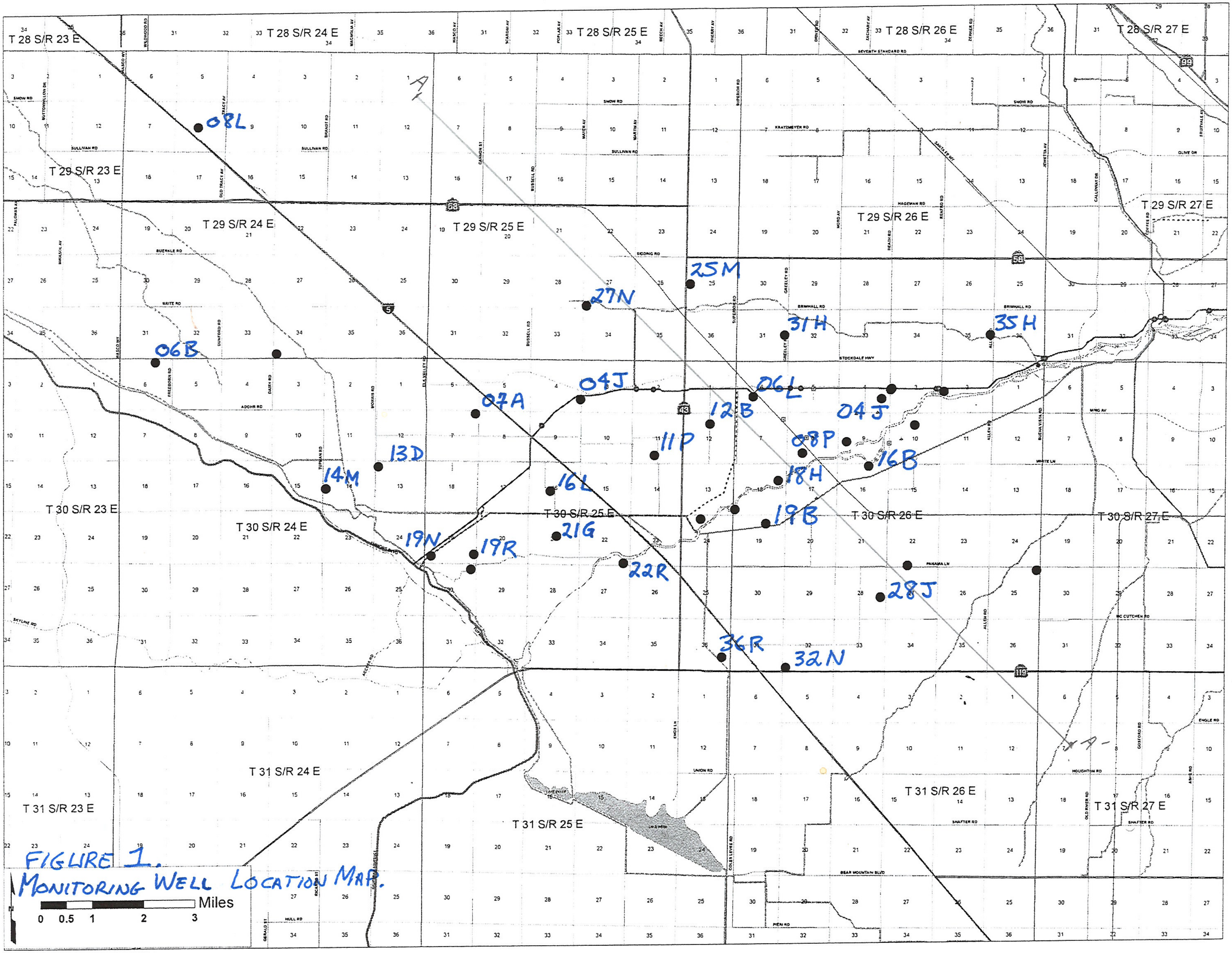


FIGURE 1.
MONITORING WELL LOCATION MAP.

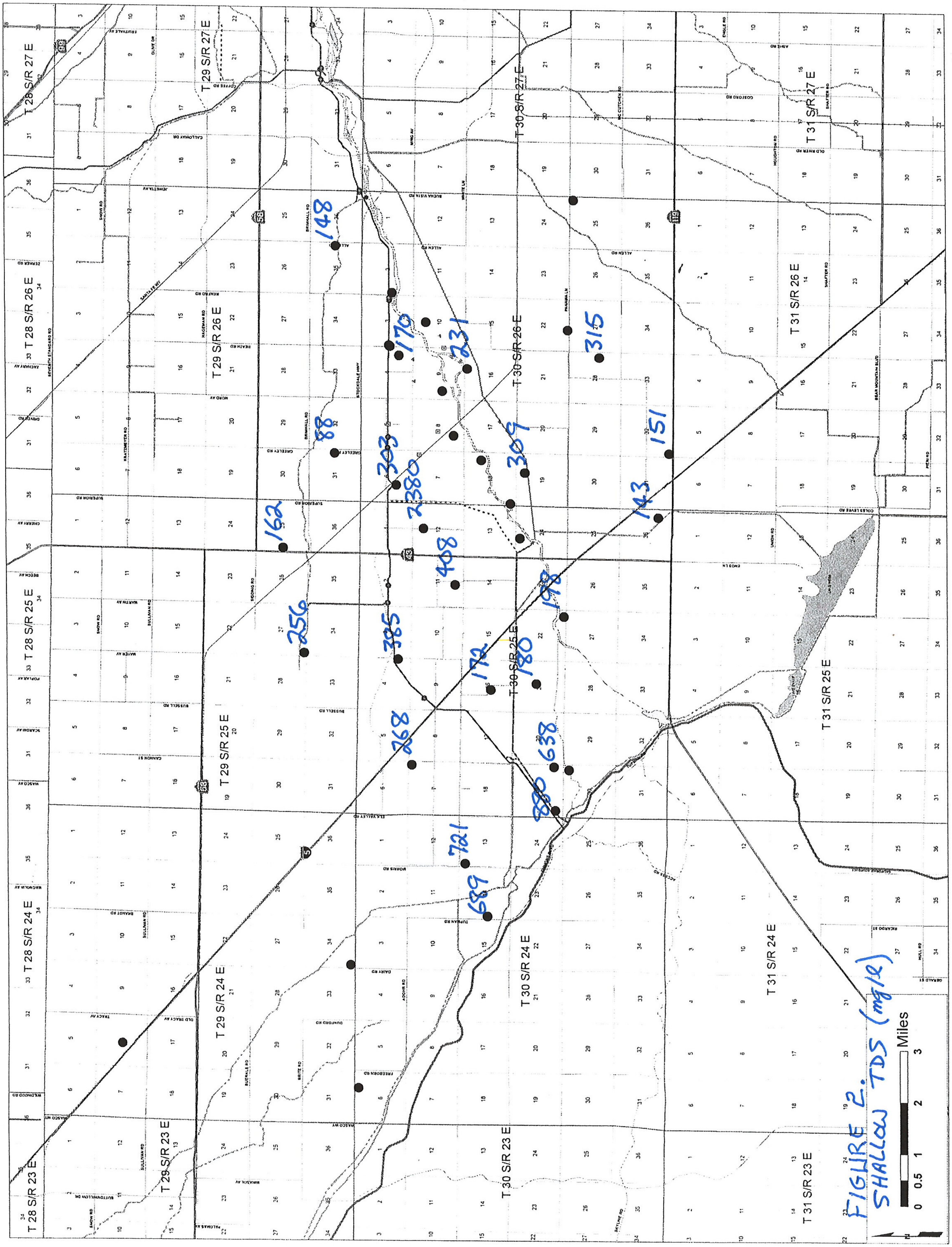


FIGURE 2.
SHALLOW TDS (mg/l)

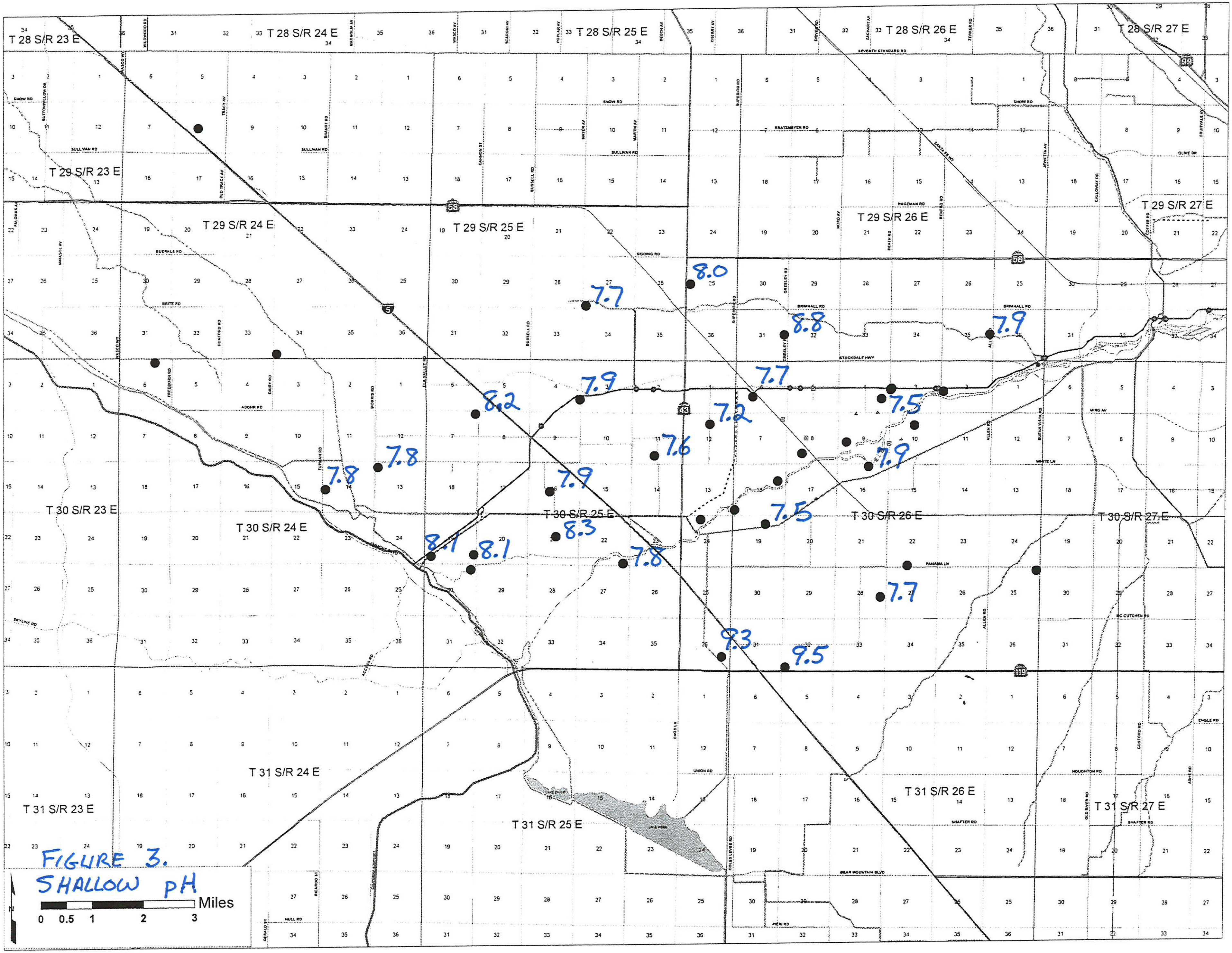


FIGURE 3.
SHALLOW pH

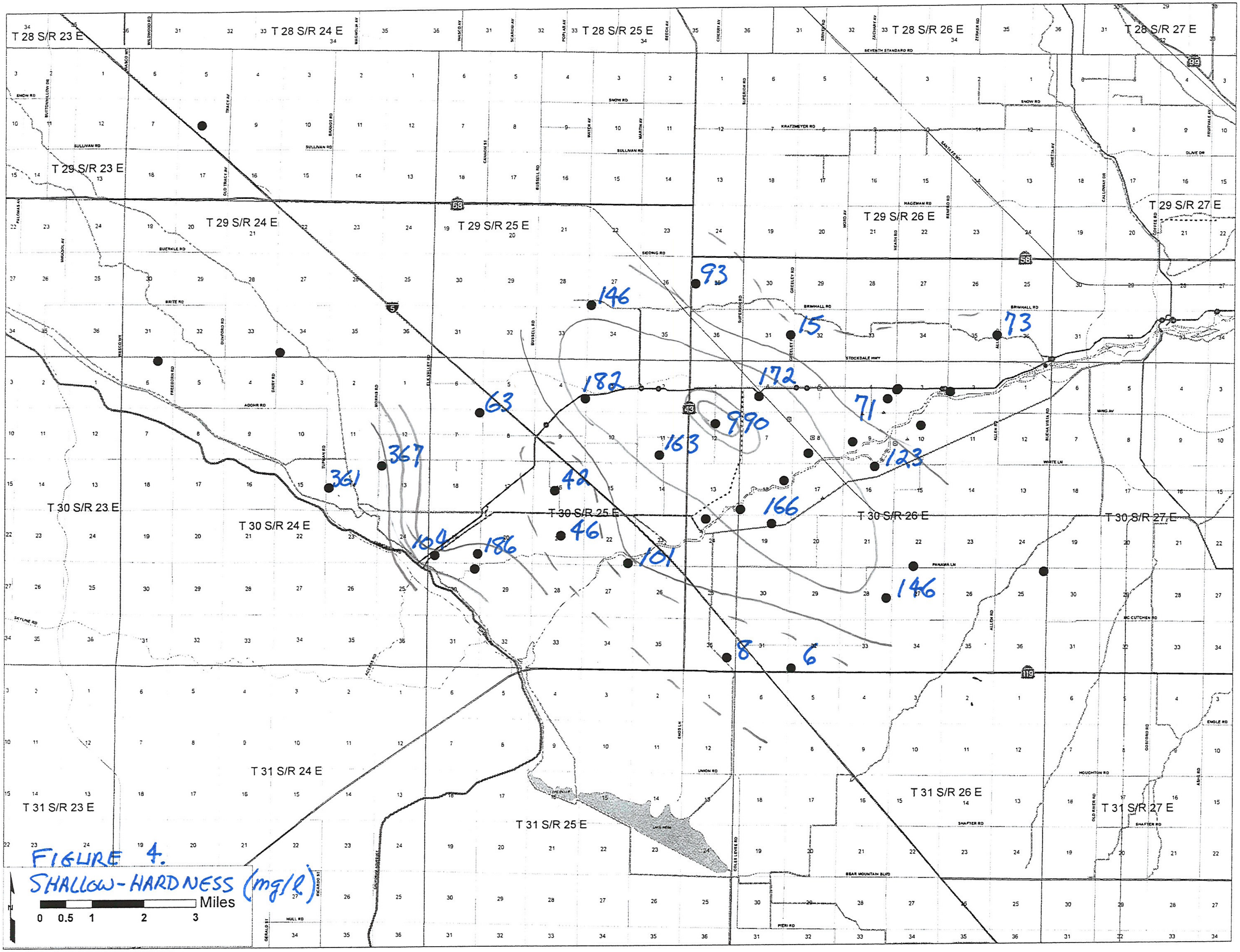


FIGURE 4.
SHALLOW-HARDNESS (mg/l)

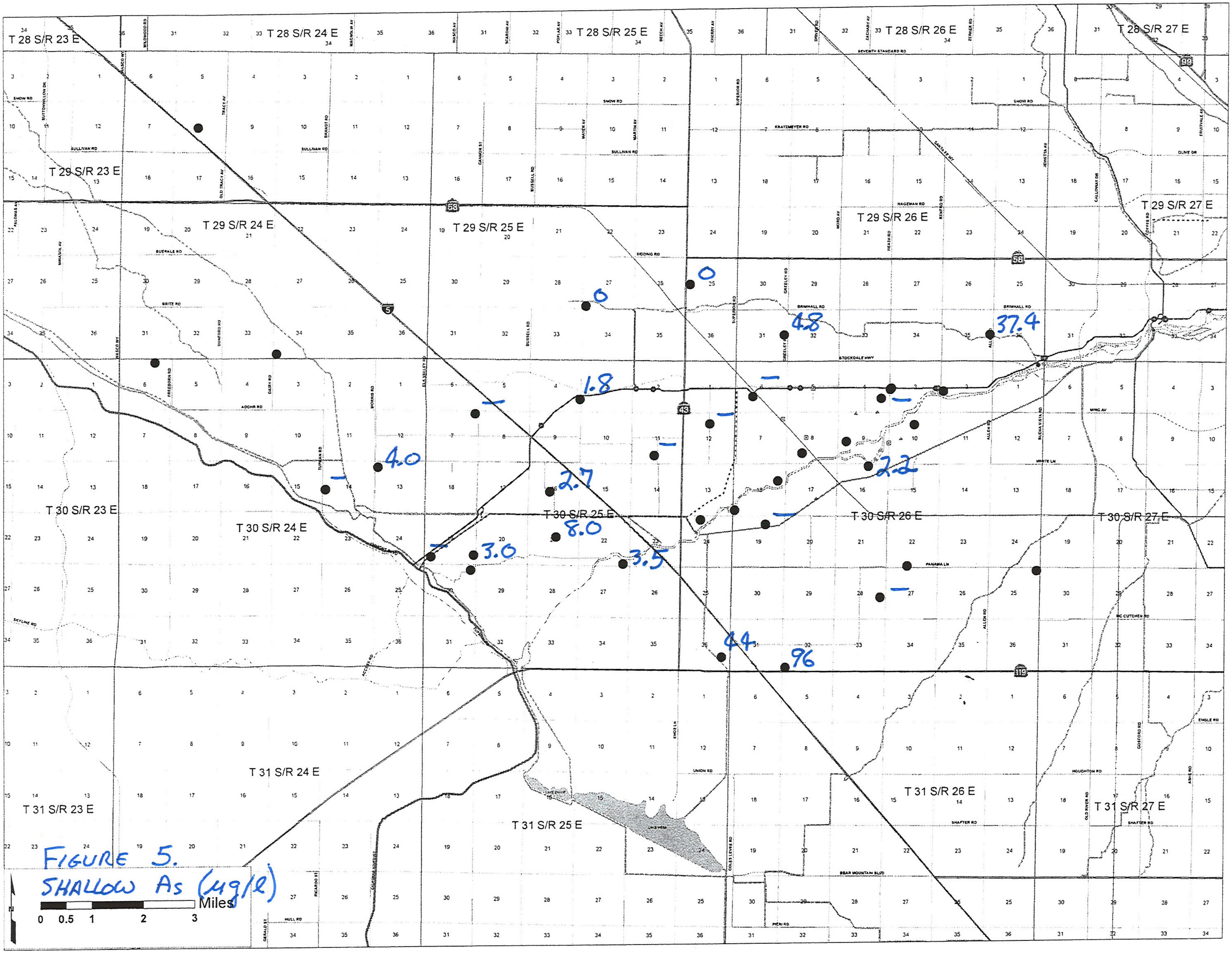


FIGURE 5.
SHALLOW As (μg/l)

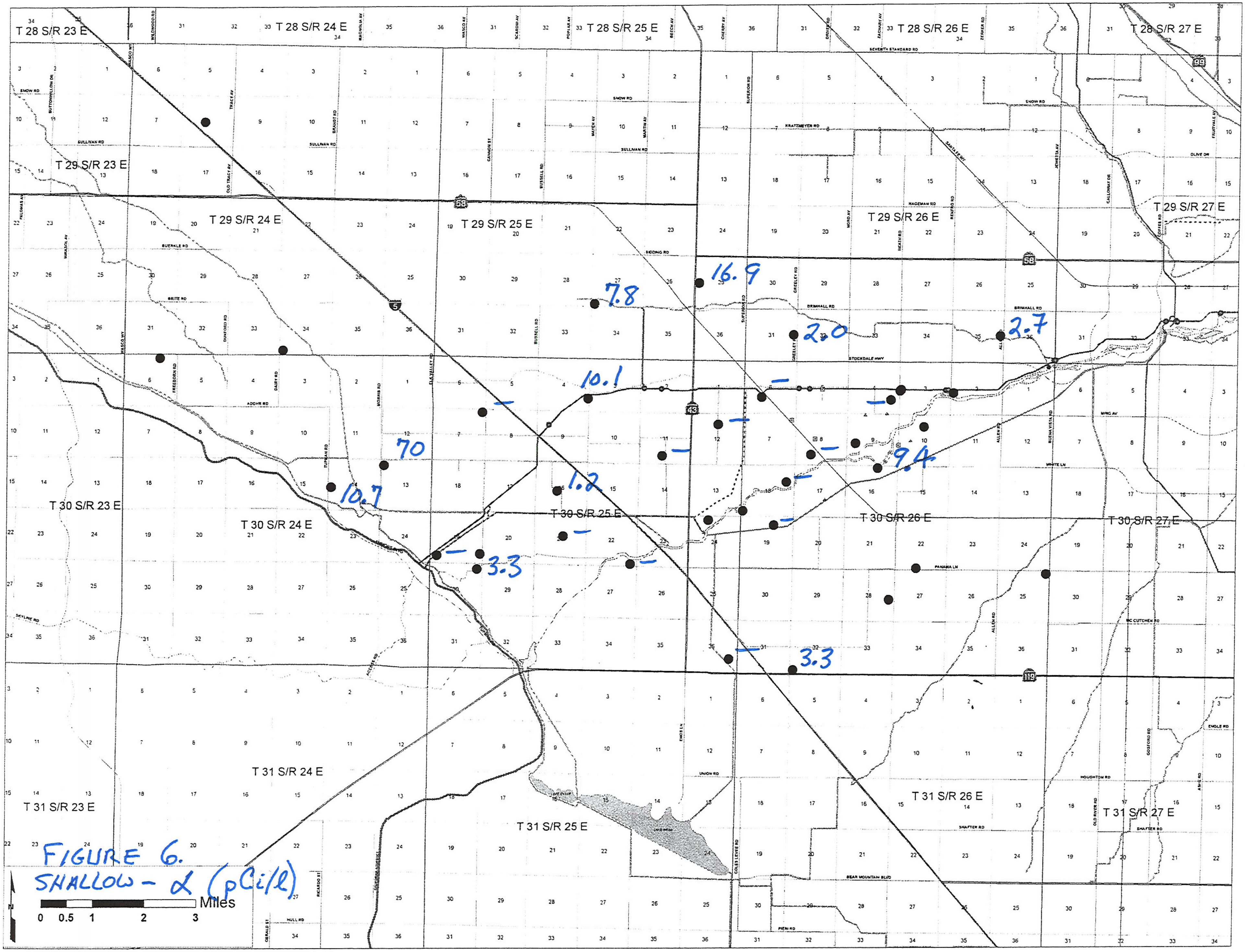


FIGURE 6.
SHALLOW - α (pCi/l)

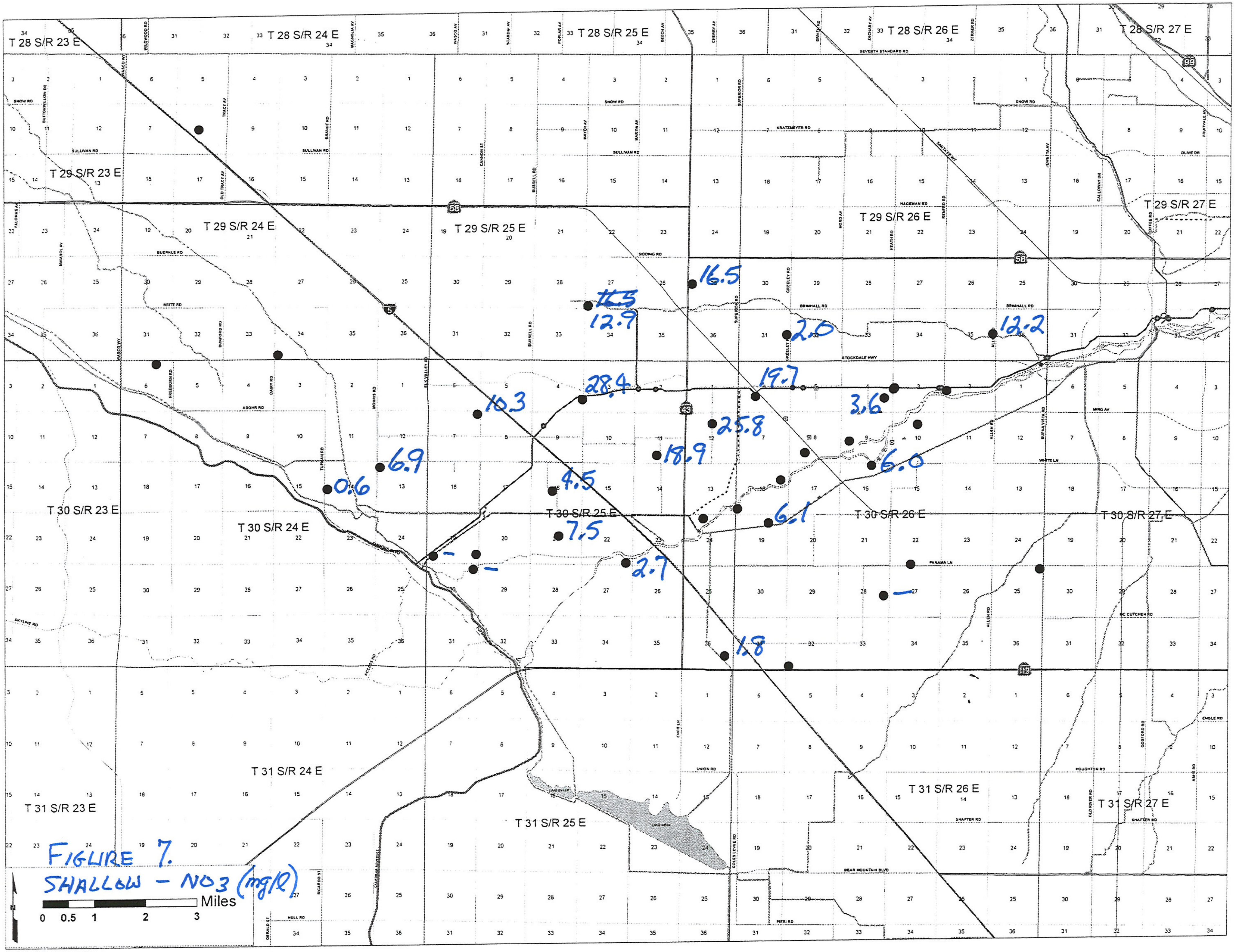


FIGURE 7.
SHALLOW - NO3 (mg/l)

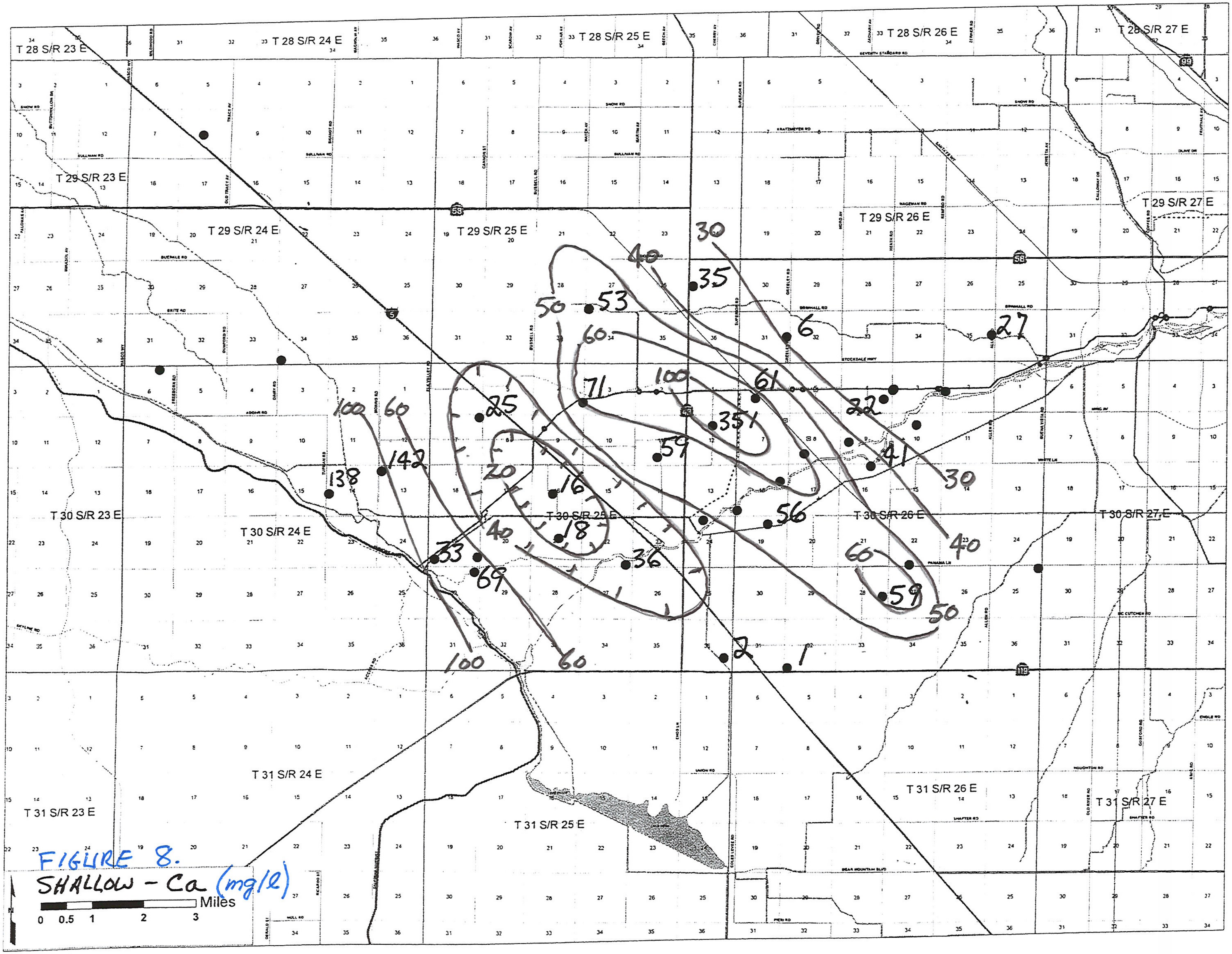


FIGURE 8.
SHALLOW - Ca (mg/l)

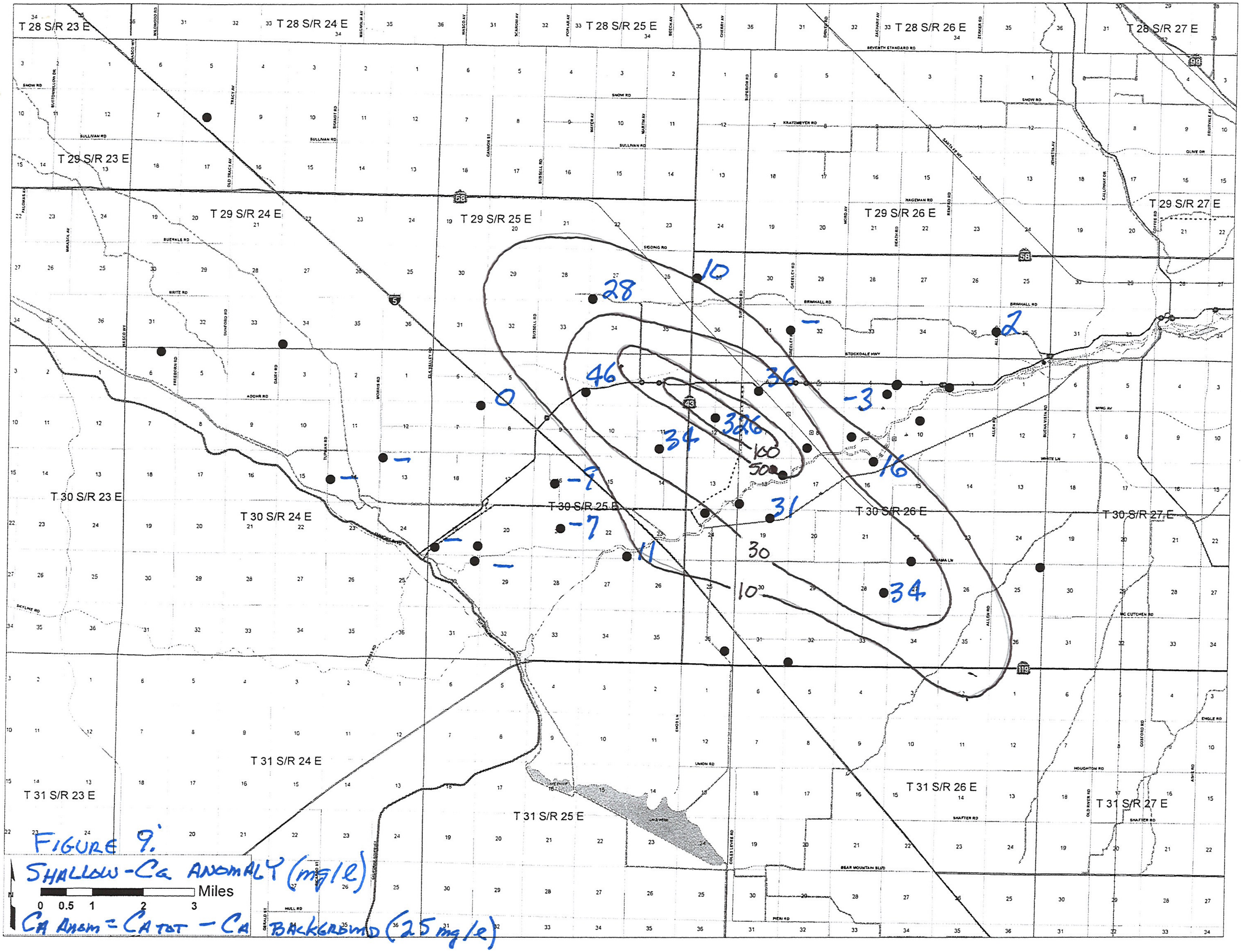
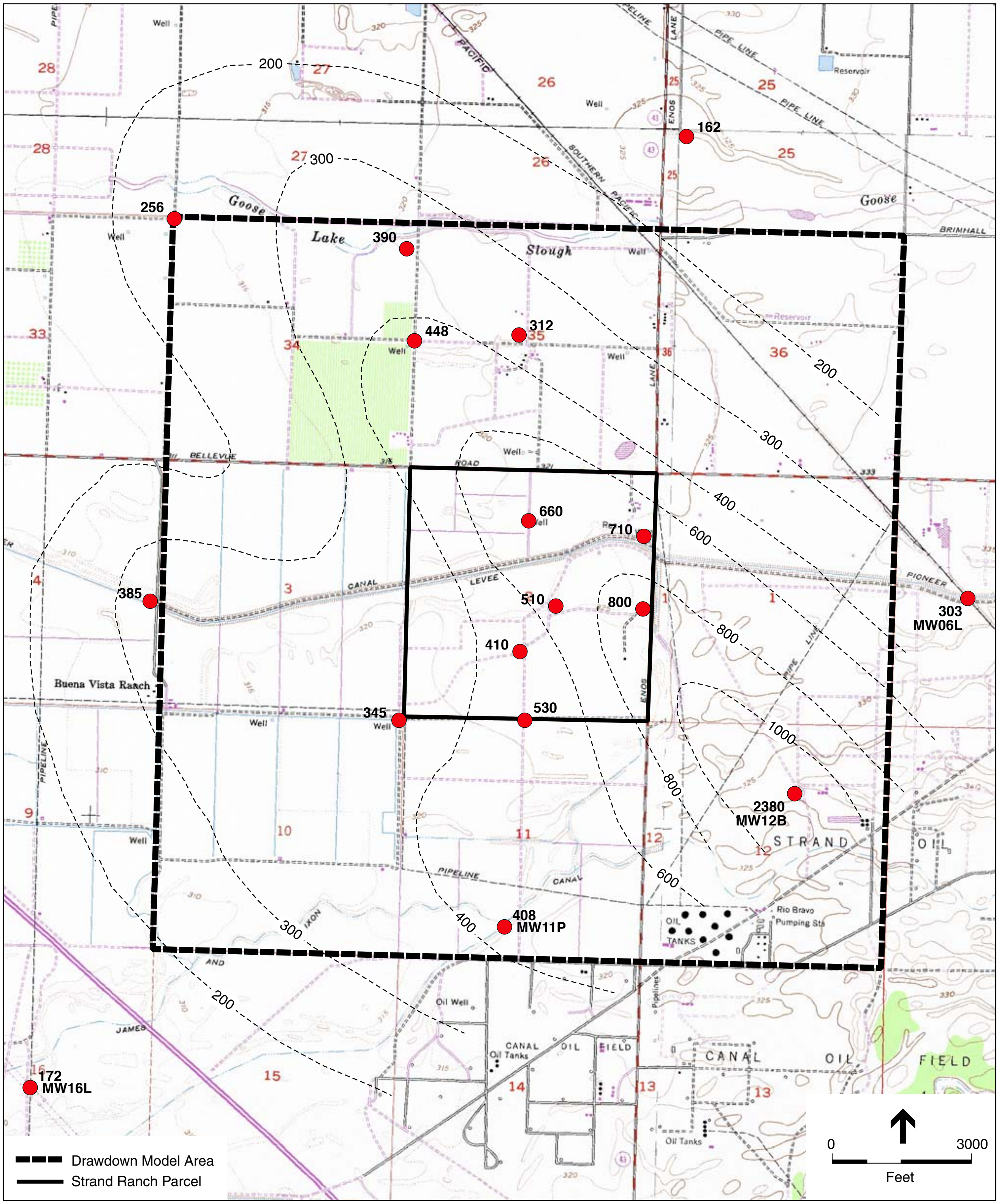


FIGURE 9.
SHALLOW-Ca ANOMALY (mg/l)
Ca Anom = Ca tot - Ca BACKGROUND (25 mg/l)



SOURCE: USGS; Sierra Scientific Services, 2007; ESA, 2007.

Irvine Ranch Water District . 205426

Figure 10

Contour Map of Shallow Aquifer
TDS Content (mg/l)
Showing Plume Impact

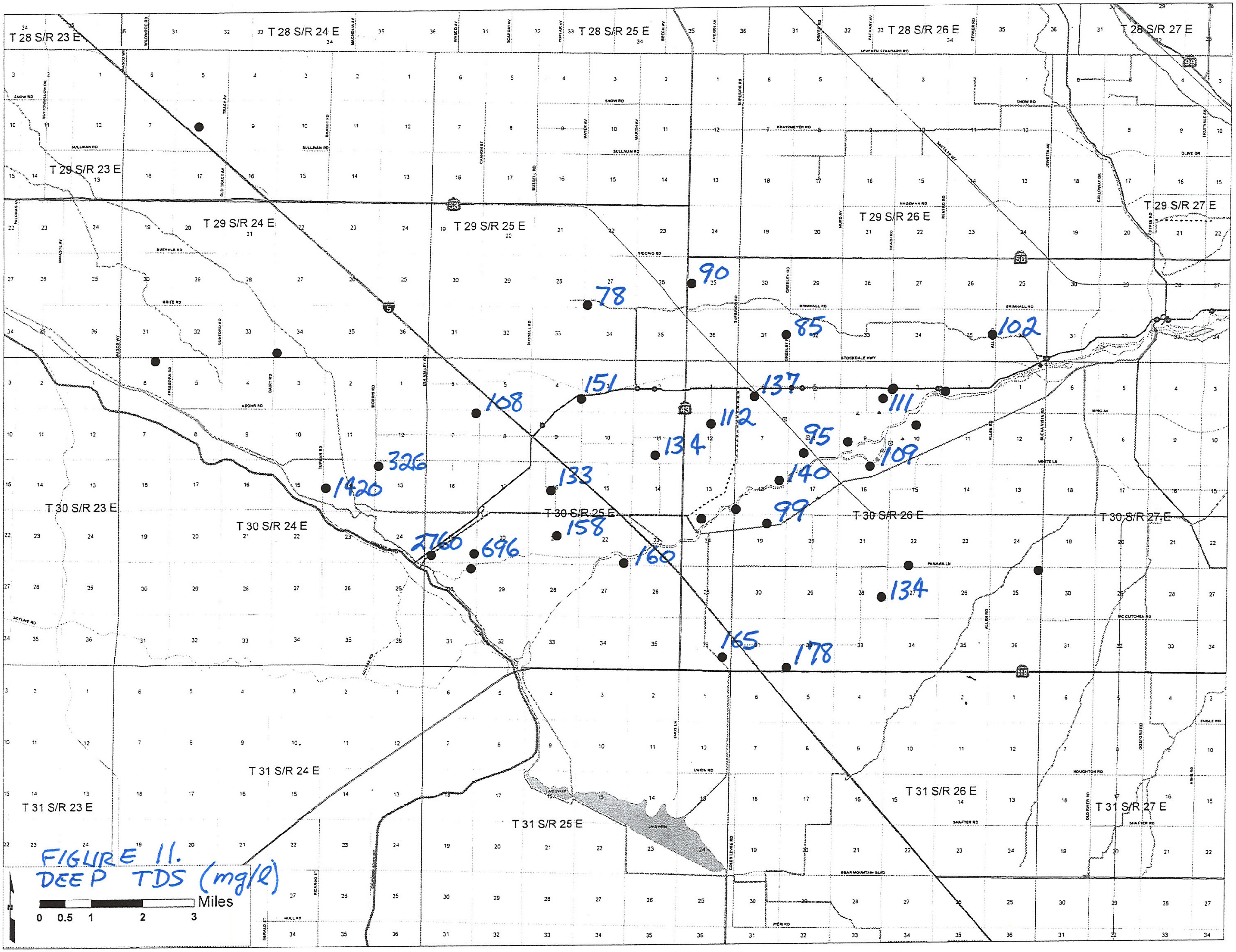


FIGURE 11.
DEEP TDS (mg/l)

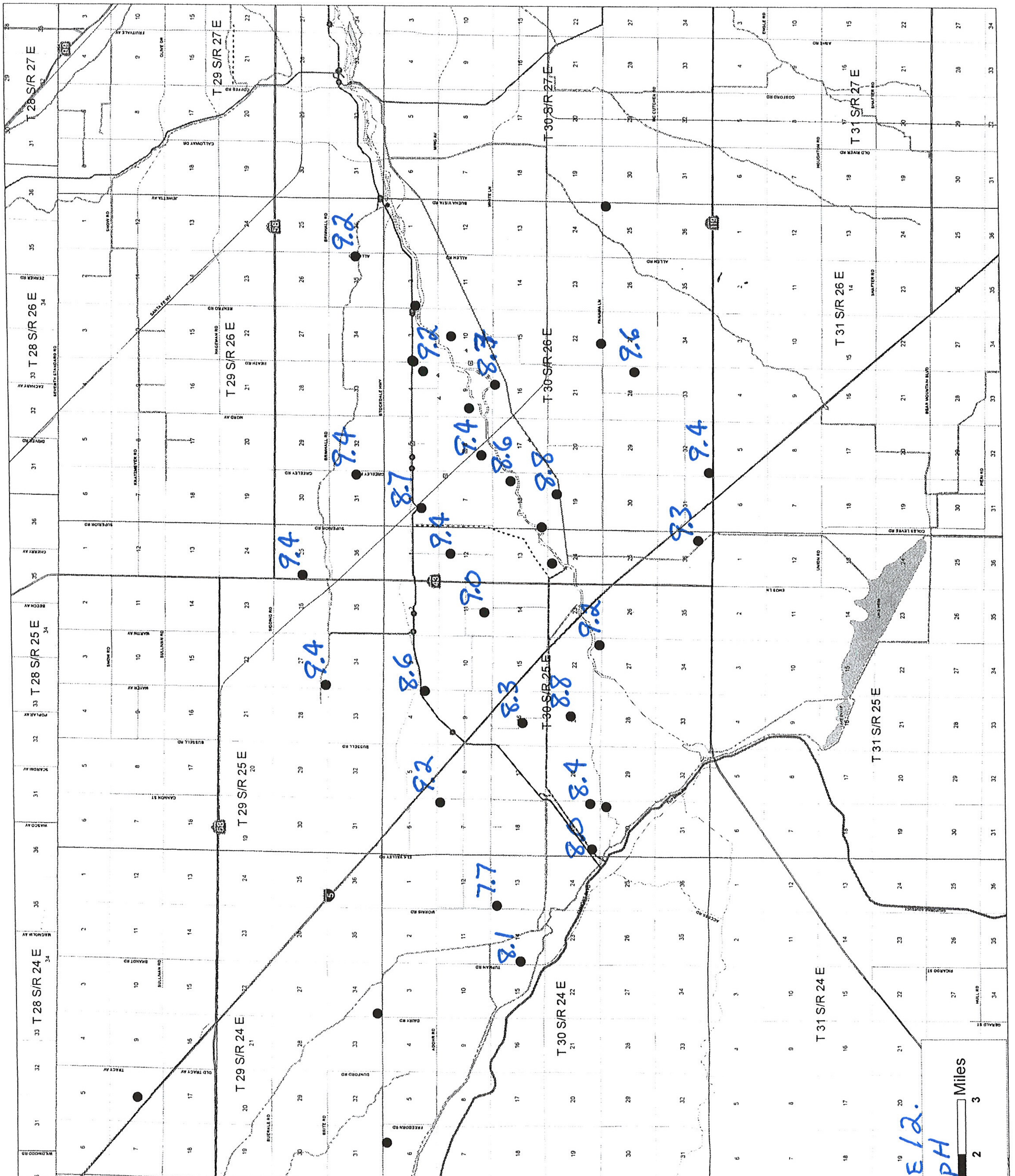


FIGURE 12.
DEEP pH

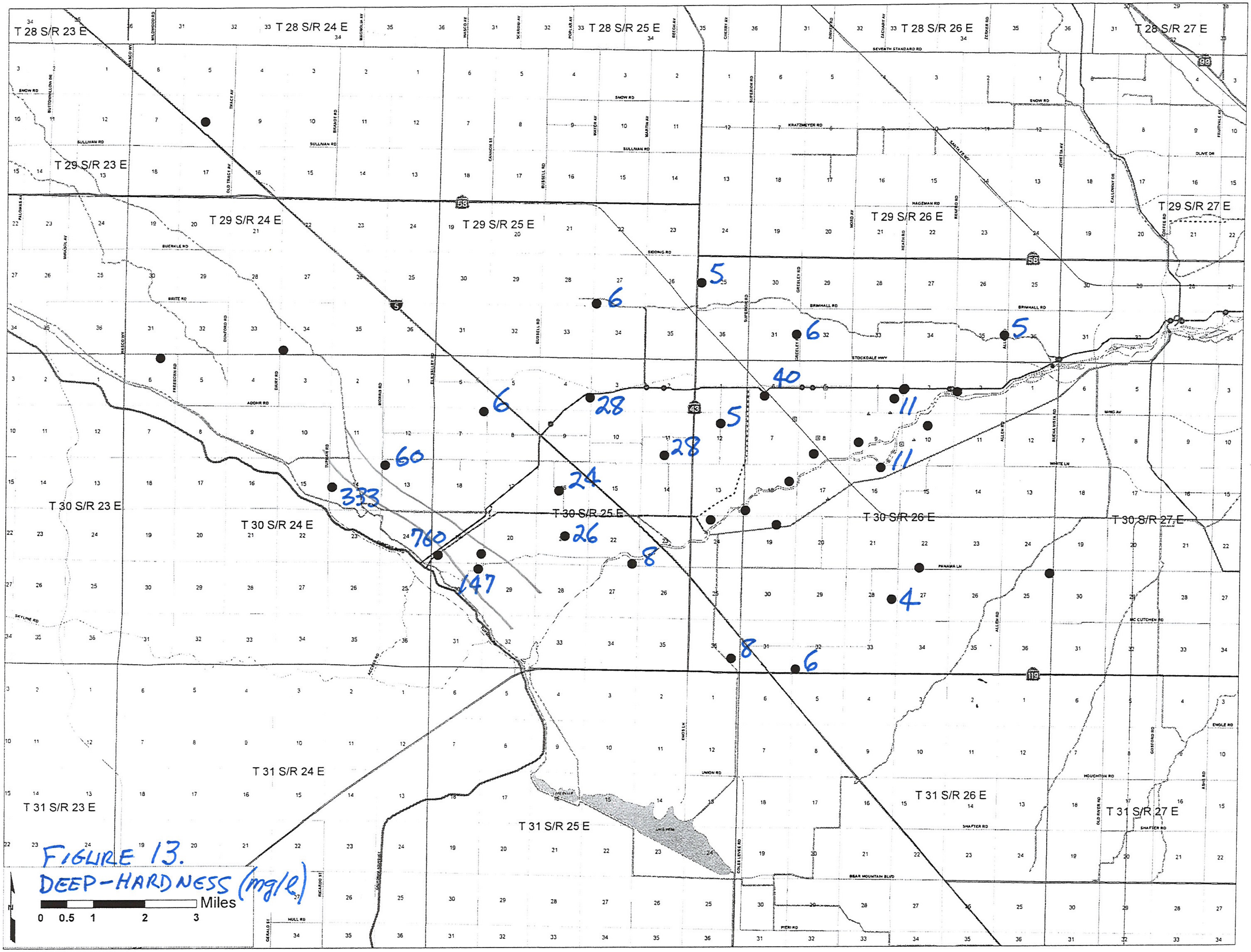


FIGURE 13.
DEEP-HARDNESS (mg/l)

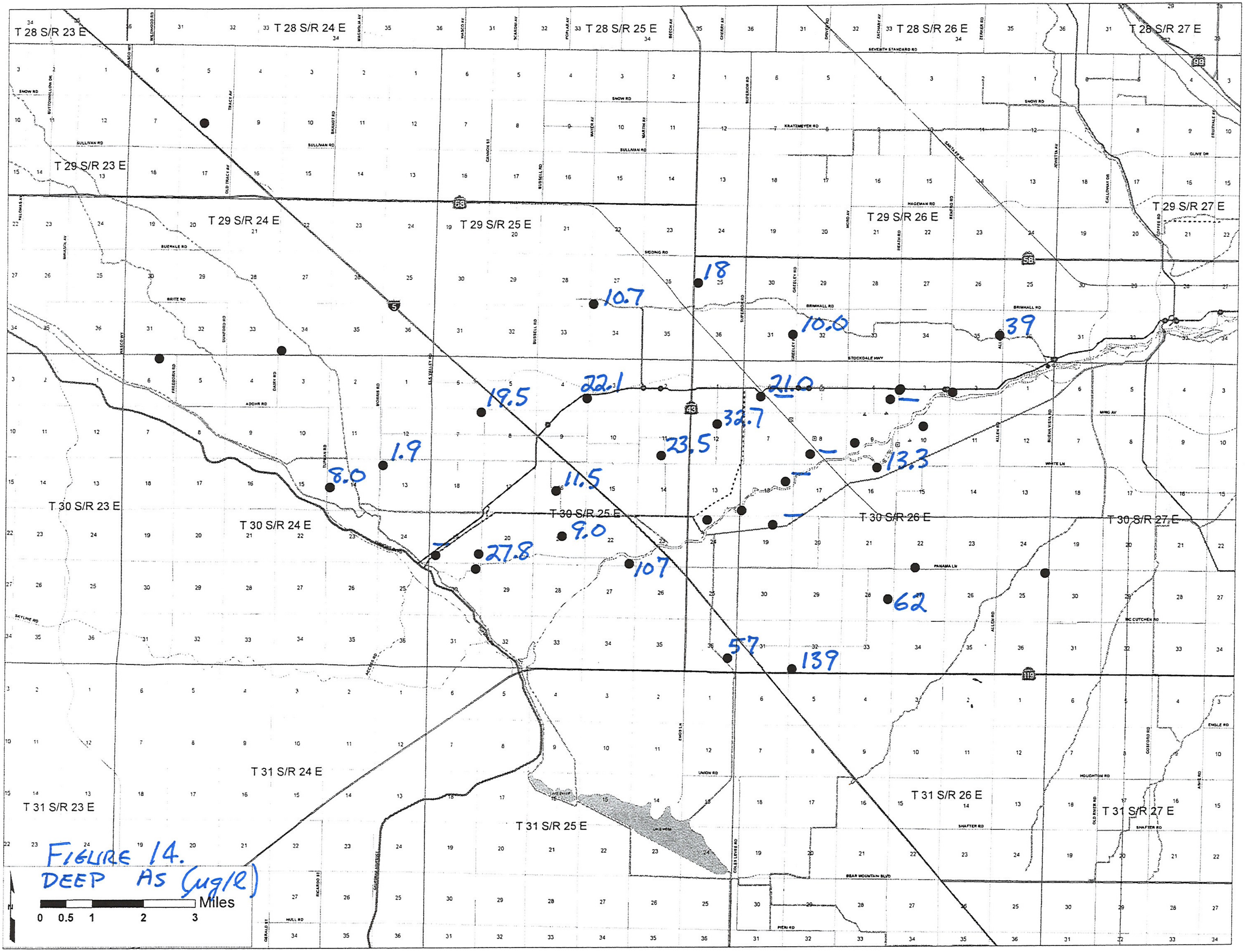


FIGURE 14.
DEEP As (ug/l)

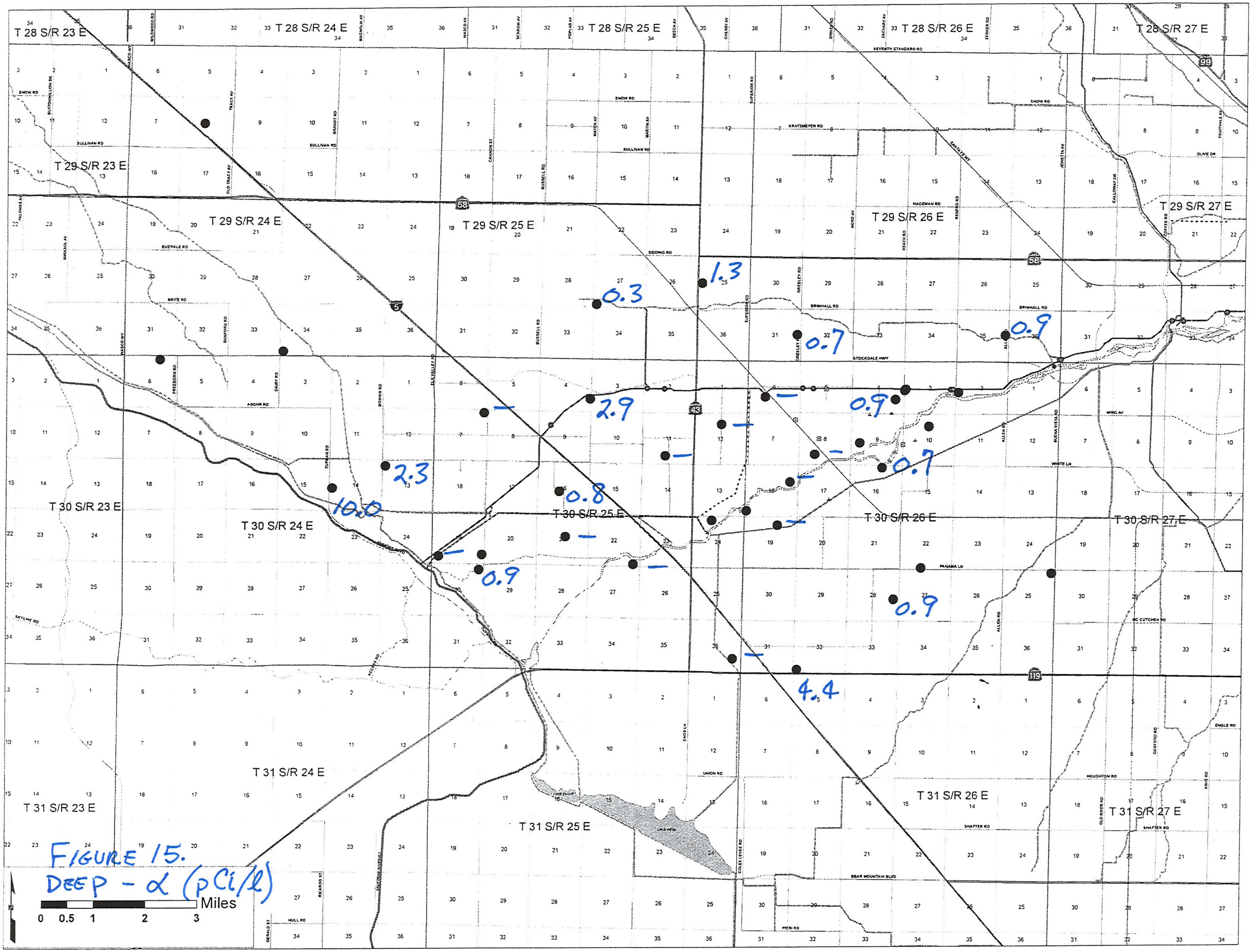


FIGURE 15.
DEEP - α (pCi/l)

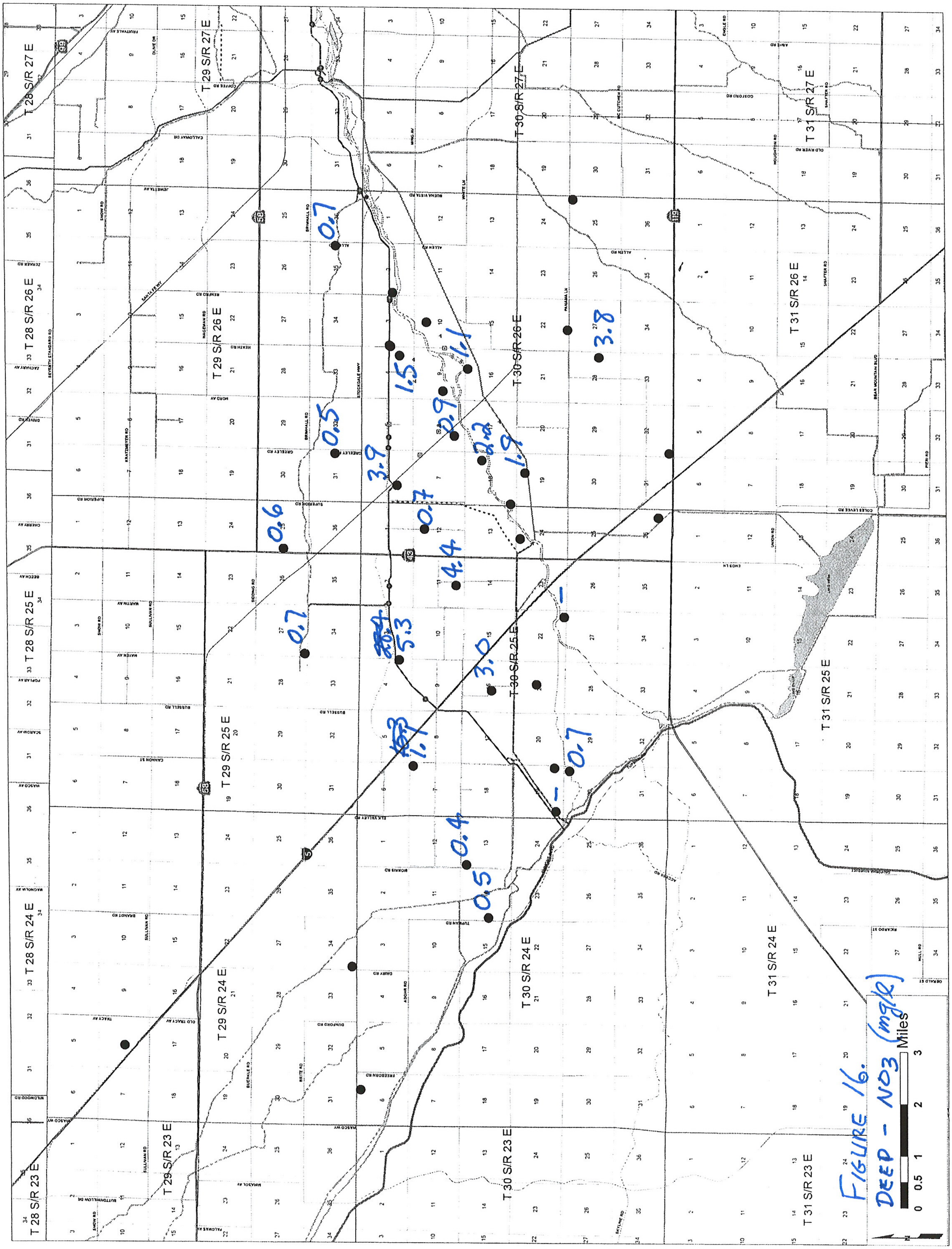


Figure 16.
Deep - NO3 (mg/l)

Tables

Table 1. **SWP Aqueduct Water TDS content by Year, Month, and Wet/Dry Season.**
(Measured in the Ca. Aqueduct at check 29, near Taft Hwy.)

																		5-yr Dry	5-yr Wet
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**		**Avg**	**Min**	**Max**	**Std**	**91-95**	**96-00**
Jan	382	469	439	499	297	417	284	66	297	315	295	374	*	345	66	499	110	424	251
Feb	369	448	485	472	328	219	251	88	227	216	250	337	*	308	88	485	116	390	206
Mar	306	433	563	470	363	263	236	147	218	158	187	280	*	302	147	563	125	418	189
Apr	335	382	358	441	357	274	211	225	108	231	206	275	*	284	108	441	90	362	196
May	355	371	366	326	340	144	265	227	78	232	239	239	*	265	78	371	88	309	208
Jun	343	361	353	346	339	152	260	219	78	228	239	227	*	262	78	361	86	310	205
Jul	338	363	377	334	333	158	214	210	124	199	189	291	*	261	124	377	84	313	187
Aug	319	359	410	339	310	178	197	224	186	153	213	245	*	261	153	410	80	319	195
Sep	280	326	361	174	395	165	146	154	206	164	164	323	*	238	146	395	88	284	167
Oct	310	329	337	206	479	141	152	180	142	258	248	365	*	262	141	479	101	298	196
Nov	357	329	464	214	480	160	195	331	130	242	262	333	*	291	130	480	107	329	232
Dec	438	356	456	311	427	270	266	293	207	219	301	310	*	321	207	456	79	364	257
Avg	344	377	414	344	371	212	223	197	167	218	233	300						344	208
Min	280	326	337	174	297	141	146	66	78	153	164	227						284	167
Max	438	469	563	499	480	417	284	331	297	315	301	374						424	257
Std	39	46	65	105	59	79	43	73	64	44	41	47						45	26
Max/Min	1.6	1.4	1.7	2.9	1.6	3.0	1.9	5.0	3.8	2.1	1.8	1.6						1.5	1.5

Data Source: KCWA 2001 Kern Fan Area Operations and Monitoring Report, Table 5D-9, p. 5-32.

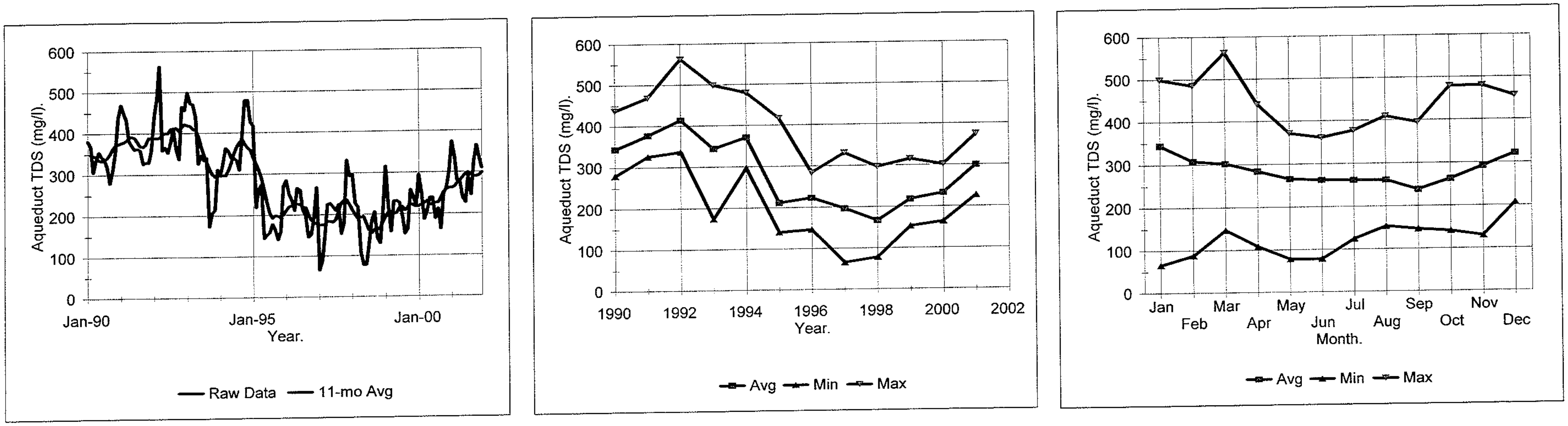


Table 1. SWP Aqueduct Water TDS content by Year, Month, and Wet/Dry Season.

Sierra Scientific Services, 2007. (661) 377 - 0123.)

Table 2. Key Constituents for the Shallow and Deep Aquifer at monitoring Well Locations.

(Avg* excludes MW data west of I-5, excludes 3 plume-related wells (04J, 11P, 12B), and excludes 3 off-fan wells (31H, 36R, 32N).

Shallow Aquifer (excl. west side)	AVG*	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG
Well		25M02	27N02	31H02	35H04	13D01	14M03	04J02	07A02	11P01	12B02	16L01	19N02
Depth	Shallow	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh
Domain		Fan-E2	Fan-E2	Fan-E1	Fan-E2	Fan-W1	Fan-W2	Fan-E3	Fan-E2	Fan-E3	Fan-E3	Fan-E3	Fan-W2
# Wells	21												
# Anal.	190	5	8		14	21	6	24	5	5	2	24	1
General Mineral													
TDS (mg/l)	225.9	162	256		148	721	689	385	268	408	2380	172	880
pH (pH)	7.8	8.0	7.7		7.9	7.8	7.8	7.9	8.2	7.6	7.2	7.9	8.1
Hd (mg/l)	103.4	93	146		69	366	375	181	63	163	991	41	100
COCs													
As (ug/l)	4.1					4.0		1.8				2.7	
Alpha pCi/l	7.6	7.8	16.9		2.7	69.5	10.7	10.2				1.2	
NO3 (mg/l)	9.3	16.5	12.9		12.2	6.9	0.5	28.4	10.3	18.9	25.8	4.5	

Deep Aquifer. (excl. west side)	AVG*	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG
Well		25M01	27N01	31H01	35H03	13D03	14M02	04J04	07A04	11P03	12B04	16L03	19N04
Depth	Deep	De	De	De	De	De	De	De	De	De	De	De	De
Domain		Fan-E2	Fan-E2	Fan-E1	Fan-E2	Fan-W1	Fan-W2	Fan-E3	Fan-E2	Fan-E3	Fan-E3	Fan-E3	Fan-W2
# Wells	24												
# Anal.	208	6	8	7	8	22	8	18	4	5	4	21	2
General Mineral													
TDS (mg/l)	123.9	90	78	85	102	326	1420	151	108	134	112	133	2760
pH (pH)	9.1	9.4	9.4	9.4	9.2	7.7	8.1	8.6	9.2	9.0	9.4	8.3	8.0
Hd (mg/l)	13.6	5	6	6	5	59	333	26	6	28	5	23	760
COCs													
As (ug/l)	35.0	18.0	10.7	10.0	39.0	1.9	8.0	22.1	19.5	23.5	32.7	11.5	
Alpha pCi/l	1.3	1.3	0.3	0.7	0.9	2.3	10.0	2.9				0.9	
NO3 (mg/l)	2.1	0.6	0.7	0.5	0.7	0.4	0.6	5.3	1.1	4.4	0.7	3.0	

Table 2. Key Constituents for the Shallow and Deep Aquifer at monitoring Well Locations.

Sierra Scientific Services, 2007. (661) 377 - 0123.

Table 2. Key Constituents for the Shallow and Deep Aquifer at monitoring Well Locations.

Shallow Aquifer													
(excl. west side)		AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG
Well		19R02	21G03	22R01	36R02	04J01	06L01	08P04	16B01	18H04	19B01	28J01	32N01
Depth		Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh	Sh
Domain		Fan-W2	Fan-E3	Fan-E3	Fan-E1	Fan-E3	Fan-E3	Fan-E2	Fan-E2	Fan-E22	Fan-E22	Fan-E2	Fan-E1
# Wells													
# Anal.		5	5	7	5	4	7		25		9	4	4
General Mineral													
TDS	(mg/l)	638	180	198	143	170	303		231		309	315	151
pH	(pH)	8.1	8.3	7.8	9.3	7.5	7.7		7.9		7.5	7.7	9.5
Hd	(mg/l)	186	46	100	5	70	171		122		166	153	2
COCs													
As	(ug/l)	3.0	8.0	3.5	44.3				2.2				95.5
Alpha	pCi/l	3.3							9.4				3.3
NO3	(mg/l)		7.5	2.7	1.8	3.6	19.7		6.0		6.1		

Deep Aquifer.													
(excl. west side)		AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG
Well		19R01	21G02	22R03	36R01	04J03	06L03	08P04	16B03	18H04	19B03	28J03	32N03
Depth		De	De	De	De	De	De	De	De	De	De	De	De
Domain		Fan-W2	Fan-E3	Fan-E3	Fan-E1	Fan-E3	Fan-E3	Fan-E2	Fan-E2	Fan-E22	Fan-E22	Fan-E2	Fan-E1
# Wells													
# Anal.		6	4	7	4	9	7	8	25	7	8	6	4
General Mineral													
TDS	(mg/l)	696	158	160	165	111	137	95	109	140	99	134	178
pH	(pH)	8.4	8.8	9.2	9.3	9.2	8.7	9.4	8.7	8.6	8.8	9.6	9.4
Hd	(mg/l)	146	26	8	8	10	38	9	10	19	26	4	5
COCs													
As	(ug/l)	27.8	9.0	106.5	57.0		21.0	0.0	13.3			62.0	138.5
Alpha	pCi/l	0.9				0.9		0.0	0.7			0.9	4.4
NO3	(mg/l)	0.7	4.0			1.5	3.9	0.9	1.1	2.2	1.9	3.8	

Table 2. Key Constituents for the Shallow and Deep Aquifer at monitoring Well Locations.

Table 3. Key Constituent Summary for Selected Surface Waters and Aquifer Waters.

WQ Summary.		SW	SW	SW	GW	GW	GW	Well	Well
Type		**AQ**	**FK**	**KR**	**Type-D**	**Type-A**	**Plume**	**KWB***	**SR1-6**
Zone					**Shallow**	**Deep**	**Shallow**	**Blend**	**Blend**
# Wells		na	na	na	8	11	3	?	5
# Analy.		9	6	48	76	66	31	11	5
General Mineral									
TDS	(mg/l)	334	41	88	229	119	1058	143	618
pH	(pH)	8.3	7.5	7.9	7.8	9.4	7.6	8.7	7.9
Hd	(mg/l)	115	22	39	122	6	445	52	272
COCs									
As	(ug/l)	7.0	2.9	5.2	0.7	44.9	0.6	9.9	0.3
Alpha	(pCi/l)	1.9	2.9	3.2	5.1	0.8	3.4	3.7	10.9
NO3	(mg/l)	2.4	1.4	1.0	9.9	0.8	24.4	2.7	24.0
								estimated blend:	
							Vsh/Vtot =	17%	67%
							Vdp/Vtot =	83%	33%

note: Surface water analyses (Aq, FK, KR) from KCWA, ID4 WWTP raw inlet water analyses.
note GW averages from tabulated long -term average monitoring well data.
note: Plume area-avg of 3 MW (neither max nor source): T30s/R25e, 04J, 11P, and 12B.
note: KWB blend from KCWA, ID4 WWTP raw inlet water analyses.
note: Strand Ranch blend from one set of 2003 well water analyses.

Table 3. Key Constituent Summary for Selected Surface Waters and Aquifer Waters.

Table 4. Kern Fan Banking Project Salt Balance Data.

Yr	Project	SWP Rchg (af)	FK Rchg (af)	KR Rchg (af)	Total Rchg (af)	SWP Salt (T)	FK Salt (T)	KR Salt (T)	Total Salt (T)	SWP TDS (T/af)	FK TDS (T/af)	KR TDS (T/af)	Total TDS (T/af)	0.0014 SWP TDS (mg/l)	FK TDS (mg/l)	KR TDS (mg/l)	Total TDS (mg/l)	SWP V wtr (%)	FK V wtr (%)	KR V wtr (%)	SWP M salt (%)	FK M salt (%)	KR M salt (%)
1995	BM	11437	18917	4132	34486	4395	1106	472	5972	0.384	0.058	0.114	0.173	283	43	84	127	33.2%	54.9%	12.0%	73.6%	18.5%	7.9%
1995	2800 ac	48287	30020	30908	109215	15860	1754	3529	21143	0.328	0.058	0.114	0.194	242	43	84	142	44.2%	27.5%	28.3%	75.0%	8.3%	16.7%
1995	KWB	70329	47035	104896	222260	18487	2749	11975	33211	0.263	0.058	0.114	0.149	193	43	84	110	31.6%	21.2%	47.2%	55.7%	8.3%	36.1%
1995	Pioneer	10177	35679	33657	79513	2319	2085	3842	8246	0.228	0.058	0.114	0.104	168	43	84	76	12.8%	44.9%	42.3%	28.1%	25.3%	46.6%
1995	KRC	0	2367	891	3258	0	138	102	240		0.058	0.114	0.074		43	84	54	0.0%	72.7%	27.3%	0.0%	57.5%	42.5%
1996	BM	920	6804	2242	9966	332	398	256	985	0.361	0.058	0.114	0.099	266	43	84	73	9.2%	68.3%	22.5%	33.7%	40.4%	26.0%
1996	2800 ac	8799	17737	12947	39483	3153	1037	1478	5667	0.358	0.058	0.114	0.144	264	43	84	106	22.3%	44.9%	32.8%	55.6%	18.3%	26.1%
1996	KWB	87492	49893	36490	173875	26411	2916	4166	33492	0.302	0.058	0.114	0.193	222	43	84	142	50.3%	28.7%	21.0%	78.9%	8.7%	12.4%
1996	Pioneer	6620	20521	18535	45676	2317	1199	2116	5632	0.350	0.058	0.114	0.123	258	43	84	91	14.5%	44.9%	40.6%	41.1%	21.3%	37.6%
1996	KRC	340	11684	6301	18325	118	683	719	1520	0.347	0.058	0.114	0.083	255	43	84	61	1.9%	63.8%	34.4%	7.8%	44.9%	47.3%
1997	BM	52	4476	2027	6555	5	262	231	498	0.096	0.059	0.114	0.076	71	43	84	56	0.8%	68.3%	30.9%	1.0%	52.6%	46.4%
1997	2800 ac	2562	0	3178	5740	1000	0	363	1363	0.390		0.114	0.237	287		84	175	44.6%	0.0%	55.4%	73.4%	0.0%	26.6%
1997	KWB	40049	28806	43407	112262	13931	1683	4955	20569	0.348	0.058	0.114	0.183	256	43	84	135	35.7%	25.7%	38.7%	67.7%	8.2%	24.1%
1997	Pioneer	3632	7328	19125	30085	1406	428	2183	4017	0.387	0.058	0.114	0.134	285	43	84	98	12.1%	24.4%	63.6%	35.0%	10.7%	54.3%
1997	KRC	0	0	6471	6471	0	0	739	739			0.114	0.114			84	84	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
1998	BM	986	4232	15131	20349	271	247	1727	2246	0.275	0.058	0.114	0.110	202	43	84	81	4.8%	20.8%	74.4%	12.1%	11.0%	76.9%
1998	2800 ac	2647	4245	49505	56397	857	248	5652	6757	0.324	0.058	0.114	0.120	238	43	84	88	4.7%	7.5%	87.8%	12.7%	3.7%	83.6%
1998	KWB	51155	55248	196312	302715	14427	3229	22411	40067	0.282	0.058	0.114	0.132	208	43	84	97	16.9%	18.3%	64.9%	36.0%	8.1%	55.9%
1998	Pioneer	7646	4835	56634	69115	2296	283	6465	9044	0.300	0.059	0.114	0.131	221	43	84	96	11.1%	7.0%	81.9%	25.4%	3.1%	71.5%
1998	KRC	8	600	264	872	2	35	30	67	0.250	0.058	0.114	0.077	184	43	84	57	0.9%	68.8%	30.3%	3.0%	52.2%	44.8%
1999	BM	0	599	34	633	0	35	4	39		0.058	0.118	0.062		43	87	45	0.0%	94.6%	5.4%	0.0%	89.7%	10.3%
1999	2800 ac	3568	3952	2743	10263	1219	231	313	1763	0.342	0.058	0.114	0.172	251	43	84	126	34.8%	38.5%	26.7%	69.1%	13.1%	17.8%
1999	KWB	26011	10563	179	36753	8846	617	20	9483	0.340	0.058	0.112	0.258	250	43	82	190	70.8%	28.7%	0.5%	93.3%	6.5%	0.2%
1999	Pioneer	6736	5892	1104	13732	2387	344	126	2858	0.354	0.058	0.114	0.208	261	43	84	153	49.1%	42.9%	8.0%	83.5%	12.0%	4.4%
1999	KRC	0	2043	0	2043	0	119	0	119		0.058		0.058		43		43	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
2000	BM	0	1027	0	1027	0	60	0	60		0.058		0.058		43		43	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
2000	2800 ac	258	30660	0	30918	78	1792	0	1870	0.302	0.058		0.060	222	43		45	0.8%	99.2%	0.0%	4.2%	95.8%	0.0%
2000	KWB	19455	8124	0	27579	5430	475	0	5905	0.279	0.058		0.214	205	43		158	70.5%	29.5%	0.0%	92.0%	8.0%	0.0%
2000	Pioneer	5589	9707	0	15296	1533	567	0	2100	0.274	0.058		0.137	202	43		101	36.5%	63.5%	0.0%	73.0%	27.0%	0.0%
2000	KRC	0	4073	0	4073	0	238	0	238		0.058		0.058		43		43	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
2001	BM	0	0	0	0	0	0	0	0														
2001	2800 ac	2539	0	0	2539	966	0	0	966	0.380			0.380	280			280	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
2001	KWB	10030	0	0	10030	3817	0	0	3817	0.381			0.381	280			280	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
2001	Pioneer	1253	0	0	1253	477	0	0	477	0.381			0.381	280			280	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%
2001	KRC	139	1262	813	2214	53	74	93	219	0.381	0.059	0.114	0.099	281	43	84	73	6.3%	57.0%	36.7%	24.2%	33.8%	42.5%
XXX																							
	Sum	428716	428329	647926	1504971	132393	25032	73967	231389	0.309	0.058	0.114	0.154	227	43	84	113	28.5%	28.5%	43.1%	57.2%	10.8%	32.0%

Data from: KCWA 2001 Kern Fan Monitoring Report, tables 5D-1 to 5D-8.

Yr	Project	SWP Rchg (af)	FK Rchg (af)	KR Rchg (af)	Total Rchg (af)	SWP Salt (T)	FK Salt (T)	KR Salt (T)	Total Salt (T)	SWP TDS (T/af)	FK TDS (T/af)	KR TDS (T/af)	Total TDS (T/af)	SWP TDS (mg/l)	FK TDS (mg/l)	KR TDS (mg/l)	Total TDS (mg/l)	SWP V wtr (%)	FK V wtr (%)	KR V wtr (%)	SWP M salt (%)	FK M salt (%)	KR M salt (%)
' 95 - 01	BM	13395	36055	23566	73016	5003	2108	2690	9800	0.373	0.058	0.114	0.134	275	43	84	99	18.3%	49.4%	32.3%	51.1%	21.5%	27.4%
' 95 - 01	2800 ac	68660	86614	99281	254555	23133	5062	11335	39529	0.337	0.058	0.114	0.155	248	43	84	114	27.0%	34.0%	39.0%	58.5%	12.8%	28.7%
' 95 - 01	KWB	304521	199669	381284	885474	91349	11669	43527	146544	0.300	0.058	0.114	0.165	221	43	84	122	34.4%	22.5%	43.1%	62.3%	8.0%	29.7%
' 95 - 01	Pioneer	41653	83962	129055	254670	12735	4906	14732	32374	0.306	0.058	0.114	0.127	225	43	84	94	16.4%	33.0%	50.7%	39.3%	15.2%	45.5%
' 95 - 01	KRC	487	22029	14740	37256	173	1287	1683	3142	0.355	0.058	0.114	0.084	261	43	84	62	1.3%	59.1%	39.6%	5.5%	41.0%	53.6%
' 95 - 01	Chk Sum	428716	428329	647926	1504971	132393	25032	73967	231389	0.309	0.058	0.114	0.154	227	43	84	113	28.5%	28.5%	43.1%	57.2%	10.8%	32.0%

Table 4. Kern Fan Banking Project Salt Balance Data.

Sierra Scientific Services, 2007. (661) 377 - 0123.

Exhibits

Exhibit 1.

Water Quality Data Collection and Evaluation Methodology.

Exhibit 1.

Water Quality Data Collection and Evaluation Methodology.

Some of the data and findings in this Report have been excerpted and modified from another ongoing water quality study for the Rosedale - Rio Bravo Water Storage District, with their permission. That study is a baseline water quality (BWQ) analysis of the groundwater aquifer in the RRBWSD area of interest, which happens to include the Strand Ranch Project area because of proximity. The RRBWSD baseline water quality analysis will be completed and presented in report form in Winter, 2007-2008.

The BWQ work program includes groundwater data collection, basic data analysis, and preliminary interpretation. The sources of data include: the Kern County Water Agency water quality database (courtesy of Tom Haslebacher, KCWA Senior Hydrogeologist), Vaughan Water Company water well analyses (courtesy of Mike Huhn, manager, VWC), and the Rosedale - Rio Bravo Water Storage District (courtesy of Robert Coffee, RRBWSD operations manager). Sierra Scientific Services specified the data screening criteria and the methods of analysis according to accepted standards and practices.

For this study, we have added water sample analyses provided by IRWD collected from the accessible irrigation wells on the Strand Ranch property and obtained from other wells located on adjacent property.

The primary task of this study is to collect the available data and describe the observed, historical water quality trends in the surface waters and groundwaters which flow into and out of the Kern Fan aquifer system as they relate to the Strand Ranch Aquifer Storage and Recovery Project.

In the BWQ analysis, SSS focused the main data collection effort on obtaining a “complete set” of water-constituent tabulations and the supporting analytical reports for each and every reported analysis. The goal was to compile and tabulate multiple analyses collected over time for each and every sampling location, from which we could determine the average value and range of natural variability for each constituent at each sample location. We applied quantitative quality control/quality assurance indicators to each dataset. Based on these indicators and our own inspection of the data, we compiled every reported analysis into a standardized reporting format, and edited all of the data, including the rejection of any data which were unacceptable for our purposes based upon our criteria. The basic statistical criteria for the acceptability of data which we applied it to the entire database is as follows:

1: Location and Date: The location, well ID, and sampling date must be known;

2: Sufficiency: To obtain no less than four (4) independent analyses at a given sampling location;

3: Timing: Sampling intervals are preferred to be between quarterly and annually;

4: Variability: Constituent coefficients of variation are no more than 0.30, suggesting normality in constituent distributions;

5: Completeness: For the general mineral constituents, all major cations, anions, and physical properties of TDS, EC, and pH must be included in an analysis in order to be included in our compilation;

6: Depth:The completion interval of the well must be known in order for the data to be used. We give high priority to water quality samples from single-zone monitoring wells. Shallow (<250 ft) irrigation and domestic wells might be included in this category subject to review even if the exact completion interval is not known. We give low - medium priority to water quality samples from irrigation and recovery wells with long, multi-zone completion intervals. We give little or no priority to water quality samples from wells with unknown completion intervals.

7: Analytical Error: The data must pass our internal analytical checks for cation/anion balance (basic analytical accuracy check) and TDS/EC balance (basic ion concentration - electric conduction check).

8: Reporting Conventions: For our purposes and for all statistical analyses such as calculating sample averages and variances, we disagree with the reporting convention of giving a "below detection threshold" measurement a numerical value equal to the detection threshold. When we find such values in the data, we reset them to zero in our database. If there is no reported value for a constituent, we leave the value "blank".

We rejected many individual analyses for failing to meet one or more statistical criteria and rejected other analyses which had no documentation or means of verification. We were reluctant to accept constituent - of - concern (COC) analyses for sample locations which had little or no established general mineral chemistry and did so in only a few case-by-case situations.

Exhibit 2.

Surface Water and Ground Water Geochemical Analyses.

WQ Analyses.		West AVG	West AVG	West AVG	West AVG	West AVG	West AVG	West AVG	West AVG	West AVG	West AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG
Well		30S/24E 13D01	30S/24E 13D02	30S/24E 13D03	30S/24E 14M02	30S/24E 14M03	30S/25E 19N02	30S/25E 19N03	30S/25E 19N04	30S/25E 19R01	30S/25E 19R02	30S/25E 04J02 S	30S/25E 04J03	30S/25E 04J04	30S/25E 07A02	30S/25E 07A03	30S/25E 07A04	30S/25E 11P01	30S/25E 11P02	30S/25E 11P03	30S/25E 12B02
Twp/Rge		30S/24E	30S/24E	30S/24E	30S/24E	30S/24E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E
Sec/40ac		**13D01**	**13D02**	**13D03**	**14M02**	**14M03**	**19N02**	**19N03**	**19N04**	**19R01**	**19R02**	**04J02**	**04J03**	**04J04**	**07A02**	**07A03**	**07A04**	**11P01**	**11P02**	**11P03**	**12B02**
Depth		Sh	Mi	De	De	Sh	Sh	Mi	De	De	Sh	Sh	Mi	De	Sh	Mi	De	Sh	Mi	De	Sh
Date		21	22	22	8	6	1	3	2	6	5	24	26	18	5	5	4	5	5	5	2
Domain		Fan-W1	Fan-W1	Fan-W1	Fan-W2	Fan-W2	Fan-W2	Fan-W2	Fan-W2	Fan-W2	Fan-W2	Fan-E3	Fan-E3	Fan-E3	Fan-E2	Fan-E2	Fan-E2	Fan-E3	Fan-E3	Fan-E3	Fan-E3
General Mineral																					
Ca	(mg/l)	142.2	40.1	23.8	125.0	138.2	33.0	25.3	250.5	56.8	69.2	71.0	17.3	10.3	25.0	2.3	2.3	59.4	39.8	10.9	351.0
Mg	(mg/l)	2.8	0.4	0.1	5.1	3.8	5.2	2.5	32.5	1.1	3.1	1.2	0.1	0.4	0.1	0.1		3.5	0.2	0.1	27.5
Na	(mg/l)	71.4	72.2	82.5	284.0	214.1	278.0	208.7	589.5	144.8	126.2	44.7	64.8	40.5	57.0	29.6	33.0	72.6	57.4	40.8	349.5
K	(mg/l)	1.5	0.9	0.6	1.8	1.5	1.3		2.3	1.0	1.1	1.7	0.9	0.7				1.1	1.0	1.0	2.8
OH	(mg/l)				30.0				0.8												
CO3	(mg/l)							7.3		9.4			8.7	14.9		16.3	19.5			6.0	
HCO3	(mg/l)	230.0	94.0	41.0	86.5	115.5	156.0	122.0	65.2	41.0	45.6	181.2	56.6	34.6	59.8	42.4	26.3	233.6	107.5	60.7	173.0
SO4	(mg/l)	313.1	186.0	167.3	203.4	203.0	221.0	115.3	441.0	93.0	275.4	42.3	24.4	18.2	66.2	10.5	12.0	37.4	29.3	14.1	46.0
Cl	(mg/l)	39.6	20.0	28.3	521.4	417.9	262.0	215.0	1223.5	252.0	110.2	77.8	79.5	27.9	40.6	5.9	6.7	60.4	68.6	30.8	1135.0
NO3	(mg/l)	6.9	1.2	0.4	0.6	0.5				0.7		28.4	11.7	5.3	10.3	0.7	1.1	18.9	17.2	4.4	25.8
NO2	(mg/l)																				
F	(mg/l)	0.4	0.3	0.1	0.2			0.5		0.5	0.2	0.2	0.2	0.3		0.3	0.4	0.2		0.3	0.1
SiO2	(mg/l)	23.8	10.8	13.0								20.8	15.3	17.3							
pH	(pH)	7.8	7.5	7.7	8.1	7.8	8.1	8.4	8.0	8.4	8.1	7.9	7.7	8.6	8.2	9.1	9.2	7.6	7.9	9.0	7.2
EC	(uS/cm)	996.1	563.0	533.1	2061.2	1827.7	1480.0	1125.7	4380.0	1068.8	987.6	596.6	439.4	254.4	401.0	157.4	165.5	663.8	500.8	263.8	3955.0
TDS	(mg/l)	720.7	346.1	326.1	1420.0	689.4	880.0	682.5	2760.0	695.6	638.0	384.5	225.0	151.4	267.7	85.0	107.7	408.0	210.0	133.8	2380.0
Hd	(mg/l)	366.2	100.3	59.4	333.1	375.4	100.0	73.5	759.5	145.8	185.6	181.1	43.3	26.2	62.6	5.9	5.7	162.8	99.5	27.6	991.0
Alk	(mg/l)	139.7	35.9	27.3	72.0	102.5		110.0		35.0	36.7	95.0	42.5	57.6	55.0	56.7	50.0	183.3	106.7	60.0	160.0
Water Quality																					
TDS	index	**Fair-Poor**	**Xlnt**	**Xlnt**	**Unacc.**	**Good**	**Fair-Poor**	**Good**	**Unacc.**	**Good**	**Good**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Good**	**Xlnt**	**Xlnt**	**Unacc.**
Hard	index	**V.Hard**	**M.Hard**	**Soft**	**V.Hard**	**V.Hard**	**M.Hard**	**M.Hard**	**V.Hard**	**Hard**	**V.Hard**	**V.Hard**	**Soft**	**Soft**	**M.Hard**	**Soft**	**Soft**	**Hard**	**M.Hard**	**Soft**	**V.Hard**
SAR	index	**Mod**	**Low**	**Low**	**High**	**High**	**High**	**Mod**	**V.High**	**Mod**	**Mod**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**V.High**
Calc'd Values																					
Cat	(meq/l)	10.47	5.20	4.80	19.05	16.56	14.20	10.55	40.87	9.25	9.23	5.62	3.72	2.33	3.73	1.41	1.55	6.44	4.52	2.36	35.05
An	(meq/l)	11.54	6.01	4.97	20.38	17.91	14.55	10.74	44.76	10.07	9.60	6.51	4.16	2.33	3.67	1.65	1.56	6.62	4.59	2.44	36.23
Hard	(mg/l)	367	102	60	333	361	104	74	760	147	186	182	44	28	63	6	6	163	100	28	990
Alk	(mg/l)	188	77	34	247	95	128	106	58	41	37	148	54	41	49	48	38	191	88	55	142
SAR	ratio	1.62	3.12	4.65	6.77	4.91	11.87	10.58	9.31	5.21	4.03	1.44	4.26	3.36	3.13	5.13		2.48	2.50	3.36	4.83
SUM	(mg/l)	691	367	323	1214	1036	877	635	2572	580	608	356	235	136	229	87	88	368	267	138	2023
ECcalc	(uS/cm)	1275	659	587	2444	2123	1713	1245	5379	1175	1155	681	447	235	430	129	129	700	517	254	4420
TDS/EC	ratio	0.72	0.61	0.61	0.69	0.38	0.59	0.61	0.63	0.65	0.65	0.64	0.51	0.60	0.67	0.54	0.65	0.61	0.42	0.51	0.60
Analyt. Checks																					
Anal.Com	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL
Cat/An	EV=1	0.90	0.85	0.97	0.93	0.92	0.98	0.98	0.91	0.92	0.96	0.85	0.89	1.00	1.02	0.85	0.99	0.97	0.99	0.96	0.97
meq/EC	EV=1	1.10	1.00	0.92	0.96	0.94	0.97	0.95	0.98	0.90	0.95	1.02	0.90	0.92	0.92	0.97	0.94	0.98	0.91	0.91	0.90
TDS/SUM	EV=1	1.04	0.94	1.01	1.17	0.67	1.00	1.08	1.07	1.20	1.05	1.08	0.96	1.12	1.17	0.98	1.22	1.11	0.79	0.97	1.18
EC/ECcalc	EV=1	0.78	0.85	0.91	0.84	0.86	0.86	0.90	0.81	0.91	0.85	0.88	0.98	1.08	0.93	1.22	1.28	0.95	0.97	1.04	0.89
CalcHCO3																					
Ternary Ratios		S/24E 13D01 Sh	S/24E 13D02 Mi	S/24E 13D03 De	S/24E 14M02 De	S/24E 14M03 Sh	S/25E 19N02 Sh	S/25E 19N03 Mi	S/25E 19N04 De	S/25E 19R01 De	S/25E 19R02 Sh	30S/25E 04J02 Sh	0S/25E 04J03 Mi	S/25E 04J04 De	S/25E 07A02 Sh	S/25E 07A03 Mi	S/25E 07A04 De	S/25E 11P01 Sh	S/25E 11P02 Mi	S/25E 11P03 De	S/25E 12B02 Sh
Ca	(%)	68%	38%	25%	33%	42%	12%	12%	31%	31%	37%	63%	23%	22%	33%	8%	7%	46%	44%	23%	50%
Mg	(%)	2%	1%	0%	2%	2%	3%	2%	7%	1%	3%	2%	0%	1%	0%	1%	0%	4%	0%	0%	6%
Na+K	(%)	30%	61%	75%	65%	56%	85%	86%	63%	68%	60%	35%	76%	76%	66%	91%	93%	49%	56%	76%	44%
SumCat	(%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HCO3+CC	(%)	33%	26%	14%	7%	11%	18%	21%	2%	10%	8%	46%	29%	46%	27%	75%	69%	58%	38%	49%	8%
SO4	(%)	56%	64%	70%	21%	24%	32%	22%	21%	19%	60%	14%	12%	16%	38%	13%	16%	12%	13%	12%	3%
Cl+NO3	(%)	11%	10%	16%	72%	66%	51%	56%	77%	71%	32%	41%	58%	37%	36%	11%	13%	30%	48%	38%	90%
SumAn	(%)	99.8%	99.8%	99.9%	99.9%	100.0%	100.0%	99.8%	100.0%	99.7%	99.9%	99.9%	99.8%	99.3%	100.0%	99.0%	98.6%	99.9%	100.0%	99.4%	100.0%
Type	Cat-An	Ca-HCO3/SO4	Na-SO4	Na-SO4	Na-Cl	Ca/Na-Cl	Na-Cl/SO4	Na-mxd	Na-Cl	Na-Cl	Ca/Na-Cl/SO4	Ca-HCO3/Cl	Na-HCO3/Cl	Na-HCO3/Cl	Na-mxd	Na-HCO3	Na-HCO3	Ca/Na-HCO3/Cl	Ca/Na-HCO3/Cl	Na-HCO3/Cl	Ca/Na-Cl
Type	A,B,D	**D21-SO4**	**B2-SO4**	**B2-SO4**	**B1b**	**B1b**	**B1-SO4**	**B2**	**B1b**	**B2**	**B1-SO4**	**D21**	**B2**	**B2**	**B2-SO4**	**A**	**A**	**B1a**	**B2**	**B2**	**D20**
COCs																					
As	(ug/l)	4	2.29	1.93	8					27.75	3	1.8	2.5	22.07		23	19.5			23.5	
Ba	(ug/l)	63.67										127.15		52							
B	(ug/l)	204.83	50.1	70.62	0.39	0.31	0.69	0.77	1.55	0.22	0.42	137.56	80.03	100.01	0.11	0.1	0.09	0.51	0.25	0.15	4.81
Alpha	pCi/l	69.53	1.34	2.29	9.97	10.7				0.93	3.3	10.15	1.12	2.88							
Radon	pCi/l																				
DBCP	(ug/l)																				
EDB	(ug/l)																				

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WQ Analyses.		East	East	East	East	East	East	East	East	East	East	East	East	East	East	East	East	East	East	East	East	East
		AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG	AVG
Well		30S/25E 12B03	30S/25E 12B04	30S/25E 16L01	30S/25E 16L02	30S/25E 16L03	30S/25E 21G02	30S/25E 21G03	30S/25E 22R01	30S/25E 22R02	30S/25E 22R03	30S/25E 36R01	30S/25E 36R02	30S/26E 04J01	30S/26E 04J02	30S/26E 04J03	30S/26E 04J05	30S/26E 06L01	30S/26E 06L02	30S/26E 06L03	30S/26E 08P04	30S/26E 16B01
Twp/Rge		30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/25E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E
Sec/40ac		**12B03**	**12B04**	**16L01**	**16L02**	**16L03**	**21G02**	**21G03**	**22R01**	**22R02**	**22R03**	**36R01**	**36R02**	**04J01**	**04J02**	**04J03**	**04J05**	**06L01**	**06L02**	**06L03**	**08P04**	**16B01**
Depth		Mi	De	Sh	Mi	De	De	Sh	Sh	Mi	De	De	Sh	Sh	Mi	De	06	Sh	Mi	De	De	Sh
Date		4	4	24	21	21	4	5	7	5	7	4	5	4	3	9	2	7	5	7	8	25
Domain		Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E1	Fan-E1	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E3	Fan-E2	Fan-E2
General Mineral																						
Ca	(mg/l)	8.5	2.0	16.4	4.1	9.2	10.3	18.2	36.1	3.1	3.1	3.2	2.0	21.8	39.0	4.1	42.5	60.7	26.0	14.9	3.3	40.5
Mg	(mg/l)	0.1	0.1	0.2		0.1	0.1	0.2	2.5	0.1	0.1	0.1	0.1	4.1	4.1	0.2	3.5	4.9	0.3	0.8	1.2	5.3
Na	(mg/l)	34.5	33.8	44.0	31.5	37.0	38.5	42.0	18.3	30.2	50.9	47.8	41.6	27.3	26.0	37.0	22.5	28.0	26.4	27.0	33.8	26.7
K	(mg/l)			0.6	1.8	0.8									1.2		1.0		1.0			1.1
OH	(mg/l)																					
CO3	(mg/l)		15.0	2.6	17.3	8.2	10.5	2.6		10.1	15.1	16.8	20.4			13.2				9.4	18.6	
HCO3	(mg/l)	68.2	51.2	56.5	50.5	48.0	54.5	75.9	125.8	60.7	48.2	49.5	46.2	89.2	149.3	44.2	130.0	152.7	79.4	57.3	38.0	137.0
SO4	(mg/l)	15.0	9.5	16.7	11.9	14.4	20.2	23.9	12.6	10.3	15.4	24.6	12.7	18.6	19.0	16.8	24.0	43.5	16.2	15.3	9.7	23.7
Cl	(mg/l)	18.5	5.9	52.6	8.6	28.8	22.1	30.0	17.7	5.4	29.1	12.5	7.0	22.9	19.0	14.8	26.5	36.1	25.2	16.0	5.5	26.5
NO3	(mg/l)	3.0	0.7	4.5	0.7	3.0	4.0	7.5	2.7	0.9			1.8	3.6	3.4	1.5	6.0	19.7	4.4	3.9	0.9	6.0
NO2	(mg/l)																					
F	(mg/l)	0.2	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.4	0.9	1.1	0.6	0.1	0.2	0.3	0.2	0.2	0.1	0.3	0.3	0.1
SiO2	(mg/l)			17.3	23.3	15.7																21.6
pH	(pH)	8.6	9.4	7.9	8.9	8.3	8.8	8.3	7.8	8.5	9.2	9.3	9.3	7.5	7.8	9.2	7.8	7.7	8.0	8.7	9.4	7.9
EC	(uS/cm)	218.0	173.0	311.8	179.5	234.1	242.8	301.6	282.4	158.0	264.4	244.8	202.0	276.5	348.3	198.4	347.0	485.0	266.6	214.4	172.8	364.9
TDS	(mg/l)	121.0	111.6	172.2	109.5	133.2	157.9	179.5	198.4	82.0	160.0	165.0	142.5	170.3	216.0	110.5	215.0	302.6	151.3	136.6	95.0	231.0
Hd	(mg/l)	21.4	5.0	41.0	10.3	22.9	26.0	45.7	100.1	8.0	7.7	8.1	4.8	70.3	113.1	10.3	120.6	171.4	65.4	38.3	8.7	122.1
Alk	(mg/l)	60.0	60.0	44.1	56.0	47.2	55.0	63.3	105.0	60.0	60.0	70.0	70.0	80.0	110.0	48.3	120.0	130.0	70.0	50.0	60.0	112.9
Water Quality																						
TDS	index	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**
Hard	index	**Soft**	**Soft**	**Soft**	**Soft**	**Soft**	**Soft**	**Soft**	**M.Hard**	**Soft**	**Soft**	**Soft**	**Soft**	**M.Hard**	**M.Hard**	**Soft**	**M.Hard**	**Hard**	**M.Hard**	**Soft**	**Soft**	**Hard**
SAR	index	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**
Calc'd Values																						
Cat	(meq/l)	1.93	1.58	2.76	1.62	2.10	2.19	2.75	2.81	1.48	2.37	2.24	1.91	2.61	3.44	1.83	3.41	4.65	2.49	1.98	1.73	3.64
An	(meq/l)	2.01	1.73	2.92	1.92	2.24	2.36	2.80	2.88	1.73	2.48	2.29	1.96	2.56	3.44	1.97	3.48	4.75	2.43	2.10	1.63	3.59
Hard	(mg/l)	22	5	42	10	23	26	46	101	8	8	8	5	71	114	11	121	172	66	40	13	123
Alk	(mg/l)	56	54	48	56	46	53	64	103	58	52	54	55	73	122	47	106	125	65	55	47	112
SAR	ratio	3.22	6.31	2.97		3.33	3.29	2.68	0.79	4.59	7.82	7.23	8.04	1.40	1.06	4.84	0.89	0.93	1.41	1.85	4.06	1.05
SUM	(mg/l)	113	92	165	101	125	133	162	152	90	138	130	109	142	185	110	190	268	139	116	92	197
ECcalc	(uS/cm)	211	142	322	155	226	231	301	293	145	237	210	164	276	355	181	367	512	268	202	140	382
TDS/EC	ratio	0.56	0.64	0.55	0.61	0.57	0.65	0.60	0.70	0.52	0.61	0.67	0.71	0.62	0.62	0.56	0.62	0.62	0.57	0.64	0.55	0.63
Analyt. Checks																						
Anal.Com	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL
Cat/An	EV=1	0.96	0.91	0.94	0.83	0.94	0.93	0.98	0.98	0.84	0.96	0.98	0.97	1.02	1.00	0.93	0.98	0.98	1.03	0.94	1.06	1.02
meq/EC	EV=1	0.90	0.95	0.91	0.99	0.93	0.94	0.92	1.01	1.02	0.92	0.93	0.96	0.93	0.99	0.96	0.99	0.97	0.92	0.95	0.97	0.99
TDS/SUM	EV=1	1.07	1.21	1.04	1.08	1.06	1.19	1.11	1.30	0.91	1.16	1.27	1.31	1.20	1.16	1.01	1.13	1.13	1.09	1.18	1.03	1.17
EC/ECcalc	EV=1	1.03	1.22	0.97	1.16	1.04	1.05	1.00	0.96	1.09	1.12	1.16	1.23	1.00	0.98	1.10	0.95	0.95	1.00	1.06	1.23	0.95
CalcHCO3																						
Ternary Ratios		S/25E 12B03 Mi	S/25E 12B04 De	S/25E 16L01 Sh	S/25E 16L02 Mi	S/25E 16L03 De	S/25E 21G02 De	S/25E 21G03 Sh	S/25E 22R01 Sh	S/25E 22R02 Mi	S/25E 22R03 De	S/25E 36R01 De	S/25E 36R02 Sh	S/26E 04J01 Sh	0S/26E 04J02 Mi	S/26E 04J03 De	S/26E 04J05 06	S/26E 06L01 Sh	S/26E 06L02 Mi	S/26E 06L03 De	S/26E 08P04 De	S/26E 16B01 Sh
Ca	(%)	22%	6%	30%	13%	22%	23%	33%	64%	11%	6%	7%	5%	42%	56%	11%	62%	65%	52%	37%	9%	55%
Mg	(%)	1%	1%	0%	0%	0%	0%	1%	7%	0%	0%	0%	0%	13%	10%	1%	8%	9%	1%	3%	6%	12%
Na+K	(%)	78%	93%	70%	87%	78%	76%	66%	28%	89%	93%	93%	95%	45%	34%	88%	29%	26%	47%	59%	85%	33%
SumCat	(%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HCO3+CC	(%)	56%	77%	35%	73%	47%	53%	47%	72%	77%	52%	60%	73%	57%	71%	59%	61%	53%	54%	60%	76%	63%
SO4	(%)	15%	11%	12%	13%	13%	18%	18%	9%	12%	13%	22%	13%	15%	11%	18%	14%	19%	14%	15%	12%	14%
Cl+NO3	(%)	28%	10%	53%	13%	38%	29%	34%	19%	10%	33%	15%	12%	28%	17%	22%	24%	28%	32%	24%	10%	24%
SumAn	(%)	99.5%	99.2%	99.7%	99.1%	99.2%	99.6%	99.6%	99.7%	98.9%	98.1%	97.5%	98.3%	99.8%	99.8%	99.2%	99.7%	99.8%	99.7%	99.2%	99.1%	99.8%
Type	Cat-An	Na-HCO3/Cl	Na-HCO3	Na-HCO3/Cl	Na-HCO3	Na-HCO3/Cl	Na-HCO3/Cl	Na-HCO3/Cl	Ca-HCO3	Na-HCO3	Na-HCO3/Cl	Na-HCO3/SO4	Na-HCO3	Ca/Na-HCO3/Cl	Ca/Na-HCO3	Na-HCO3/Cl	Ca-HCO3	Ca-HCO3/Cl	Ca/Na-HCO3/Cl	Ca/Na-HCO3/Cl	Na-HCO3	Ca/Na-HCO3
Type	A,B,D	**B2**	**A**	**B2**	**B2**	**B2**	**B2**	**B2**	**D1**	**B2**	**A**	**A**	**A**	**B1a**	**D1**	**B2**	**D1**	**D1**	**D20**	**B1b**	**A**	**D1**
COCs																						
As	(ug/l)		32.67	2.7	19.57	11.5	9	8	3.5		106.5	57	44.33						0	21	0	2.22
Ba	(ug/l)																42.85		0		0	58.6
B	(ug/l)	1.47	0.1	75.03	87.52	73.72	0.11	0.12	0.09	0.1	0.22	0.28	0.13	0.11	0.13	0.08	0.12	0.21	0.12	0.11	0.09	0.14
Alpha	pCi/l			1.16	0.58	0.85									19	0.9	10.58		0		0	9.41
Radon	pCi/l																					
DBCP	(ug/l)																		0		0	0
EDB	(ug/l)																		0		0	0

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WQ Analyses.		East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	East AVG	RRB AVG	RRB AVG	RRB AVG	RRB AVG	RRB AVG	RRB AVG	RRB AVG
Well		30S/26E 16B02	30S/26E 16B03	30S/26E 16B04	30S/26E 18H04	30S/26E 19B01	30S/26E 19B02	30S/26E 19B03	30S/26E 28J01	30S/26E 28J02	30S/26E 28J03	30S/26E 32N01	30S/26E 32N02	30S/26E 32N03 De	29S/25E 25M02	29S/25E 25M01	29S/25E 27N02	29S/25E 27N01	29S/26E 31H02	29S/26E 31H01	29S/26E 35H04
Twp/Rge		30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	30S/26E	29S/25E	29S/25E	29S/25E	29S/25E	29S/26E	29S/26E	29S/26E
Sec/40ac		**16B02**	**16B03**	**16B04**	**18H04**	**19B01**	**19B02**	**19B03**	**28J01**	**28J02**	**28J03**	**32N01**	**32N02**	**32N03**	**25M02**	**25M01**	**27N02**	**27N01**	**31H02**	**31H01**	**35H04**
Depth		Mi	De	Sh	De	Sh	Mi	De	Sh	Mi	De	Sh	Mi	De	Sh	De	Sh	De	Sh	De	Sh
Date		21	25	1	7	9	2	8	4	5	6	4	4	4	5	6	8	8	14	7	14
Domain		Fan-E2	Fan-E2	Fan-E2					Fan-E2	Fan-E2	Fan-E2	Fan-E1	Fan-E1	Fan-E1	Fan-E2	Fan-E2	Fan-E2	Fan-E2	Fan-E1	Fan-E1	Fan-E2
General Mineral																					
Ca	(mg/l)	9.2	3.9	35.0	7.6	56.0	7.5	9.3	58.5	3.4	1.6	0.8	0.5	1.9	35.4	1.9	53.1	2.3	6.1	2.2	27.3
Mg	(mg/l)	0.0	0.3	3.9	0.1	6.2		1.3		0.1	0.1			0.2	1.2	0.0	3.2	0.0	0.1	0.0	1.1
Na	(mg/l)	26.8	33.4	23.0	33.3	37.9	40.0	35.5	44.3	50.4	44.3	62.8	52.8	63.0	27.0	32.5	33.1	28.1	27.1	29.7	23.8
K	(mg/l)	1.2	0.6			1.0									1.2	0.0	1.0	0.0	0.1	0.0	1.5
OH	(mg/l)														0.0	0.0	0.0	0.0	0.0	0.0	
CO3	(mg/l)	10.0	16.6		5.1			18.7		16.3	22.3	28.8	42.9	23.2	0.0	19.0	0.0	15.3	4.2	16.3	6.0
HCO3	(mg/l)	56.7	45.3	117.0	67.6	216.8	75.0	66.4	149.5	50.8	44.2	53.7	37.9	63.8	102.6	33.8	155.8	28.7	64.4	33.3	78.3
SO4	(mg/l)	14.6	10.4	19.0	16.6	33.3	30.0	15.9	77.0	30.0	12.8	17.4	11.4	19.7	33.4	8.7	25.8	8.8	8.8	8.4	19.4
Cl	(mg/l)	11.0	7.8	22.0	12.7	23.4	17.5	10.5	26.3	15.5	7.0	20.4	7.7	16.0	16.0	5.8	36.4	5.1	4.6	5.3	22.4
NO3	(mg/l)	1.7	1.1	3.5	2.2	6.1	4.3	1.9			3.8				16.5	0.6	12.9	0.7	2.0	0.5	12.2
NO2	(mg/l)														1.7	0.1	1.3	0.2	0.4	0.1	2.6
F	(mg/l)	0.2	0.3	0.2	0.2	0.3	0.2	0.4	0.2	0.2	0.6	1.5	0.8	2.4	0.1	0.4	0.1	0.4	0.1	0.5	0.2
SiO2	(mg/l)	18.0	16.3																		
pH	(pH)	8.3	8.7	8.2	8.6	7.5	8.7	8.8	7.7	9.3	9.6	9.5	9.6	9.4	8.0	9.4	7.7	9.4	8.8	9.4	7.9
EC	(uS/cm)	180.2	173.5	240.0	203.9	487.6	257.0	218.4	512.5	267.0	214.3	307.0	250.0	301.5	321.4	164.0	444.4	144.6	152.2	151.6	276.4
TDS	(mg/l)	112.7	108.9	223.0	140.0	309.0		99.0	314.7	120.5	134.2	151.0	127.0	178.0	161.7	89.8	255.8	78.0	87.9	84.8	148.0
Hd	(mg/l)	22.9	10.4	104.0	19.2	166.5	18.8	25.8	152.5	8.5	4.0	2.1	1.6	4.8	93.0	4.7	145.6	5.7	15.4	5.6	69.4
Alk	(mg/l)	52.4	57.9		60.0	168.3	60.0	78.0	140.0	53.3	77.5	90.0	110.0	95.0	86.7	46.0	128.0	50.0	57.5	50.0	66.3
Water Quality																					
TDS	index	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**	**XInt**
Hard	index	**Soft**	**Soft**	**M.Hard**	**Soft**	**Hard**	**Soft**	**Soft**	**Hard**	**Soft**	**Soft**	**Soft**	**Soft**	**Soft**	**M.Hard**	**Soft**	**Hard**	**Soft**	**Soft**	**Soft**	**M.Hard**
SAR	index	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**
Calc'd Values																					
Cat	(meq/l)	1.65	1.68	3.07	1.84	4.98	2.11	2.11	4.84	2.37	2.01	2.77	2.32	2.85	3.07	1.51	4.38	1.34	1.49	1.40	2.53
An	(meq/l)	1.91	1.77	3.00	2.03	5.02	2.42	2.39	4.81	2.45	2.02	2.86	2.55	2.81	3.10	1.57	4.33	1.34	1.55	1.45	2.73
Hard	(mg/l)	23	11	103	19	165	19	28	146	9	4	2	1	5	93	5	146	6	15	6	73
Alk	(mg/l)	55	51	96	60	178	61	70	122	55	55	68	67	71	84	43	128	36	56	41	69
SAR	ratio	2.43	4.45	0.98	3.29	1.28		2.90		7.44	9.44			11.71	1.22	6.52	1.19	5.11	3.00	5.47	1.21
SUM	(mg/l)	103	97	164	111	271	136	126	280	141	114	158	135	158	183	86	244	75	85	79	155
ECcalc	(uS/cm)	172	150	319	195	515	247	201	528	232	169	245	175	250	334	125	467	112	146	118	276
TDS/EC	ratio	0.63	0.63	0.93	0.69	0.63		0.45	0.61	0.45	0.63	0.49	0.51	0.59	0.50	0.55	0.58	0.54	0.58	0.56	0.54
Analyt. Checks																					
Anal.Com	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL
Cat/An	EV=1	0.85	0.95	1.02	0.90	0.99	0.86	0.88	1.01	0.97	0.99	0.97	0.91	1.02	0.99	0.96	1.01	1.00	0.96	0.97	0.92
meq/EC	EV=1	0.99	0.99	1.26	0.95	1.03	0.88	1.03	0.94	0.90	0.94	0.92	0.97	0.94	0.96	0.94	0.98	0.92	1.00	0.94	0.95
TDS/SUM	EV=1	1.10	1.13	1.36	1.26	1.14		0.79	1.12	0.86	1.17	0.95	0.94	1.13	0.88	1.05	1.05	1.04	1.03	1.07	0.95
EC/ECcalc	EV=1	1.05	1.16	0.75	1.05	0.95	1.04	1.09	0.97	1.15	1.27	1.25	1.43	1.21	0.96	1.31	0.95	1.30	1.05	1.29	1.00
CalcHCO3																					
Ternary Ratios		S/26E 16B02 Mi	S/26E 16B03 De	S/26E 16B04 Sh	S/26E 18H04 De	S/26E 19B01 Sh	S/26E 19B02 Mi	S/26E 19B03 De	S/26E 28J01 Sh	0S/26E 28J02 Mi	S/26E 28J03 De	S/26E 32N01 Sh	S/26E 32N02 Mi	32N03 De	29S/25E 2	29S/25E 2	29S/25E 2	29S/25E 2	29S/26E 3	29S/26E 3	29S/26E 3
Ca	(%)	28%	11%	57%	21%	56%	18%	22%	60%	7%	4%	2%	1%	3%	58%	6%	60%	9%	20%	8%	54%
Mg	(%)		1%	10%	0%	10%	0%	5%	0%	0%	0%	0%	0%	1%	3%		6%		0%	0%	4%
Na+K	(%)	72%	87%	33%	79%	34%	82%	73%	40%	93%	96%	98%	99%	96%	39%	94%	33%	91%	79%	92%	42%
SumCat	(%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HCO3+CC	(%)	66%	73%	64%	63%	71%	51%	72%	51%	56%	73%	64%	80%	65%	54%	76%	59%	73%	77%	75%	54%
SO4	(%)	16%	12%	13%	17%	14%	26%	14%	33%	26%	13%	13%	9%	15%	22%	12%	12%	14%	12%	12%	15%
Cl+NO3	(%)	18%	13%	23%	19%	15%	23%	14%	15%	18%	13%	20%	9%	16%	23%	11%	28%	12%	11%	11%	30%
SumAn	(%)	99.5%	99.1%	99.6%	99.5%	99.7%	99.7%	99.2%	99.8%	99.6%	98.5%	97.2%	98.3%	95.5%	99.8%	98.5%	99.8%	98.6%	99.6%	98.3%	99.6%
Type	Cat-An	Na-HCO3	Na-HCO3	Ca/Na-HCO3	Na-HCO3	Ca/Na-HCO3	Na-mxd	Na-HCO3	Ca-HCO3/SO4	Na-HCO3/SO4	Na-HCO3	Na-HCO3	Na-HCO3	Na-HCO3	**Ca/Na-mxd**	**Na-HCO3**	**-HCO3/Cl**	**Na-HCO3**	**Na-HCO3**	**Na-HCO3**	**-HCO3/Cl**
Type	A,B,D	**B2**	**B2**	**D1**	**B2**	**D1**	**B2-SO4**	**B1b**	**D21-SO4**	**A-SO4**	**A**	**A**	**A**	**A**	**D21**	**A**	**D1**	**A**	**B2**	**A**	**D20**
COCs																					
As	(ug/l)	4.35	13.33	0							62	95.5		138.5		18		10.67	4.75	10	
Ba	(ug/l)			0											57.5	4.2	70.93	2.27	7.07	1.17	37.53
B	(ug/l)	0.1	0.07	0.16	0.1	0.2	0.1	0.12	0.31	0.1	0.1	0.35	0.17	0.38	0.11	0.08	0.14	0.03	7.75	0.02	0.1
Alpha	pCi/l	1.17	0.7	4							0.91	3.31		4.43	7.83	1.28	16.93	0.26	2.04	0.68	2.69
Radon	pCi/l																				
DBCP	(ug/l)	0	0	0											0.05						
EDB	(ug/l)	0	0	0											0.088		0.054				

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WQ Analyses.		RRB	ID4RAW	ID4RAW	ID4RAW	ID4RAW													
		AVG	AVG	AVG	AVG	AVG						AVG	KWB	KWB	KWB	KWB	Enns-N	Enns-S	Nikkel
Well		29S/26E 35H03 De	KWB	CAL AQ	FK	KR	SR 1	SR 2	SR 3	SR 4	SR 6	SR1-6	30s/25e 0	30s/25e 0	30s/25e 1	30s/25e 11C	29s/25e 3	29s/25e 3	29s/25e 35F01 ??
Twp/Rge		29S/26E	*KWB	*MCH	*MFK	*MKR	T30s/R25e	T30s/R25e	T30s/R25e	T30s/R25e	T30s/R25e	T30s/R25e	30s/25e	30s/25e	30s/25e	30s/25e	29s/25e	29s/25e	29s/25e
Sec/40ac		35H03	KWB	CAL AQ	FK	KR	02B01	02H01	02J01	02K	02L	02x	03Q01	03R01	11A01	11C01	34A01	34H01	35F01
Depth		De					99	504	251	504	504	99 - 504	SD	SD	SD	SD	??	??	??
Date		8	11	9	6	48	12/03	12/03	12/03	12/03	12/03	12/03	37727	37732	37732	36916	37272	37272	37272
Domain		Fan-E2	KWB	AQ	FK	KR													
General Mineral																			
Ca	(mg/l)	2.1	17.7	26.7	6.5	12.3	110	110	130	85	78	103	43	63	12	110	75	83	62
Mg	(mg/l)		1.8	12.6	1.9	2.5	4.4	2.7	4.8	3.2	4.3	3.9	0.78	2.6	bdt	4.7	6.1	9.8	3.6
Na	(mg/l)	37.6	31.1	63.8	5.8	10.8	52	75	83	52	49	62	49	44	33	51	41	43	33
K	(mg/l)		1.2	2.9	1.1	1.4	1.7	1.7	1.8	1.4	1.3	1.6				1.6	1.6	1.1	1.5
OH	(mg/l)	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.01	0.01	0.01	0.01	114						
CO3	(mg/l)	14.8	12.6	0.9	0.5	0.7	0.568	0.345	0.447	0.604	0.783	0.55	0.74	0.58	3.3				
HCO3	(mg/l)	55.5	69.6	97.1	30.2	58.1	110	66.8	109	117	191	119	114	179	64	207	140	179	121
SO4	(mg/l)	9.1	19.2	44.6	5.0	9.0	37	21	28	30	82	40	28	32	16	53	51	70	49
Cl	(mg/l)	5.1	16.8	84.1	3.9	3.8	180	260	270	140	200	210	65	65	22	98	65	70	42
NO3	(mg/l)	0.7	2.7	2.4	1.4	1.0	28				19	24					6.2	6.7	6
NO2	(mg/l)	0.2															bdt	bdt	bdt
F	(mg/l)	0.4	0.2	0.3	0.1	0.9	0.05	0.08	0.08	0.06	0.05	0.06	0.06	0.07	0.16	bdt	bdt	bdt	bdt
SiO2	(mg/l)		6.2	6.7	4.7	4.8													
pH	(pH)	9.2	8.7	8.3	7.5	7.9	7.9	7.9	7.8	7.9	7.8	7.9	8	7.7	8.9	7.4	7.5	7.5	7.8
EC	(uS/cm)	182.0	230.9	483.9	77.6	128.0	944	1070	1190	775	683	932	487	546	221	730	631	742	510
TDS	(mg/l)	102.0	142.8	334.0	41.5	87.7	660	710	800	510	410	618	285	345	140	530	390	448	312
Hd	(mg/l)	5.1	51.8	115.3	22.0	39.3	293	286	344	225	212	272	111	168	30	294	216	236	174
Alk	(mg/l)	70.0	67.8	79.3	22.8	48.0	90.1	54.9	89.6	95.9	157	98	94	147	54	170	140	179	121
Water Quality																			
TDS	index	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Xlnt**	**Good**	**Fair-Poor**	**Fair-Poor**	**Good**	**Good**	**Good**	**Xlnt**	**Xlnt**	**Xlnt**	**Good**	**Xlnt**	**Good**	**Xlnt**
Hard	index	**Soft**	**Soft**	**M.Hard**	**Soft**	**Soft**	**V.Hard**	**V.Hard**	**V.Hard**	**V.Hard**	**V.Hard**	**V.Hard**	**M.Hard**	**Hard**	**Soft**	**V.Hard**	**V.Hard**	**V.Hard**	**Hard**
SAR	index	**Low**	**Low**	**Low**	**Low**	**Low**	**Mod**	**Mod**	**Mod**	**Low**	**Mod**	**Mod**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**
Calc'd Values																			
Cat	(meq/l)	1.74	2.42	5.22	0.76	1.32	8.16	9.02	10.54	6.80	6.41	8.18	4.34	5.27	2.03	8.13	6.07	6.85	4.86
An	(meq/l)	1.77	2.49	4.97	0.76	1.33	8.12	8.88	10.00	6.51	10.81	9.10	4.31	5.46	2.12	7.26	5.29	6.47	4.28
Hard	(mg/l)	5	52	119	24	41	293	286	345	226	213	272	111	168	30	294	212	248	170
Alk	(mg/l)	58	67	80	25	48	91	55	90	96	157	98	764	147	55	170	115	147	99
SAR	ratio		1.88	2.55	0.52	0.74	1.32	1.93	1.95	1.51	1.46	1.64	2.03	1.48		1.29	1.22	1.19	1.10
SUM	(mg/l)	97	138	286	41	71	468	504	572	370	529	502	357	295	118	420	315	372	257
ECcalc	(uS/cm)	151	240	580	78	132	970	1096	1235	776	1039	1039	483	584	219	855	633	740	507
TDS/EC	ratio	0.56	0.62	0.69	0.53	0.69	0.70	0.66	0.67	0.66	0.60	0.66	0.59	0.63	0.63	0.73	0.62	0.60	0.61
Analyt. Checks																			
Anal.Com	FULL	FULL	FULL	FULL	FULL	FULL	FULL	FULL-min	FULL-min	FULL-min	FULL	FULL	FULL-min	FULL-min	FULL-min	FULL-min	FULL-min	FULL-min	FULL-min
Cat/An	EV=1	0.98	0.97	1.05	1.00	0.99	1.00	1.02	1.05	1.04	0.49	0.89	1.01	0.97	0.96	1.11	1.14	1.06	1.13
meq/EC	EV=1	0.96	1.06	1.05	0.98	1.04	0.86	0.84	0.86	0.86	1.26	0.93	0.89	0.98	0.94	1.05	0.90	0.90	0.90
TDS/SUM	EV=1	1.05	1.04	1.17	1.01	1.24	1.41	1.41	1.40	1.38	0.78	1.23	0.80	1.17	1.19	1.26	1.24	1.21	1.22
EC/ECcalc	EV=1	1.21	0.96	0.83	1.00	0.97	0.97	0.98	0.96	1.00	0.66	0.90	1.01	0.94	1.01	0.85	1.00	1.00	1.01
CalcHCO3																			
Ternary Ratios		35H03 De	KWB	CAL AQ	FK	KR	SR 1	SR 2	SR 3	SR 4	SR 6	SR1-6	30s/25e 03Q	30s/25e 03R	30s/25e 11A	30s/25e 11C01	29s/25e 34A	29s/25e 34H	29s/25e 35F01 ??
Ca	(%)	6%	37%	26%	43%	46%	67%	61%	62%	62%	61%	63%	49%	60%	29%	67%	62%	60%	64%
Mg	(%)	0%	6%	20%	21%	15%	4%	2%	4%	4%	6%	4%	1%	4%	0%	5%	8%	12%	6%
Na+K	(%)	94%	57%	55%	37%	38%	28%	37%	35%	34%	34%	34%	49%	36%	71%	28%	30%	28%	30%
SumCat	(%)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
HCO3+CC	(%)	79%	63%	33%	68%	73%	22%	12%	18%	30%	29%	22%	44%	54%	55%	47%	43%	45%	46%
SO4	(%)	11%	16%	19%	14%	14%	9%	5%	6%	10%	16%	9%	14%	12%	16%	15%	20%	23%	24%
Cl+NO3	(%)	9%	21%	48%	18%	9%	68%	83%	76%	61%	55%	69%	43%	34%	29%	38%	37%	32%	30%
SumAn	(%)	98.9%	99.5%	99.7%	99.2%	96.6%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.9%	99.9%	99.6%	100.0%	100.0%	100.0%	100.0%
Type	Cat-An	Na-HCO3	Ca/Na-HCO3	Ca/Na-HCO3/Cl	mxd-HCO3	Ca/Na-HCO3	Ca-Cl	Ca-Cl	Ca-Cl	Ca-Cl	Ca-HCO3/Cl	Ca-Cl	Ca/Na-HCO3/Cl	Ca/Na-HCO3/Cl	Na-HCO3/Cl	Ca-HCO3/Cl	Ca-mxd	Ca-mxd	Ca-mxd
Type	A,B,D	**A**	**B1b**	**B1a**	**B1a**	**B1a**	**D21**	**D21**	**D21**	**D21**	**D21**	**D21**	**D20**	**D21**	**B2**	**D21**	**D1**	**D1**	**D1**
COCs																			
As	(ug/l)	39	9.85	6.97	2.9	5.17	0	1.4	0	0	0	0.28	1.2	3.1	6.6	1.8	0.8	0.8	0.8
Ba	(ug/l)	1.57					170	170	200	130	100	154	66	93	16	170	110	88	86
B	(ug/l)	0.09															200	300	200
Alpha	pCi/l	0.92	3.67	1.89	2.87	3.18	7.8	9.2	7.6	8	22	10.92				40	20.5	30.8	21.4
Radon	pCi/l																679	664	667
DBCP	(ug/l)															0	0.05	0.36	0.11
EDB	(ug/l)															0	0	0	0.02

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Exhibit 3.

Strand Ranch ASR Project
Salt Balance Analysis.

Exhibit 3. IRWD Strand Ranch Salt Balance.

Table 3.1 Hypothetical Recharge-TDS Blends.

Hypothetical Instantaneous Recharge TDS for Various Recharge Blends.

Source:	SWP1	KR	FK	Blend
Source TDS:	334	88	41	(mg/l)
In-Blend 11	100%	0%	0%	334
In-Blend 12	60%	30%	10%	231
In-Blend 13	30%	60%	10%	157
In-Blend 14	20%	70%	10%	133
In-Blend 15	10%	80%	10%	108
In-Blend 16	0%	100%	0%	88

Note: SWP1 at 334 mg/l is the long-term average in-aqueduct TDS.
Note: Blend is positive to represent salt added to aquifer.

Hypothetical Instantaneous Recharge TDS for Various Recharge Blends.

Source:	SWP2	KR	FK	Blend
Source TDS:	227	88	41	(mg/l)
In-Blend 21	100%	0%	0%	227
In-Blend 22	60%	30%	10%	167
In-Blend 23	30%	60%	10%	125
In-Blend 24	20%	70%	10%	**111**
In-Blend 25	10%	80%	10%	97
In-Blend 26	0%	100%	0%	88

Note: SWP2 at 227 mg/l is the 5-year average wet-cycle SWP TDS delivered to the Kern Fan.
Note: Blend is positive to represent salt added to aquifer.

Table 3.2 Hypothetical Recovery-TDS Blends.

Hypothetical Instantaneous Recovery TDS for Various Recovery Blends.

Source:	Shal Aq	Deep Aq	Blend
Source TDS:	559	119	(mg/l)
Out-Blend 31	100%	0%	(559)
Out-Blend 32	80%	20%	(471)
Out-Blend 33	60%	40%	(383)
Out-Blend 33	40%	60%	(295)
Out-Blend 35	30%	70%	(251)
Out-Blend 36	25%	75%	**(229)**
Out-Blend 37	10%	90%	(163)
Out-Blend 38	0%	100%	(119)

Note: Shallow Aq at 559 mg/l is the average plume-impacted TDS.
Note: Blend is negative to represent salt removed from aquifer.

Hypothetical Instantaneous Recovery TDS for Various Recovery Blends.

Source:	Shal Aq	Deep Aq	Blend
Source TDS:	237	119	(mg/l)
Out-Blend 41	100%	0%	(237)
Out-Blend 42	80%	20%	(213)
Out-Blend 43	60%	40%	(190)
Out-Blend 44	40%	60%	(166)
Out-Blend 45	30%	70%	(154)
Out-Blend 46	20%	80%	(143)
Out-Blend 47	10%	90%	(131)
Out-Blend 48	0%	100%	(119)

Note: Shallow Aq at 237mg/l is the average unimpacted TDS.
Note: Blend is negative to represent salt removed from aquifer.

Exhibit 3. IRWD Strand Ranch Salt Balance.

Table 3.3   Hypothetical Project Salt Balance Matrix.

Recharge	SWP1		227	100%	60%	30%	**20%**	10%	0%
Recharge	KR		88	0%	30%	60%	**70%**	80%	100%
Recharge	FK		41	0%	10%	10%	**10%**	10%	0%
Recharge	Blend	(mg/l)		227	167	125	**111**	97	88

	Shal Aq	Deep Aq	Blend						
Recovery	559	119	(mg/l)						
Out-Blend 31	100%	0%	(559)	(332)	(392)	(434)	(448)	(462)	(471)
Out-Blend 32	80%	20%	(471)	(244)	(304)	(346)	(360)	(374)	(383)
Out-Blend 33	60%	40%	(383)	(156)	(216)	(258)	(272)	(286)	(295)
Out-Blend 33	40%	60%	(295)	**(68)**	(128)	(170)	(184)	(198)	(207)
Out-Blend 35	30%	70%	(251)	**(24)**	(84)	(126)	(140)	(154)	(163)
Out-Blend 36	**25%**	**75%**	**(229)**	**(2)**	**(62)**	(104)	**(118)**	(132)	(141)
Out-Blend 37	10%	90%	(163)	**64**	**4**	(38)	(52)	(66)	(75)
Out-Blend 38	0%	100%	(119)	**108**	**48**	**6**	**(8)**	(22)	(31)

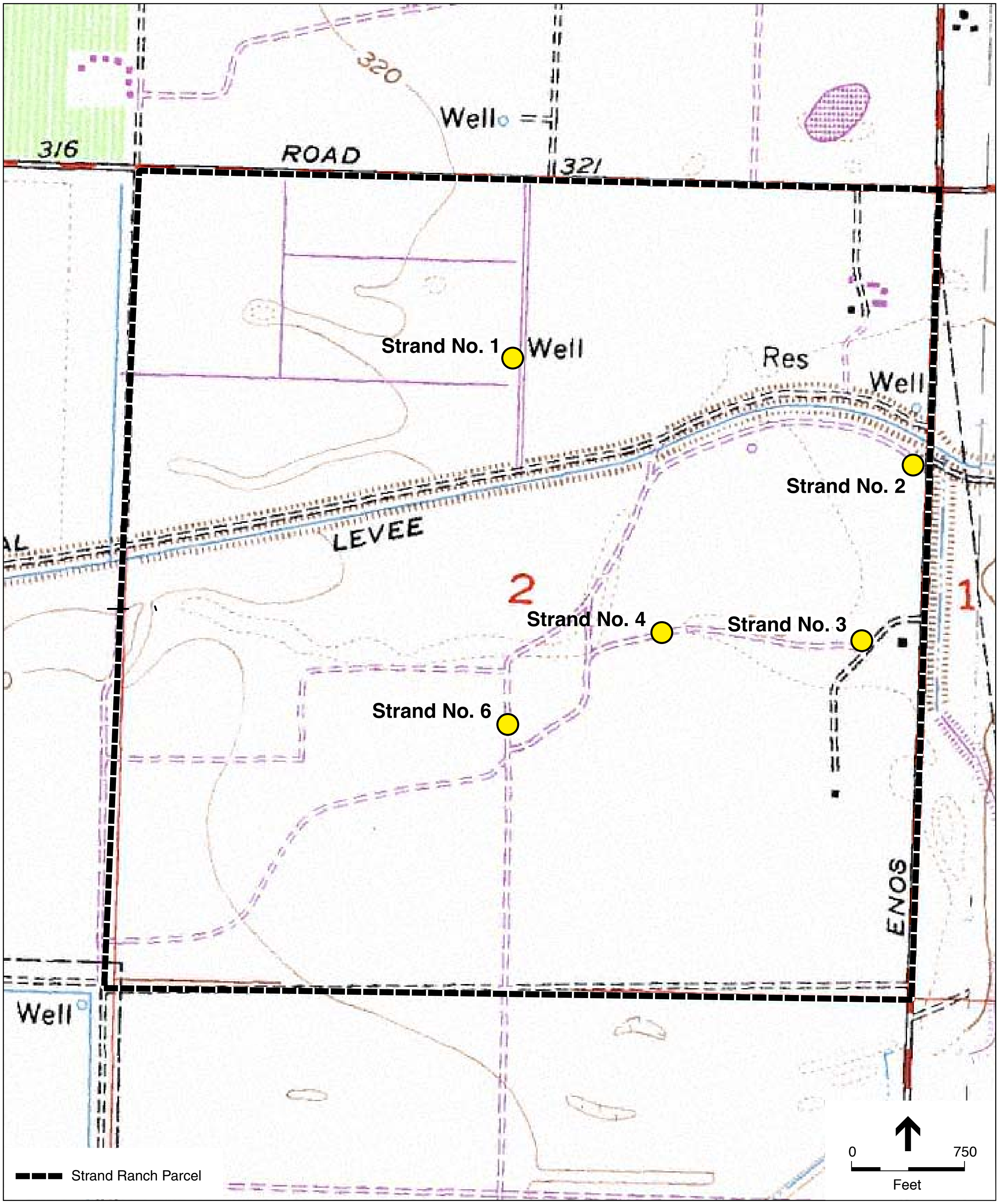
Note: Shallow Aq at 559mg/l is the average plume-impacted TDS.

	Shal Aq	Deep Aq	Blend						
Recovery	237	119	(mg/l)						
Out-Blend 41	100%	0%	(237)	**(10)**	(70)	(112)	(126)	(140)	(149)
Out-Blend 42	80%	20%	(213)	**14**	**(47)**	(88)	(102)	(116)	(125)
Out-Blend 43	60%	40%	(190)	**37**	**(23)**	(65)	(79)	(93)	(102)
Out-Blend 44	40%	60%	(166)	**61**	**1**	(41)	(55)	(69)	(78)
Out-Blend 45	30%	70%	(154)	**73**	**12**	**(29)**	(43)	(57)	(66)
Out-Blend 46	20%	80%	(143)	**84**	**24**	**(18)**	(32)	(45)	(55)
Out-Blend 47	10%	90%	(131)	**96**	**36**	**(6)**	**(20)**	(34)	(43)
Out-Blend 48	0%	100%	(119)	**108**	**48**	**6**	**(8)**	(22)	(31)

Note: Shallow Aq at 237mg/l is the average unimpacted TDS.

Appendix H

Title 22 Sample Analysis Results



SOURCE: USGS; ESA, 2007.

Irvine Ranch Water District . 205426

Figure H-1
Operable Existing Wells
on Strand Ranch

MWH Laboratories
A Division of MWH Americas, Inc.

750 Royal Oaks Drive
Suite 100
Monrovia, California 91016-3629
Tel: 626 568 6400
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1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Layne Christensen
11001 Etiwanda Ave.

Fontana , CA 92337

Attention: Tony Morgan
Fax: (909) 390-6097

01114CA

LXG Linda Geddes
Project Manager

Report#: 153979
DRINKING

Laboratory certifies that the test results meet all **NELAC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Report,QC Summary,Data Report,Hits Report, totaling 58 page[s].

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**Laboratory
Hits Report
#153979**

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 19:31:00

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080247	**STRAND #1**				
08/17/05	Alpha, Gross		7.8	15	pCi/l	2.0
08/17/05	Alpha, Min Detectable Activity		2.00		pCi/l	
08/17/05	Alpha, Two Sigma Error		2.4		pCi/l	
08/16/05	Agressiveness Index-Calculated		12.44		Not Appl.	0.10
08/12/05	Alkalinity in CaCO3 units		90.1		mg/l	2.0
08/09/05	Barium, dissolved, ICAP/MS		170		ug/l	2.0
08/16/05	Bicarb.Alkalinity as HCO3,calc		110.		mg/l	0.001
08/17/05	Bromide		1100		ug/l	25
08/09/05	Calcium, Total, ICAP		110		mg/l	1.0
08/16/05	Carbon Dioxide,Free(25C)-Calc.		2.27		mg/l	0.001
08/16/05	Carbonate as CO3, Calculated		0.568		mg/l	0.001
08/09/05	Chloride		180	250	mg/l	10
08/09/05	Chromium, dissolved, ICAP/MS		3.6		ug/l	2.0
08/08/05	Field pH		7.4		Units	
08/11/05	Fluoride		0.05	4	mg/l	0.050
08/08/05	Hexavalent chromium(Dissolved)		1.9		ug/l	0.10
08/15/05	Hydroxide as OH, Calculated		0.01		mg/l	0.001
08/16/05	Langelier Index - 25 degree		0.54		None	
08/09/05	Magnesium, Total, ICAP		4.4		mg/l	0.10
08/08/05	Odor		2	3	TON	1.0
08/11/05	PH (H1=past HT, not compliant)		7.9	6.5-8.5	Units	0.001
08/09/05	Potassium, Total, ICAP		1.7		mg/l	1.0
08/09/05	Sodium, Total, ICAP		52		mg/l	1.0
08/08/05	Source Temperature		24.1		Degrees C	
08/09/05	Specific Conductance		944		umho/cm	2.0
08/08/05	Sulfate		37	250	mg/l	1.0
08/09/05	Total Dissolved Solid (TDS)		660	500	mg/l	10
08/10/05	Total Hardness as CaCO3 by ICP		293.		mg/l	3.0
08/09/05	Turbidity		0.35	5	NTU	0.050
08/25/05	Uranium by ICPMS as pCi/L		14.1		pCi/l	0.70

SUMMARY OF POSITIVE DATA ONLY.

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Hits Report
#153979

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Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 19:31:00

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080247	**STRAND #1**				
08/24/05	Uranium, ICAP/MS		21	30	ug/l	1.0
08/16/05	pH of CaCO3 saturation(25C)		7.36		Units	0.10
08/16/05	pH of CaCO3 saturation(60C)		6.92		Units	0.10
	2508080248	**TRAVEL BLANK-ANALYZE**				

SUMMARY OF POSITIVE DATA ONLY.

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Laboratory Data Report #153979

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08/08/05

STRAND #1 (2508080247) Sampled on 08/08/05 11:40

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 13:05	282802	(EPA/ML 200.8)	Silver, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/16/05 22:58		(ML/SM2330)	Agressiveness Index-Calculated	12.44	NA	0.10	1
	08/09/05 13:05	282808	(EPA/ML 200.8)	Aluminum, dissolved, ICAP/MS	ND	ug/l	25	1
	08/12/05 12:41	283063	(SM2320B/ 310.1)	Alkalinity in CaCO3 units	90.1	mg/l	2.0	1
	08/09/05 13:05	282801	(EPA/ML 200.8)	Arsenic, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 13:05	282805	(EPA/ML 200.8)	Barium, dissolved, ICAP/MS	170	ug/l	2.0	1
	08/09/05 13:05	282799	(EPA/ML 200.8)	Beryllium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/17/05 00:00	283494	(ML/EPA 300.0)	Bromide	1100	ug/l	25	5
	08/09/05 16:16	282400	(ML/EPA 200.7)	Calcium, Total, ICAP	110	mg/l	1.0	1
	08/09/05 13:05	282803	(EPA/ML 200.8)	Cadmium, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/09/05 14:26	282412	(ML/EPA 300.0)	Chloride	180	mg/l	10	10
	08/16/05 22:44		(SM4500-CO2-D)	Carbon Dioxide,Free(25C)-Calc.	2.27	mg/l	0.001	1
	08/16/05 22:39		(SM2320B/E310.1)	Carbonate as CO3, Calculated	0.568	mg/l	0.001	1
	08/08/05 00:00	282314	(ML/S2120B)	Apparent Color	ND	ACU	3.0	1
	08/09/05 13:05	282810	(EPA/ML 200.8)	Chromium, dissolved, ICAP/MS	3.6	ug/l	2.0	1
	08/08/05 23:03	283768	(EPA 218.6)	Hexavalent chromium(Dissolved)	1.9	ug/l	0.10	1
	08/09/05 13:05	282813	(EPA/ML 200.8)	Copper, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/29/05 08:37	285047	(ML/SM 5310C)	Dissolved Organic Carbon	ND	mg/l	0.30	1
	08/09/05 13:34	282308	(2510B/ SW9050)	Specific Conductance	944	umho/cm	2.0	1
08/12/05	08/16/05 00:00	283673	(ML/EPA 548.1)	Endothall	ND	ug/l	20	4
	08/11/05 00:00	282675	(SM 4500C)	Fluoride	0.05	mg/l	0.050	1
	08/11/05 00:00	282726	(ML/EPA 200.7)	Iron, Dissolved, ICAP	ND	mg/l	0.020	1
	08/10/05 18:49		(ML/SM2340B)	Total Hardness as CaCO3 by ICP	293.	mg/l	3.0	1
	08/16/05 22:27		(SM2320B/E310.1)	Bicarb.Alkalinity as HCO3,calc	110.	mg/l	0.001	1
	08/17/05 12:13	283386	(EPA/ML 245.1)	Mercury, dissolved	ND	ug/l	0.20	1
	08/09/05 16:16	282385	(ML/EPA 200.7)	Potassium, Total, ICAP	1.7	mg/l	1.0	1
	08/16/05 22:47		(ML/SM2330B)	Langelier Index - 25 degree	0.54	None	0.0000	1
	08/09/05 13:30	282466	(SM5540C/E425.1)	Surfactants	ND	mg/l	0.050	1
	08/09/05 16:16	282389	(ML/EPA 200.7)	Magnesium, Total, ICAP	4.4	mg/l	0.10	1
	08/09/05 13:05	282811	(EPA/ML 200.8)	Manganese, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/09/05 16:16	282392	(ML/EPA 200.7)	Sodium, Total, ICAP	52	mg/l	1.0	1
	08/09/05 00:00	284112	(EPA/ML 200.8)	Nickel, dissolved, ICAP/MS	ND	ug/l	5.0	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 17:00	282312	(ML/S2150B)	Odor	2	TON	1.0	1
	08/15/05 14:59		(SM2320B/E310.1)	Hydroxide as OH, Calculated	0.01	mg/l	0.001	1
	08/09/05 13:05	282807	(EPA/ML 200.8)	Lead, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/11/05 00:00	282674	(4500HB/ E 150)	PH (H1=past HT, not compliant)	7.9	Units	0.001	1
	08/08/05 00:00		(ML/EPA 150.1)	Field pH	7.4	Units	0.0000	1
	08/16/05 22:45		(ML/SM2330B)	pH of CaCO3 saturation(25C)	7.36	Units	0.10	1
	08/16/05 22:47		(ML/SM2330B)	pH of CaCO3 saturation(60C)	6.92	Units	0.10	1
	08/09/05 13:05	282804	(EPA/ML 200.8)	Antimony, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/23/05 00:00	284107	(EPA/ML 200.8)	Selenium, dissolved, ICAP/MS	ND	ug/l	5.0	1
	08/08/05 22:07	282253	(ML/EPA 300.0)	Sulfate	37	mg/l	1.0	2
08/09/05	08/09/05 12:00	282564	(SM 2540C)	Total Dissolved Solid (TDS)	660	mg/l	10	1
	08/08/05 00:00		(FIELD/SM2550B)	Source Temperature	24.1	DEGC	0.0000	1
	08/09/05 13:05	282806	(EPA/ML 200.8)	Thallium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 15:59	282493	(ML/EPA 180.1)	Turbidity	0.35	NTU	0.050	1
	08/24/05 13:45	284243	(ML/EPA 200.8)	Uranium, ICAP/MS	21	ug/l	1.0	1
	08/25/05 20:33		(EPA/ML 200.8)	Uranium by ICPMS as pCi/L	14.1	pCi/l	0.70	1
	08/09/05 13:05	282800	(EPA/ML 200.8)	Zinc, dissolved, ICAP/MS	ND	ug/l	5.0	1

525 Semivolatiles by GC/MS

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	2,4-Dinitrotoluene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	alpha-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Diazinon (Qualitative)	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Acenaphthylene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Alachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Aldrin	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Anthracene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Atrazine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Benz(a)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Benzo(a)pyrene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Benzo(b)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Benzo(g,h,i)Perylene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Benzo(k)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Di(2-Ethylhexyl)phthalate	ND	ug/l	0.60	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Butylbenzylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Bromacil	ND	ug/l	0.20	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Butachlor	ND	ug/l	0.050	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Caffeine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Chrysene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Dibenz(a,h)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Di-(2-Ethylhexyl)adipate	ND	ug/l	0.60	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Diethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Dieldrin	ND	ug/l	0.20	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Dimethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Dimethoate	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Di-n-Butylphthalate	ND	ug/l	1.0	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Endrin	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Fluoranthene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Fluorene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	gamma-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Hexachlorobenzene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Hexachlorocyclopentadiene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Heptachlor	ND	ug/l	0.040	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Heptachlor Epoxide (isomer B)	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Indeno(1,2,3,c,d)Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Isophorone	ND	ug/l	0.50	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Lindane	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Methoxychlor	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Metribuzin	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Molinate	ND	ug/l	0.10	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Metolachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	trans-Nonachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Pentachlorophenol	ND	ug/l	1.0	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Phenanthrene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Prometryn	ND	ug/l	0.50	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Propachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Simazine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Thiobencarb	ND	ug/l	0.20	1
08/18/05	09/01/05 12:55	285766	(ML/EPA 525.2)	Trifluralin	ND	ug/l	0.10	1
			(ML/EPA 525.2)	Triphenylphosphate(70-130)	94	% Rec		
			(ML/EPA 525.2)	Perylene-d12(70-130)	88	% Rec		
			(ML/EPA 525.2)	1.3-dimethyl-2-nbenz(70-130)	99	% Rec		

Layne Christensen
(continued)

Aldicarbs by 531.2

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/25/05 00:00	284485	(ML/EPA 531.2)	3-Hydroxycarbofuran	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb (Temik)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfone	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfoxide	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Baygon (Propoxur)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Carbofuran (Furadan)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Carbaryl	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Methiocarb	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Methomyl	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Oxamyl (Vydate)	ND	ug/l	0.50	1
			(ML/EPA 531.2)	BDMC(70-130)	100	% Rec		

Diuron by method 532

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/11/05	08/24/05 00:00	284321	(EPA 532)	Diuron	ND	ug/l	1.0	1
			(EPA 532)	Monuron(70-130)	83	% Rec		
			(EPA 532)	Carbazole(70-130)	79	% Rec		

EDB and DBCP by GC-ECD

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/16/05	08/16/05 07:08	283338	(ML/EPA 504.1)	Dibromochloropropane (DBCP)	ND	ug/l	0.010	1
08/16/05	08/16/05 07:08	283338	(ML/EPA 504.1)	Ethylene Dibromide (EDB)	ND	ug/l	0.010	1

Gross Alpha Radiation

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Gross	7.8	pCi/l	2.0	1
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Two Sigma Error	2.4	pCi/l	0.0000	1
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Min Detectable Activity	2.00	pCi/l	0.0000	1

Herbicides by 515.4

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-T	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-TP (Silvex)	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-D	ND	ug/l	0.10	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-DB	ND	ug/l	2.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dichlorprop	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Acifluorfen	ND	ug/l	0.20	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Bentazon	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dalapon	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	3,5-Dichlorobenzoic acid	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Tot DCPA Mono&Diacid Degradate	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dicamba	ND	ug/l	0.080	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dinoseb	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Pentachlorophenol	ND	ug/l	0.040	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Picloram	ND	ug/l	0.10	1
			(ML/EPA 515.4)	4.4-Dibrombiphenyl(60-140)	114	% Rec		
			(ML/EPA 515.4)	2.4-DCPAA (70-130)	93	% Rec		

Pesticides by EPA 505

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1016 Aroclor	ND	ug/l	0.070	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1221 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1232 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1242 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1248 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1254 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	PCB 1260 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Alachlor (Alanex)	ND	ug/l	0.050	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Aldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Chlordane	ND	ug/l	0.10	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Dieldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Endrin	ND	ug/l	0.010	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Heptachlor	ND	ug/l	0.010	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Heptachlor Epoxide	ND	ug/l	0.010	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Lindane (gamma-BHC)	ND	ug/l	0.010	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Methoxychlor	ND	ug/l	0.050	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Total PCBs	ND	ug/l	0.070	1
08/10/05	08/10/05 22:25	283059	(ML/EPA 505)	Toxaphene	ND	ug/l	0.50	1

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 22:36	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/08/05 22:36	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	102	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	94	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	119	% Rec		

Layne Christensen
(continued)

TRAVEL BLANK-ANALYZE (2508080248)   Sampled on 08/08/05 00:00

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 00:49	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/09/05 00:49	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
			(EPA 524.2)	Toluene-d8(70-130)	94	% Rec		
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	103	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	121	% Rec		

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Laboratory Report

for

Layne Christensen
11001 Etiwanda Ave.

Fontana , CA 92337

Attention: Tony Morgan
Fax: (909) 390-6097

ACCREDITED IN ACCORDANCE WITH
nelac
01114CA

LXG Linda Geddes
Project Manager

Report#: 153971
DRINKING

Laboratory certifies that the test results meet all **NELAC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Report,QC Summary,Data Report,Hits Report, totaling 58 page[s].

MWH Laboratories
A Division of MWH Americas, Inc.

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Laboratory
Hits Report
#153971

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 18:46:01

2508080235 STRAND #2

Analyzed	Sample# / Sample ID	Result	Federal MCL	UNITS	MRL
08/15/05	Alpha, Gross	9.2	15	pCi/l	2.0
08/15/05	Alpha, Min Detectable Activity	2.00		pCi/l	
08/15/05	Alpha, Two Sigma Error	2.5		pCi/l	
08/08/05	Benzene	0.7	5	ug/l	0.50
08/16/05	Agressiveness Index-Calculated	12.22		Not Appl.	0.10
08/12/05	Alkalinity in CaCO3 units	54.9		mg/l	2.0
08/09/05	Arsenic, dissolved, ICAP/MS	1.4		ug/l	1.0
08/09/05	Barium, dissolved, ICAP/MS	170		ug/l	2.0
08/16/05	Bicarb.Alkalinity as HCO3,calc	66.8		mg/l	0.001
08/09/05	Calcium, Total, ICAP	110		mg/l	1.0
08/16/05	Carbon Dioxide,Free(25C)-Calc.	1.38		mg/l	0.001
08/16/05	Carbonate as CO3, Calculated	0.345		mg/l	0.001
08/09/05	Chloride	260	250	mg/l	10
08/09/05	Chromium, dissolved, ICAP/MS	6.9		ug/l	2.0
08/08/05	Field pH	7.6		Units	
08/11/05	Fluoride	0.08	4	mg/l	0.050
08/08/05	Hexavalent chromium(Dissolved)	1.9		ug/l	0.10
08/15/05	Hydroxide as OH, Calculated	0.01		mg/l	0.001
08/16/05	Langelier Index - 25 degree	0.32		None	
08/09/05	Magnesium, Total, ICAP	2.7		mg/l	0.10
08/09/05	Manganese, dissolved, ICAP/MS	4.4		ug/l	2.0
08/17/05	Mercury, dissolved	1.01		ug/l	0.20
08/08/05	Odor	1	3	TON	1.0
08/11/05	PH (H1=past HT, not compliant)	7.9	6.5-8.5	Units	0.001
08/09/05	Potassium, Total, ICAP	1.7		mg/l	1.0
08/09/05	Sodium, Total, ICAP	75		mg/l	1.0
08/08/05	Source Temperature	23.4		Degrees C	
08/09/05	Specific Conductance	1070		umho/cm	2.0
08/08/05	Sulfate	21	250	mg/l	2.5
08/09/05	Total Dissolved Solid (TDS)	710	500	mg/l	10

SUMMARY OF POSITIVE DATA ONLY.

MWH Laboratories
A Division of MWH Americas, Inc.

750 Royal Oaks Drive
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1 800 566 LABS (1 800 566 5227)

Laboratory
Hits Report
#153971

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 18:46:01

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080235	**STRAND #2**				
08/10/05	Total Hardness as CaCO3 by ICP		286.		mg/l	3.0
08/09/05	Turbidity		0.30	5	NTU	0.050
08/25/05	Uranium by ICPMS as pCi/L		6.70		pCi/l	0.70
08/24/05	Uranium, ICAP/MS		10	30	ug/l	1.0
08/16/05	pH of CaCO3 saturation(25C)		7.58		Units	0.10
08/16/05	pH of CaCO3 saturation(60C)		7.14		Units	0.10
	2508080236	**TRAVEL BLANK-ANALYZE**				

SUMMARY OF POSITIVE DATA ONLY.

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Laboratory Data Report #153971

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08/08/05

STRAND #2 (2508080235) Sampled on 08/08/05 09:00

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 12:57	282802	(EPA/ML 200.8)	Silver, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/16/05 22:58		(ML/SM2330)	Agressiveness Index-Calculated	12.22	NA	0.10	1
	08/09/05 12:57	282808	(EPA/ML 200.8)	Aluminum, dissolved, ICAP/MS	ND	ug/l	25	1
	08/12/05 12:41	283063	(SM2320B/ 310.1)	Alkalinity in CaCO3 units	54.9	mg/l	2.0	1
	08/09/05 12:57	282801	(EPA/ML 200.8)	Arsenic, dissolved, ICAP/MS	1.4	ug/l	1.0	1
	08/09/05 12:57	282805	(EPA/ML 200.8)	Barium, dissolved, ICAP/MS	170	ug/l	2.0	1
	08/09/05 12:57	282799	(EPA/ML 200.8)	Beryllium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 16:30	282400	(ML/EPA 200.7)	Calcium, Total, ICAP	110	mg/l	1.0	1
	08/09/05 12:57	282803	(EPA/ML 200.8)	Cadmium, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/09/05 14:38	282412	(ML/EPA 300.0)	Chloride	260	mg/l	10	10
	08/16/05 22:44		(SM4500-CO2-D)	Carbon Dioxide,Free(25C)-Calc.	1.38	mg/l	0.001	1
	08/16/05 22:39		(SM2320B/E310.1)	Carbonate as CO3, Calculated	0.345	mg/l	0.001	1
	08/08/05 00:00	282313	(ML/S2120B)	Apparent Color	ND	ACU	3.0	1
	08/09/05 12:57	282810	(EPA/ML 200.8)	Chromium, dissolved, ICAP/MS	6.9	ug/l	2.0	1
	08/08/05 22:39	283768	(EPA 218.6)	Hexavalent chromium(Dissolved)	1.9	ug/l	0.10	1
	08/09/05 12:57	282813	(EPA/ML 200.8)	Copper, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/29/05 08:37	285047	(ML/SM 5310C)	Dissolved Organic Carbon	ND	mg/l	0.30	1
	08/09/05 13:34	282308	(2510B/ SW9050)	Specific Conductance	1070	umho/cm	2.0	1
08/09/05	08/11/05 00:00	282734	(ML/EPA 548.1)	Endothall	ND	ug/l	20	4
	08/11/05 00:00	282675	(SM 4500C)	Fluoride	0.08	mg/l	0.050	1
	08/11/05 00:00	282726	(ML/EPA 200.7)	Iron, Dissolved, ICAP	ND	mg/l	0.020	1
	08/10/05 18:49		(ML/SM2340B)	Total Hardness as CaCO3 by ICP	286.	mg/l	3.0	1
	08/16/05 22:27		(SM2320B/E310.1)	Bicarb.Alkalinity as HCO3,calc	66.8	mg/l	0.001	1
	08/17/05 12:13	283386	(EPA/ML 245.1)	Mercury, dissolved	1.01	ug/l	0.20	1
	08/09/05 16:30	282385	(ML/EPA 200.7)	Potassium, Total, ICAP	1.7	mg/l	1.0	1
	08/16/05 22:47		(ML/SM2330B)	Langelier Index - 25 degree	0.32	None	0.0000	1
	08/09/05 13:30	282466	(SM5540C/E425.1)	Surfactants	ND	mg/l	0.050	1
	08/09/05 16:30	282389	(ML/EPA 200.7)	Magnesium, Total, ICAP	2.7	mg/l	0.10	1
	08/09/05 12:57	282811	(EPA/ML 200.8)	Manganese, dissolved, ICAP/MS	4.4	ug/l	2.0	1
	08/09/05 16:30	282392	(ML/EPA 200.7)	Sodium, Total, ICAP	75	mg/l	1.0	1
	08/09/05 00:00	284112	(EPA/ML 200.8)	Nickel, dissolved, ICAP/MS	ND	ug/l	5.0	1
	08/08/05 17:00	282311	(ML/S2150B)	Odor	1	TON	1.0	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/15/05 14:59		(SM2320B/E310.1)	Hydroxide as OH, Calculated	0.01	mg/l	0.001	1
	08/09/05 12:57	282807	(EPA/ML 200.8)	Lead, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/11/05 00:00	282674	(4500HB/ E 150)	PH (H1=past HT, not compliant)	7.9	Units	0.001	1
	08/08/05 00:00		(ML/EPA 150.1)	Field pH	7.6	Units	0.0000	1
	08/16/05 22:45		(ML/SM2330B)	pH of CaCO3 saturation(25C)	7.58	Units	0.10	1
	08/16/05 22:47		(ML/SM2330B)	pH of CaCO3 saturation(60C)	7.14	Units	0.10	1
	08/09/05 12:57	282804	(EPA/ML 200.8)	Antimony, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/23/05 00:00	284107	(EPA/ML 200.8)	Selenium, dissolved, ICAP/MS	ND	ug/l	5.0	1
	08/08/05 22:19	282253	(ML/EPA 300.0)	Sulfate	21	mg/l	2.5	5
08/09/05	08/09/05 12:00	282564	(SM 2540C)	Total Dissolved Solid (TDS)	710	mg/l	10	1
	08/08/05 00:00		(FIELD/SM2550B)	Source Temperature	23.4	DEGC	0.0000	1
	08/09/05 12:57	282806	(EPA/ML 200.8)	Thallium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 15:59	282492	(ML/EPA 180.1)	Turbidity	0.30	NTU	0.050	1
	08/24/05 13:41	284243	(ML/EPA 200.8)	Uranium, ICAP/MS	10	ug/l	1.0	1
	08/25/05 20:33		(EPA/ML 200.8)	Uranium by ICPMS as pCi/L	6.70	pCi/l	0.70	1
	08/09/05 12:57	282800	(EPA/ML 200.8)	Zinc, dissolved, ICAP/MS	ND	ug/l	5.0	1

525 Semivolatiles by GC/MS

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	2,4-Dinitrotoluene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	alpha-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Diazinon (Qualitative)	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Acenaphthylene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Alachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Aldrin	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Anthracene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Atrazine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Benz(a)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Benzo(a)pyrene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Benzo(b)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Benzo(g,h,i)Perylene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Benzo(k)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Di(2-Ethylhexyl)phthalate	ND	ug/l	0.60	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Butylbenzylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Bromacil	ND	ug/l	0.20	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Butachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Caffeine	ND	ug/l	0.050	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Chrysene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Dibenz(a,h)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Di-(2-Ethylhexyl)adipate	ND	ug/l	0.60	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Diethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Dieldrin	ND	ug/l	0.20	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Dimethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Dimethoate	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Di-n-Butylphthalate	ND	ug/l	1.0	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Endrin	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Fluoranthene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Fluorene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	gamma-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Hexachlorobenzene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Hexachlorocyclopentadiene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Heptachlor	ND	ug/l	0.040	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Heptachlor Epoxide (isomer B)	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Indeno(1,2,3,c,d)Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Isophorone	ND	ug/l	0.50	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Lindane	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Methoxychlor	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Metribuzin	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Molinate	ND	ug/l	0.10	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Metolachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	trans-Nonachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Pentachlorophenol	ND	ug/l	1.0	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Phenanthrene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Prometryn	ND	ug/l	0.50	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Propachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Simazine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Thiobencarb	ND	ug/l	0.20	1
08/18/05	09/01/05 12:11	285766	(ML/EPA 525.2)	Trifluralin	ND	ug/l	0.10	1
			(ML/EPA 525.2)	Triphenylphosphate(70-130)	97	% Rec		
			(ML/EPA 525.2)	1.3-dimethyl-2-nbenz(70-130)	95	% Rec		
			(ML/EPA 525.2)	Perylene-d12(70-130)	91	% Rec		

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
			Aldicarbs by 531.2					
	08/24/05 00:00	284485	(ML/EPA 531.2)	3-Hydroxycarbofuran	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Aldicarb (Temik)	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfone	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfoxide	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Baygon (Propoxur)	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Carbofuran (Furadan)	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Carbaryl	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Methiocarb	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Methomyl	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Oxamyl (Vydate)	ND	ug/l	0.50	1
			(ML/EPA 531.2)	BDMC(70-130)	103	% Rec		
			Diuron by method 532					
08/11/05	08/24/05 00:00	284321	(EPA 532)	Diuron	ND	ug/l	1.0	1
			(EPA 532)	Monuron(70-130)	108	% Rec		
			(EPA 532)	Carbazole(70-130)	103	% Rec		
			EDB and DBCP by GC-ECD					
08/16/05	08/17/05 00:40	283333	(ML/EPA 504.1)	Dibromochloropropane (DBCP)	ND	ug/l	0.010	1
08/16/05	08/17/05 00:40	283333	(ML/EPA 504.1)	Ethylene Dibromide (EDB)	ND	ug/l	0.010	1
			Gross Alpha Radiation					
	08/15/05 00:00	283971	(ML/EPA 900.0)	Alpha, Gross	9.2	pCi/l	2.0	1
	08/15/05 00:00	283971	(ML/EPA 900.0)	Alpha, Two Sigma Error	2.5	pCi/l	0.0000	1
	08/15/05 00:00	283971	(ML/EPA 900.0)	Alpha, Min Detectable Activity	2.00	pCi/l	0.0000	1
			Herbicides by 515.4					
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-T	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-TP (Silvex)	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-D	ND	ug/l	0.10	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-DB	ND	ug/l	2.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dichlorprop	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Acifluorfen	ND	ug/l	0.20	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Bentazon	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dalapon	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	3,5-Dichlorobenzoic acid	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Tot DCPA Mono&Diacid Degradate	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dicamba	ND	ug/l	0.080	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dinoseb	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Pentachlorophenol	ND	ug/l	0.040	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Picloram	ND	ug/l	0.10	1
			(ML/EPA 515.4)	4.4-Dibrombiphenyl(60-140)	105	% Rec		
			(ML/EPA 515.4)	2.4-DCPAA (70-130)	96	% Rec		

Pesticides by EPA 505

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1016 Aroclor	ND	ug/l	0.070	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1221 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1232 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1242 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1248 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1254 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	PCB 1260 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Alachlor (Alanex)	ND	ug/l	0.050	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Aldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Chlordane	ND	ug/l	0.10	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Dieldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Endrin	ND	ug/l	0.010	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Heptachlor	ND	ug/l	0.010	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Heptachlor Epoxide	ND	ug/l	0.010	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Lindane (gamma-BHC)	ND	ug/l	0.010	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Methoxychlor	ND	ug/l	0.050	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Total PCBs	ND	ug/l	0.070	1
08/10/05	08/10/05 19:29	283059	(ML/EPA 505)	Toxaphene	ND	ug/l	0.50	1

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Benzene	0.7	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:03	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/08/05 23:03	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	99	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	118	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	95	% Rec		

TRAVEL BLANK-ANALYZE (2508080236) Sampled on 08/08/05 00:00

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 01:16	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/09/05 01:16	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	100	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	95	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	120	% Rec		

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Laboratory Report

for

Layne Christensen
11001 Etiwanda Ave.

Fontana , CA 92337

Attention: Tony Morgan
Fax: (909) 390-6097

ACCREDITED IN ACCORDANCE WITH
nelac
01114CA

LXG Linda Geddes
Project Manager

Report#: 153978
DRINKING

Laboratory certifies that the test results meet all **NELAC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Report,QC Summary,Data Report,Hits Report, totaling 58 page[s].

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**Laboratory
Hits Report
#153978**

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 19:18:32

2508080245 STRAND #3

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
08/17/05	Alpha, Gross		7.6	15	pCi/l	2.0
08/17/05	Alpha, Min Detectable Activity		2.00		pCi/l	
08/17/05	Alpha, Two Sigma Error		2.3		pCi/l	
08/16/05	Agressiveness Index-Calculated		12.41		Not Appl.	0.10
08/12/05	Alkalinity in CaCO3 units		89.6		mg/l	2.0
08/09/05	Barium, dissolved, ICAP/MS		200		ug/l	2.0
08/16/05	Bicarb.Alkalinity as HCO3,calc		109.		mg/l	0.001
08/17/05	Bromide		1700		ug/l	25
08/09/05	Calcium, Total, ICAP		130		mg/l	1.0
08/16/05	Carbon Dioxide,Free(25C)-Calc.		2.83		mg/l	0.001
08/16/05	Carbonate as CO3, Calculated		0.447		mg/l	0.001
08/09/05	Chloride		270	250	mg/l	10
08/09/05	Chromium, dissolved, ICAP/MS		2		ug/l	2.0
08/29/05	Dissolved Organic Carbon		0.30		mg/l	0.30
08/08/05	Field pH		7.5		Units	
08/11/05	Fluoride		0.08	4	mg/l	0.050
08/08/05	Hexavalent chromium(Dissolved)		1.8		ug/l	0.10
08/15/05	Hydroxide as OH, Calculated		0.01		mg/l	0.001
08/16/05	Langelier Index - 25 degree		0.51		None	
08/09/05	Magnesium, Total, ICAP		4.8		mg/l	0.10
08/09/05	Manganese, dissolved, ICAP/MS		6.6		ug/l	2.0
08/08/05	Odor		2	3	TON	1.0
08/11/05	PH (H1=past HT, not compliant)		7.8	6.5-8.5	Units	0.001
08/09/05	Potassium, Total, ICAP		1.8		mg/l	1.0
08/09/05	Sodium, Total, ICAP		83		mg/l	1.0
08/08/05	Source Temperature		23.3		Degrees C	
08/09/05	Specific Conductance		1190		umho/cm	2.0
08/08/05	Sulfate		28	250	mg/l	2.5
08/09/05	Total Dissolved Solid (TDS)		800	500	mg/l	10
08/10/05	Total Hardness as CaCO3 by ICP		344.		mg/l	3.0

SUMMARY OF POSITIVE DATA ONLY.

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 19:18:32

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080245	**STRAND #3**				
08/09/05	Turbidity		0.25	5	NTU	0.050
08/25/05	Uranium by ICPMS as pCi/L		14.1		pCi/l	0.70
08/24/05	Uranium, ICAP/MS		21	30	ug/l	1.0
08/16/05	pH of CaCO3 saturation(25C)		7.29		Units	0.10
08/16/05	pH of CaCO3 saturation(60C)		6.85		Units	0.10
	2508080246	**TRAVEL BLANK-ANALYZE**				

SUMMARY OF POSITIVE DATA ONLY.

MWH Laboratories
A Division of MWH Americas, Inc.

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Laboratory Data Report #153978

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08/08/05

STRAND #3 (2508080245) Sampled on 08/08/05 09:40

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 13:01	282802	(EPA/ML 200.8)	Silver, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/16/05 22:58		(ML/SM2330)	Agressiveness Index-Calculated	12.41	NA	0.10	1
	08/09/05 13:01	282808	(EPA/ML 200.8)	Aluminum, dissolved, ICAP/MS	ND	ug/l	25	1
	08/12/05 12:41	283063	(SM2320B/ 310.1)	Alkalinity in CaCO3 units	89.6	mg/l	2.0	1
	08/09/05 13:01	282801	(EPA/ML 200.8)	Arsenic, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 13:01	282805	(EPA/ML 200.8)	Barium, dissolved, ICAP/MS	200	ug/l	2.0	1
	08/09/05 13:01	282799	(EPA/ML 200.8)	Beryllium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/17/05 00:00	283494	(ML/EPA 300.0)	Bromide	1700	ug/l	25	5
	08/09/05 16:34	282400	(ML/EPA 200.7)	Calcium, Total, ICAP	130	mg/l	1.0	1
	08/09/05 13:01	282803	(EPA/ML 200.8)	Cadmium, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/09/05 14:50	282412	(ML/EPA 300.0)	Chloride	270	mg/l	10	10
	08/16/05 22:44		(SM4500-CO2-D)	Carbon Dioxide,Free(25C)-Calc.	2.83	mg/l	0.001	1
	08/16/05 22:39		(SM2320B/E310.1)	Carbonate as CO3, Calculated	0.447	mg/l	0.001	1
	08/08/05 00:00	282313	(ML/S2120B)	Apparent Color	ND	ACU	3.0	1
	08/09/05 13:01	282810	(EPA/ML 200.8)	Chromium, dissolved, ICAP/MS	2	ug/l	2.0	1
	08/08/05 22:47	283768	(EPA 218.6)	Hexavalent chromium(Dissolved)	1.8	ug/l	0.10	1
	08/09/05 13:01	282813	(EPA/ML 200.8)	Copper, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/29/05 08:37	285047	(ML/SM 5310C)	Dissolved Organic Carbon	0.30	mg/l	0.30	1
	08/09/05 13:34	282308	(2510B/ SW9050)	Specific Conductance	1190	umho/cm	2.0	1
08/09/05	08/11/05 00:00	282734	(ML/EPA 548.1)	Endothall	ND	ug/l	20	4
	08/11/05 00:00	282675	(SM 4500C)	Fluoride	0.08	mg/l	0.050	1
	08/11/05 00:00	282726	(ML/EPA 200.7)	Iron, Dissolved, ICAP	ND	mg/l	0.020	1
	08/10/05 18:49		(ML/SM2340B)	Total Hardness as CaCO3 by ICP	344.	mg/l	3.0	1
	08/16/05 22:27		(SM2320B/E310.1)	Bicarb.Alkalinity as HCO3,calc	109.	mg/l	0.001	1
	08/17/05 12:13	283386	(EPA/ML 245.1)	Mercury, dissolved	ND	ug/l	0.20	1
	08/09/05 16:34	282385	(ML/EPA 200.7)	Potassium, Total, ICAP	1.8	mg/l	1.0	1
	08/16/05 22:47		(ML/SM2330B)	Langelier Index - 25 degree	0.51	None	0.0000	1
	08/09/05 13:30	282466	(SM5540C/E425.1)	Surfactants	ND	mg/l	0.050	1
	08/09/05 16:34	282389	(ML/EPA 200.7)	Magnesium, Total, ICAP	4.8	mg/l	0.10	1
	08/09/05 13:01	282811	(EPA/ML 200.8)	Manganese, dissolved, ICAP/MS	6.6	ug/l	2.0	1
	08/09/05 16:34	282392	(ML/EPA 200.7)	Sodium, Total, ICAP	83	mg/l	1.0	1
	08/09/05 00:00	284112	(EPA/ML 200.8)	Nickel, dissolved, ICAP/MS	ND	ug/l	5.0	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 17:00	282311	(ML/S2150B)	Odor	2	TON	1.0	1
	08/15/05 14:59		(SM2320B/E310.1)	Hydroxide as OH, Calculated	0.01	mg/l	0.001	1
	08/09/05 13:01	282807	(EPA/ML 200.8)	Lead, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/11/05 00:00	282674	(4500HB/ E 150)	PH (H1=past HT, not compliant)	7.8	Units	0.001	1
	08/08/05 00:00		(ML/EPA 150.1)	Field pH	7.5	Units	0.0000	1
	08/16/05 22:45		(ML/SM2330B)	pH of CaCO3 saturation(25C)	7.29	Units	0.10	1
	08/16/05 22:47		(ML/SM2330B)	pH of CaCO3 saturation(60C)	6.85	Units	0.10	1
	08/09/05 13:01	282804	(EPA/ML 200.8)	Antimony, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/23/05 00:00	284107	(EPA/ML 200.8)	Selenium, dissolved, ICAP/MS	ND	ug/l	5.0	1
	08/08/05 22:30	282253	(ML/EPA 300.0)	Sulfate	28	mg/l	2.5	5
08/09/05	08/09/05 12:00	282564	(SM 2540C)	Total Dissolved Solid (TDS)	800	mg/l	10	1
	08/08/05 00:00		(FIELD/SM2550B)	Source Temperature	23.3	DEGC	0.0000	1
	08/09/05 13:01	282806	(EPA/ML 200.8)	Thallium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 15:59	282492	(ML/EPA 180.1)	Turbidity	0.25	NTU	0.050	1
	08/24/05 13:43	284243	(ML/EPA 200.8)	Uranium, ICAP/MS	21	ug/l	1.0	1
	08/25/05 20:33		(EPA/ML 200.8)	Uranium by ICPMS as pCi/L	14.1	pCi/l	0.70	1
	08/09/05 13:01	282800	(EPA/ML 200.8)	Zinc, dissolved, ICAP/MS	ND	ug/l	5.0	1

525 Semivolatiles by GC/MS

08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	2,4-Dinitrotoluene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	alpha-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Diazinon (Qualitative)	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Acenaphthylene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Alachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Aldrin	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Anthracene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Atrazine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Benz(a)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Benzo(a)pyrene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Benzo(b)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Benzo(g,h,i)Perylene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Benzo(k)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Di(2-Ethylhexyl)phthalate	ND	ug/l	0.60	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Butylbenzylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Bromacil	ND	ug/l	0.20	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Butachlor	ND	ug/l	0.050	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Caffeine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Chrysene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Dibenz(a,h)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Di-(2-Ethylhexyl)adipate	ND	ug/l	0.60	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Diethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Dieldrin	ND	ug/l	0.20	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Dimethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Dimethoate	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Di-n-Butylphthalate	ND	ug/l	1.0	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Endrin	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Fluoranthene	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Fluorene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	gamma-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Hexachlorobenzene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Hexachlorocyclopentadiene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Heptachlor	ND	ug/l	0.040	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Heptachlor Epoxide (isomer B)	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Indeno(1,2,3,c,d)Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Isophorone	ND	ug/l	0.50	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Lindane	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Methoxychlor	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Metribuzin	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Molinate	ND	ug/l	0.10	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Metolachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	trans-Nonachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Pentachlorophenol	ND	ug/l	1.0	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Phenanthrene	ND	ug/l	0.020	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Prometryn	ND	ug/l	0.50	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Propachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Simazine	ND	ug/l	0.050	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Thiobencarb	ND	ug/l	0.20	1
08/18/05	09/01/05 12:33	285766	(ML/EPA 525.2)	Trifluralin	ND	ug/l	0.10	1
			(ML/EPA 525.2)	Perylene-d12(70-130)	88	% Rec		
			(ML/EPA 525.2)	1.3-dimethyl-2-nbenz(70-130)	105	% Rec		
			(ML/EPA 525.2)	Triphenylphosphate(70-130)	96	% Rec		

Layne Christensen
(continued)

Aldicarbs by 531.2

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/25/05 00:00	284485	(ML/EPA 531.2)	3-Hydroxycarbofuran	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb (Temik)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfone	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfoxide	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Baygon (Propoxur)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Carbofuran (Furadan)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Carbaryl	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Methiocarb	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Methomyl	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Oxamyl (Vydate)	ND	ug/l	0.50	1
			(ML/EPA 531.2)	BDMC(70-130)	101	% Rec		

Diuron by method 532

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/11/05	08/24/05 00:00	284321	(EPA 532)	Diuron	ND	ug/l	1.0	1
			(EPA 532)	Carbazole(70-130)	99	% Rec		
			(EPA 532)	Monuron(70-130)	106	% Rec		

EDB and DBCP by GC-ECD

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/16/05	08/17/05 01:09	283333	(ML/EPA 504.1)	Dibromochloropropane (DBCP)	ND	ug/l	0.010	1
08/16/05	08/17/05 01:09	283333	(ML/EPA 504.1)	Ethylene Dibromide (EDB)	ND	ug/l	0.010	1

Gross Alpha Radiation

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Gross	7.6	pCi/l	2.0	1
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Two Sigma Error	2.3	pCi/l	0.0000	1
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Min Detectable Activity	2.00	pCi/l	0.0000	1

Herbicides by 515.4

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-T	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-TP (Silvex)	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-D	ND	ug/l	0.10	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-DB	ND	ug/l	2.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dichlorprop	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Acifluorfen	ND	ug/l	0.20	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Bentazon	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dalapon	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	3,5-Dichlorobenzoic acid	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Tot DCPA Mono&Diacid Degradate	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dicamba	ND	ug/l	0.080	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dinoseb	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Pentachlorophenol	ND	ug/l	0.040	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Picloram	ND	ug/l	0.10	1
			(ML/EPA 515.4)	4.4-Dibrombiphenyl(60-140)	104	% Rec		
			(ML/EPA 515.4)	2.4-DCPAA (70-130)	95	% Rec		

Pesticides by EPA 505

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1016 Aroclor	ND	ug/l	0.070	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1221 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1232 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1242 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1248 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1254 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	PCB 1260 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Alachlor (Alanex)	ND	ug/l	0.050	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Aldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Chlordane	ND	ug/l	0.10	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Dieldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Endrin	ND	ug/l	0.010	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Heptachlor	ND	ug/l	0.010	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Heptachlor Epoxide	ND	ug/l	0.010	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Lindane (gamma-BHC)	ND	ug/l	0.010	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Methoxychlor	ND	ug/l	0.050	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Total PCBs	ND	ug/l	0.070	1
08/10/05	08/10/05 21:41	283059	(ML/EPA 505)	Toxaphene	ND	ug/l	0.50	1

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:29	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/08/05 23:29	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	99	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	120	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	93	% Rec		

TRAVEL BLANK-ANALYZE (2508080246) Sampled on 08/08/05 00:00

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 01:42	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/09/05 01:42	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	117	% Rec		
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	99	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	91	% Rec		

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1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Layne Christensen
11001 Etiwanda Ave.

Fontana , CA 92337

Attention: Tony Morgan
Fax: (909) 390-6097

01114CA

LXG Linda Geddes
Project Manager

Report#: 153980
DRINKING

Laboratory certifies that the test results meet all **NELAC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Report,QC Summary,Data Report,Hits Report, totaling 58 page[s].

MWH Laboratories
A Division of MWH Americas, Inc.

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Laboratory
Hits Report
#153980

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 19:43:23

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080249	**STRAND #4**				
08/17/05	Alpha, Gross		8.0	15	pCi/l	2.0
08/17/05	Alpha, Min Detectable Activity		2.00		pCi/l	
08/17/05	Alpha, Two Sigma Error		2.6		pCi/l	
08/16/05	Agressiveness Index-Calculated		12.35		Not Appl.	0.10
08/12/05	Alkalinity in CaCO3 units		95.9		mg/l	2.0
08/09/05	Barium, dissolved, ICAP/MS		130		ug/l	2.0
08/16/05	Bicarb.Alkalinity as HCO3,calc		117.		mg/l	0.001
08/17/05	Bromide		900		ug/l	25
08/09/05	Calcium, Total, ICAP		85		mg/l	1.0
08/16/05	Carbon Dioxide,Free(25C)-Calc.		2.42		mg/l	0.001
08/16/05	Carbonate as CO3, Calculated		0.604		mg/l	0.001
08/08/05	Chloride		140	250	mg/l	5.0
08/09/05	Chromium, dissolved, ICAP/MS		4.1		ug/l	2.0
08/08/05	Field pH		7.5		Units	
08/11/05	Fluoride		0.06	4	mg/l	0.050
08/08/05	Hexavalent chromium(Dissolved)		2.5		ug/l	0.10
08/15/05	Hydroxide as OH, Calculated		0.01		mg/l	0.001
08/16/05	Langelier Index - 25 degree		0.45		None	
08/09/05	Magnesium, Total, ICAP		3.2		mg/l	0.10
08/08/05	Odor		1	3	TON	1.0
08/11/05	PH (H1=past HT, not compliant)		7.9	6.5-8.5	Units	0.001
08/09/05	Potassium, Total, ICAP		1.4		mg/l	1.0
08/09/05	Sodium, Total, ICAP		52		mg/l	1.0
08/08/05	Source Temperature		23.5		Degrees C	
08/09/05	Specific Conductance		775		umho/cm	2.0
08/08/05	Sulfate		30	250	mg/l	2.5
08/09/05	Total Dissolved Solid (TDS)		510	500	mg/l	10
08/10/05	Total Hardness as CaCO3 by ICP		225.		mg/l	3.0
08/09/05	Turbidity		0.20	5	NTU	0.050
08/25/05	Uranium by ICPMS as pCi/L		13.4		pCi/l	0.70

SUMMARY OF POSITIVE DATA ONLY.

MWH Laboratories
A Division of MWH Americas, Inc.

750 Royal Oaks Drive
Suite 100
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Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

**Laboratory
Hits Report
#153980**

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 19:43:23

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080249	**STRAND #4**				
08/24/05	Uranium, ICAP/MS		20	30	ug/l	1.0
08/16/05	pH of CaCO3 saturation(25C)		7.45		Units	0.10
08/16/05	pH of CaCO3 saturation(60C)		7.00		Units	0.10
	2508080250	**TRAVEL BLANK-ANALYZE**				

SUMMARY OF POSITIVE DATA ONLY.

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1 800 566 LABS (1 800 566 5227)

Laboratory Data Report #153980

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08/08/05

STRAND #4 (2508080249) Sampled on 08/08/05 11:10

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 13:08	282802	(EPA/ML 200.8)	Silver, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/16/05 22:58		(ML/SM2330)	Agressiveness Index-Calculated	12.35	NA	0.10	1
	08/09/05 13:08	282808	(EPA/ML 200.8)	Aluminum, dissolved, ICAP/MS	ND	ug/l	25	1
	08/12/05 12:41	283063	(SM2320B/ 310.1)	Alkalinity in CaCO3 units	95.9	mg/l	2.0	1
	08/09/05 13:08	282801	(EPA/ML 200.8)	Arsenic, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 13:08	282805	(EPA/ML 200.8)	Barium, dissolved, ICAP/MS	130	ug/l	2.0	1
	08/09/05 13:08	282799	(EPA/ML 200.8)	Beryllium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/17/05 00:00	283494	(ML/EPA 300.0)	Bromide	900	ug/l	25	5
	08/09/05 16:21	282400	(ML/EPA 200.7)	Calcium, Total, ICAP	85	mg/l	1.0	1
	08/09/05 13:08	282803	(EPA/ML 200.8)	Cadmium, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/08/05 22:42	282244	(ML/EPA 300.0)	Chloride	140	mg/l	5.0	5
	08/16/05 22:44		(SM4500-CO2-D)	Carbon Dioxide,Free(25C)-Calc.	2.42	mg/l	0.001	1
	08/16/05 22:39		(SM2320B/E310.1)	Carbonate as CO3, Calculated	0.604	mg/l	0.001	1
	08/08/05 00:00	282313	(ML/S2120B)	Apparent Color	ND	ACU	3.0	1
	08/09/05 13:08	282810	(EPA/ML 200.8)	Chromium, dissolved, ICAP/MS	4.1	ug/l	2.0	1
	08/08/05 23:12	283768	(EPA 218.6)	Hexavalent chromium(Dissolved)	2.5	ug/l	0.10	1
	08/09/05 13:08	282813	(EPA/ML 200.8)	Copper, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/29/05 08:37	285047	(ML/SM 5310C)	Dissolved Organic Carbon	ND	mg/l	0.30	1
	08/09/05 13:34	282308	(2510B/ SW9050)	Specific Conductance	775	umho/cm	2.0	1
08/12/05	08/16/05 00:00	283673	(ML/EPA 548.1)	Endothall	ND	ug/l	20	4
	08/11/05 00:00	282675	(SM 4500C)	Fluoride	0.06	mg/l	0.050	1
	08/11/05 00:00	282726	(ML/EPA 200.7)	Iron, Dissolved, ICAP	ND	mg/l	0.020	1
	08/10/05 18:49		(ML/SM2340B)	Total Hardness as CaCO3 by ICP	225.	mg/l	3.0	1
	08/16/05 22:27		(SM2320B/E310.1)	Bicarb.Alkalinity as HCO3,calc	117.	mg/l	0.001	1
	08/17/05 12:13	283386	(EPA/ML 245.1)	Mercury, dissolved	ND	ug/l	0.20	1
	08/09/05 16:21	282385	(ML/EPA 200.7)	Potassium, Total, ICAP	1.4	mg/l	1.0	1
	08/16/05 22:47		(ML/SM2330B)	Langelier Index - 25 degree	0.45	None	0.0000	1
	08/09/05 13:30	282466	(SM5540C/E425.1)	Surfactants	ND	mg/l	0.050	1
	08/09/05 16:21	282389	(ML/EPA 200.7)	Magnesium, Total, ICAP	3.2	mg/l	0.10	1
	08/09/05 13:08	282811	(EPA/ML 200.8)	Manganese, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/09/05 16:21	282392	(ML/EPA 200.7)	Sodium, Total, ICAP	52	mg/l	1.0	1
	08/09/05 00:00	284112	(EPA/ML 200.8)	Nickel, dissolved, ICAP/MS	ND	ug/l	5.0	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 17:00	282311	(ML/S2150B)	Odor	1	TON	1.0	1
	08/15/05 14:59		(SM2320B/E310.1)	Hydroxide as OH, Calculated	0.01	mg/l	0.001	1
	08/09/05 13:08	282807	(EPA/ML 200.8)	Lead, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/11/05 00:00	282674	(4500HB/ E 150)	PH (H1=past HT, not compliant)	7.9	Units	0.001	1
	08/08/05 00:00		(ML/EPA 150.1)	Field pH	7.5	Units	0.0000	1
	08/16/05 22:45		(ML/SM2330B)	pH of CaCO3 saturation(25C)	7.45	Units	0.10	1
	08/16/05 22:47		(ML/SM2330B)	pH of CaCO3 saturation(60C)	7.00	Units	0.10	1
	08/09/05 13:08	282804	(EPA/ML 200.8)	Antimony, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/23/05 00:00	284107	(EPA/ML 200.8)	Selenium, dissolved, ICAP/MS	ND	ug/l	5.0	1
	08/08/05 22:42	282253	(ML/EPA 300.0)	Sulfate	30	mg/l	2.5	5
08/09/05	08/09/05 12:00	282564	(SM 2540C)	Total Dissolved Solid (TDS)	510	mg/l	10	1
	08/08/05 00:00		(FIELD/SM2550B)	Source Temperature	23.5	DEGC	0.0000	1
	08/09/05 13:08	282806	(EPA/ML 200.8)	Thallium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 15:59	282492	(ML/EPA 180.1)	Turbidity	0.20	NTU	0.050	1
	08/24/05 13:48	284243	(ML/EPA 200.8)	Uranium, ICAP/MS	20	ug/l	1.0	1
	08/25/05 20:33		(EPA/ML 200.8)	Uranium by ICPMS as pCi/L	13.4	pCi/l	0.70	1
	08/09/05 13:08	282800	(EPA/ML 200.8)	Zinc, dissolved, ICAP/MS	ND	ug/l	5.0	1

525 Semivolatiles by GC/MS

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	2,4-Dinitrotoluene	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	alpha-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Diazinon (Qualitative)	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Acenaphthylene	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Alachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Aldrin	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Anthracene	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Atrazine	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Benz(a)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Benzo(a)pyrene	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Benzo(b)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Benzo(g,h,i)Perylene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Benzo(k)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Di(2-Ethylhexyl)phthalate	ND	ug/l	0.60	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Butylbenzylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Bromacil	ND	ug/l	0.20	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Butachlor	ND	ug/l	0.050	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Caffeine	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Chrysene	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Dibenz(a,h)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Di-(2-Ethylhexyl)adipate	ND	ug/l	0.60	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Diethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Dieldrin	ND	ug/l	0.20	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Dimethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Dimethoate	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Di-n-Butylphthalate	ND	ug/l	1.0	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Endrin	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Fluoranthene	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Fluorene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	gamma-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Hexachlorobenzene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Hexachlorocyclopentadiene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Heptachlor	ND	ug/l	0.040	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Heptachlor Epoxide (isomer B)	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Indeno(1,2,3,c,d)Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Isophorone	ND	ug/l	0.50	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Lindane	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Methoxychlor	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Metribuzin	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Molinate	ND	ug/l	0.10	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Metolachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	trans-Nonachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Pentachlorophenol	ND	ug/l	1.0	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Phenanthrene	ND	ug/l	0.020	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Prometryn	ND	ug/l	0.50	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Propachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Simazine	ND	ug/l	0.050	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Thiobencarb	ND	ug/l	0.20	1
08/18/05	09/01/05 13:18	285766	(ML/EPA 525.2)	Trifluralin	ND	ug/l	0.10	1
			(ML/EPA 525.2)	Perylene-d12(70-130)	89	% Rec		
			(ML/EPA 525.2)	1.3-dimethyl-2-nbenz(70-130)	100	% Rec		
			(ML/EPA 525.2)	Triphenylphosphate(70-130)	90	% Rec		

Layne Christensen
(continued)

Aldicarbs by 531.2

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/25/05 00:00	284485	(ML/EPA 531.2)	3-Hydroxycarbofuran	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb (Temik)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfone	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfoxide	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Baygon (Propoxur)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Carbofuran (Furadan)	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Carbaryl	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Methiocarb	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Methomyl	ND	ug/l	0.50	1
	08/25/05 00:00	284485	(ML/EPA 531.2)	Oxamyl (Vydate)	ND	ug/l	0.50	1
			(ML/EPA 531.2)	BDMC(70-130)	104	% Rec		

Diuron by method 532

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/11/05	08/24/05 00:00	284321	(EPA 532)	Diuron	ND	ug/l	1.0	1
			(EPA 532)	Carbazole(70-130)	91	% Rec		
			(EPA 532)	Monuron(70-130)	107	% Rec		

EDB and DBCP by GC-ECD

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/17/05	08/17/05 09:54	283599	(ML/EPA 504.1)	Dibromochloropropane (DBCP)	ND	ug/l	0.010	1
08/17/05	08/17/05 09:54	283599	(ML/EPA 504.1)	Ethylene Dibromide (EDB)	ND	ug/l	0.010	1

Gross Alpha Radiation

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Gross	8.0	pCi/l	2.0	1
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Two Sigma Error	2.6	pCi/l	0.0000	1
	08/17/05 00:00	284048	(ML/EPA 900.0)	Alpha, Min Detectable Activity	2.00	pCi/l	0.0000	1

Herbicides by 515.4

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-T	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-TP (Silvex)	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-D	ND	ug/l	0.10	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-DB	ND	ug/l	2.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dichlorprop	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Acifluorfen	ND	ug/l	0.20	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Bentazon	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dalapon	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	3,5-Dichlorobenzoic acid	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Tot DCPA Mono&Diacid Degradate	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dicamba	ND	ug/l	0.080	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dinoseb	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Pentachlorophenol	ND	ug/l	0.040	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Picloram	ND	ug/l	0.10	1
			(ML/EPA 515.4)	4.4-Dibrombiphenyl(60-140)	108	% Rec		
			(ML/EPA 515.4)	2.4-DCPAA (70-130)	91	% Rec		

Pesticides by EPA 505

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1016 Aroclor	ND	ug/l	0.070	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1221 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1232 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1242 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1248 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1254 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	PCB 1260 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Alachlor (Alanex)	ND	ug/l	0.050	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Aldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Chlordane	ND	ug/l	0.10	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Dieldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Endrin	ND	ug/l	0.010	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Heptachlor	ND	ug/l	0.010	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Heptachlor Epoxide	ND	ug/l	0.010	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Lindane (gamma-BHC)	ND	ug/l	0.010	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Methoxychlor	ND	ug/l	0.050	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Total PCBs	ND	ug/l	0.070	1
08/10/05	08/10/05 23:09	283059	(ML/EPA 505)	Toxaphene	ND	ug/l	0.50	1

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 23:56	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/08/05 23:56	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	102	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	94	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	121	% Rec		

TRAVEL BLANK-ANALYZE (2508080250) Sampled on 08/08/05 00:00

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 02:09	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/09/05 02:09	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	99	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	119	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	93	% Rec		

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Laboratory Report

for

Layne Christensen
11001 Etiwanda Ave.

Fontana , CA 92337

Attention: Tony Morgan
Fax: (909) 390-6097

ACCREDITED IN ACCORDANCE WITH nelac
01114CA

LXG Linda Geddes
Project Manager

Report#: 153967
DRINKING

Laboratory certifies that the test results meet all **NELAC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Report,QC Summary,Data Report,Hits Report, totaling 58 page[s].

MWH Laboratories
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Laboratory Hits Report #153967

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 18:16:58

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080220	**STRAND #6**				
08/15/05	Alpha, Gross		22	15	pCi/l	2.0
08/15/05	Alpha, Min Detectable Activity		2.00		pCi/l	
08/15/05	Alpha, Two Sigma Error		4.3		pCi/l	
08/16/05	Agressiveness Index-Calculated		12.43		Not Appl.	0.10
08/12/05	Alkalinity in CaCO3 units		157		mg/l	2.0
08/09/05	Barium, dissolved, ICAP/MS		100		ug/l	2.0
08/16/05	Bicarb.Alkalinity as HCO3,calc		191.		mg/l	0.001
08/17/05	Bromide		420		ug/l	10
08/09/05	Calcium, Total, ICAP		78		mg/l	1.0
08/16/05	Carbon Dioxide,Free(25C)-Calc.		4.96		mg/l	0.001
08/16/05	Carbonate as CO3, Calculated		0.783		mg/l	0.001
08/08/05	Chloride		200	250	mg/l	5.0
08/09/05	Copper, dissolved, ICAP/MS		5.6		ug/l	2.0
08/29/05	Dissolved Organic Carbon		0.37		mg/l	0.30
08/08/05	Field pH		7.3		Units	
08/11/05	Fluoride		0.05	4	mg/l	0.050
08/08/05	Hexavalent chromium(Dissolved)		1.3		ug/l	0.10
08/15/05	Hydroxide as OH, Calculated		0.01		mg/l	0.001
08/16/05	Langelier Index - 25 degree		0.53		None	
08/09/05	Lead, dissolved, ICAP/MS		1.5		ug/l	0.50
08/09/05	Magnesium, Total, ICAP		4.3		mg/l	0.10
08/08/05	Odor		1	3	TON	1.0
08/11/05	PH (H1=past HT, not compliant)		7.8	6.5-8.5	Units	0.001
08/09/05	Potassium, Total, ICAP		1.3		mg/l	1.0
08/09/05	Sodium, Total, ICAP		49		mg/l	1.0
08/08/05	Source Temperature		23.3		Degrees C	
08/09/05	Specific Conductance		683		umho/cm	2.0
08/08/05	Sulfate		82	250	mg/l	2.5
08/09/05	Total Dissolved Solid (TDS)		410	500	mg/l	10
08/10/05	Total Hardness as CaCO3 by ICP		212.		mg/l	3.0

SUMMARY OF POSITIVE DATA ONLY.

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Laboratory Hits Report #153967

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08-aug-2005 18:16:58

Analyzed	Sample#	Sample ID	Result	Federal MCL	UNITS	MRL
	2508080220	**STRAND #6**				
08/09/05	Turbidity		0.35	5	NTU	0.050
08/25/05	Uranium by ICPMS as pCi/L		27.5		pCi/l	0.70
08/24/05	Uranium, ICAP/MS		41	30	ug/l	1.0
08/09/05	Zinc, dissolved, ICAP/MS		5.2		ug/l	5.0
08/16/05	pH of CaCO3 saturation(25C)		7.27		Units	0.10
08/16/05	pH of CaCO3 saturation(60C)		6.83		Units	0.10
	2508080224	**TRAVEL BLANK-ANALYZE**				

SUMMARY OF POSITIVE DATA ONLY.

MWH Laboratories
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Laboratory Data Report #153967

Layne Christensen
Tony Morgan
11001 Etiwanda Ave.
Fontana , CA 92337

Samples Received
08/08/05

STRAND #6 (2508080220) Sampled on 08/08/05 10:25

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 12:46	282802	(EPA/ML 200.8)	Silver, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/16/05 22:58		(ML/SM2330)	Agressiveness Index-Calculated	12.43	NA	0.10	1
	08/09/05 12:46	282808	(EPA/ML 200.8)	Aluminum, dissolved, ICAP/MS	ND	ug/l	25	1
	08/12/05 12:41	283063	(SM2320B/ 310.1)	Alkalinity in CaCO3 units	157	mg/l	2.0	1
	08/09/05 12:46	282801	(EPA/ML 200.8)	Arsenic, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 12:46	282805	(EPA/ML 200.8)	Barium, dissolved, ICAP/MS	100	ug/l	2.0	1
	08/09/05 12:46	282799	(EPA/ML 200.8)	Beryllium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/17/05 00:00	283494	(ML/EPA 300.0)	Bromide	420	ug/l	10	2
	08/09/05 16:25	282400	(ML/EPA 200.7)	Calcium, Total, ICAP	78	mg/l	1.0	1
	08/09/05 12:46	282803	(EPA/ML 200.8)	Cadmium, dissolved, ICAP/MS	ND	ug/l	0.50	1
	08/08/05 22:54	282244	(ML/EPA 300.0)	Chloride	200	mg/l	5.0	5
	08/16/05 22:44		(SM4500-CO2-D)	Carbon Dioxide,Free(25C)-Calc.	4.96	mg/l	0.001	1
	08/16/05 22:39		(SM2320B/E310.1)	Carbonate as CO3, Calculated	0.783	mg/l	0.001	1
	08/08/05 00:00	282313	(ML/S2120B)	Apparent Color	ND	ACU	3.0	1
	08/09/05 12:46	282810	(EPA/ML 200.8)	Chromium, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/08/05 22:55	283768	(EPA 218.6)	Hexavalent chromium(Dissolved)	1.3	ug/l	0.10	1
	08/09/05 12:46	282813	(EPA/ML 200.8)	Copper, dissolved, ICAP/MS	5.6	ug/l	2.0	1
	08/29/05 08:37	285047	(ML/SM 5310C)	Dissolved Organic Carbon	0.37	mg/l	0.30	1
	08/09/05 13:34	282308	(2510B/ SW9050)	Specific Conductance	683	umho/cm	2.0	1
08/09/05	08/11/05 00:00	282734	(ML/EPA 548.1)	Endothall	ND	ug/l	20	4
	08/11/05 00:00	282675	(SM 4500C)	Fluoride	0.05	mg/l	0.050	1
	08/11/05 00:00	282726	(ML/EPA 200.7)	Iron, Dissolved, ICAP	ND	mg/l	0.020	1
	08/10/05 18:49		(ML/SM2340B)	Total Hardness as CaCO3 by ICP	212.	mg/l	3.0	1
	08/16/05 22:27		(SM2320B/E310.1)	Bicarb.Alkalinity as HCO3,calc	191.	mg/l	0.001	1
	08/17/05 12:13	283386	(EPA/ML 245.1)	Mercury, dissolved	ND	ug/l	0.20	1
	08/09/05 16:25	282385	(ML/EPA 200.7)	Potassium, Total, ICAP	1.3	mg/l	1.0	1
	08/16/05 22:47		(ML/SM2330B)	Langelier Index - 25 degree	0.53	None	0.0000	1
	08/09/05 13:30	282466	(SM5540C/E425.1)	Surfactants	ND	mg/l	0.050	1
	08/09/05 16:25	282389	(ML/EPA 200.7)	Magnesium, Total, ICAP	4.3	mg/l	0.10	1
	08/09/05 12:46	282811	(EPA/ML 200.8)	Manganese, dissolved, ICAP/MS	ND	ug/l	2.0	1
	08/09/05 16:25	282392	(ML/EPA 200.7)	Sodium, Total, ICAP	49	mg/l	1.0	1
	08/09/05 00:00	284112	(EPA/ML 200.8)	Nickel, dissolved, ICAP/MS	ND	ug/l	5.0	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/08/05 17:00	282311	(ML/S2150B)	Odor	1	TON	1.0	1
	08/15/05 14:59		(SM2320B/E310.1)	Hydroxide as OH, Calculated	0.01	mg/l	0.001	1
	08/09/05 12:46	282807	(EPA/ML 200.8)	Lead, dissolved, ICAP/MS	1.5	ug/l	0.50	1
	08/11/05 00:00	282674	(4500HB/ E 150)	PH (H1=past HT, not compliant)	7.8	Units	0.001	1
	08/08/05 00:00		(ML/EPA 150.1)	Field pH	7.3	Units	0.0000	1
	08/16/05 22:45		(ML/SM2330B)	pH of CaCO3 saturation(25C)	7.27	Units	0.10	1
	08/16/05 22:47		(ML/SM2330B)	pH of CaCO3 saturation(60C)	6.83	Units	0.10	1
	08/09/05 12:46	282804	(EPA/ML 200.8)	Antimony, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/23/05 00:00	284107	(EPA/ML 200.8)	Selenium, dissolved, ICAP/MS	ND	ug/l	5.0	1
	08/08/05 22:54	282253	(ML/EPA 300.0)	Sulfate	82	mg/l	2.5	5
08/09/05	08/09/05 12:00	282564	(SM 2540C)	Total Dissolved Solid (TDS)	410	mg/l	10	1
	08/08/05 00:00		(FIELD/SM2550B)	Source Temperature	23.3	DEGC	0.0000	1
	08/09/05 12:46	282806	(EPA/ML 200.8)	Thallium, dissolved, ICAP/MS	ND	ug/l	1.0	1
	08/09/05 15:59	282492	(ML/EPA 180.1)	Turbidity	0.35	NTU	0.050	1
	08/24/05 13:39	284243	(ML/EPA 200.8)	Uranium, ICAP/MS	41	ug/l	1.0	1
	08/25/05 20:33		(EPA/ML 200.8)	Uranium by ICPMS as pCi/L	27.5	pCi/l	0.70	1
	08/09/05 12:46	282800	(EPA/ML 200.8)	Zinc, dissolved, ICAP/MS	5.2	ug/l	5.0	1

525 Semivolatiles by GC/MS

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	2,4-Dinitrotoluene	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	alpha-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Diazinon (Qualitative)	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Acenaphthylene	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Alachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Aldrin	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Anthracene	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Atrazine	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Benz(a)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Benzo(a)pyrene	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Benzo(b)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Benzo(g,h,i)Perylene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Benzo(k)Fluoranthene	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Di(2-Ethylhexyl)phthalate	ND	ug/l	0.60	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Butylbenzylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Bromacil	ND	ug/l	0.20	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Butachlor	ND	ug/l	0.050	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Caffeine	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Chrysene	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Dibenz(a,h)Anthracene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Di-(2-Ethylhexyl)adipate	ND	ug/l	0.60	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Diethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Dieldrin	ND	ug/l	0.20	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Dimethylphthalate	ND	ug/l	0.50	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Dimethoate	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Di-n-Butylphthalate	ND	ug/l	1.0	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Endrin	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Fluoranthene	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Fluorene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	gamma-Chlordane	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Hexachlorobenzene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Hexachlorocyclopentadiene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Heptachlor	ND	ug/l	0.040	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Heptachlor Epoxide (isomer B)	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Indeno(1,2,3,c,d)Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Isophorone	ND	ug/l	0.50	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Lindane	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Methoxychlor	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Metribuzin	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Molinate	ND	ug/l	0.10	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Metolachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	trans-Nonachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Pentachlorophenol	ND	ug/l	1.0	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Phenanthrene	ND	ug/l	0.020	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Prometryn	ND	ug/l	0.50	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Propachlor	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Pyrene	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Simazine	ND	ug/l	0.050	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Thiobencarb	ND	ug/l	0.20	1
08/18/05	09/01/05 11:48	285766	(ML/EPA 525.2)	Trifluralin	ND	ug/l	0.10	1
			(ML/EPA 525.2)	Perylene-d12(70-130)	89	% Rec		
			(ML/EPA 525.2)	1.3-dimethyl-2-nbenz(70-130)	100	% Rec		
			(ML/EPA 525.2)	Triphenylphosphate(70-130)	93	% Rec		

Layne Christensen
(continued)

Aldicarbs by 531.2

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/24/05 00:00	284485	(ML/EPA 531.2)	3-Hydroxycarbofuran	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Aldicarb (Temik)	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfone	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Aldicarb sulfoxide	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Baygon (Propoxur)	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Carbofuran (Furadan)	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Carbaryl	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Methiocarb	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Methomyl	ND	ug/l	0.50	1
	08/24/05 00:00	284485	(ML/EPA 531.2)	Oxamyl (Vydate)	ND	ug/l	0.50	1
			(ML/EPA 531.2)	BDMC(70-130)	102	% Rec		

Diuron by method 532

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/11/05	08/24/05 00:00	284321	(EPA 532)	Diuron	ND	ug/l	1.0	1
			(EPA 532)	Carbazole(70-130)	95	% Rec		
			(EPA 532)	Monuron(70-130)	106	% Rec		

EDB and DBCP by GC-ECD

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/16/05	08/17/05 00:11	283333	(ML/EPA 504.1)	Dibromochloropropane (DBCP)	ND	ug/l	0.010	1
08/16/05	08/17/05 00:11	283333	(ML/EPA 504.1)	Ethylene Dibromide (EDB)	ND	ug/l	0.010	1

Gross Alpha Radiation

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/15/05 00:00	283971	(ML/EPA 900.0)	Alpha, Gross	22	pCi/l	2.0	1
	08/15/05 00:00	283971	(ML/EPA 900.0)	Alpha, Two Sigma Error	4.3	pCi/l	0.0000	1
	08/15/05 00:00	283971	(ML/EPA 900.0)	Alpha, Min Detectable Activity	2.00	pCi/l	0.0000	1

Herbicides by 515.4

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-T	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4,5-TP (Silvex)	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-D	ND	ug/l	0.10	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	2,4-DB	ND	ug/l	2.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dichlorprop	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Acifluorfen	ND	ug/l	0.20	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Bentazon	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dalapon	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	3,5-Dichlorobenzoic acid	ND	ug/l	0.50	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Tot DCPA Mono&Diacid Degradate	ND	ug/l	1.0	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dicamba	ND	ug/l	0.080	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Dinoseb	ND	ug/l	0.20	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Pentachlorophenol	ND	ug/l	0.040	1
08/10/05	08/12/05 00:00	283006	(ML/EPA 515.4)	Picloram	ND	ug/l	0.10	1
			(ML/EPA 515.4)	2.4-DCPAA (70-130)	100	% Rec		
			(ML/EPA 515.4)	4.4-Dibrombiphenyl(60-140)	101	% Rec		

Pesticides by EPA 505

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1016 Aroclor	ND	ug/l	0.070	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1221 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1232 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1242 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1248 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1254 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	PCB 1260 Aroclor	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Alachlor (Alanex)	ND	ug/l	0.050	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Aldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Chlordane	ND	ug/l	0.10	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Dieldrin	ND	ug/l	0.010	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Endrin	ND	ug/l	0.010	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Heptachlor	ND	ug/l	0.010	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Heptachlor Epoxide	ND	ug/l	0.010	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Lindane (gamma-BHC)	ND	ug/l	0.010	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Methoxychlor	ND	ug/l	0.050	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Total PCBs	ND	ug/l	0.070	1
08/10/05	08/10/05 17:17	283059	(ML/EPA 505)	Toxaphene	ND	ug/l	0.50	1

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1

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(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 00:22	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/09/05 00:22	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1
			(EPA 524.2)	Toluene-d8(70-130)	95	% Rec		
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	103	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	121	% Rec		

Layne Christensen
(continued)

TRAVEL BLANK-ANALYZE (2508080224) Sampled on 08/08/05 00:00

Regulated VOCs plus Lists 1&3

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1,1,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1,1-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1,2,2-Tetrachloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1,2-Trichloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,1-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,2,3-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,2,3-Trichloropropane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,2,4-Trichlorobenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,2,4-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,2-Dichloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,3,5-Trimethylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	1,3-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	p-Dichlorobenzene (1,4-DCB)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	2,2-Dichloropropane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	2-Butanone (MEK)	ND	ug/l	5.0	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	o-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	p-Chlorotoluene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	4-Methyl-2-Pentanone (MIBK)	ND	ug/l	5.0	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Benzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Bromobenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Bromomethane (Methyl Bromide)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Bromoethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	cis-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Chlorobenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Carbon Tetrachloride	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	cis-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Bromoform	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Chloroform (Trichloromethane)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Bromochloromethane	ND	ug/l	0.50	1

Layne Christensen
(continued)

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	08/09/05 02:35	282541	(ML/EPA 524.2)	Chloroethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Chloromethane(Methyl Chloride)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Chlorodibromomethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Dibromomethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Bromodichloromethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Dichloromethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Di-isopropyl ether	ND	ug/l	3.0	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Ethyl benzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Dichlorodifluoromethane	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Fluorotrichloromethane-Freon11	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Hexachlorobutadiene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Isopropylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	m-Dichlorobenzene (1,3-DCB)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	m,p-Xylenes	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Methyl Tert-butyl ether (MTBE)	ND	ug/l	1.0	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Naphthalene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	n-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	n-Propylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	o-Xylene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	o-Dichlorobenzene (1,2-DCB)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Tetrachloroethylene (PCE)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	p-Isopropyltoluene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	sec-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Styrene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	trans-1,2-Dichloroethylene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	tert-amyl Methyl Ether	ND	ug/l	3.0	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	tert-Butyl Ethyl Ether	ND	ug/l	3.0	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	tert-Butylbenzene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Trichloroethylene (TCE)	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Trichlorotrifluoroethane(Freon	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	trans-1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Toluene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Total 1,3-Dichloropropene	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Total THM	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Total xylenes	ND	ug/l	0.50	1
	08/09/05 02:35	282541	(ML/EPA 524.2)	Vinyl chloride (VC)	ND	ug/l	0.30	1

Prepared	Analyzed	QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
			(EPA 524.2)	4-Bromofluorobenzene(70-130)	101	% Rec		
			(EPA 524.2)	Toluene-d8(70-130)	95	% Rec		
			(EPA 524.2)	1.2-Dichloroethane-d4(70-130)	120	% Rec		

Appendix I

Wildermuth Environmental Credentials

WILDERMUTH™
ENVIRONMENTAL INC.

Wildermuth Environmental Inc. (WEI) is a specialized water resources consulting firm dedicated to creating visionary yet practical solutions to the complex water problems facing California municipalities, governmental agencies, and private companies.

Founded in 1990, WEI has built a solid reputation as a trusted partner to water districts, municipalities, dischargers, regulators, and others in the water community by providing sage water resources consulting and innovative solutions with a focus on a sustainable resource utilization.

WEI is unmatched in its ability to design and implement holistic, sustainable solutions that fuse the needs of clients, the environment, and surrounding communities. The forward-thinking scientists and environmental engineers at WEI identify problems precisely, and solve them through a methodical process that weighs political, legal, and technical considerations while building consensus for ideas and solutions. The cornerstone of the firm's relationships with employees, clients, regulatory agencies, and business partners is its pledge to perform every service, every engagement, and every project with integrity. In essence, WEI serves as extended staff to its clients, which is reflected in the firm's commitment to excellence, professionalism, and responsibility.

After leading the water resources groups of two large consulting companies, Mark Wildermuth discovered that his 14 years of water engineering experience highly coveted by agencies and companies in need of strategic guidance for water resource problems. He spent the first half of his career working for large companies where their bottom line was more important than their clients needs and often more important than developing long-term sustainable solutions. It was during this time that he developed a unique outlook and distinct method for how water resources consulting should be approached.

In 1990, Mark broke out on his own and founded WEI. Since that time many like-minded engineers and scientists with similar values have joined WEI. Today, WEI has a staff of 25 employees and continues to grow. Since the launch, the company has adhered to a singular vision: to participate in significant and positive ways to the solution of important environmental problems and to support important environmental decision processes."

WEI is known for accurately identifying water resource issues, and, through the application of science and mediation, developing solutions that place equal value on fusing the needs of clients, preserving environmental integrity and supporting surrounding communities. This holistic "big picture" approach has set WEI apart from competitors, who largely focus on short-term technical solutions.

Assignment

Principal Engineer / President

Education

M.S., Systems Engineering, University of California, Los Angeles, 1976

B.S., Engineering, University of California, Los Angeles, 1975

Registrations

Professional Civil Engineer, California C32331

Mark J. Wildermuth, PE
Principal Engineer / President

Summary

Mr. Wildermuth has 31 years of experience in water resources engineering and planning including: surface and groundwater hydrology and hydraulics; water resources planning; surface water and groundwater computer simulation modeling; water rights; surface water and groundwater quality; flood plain management; municipal recycled water discharge impacts in receiving waters; and water supply and flood control facility design. He has also developed extensive expertise in the development of water resources management plans for groundwater basins and watersheds in southern California, and has provided expert witness and opinions for litigation support and mediation in several important issues.

His past experience has included responsible positions at major environmental consulting firms including James M. Montgomery, Consulting Engineers, Inc., where he was a principal engineer from 1987 to 1990; and Camp Dresser and McKee, Inc., 1980 to 1987. Mr. Wildermuth began his own company in 1990 to focus specifically on water resources management studies and the application of state-of-the-art technology to water resources projects. The company has now grown to 20 professionals and became incorporated as WEI in 1998. Mr. Wildermuth received a B.S. in Engineering from the University of California at Los Angeles in 1975, and a M.S. in Water Resources Engineering from University of California at Los Angeles in 1976. He is a registered professional civil engineer in the State of California, and a member of the National Ground Water Association, American Water Resources Association, and Groundwater Resources Association of California.

Selected Project Experience

Wildermuth Environmental, Inc., Lake Forest, CA – 1990 / Current

Optimum Basin Management Program (OBMP), Chino Basin Watermaster

Mr. Wildermuth was the project manager and lead technical analyst to provide as-needed engineering services to the Chino Basin Watermaster. Activities included review of water rights applications, storage losses from over-year groundwater storage accounts, groundwater monitoring, estimating salt offset credits, estimating replenishment volumes required for proposed groundwater

Mark J. Wildermuth, PE, cont'd

treatment project(s), coordination with San Bernardino County Flood Control District and Conservation District regarding recharge, coordination with Metropolitan Water District regarding water rates and seasonal storage service.

Mr. Wildermuth was the project manager to develop the scope of work and to implement that scope of work for the Chino Basin OBMP. The San Bernardino Court ordered the development of the OBMP. Mr. Wildermuth developed the process used to develop the OBMP scope of work and authored the engineering and institutional scopes of work. WEI, under the direction of Mr. Wildermuth, completed the engineering studies and developed the resulting management plan. The engineering scope of work included the problem definition, development of goals, developing and analyzing management components, integration of management components, financial analysis and development of an implementation strategy.

Optimum Basin Management Program Implementation, Chino Basin Watermaster

Mr. Wildermuth is the WEI project manager for WEI involvement in the OBMP Implementation. WEI efforts include running a large-scale surface water discharge and water quality monitoring (20 stations), groundwater level and water quality (600 wells), groundwater recharge, InSAR, and extensometer monitoring programs. WEI is also providing oversight to well siting and related impact analysis for new desalter wells.

Chino Basin Dry-Year Yield Program, Chino Basin Watermaster

Mr. Wildermuth is the WEI project manager for WEI involvement in the development of the Chino Basin Dry-Year Yield (DYY) Program. WEI is role is to assist the Watermaster and Inland Empire Utilities Agency in the development of the 100,000 acre-ft DYY program. WEI completed a thorough reassessment of the hydrogeologic conditions in the Chino Basin. WEI assisted other consultants with facility planning including well siting, water quality evaluations, and specialized mapping. WEI developed and applied a sophisticated set of surface and ground water models to evaluate the DYY impacts on groundwater levels, contaminant plume movement, and surface and ground water interaction in the southern part of the basin. Currently, WEI is expanding this analysis to investigate groundwater storage programs of up to 500,000 acre-ft.

Groundwater Quality Monitoring Program, Chino Basin Watermaster

Mr. Wildermuth conducted a groundwater quality-monitoring program for the Chino Basin Watermaster involving the collection of about 70 water samples in the field and about 200 samples from cooperating agencies. This project started in 1990 and was continued through 1996. Subsequently WEI has expanded this program to about 600 wells as part of the Chino Basin OBMP

Analyses of recharge & Recharge Facilities, Chino Basin Water Conservation District

Mr. Wildermuth conducted studies to determine the annual average recharge at stormwater recharge facilities owned by the Chino Basin Water Conservation District. Daily flow simulation models were developed and applied for a period of forty one years. The results of this study are being used to improve operations and maintenance schedules at the existing facilities.

Mr. Wildermuth developed a monitoring program to determine changes in percolation rates and subsequent maintenance practices to restore maximum percolation rates. One of the key components of the monitoring program was the installation of digital water level sensors with integral data loggers to measure basin water levels every ten minutes. Wildermuth Environmental developed the analytical methods and software to convert these observations into estimates of basin inflow, outlet discharge, evaporation losses, and basin recharge.

Recharge Master Plan, Chino Basin Water Conservation District, Chino Basin Watermaster, San Bernardino County Flood Control District

Mr. Wildermuth was the project manager and lead technical analyst for the recharge master plan for the Chino Basin. The objectives of the master plan were to develop a plan of recharge to meet future groundwater replenishment requirements utilizing stormwater, recycled water, and imported water; and to evaluate the change in groundwater recharge caused by the construction of flood control improvements for San Sevaine Creek and East Etiwanda Creek. This study utilized a daily runoff model to estimate the magnitude and temporal distribution of stormwater recharge.

Recycled water and imported water will be recharged in periods with minimum conflict with stormwater recharge. New facilities and modifications to existing facilities were recommended. A second phase of the recharge master plan was completed as part of the Chino Basin OBMP where WEI collaborated with the Black and Veatch Corporation. Subsequently, the Chino Basin Watermaster, Inland Empire Utilities Agency, the Chino Basin Water Conservation District are converting 19 flood retention basin to spreading basins and are building two new recharge facilities. The total cost of the recharge improvements are approximately $45 million.

Nitrogen / Total Dissolved Solids (N/TDS) Task Force, Santa Ana Watershed Project Authority

Mr. Wildermuth was the architect and co-project leader for a multi-phase comprehensive evaluation of the fate of nitrogen and TDS in the Santa Ana Watershed. In this investigation, the basin plan objectives for TDS and nitrogen were reset based on the best available data and scientific methods, and new procedures were developed to assess the availability of assimilative capacity.

Phase one involved development of procedures for evaluation of TDS and nitrogen impacts from recycling projects in the Santa Ana watershed, a massive data collection and validation effort, watershed characterization, and an initial assessment of TDS and nitrogen loads to surface water and groundwater from municipal recycled water treatment plants and non-point sources. Phase 2A of this project involved: delineating new basin/management zone boundaries; development of groundwater storage estimates in each management unit; estimating TDS and nitrogen statistics at wells; computing volume weighted TDS and nitrate concentration for the new basin/management zones; and completing a new wasteload allocation analysis for the Santa Ana River and selected tributaries.

Phase 2B of the project involved the development and implementation of a sophisticated modeling system to evaluate the current wasteload allocation for TDS and total inorganic nitrogen for municipal recycled water plants that discharge to the Santa Ana River and its tributaries. A daily stream flow simulation model was used to estimate the TDS and TIN concentration in the Santa Ana River and its tributaries in response to recycled water discharge, stormwater runoff, non-tributary discharges, and groundwater interaction.

Assignment

Associate Engineer 1

Education

M.S., Civil and Environmental Engineering, University of California, Los Angeles, 1998

B.S., Geological Sciences, University of Oregon, 1996

Registrations

Professional Civil Engineer, California C67516

Professional Geologist, California, No. 8207

Additional Training & Certifications

American Red Cross CPR & First Aid Training

Tom McCarthy, PE, PG
Associate Engineer 1

Summary

Mr. McCarthy is an Associate Engineer at Wildermuth Environmental, Inc. He has over 10 years of professional experience working with private consulting firms and public agencies. His expertise includes water resources engineering, water resources planning, numerical modeling, and data management. The bulk of Mr. McCarthy's experience has been concentrated in the area of water resources engineering and planning, specifically with the optimization of well field operations considering constraints such as surface water interaction, ecologic conditions, and or legal constraints. Mr. McCarthy has worked also with decision, hydraulic, sewer, groundwater, ecologic, and reverse osmosis system models. Mr. McCarthy has completed several groundwater modeling projects as the project manager or lead groundwater modeler.

Mr. McCarthy received a B.S. in Geological Sciences from the University of Oregon in 1996, and an M.S. in Civil and Environmental Engineering, with an emphasis on water resources, from the University of California, Los Angeles, in 1998. His professional experience includes employment as a geologic technician for Leighton and Associates 1995 to 1996; a geologist for the United States Geological Survey in 1997 as a National Association of Geoscience Teachers appointee; and a Senior Engineer with MWH Americas, Inc., from 1998 to 2005.

At MWH Americas, Mr. McCarthy was responsible for four well field modeling projects in the Owens Valley. These projects included the development of MODFLOW models based on researched conceptual models. The calibrated numerical models were used to determine optimal extraction within existing constraints, e.g. vegetation impacts.

Mr. McCarthy was also an Associate Engineer from 2005 to 2006 with Mammoth Community Water District. Mr. McCarthy is a registered professional civil engineer, as well as a registered professional geologist, both within the State of California. Mr. McCarthy has served on the Board of Directors of the Meadow Creek Mutual Water Company. He is a member of the American Society of Civil Engineers, American Water Works Association, and the American Geophysical Union. Selected project experience continues on the following pages:

Tom McCarthy, PE, PG, cont'd

Wildermuth Environmental, Inc., Lake Forest, CA – 2006 - Current

Chino Basin Groundwater Model Recalibration, Chino Basin Watermaster, Rancho Cucamonga, CA

Project Manager: Mr. McCarthy currently serves as the project manger updating the existing Chino Basin MODFLOW groundwater flow model. This project involves updating the numerical model with recent revisions to the conceptual model and data processing of historic data prior to the previous model calibration period. The model domain encompasses approximately 220-square miles. The updated model will have a longer calibration period than the previous model and allow for longer planning alternative testing. The model is in the process of being recalibrated, with the finished model ready for planning use summer of 2007.

Fee Determination, Beaumont Basin Watermaster, Beaumont, CA

Project Manager: Based on Beaumont Watermaster member agency water supply plans, a salt mitigation fee is being determined to potentially allocate costs for basin groundwater desalting. Wildermuth Environmental is tasked with developing a reaction model to estimate basin water quality dynamics over time and establish a salt credit and debit system to allocate desalter costs. Wildermuth Environmental is also tasked with developing salt management alternatives and costs to manage the need for and timing of a desalter.

Mammoth Community Water District, Mammoth, CA – 2005 - 2006

Mammoth Community Water Basin Hydrologic Analysis/Numerical Groundwater Model Development, Mammoth Community Water District

Project Manager: Mr. McCarthy served as the project manager to establish a conceptual model for the Mammoth Basin for conversion to a numerical model. This project consisted of reference gathering, cross-section generation, monitoring well cuttings review, model layer determination and the initial stages of the water budget summarization.

Water and Wastewater Modeling for Capital Improvement Plan Determination, Mammoth Community Water District

Project Manager: Mr. McCarthy served as the project manager for the water and wastewater system modeling, capital improvement plan updating, Mr. McCarthy directed the determination of new projects required to serve new connections, the financial analysis to determine the appropriate and fair fees for the new connections, and the conversion from a land use based system (EDU) to a meter size based (MEU) system.

MWH Americas, Inc. (Consultant) – 2005 - 2006 (Water Systems)

Los Angeles Dept. of Water & Power Irrigation Reduction Incentive Program EIR, Los Angeles Dept. of Water & Power

Project Engineer: The intent of the project was to provide incentives to agricultural water users to use less water. As a consultant to MWH Americas, Mr. McCarthy evaluated the effects of using less water for irrigation on groundwater levels. Using a MODFLOW model and an analytical model, Mr. McCarthy evaluated different irrigation operations for varying vegetation communities.

MWH Americas, Inc. Pasadena, San Diego, & Bishop, CA – 1998 - 2005

Bishop Area Management Study, Los Angeles Dept. of Water & Power

Project Manager: Mr. McCarthy initiated this project as the Task Manger leading a team in developing a conceptual and numerical model for well field management optimization. This project served as an extension of the existing Laws Well Field conceptual and numerical models previously developed. The numerical model (MODFLOW) was based on an existing USGS groundwater model at a much more coarse scale. The goal of the project was to determine management practices based on climate trends, water needs, private pumping, legal constraints, and overall vegetation conditions.

Lower Owens River Final EIR, Los Angeles Dept. of Water & Power

Engineer: Mr. McCarthy assisted with the finalization of the Lower Owens River Restoration Project Environmental Impact Report for the Los Angeles Department of Water and Power. Assistance consisted of, but was not limited to researching vegetation and groundwater questions presented by the public, obtaining permits for the California State Land Commission, Bureau of Land Management, and the California Department of Transportation.

LA-Inyo Cooperative Deep Well Study and Analysis, Los Angeles Department of Water and Power

Project Engineer: Mr. McCarthy served as the Project Engineer for deep well pumping test within the Taboose Aberdeen Well Field and analysis of these resulting data. Mr. McCarthy compiled the specifications for the year long pump test and data collection requirements. Following the year long pump test and data collection effort by LADWP, Mr. McCarthy worked with all parties on the study to estimate drawdown in the shallow aquifer due to deep well pumping and document the effects for incorporation into management policy.

Taboose-Thibaut Well Field Management Study, Los Angeles Department of Water and Power

Project Manager: Mr. McCarthy was the Task Manger leading a team in developing a conceptual and numerical model for well field management optimization. The numerical model (MODFLOW) was based on an existing USGS groundwater model at a much more coarse scale. The model for this specific region was re-built at a more fine scale. The ultimate goal of the project was to determine management practices based on climate trends, water needs, and overall vegetation conditions.

Laredo Pre-Verification Study, City of Laredo, Texas

Engineer: This study was conducted to determine alternative drinking water sources for the City of Laredo, Texas. Using data obtained from video logs and aquifer performance testing.

Mr. McCarthy conducted an analysis of a potential well field for the City of Laredo second drinking water source. The modeling was completed using MODFLOW and analytical spreadsheet methods to determine response to pumping, other variable conditions, pipeline alignments, and rough cost estimations. This modeling and following analysis provided the City of Laredo with preliminary aquifer pump rates and sustainability estimates.

Confining Layer Study, Los Angeles Department of Water and Power

Project Manager: Mr. McCarthy completed a geostatistical analysis with pump test data and categorized hydrogeologic parameter data sets. From the geostatistical results, numerous maps were created that mapped the areas of confinement within the Owens Valley. Mr. McCarthy also maintained numerous project management responsibilities including managing sub consultants, budgets, and project schedules.

Assignment

Senior Scientist/Hydrogeologist

Education

Ph.D., Hydrology, Mathematics, University of Arizona, Tucson, 2002

M.S., Hydrogeology, University of Technology (CDUT), China, 1989

B.S., Hydrogeology, Chengdu University of Technology, China, 1984

Additional Training & Certifications

CPR & First Aid Training

Wenbin Wang, PhD
Senior Scientist / Hydrogeologist

Summary

Dr. Wang has more than 15 years of professional experience in the hydrogeologic field. His technical expertise includes numerical modeling of multiphase flow and contaminant transport in saturated and unsaturated porous and fractured medium, developing flow and transport codes and design of window-based software, estimation of hydraulic parameters via direct and indirect methods, application of statistics, geostatistics and stochastic methods in hydrogeology, sensitivity and error analysis, and site characterization.

Dr. Wang received a B.A. and a M.S. in hydrogeology from the Chengdu University of Technology in 1984 and 1989, and a Ph.D. in subsurface hydrology from the Department of Hydrology and Water Resources at the University of Arizona in 2002. His experience includes work as a hydrogeologist in China Geological Survey, Lecturer and Associate Professor at Chengdu University of Technology, and Project Hydrogeologist at an Arizona-based water management consulting company.

Dr. Wang is well-versed in various modeling software including TOUGH2/ITOUGH2, MODFLOW, PEST, MT3D, GW Vistas, PATH3D, MODPATH, FLOWPATH, HYDRUS-1D/2D, UNSAT, HEC, ROSETTA, AQTESOLV, PHREEQC, and MINTEQ.

He is a member of the America Geophysical Union (AGU) and Soil Science Society of America (SSSA). He is also a member of Groundwater Resources Association of California (GRA) and National Groundwater Association (NGWA).

Selected Project Experience

Wildermuth Environmental, Inc.

Subsidence Study of Chino Basin, 2005-2006.

Senior Scientist: Dr. Wang developed subsidence conceptual model and numerical model in Chino Basin, Conducted pumping test analysis and simulation of flow under different water extraction scenarios, determination of optimum water extraction scenario.

Ontario Contamination Simulation and Remediation, 2005-2006

Senior Scientist: Dr. Wang conducted simulation of contamination plume movement in Chino Basin, and finally determined the optimum remediation scenario.

Wenbin Wang, PhD, cont'd

Contaminant Source Investigation in Groundwater, Confidential Client, 2004-2005

Senior Scientist: **Dr. Wang** developed hydrogeological conceptual models for unsaturated and saturated zone, conducted simulations of flow and transport in the unsaturated zone of the San Bernardino Basin. Dr. Wang calibrated the flow and transport model paramaters, performed uncertainty analyses by using stochastic–Monte Carlo simulation, and settled conclusively the contaminant source.

Support on Title 22 Engineering Report, Chino Basin, 2005-2006

Senior Scientist: Dr. Wang conducted simulation of input/recycle water movement in Chino Basin, and finally determined the optimum scenario of distributing the amount of input/recycle water in various recharge basins in Chino Basin.

Engineering Support of RIX Expansion, 2005-2006

Senior Scientist: Dr. Wang estimated unsaturated and saturated hydraulic properties in the RIX site, Characterized site hydrogeology and developed conceptual models, conducted unsaturated and saturated flow model under the condition of Rapid Infiltration and Extraction operation, and finally provided the optimum scenario of infiltration and extraction.

Groundwater Simulation of Beaumont Basin, Riverside, 2005-2006

Senior Scientist: Dr. Wang was responsible for the development of a high resolution regional groundwater model for the Beaumont Basin. Dr. Wang developed a hydrogeological conceptual model for this complex heterogeneous anisotropic multilayer media with various horizontal barriers. Combined with the unsaturated flow model result, the developed numerical flow model was then calibrated by using PEST against the observation data of water level during the period of 1927-2005. Dr. Wang also developed a nitrate transport model for Beaumont Basin and used the flow-transport model to predict the water level variations and manage the water resources under future optimum basin management.

During the development of this flow-transport model, all the related inputs and their variations, such as rainfall, return flow related the land use, septic tank inflow, side boundary inflow, front-mountain inflow, stream percolation, artificial recharge, evapotranspiration, buffer action of thick unsaturated zone, etc. were taken into account. The model also took both anisotropic heterogeneity and parameter zonation into account.

China Airport Contamination Simulation and Remediation, 2006

Senior Scientist: Dr. Wang developed transport models and conducted flow and transport (PCE/TCE) simulations of existing contamination plume movements nearby Chino Airport, and finally determined the optimum remediation scenario.

Groundwater Simulation of Arlington Basin, Riverside, 2006-2007

Senior Scientist: Dr. Wang was responsible for the development of a high resolution regional groundwater model for the Arlington Basin. The developed flow model was calibrated by using parallel PEST in 24-processor computers against the observation data of water level during the period of 1966-2004. The developed model had heterogeneous anisotropic functions.

Water Management Consultants, Tucson, Arizona, 2002 to 2004

Hydrogeologist/Modeler: Dr. Wang conducted forward and inverse modeling of flow and transport in heterogeneous, unsaturated/saturated porous/fracture media and geostatistical analyses and simulations using geophysical data. Performed the design and analyses for pumping/slug and tracer tests.

Responsible for computing and maintaining very large geophysical databases, computing 3-dimensional ERT, as well as software design, including the development of U-Win software, and programming for flow and solute transport and hydrogeochemical analysis. Performed hydraulic parameter estimation and site characterizations and developed heap leaching technology, including a geophysical monitoring system.

University of Arizona, Department of Hydrology and Water Resources, Arizona – 1997 to 2002

Research Associate/Assistant ship: Conducted testing of groundwater flow and transport models and uncertainty analyses related to hydrogeological conceptualization, modeling, and predictions. Applied various parameter estimation approaches to interpret and evaluate hydrogeologic data from this Maricopa site. Designed the conceptualization and modeling flow and transport and developed various codes for flow and transport. Responsible for the GIS to Maricopa area, site characterization and the pedotransfer function analysis and the Bayesian update coding and computations. Conducted geostatistical analysis of hydraulic parameters and pedological data, and geostatistical simulation.

Dr. Wang performed forward and inverse numerical modeling of multiphase flow and transport in heterogeneous, unsaturated and saturated porous media. He also performed sensitivity and error analysis and field experiment design, as well as uncertainty analysis of flow and solute transport modeling results.

Chengdu University of Technology (CDUT), Department of Hydrogeology and Engineering Geology, China. Lecturer from 1989 to 1994, Associate Professor from 1994 to 1996

At the Chengdu University, Mr. Dr. Wang lectured on hydrogeology and hydrogeochemistry. In addition, he completed various research projects, which included site characterizations of hydrogeology and geology, paleo-hydrogeological analysis, reservoir analysis, fluid flow and transport modeling, and hydrogeochemistry complex programming and computation

Chengdu University of Technology (CDUT), Department of Hydrogeology and Engineering Geology, China – 1986 to 1989

Research Assistant: Performed modeling of groundwater flow in fractured karst medium and model parameter identification

China Geological Survey, China – 1984 to 1986

Hydrogeologist: Conducted geological and hydrogeological investigations and mappings, as well as conducting pumping test, soil, and water sampling.

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