The Challenges of Developing and Implementing a Groundwater Monitoring Plan to Comply With SB-4*

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Search and Discovery Article #80448 (2015)**
Posted June 22, 2015

*Adapted from oral presentation given at Pacific Section AAPG, SEG and SEPM Joint Technical Conference, Oxnard, California, May 3-5, 2015

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Abstract

SB4 interim regulations requiring a well-specific or area-specific Groundwater Monitoring Plan (GMP) for all well stimulation treatments (hydraulic fracturing and acid stimulations) that penetrate an USDW are being implemented by DOGGR until July 2015 when the State Water Resources Control Board (SWRCB) will become the lead agency for SB4 GMPs. Emergency regulations were introduced in January 2014, and then readopted in July 2014; final regulations from DOGGR will be implemented in July 2015 but will not include GMPs. The regulations regarding GMPs will become the responsibility of the SWRCB in July 2015; the upcoming changes are unknown to those trying to meet the regulatory requirements. Complying with the regulatory requirements has been a challenge for oil companies and regulators alike. Developing a hydrogeologic model is difficult when data on water wells, including their location, completion details, and groundwater analytical results are not public information. Calculations from electric logs to determine the base of the USDW, water with a Total Dissolved Solids concentration of less than 10,000 ppm, is of questionable accuracy. Scanned formation water analytical data available on the DOGGR web site is often of questionable quality and it is difficult to determine where and how the water samples were collected. Drilling and constructing a deep groundwater monitoring well with an oil drilling rig is fast and efficient but difficult when the companies do not have the required C-57 licensed contractor on staff. Determining the interval to perforate above the depth of protected water requires log interpretation, again with an uncertain margin of error. Collecting groundwater samples from deep monitoring wells is new to the groundwater sampling technicians. We have successfully used HydraSleeves, but not without breaking some of them in the process. Analytical laboratories need approximately 3.5 gallons of groundwater to run the required tests. Most laboratories cannot perform the radionuclide analysis. Discussions with the laboratory are important to ensure that the radionuclide results will be expressed in the required units, piC/L. Finding and meeting with neighboring water well owners to request permission to sample their water wells adds an important public relations aspect to the challenge.

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CHALLENGES

1. REGULATIONS
2. GROUNDWATER DATA AVAILABILITY
3. IMPLEMENTATION

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SB4 Regulations – quick review

- SB4 became law on September 20, 2013
- Rulemaking was rushed by DOGGR, interim rules were published in January 2014
- Readopted rules were published on June 27, 2014
- Emergency regulations allowed the interim rules to stay in effect until July 2015
- In July 2015 the State Water Board will be the agency responsible for reviewing and approving GMP's

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- Does the planned Well Stimulation Treatment (**WST**) require a GROUNDWATER MONITORING PLAN (**GMP**)?
  - **GROUNDWATER** with a TDS content **<10,000 ppm is Protected Groundwater**
  - *PROTECTED GROUNDWATER* =* **GMP**

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Many operators have proven the absence of protected water.

Index of ftp://ftp.consrv.ca.gov/pub/oil/SWRCB Concurrence Letters and Groundwater Monitoring Exemption Documents Directory/

Up to higher level directory

Name	Size	Last Modified	
Aera S. Belridge Field porition of Section 21, T29S, R21E		3/30/2015	9:15:00 AM
Aera_N. Belridge Field_Sections 1 ,2, 35, & 36		7/2/2014	1:11:00 PM
Aera_S. Belridge Field_Sections 2 & 29		6/2/2014	11:22:00 AM
Aera_S. Belridge Field_Sections 28, 33, & 34		6/10/2014	4:49:00 PM
Breitburn_Dow Chanslor Lease_N. & S. Belridge Fields		6/23/2014	1:44:00 PM
Oxy of Elk Hills Field 240 acres in N portion of Section 33R		12/16/2014	2:41:00 PM
Oxy of Elk Hills Field 260 acre portion of Section 24R		8/7/2014	3:06:00 PM
Oxy of Elk Hills Field 445 acre portion of Section 20R		9/25/2014	2:02:00 PM
Oxy of Elk Hills Field 535 acre portion of Section 23R		8/7/2014	3:06:00 PM
Oxy of Elk Hills Field approx 626 acre portion of Section 22R		9/25/2014	2:02:00 PM
Oxy of Elk Hills Field North Half of Section 34R		6/23/2014	1:45:00 PM
Oxy of Elk Hills Field Section 28R		6/23/2014	1:46:00 PM
Oxy of Elk Hills Field Section 29R		9/25/2014	2:02:00 PM
Oxy of Elk Hills Field Section 31S		12/16/2014	2:41:00 PM
Oxy of Elk Hills Field Section 32S		1/23/2015	2:19:00 PM
Oxy of Elk Hills Field Section 36R		9/25/2014	2:02:00 PM
Oxy of Elk Hills Field South Half of Section 34R		8/7/2014	3:06:00 PM
Oxy of Elk Hills Filed Section 27R		8/7/2014	3:06:00 PM
Seneca_Coalinga Field_Section 2 & 11		6/25/2014	3:08:00 PM

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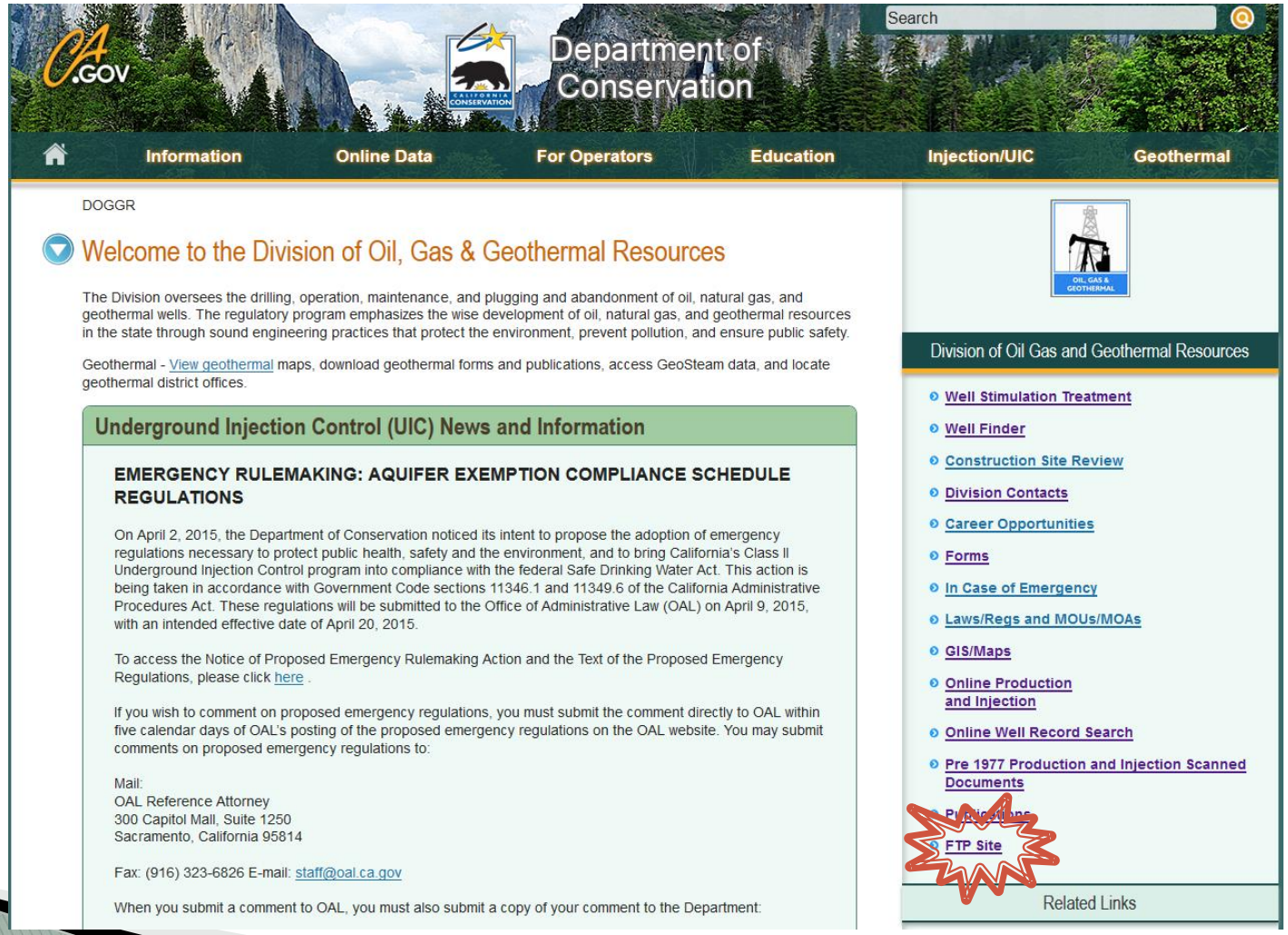
PREPARING THE GMP

How do we find out if there is *protected groundwater*?

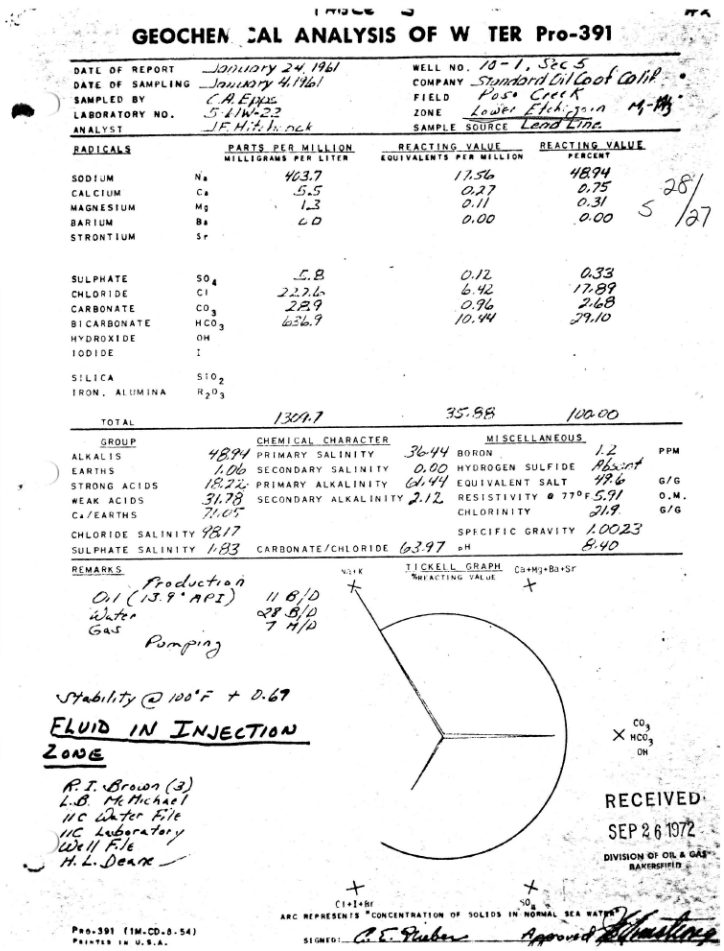
Publicly available data sources

- *DOGGR (District 4)*
- *DWR: Water Data Library and Groundwater Information Center*
- *CASGEM*
- *GAMA*
- *Geotracker*
- *County agencies (confidentiality problems!)*

DOGGR District 4 Formation Water Analyses



DOGGR Formation Water Geochemical Analysis



GEOCHEMICAL ANALYSIS OF WATER Pro-391

DATE OF REPORT January 24, 1961
DATE OF SAMPLING January 4, 1961
SAMPLED BY C.A. Epps
LABORATORY NO. 5-41W-22
ANALYST J.F. H. Hinck

WELL NO. 18-1, Sec 5
COMPANY Standard Oil Co of Calif.
FIELD Poso Creek
ZONE Lower Etchegoin
SAMPLE SOURCE Lead Line

RADICALS		PARTS PER MILLION MILLIGRAMS PER LITER	REACTING VALUE EQUIVALENTS PER MILLION	REACTING VALUE PERCENT
SODIUM	Na	403.7	17.56	48.94
CALCIUM	Ca	5.5	0.27	0.75
MAGNESIUM	Mg	1.3	0.11	0.31
BARIUM	Ba	0.0	0.00	0.00
STRONTIUM	Sr			
SULPHATE	SO_4	5.8	0.12	0.33
CHLORIDE	Cl	227.6	6.42	17.89
CARBONATE	CO_3	28.9	0.96	2.68
BICARBONATE	HCO_3	626.9	10.44	29.10
HYDROXIDE	OH			
IODIDE	I			
SILICA	SiO_2			
IRON, ALUMINA	R_2O_3			
TOTAL		1301.7	35.88	100.00

GROUP		CHEMICAL CHARACTER		MISCELLANEOUS		
ALKALIS	48.94	PRIMARY SALINITY	36.44	BORON	1.2	PPM
EARTHS	1.06	SECONDARY SALINITY	0.00	HYDROGEN SULFIDE	Absent	
STRONG ACIDS	18.22	PRIMARY ALKALINITY	61.44	EQUIVALENT SALT	49.6	G/G
WEAK ACIDS	31.78	SECONDARY ALKALINITY	2.12	RESISTIVITY @ 77°F	5.91	O.M.
CA/EARTHS	71.05			CHLORINITY	21.9	G/G
CHLORIDE SALINITY	98.17			SPECIFIC GRAVITY	1.0023	
SULPHATE SALINITY	1.83	CARBONATE/CHLORIDE	63.97	pH	8.40	

REMARKS

Production
Oil (13.9° API) 11 B/D
Water 28 B/D
Gas 7 M/D
Pumping

Stability @ 100°F + 0.69

ELUID IN INJECTION ZONE

R.I. Brown (3)
L.B. McMichael
HC Water File
HC Laboratory
Well File
H.L. Deane

TICKELL GRAPH
REACTING VALUE

Na+K
Ca+Mg+Ba+Sr
CO_3
HCO_3
OH
Cl+I+Br
SO_4

ARC REPRESENTS "CONCENTRATION OF SOLIDS IN NORMAL SEA WATER"

SIGNED: A.E. Huber Approved

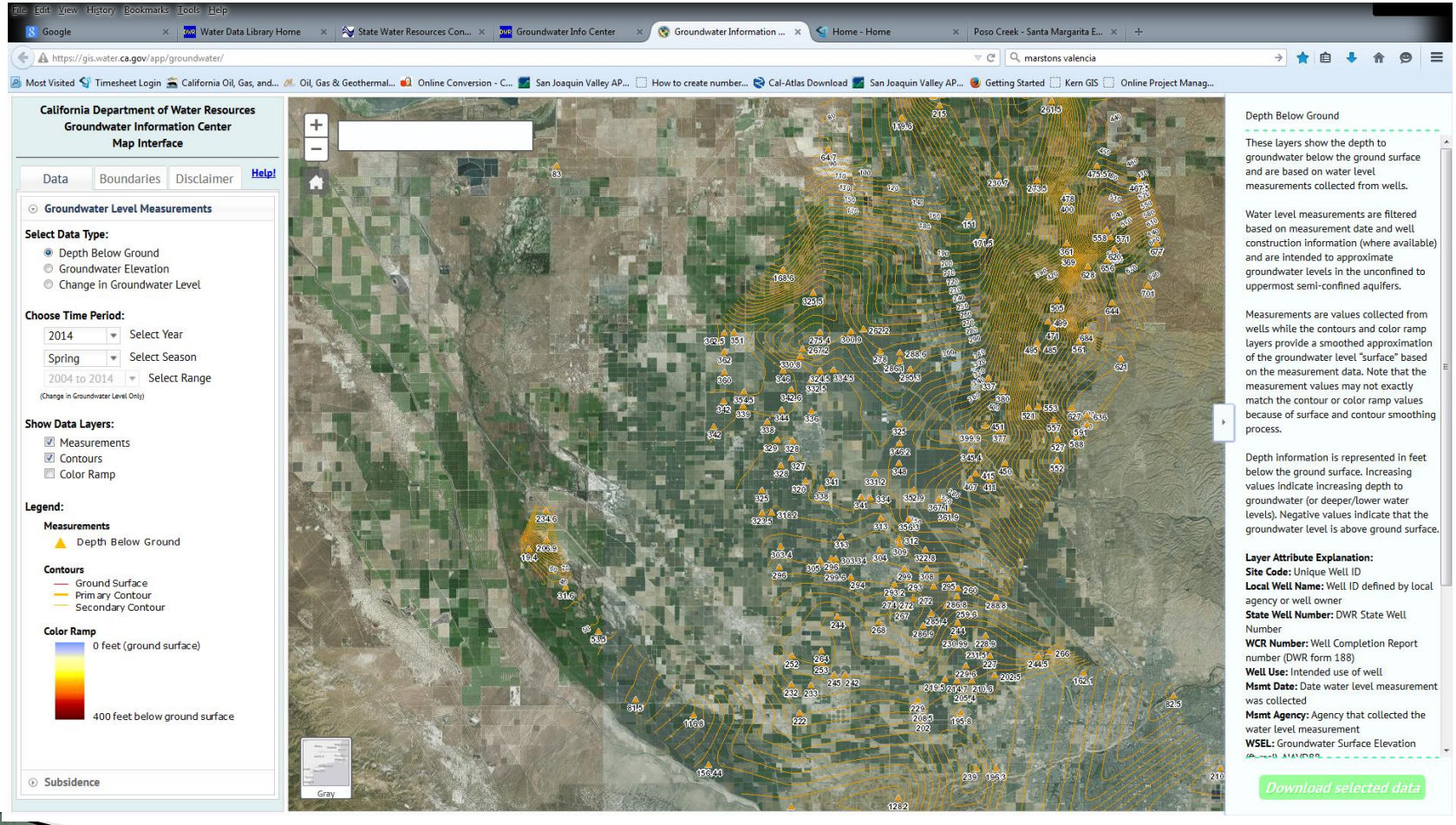
RECEIVED
SEP 26 1972
DIVISION OF OIL & GAS
BAKERSFIELD

Pro-391 (1M-CD-8-54)
PRINTED IN U.S.A.

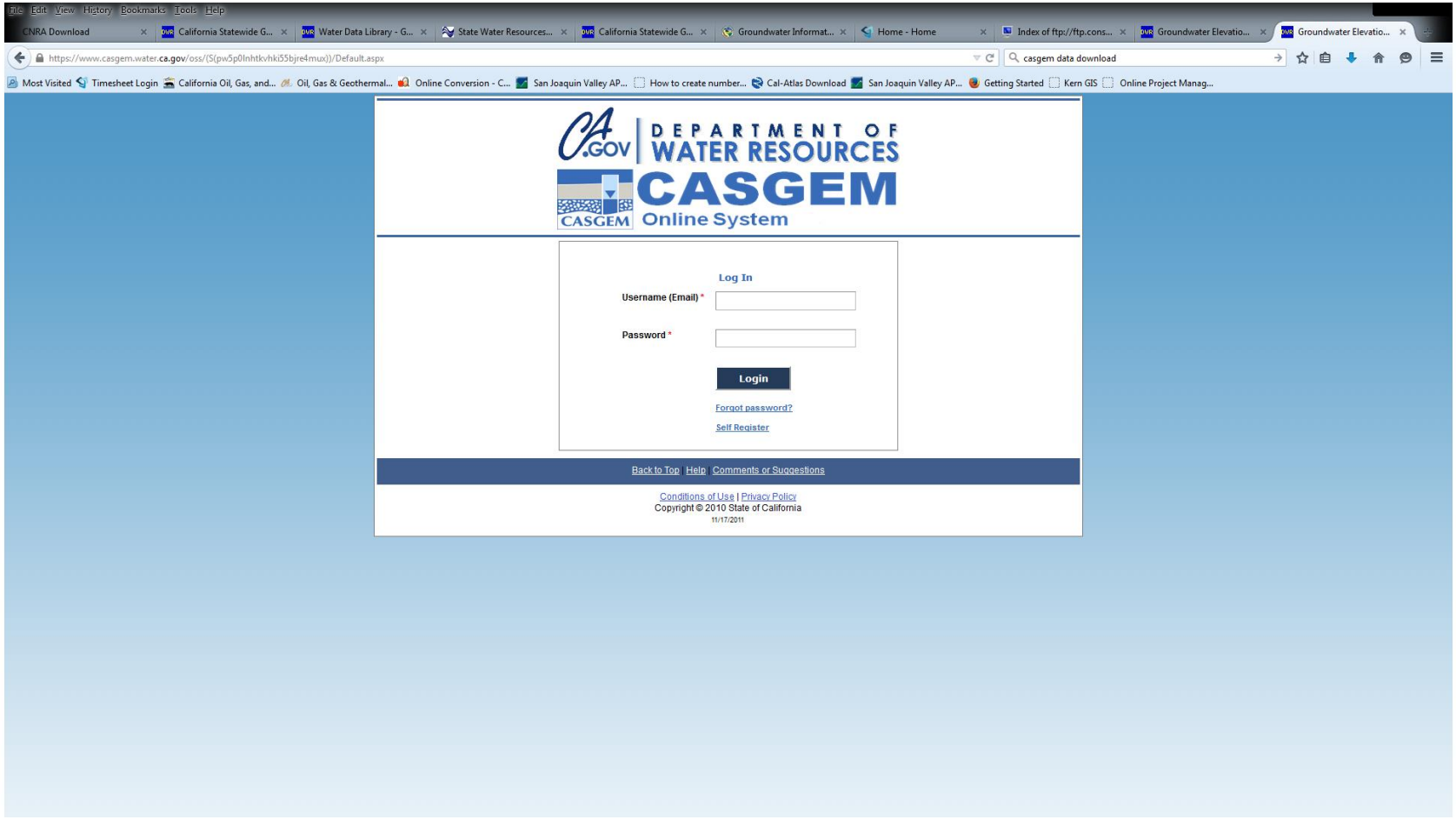
Each formation water analysis has to be checked to determine if it is reliable.

CSUB is working on this database for DOGGR.

California DWR – Water Data Library & Groundwater Information Center



CASGEM


File Edit View History Bookmarks Tools Help
CNRA Download
California Statewide G...
Water Data Library - G...
State Water Resources...
California Statewide G...
Groundwater Informat...
Home - Home
Index of ftp://ftp.cons...
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Groundwater Elevatio...
https://www.casgem.water.ca.gov/oss/(S(pw5p0lnhtkvhki55bjre4mux))/Default.aspx
casgem data download
Most Visited
Timesheet Login
California Oil, Gas, and...
Oil, Gas & Geothermal...
Online Conversion - C...
San Joaquin Valley AP...
How to create number...
Cal-Atlas Download
San Joaquin Valley AP...
Getting Started
Kern GIS
Online Project Manag...
CA.GOV
DEPARTMENT OF WATER RESOURCES
CASGEM
CASGEM Online System
Log In
Username (Email) *
Password *
Login
Forgot password?
Self Register
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11/17/2011

GAMA – Groundwater Ambient Monitoring & Assessment Program

Sources of data:

- California Department of Public Health
- California Department of Water Resources
- California Department of Pesticide Regulation
- USGS
- Lawrence Livermore National Laboratories
- Private Well Analytical Data

***GeoTracker GAMA well locations are not accurate*.**

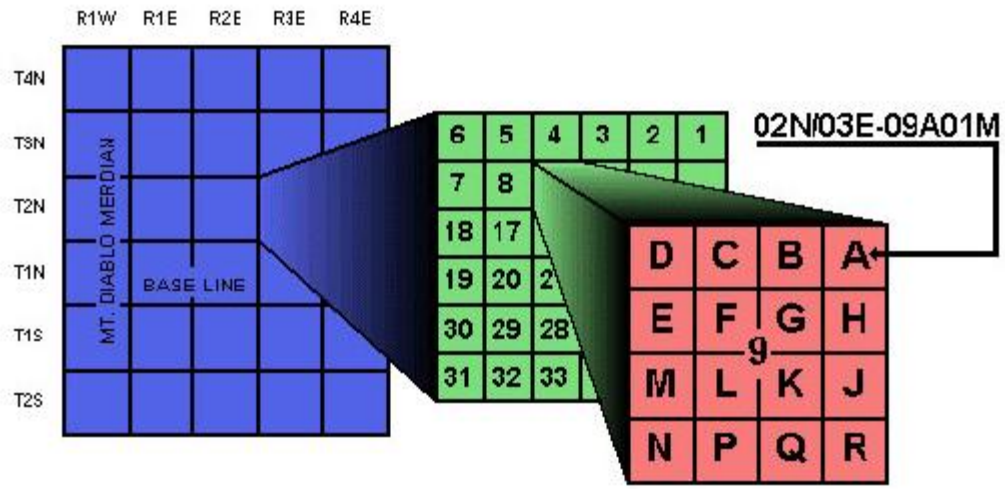
Downloading information

- GAMA data **can be downloaded** for use in other software programs.
- Downloads are comma delimited text files
- GAMA text file for Kern Co. is 127,930 KB
- GAMA Problems well ID's
  - and <u>approximate</u> well locations

ONE WELL, DIFFERENT NAMES

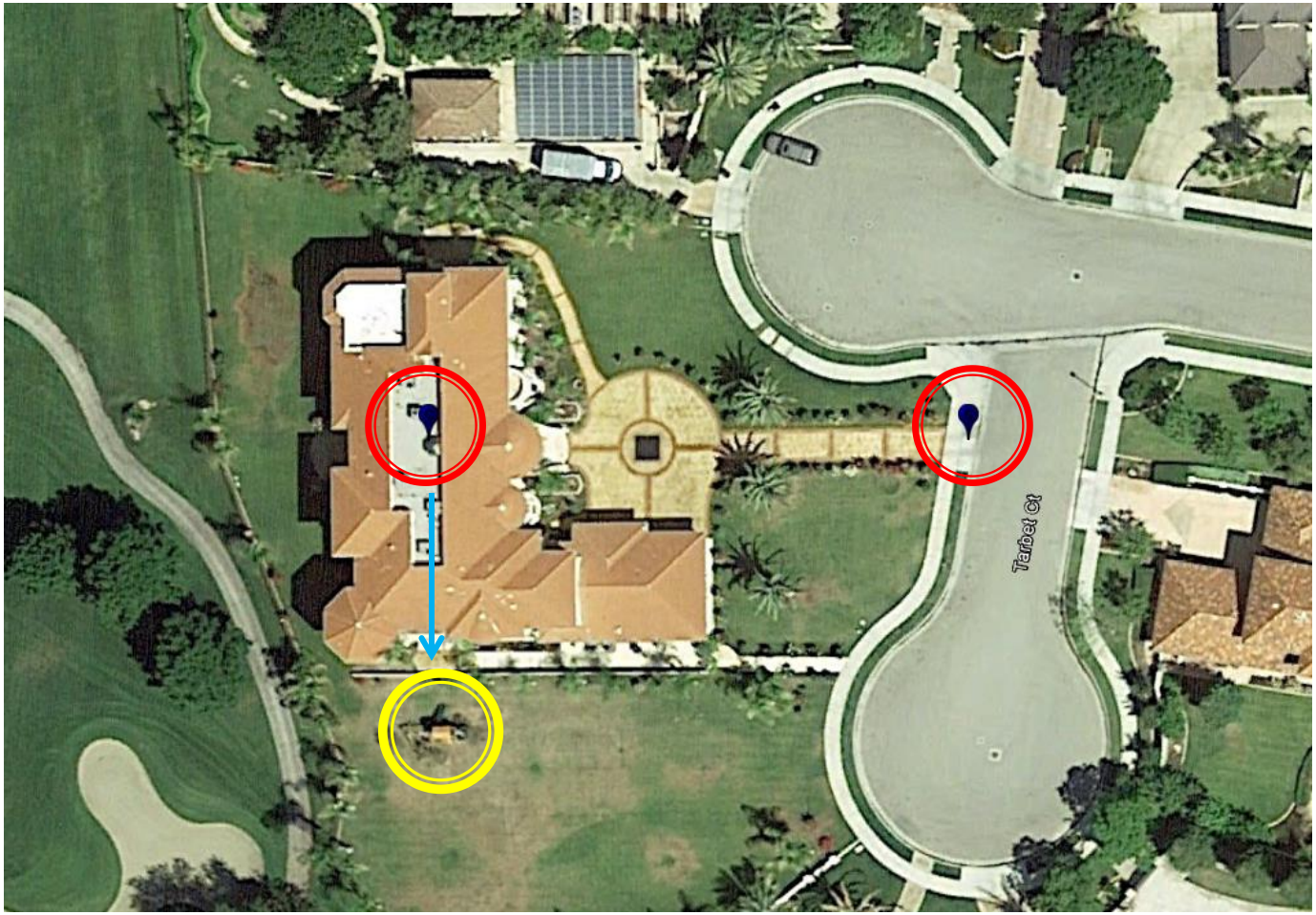
GAMA: 1500063-001
USGS: 354634119401301

- CASGEM: 344779N1192479W001
- STATE WELL NUMBER: 28S25E23J001M
- LOCAL DESIGNATION: Furrow #1
- COUNTY: 28S/25E – 23J



County and Water Agency Data

- Water Code Section 13752 – Well completion reports are CONFIDENTIAL
- Some County agencies will provide a list of well owners and the well parcel numbers
- Some will provide analytical data
- Data can be released by agencies only ‘for the purpose of conducting a study’
- Data can be requested from the well owner privately or through a form provided by DWR



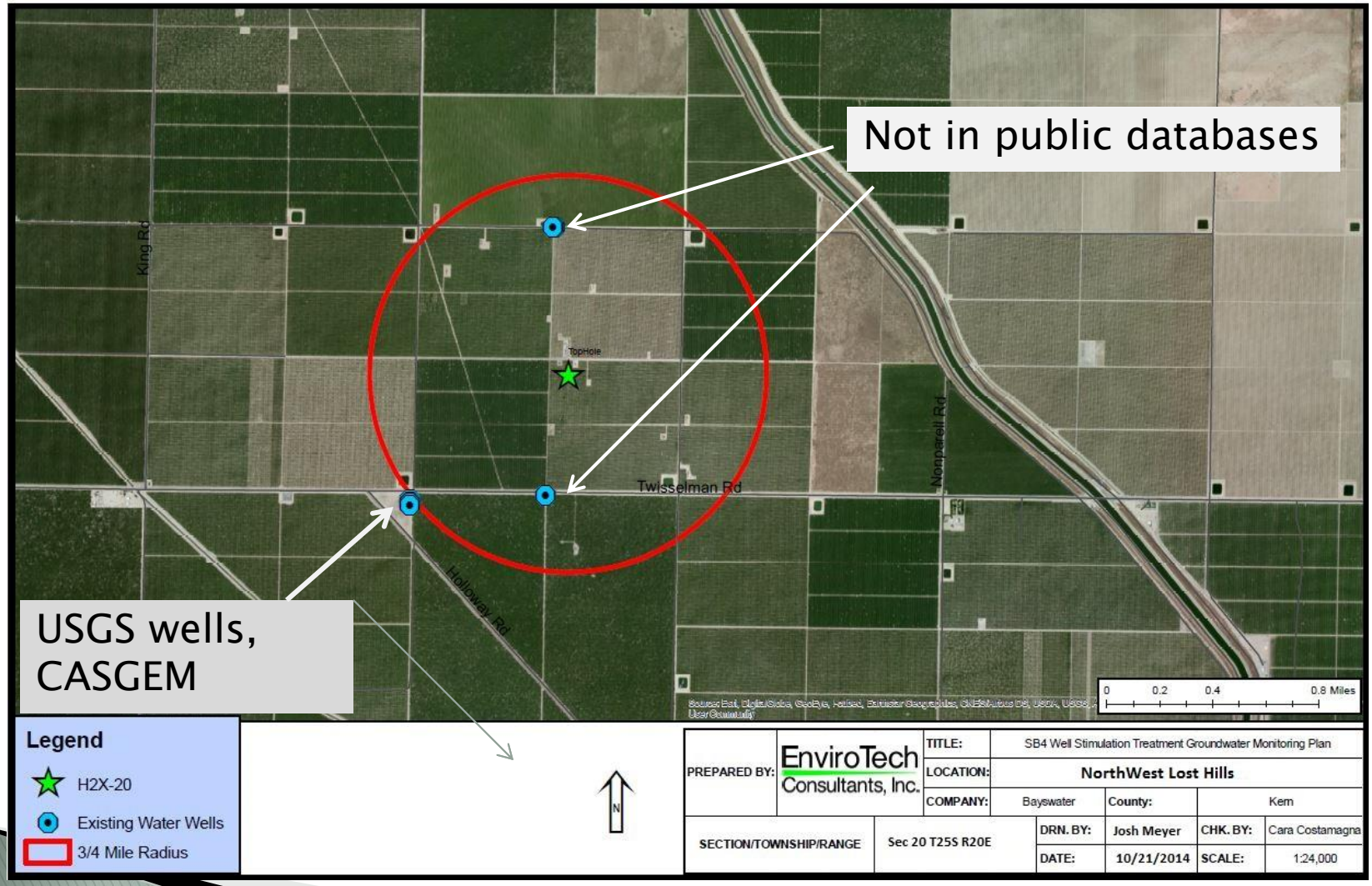
Finding water wells……DWR Water Data Library – inaccurate locations

Search for wells: Google earth

Field Check

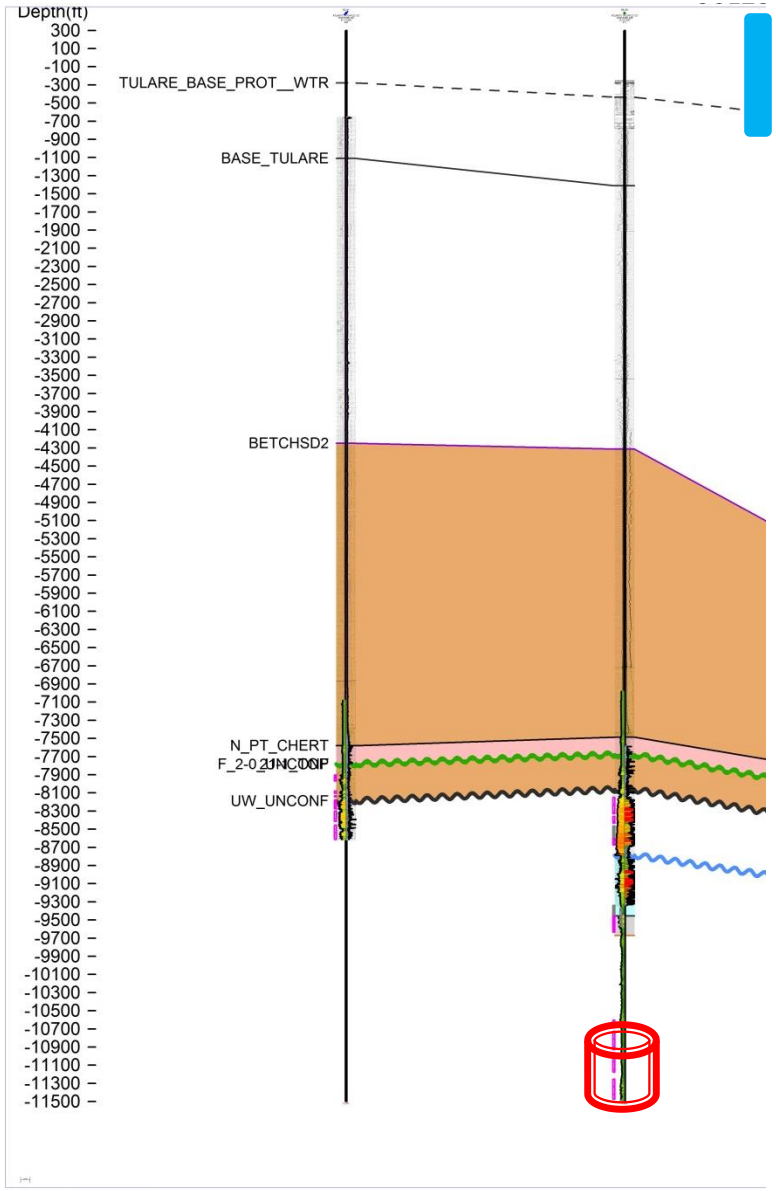

Citadel SB4 well
Well #1
Water well
N 35.108251 5G70/25
E -119.269456 4091-2012
well #2
5G71 21
CAUTION
UNTREATED WATER
UNSAFE TO DRINK
CUIDADO
NO BEBE EL AGUA
NO ES PURIFICADA
5G7
21

Planning the 'Plan' – an example



Existing groundwater quality data to document in the GMP

- Search groundwater databases (GAMA – Geotracker)
- Phone USGS and other agencies
- Carefully check literature and published information
- Look at e-logs, calculate depth to protected water
- Background groundwater quality data is important to protect the oil field operator from pre-existing conditions



Groundwater Monitoring

9,900 feet

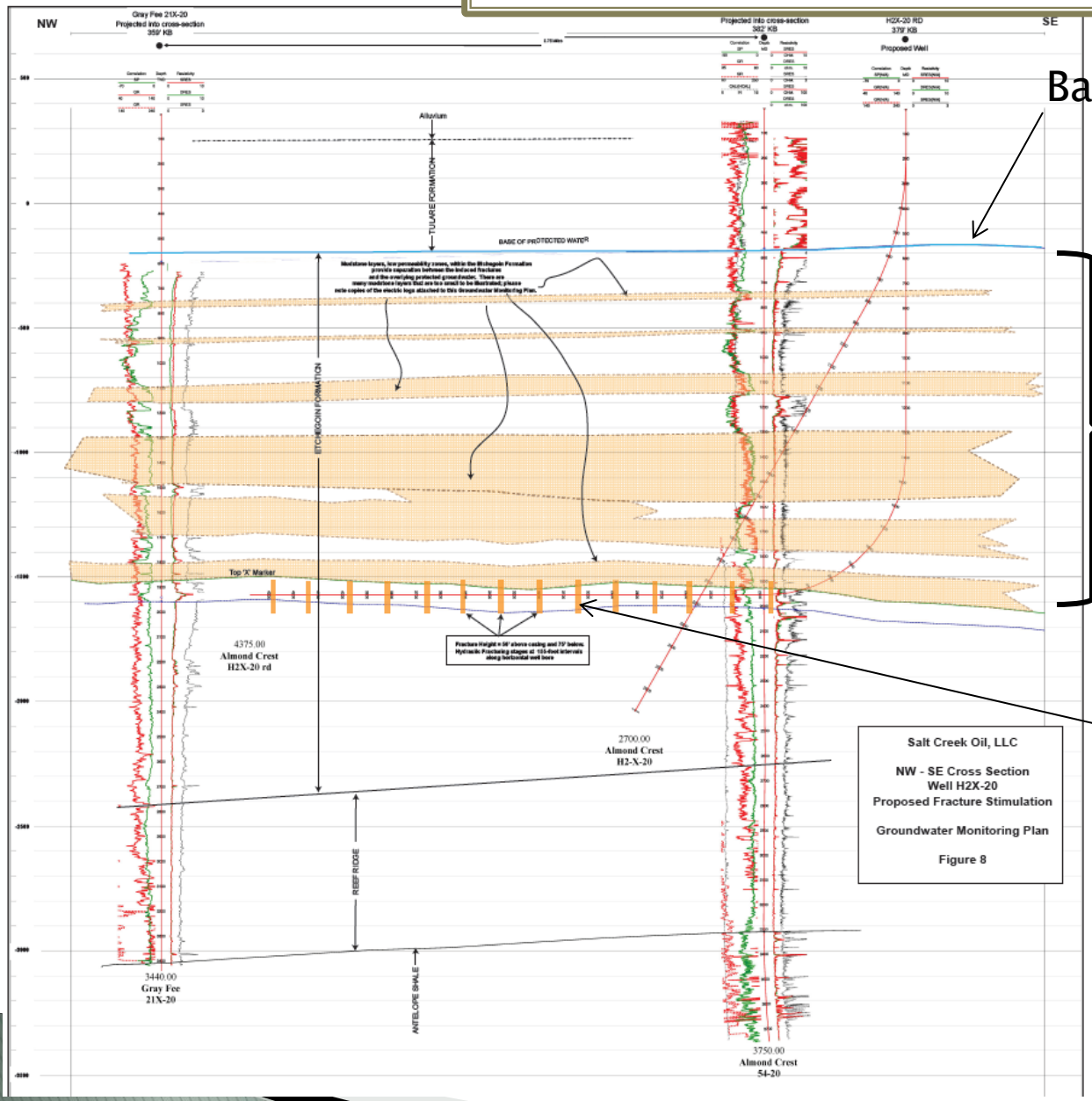
Hydraulic Fracturing

Collect water quality data

API Number	Well #	Field	S/T/R (MDB&M)	Perforation Depth (feet)	Formation	TDS (ppm)
030-25612	65I-20	NWLH	20/T25S/R20E	762-962	Lower Tulare	41,000
029-19923	2	NWLH	33/T325S/R20E	2079-3177	Antelope Shale	36,600
USGS WW	025S020E30A001M	NWLH	30/T25S/R19E	137-155	Holocene	3,530
USGS WW	025S020E30A002M	NWLH	30/T25S/ R20E	211-221	Holocene	2,400
USGS WW	025S020E30A003M	NWLH	30/T25S/ R20E	99-109	Holocene	2,040
USGS WW	025S020E30A004M	NWLH	30T25S/ R20E	9-71	Holocene	7,710

The USGS monitoring wells contain water with a TDS < 10,000 ppm

Illustrate water quality on a cross section

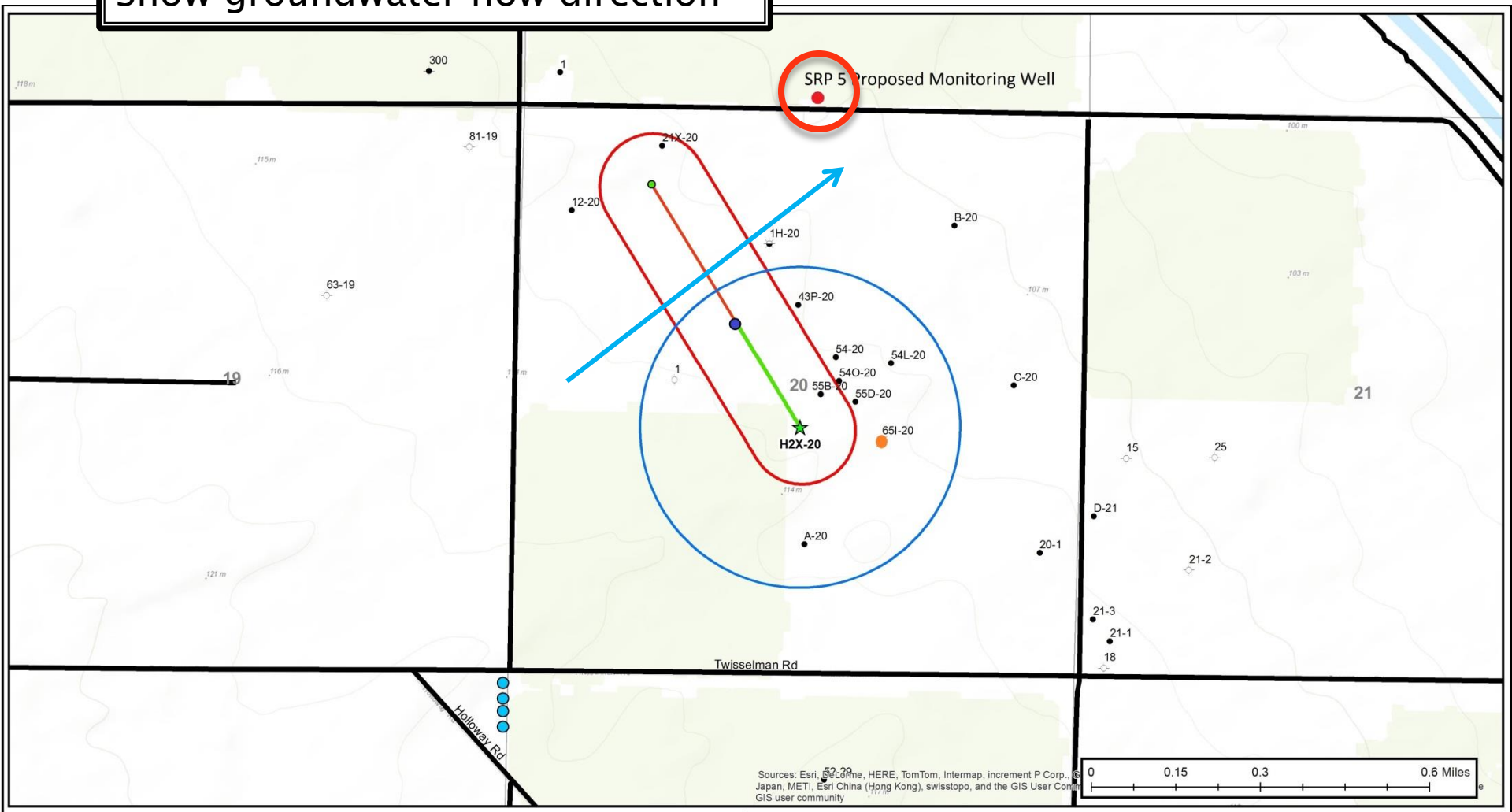


Base of protected water

Low permeability layers

Proposed fractures

Show groundwater flow direction



Legend

- H2X-20 RD Path
- H2X-20 OH
- H2X-20 OH BH
- 65I-20 Injection Well
- H2X-20 RD BH
- H2X-20 OH Path
- 500 ft Buffer
- 1500 ft Buffer
- Existing USGS Monitoring Well
- Groundwater Monitoring Well

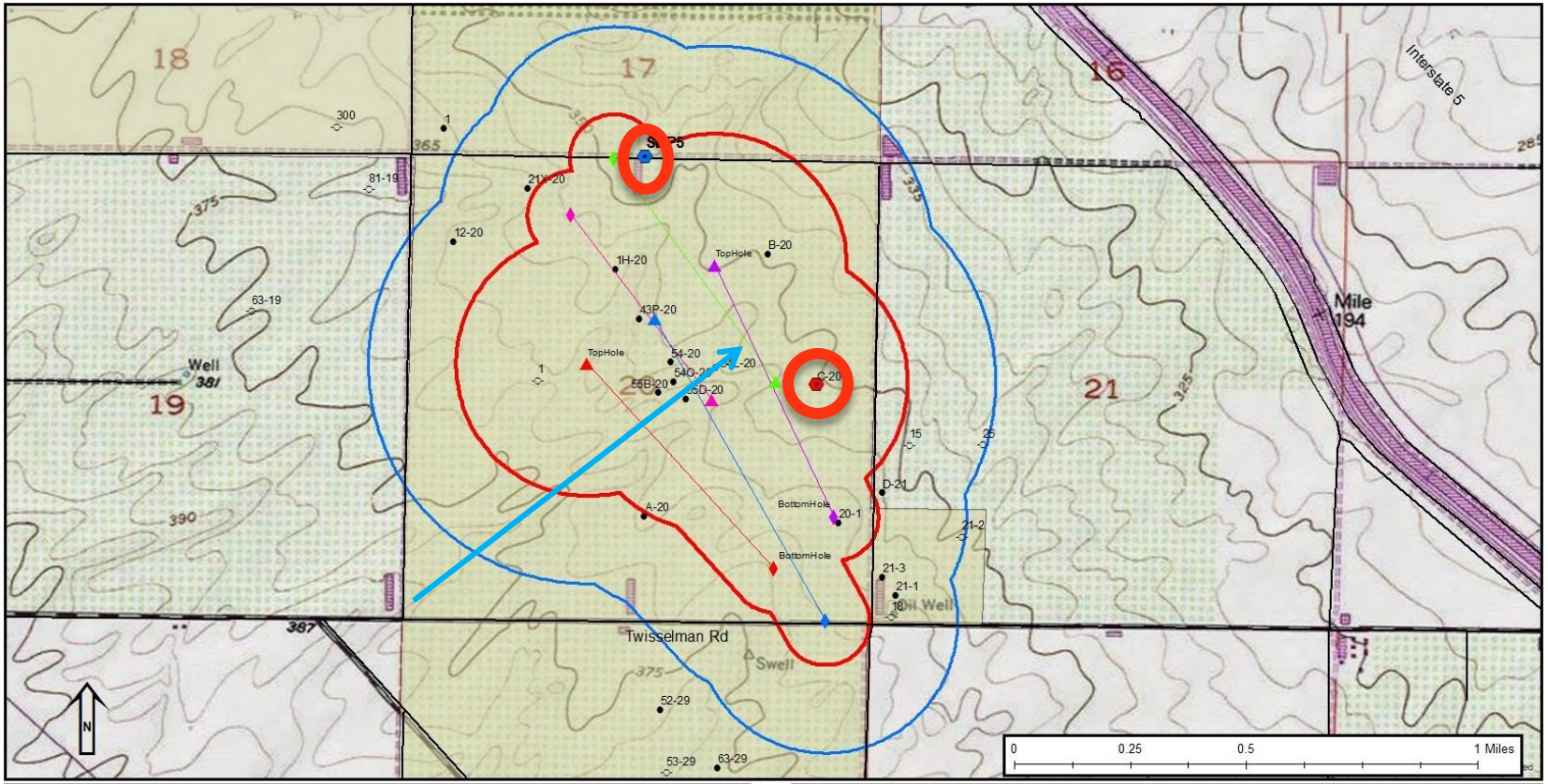
N

PREPARED BY:	EnviroTech Consultants, Inc.	TITLE:	SB4 Well Stimulation Treatment Groundwater Monitoring Plan		
		LOCATION:	North West Lost Hills Oil Field		
		COMPANY:	Salt Creek Oil, LLC	County:	Kern
SECTION/TOWNSHIP/RANGE	T25S/R20E - SEC 20	DRN. BY:	Joshua Meyer	Jane McNaboe	
		DATE:	11/13/14	SCALE:	1:8,000

Finding the well owner – Public Relations

- Found property owner name from County Records
- Phoned farming company repeatedly, no response
- Oil field operator finally found farming foreman and was able to get a contact name and number.
- Well owner gave the operator permission to use the water well as a groundwater monitoring well, and as a water supply well.

Monitoring well installation



Legend

- H3X_20 BHL
- H3X_20 THL
- H4X_20 BHL
- H4X_20 THL
- H5X_20 BHL
- H5X_20 THL
- H6X_20 BHL
- H6X_20 THL
- H7X_20 BHL
- H7X_20 THL
- H3X_20 Well Path
- H4X_20 Well Path
- H5X_20 Well Path
- H6X_20 Well Path
- H7X_20 Well Path
- SaltCreek MW 1
- SRP5 Existing MW

DOGGR Well Status

GIS Symbol

- Active
- Idle
- Plugged

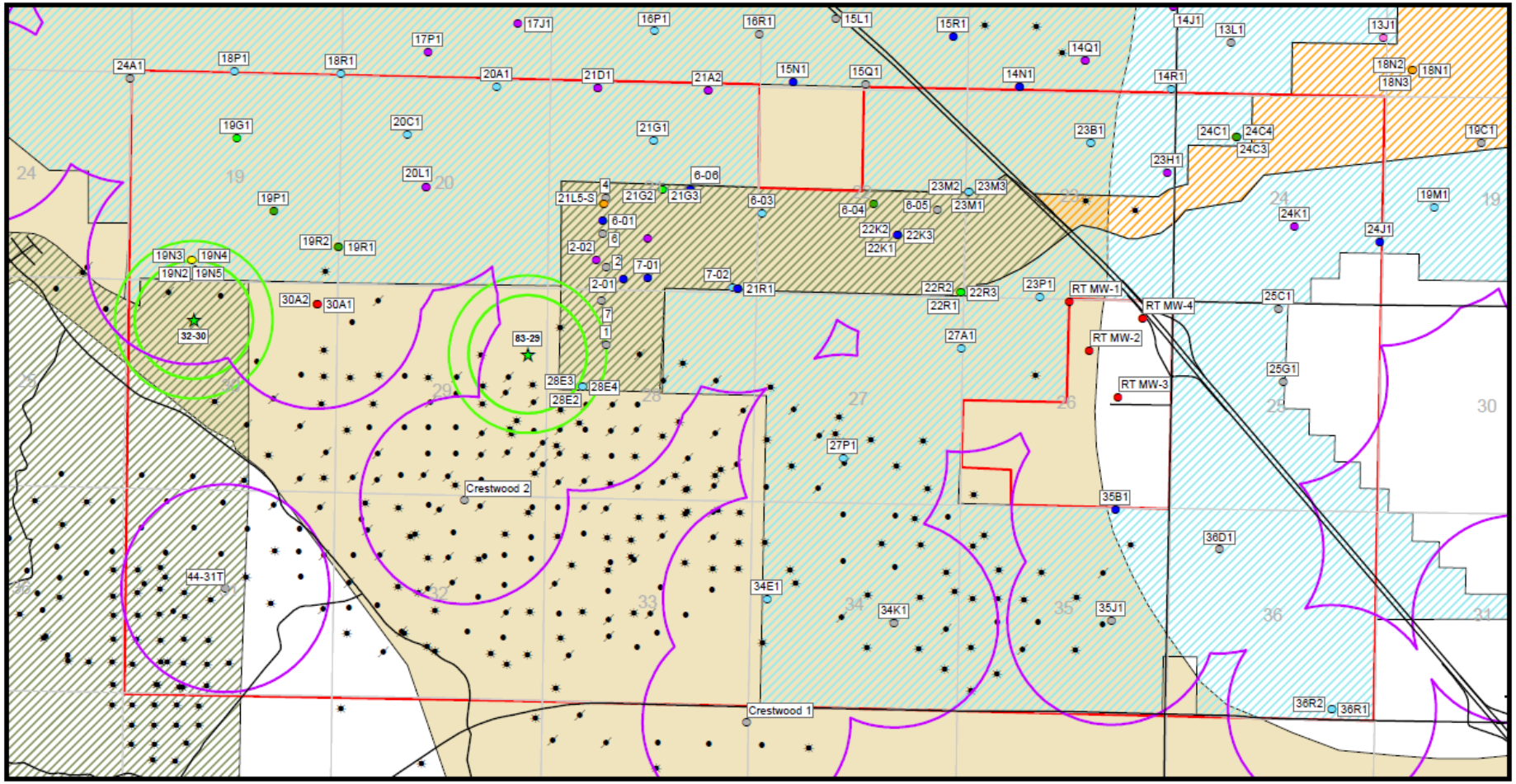
- Additional 1000' Buffer
- GWMP Standard Buffer
- Groundwater Flow Direction

PREPARED BY:	EnviroTech Consultants, Inc.	TITLE:	SB4 Well Stimulation Treatment Groundwater Monitoring Report		
		LOCATION:	North West Lost Hills Oil Field		
		COMPANY:	Salt Creek Oil, LLC	County:	Kern
SECTION/TOWNSHIP/RANGE	T25S/R20E - SEC 20	DRN. BY:	Joshua Meyer		
		DATE:	26-Jan-15	SCALE:	1:9,000

Monitoring well installation…

- Cannot permit the monitoring well through DOGGR. MW's have to be permitted with a County Agency
- MW's must be drilled by a C-57 licensed contractor
- Water well drilling company are not available (due to the drought), are expensive, work daylight hours only
- May have difficulty reaching the depth needed

North Coles Levee



Legend

- Well Sites To Be Stimulated
- Roads
- Monitoring Wells 0.5 mi radius
- 1500
- 2000
- Sections
- North Coles Levee Oil Field

Well Bottom Perf Depth

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1000

DOGGR Well Status

- Active
- Idle
- Plugged

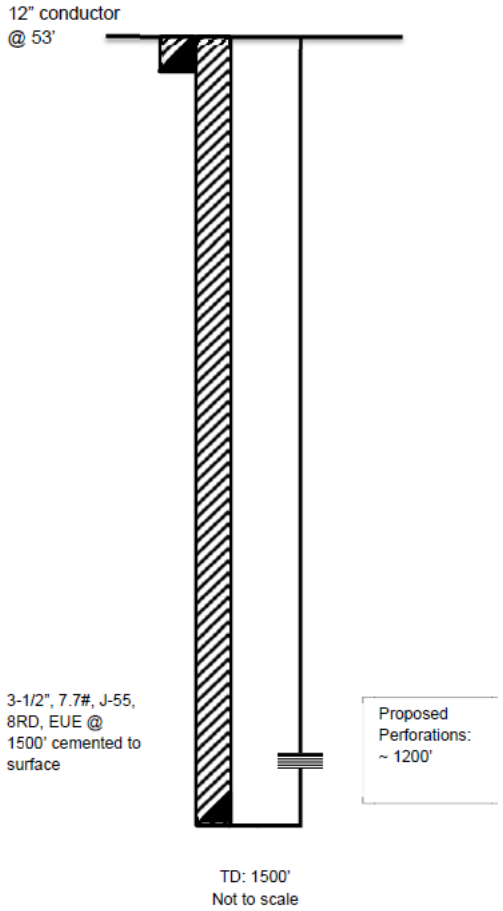
Kern County Water Districts

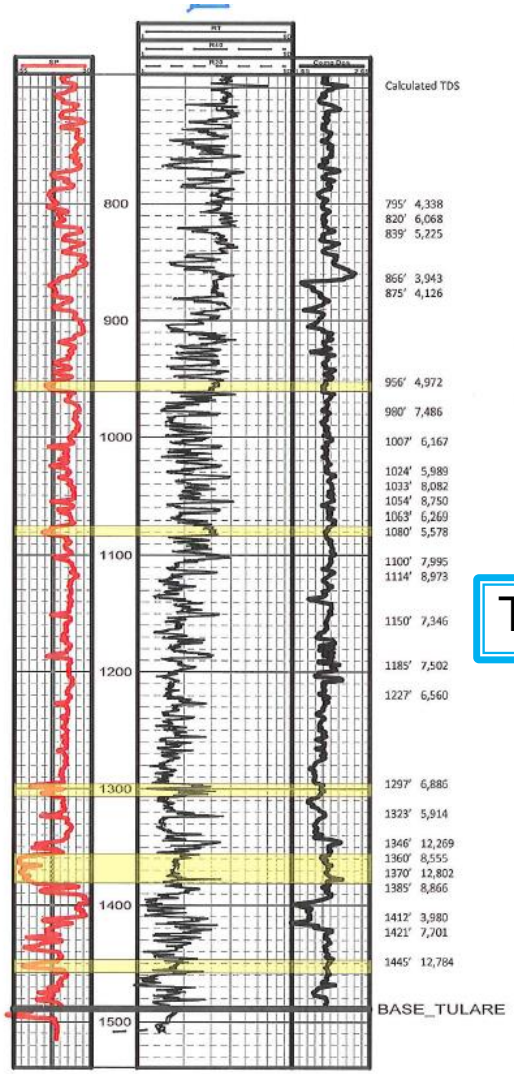
- COB 2800
- KERN WATER BANK
- WEST KERN WD
- Corcoran Clay Extent

North Coles Levee Oil Field
Groundwater Monitoring Wells

1 0.5 0 1
Miles

N





Perforations

950'-960'

1075'-1085'

TDS 8400 ppm

Groundwater Sampling

Traditional three volume purge vs. HydraSleeve no purge

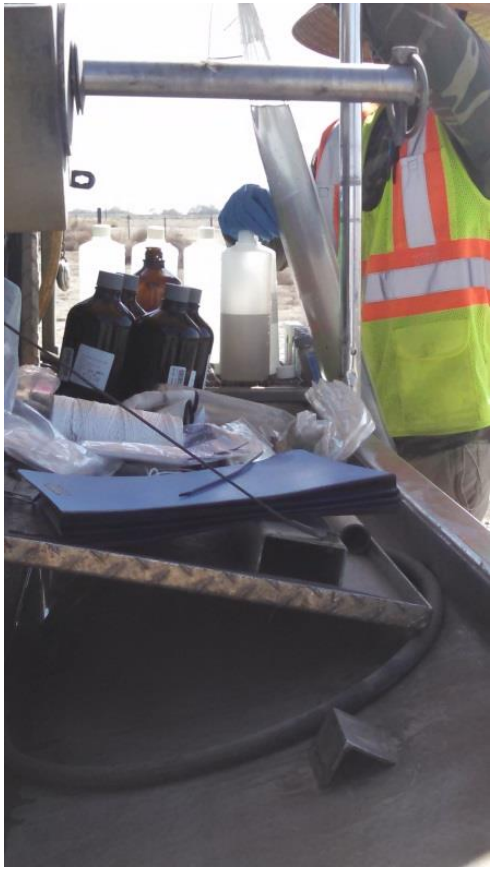
The required analytical suite is extensive, the lab needs about 3.5 gallons of groundwater

Note that 1 HydraSleeve only retrieves1.5 to 2 liters of groundwater

Volume of groundwater needed for one analytical suite.

Groundwater sampling

Groundwater sampling



Summary

- SB4 GMP are difficult to develop due to the lack publicly available data.
- If no water wells are available or suitable for use as a monitoring well, monitoring well installation is expensive.
- Groundwater sampling is difficult in some cases due to the depth and the amount of water needed by the laboratory.

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