12th Annual Groundwater Quality Workshop

4040 Paramount Boulevard
Lakewood, CA 90712

August 9, 2017 (9:30AM ~ 2:30PM)

WRD
WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

Speaker #1

WRD Overview – August 2017

Brian Partington

Water Replenishment District

bpartington@wrd.org

WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

Overview - August 2017

Brian Partington, PG, CHg

August 9, 2017

Program

<u>9:30 – 10:00</u>

WRD Overview

Brian Partington, WRD

<u>10:00 – 10:30</u>

DDW Regulatory Updates

Jeff O-Keefe, SWRCB - DDW

<u>10:30 – 11:00</u>

Well Profiling Tool to Identify Zones of Contamination in Water Supply Wells

Noah Heller, BESST Inc.

<u>11:00 – 11:30</u>

Designing and Implementing a Multi-Facility SCADA System in the Age of Information

Phuong Ly, WRD; Luke Stephenson & Chris Schleich, Enterprise Automation

<u>11:30 – 12:00</u>

Ex-Situ Groundwater Remediation Options for Perchlorate

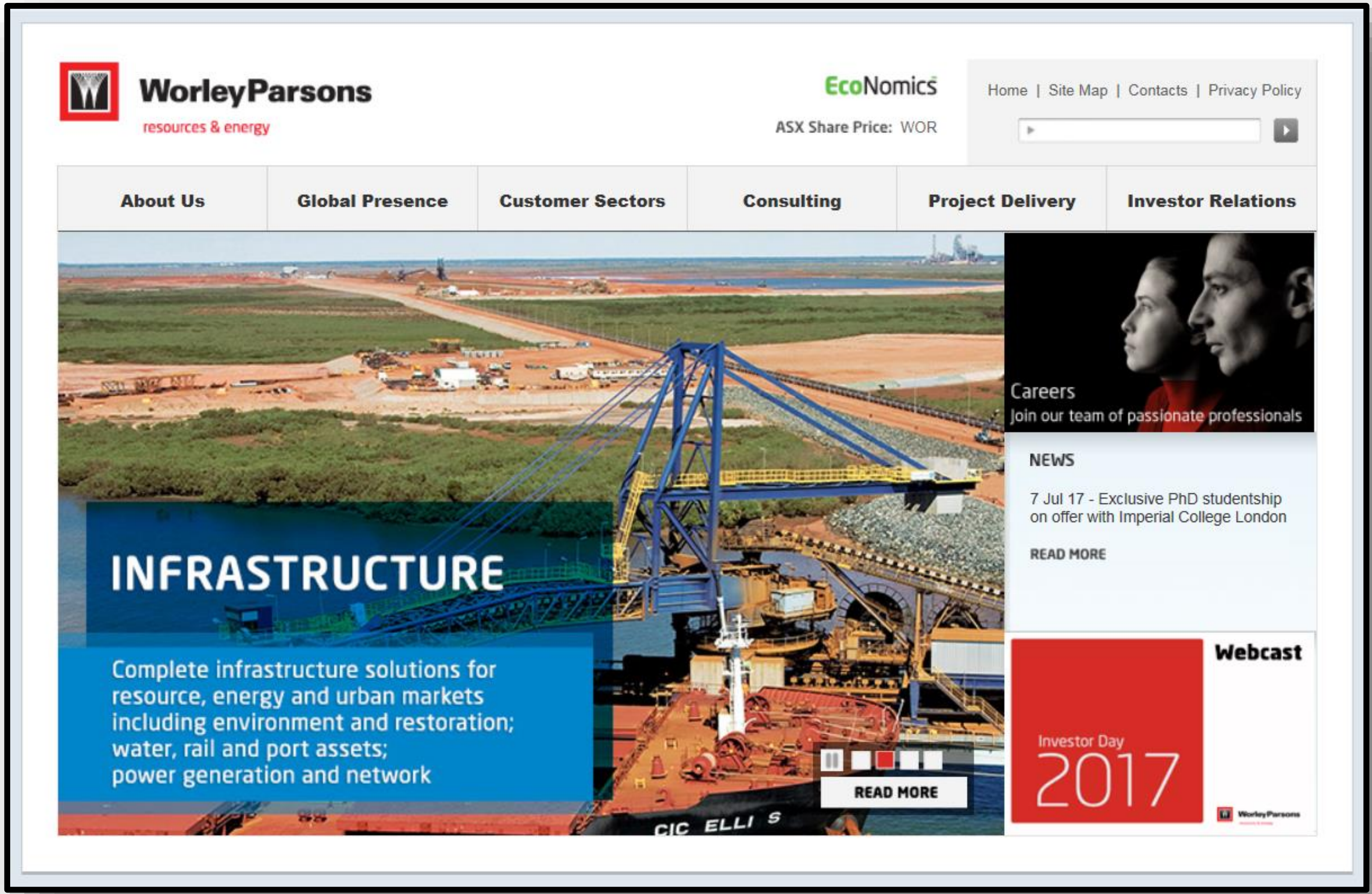
Steve Winners, WorleyParsons Advisian

Cathy Swanson, Evoqua Water Technologies, LLC.

Program

12:00 – 12:45

Lunch provided by WorleyParsons



Program

<u>12:45 – 1:15</u>

UCMR4 Implementation Strategies for Water Systems

Rick Zimmer, Eurofins Eaton Analytical

<u>1:15 – 1:45</u>

Principles of Efficient Water Well Design

Kevin McGillicuddy, Roscoe Moss Company

<u>1:45 – 2:15</u>

Groundwater Basins Master Plan

Everett Ferguson, WRD

<u>2:15 – 2:30</u>

Questions and Certificates

The presentations will be emailed to the participants and/or uploaded to http://www.wrd.org

High Level Overview of WRD

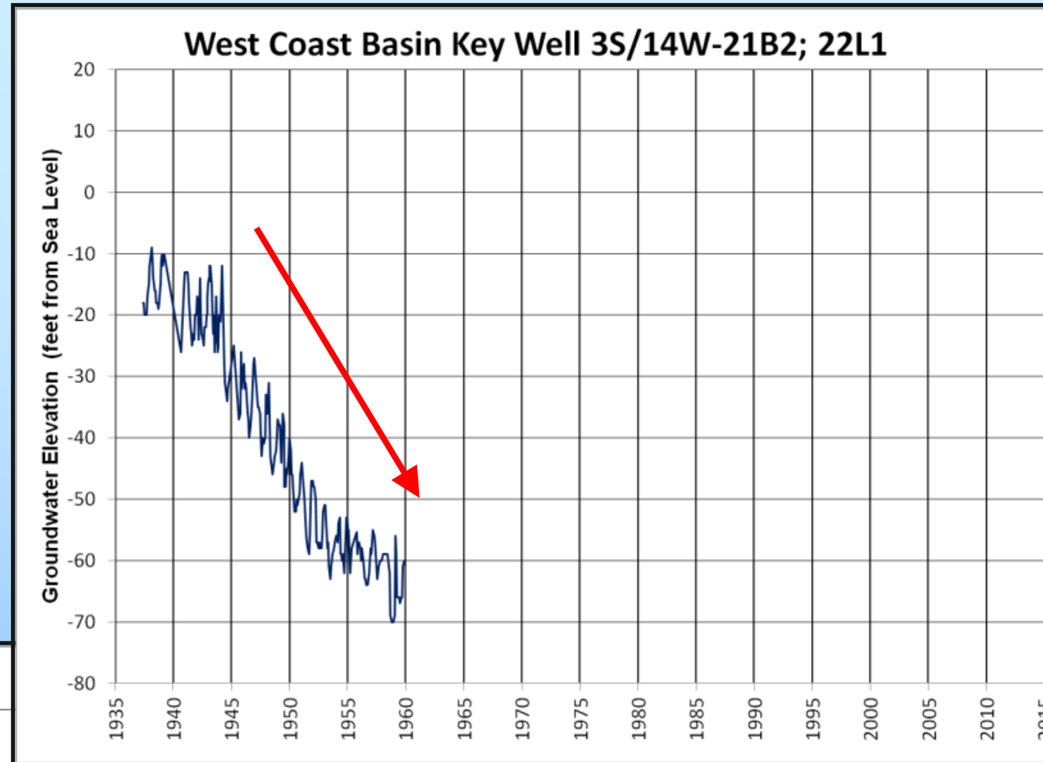
- History and Mission
- Major Programs
- Resources and Online Programs
- Water Independence Now

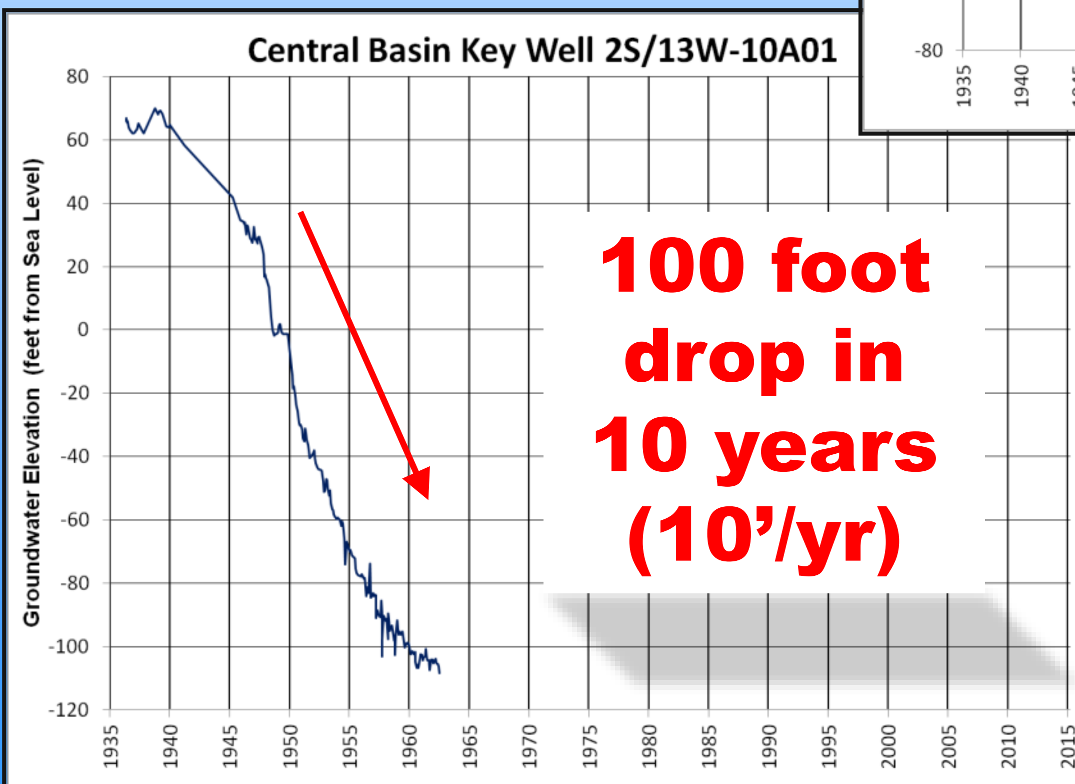
Past History:

1900s-1950s

Pumping Double Natural Replenishment.

OVERDRAFT





100 foot drop in 10 years (10'/yr)

- **Plunging Water Levels**
- **Loss of Supply**
- **Wells going Dry**
- **Seawater Intrusion**

Solutions

- WRD formed in 1959 to eliminate overdraft via Managed Aquifer Recharge (MAR).
- Pumping adjudicated at 281,835 acre feet/year (AFY).
- Higher than natural recharge within the basin, but the difference is made up WRD.

GROUNDWATER BASINS IN THE WRD SERVICE AREA

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

SERVICE AREA = 420 SQUARE MILES

43 CITIES

POPULATION > 4 MILLION

550,000 ACRE FEET USED PER YEAR

50% GROUNDWATER FROM LOCAL WATER WELLS

50% IMPORTED WATER

WRD SUPPLEMENTS NATURAL GROUNDWATER RECHARGE

SECURING OUR WATER FUTURE TODAY

4040 Paramount Boulevard | Lakewood, California 90712

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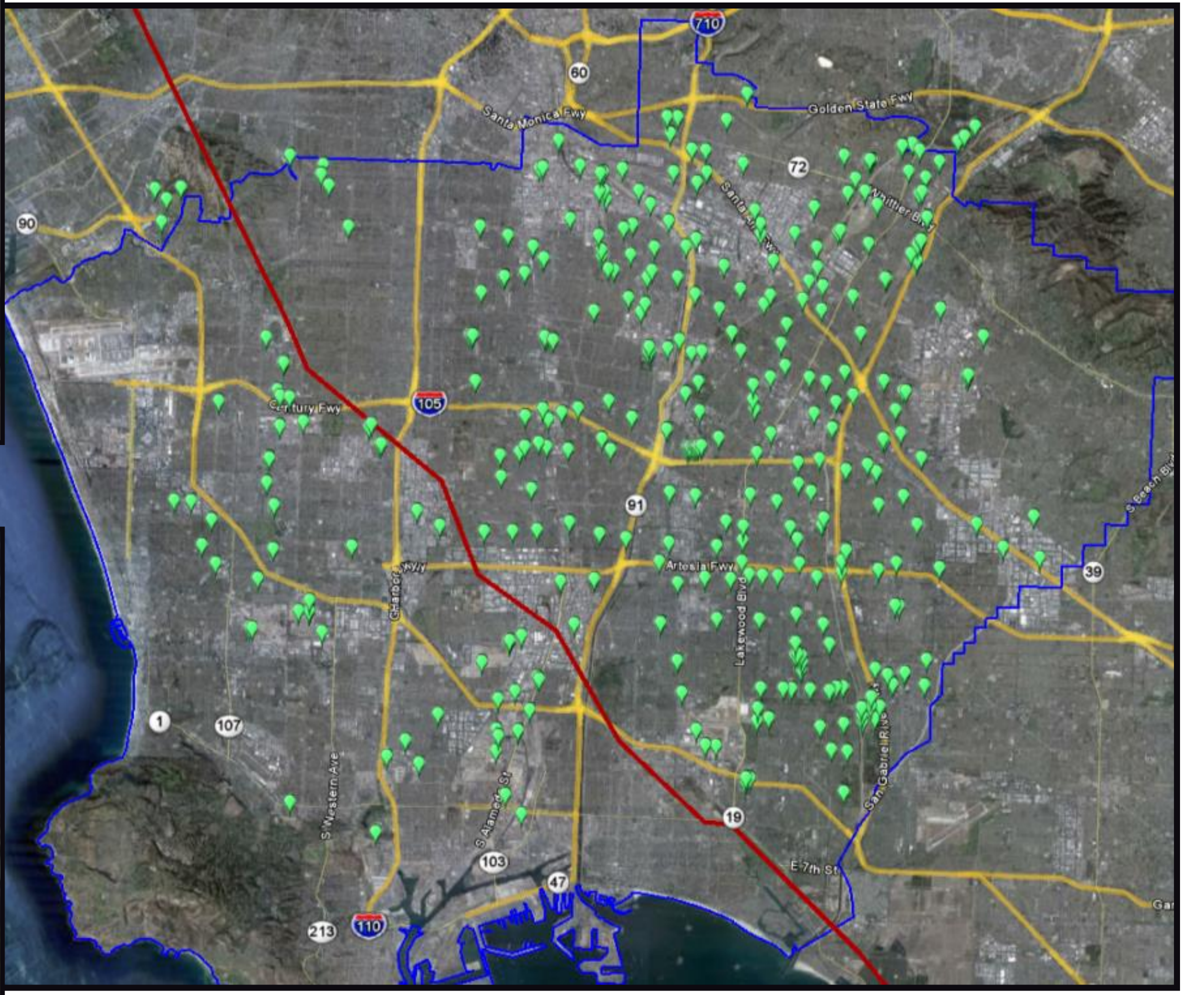
www.wrd.org

Over 400 Wells Provide Water Supply



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WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

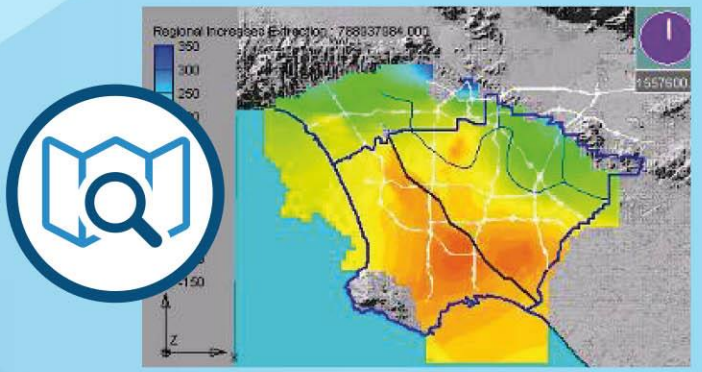
HOW WRD MANAGES THE BASINS

REPLENISHMENT OF GROUNDWATER

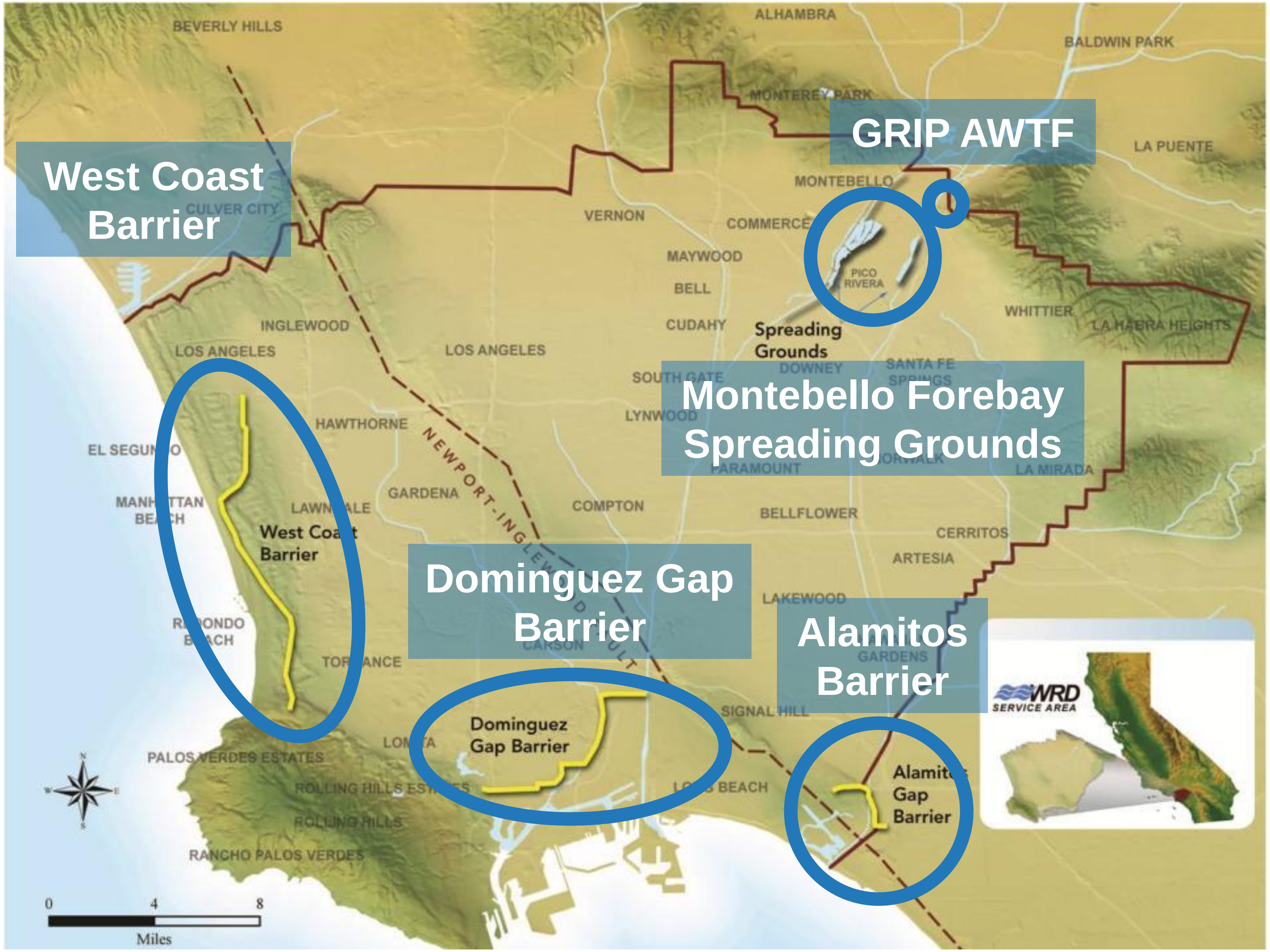
GROUNDWATER CLEAN UP

BASIN MONITORING

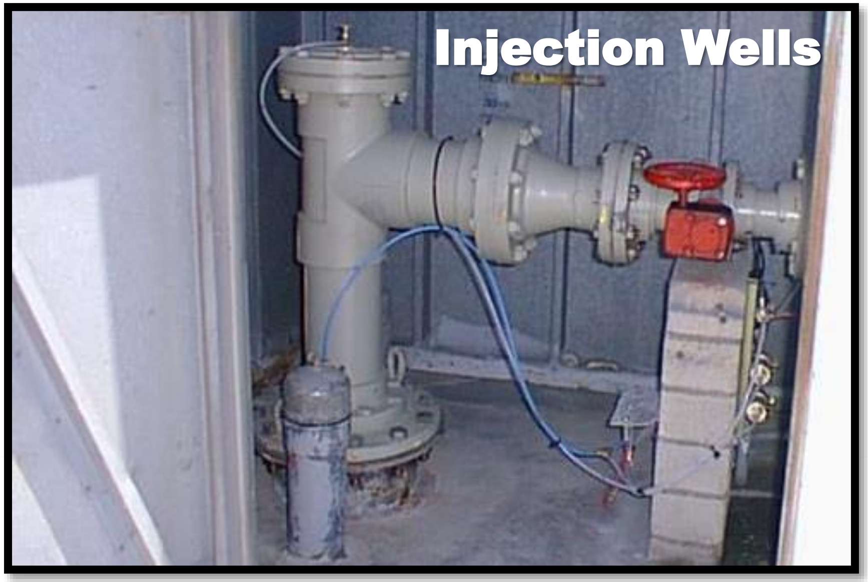
BASIN MODELING



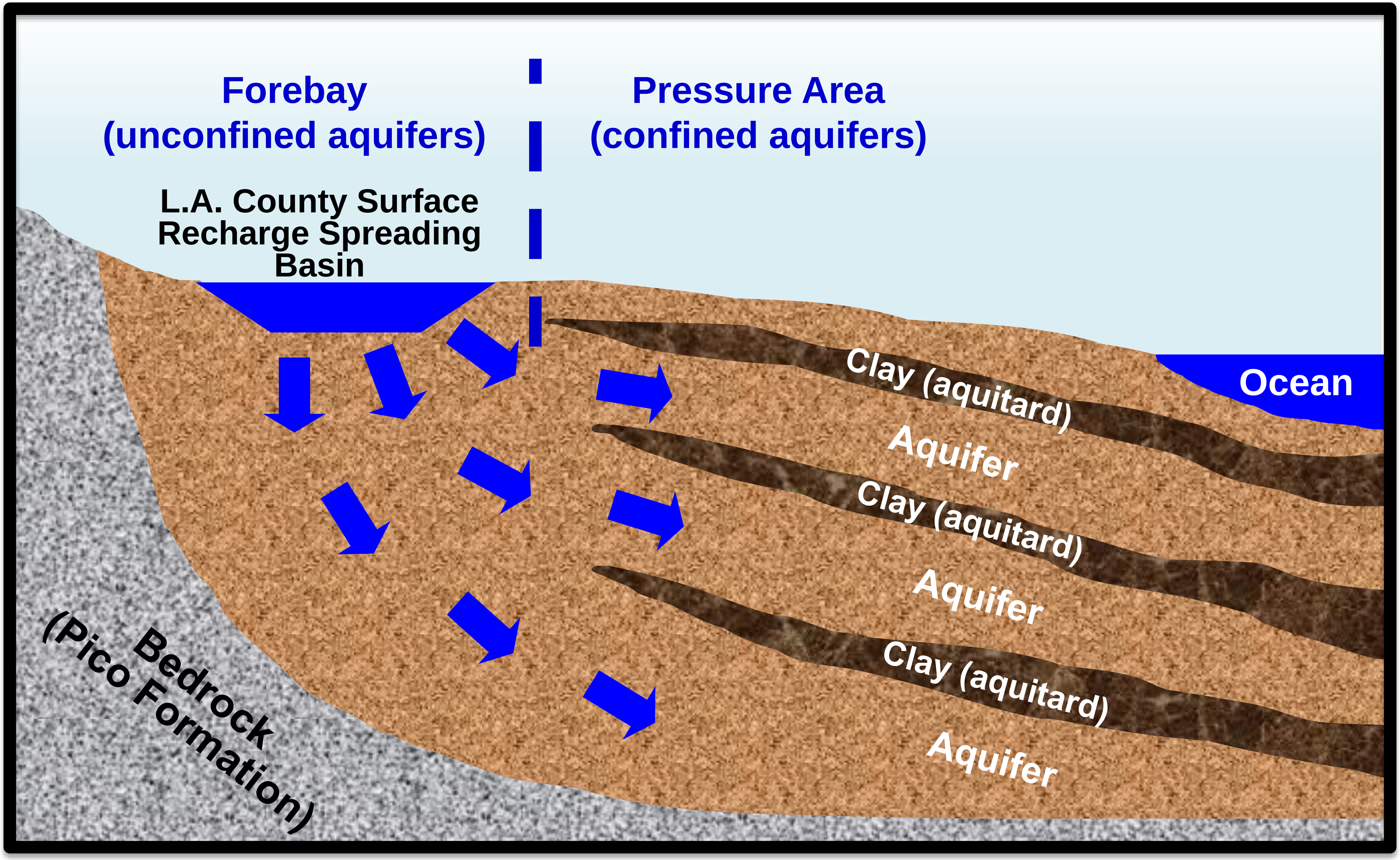
Replenishment Facilities



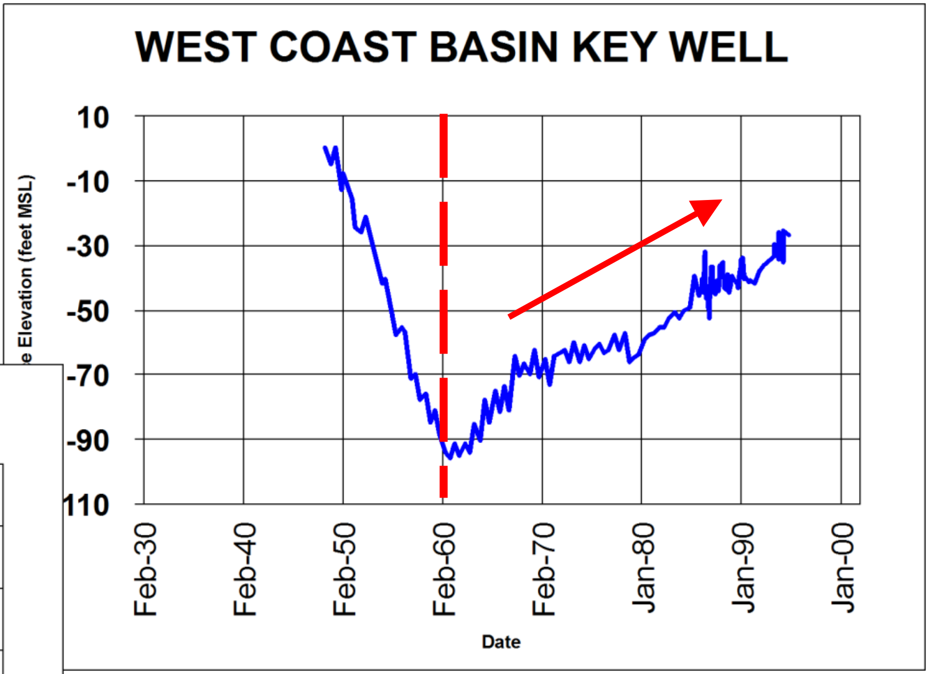
LA County Public Works Recharge Facilities

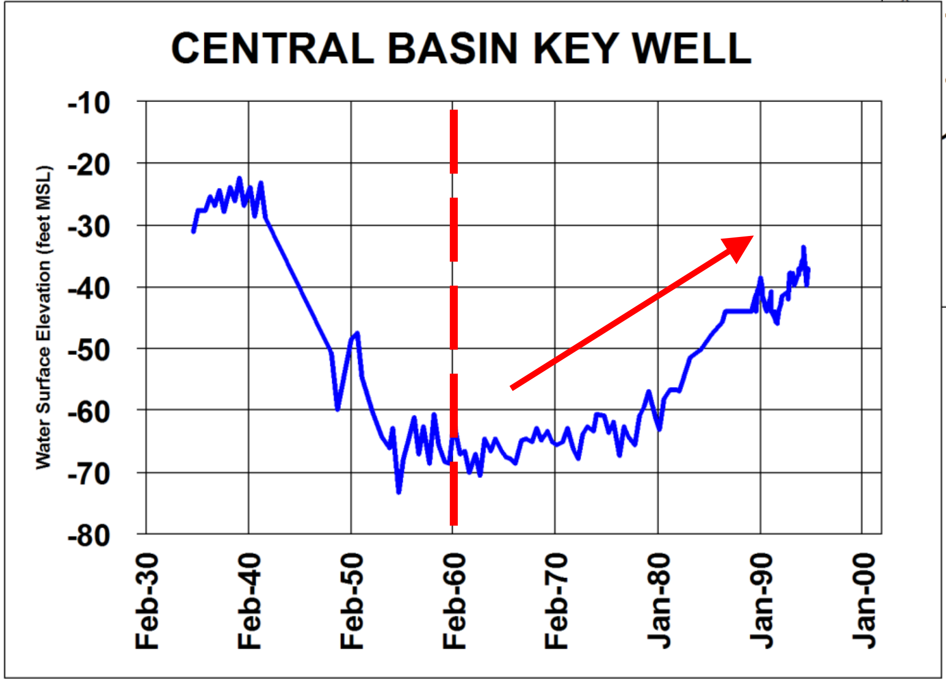


Replenishing Groundwater Basin



Results of WRD Basin Management

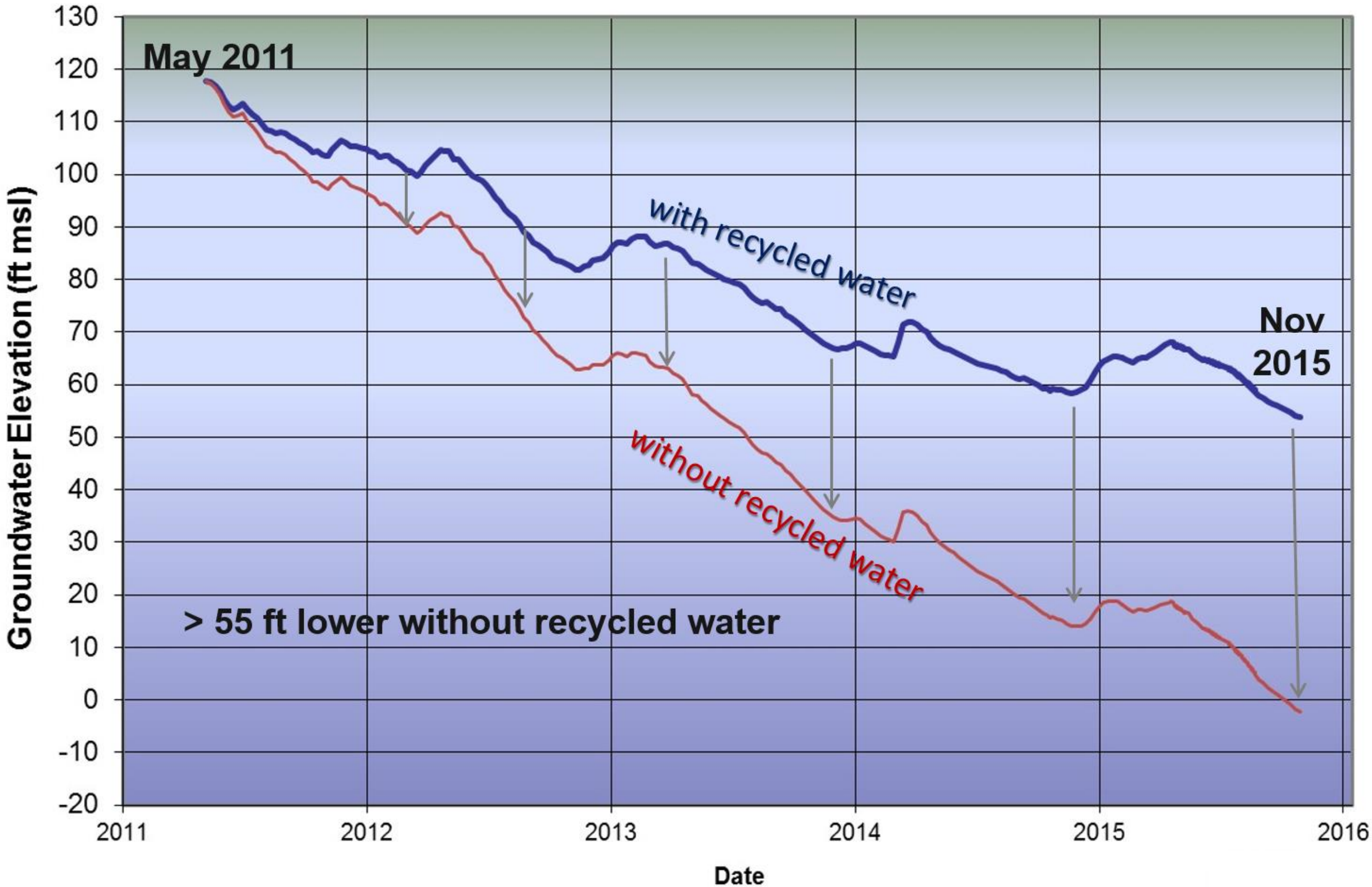




Rising water levels & drought protection

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

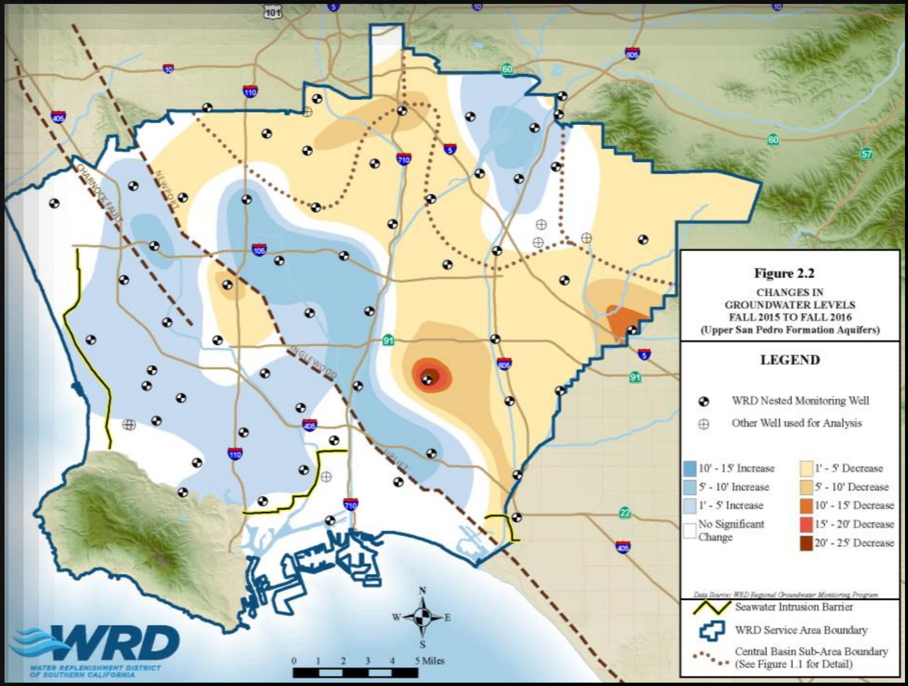
Forecasted water levels during drought without recharge



Regional Groundwater Monitoring Program

Sampling

Nested Monitoring Wells



Drilling with USGS

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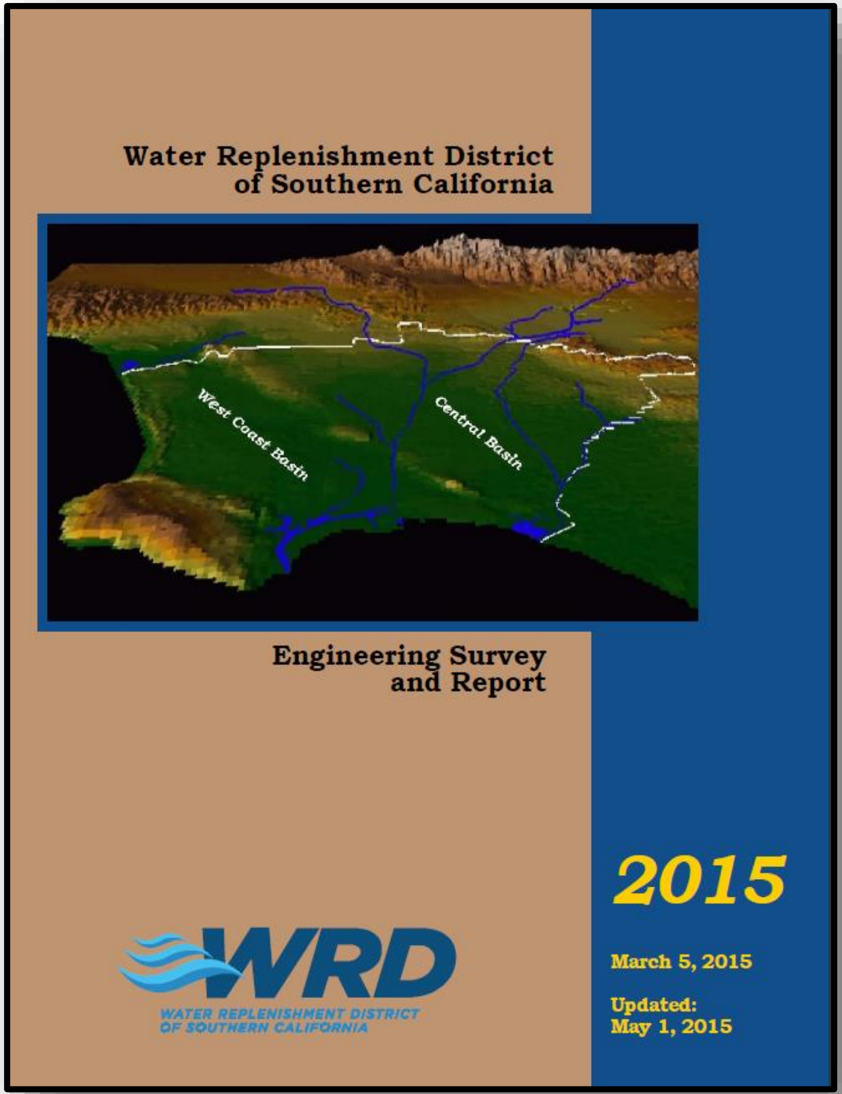
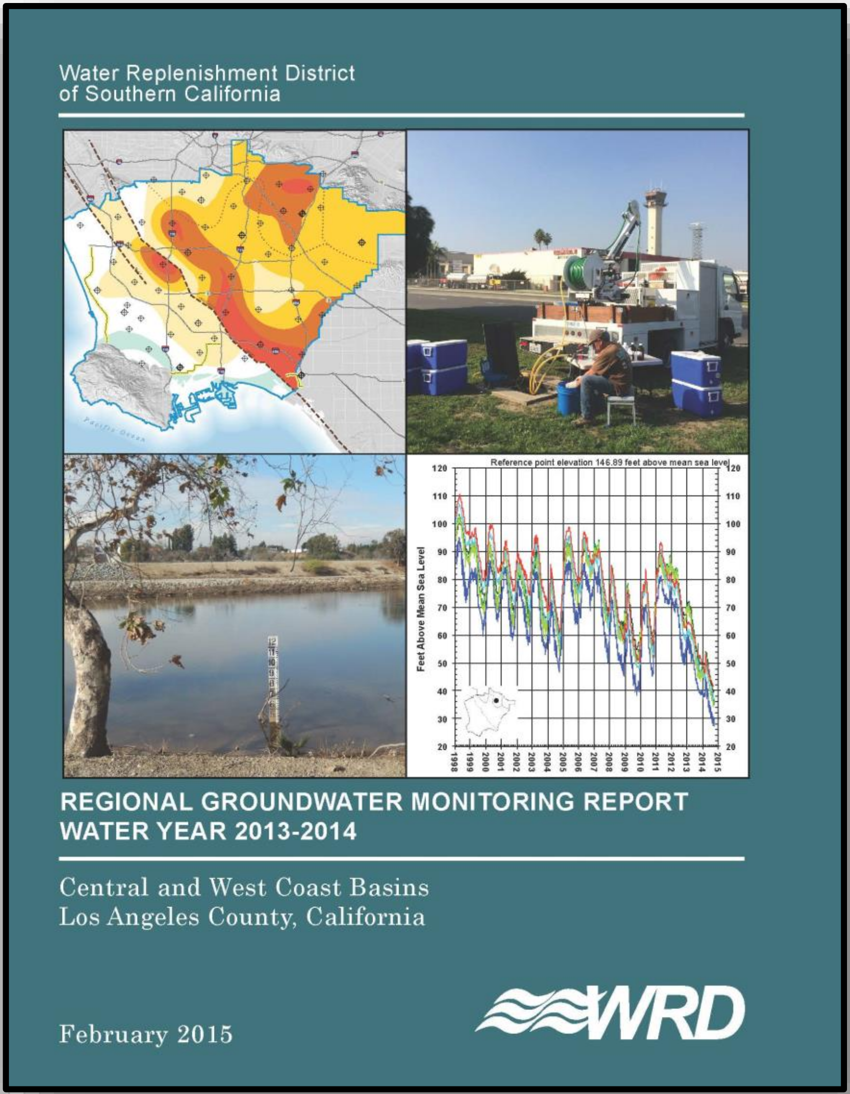
Data Presented in Two Annual Reports





Reports are available at http://www.wrd.org

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OF SOUTHERN CALIFORNIA

Interactive Well Search

http://gis.wrd.org/wrdmap/index.asp — WRD Interactive Well Search

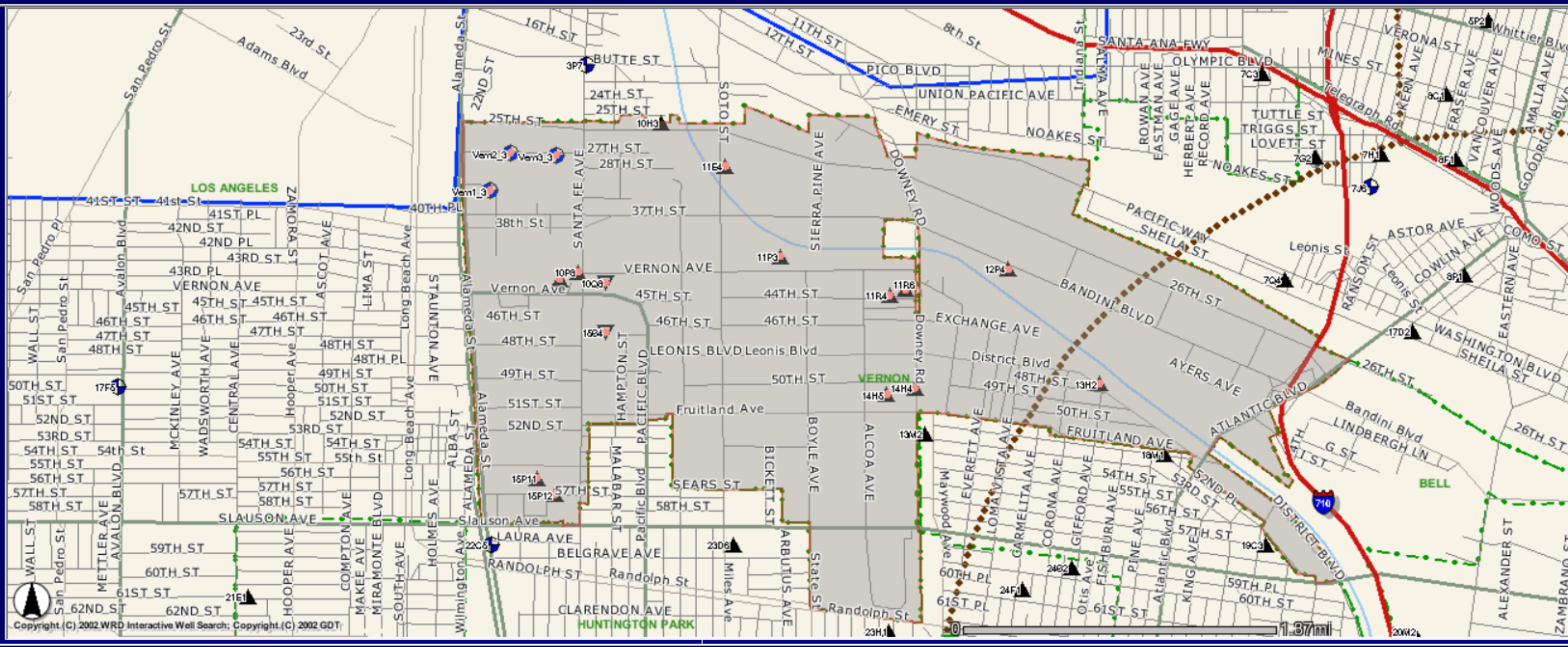
File Edit View Favorites Tools Help

WRD **Interactive Well Search** Map Search

NEW SEARCH | WRD HOME | HELP | LOGOUT

- Zoom In
- Zoom Out
- Full Extent
- Pan Map
- Select Well
- Select by Rectangle
- Select by Polygon
- Select by Circle
- Clear Selection
- Measure Distance
- Set Units
- Print Map
- View Map Legend
- Toggle Overview

Select Wells to Report On

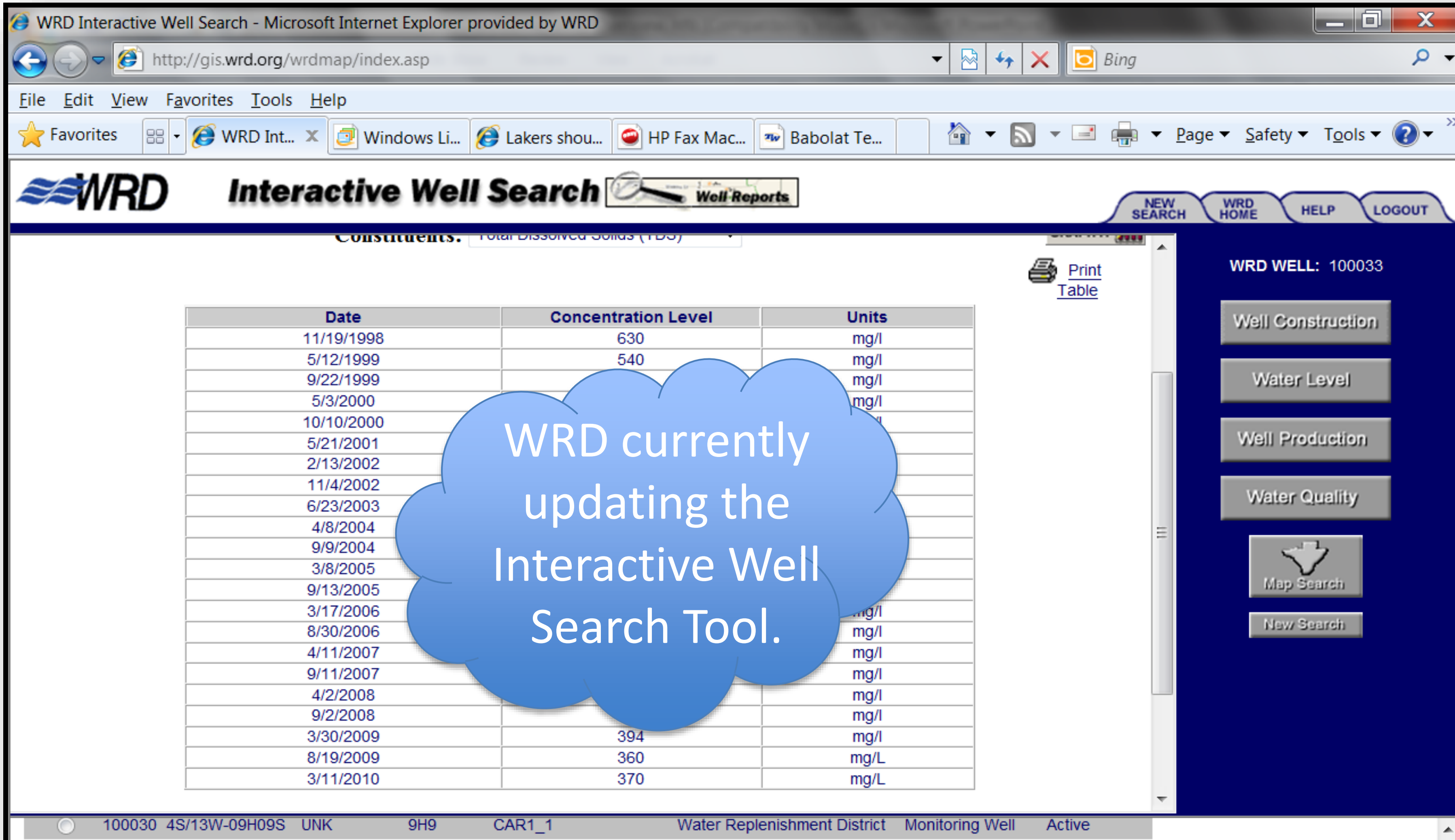


REPORT	WRD ID	State #	County #	Map Label	Common Name	Well Owner	Well Type	Well Status
○	102241	UNK		Vern1_1	Vern1_1	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102242	UNK		Vern1_2	Vern1_2	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102243	UNK		Vern1_3	Vern1_3	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102244	UNK		Vern2_1	Vern2_1	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102245	UNK		Vern2_2	Vern2_2	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102246	UNK		Vern2_3	Vern2_3	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102247	UNK		Vern3_1	Vern3_1	Water Replenishment District of Southern California	Barrier Observation Well	Active
○	102248	UNK		Vern3_2	Vern3_2	Water Replenishment District of Southern California	Barrier Observation Well	Active

Tools
- Print Table
- Map Results

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

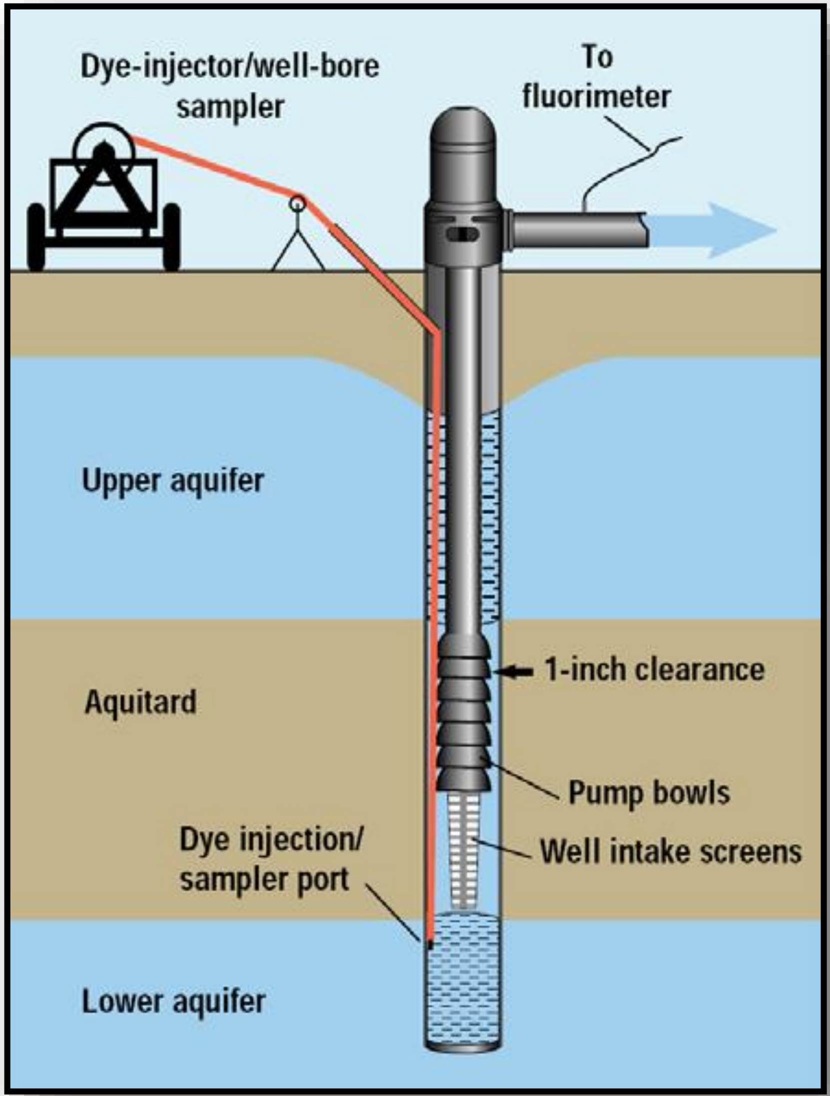
Interactive Well Search



Account requests at http://gis.wrd.org/wrdmap/login.asp

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

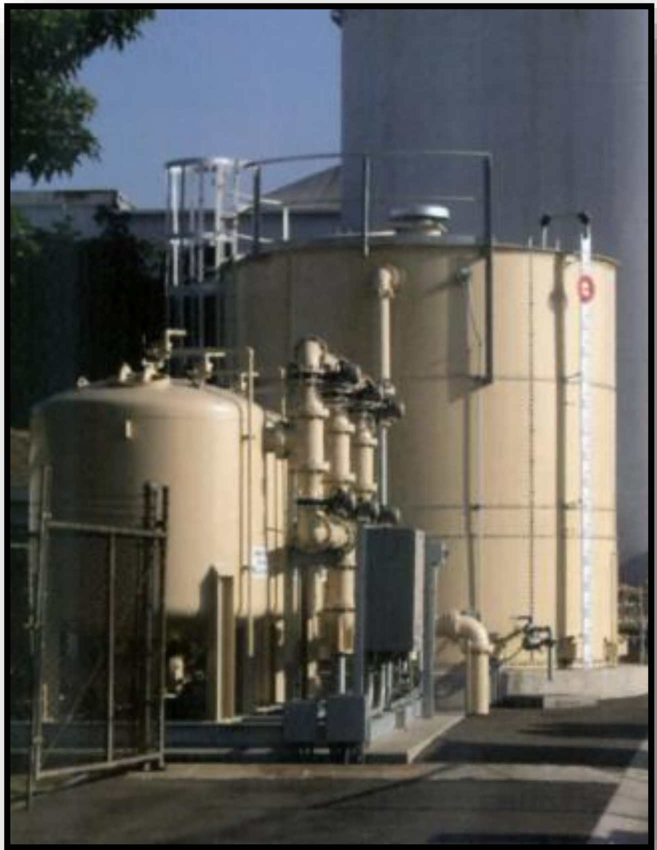
Well Profiling Program

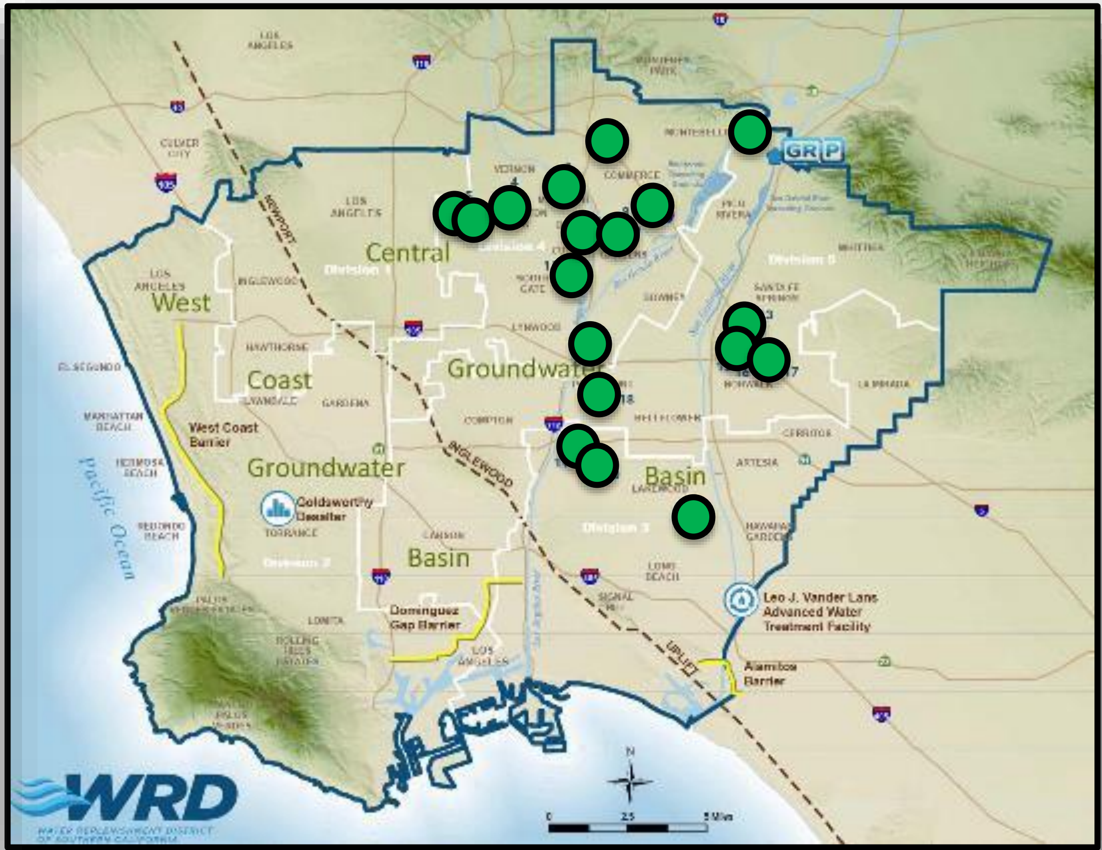


Contact Charlene King at cking@wrd.org (562.275.4252)

Safe Drinking Water Program (since1991)

- Financial assistance for wellhead treatment.
- Outreach program for DACs.





Contact Charlene King at cking@wrd.org (562.275.4252)

Groundwater Contamination Program

- WRD staff track the progress of high priority environmental investigations located in the West Coast Basin and Central Basin (currently 48).
- Conduct high level reviews and when necessary provide feedback to the various regulatory agencies including EPA, DTSC, RWQCB.

WRD awarded $7.28M in Proposition 1 grant funds to cleanup a Perchlorate and VOC “hot spot” in the City of Vernon (March 30, 2017).

Contact Brian Partington at bpartington@wrd.org (562.275.4249)

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

(WIN) WATER INDEPENDENCE NOW PROGRAM

COLLECTION OF PROJECTS TO ELIMINATE REMAINING DEMAND FOR IMPORTED WATER

WIN

WATER INDEPENDENCE NOW

A key to developing independence from imported water is the development of local recycled water sources.

PROJECTS TO:

- CAPTURE AND CONSERVE ADDITIONAL STORMWATER
- INCREASE USE OF RECYCLED WATER FOR GROUNDWATER REPLENISHMENT

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

(WIN) WATER INDEPENDENCE NOW PROGRAM

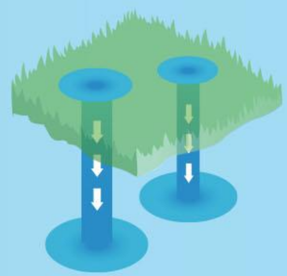
GOAL IS TO REPLACE IMPORTED WATER WITH LOCALLY AVAILABLE WATER (E.G. RECYCLED WATER) FOR AQUIFER REPLENISHMENT.

WIN
WATER INDEPENDENCE NOW

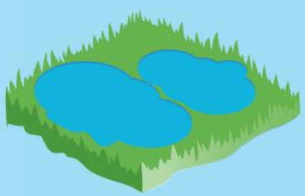
BENEFITS OF RECYCLED WATER OVER IMPORTED WATER:

INCREASED RELIABILITY

COST-EFFECTIVE



LOCALLY CONTROLLED



DROUGHT PROOF

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

GROUNDWATER RELIABILITY IMPROVEMENT ADVANCED WATER TREATMENT FACILITY

GRIP IS THE CORNERSTONE OF WRD'S WIN PROGRAM

GRIP
GROUNDWATER RELIABILITY IMPROVEMENT PROJECT

GRIP WILL PROVIDE 21,000 ACRE-FEET PER YEAR OF RECYCLED WATER IN PLACE OF EXPENSIVE IMPORTED WATER.

UPON COMPLETION, GROUNDWATER BASINS WILL BE COMPLETELY LOCALLY SUSTAINABLE

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

GROUNDWATER RELIABILITY IMPROVEMENT ADVANCED WATER TREATMENT FACILITY

WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

Thank You!

Brian Partington

bpartington@wrd.org

562.275.4249

GROUNDWATER RELIABILITY IMPROVEMENT PROJECT

WATER INDEPENDENCE NOW

Speaker #2

DDW Regulatory Update

Jeff O'Keefe

SWRCB - DDW

Jeff.okeefe@waterboards.ca.gov

California Drinking Water Program Regulatory Update

WRD Groundwater Quality Workshop

August 9, 2017

Jeff O’Keefe, P.E., Chief
Southern California Coast Section
Southern California Field Operations Branch
SWRCB – Division of Drinking Water

Presentation Outline

1. 1,2,3-TCP Maximum Contaminant Level (MCL)
2. Hexavalent Chromium MCL Removal
3. Lead and Copper – Recent Developments
4. Revised Total Coliform Rule
5. Perchlorate MCL Revision
6. Potable Reuse of Recycled Water
7. ELAP Regulations
8. Cross-Connection Control regulations

California's Division of Drinking Water

– Northern California Field Operations Branch

– Southern California Field Operations Branch

– Program Management Branch

- Technical Operations Section
- Environmental Laboratory Accreditation Program (ELAP)
- Quality Assurance Section - **NEW**

District Offices and LPAs:

- 7500+ Water Systems
- 5 Regions
- 24 State District Offices
- 30 County Local Primacy Agencies

1,2,3-TCP Maximum Contaminant Level

(1,2,3-Trichloropropane)

- Synthetic organic chemical (SOC)
  - Industrial solvent, degreaser
  - Ingredient in soil fumigants widely used for many decades
- Public Health Goal (PHG) established 2009
  - 0.7 ppt (parts per trillion)
  - Possible carcinogen
- **MCL adopted by Board on July 18, 2017**
  - **5 ppt (DLR also 5 ppt)**
- GAC is a best available technology

1,2,3-TCP Maximum Contaminant Level

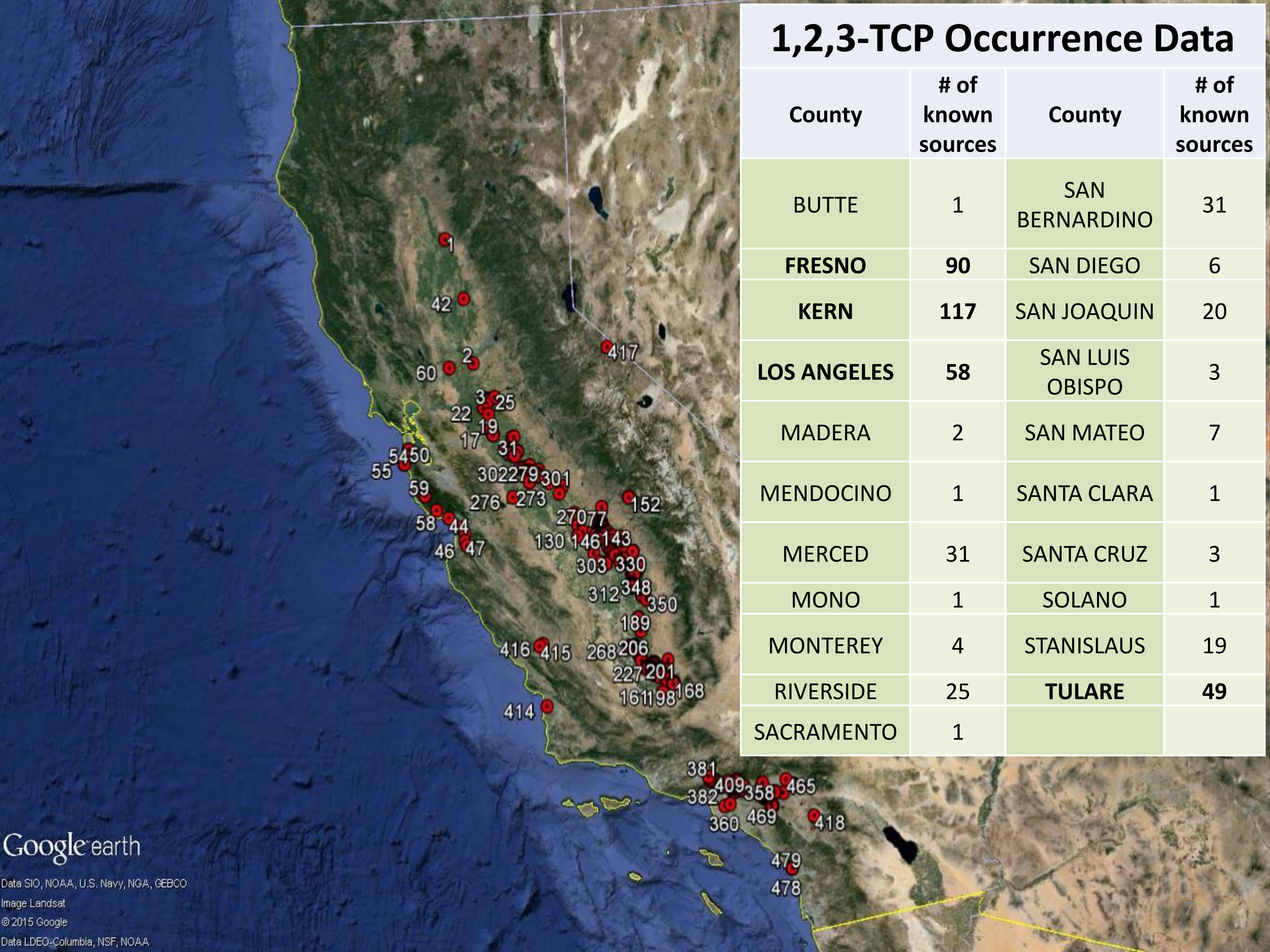
- Regulation will be effective October 2, 2017
- Initial monitoring period begins January 1, 2018
  - 4 quarterly samples
- Compliance determination
  - For PWS serving >3,300 population, compliance based on initial, confirmation sample(s), and 6 monthly samples
  - For PWS serving <3,300 population, compliance based annual average of initial, confirmation sample(s), and quarterly samples
- Grandfathering of previous monitoring
  - Results collected within two calendar years of effective date
  - Substituted for same quarter of initial period
    - 2nd quarter 2016 for 2nd quarter 2018
  - Only substitute 3 of 4 required initial samples
  - Request must be in writing to DDW

1,2,3-TCP Maximum Contaminant Level

- 2001-2015 Occurrence Data:
  - **471 wells with confirmed detections above 5 parts per trillion (ppt)**
  - Range of Detections: **5 ppt to >10,000 ppt**
- Vast majority of detections in groundwater
  - Most in Central Valley (Kern, Fresno, Tulare counties)
  - Riverside – 25 sources
  - San Bernardino - 31 sources
  - Los Angeles – 58 sources

1,2,3-TCP Occurrence Data

County	# of known sources	County	# of known sources
BUTTE	1	SAN BERNARDINO	31
FRESNO	**90**	SAN DIEGO	6
KERN	**117**	SAN JOAQUIN	20
LOS ANGELES	**58**	SAN LUIS OBISPO	3
MADERA	2	SAN MATEO	7
MENDOCINO	1	SANTA CLARA	1
MERCED	31	SANTA CRUZ	3
MONO	1	SOLANO	1
MONTEREY	4	STANISLAUS	19
RIVERSIDE	25	**TULARE**	**49**
SACRAMENTO	1		



Hexavalent Chromium (Cr 6)

- On May 31, 2017, the Superior Court of Sacramento County invalidated the Cr 6 MCL stating the regulator did not adequately document the economic feasibility of complying with the MCL
- On August 1, 2017 the State Board adopted a resolution to remove the current Cr 6 MCL
- Staff will begin the process of having the regulatory text deleted, which should take effect in late September 2017, and develop a new standard as soon as possible

Lead and Copper Rule – DDW Recommendations

- March 7, 2016, DDW sent a letter to all community and nontransient noncommunity water systems
- Recommendations on improving public access to Lead and Copper Rule (LCR) information
- Reminder to provide sample results to those participating in LCR tap sampling:
  - w/in 30 days of receiving the results from lab, and;
  - w/in 1-2 working days if lead and/or copper levels over the respective action levels are found

http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/leadandcopperrule.shtml

Lead in Drinking Water

- U.S. EPA is working to issue a **Revised Federal Lead & Copper Rule**
- EPA Resources on its Web Site
  - Basic Information about Lead in Drinking Water
  - Lead in Drinking Water at Schools and Child Care Facilities
  - 3Ts for Reducing Lead in Drinking Water in Schools
- State Board priority regulation
- **NEW** Electronic submittal of lead and copper tap sample results using Lab to State Portal
  - Training for laboratories provided on 6/20/2017, check with your certified lab

Lead Sampling in Schools

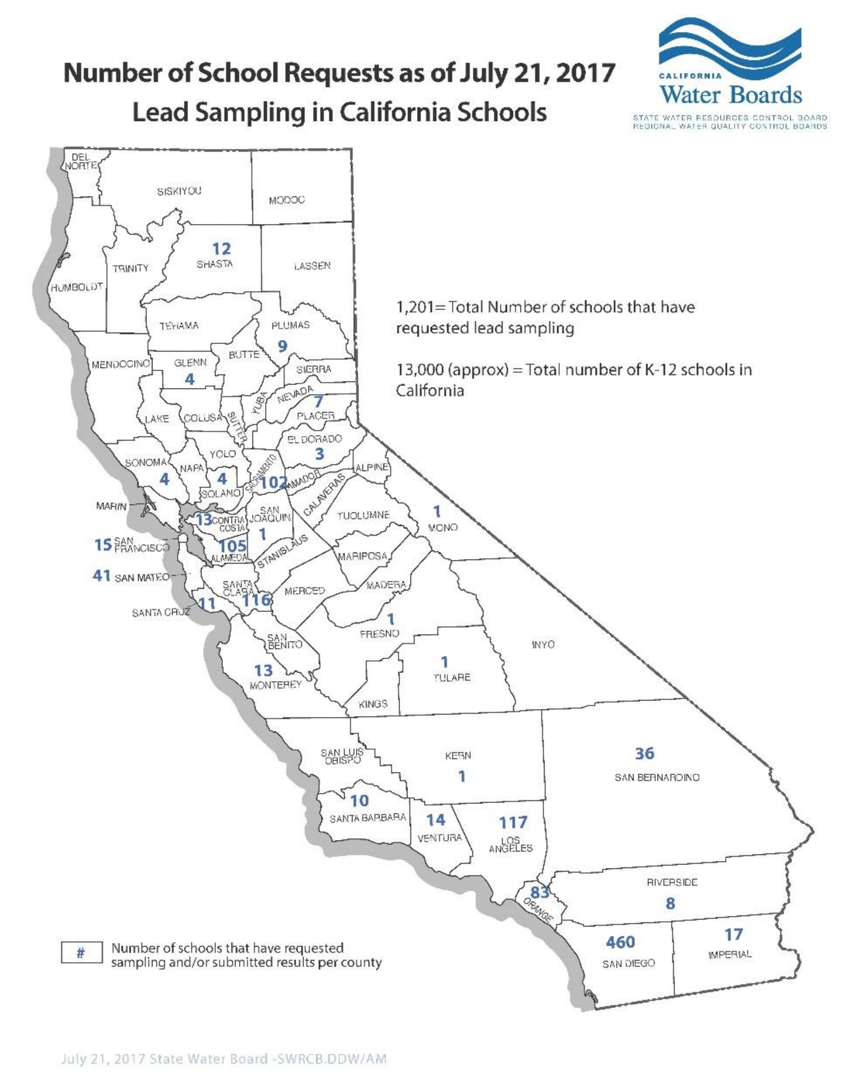
- Meetings with the Governors office and Department of Education throughout 2016 resulted in the decision for DDW to issue an amended permit to all community water systems who serve a K-12 school
- Permit requires water systems to sample at school (5 sample sites) when a school official makes a request in writing to the water system for sampling assistance
- Permits issued January 17, 2017 along with a media release and resources on the DDW website (FAQs, details of sampling procedures, lab data submittals)

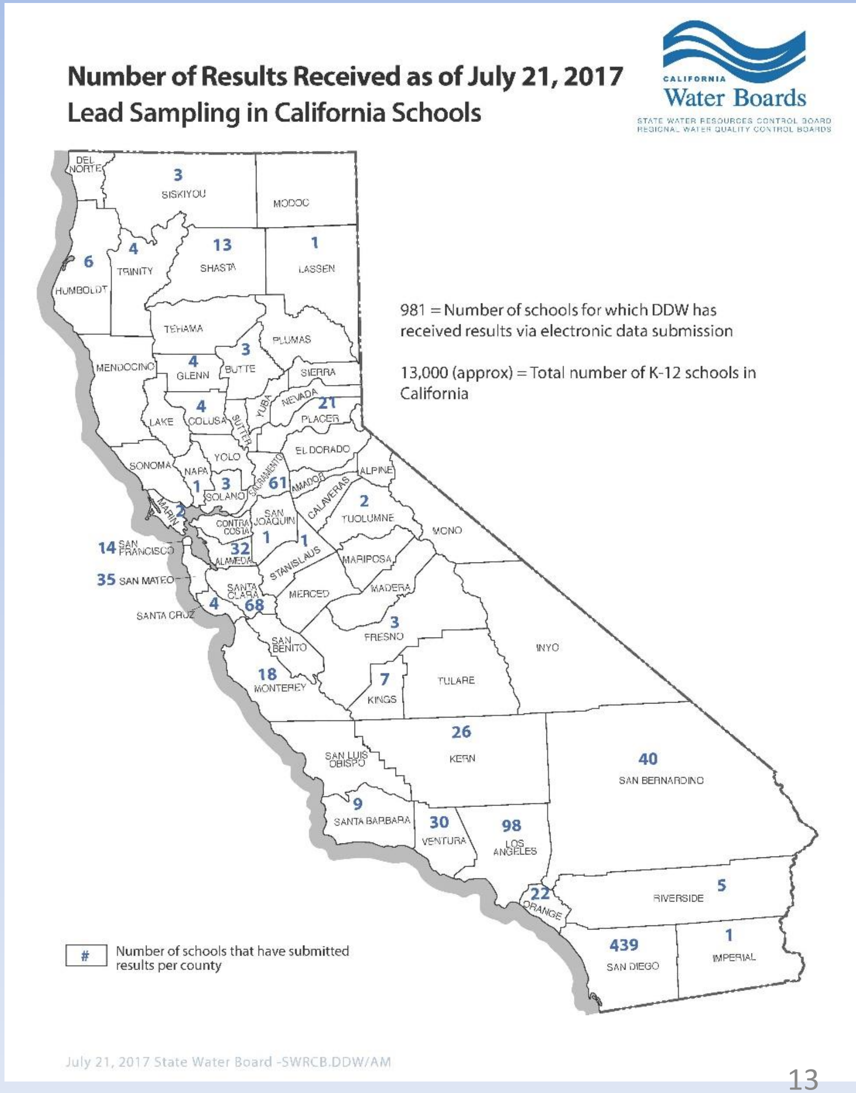
http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/leadsamplinginschools.shtml

Lead Sampling in Schools

- Schools can request sampling assistance anytime prior to November 1, 2019.
- As of July 21, 2017, a total of 1,201 schools have provided a copy of their request letter to the Division, and 981 schools have submitted results
- Schools will be responsible for corrective actions (removing/replacing drinking fountains, POU devices, etc.)
- Drinking Water for Schools Grant Program
  - $9.5 M available, serving small DACs

School Requests and Results Received





Lead Service Lines: Requirements of SB 1398

- All public water systems must compile an inventory of known lead service lines by July 1, 2018
- PWS must also identify areas that may have lead service lines and identify any areas where the PWS cannot identify the service line material
- By July 1, 2020, PWS will be required to propose a schedule to replace all the known lead service and service lines constructed of unknown material
- SB-427 has been introduced to change and clarify - the requirement should only apply to community water systems (bill is still in committee)
- DDW will have a web portal available in Fall 2017 to begin receiving documents for the water system's inventory.
- FAQs, guidance and updates available on DDW website

http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/lead_service_line_inventory_pws.shtml

Revised Total Coliform Rule

- Federal RTCR effective April 1, 2016
- Interim Period before state adoption
  - All PWS must comply with existing CA rule and Federal RTCR
- CA regulation in development and anticipated in 2018
  - Draft regulation available on DDW website

Revised Total Coliform Rule

- Overall approach is to "Find and Fix" problems
- Minor changes to routine and repeat sampling
  - No changes to # of samples per week or month
  - 3 repeat samples for each TC+ routine
    - Existing location, U/S and D/S within 5 service conn.
    - PWS collecting 1 routine/month, 4 repeats still needed
- Established E.coli MCL
  - EC+ Routine, TC+ Repeat
  - TC+ Routine, EC+ Repeat
  - EC+ Routine, no repeats collected
  - TC+ Routine, fail to analyze for E.coli
- Established Coliform Treatment Technique

Revised Total Coliform Rule

Level 1 Coliform Treatment Technique

- Triggers when:
  - > 5% of samples TC+, if collecting 40 or more samples/month
  - 2 or more samples TC+, if collecting fewer than 40 samples/month
  - Failure to collect all repeats following TC+ routine
- Water system must complete Level 1 assessment and make corrective actions within 30 days
- Issue Tier 2 public notice within 30 days
  - INTERIM PERIOD ONLY

Revised Total Coliform Rule

Level 2 Coliform Treatment Technique

- Triggers when:
  - E. Coli MCL violation
  - Second Level 1 trigger within a 12-month period
- Issue Tier 1 Public Notice by end of day
- Contact DDW (or LPA) by end of day
- DDW (or LPA) staff will conduct Level 2 assessment and water system must complete and make corrective actions within 30 days

Revised Total Coliform Rule

- Failure to conduct the Level 1 or Level 2 assessments within 30 days or failure to complete corrective actions is a violation requiring a Tier 2 Public Notice
- New requirements for seasonal water systems to follow approved start-up protocol including sampling before serving water to the public

http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/rtcr.shtml

Perchlorate MCL Revision

- Current MCL 6 ug/L is greater than revised Public Health Goal of 1 ug/L (2015).
- Current Detection Level for Reporting (DLR) is 4 ug/L.
- July 5 Board meeting decision to initiate two-step process for revising perchlorate MCL
  1. Amend Title 22 regulations to lower DLR
  2. Gather occurrence data below 4 ug/L for use in considering a revised perchlorate MCL

Potable Reuse of Recycled Water

- ***Groundwater Recharge*** is "the planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system"
- ***Surface Water Augmentation*** is "the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply"
- ***Direct Potable Reuse*** is "the planned introduction of recycled water either directly into a public water system, as defined in Section 116275 of the Health and Safety Code, or into a raw water supply immediately upstream of a water treatment plant"

Potable Reuse - Statutory Requirements

Task	Deadline	Status
Adopt Groundwater Recharge Regulations	Dec 31, 2013	✓
Adopt Surface Water Augmentation Regulations	Dec 31, 2016	Moving quickly
Prepare Draft Report on Expert Panel Recommendations & Research Status	June 30, 2016	✓
Release Public Review Draft Report on Feasibility of Developing Direct Potable Reuse Criteria	Sept 1, 2016	✓
Submit Final Report to the Legislature	Dec 31, 2016	✓

Surface Water Augmentation Regulations

- GW recharge regulations built over 38 years experience
- **Key components**
  - Pathogen reduction requirements – reclamation plant + Surface Water Treatment Plant (SWTP)
  - Reservoir criteria, meaningful environmental buffer
  - Wastewater source control
  - Full advanced treatment (RO + advanced oxidation)
  - Monitoring for regulated & unregulated chemicals
- Public Hearing Sept 7, comment period closes Sept 12, 2017
- 0 approved SWA projects in CA; 3 SWA projects in planning

Direct Potable Reuse - Feasibility

- **Public health is most important**
- Expert Panel & Advisory Group
- Research needs & knowledge gaps
- Lessons learned from other projects
- Crafting effective criteria
- Deliberate and phased approach

Environmental Laboratory Accreditation Program (ELAP)

- Preliminary draft regulations released on 7/24/2017 and six stakeholder workshops were held statewide from 7/25/2017 to 8/3/2017
- Comments can be submitted by email to elapca_comments@waterboards.ca.gov
  Use subject line: ELAP Preliminary Draft Regulations Comments
- Board adoption expected in 2018

Cross-Connection Control Regulations

- Work on updating these regulations, which are currently in CCR Title 17, is anticipated to begin soon

Questions?

Jeff O'Keefe
Jeff.okeefe@waterboards.ca.gov
(818) 551-2068

Speaker #3

Well Profiling Tool to Identify Zones of Contamination in Water Supply Wells

Noah Heller

BESST Inc.

nheller@besstinc.com

Selective Groundwater Extraction

Profiling Groundwater Production Wells and Temporary Long Screened Test Wells For Zonal Flow, Zonal Water Chemistry

By

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BESST INC.
GLOBAL SUBSURFACE TECHNOLOGIES


Flow and Water Chemistry Profiling

Basic Purpose Historically: To Understand Zonal Flow and Water Chemistry into Well

Why?: Lost Production and Water Quality Problems

Historical Well Profile Frequency – Rare (1970-2006)

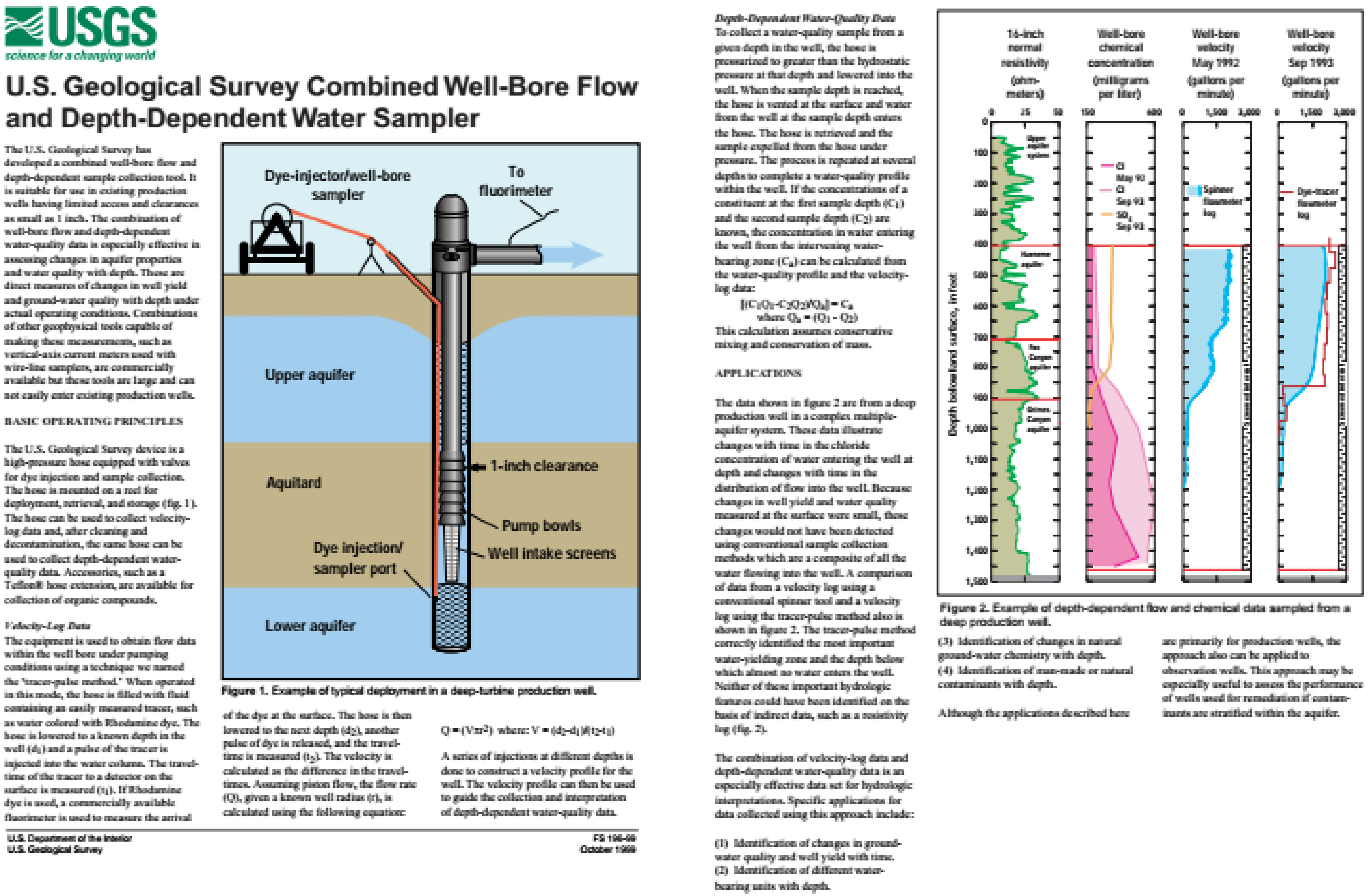
Why? Cost, Relatively New Idea, Not enough institutional and market sector knowledge

GOALS

- AVOID TREATMENT
- MINIMIZE TREATMENT
- UNDERSTAND STRATIFICATION OF CONTAMINANTS IN WATER RESOURCE AQUIFERS
- USE GEOCHEMICAL STRTIFICATION DATA TO SELECT TEST HOLE LOCATIONS FOR NEW WELLS
- USE IN LONG SCREENED, TEMPORARY TEST WELLS TO INCREASE DATA DENSITY (AVOID WATER QUALITY FAILURES FOR NEW WELLS)
- SUPPORT FOCUSED WELL REHABILITATION (BEFORE AND AFTER PERFORMANCE METRIC – ZONAL SPECIFIC CAPACITY)

Dr. John Izbicki

- Over 90 Peer Reviewed Articles
- Recipient of California Groundwater Resources Association Lifetime Achievement Award
- Inventor of Dye Tracer



USGS science for a changing world

U.S. Geological Survey Combined Well-Bore Flow and Depth-Dependent Water Sampler

The U.S. Geological Survey has developed a combined well-bore flow and depth-dependent sample collection tool. It is suitable for use in existing production wells having limited access and clearances as small as 1 inch. The combination of well-bore flow and depth-dependent water-quality data is especially effective in assessing changes in aquifer properties and water quality with depth. These are direct measures of changes in well yield and ground-water quality with depth under actual operating conditions. Combinations of other geophysical tools capable of making these measurements, such as vertical-axis current meters used with wire-line samplers, are commercially available but these tools are large and can not easily enter existing production wells.

BASIC OPERATING PRINCIPLES

The U.S. Geological Survey device is a high-pressure hose equipped with valves for dye injection and sample collection. The hose is mounted on a reel for deployment, retrieval, and storage (fig. 1). The hose can be used to collect velocity-log data and, after cleaning and decontamination, the same hose can be used to collect depth-dependent water-quality data. Accessories, such as a Teflon® hose extension, are available for collection of organic compounds.

Velocity-Log Data

The equipment is used to obtain flow data within the well bore under pumping conditions using a technique we named the 'tracer-pulse method.' When operated in this mode, the hose is filled with fluid containing an easily measured tracer, such as water colored with Rhodamine dye. The hose is lowered to a known depth in the well (d_1) and a pulse of the tracer is injected into the water column. The travel-time of the tracer to a detector on the surface is measured (t_1). If Rhodamine dye is used, a commercially available fluorimeter is used to measure the arrival

Figure 1. Example of typical deployment in a deep-turbine production well.

of the dye at the surface. The hose is then lowered to the next depth (d_2), another pulse of dye is released, and the travel-time is measured (t_2). The velocity is calculated as the difference in the travel-times. Assuming piston flow, the flow rate (Q), given a known well radius (r), is calculated using the following equation:

$$Q = (V\pi r^2) \quad \text{where: } V = (d_2 - d_1)/(t_2 - t_1)$$

A series of injections at different depths is done to construct a velocity profile for the well. The velocity profile can then be used to guide the collection and interpretation of depth-dependent water-quality data.

Depth-Dependent Water-Quality Data

To collect a water-quality sample from a given depth in the well, the hose is pressurized to greater than the hydrostatic pressure at that depth and lowered into the well. When the sample depth is reached, the hose is vented at the surface and water from the well at the sample depth enters the hose. The hose is retrieved and the sample expelled from the hose under pressure. The process is repeated at several depths to complete a water-quality profile within the well. If the concentrations of a constituent at the first sample depth (C_1) and the second sample depth (C_2) are known, the concentration in water entering the well from the intervening water-bearing zone (C_a) can be calculated from the water-quality profile and the velocity-log data:

$$[(C_1Q_1 - C_2Q_2)/Q_a] = C_a$$
$$\text{where } Q_a = (Q_1 - Q_2)$$

This calculation assumes conservative mixing and conservation of mass.

APPLICATIONS

The data shown in figure 2 are from a deep production well in a complex multiple-aquifer system. These data illustrate changes with time in the chloride concentration of water entering the well at depth and changes with time in the distribution of flow into the well. Because changes in well yield and water quality measured at the surface were small, these changes would not have been detected using conventional sample collection methods which are a composite of all the water flowing into the well. A comparison of data from a velocity log using a conventional spinner tool and a velocity log using the tracer-pulse method also is shown in figure 2. The tracer-pulse method correctly identified the most important water-yielding zone and the depth below which almost no water enters the well. Neither of these important hydrologic features could have been identified on the basis of indirect data, such as a resistivity log (fig. 2).

The combination of velocity-log data and depth-dependent water-quality data is an especially effective data set for hydrologic interpretations. Specific applications for data collected using this approach include:

(1) Identification of changes in ground-water quality and well yield with time.
(2) Identification of different water-bearing units with depth.

Figure 2. Example of depth-dependent flow and chemical data sampled from a deep production well.

(3) Identification of changes in natural ground-water chemistry with depth.
(4) Identification of man-made or natural contaminants with depth.

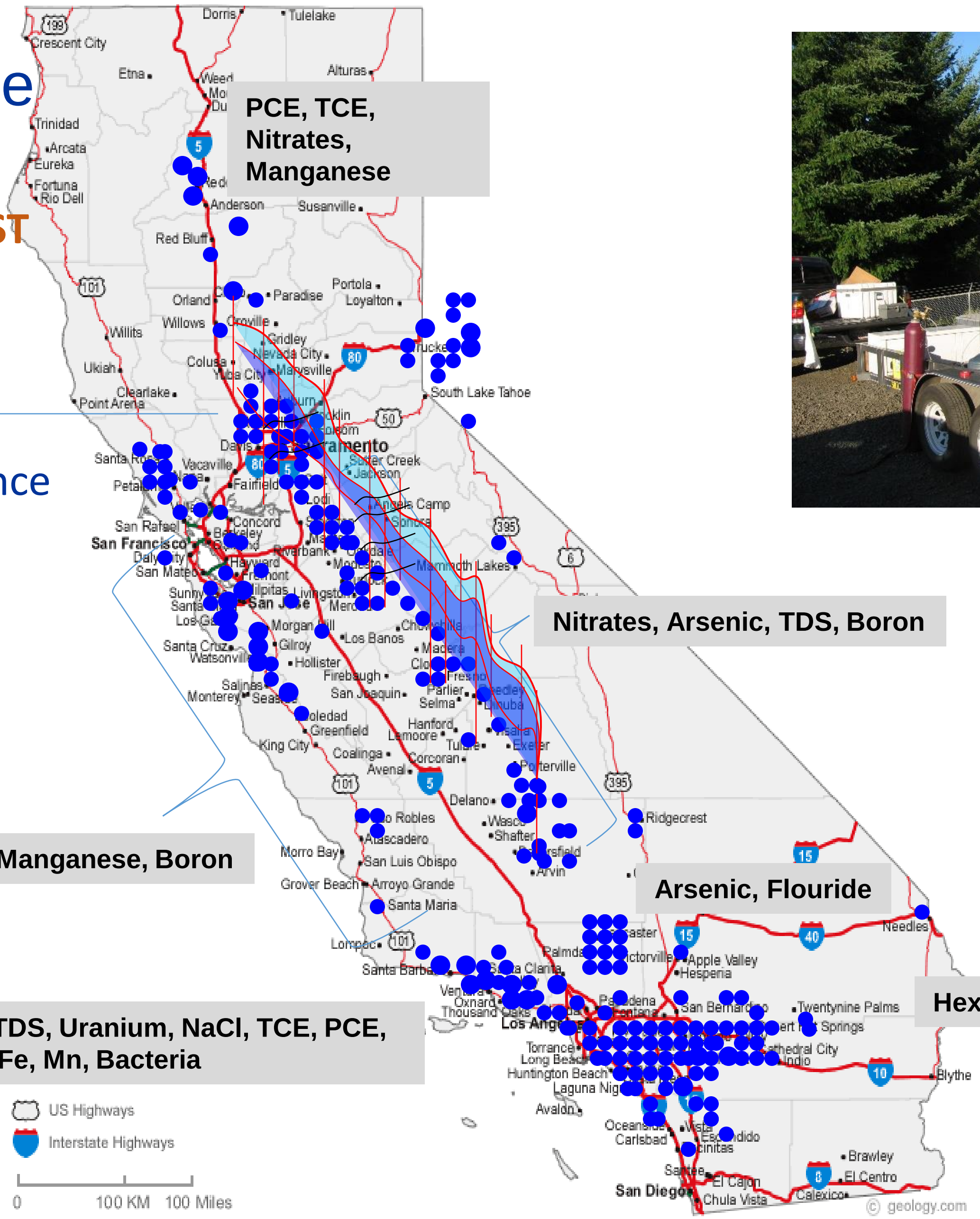
Although the applications described here are primarily for production wells, the approach also can be applied to observation wells. This approach may be especially useful to assess the performance of wells used for remediation if contaminants are stratified within the aquifer.

U.S. Department of the Interior
U.S. Geological Survey

FS 196-99
October 1999

2005-2017: BESST Selective Groundwater Extraction Database California

= 1 – 10 Production Wells Profiled by BESST

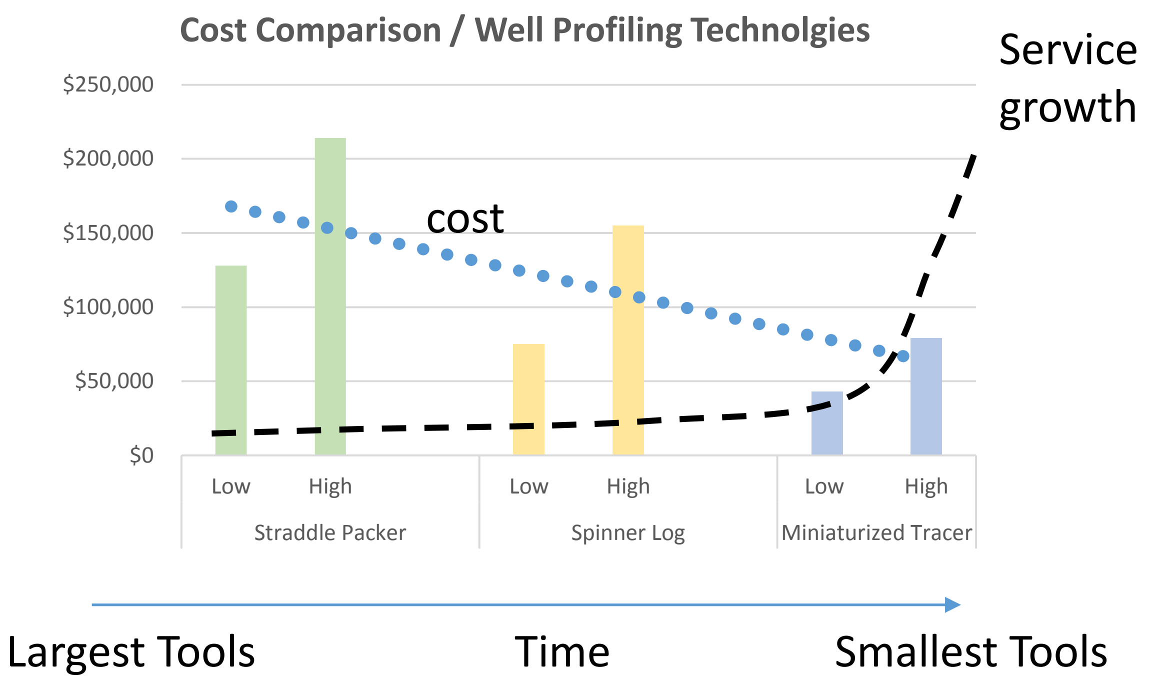


- >700 Municipal Production Wells Profiled Since 2005
- Largest Stratified, Dissolved Aqueous Phase Geochemistry Data Base in California for Production Wells

How Has Miniaturization Changed Frequency of Well Profiling Groundwater Production Wells?

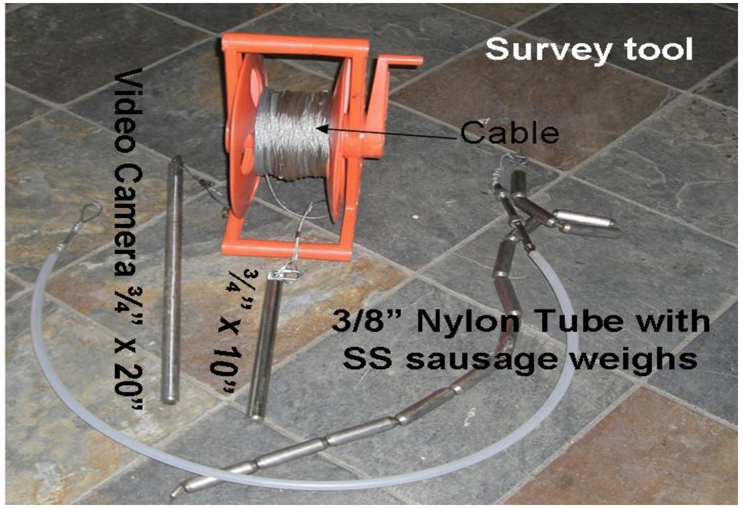
Single Diameter Well		
Technology: Spinner Log Survey	Low	High
Remove Pump	$8,000	$ 12,000.00
Install and Rent Test Pump with Access Pipe	$30,000	$ 80,000.00
Perform Spinner Log Survey	$3,000	$ 5,000.00
Perform Water Sampling Survey (5 to 8 Samples)	$4,000	$ 6,000.00
Reinstall Pump	$8,000	$ 12,000.00
Consulting Planning. Workplan, Field Fees	$12,000	$ 20,000.00
Consulting Fee	$10,000	$ 20,000.00
Total	$75,000	$ 155,000.00
Single or Telescoping Well		
Technology: Straddle Packer Survey		
Remove Pump	$8,000	$ 12,000.00
Install Straddle Packer (3 to 5 Zone Tests)	$90,000	$ 150,000.00
Perform Spinner Log Survey	$0	$0
Perform Water Sampling Survey (5 to 6 Samples)	$0	$0
Reinstall Pump	$8,000	$ 12,000.00
Consulting Planning. Workplan, Field Fees	$12,000	$ 20,000.00
Consulting Fee	$10,000	$ 20,000.00
Total	$128,000	$ 214,000.00
Technology: Miniaturized Tracer / Water Samp.		
Remove Pump	$ -	$ 12,000.00
Install Straddle Packer (3 to 5 Zone Tests)	$ -	$ -
Perform Spinner Log Survey	$ -	$ -
Perform Water Sampling Survey (5 to 6 Samples)	$ -	$ -
Perform Tracer / Water Sampling Survey	$ 25,000.00	$ 35,000.00
Reinstall Pump	$ 8,000.00	$ 12,000.00
Consulting Planning. Workplan, Field Fees	$ 5,000.00	$ 10,000.00
Consulting Fee	$ 5,000.00	$ 10,000.00
Total	$ 43,000.00	$ 79,000.00

COST versus Technology Apparatus Size versus Rate of Groundwater Profiling Growth

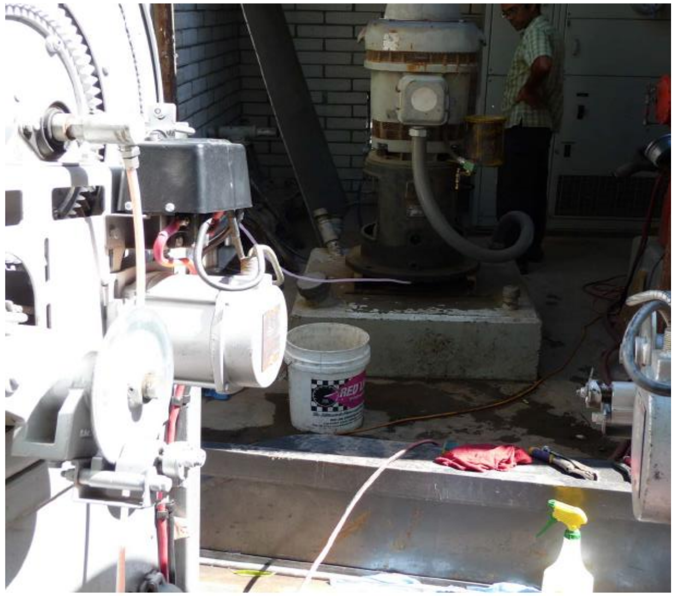


As profiling tools get smaller and wells more accessible, profiling cost decreases

Well Access and Incrementally Tiered Access Survey



Vent Tubes, Bolt Holes, Plug Holes, Existing Sounding Pipes



Pump Pedestal (Block) Coring

First core hole attempt on north side of 20 inch well (with 14” bowls) found less than ¾” annular clearance with pump column.

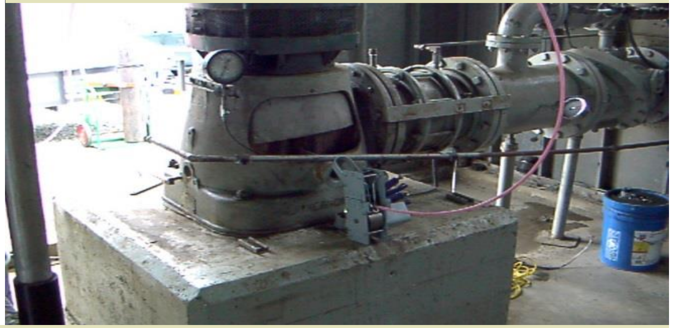
Core hole was drilled at 5 Degree angle from vertical and at 1.5” in diameter.

Portable drill is adjustable to various angles and is mounted directly to pedestal.

Pedestal Core

Elliptical Piece of Metal From Outer Casing generated from steep angle core hole.

Core Hole # 2 was successful and found 5+ inches of annulus on south side of well.



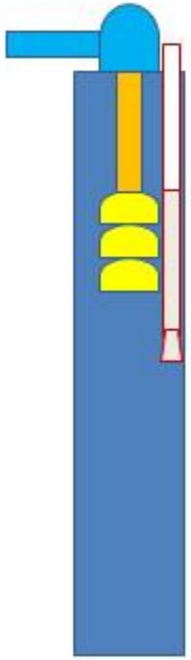
Approximate drill time for each of the core holes (1st attempt north side of well and 2nd attempt (successful) on south side of well was 2.5 hours per hole. Coring cost was about $125 / hr. The core hole was temporarily lined with a section of PVC pipe to protect the tracer hose from scraping and tearing against any rough surfaces within the hole.

Lift and Shift

No Access Pipe(s)

Remove Primary Pump and Reinstall Primary Pump With Access Pipe(s)

Access Pipe Layout with Bottom End Cone Flare



Riser Pipe Requirements:
Either
1) 1.25" ID x 1.66" OD
2) 1.00" ID x 1.31" OD

And,

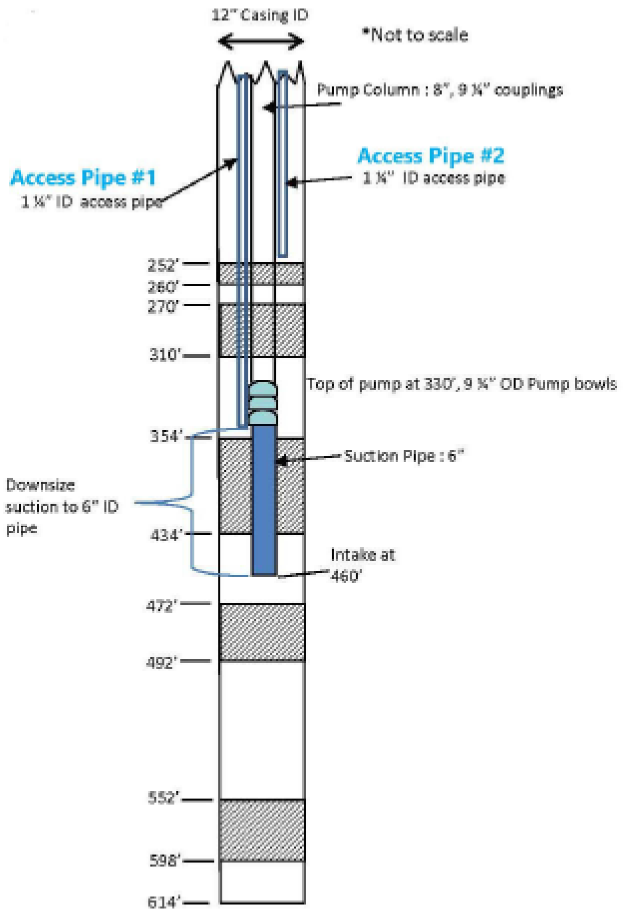
3) Flush threaded PVC above bowls
4) Flush threaded stainless steel along Bowls and extending 10' feet past bowls.
5) Flared, smoothed, rounded of bottom.

Optional:

6) Client can used galvanized steel pipe with couplings provided there is enough annular space.

Well Screen above Pump Scenario

If the primary pump and the intake are located within the well screen then alternate strategy can be taken by installing two access pipes as shown in Figure 2 below.



Remove Primary Pump and Reinstall With Test Pump and Access Pipe(s)

Access Pipe Installation

Assuming that the position of the primary pump is located above the well screen, the bottom of the access pipe should extend at least 10 feet below the pump intake and still be above the well screen.

The access pipe should be secured firmly to the pump column at intervals to prevent movement of the pipe as shown in the following examples.

Figure 2: Riser banded to pump bowls

Figure 3: Stainless Steel Pipe attached to pump

The access pipe should terminate above the wellhead, and should be smoothed as well to prevent snagging of tools or sampling tubing.

Brief Description of Conventional Technologies

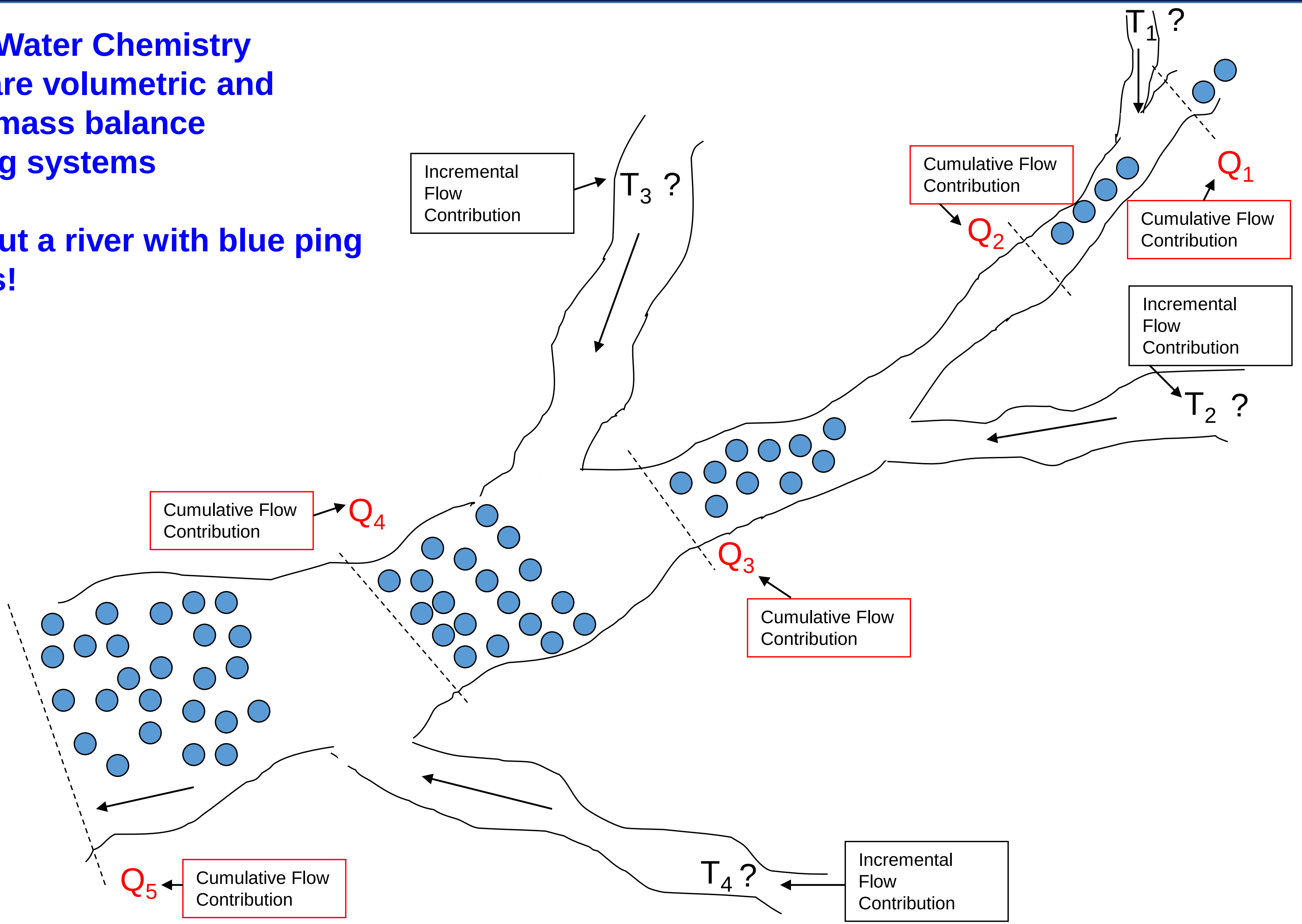
Straddle Packer

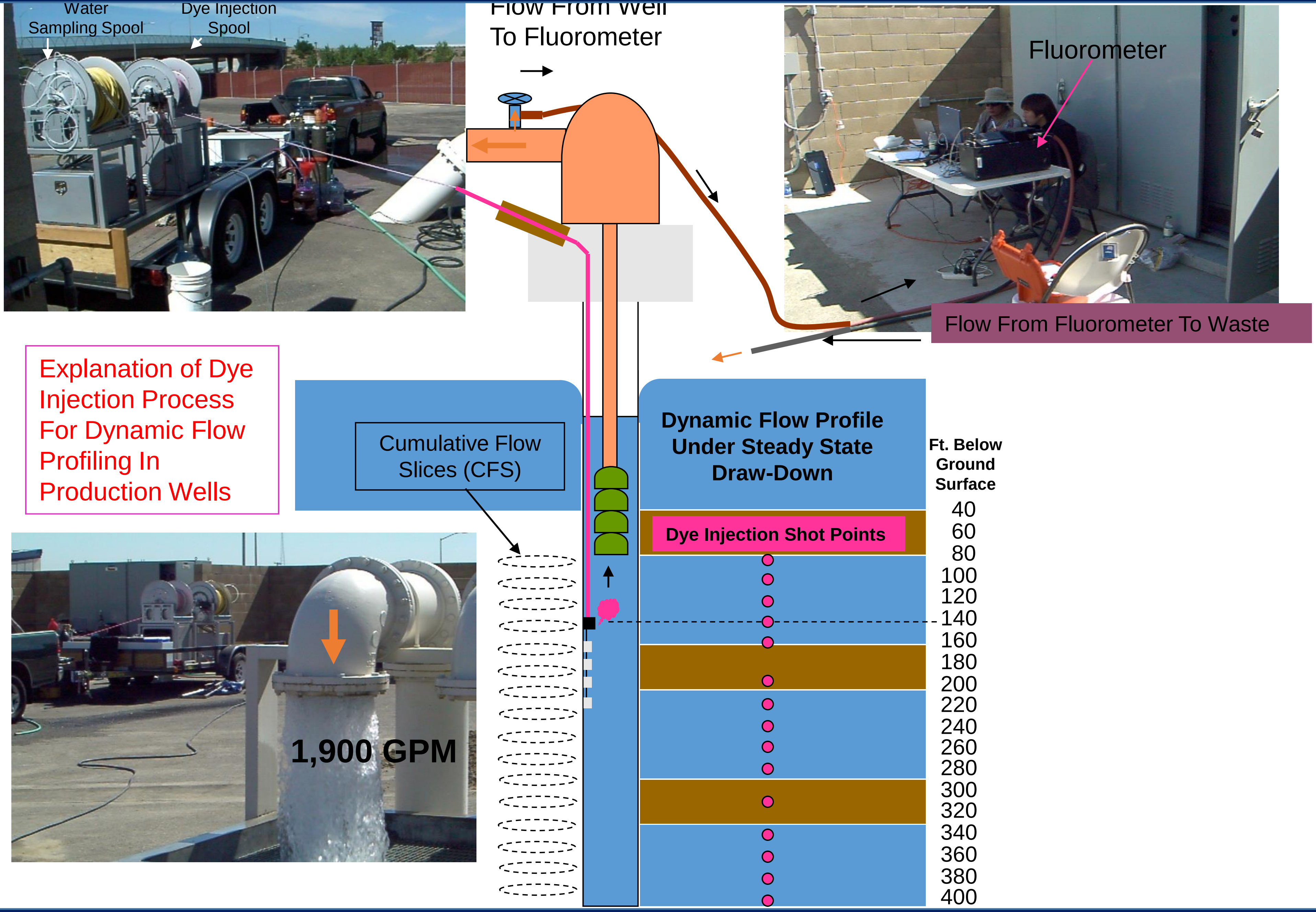
Spinner

Tracer Technology

Flow and Water Chemistry Profiling are volumetric and chemical mass balance accounting systems

Think about a river with blue ping pong balls!




Water
Sampling Spool
Dye Injection
Spool
Flow From Well
To Fluorometer
Fluorometer
Flow From Fluorometer To Waste
Explanation of Dye Injection Process For Dynamic Flow Profiling In Production Wells
Cumulative Flow Slices (CFS)
Dynamic Flow Profile Under Steady State Draw-Down
Ft. Below Ground Surface
Dye Injection Shot Points
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
1,900 GPM

Cumulative Flow Can Be Defined As

$$Q_1 = V_1 \times A_1$$

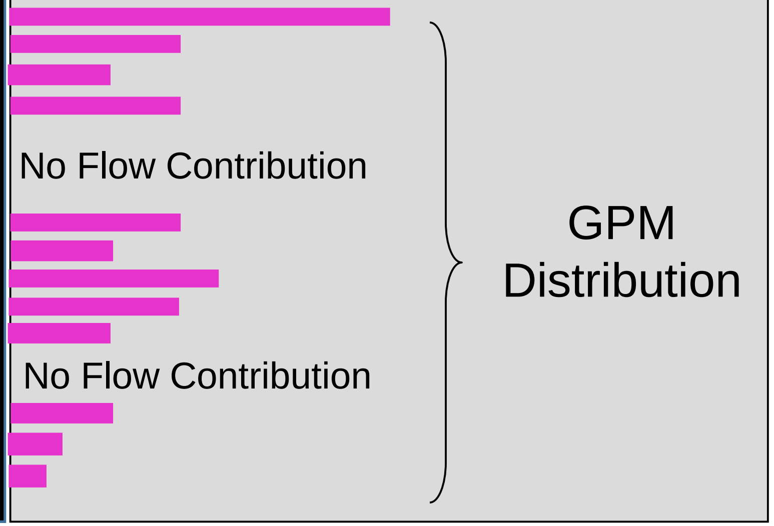
$$V_1 = (d_1 - d_2)/(t_1 - t_2)$$

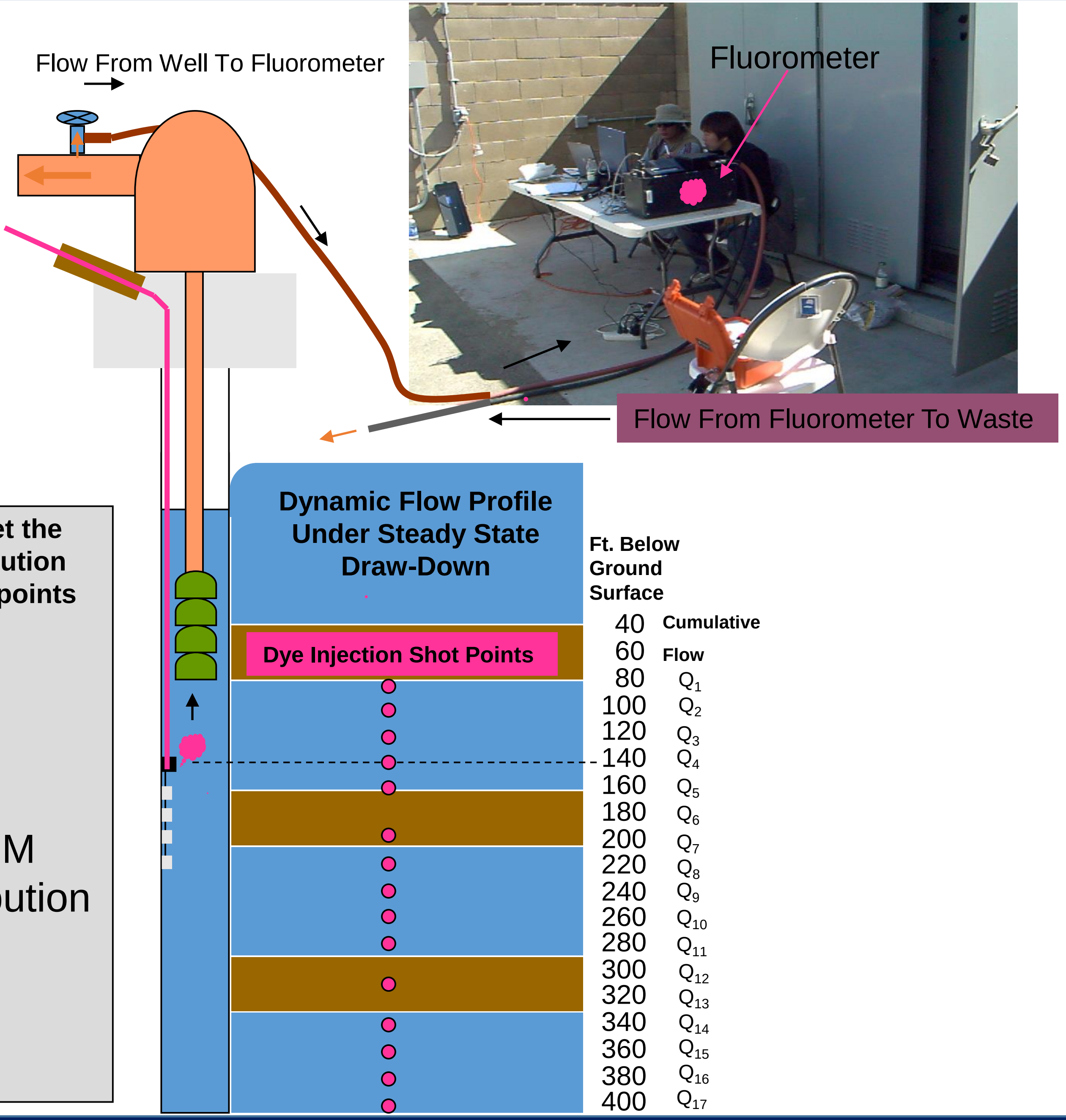
$$A1 = \pi r^2$$

Incremental Flow Can Be Defined As

$$Q_1 - Q_2$$

When we subtract Q_2 from Q_1, we get the incremental flow (IF or GPM) contribution between the two measured injection points

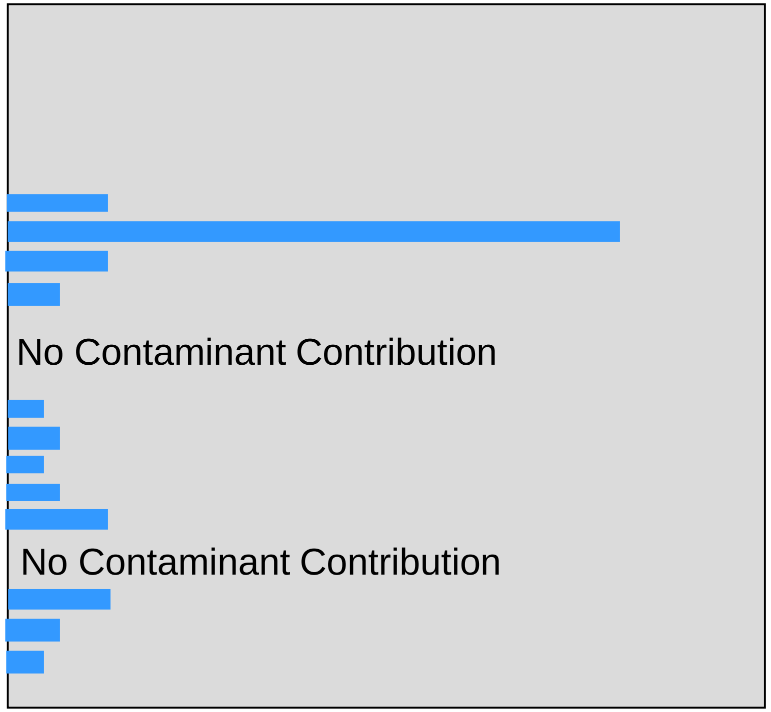


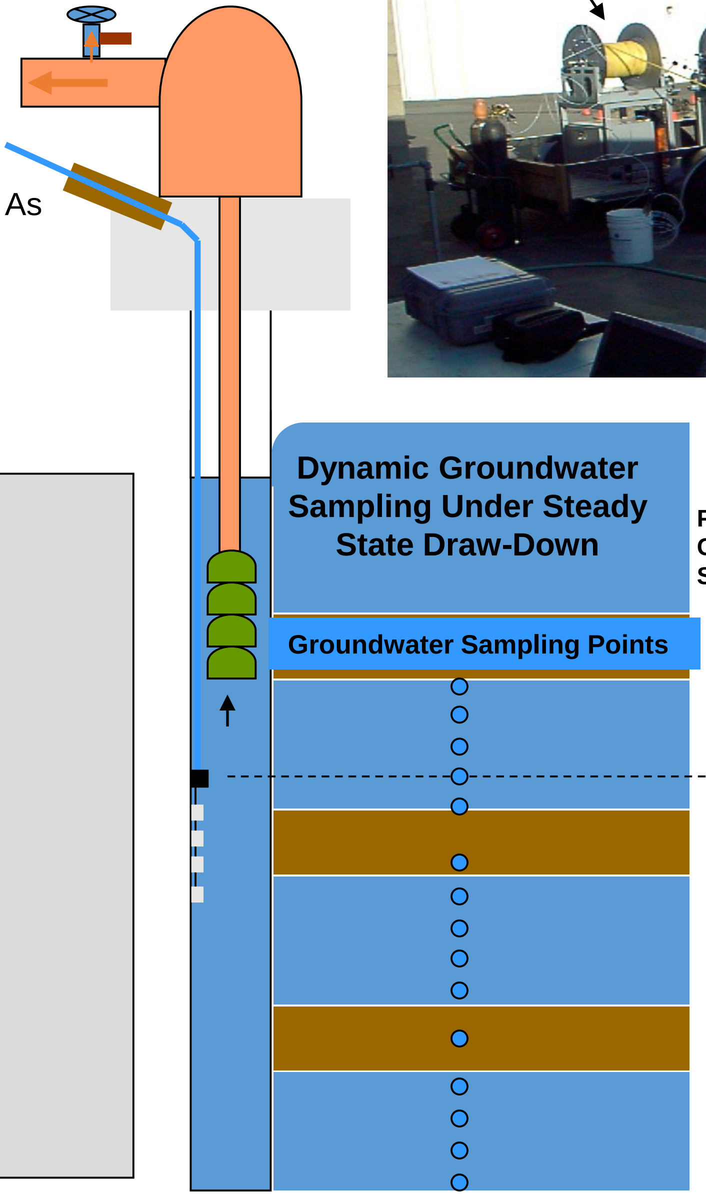


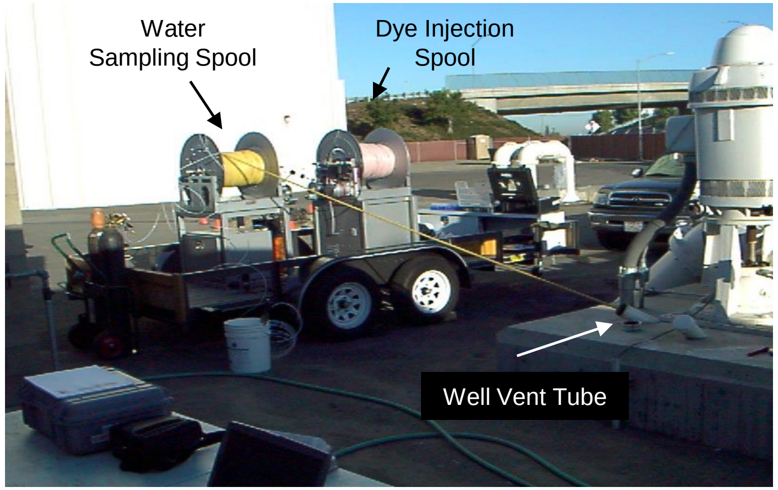
Average Cumulative Contaminant Concentration Can Be Defined As

$$Ca_1 = (Q_1C_1 - Q_2C_2)/(Q_1-Q_2)$$

Incremental Average Contaminant Concentration between two imaginary flow planes within the well can be expressed



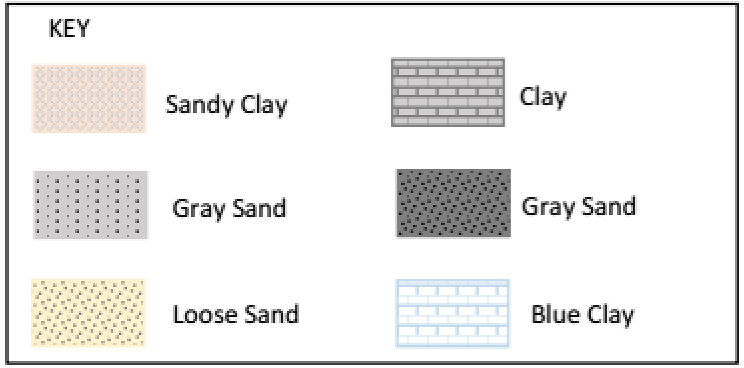


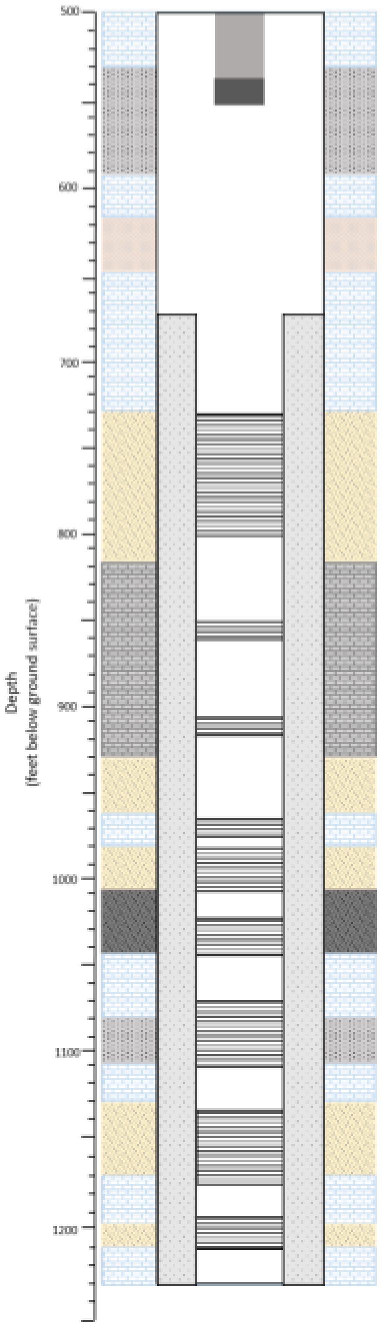


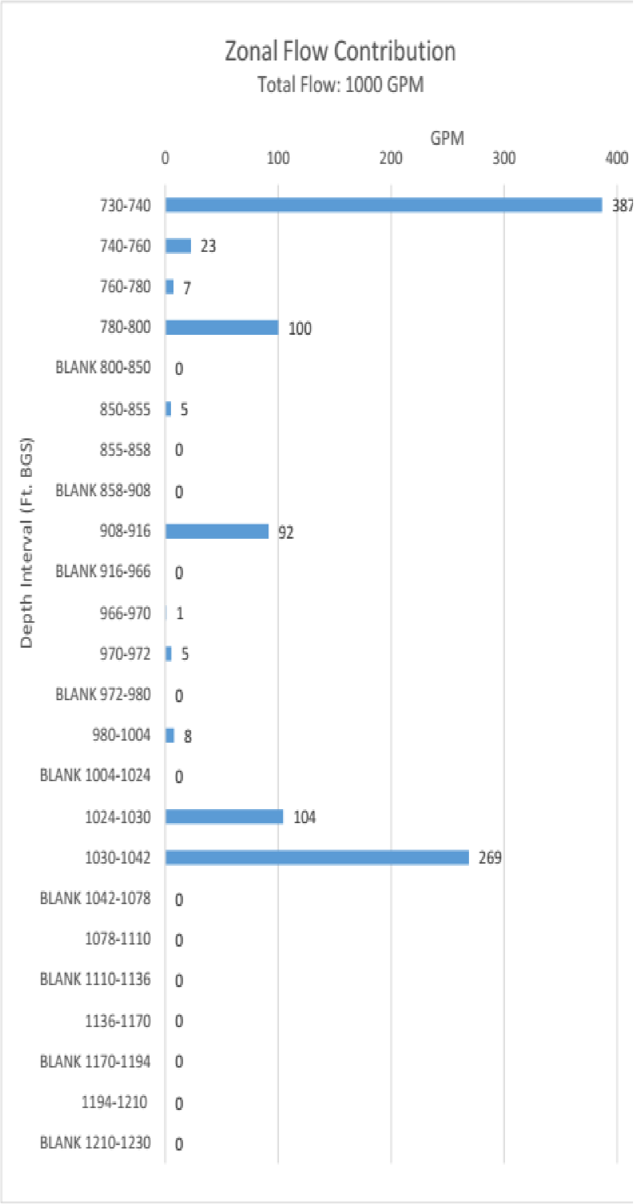
Houston Metro Area Well

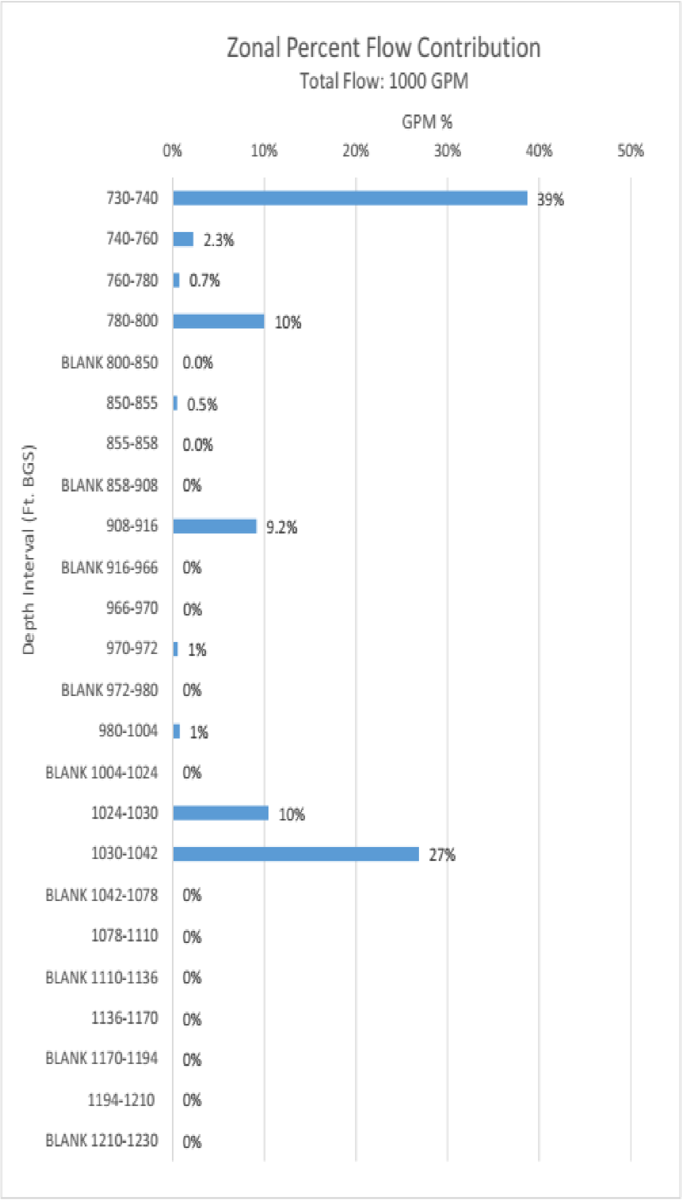
Well Information	Diameter	GPM	Ft. BGS
Total Depth			1230
Pump Intake Depth			550
Pumping Water Level*			356
Pumping Rate *		1000	
Casing Schedule			
Blank	20		0-724
Blank	14		650-730
Perforated	14		730-800
Blank	14		800-850
Perforated	14		850-858
Blank	14		858-908
Perforated	14		908-916
Blank	14		916-966
Perforated	14		966-972
Blank	14		972-980
Perforated	14		980-1004
Blank	14		1004-1024
Perforated	14		1024-1042
Blank	14		1042-1078
Perforated	14		1078-1110
Blank	14		1110-1136
Perforated	14		1136-1170
Blank	14		1170-1194
Perforated	14		1194-1210
Blank	14		1210-1230

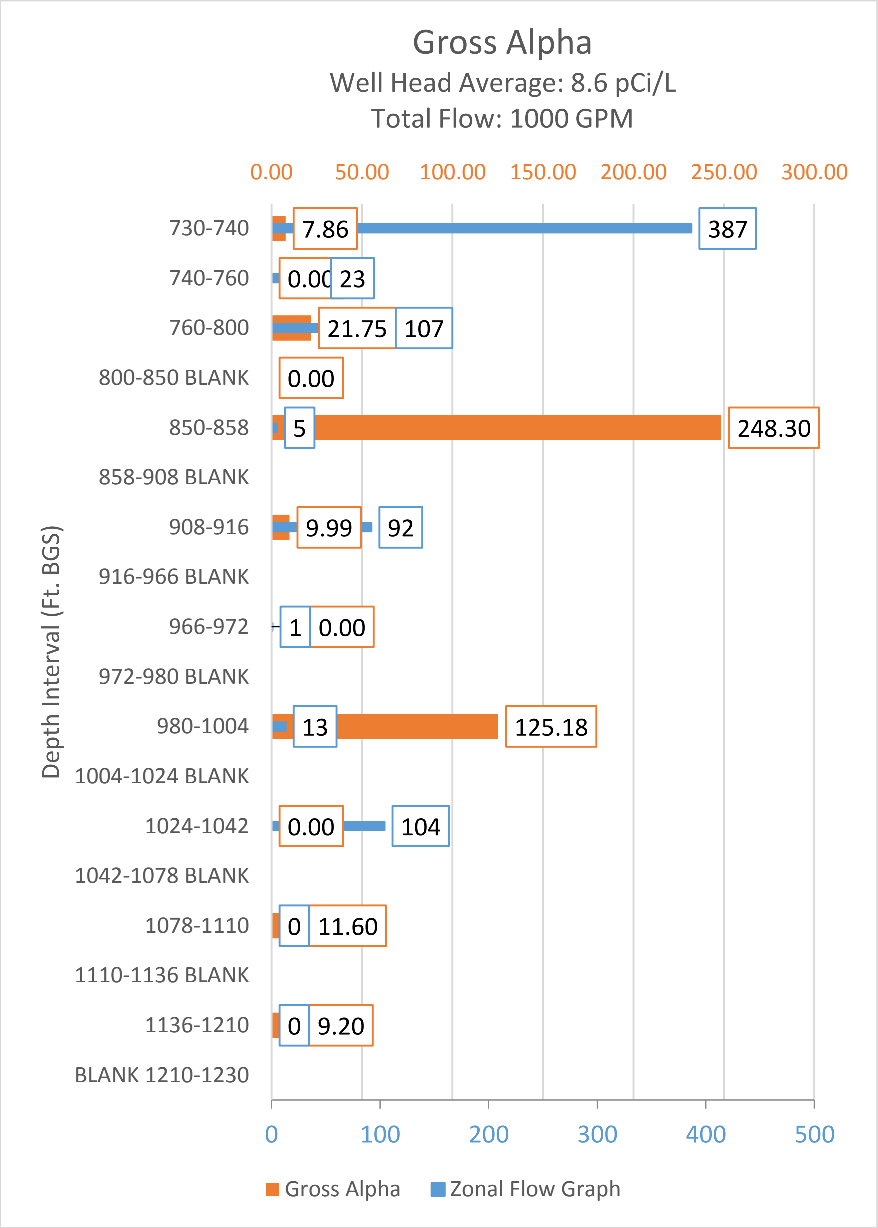
*At the time of testing



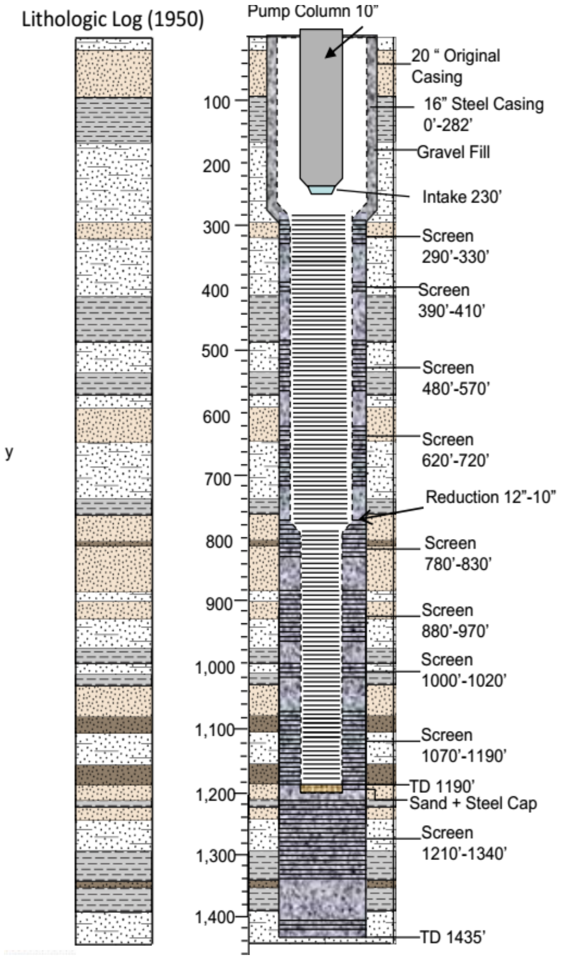








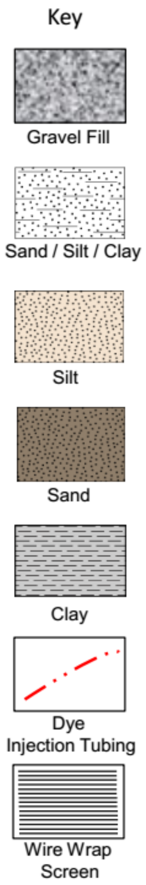
Gross Alpha
Well Head Average: 8.6 pCi/L
Total Flow: 1000 GPM
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Depth Interval (Ft. BGS)
730-740
7.86
387
740-760
0.00
23
760-800
21.75
107
800-850 BLANK
0.00
850-858
5
248.30
858-908 BLANK
908-916
9.99
92
916-966 BLANK
966-972
1
0.00
972-980 BLANK
980-1004
13
125.18
1004-1024 BLANK
1024-1042
0.00
104
1042-1078 BLANK
1078-1110
0
11.60
1110-1136 BLANK
1136-1210
0
9.20
BLANK 1210-1230
0
100
200
300
400
500
Gross Alpha
Zonal Flow Graph



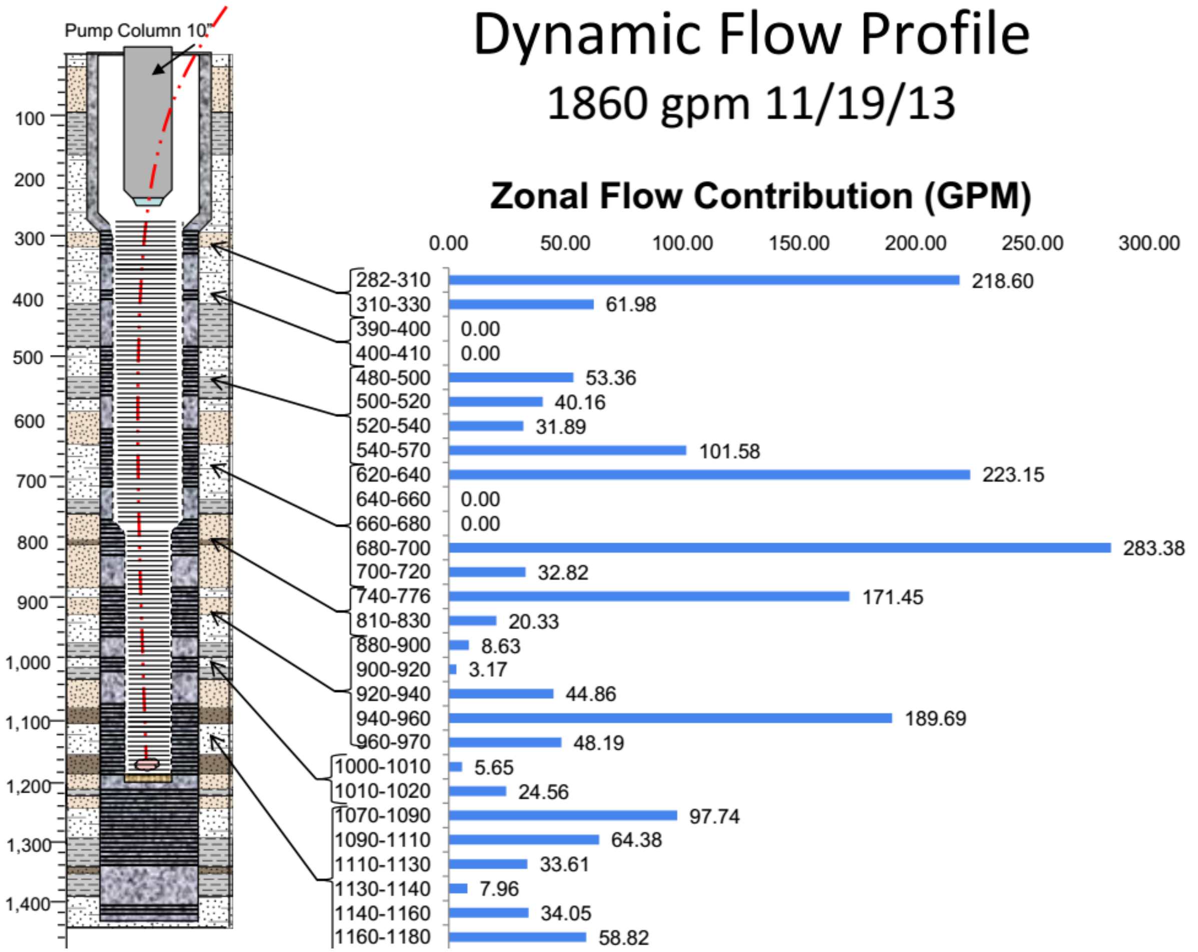
City Yard
Well Information and Lithology Log

Well Information

- Old (outside) well casing diameter: 20" -> 14"
- Outside screened Intervals (ft. bgs): (290-330), (390-410), (480-570), (620-720), (780-830), (880-970), (1000-1020), (1070-1190)
- New well casing diameter: 16" -> 12" -> 10"
  - New well casing is constructed with all stainless steel wire wrap.
- New pump column diameter (in): 10" (16" casing)
- Cross sectional area of new well casing:
  - From 0'-282': 1.40 ft^2
  - From 282'-786': 0.79 ft^2
  - From 786'-1206': 0.55 ft^2
- Reported new well bottom: 1190 ft. bgs
- Pump Intake Depth: 230 ft bgs
- Pumping water level: 143 ft bgs
- Flow rate: 1860 USG min^{-1}



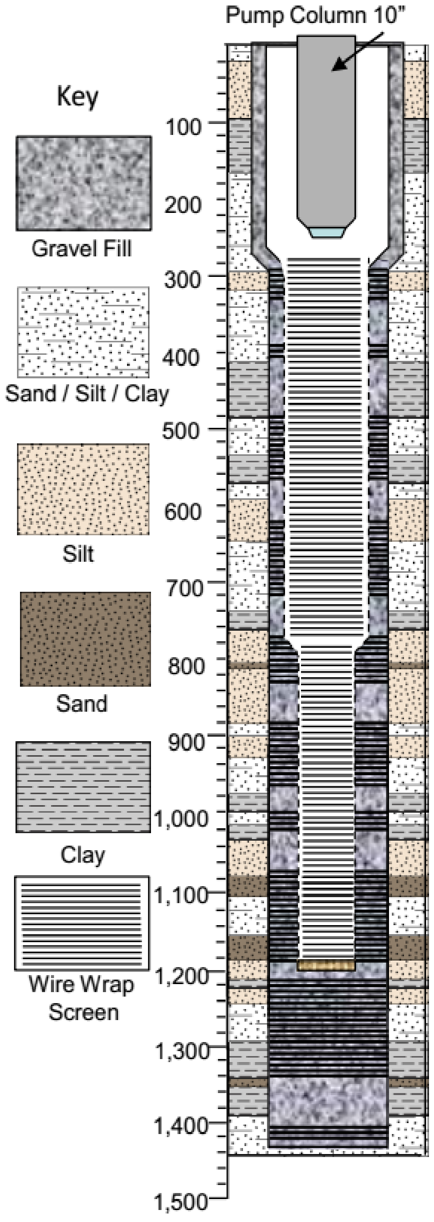
Dynamic Flow Profile
1860 gpm 11/19/13

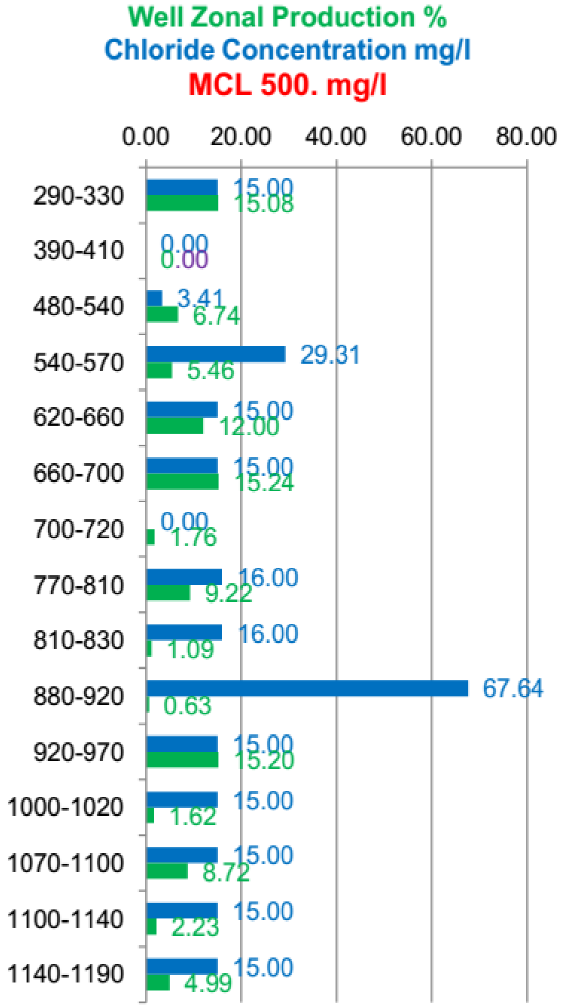


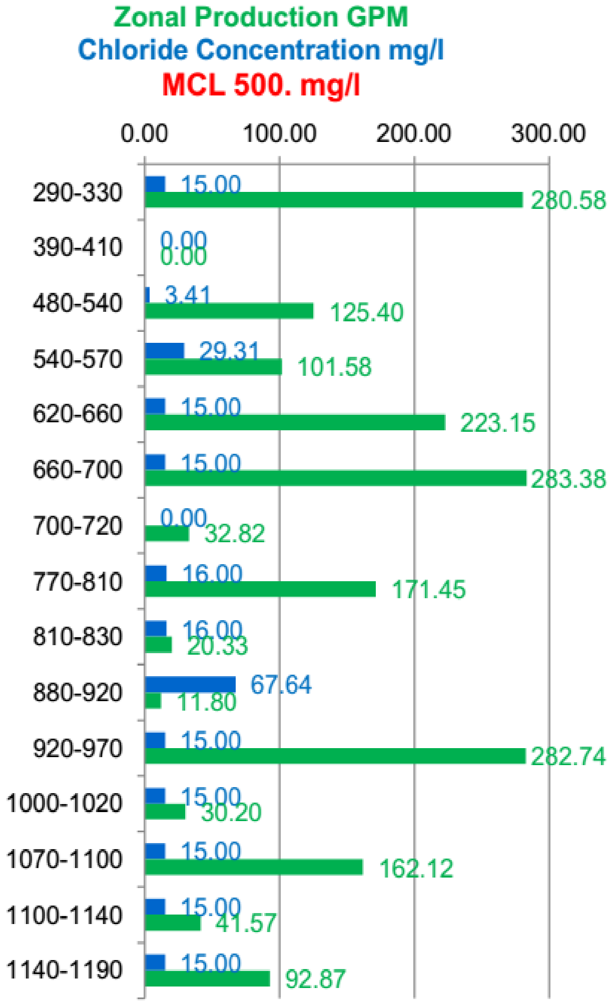
Chemistry Profile

1860 gpm 11/20/13

Average Chloride Well Head Concentration: 15 mg/L







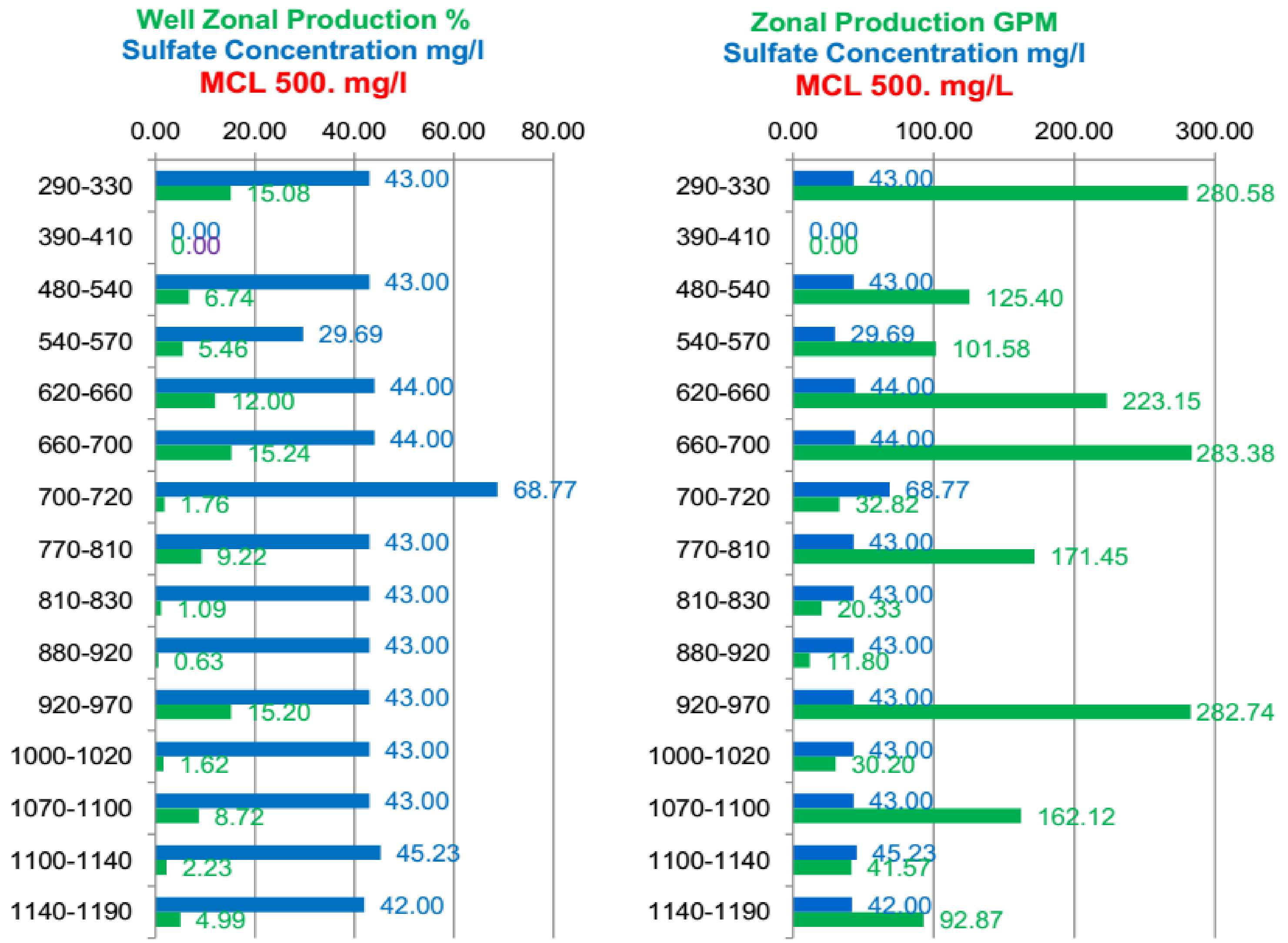
2 Field Days

To collect data

Chemistry Profile

1860 gpm 11/20/13

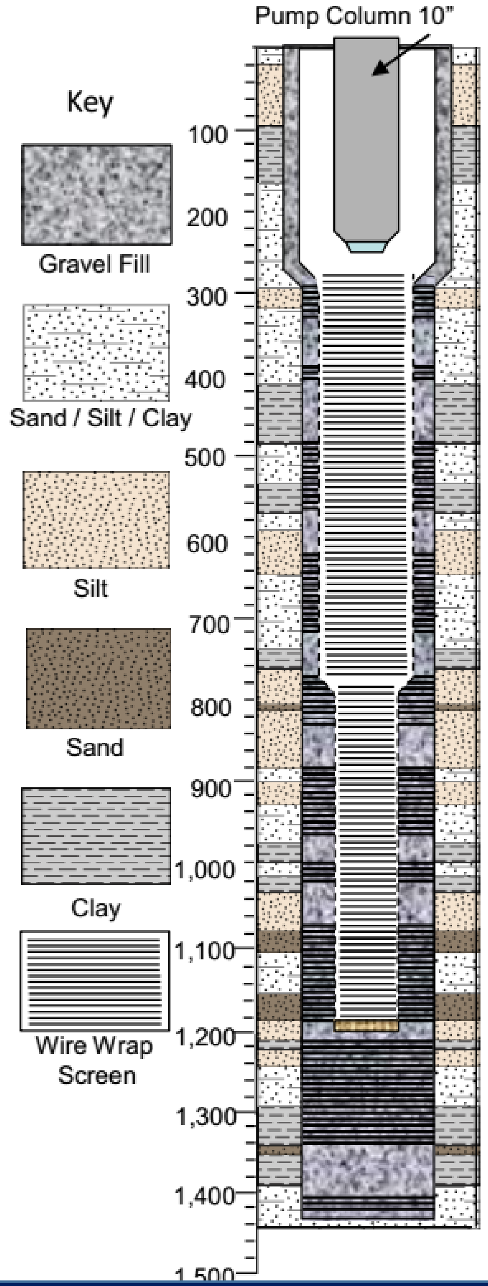
Average Sulfate Well Head Concentration: 43 mg/L

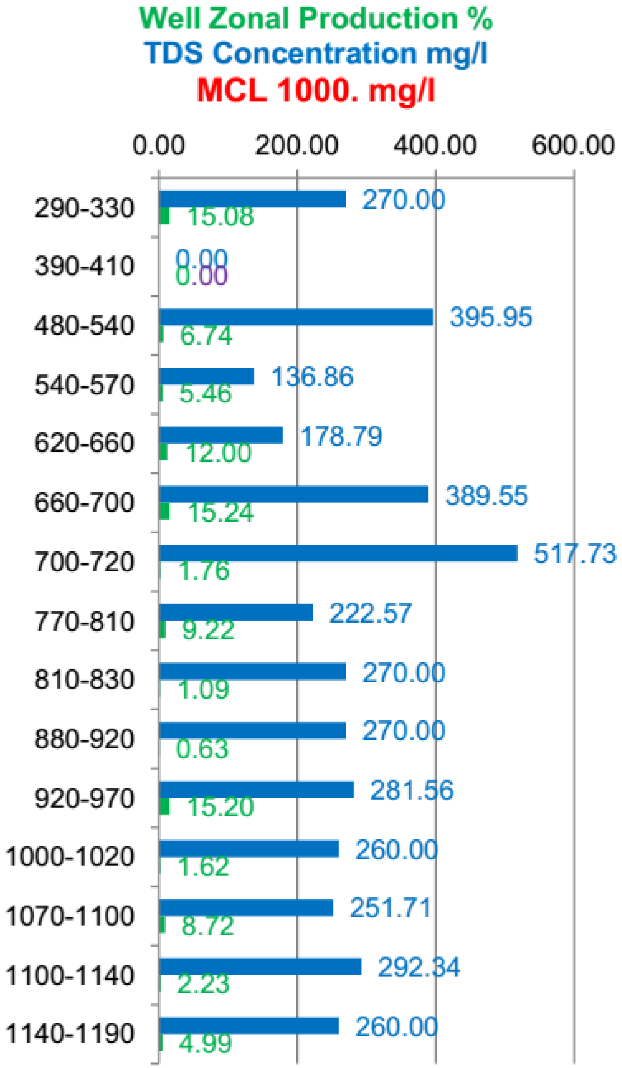


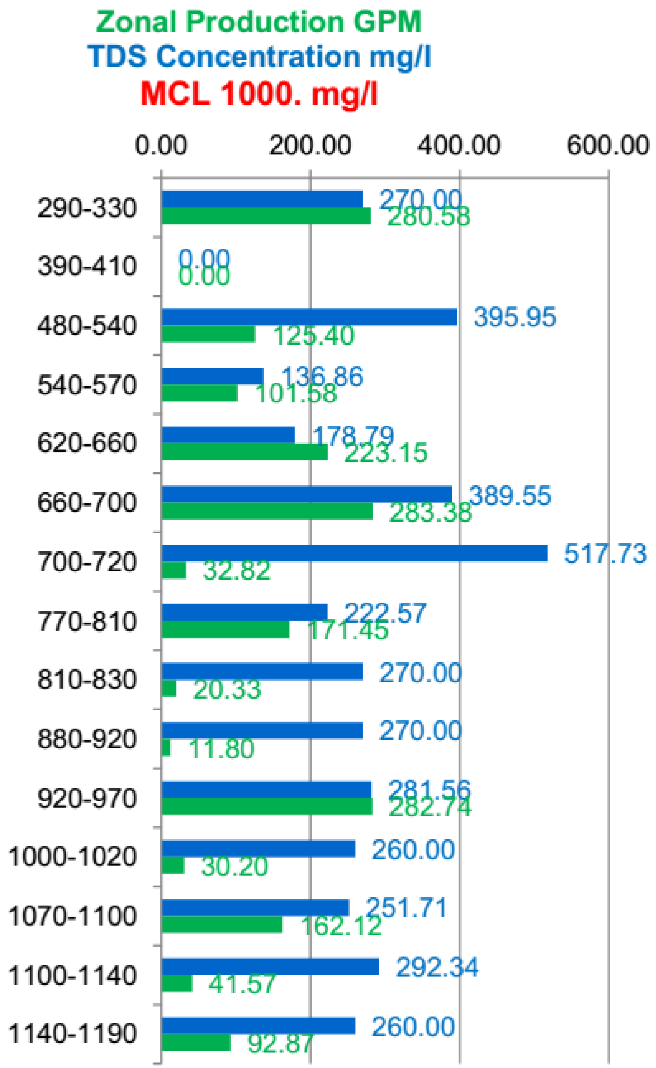
Chemistry Profile

1860 gpm 11/20/13

Average TDS Well Head Concentration: 270 mg/L



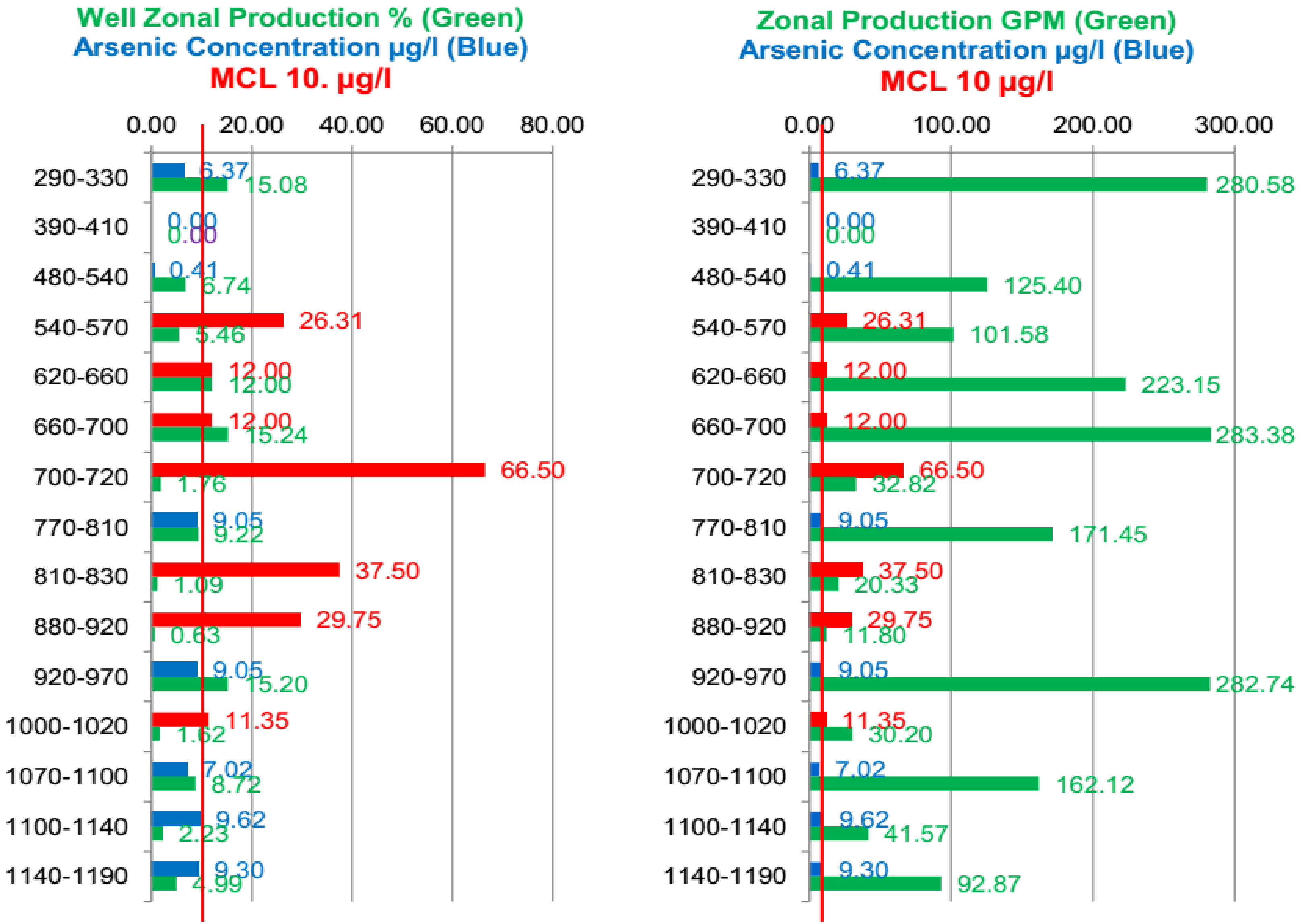




Chemistry Profile

1860 gpm 11/20/13

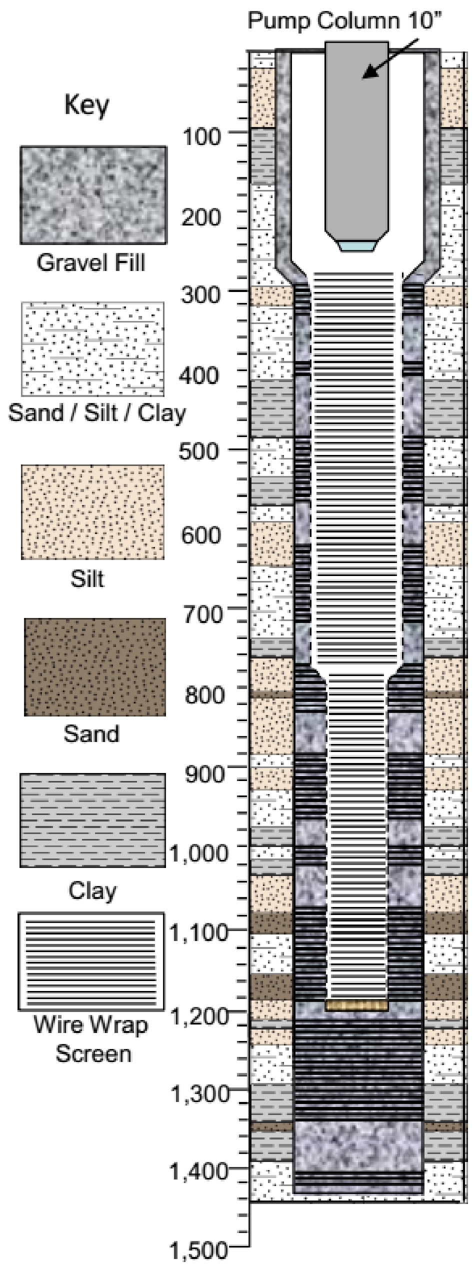
Average Arsenic Well Head Concentration: **12.5** µg/L

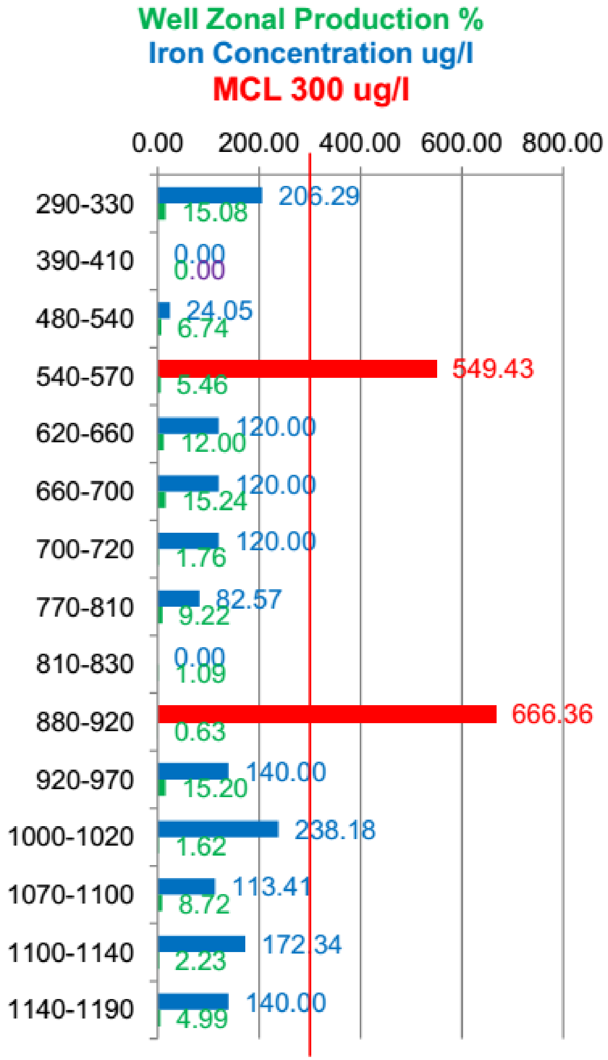


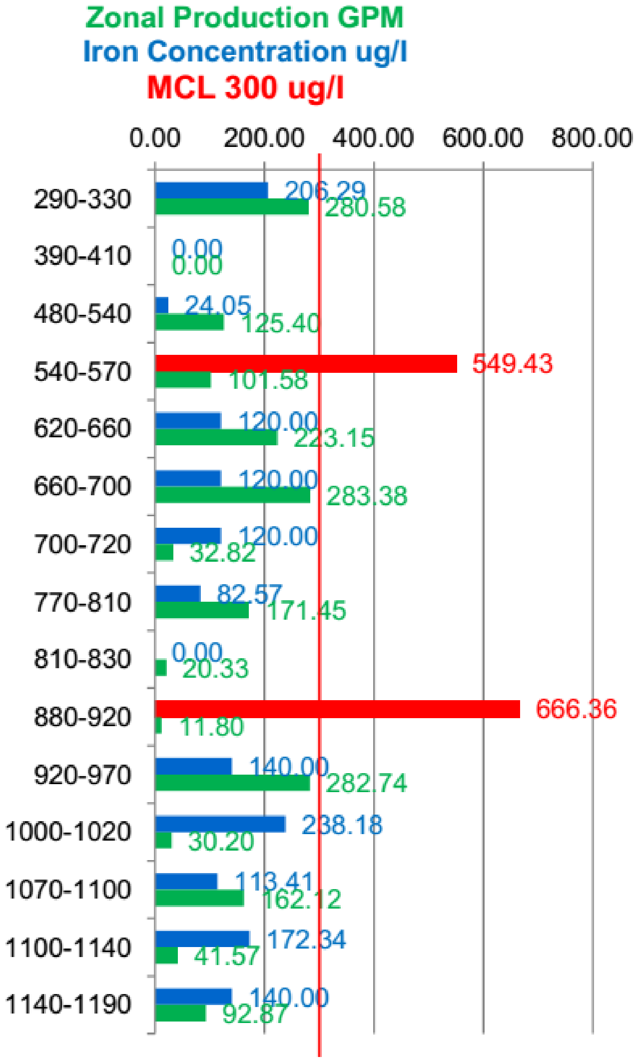
Chemistry Profile

1860 gpm 11/20/13

Average Iron Well Head Concentration: 145 µg/L



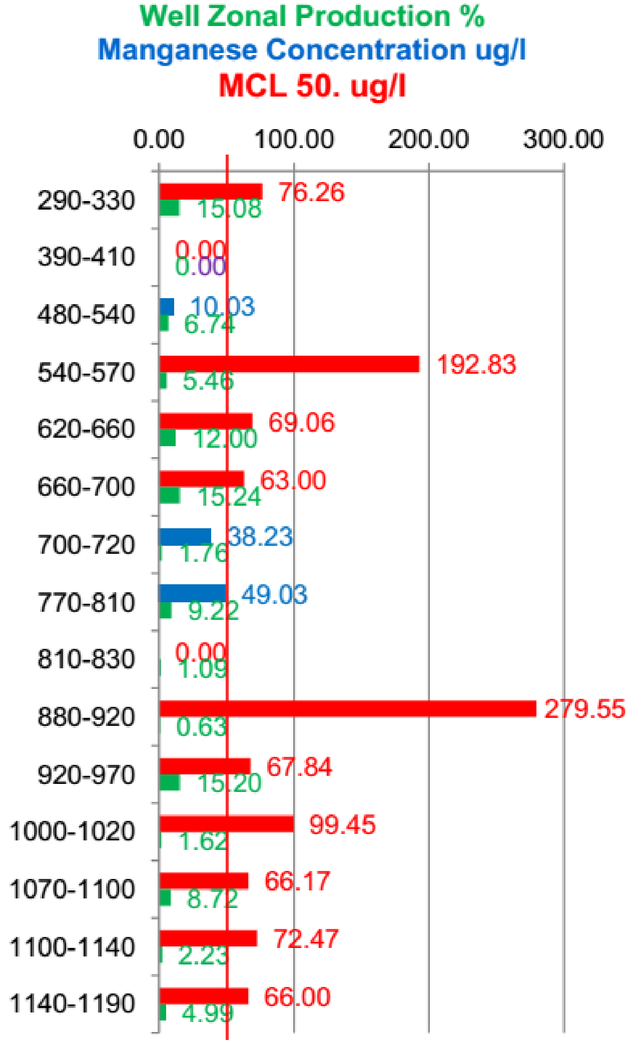


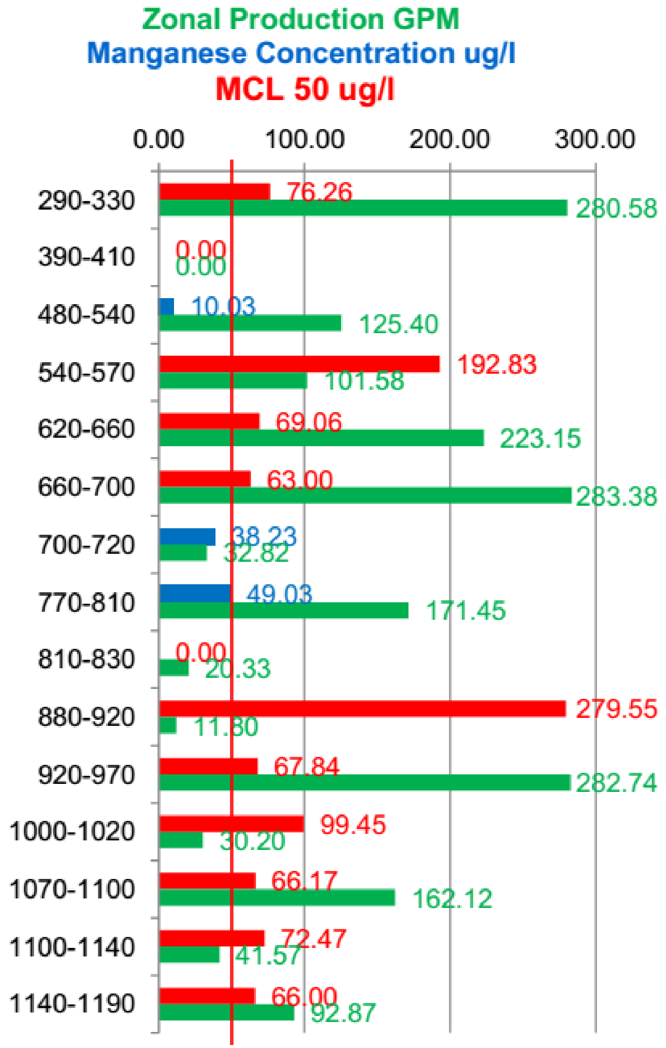


Chemistry Profile

1860 gpm 11/20/13

Average Manganese Well Head Concentration: **64** µg/L





Well Reconstruction / Re-Engineering

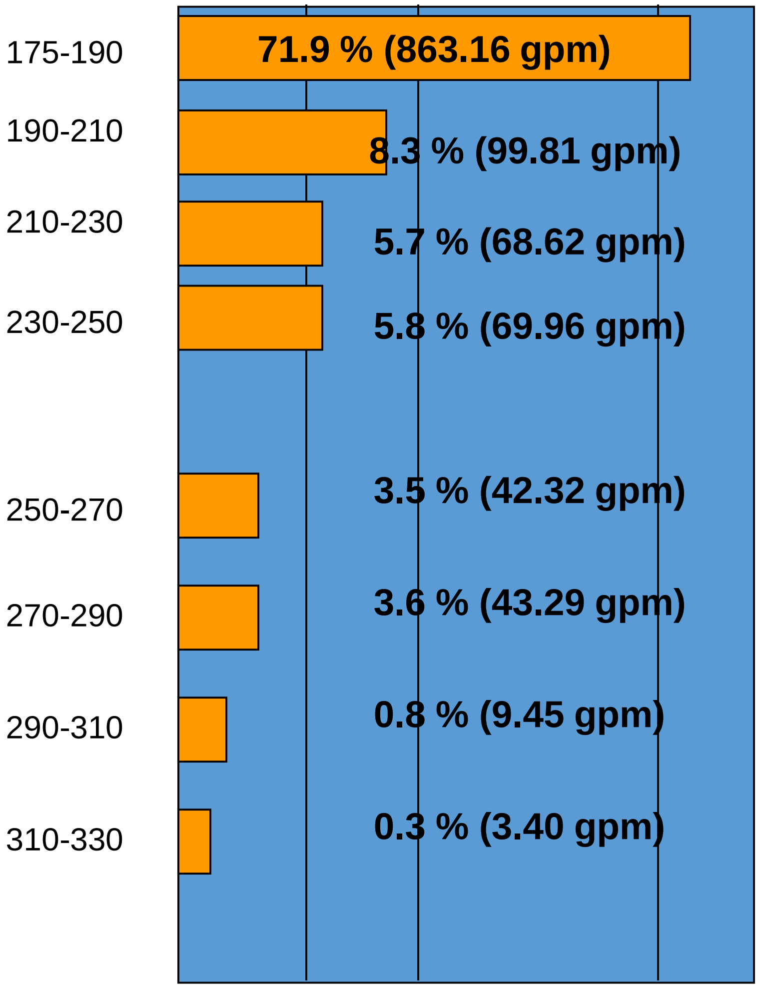
How Do We Hydraulically Manipulate Groundwater Production Wells?

- Change Pumping Rate
  - Higher Pumping Rate Vertically Shifts Flow Contribution Downward Inside Well – Away From Pump Intake
  - Lower Pumping Rate Vertically Shifts Flow Contribution Upward Inside Well – Towards Pump Intake
- Change Pump Intake Location and/or Diameter
  - Lower or Raise Pump (Intake)
  - Attach Suction Pipe To Bottom of Pump
- Packers, Sleeves and Engineered Suctions
- Focused Well Rehabilitation
  - Remove Mineral Encrustations and Bio-film on Inside and Outside of Well Screen

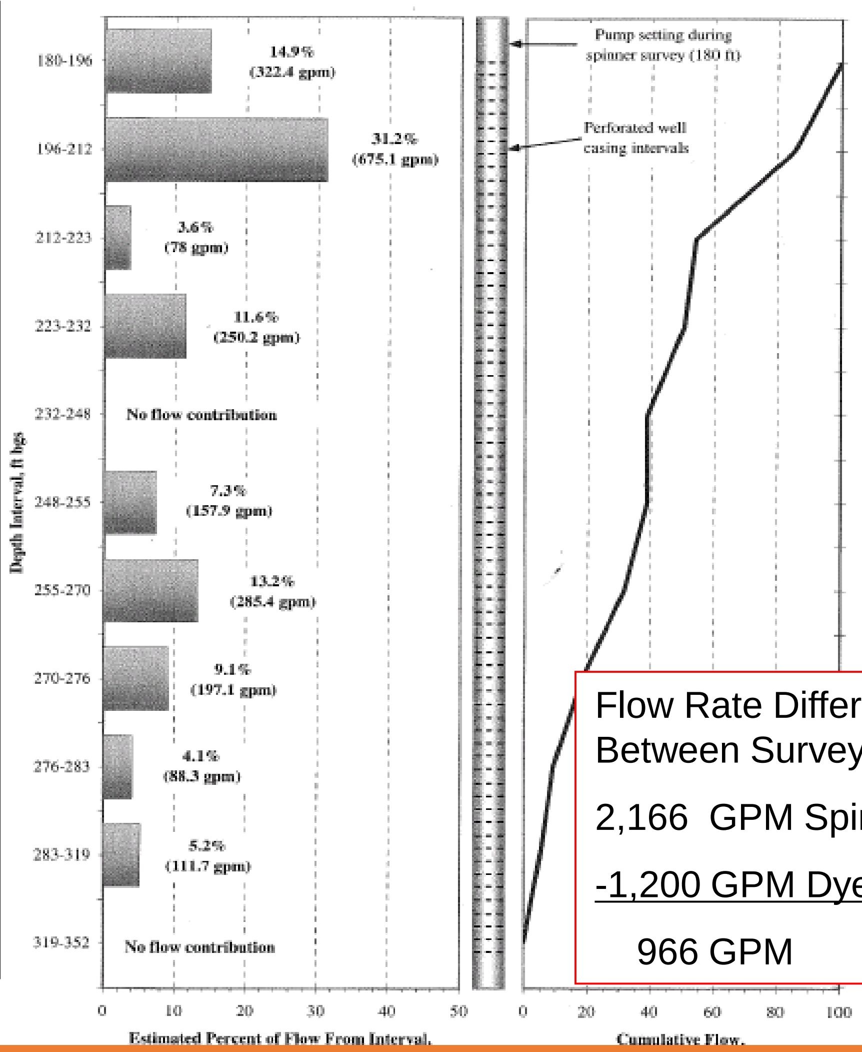
- Change Pumping Rate

Example #1

Dynamic Tracer Pulse Flow Meter Survey @ 1,200 GPM / 11/08/07



Dynamic Spinner Log Flow Meter Survey @ 2,166 GPM / 04/29/05



Flow Rate Difference Between Surveys:

2,166 GPM Spinner

-1,200 GPM Dye

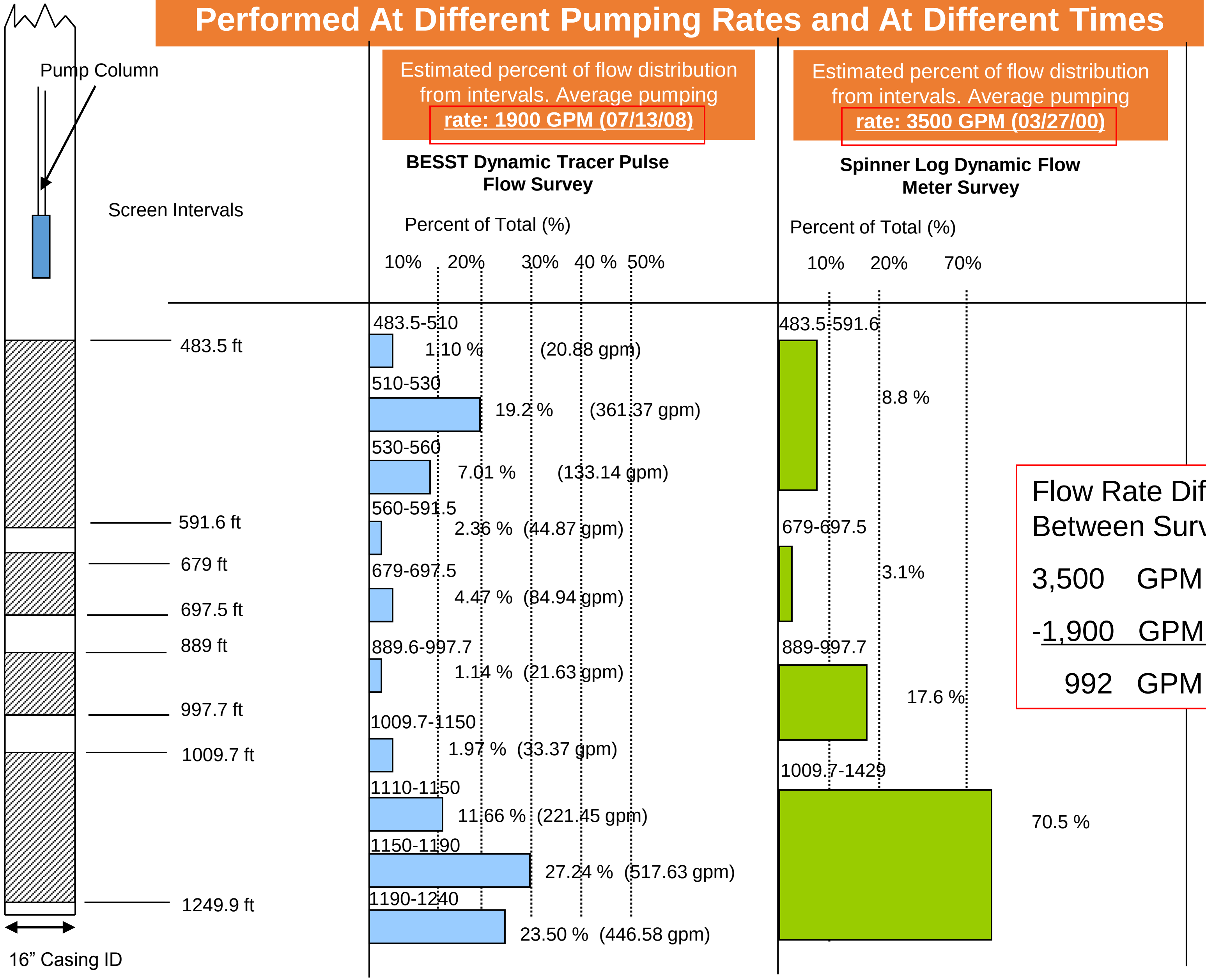
966 GPM

Comparison of BESST Dynamic Tracer Pulse Flow Survey with Spinner Log Flow Meter Survey: Performed At Different Pumping Rates and At Different Times

Comparison of BESST Dynamic Tracer Pulse Flow Survey with Spinner Log Flow Meter Survey:

Performed At Different Pumping Rates and At Different Times

Example #2



Flow Rate Difference Between Surveys:

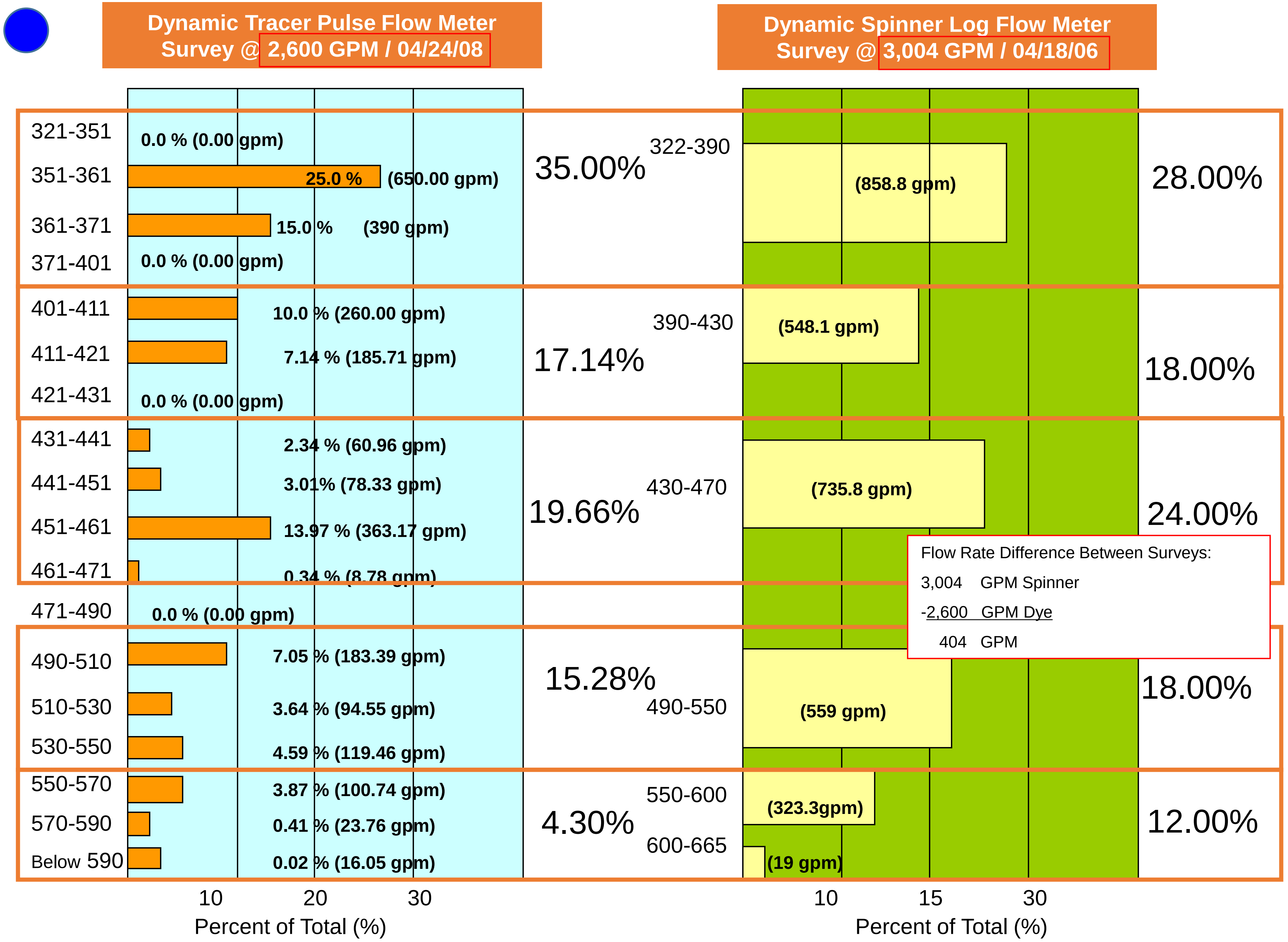
3,500 GPM Spinner

-1,900 GPM Dye

992 GPM

33

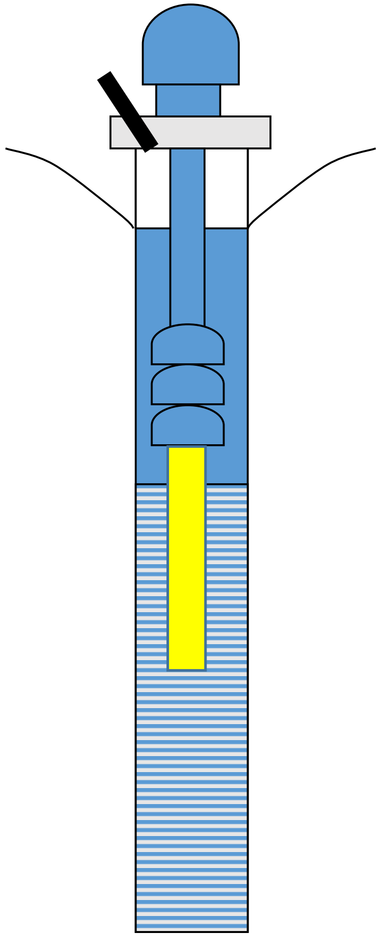
Example #3



Dynamic Tracer Pulse Flow Meter
Survey @ 2,600 GPM / 04/24/08
Dynamic Spinner Log Flow Meter
Survey @ 3,004 GPM / 04/18/06
321-351
0.0 % (0.00 gpm)
351-361
25.0 % (650.00 gpm)
361-371
15.0 % (390 gpm)
371-401
0.0 % (0.00 gpm)
401-411
10.0 % (260.00 gpm)
411-421
7.14 % (185.71 gpm)
421-431
0.0 % (0.00 gpm)
431-441
2.34 % (60.96 gpm)
441-451
3.01% (78.33 gpm)
451-461
13.97 % (363.17 gpm)
461-471
0.34 % (8.78 gpm)
471-490
0.0 % (0.00 gpm)
490-510
7.05 % (183.39 gpm)
510-530
3.64 % (94.55 gpm)
530-550
4.59 % (119.46 gpm)
550-570
3.87 % (100.74 gpm)
570-590
0.41 % (23.76 gpm)
Below 590
0.02 % (16.05 gpm)
35.00%
17.14%
19.66%
15.28%
4.30%
322-390
(858.8 gpm)
28.00%
390-430
(548.1 gpm)
18.00%
430-470
(735.8 gpm)
24.00%
490-550
(559 gpm)
18.00%
550-600
(323.3gpm)
600-665
(19 gpm)
12.00%
Flow Rate Difference Between Surveys:
3,004 GPM Spinner
-2,600 GPM Dye
404 GPM
10
20
30
Percent of Total (%)
10
15
30
Percent of Total (%)

Change Pump Intake Location

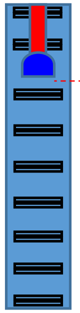
Change Pump Intake Diameter



Pump Depth Location From Top Of 16” Well Screen

ENTRANCE VELOCITITES

32.25 feet
Below Top Of Well Screen



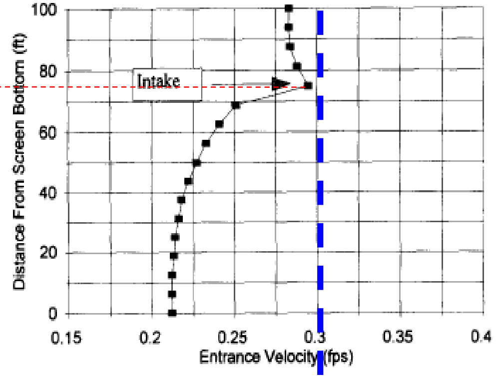
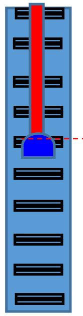


FIG. 4. Entrance Velocity Profile with Pump Intake Located 32.25 ft into Well Screen

43.75 feet
Below Top Of Well Screen
Lowest Entrance Velocities
Least Drawdown (Head Loss)



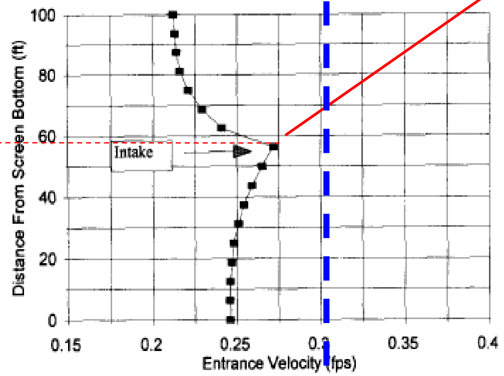
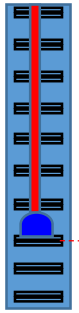


FIG. 5. Entrance Velocity Profile with Pump Intake Located 43.75 ft into Well Screen

67.85 feet
Below Top of Well Screen



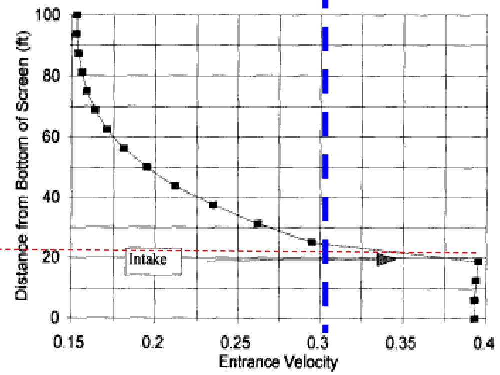


FIG. 6. Entrance Velocity Profile with Pump Intake Located 67.85 ft into Well Screen

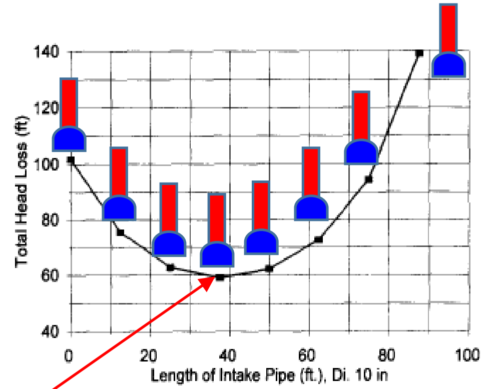


FIG. 7. Total Drawdown as Function of Pump Intake Location in Well Screen

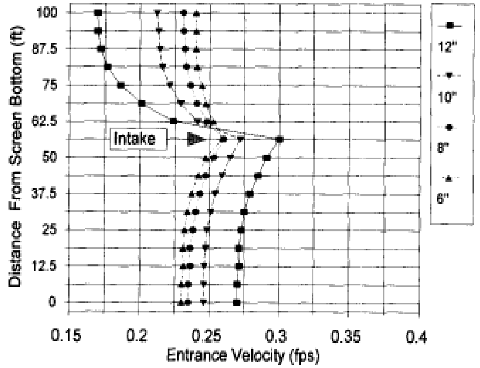


FIG. 8. Entrance Velocity Profile for Different Intake Diameters

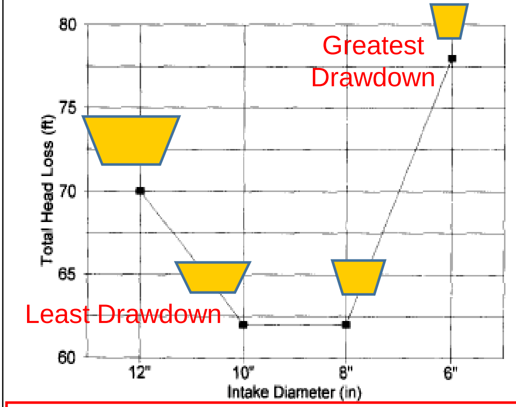


FIG. 9. Total Drawdown as Function of Pump Intake Diameter

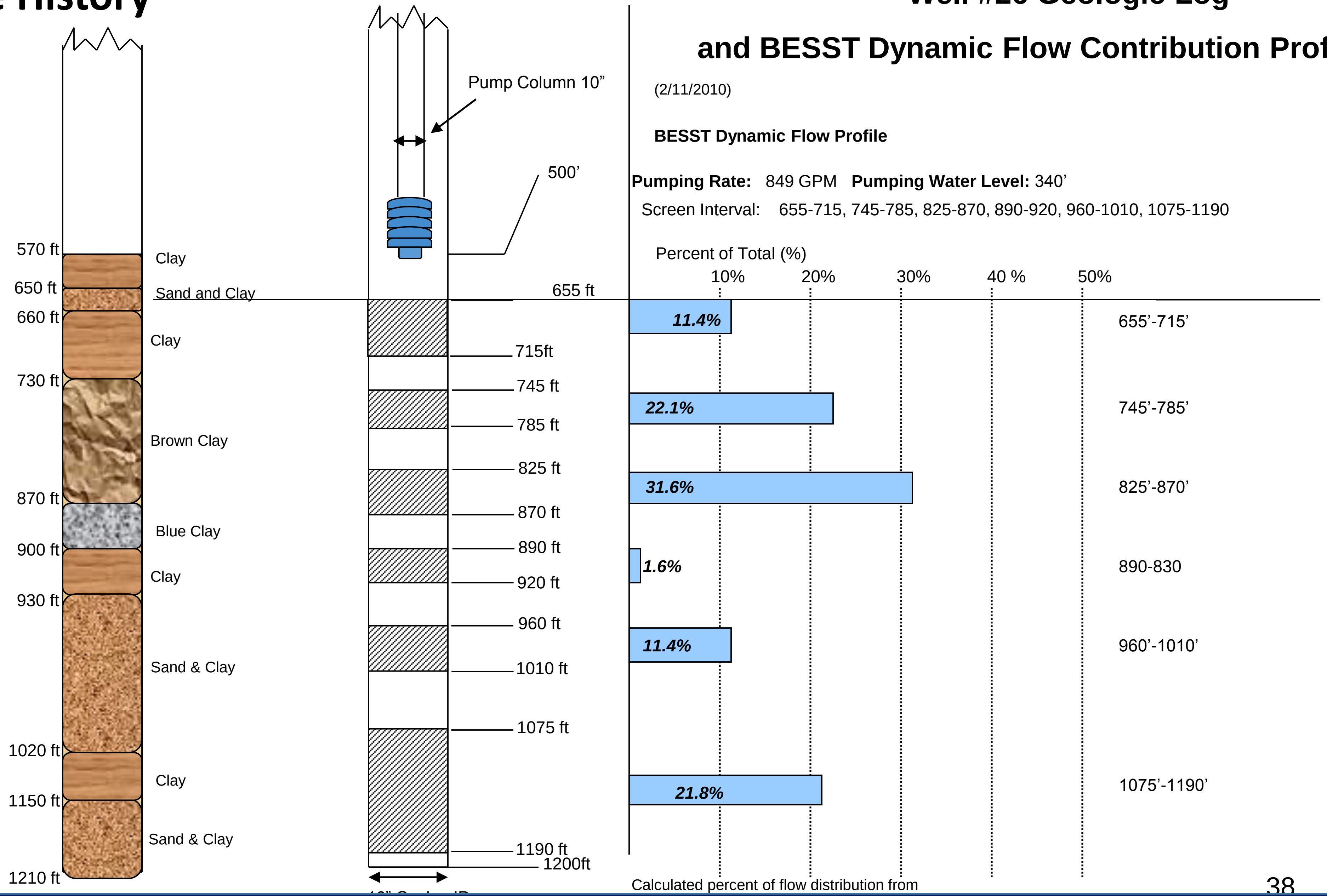
greatest uniformity of entrance velocity, the cost becomes pro-

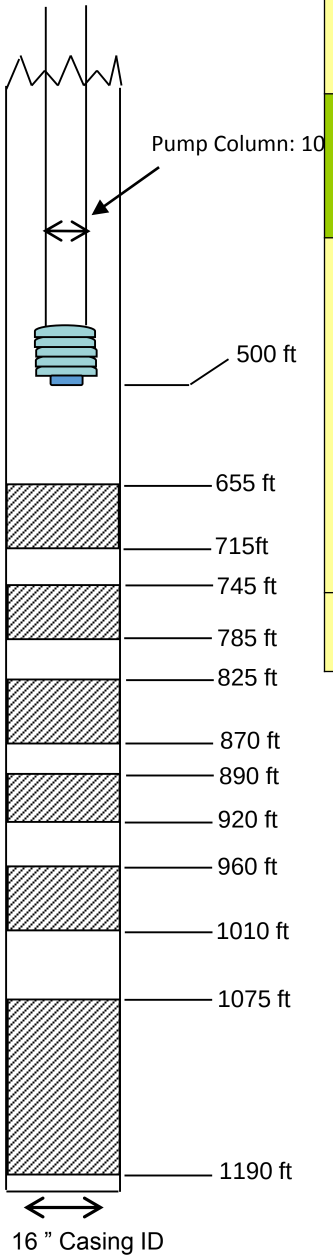
- Packers, Sleeves and Engineered Suctions

Packer Case History

Well #26 Geologic Log

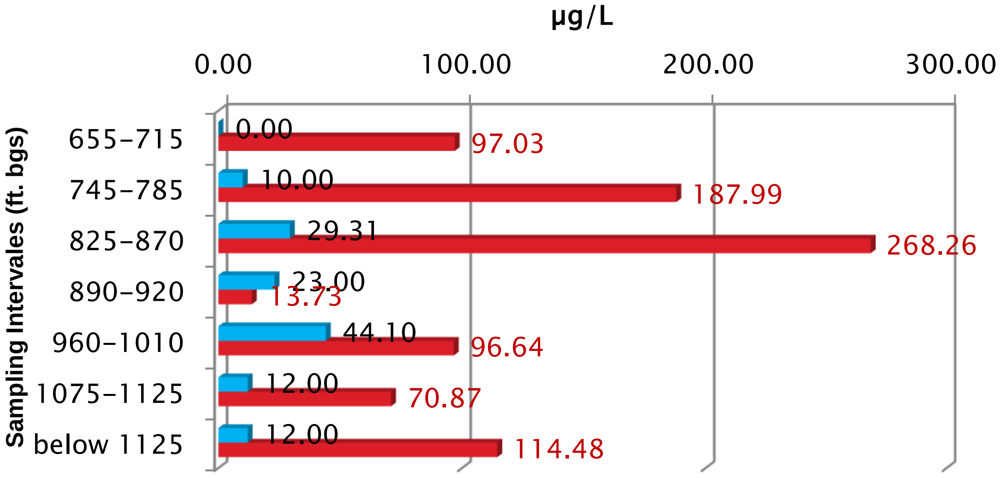
and BESST Dynamic Flow Contribution Profile





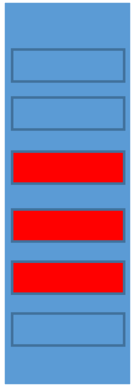
As	Sample Depth (ft bgs)	Screen Interval (ft bgs)	Cumulative Flow Per Screen Interval (GPM)	Incremental Flow Per Screen Interval	As Measured Concentration (From Lab)	CnQn	CnQn-Cn+1Qn+1	Incremental Flow	Mass Balance As Incremental Concentration		Predicted Discharge Average
	600	655-715	849.00	**97.00**	19.50	16555.5	11.5	**97.00**	**0.12**	11.5	
	730	745-785	752.00	**188.00**	22.00	16544.0	1880.0	**188.00**	**10.00**	1880	
	805	825-870	564.00	**268.00**	26.00	14664.0	7856.0	**268.00**	**29.31**	7856	
	880	890-920	296.00	**14.00**	23.00	6808.0	322.0	**14.00**	**23.00**	322	
	940	960-1010	282.00	**97.00**	23.00	6486.0	4266.0	**97.00**	**43.98**	4266	
	1055	1075-1190	185.00	**185.00**	12.00	2220.0	2220.0	**185.00**	**12.00**	2220	
								849.00			
								100%			
	Spigot 1	Cumulative	849.00		19.00					16555.5	19.50
	Spigot 2	Cumulative	849.00		19.00						

Dynamic Chemical Profile: Well 26
2/11/10 849 GPM
Arsenic



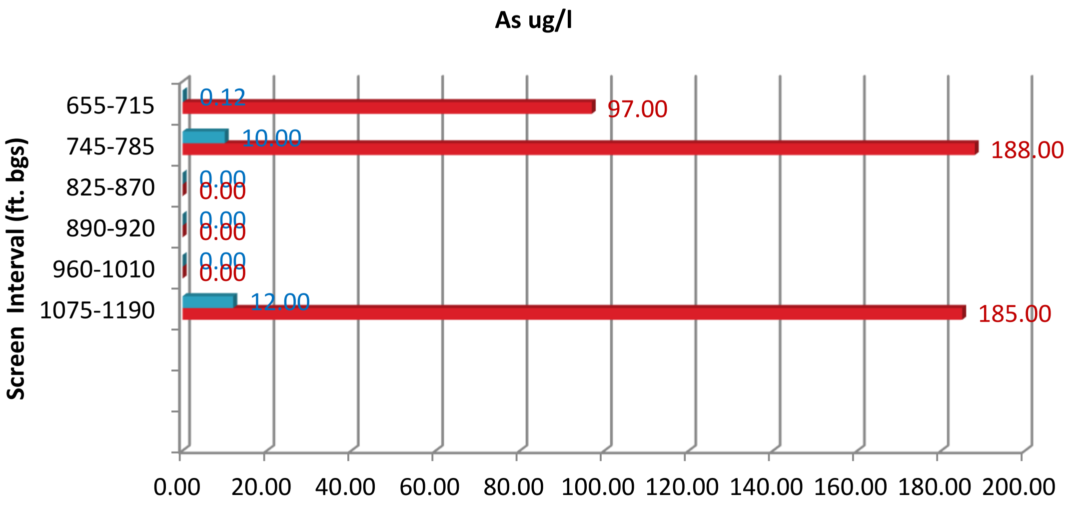
Well 26: Estimated Arsenic Distribution By Screen Interval Blocking Off 3rd, 4th and 5th Screen From Top Of Well										Predicted Discharge Average	
	Sample Depth	Screen Interval	Cumulative Flow Per Screen Interval	Incremental Flow Per Screen Interval	Measured Concentration (From Lab)	CnQn	CnQn-Cn+1Qn+1	Incremental Flow	Mass Balance Incremental Concentration		
	600	655-715	470.00	97.00	19.50	16555.5	11.5	97.00	0.12	11.5	
	730	745-785	373.00	188.00	22.00	16544.0	1880.0	188.00	10.00	1880	
	805	825-870	0.00	0.00	0.00	14664.0	7856.0	0.00	0.00	0	
	880	890-920	0.00	0.00	0.00	6808.0	322.0	0.00	0.00	0	
	940	960-1010	0.00	0.00	0.00	6486.0	4266.0	0.00	0.00	0	
	1055	1075-1190	185.00	185.00	12.00	2220.0	2220.0	185.00	12.00	2220	
								470.00	GPM		
								55%	of 849 GPM		
	Spigot 1	Cumulative	470.00		8.75					4111.5	**8.75**
	Spigot 2	Cumulative	470.00		8.75						

The hypothetical scenario presented represents a worse case scenario in terms of estimated maximum production loss from well. Feasibility testing is recommended to determine hydraulic compensation yield from unblocked zones.

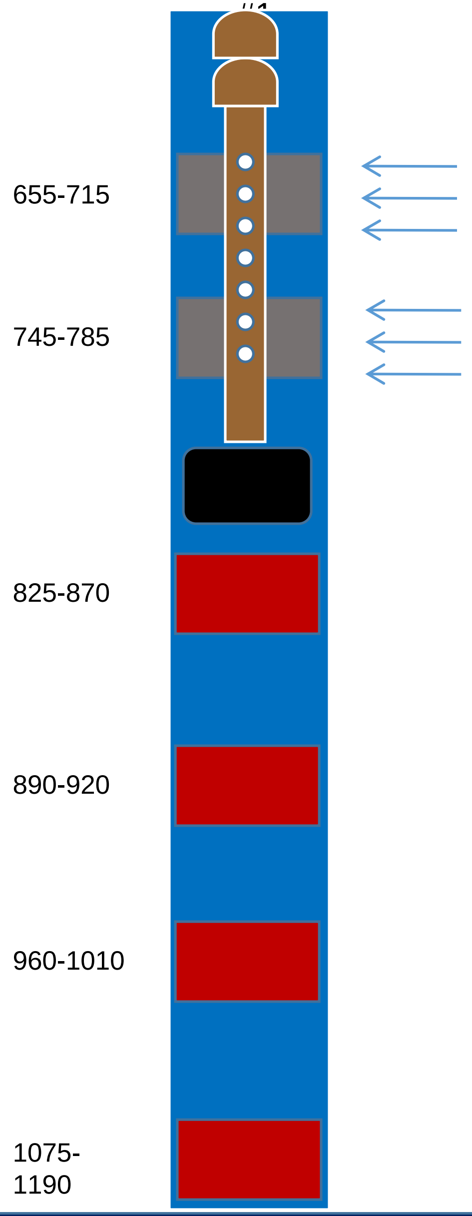


Dynamic Arsenic Profile: Well 26

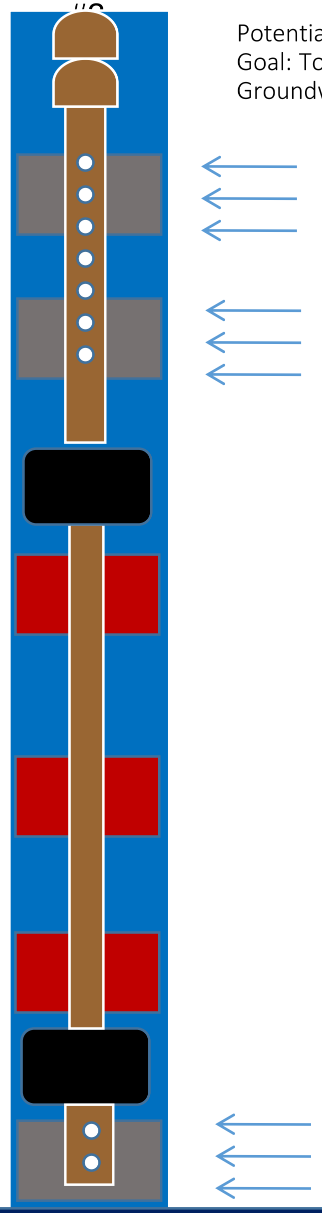
849 GPM



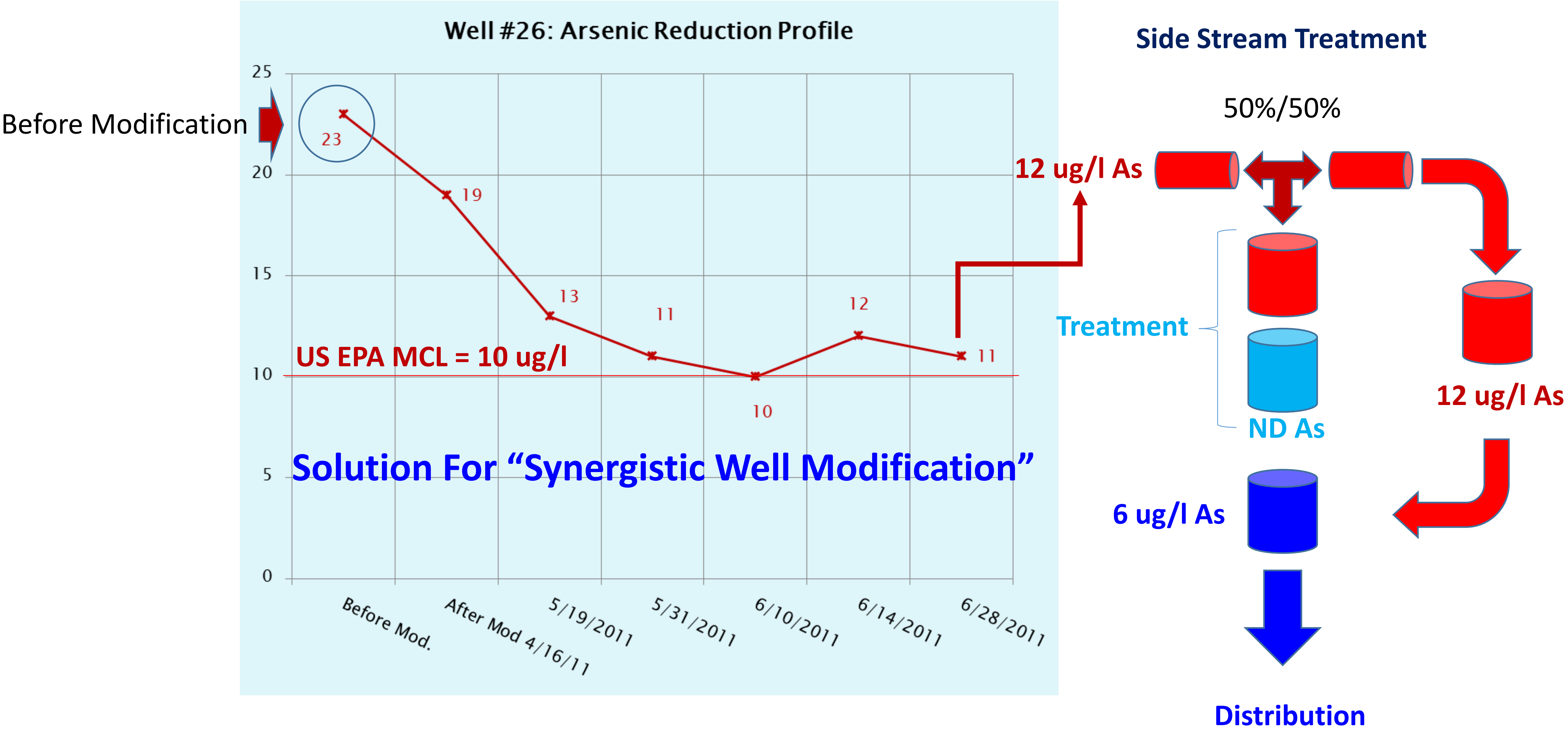
Packer Test Scenario



Packer Test Scenario



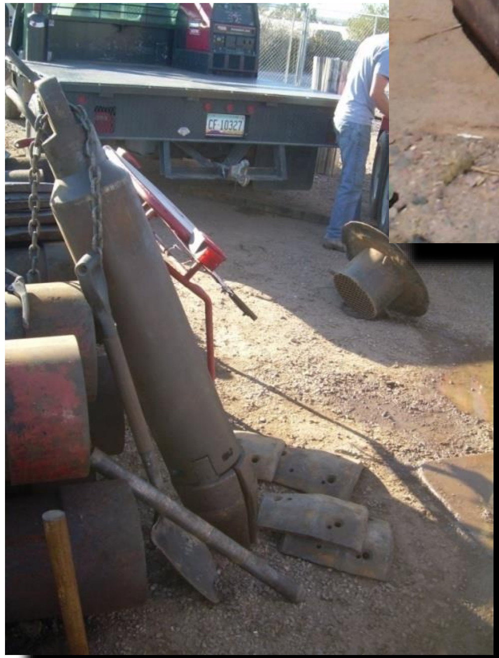
Potential Strategies for a Feasibility Test:
Goal: To Produce Less Arsenic at Discharge and Hydraulically Compensate for Groundwater Production Lost From Blocked Zones (red)



Well #26: Arsenic Reduction Profile
Before Modification
25
20
15
10
5
0
23
19
13
11
10
12
11
US EPA MCL = 10 ug/l
Solution For "Synergistic Well Modification"
Before Mod.
After Mod 4/16/11
5/19/2011
5/31/2011
6/10/2011
6/14/2011
6/28/2011
Side Stream Treatment
50%/50%
12 ug/l As
Treatment
ND As
12 ug/l As
6 ug/l As
Distribution

Tools of the Trade: Swage

Drive Swage



Hydraulic Swage

Hydraulic Swage, ready for use

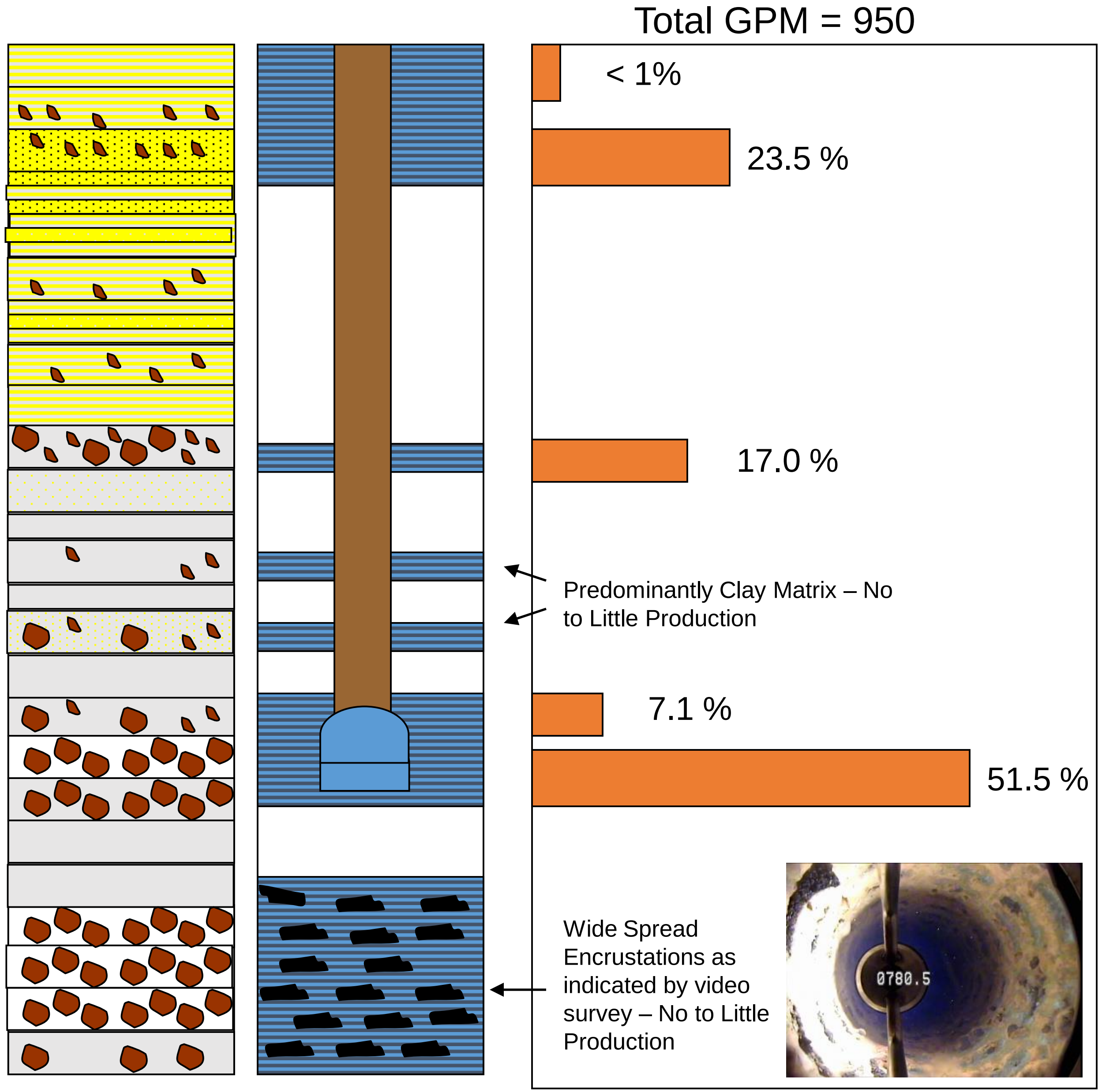
Casing Patch

Swaging & Patching

Hydraulic Swage

Hydraulic Swage ready to set a casing patch

- Focused Well Rehabilitation


Total GPM = 950
< 1%
23.5 %
17.0 %
Predominantly Clay Matrix – No to Little Production
7.1 %
51.5 %
Wide Spread Encrustations as indicated by video survey – No to Little Production
0780.5



BEFORE AND AFTER REHAB WELL PROFILING

One of the least used performance metrics

Before and After Well Profiling

Rehab Performance Metrics

Pre-Rehabilitation

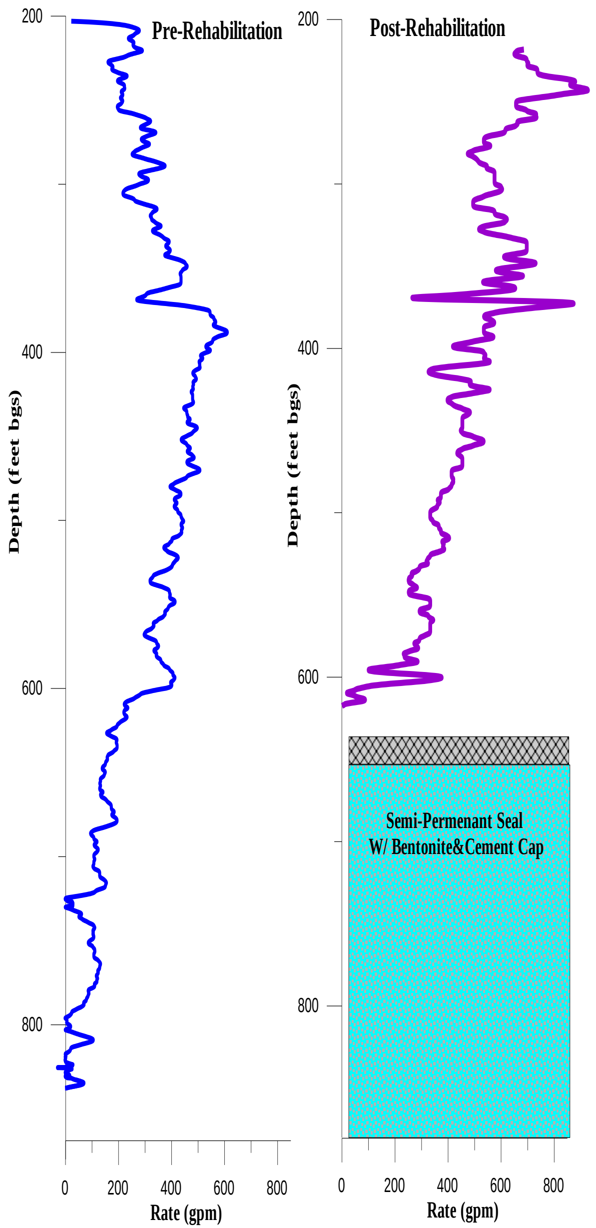
S.C. 17.4

Q 700 gpm

Eff. 62%

Mn 75 ug/L

Zone of High Manganese Production



Post-Rehabilitation

S.C. 22.6

Q 850 gpm

Eff. 72%

Mn < 20 ug/L

Cement/Bentonite Cap

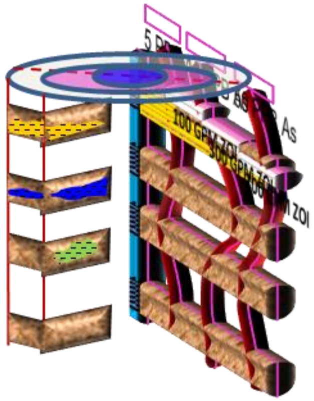
Gravel Fill Material

Zonal Profiling During or After Pump Tests

Rules, Recommendations and Insights:

1. Zonal flow profiling assumes dynamic steady state condition.
2. Can be performed during or following pump test.
3. If performed following pump test, then dynamic profile must be performed at same pumping rate as pump test.
4. Use of zonal profiling during or following pump test provides estimate of hydraulic conductivity.
5. Can be performed with primary pump or test pump.
6. Recommend that pump intake depths are the same when dynamic zonal test is performed following pump test.
7. Estimates may be skewed in wells lacking recent rehab; however data may still be very useful on a relative basis and provide clues concerning sections of gravel pack clogging.

Using Pump Test and Zonal Flow Results To Calculate Estimated Zonal Hydraulic Conductivity From Production Wells



$$\frac{K_{FM,i}}{\bar{K}} = \frac{\triangle Q_i / Q_p}{\triangle b_i / B}$$

Molz et. al 1989 and 1994

$\bar{\mathrm{K}}$ = Average hydraulic conductivity from well pump test

Q_{p} = Average pumping rate from well

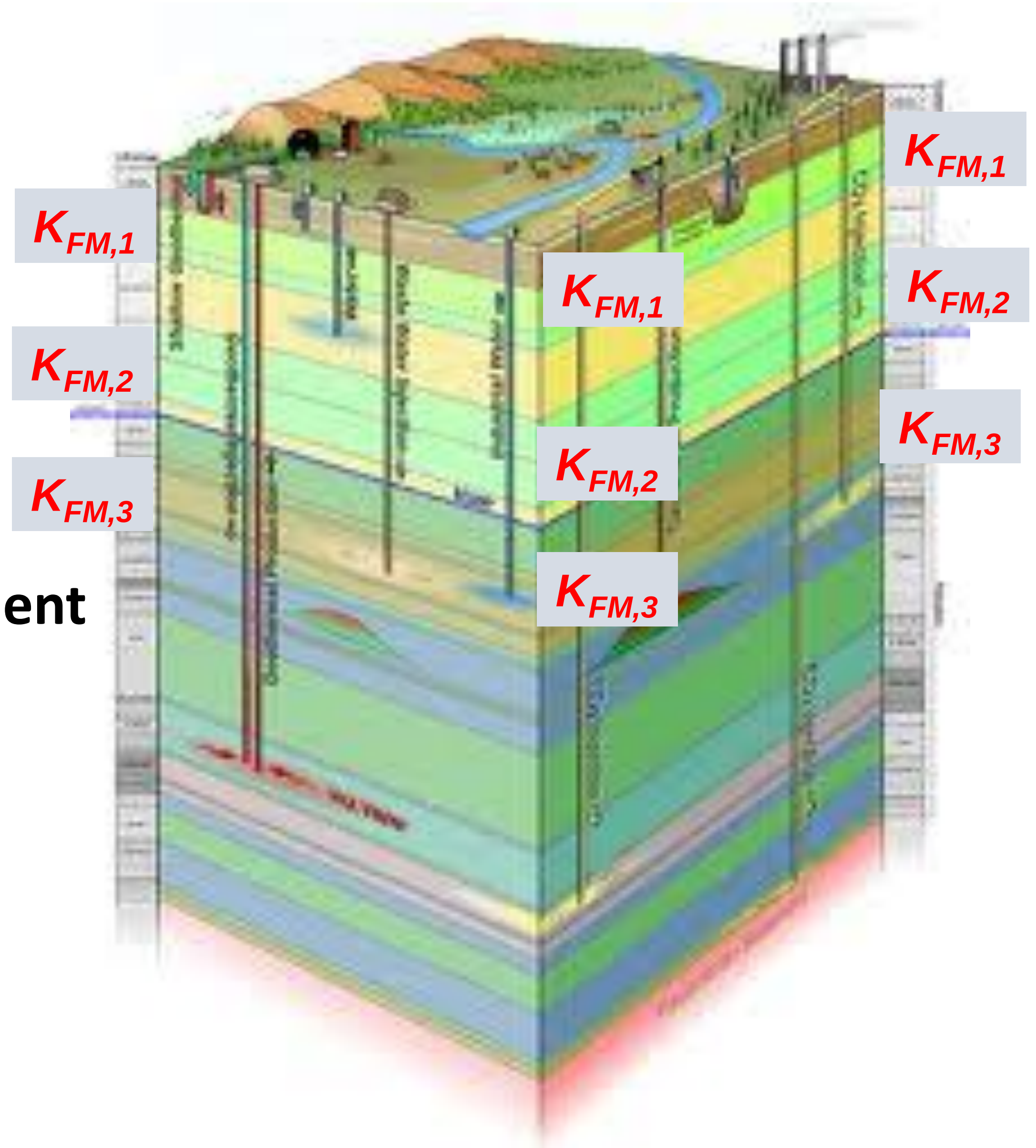
B = Screened thickness of aquifer

$\triangle Q_i$ = Discharge measured within the i-th sampling interval of vertical thickness $\triangle b_i$

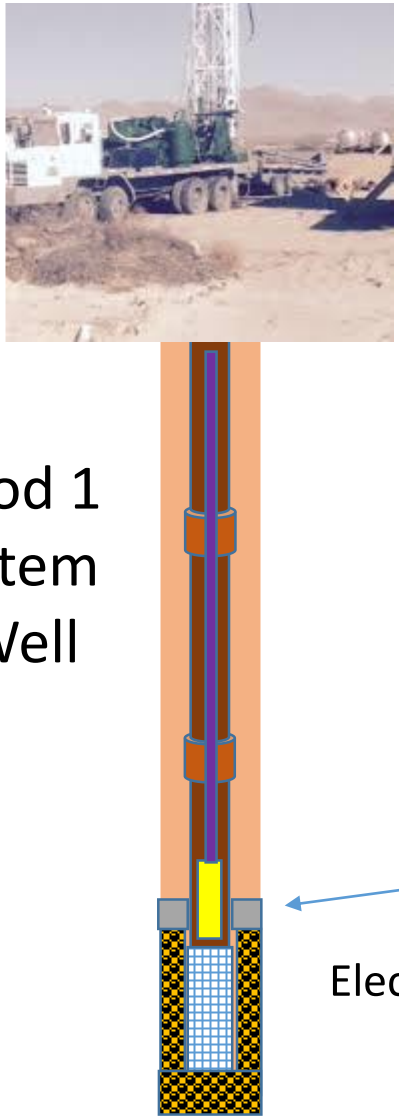
$K_{FM,i}$ = Estimated value for the hydraulic conductivity representative of the *i-th* vertical interval

Compelling Application:

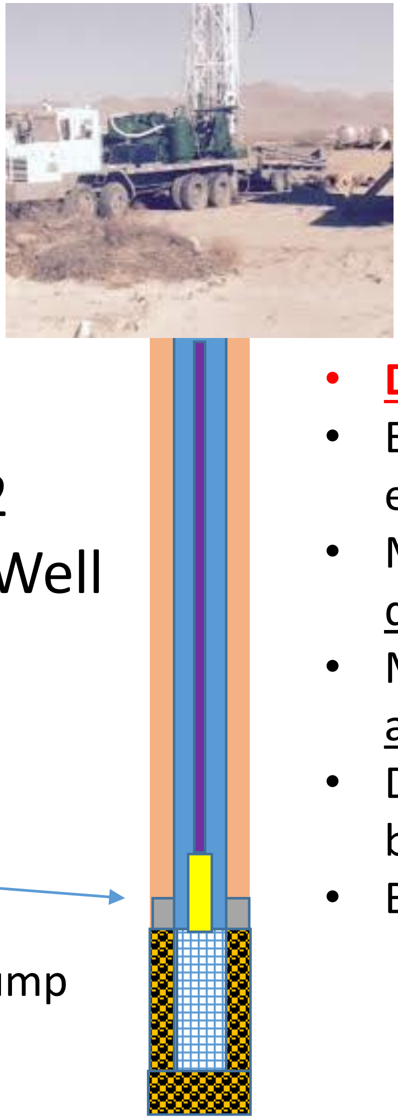
Well Field Design, Expansion, Management



Standard Exploration Test Method Options



Method 1
Drill Stem
Test Well



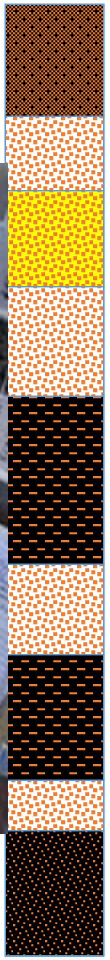
Method 2
PVC Test Well

Seals

Electric Submersible Pump

- **Drill Rig Can Never Leave Site**
- Expensive: funding typically enough for ONLY 3 to 5 zones
- More time and difficult to develop
- More time and costly to abandon
- Drill String could become buried (method 1)
- Bentonite seal may leak

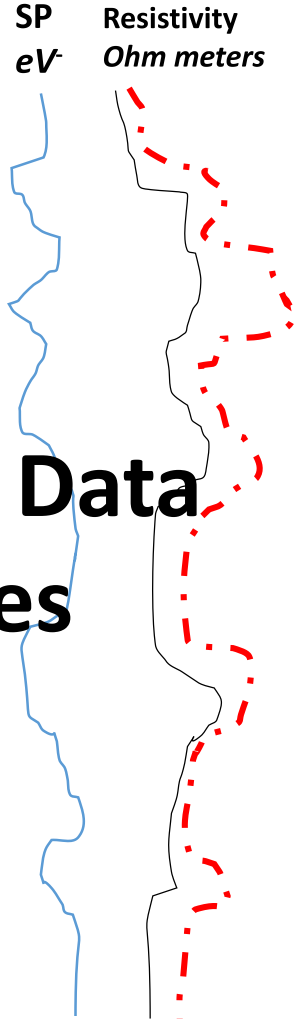
Exploratory Borehole



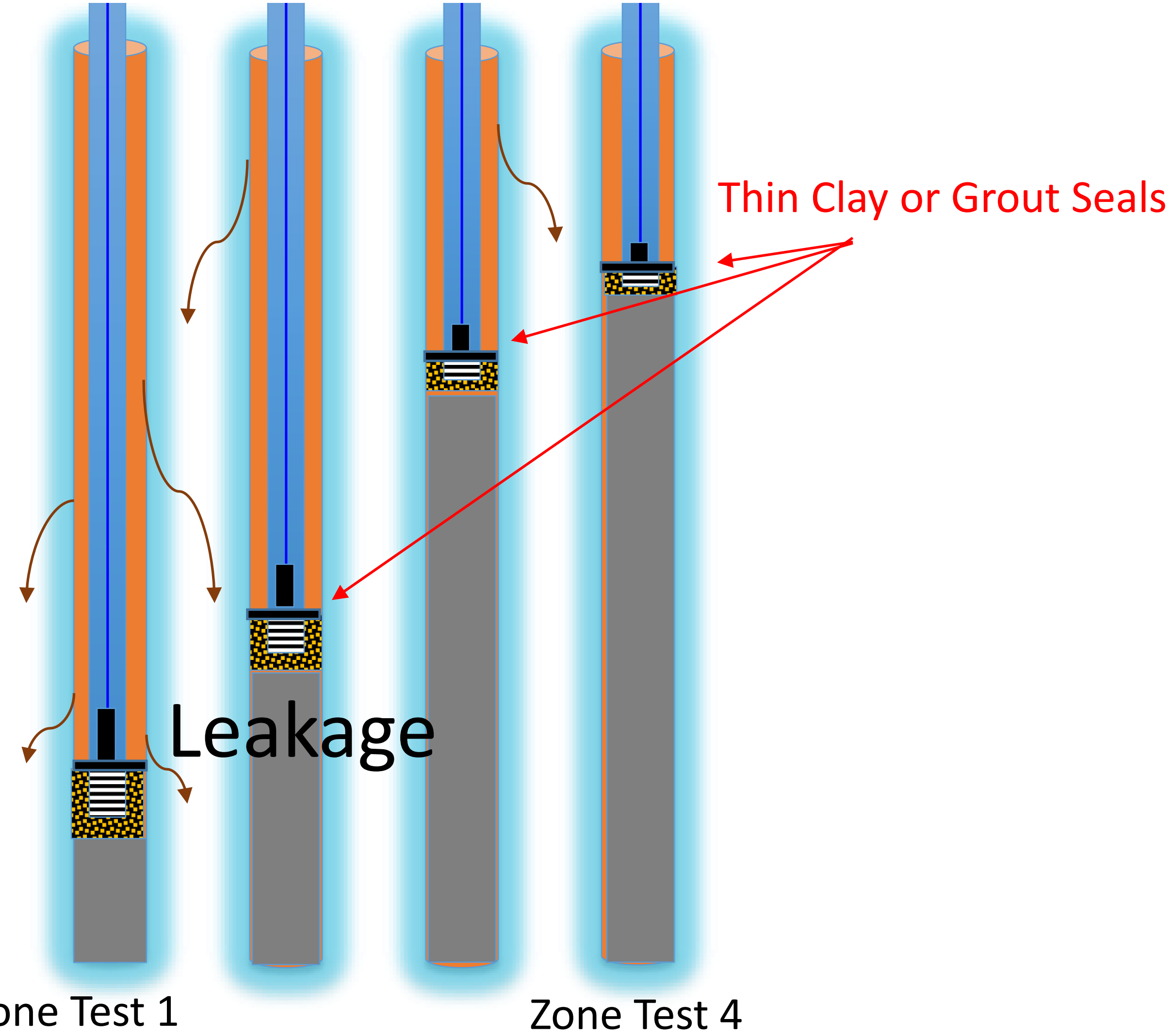
Total Depth

Expensive Data Deficiencies

Run Geophysics

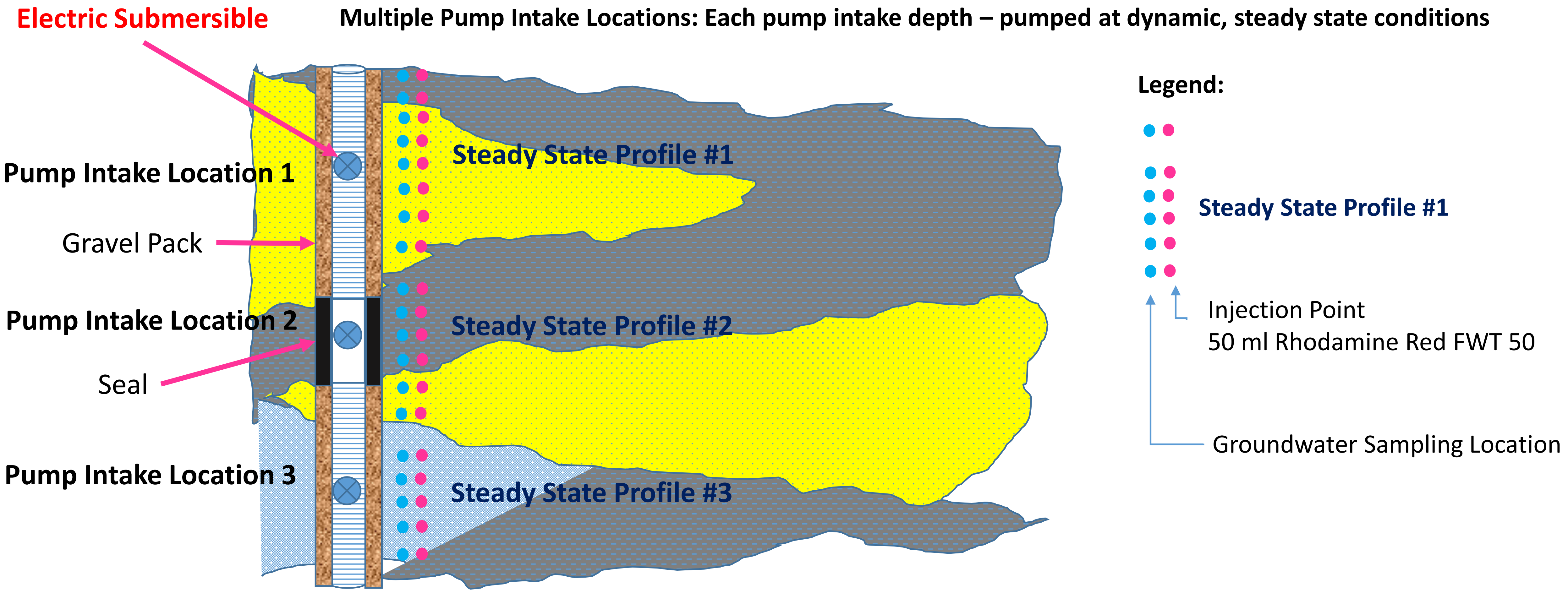


Zone Testing 6 to 24 Hours Per Zone
Using Sequential Backfill Method
Determine Pumping Rate For Each Test?
Zone Selections are COARSIFIED!!!

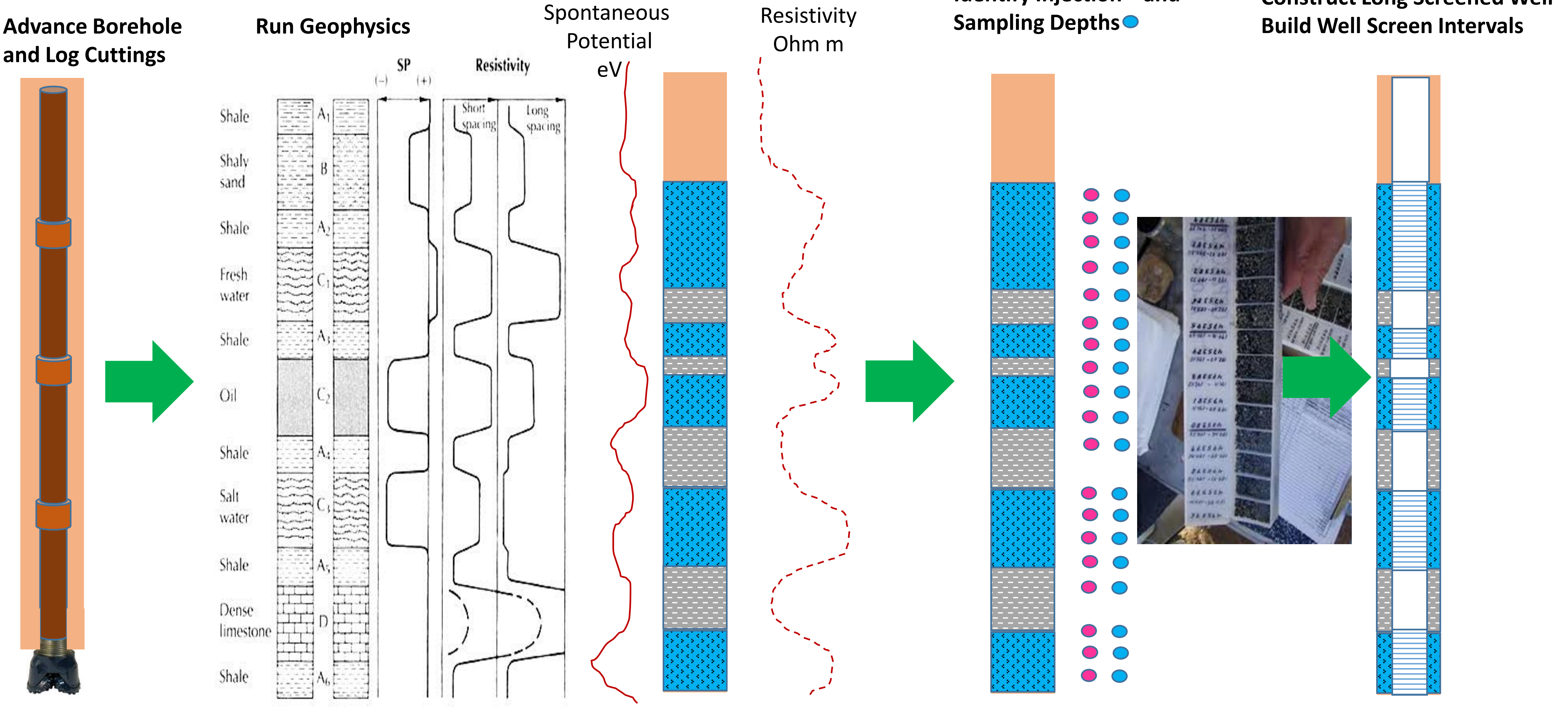


Profiling Temporary Long Screened Wells with BESST Tracer Technology

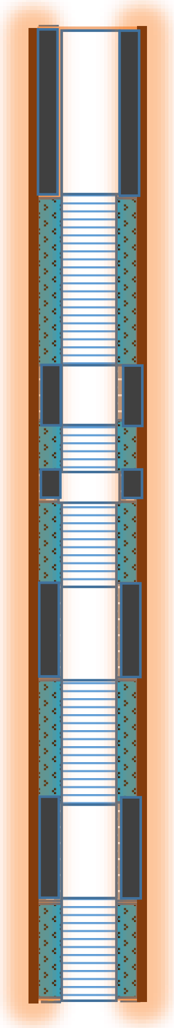
Multiple Pump Intake Locations: Each pump intake depth – pumped at dynamic, steady state conditions



Long Screened Test Well



Construct Long Screened Well Gravel Pack and Seals (tremmied)



Drilling Rig Demobs From Site

Pump Rig Mobs Onto Site

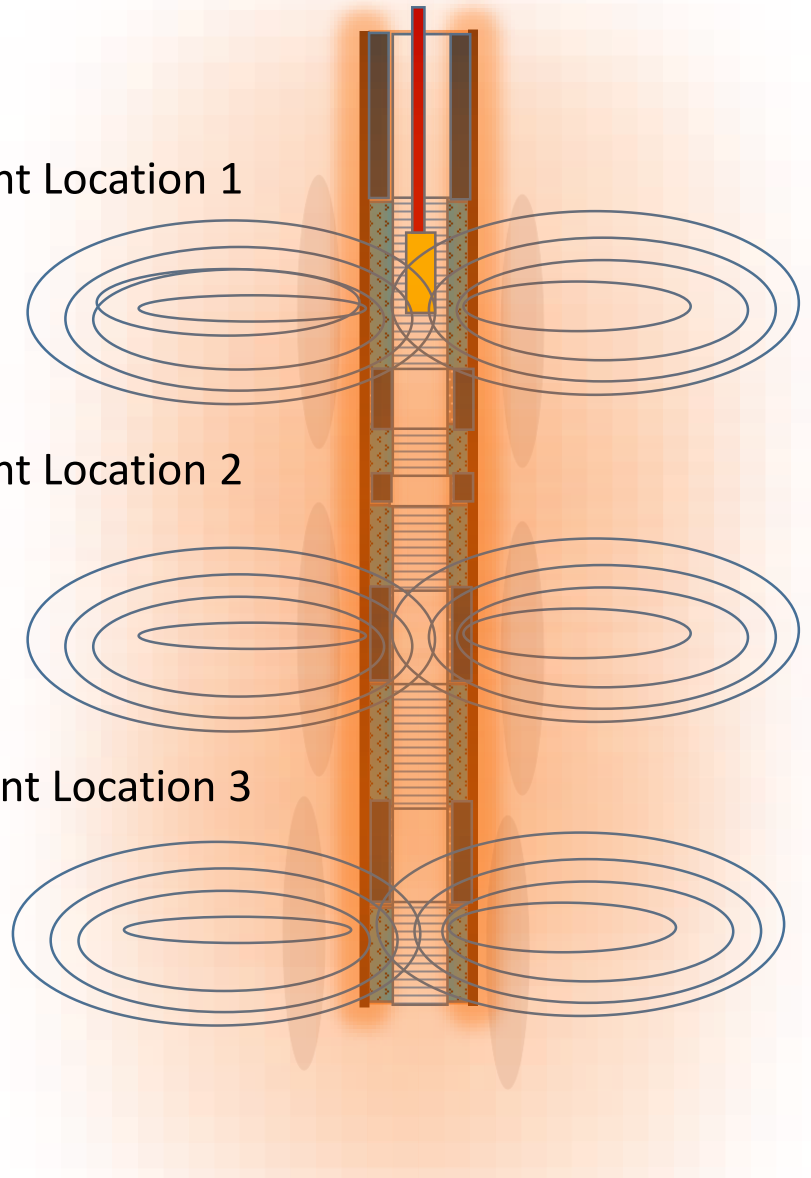
Develop Well: Remove Mud Cake and Drilling Fluid w/ Electric Submersible Pump

Pump Development Location 1

GOAL = 10 NTUs

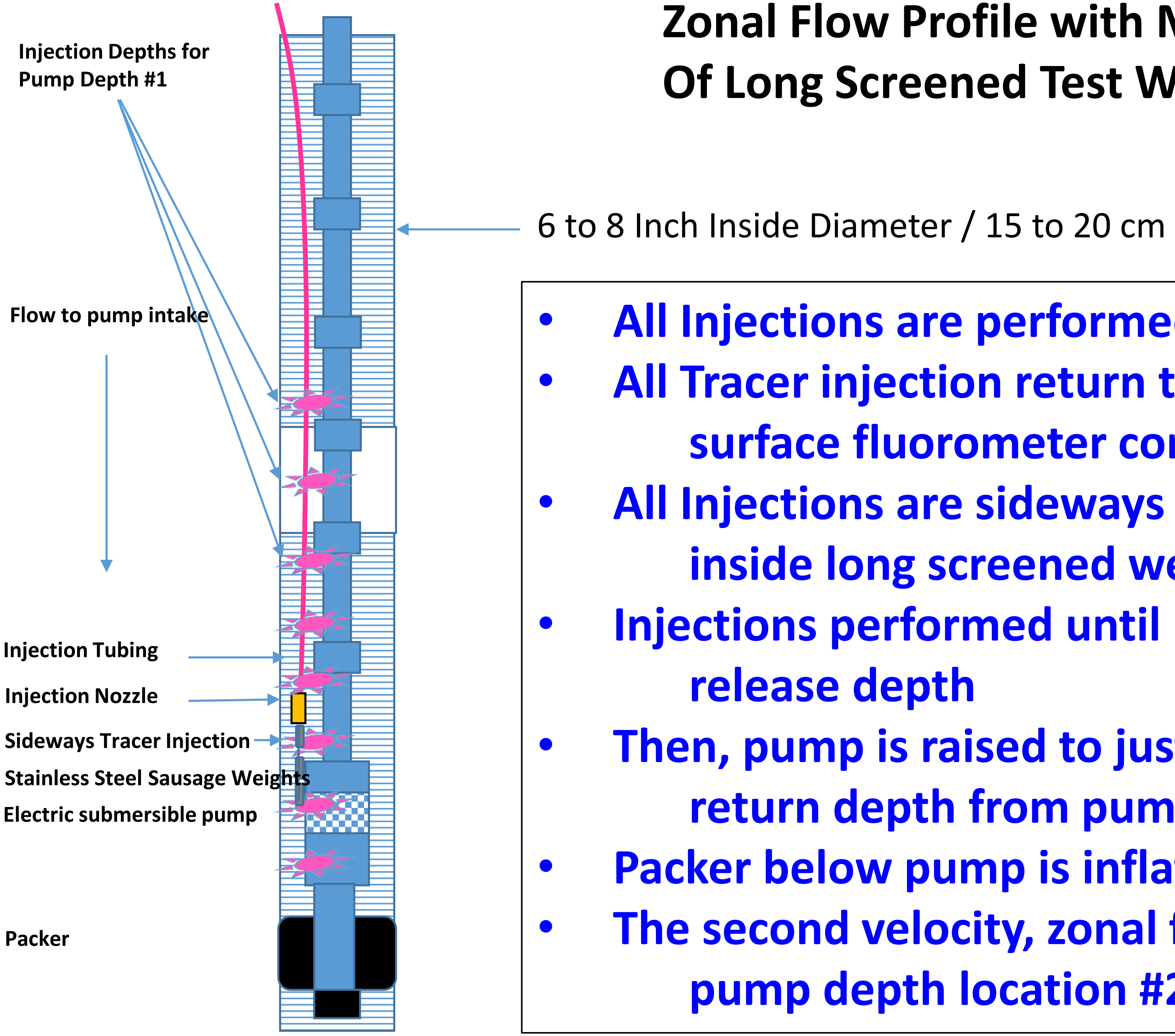
Pump Development Location 2

Pump Development Location 3



Development

Zonal Flow Profile with Miniaturized USGS/BESST Tooling Of Long Screened Test Well



- All Injections are performed one depth at a time
- All Tracer injection return times monitored with ground surface fluorometer connected to line tap
- All Injections are sideways to obtain most accurate flow rate inside long screened well
- Injections performed until no return from furthest tracer release depth
- Then, pump is raised to just below the furthest tracer return depth from pump depth location #1
- Packer below pump is inflated
- The second velocity, zonal flow profile is now performed from pump depth location #2

Speaker #4

Designing and Implementing a Multi-Facility SCADA System in the Age of Information

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Water Replenishment District

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Enterprise Automation

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Enterprise Automation

Chris.Schleich@eaintegrator.com

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

Designing & Implementing a Multi-Facility SCADA System in the Age of Information

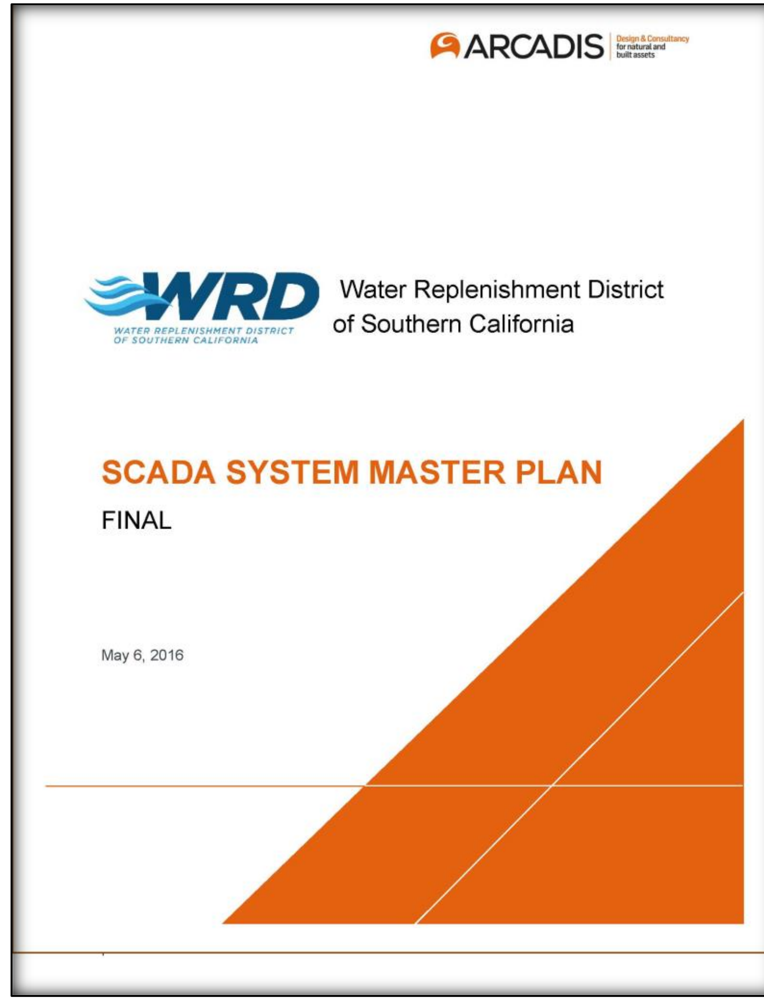
WRD Groundwater Quality Workshop
August 9, 2017

Agenda

- Purpose of the WRD SCADA Master Plan
- SCADA Master Plan Development
- Key WRD SCADA Projects
- Partnering with the Right Integrator
- Benefits of executing the WRD SCADA Master Plan
- Road Map to Success

SCADA Master Plan

- A SCADA System Master Plan was completed in May 2016
- Some key components:
  - ➢ Support the design of future facilities
  - ➢ Integration with existing facilities, including communications back to a centralized SCADA system
  - ➢ Network design and cybersecurity program
  - ➢ Develop & implement stds for software, hardware, graphics, programming, etc.
- Major challenges:
  - ➢ WRD is not an operating agency
  - ➢ Facilities constructed at different times with no standards in place
  - ➢ Construction projects in progress
  - ➢ Lack of internal staff with expertise


ARCADIS Design & Consultancy for natural and built assets

WRD Water Replenishment District of Southern California

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

SCADA SYSTEM MASTER PLAN

FINAL

May 6, 2016

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

Key Objectives of SCADA Master Plan

- **Build consensus & determine future direction**
- **Prioritize SCADA projects with useable budgets**
- **Maximize investment in control system equipment**
- **Retain SCADA system integrator (Enterprise Automation) to assist with integration of key WRD projects**

SCADA Master Plan Dvlpt

Project Initiation/ Identify Goals and Metrics → **Baseline Assessment** → **Evaluate Alternatives & Recommend Actions** → **Final SCADA Master Plan**

Phase I: Project Initiation/ Visioning Work Shop

- Task 1 – Project Initiation
- Task 2 – Visioning Workshop

→

Phase II: Evaluation, Research and Assessment

- Task 3 – Perform Baseline Assessment

→

Phase III: Systems Analysis and Development of Recommendations

- Task 4 – Perform Requirements Definition
- Task 5 – Evaluate SMP Alternatives and Recommend Initiatives

→

Phase IV – Development of Draft Technology Master Plan

- Task 6 – Draft SCADA Master Plan

→

Phase V: Development and Delivery of Final Technology Master Plan

- Task 7 – Finalize SCADA Master Plan

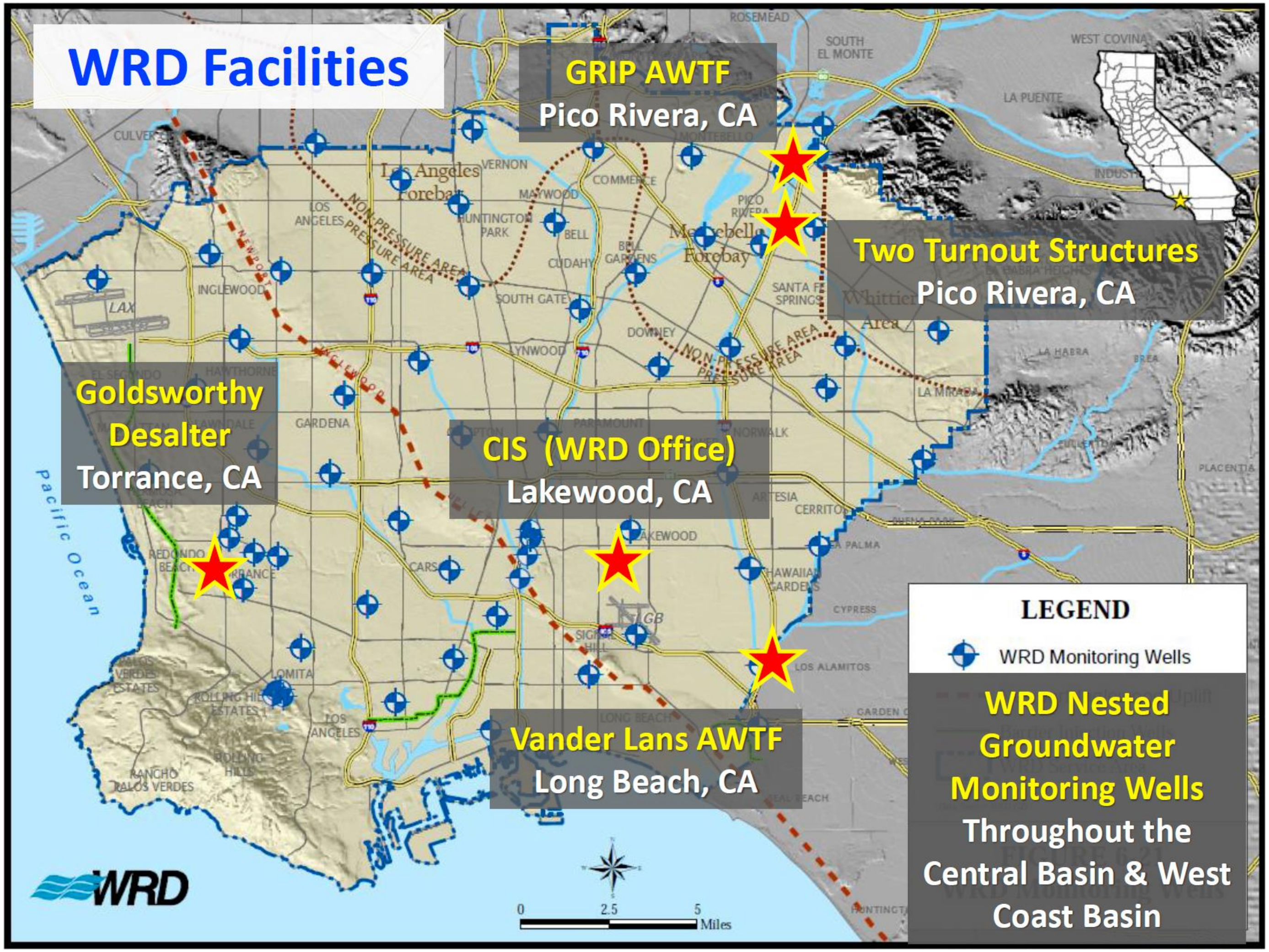
Enterprise Automation

- **CSIA Certified Integrator** **(1 of 3 in SoCal)**
- **Schneider Electric's #1 Integrator in U.S.**
  - ***SCADA Certified Alliance I.P.*** ***(1 of 1 in U.S.)***
  - ***PlantStruxure Certified Alliance I.P.*** ***(1 of 1 in CA)***
- **Wonderware System Platform Certified** **(1 of 3 in SoCal)**

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

WRD System Overview



WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

Central Information System (CIS)

- The CIS is being established at WRD's headquarters
- The CIS will be able to view, and eventually operate, all of WRD's facilities

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

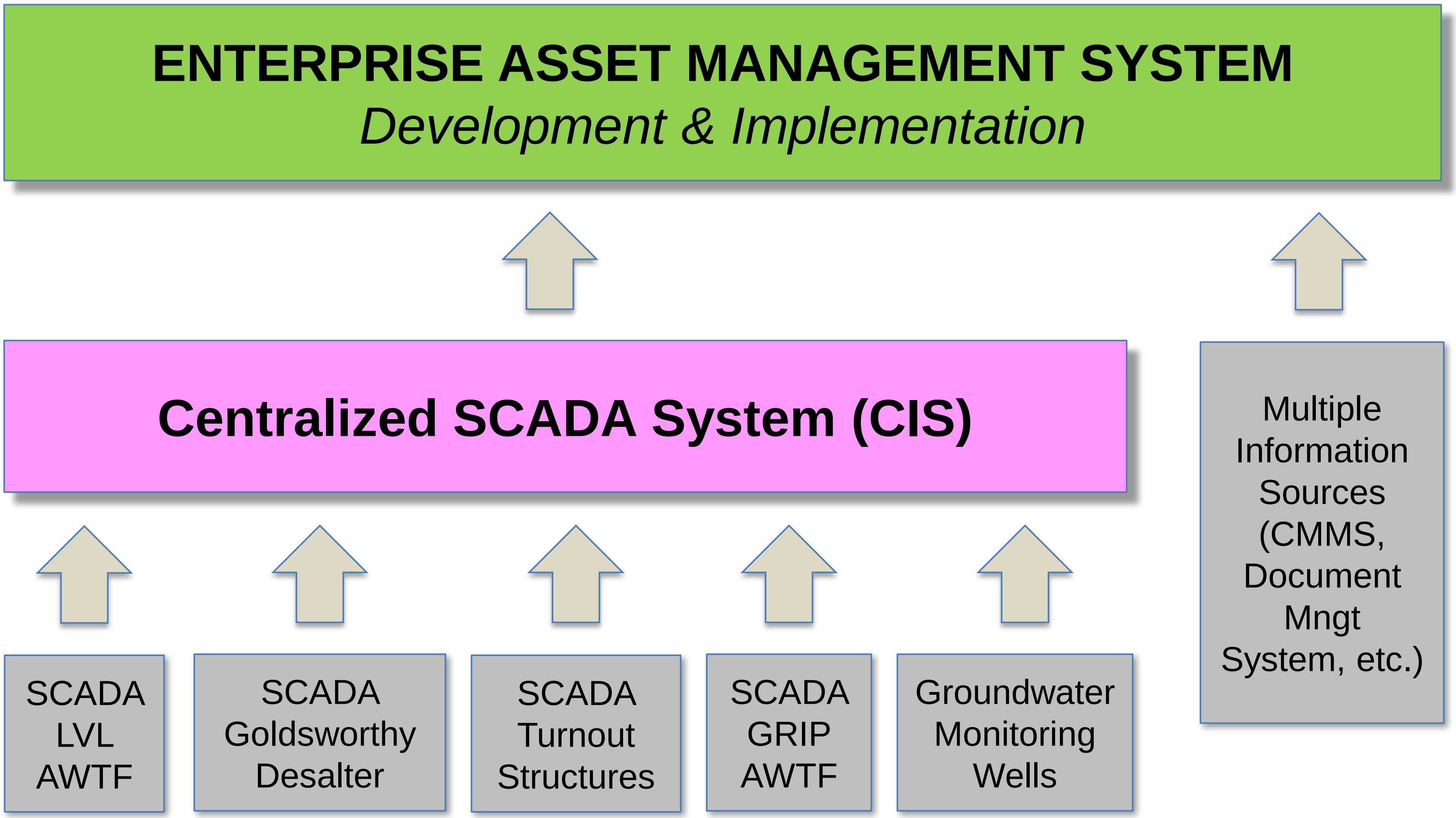
ENTERPRISE AUTOMATION

Groundwater Reliability Improvement Program (GRIP) Advanced Water Treatment Facility (AWTF)

- **By Summer 2018, the GRIP AWTF will be completed and have the ability to produce up to 21,000 AFY of advanced treated recycled water for recharge at the Montebello Forebay Spreading Grounds**
- **The current design requires coordination with the SCADA Master Plan**

GROUNDWATER RELIABILITY IMPROVEMENT PROJECT

Enterprise Asset Mngt System



The Right Integration Partner

Long-term captive integrator (3+ years)

Qualified, **based on the needs of the Master Plan**

Partnership, **behaves like an extension of staff**

Participation, **seeks to engage with you**

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

Winning Formula

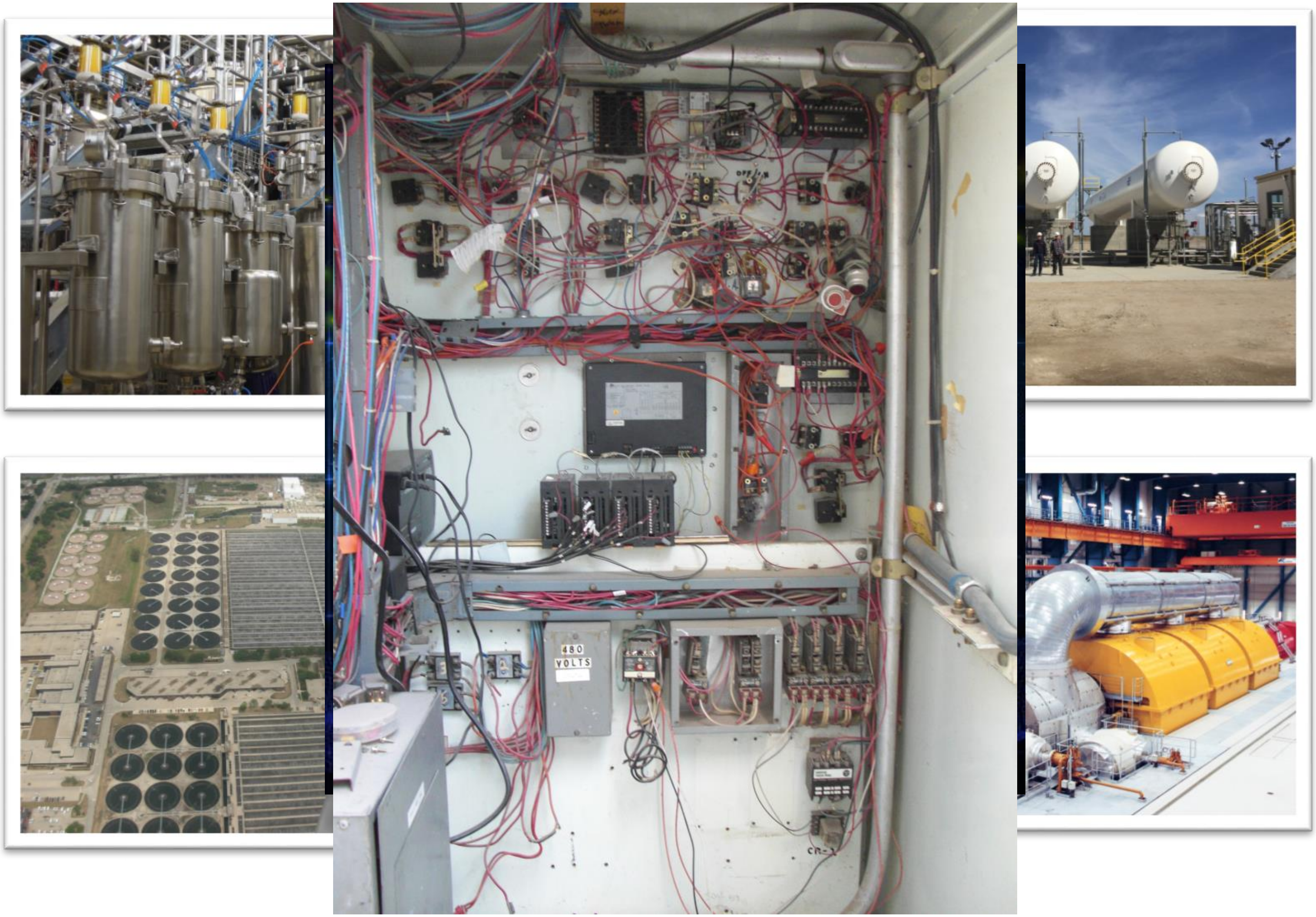
Right Plan + Right Partner = Incredible Value

Long-term, qualified partner who wants to collaborate

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

Introduction



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WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

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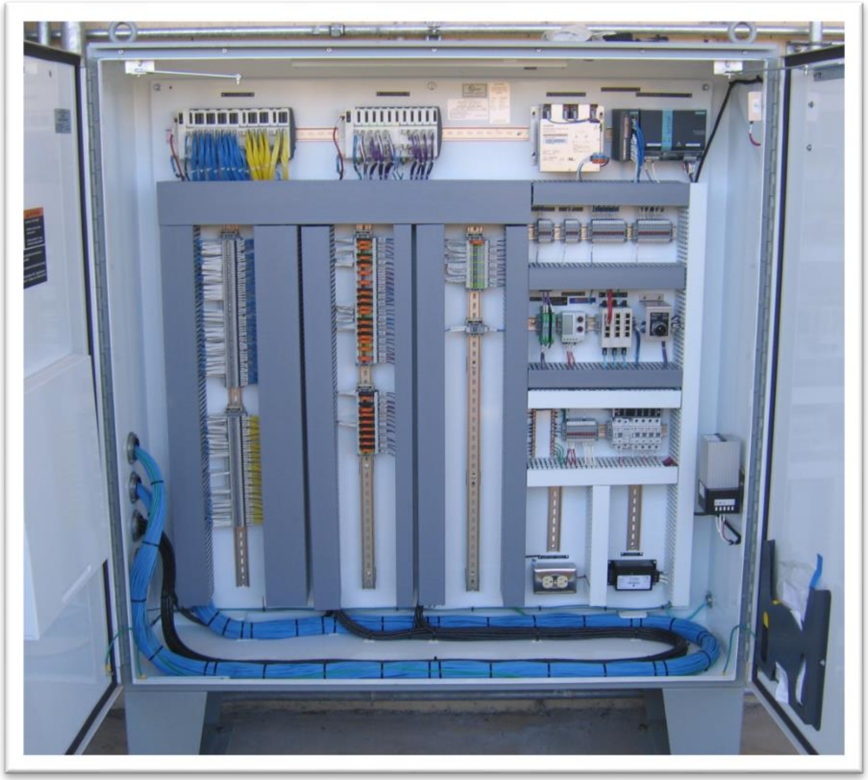
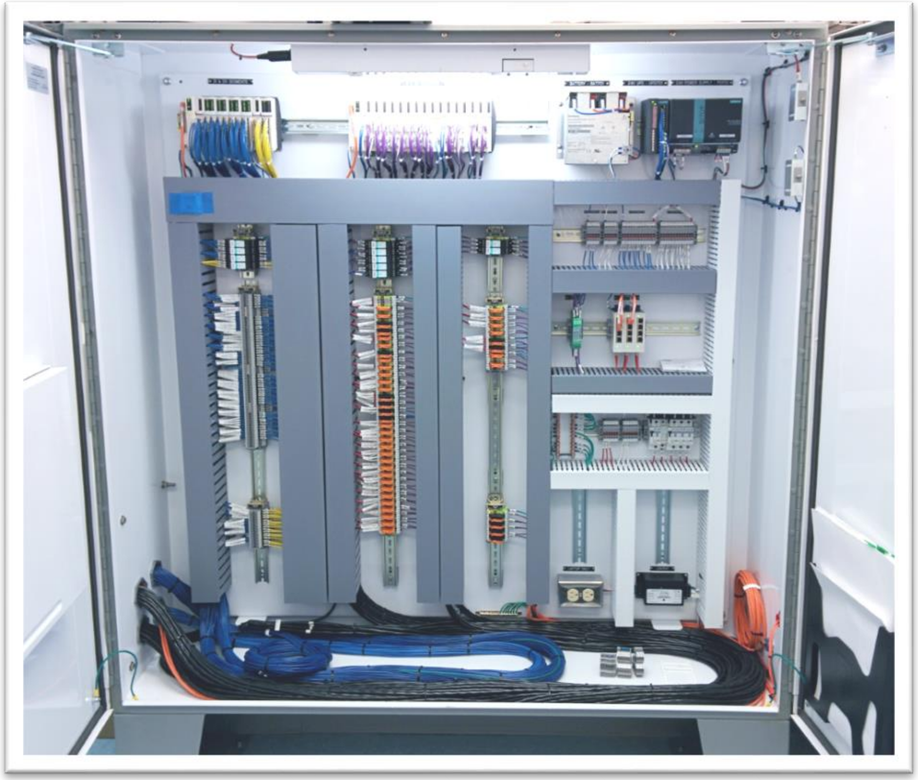
World Class SCADA Benefits

Consistency

Consistency

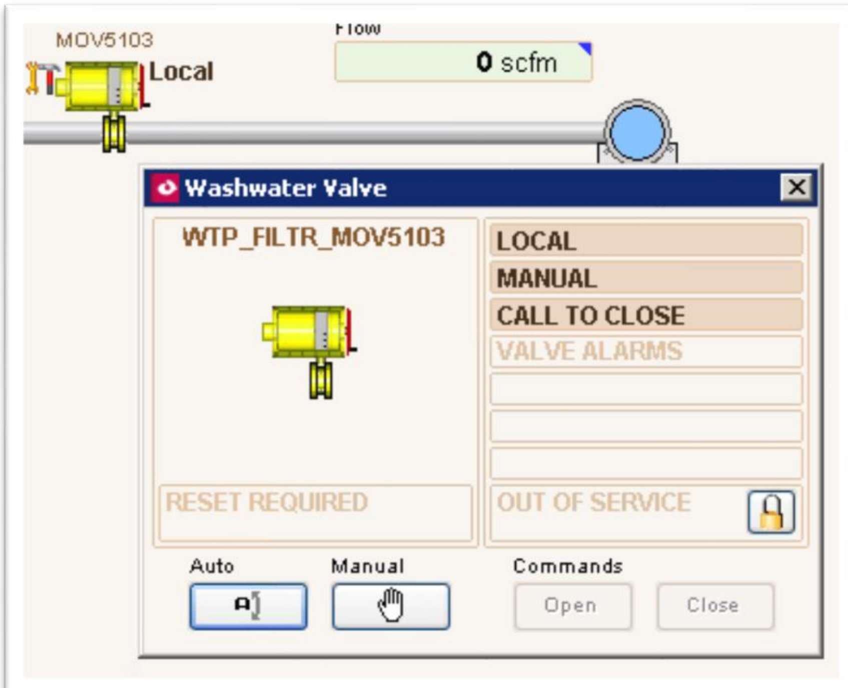


Installed 2008

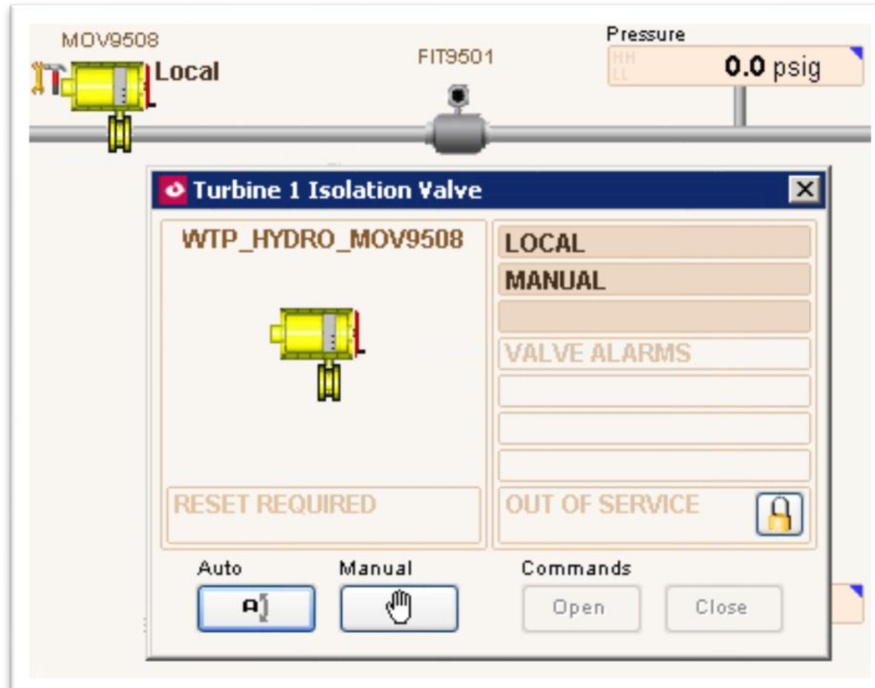


Installed 2012

Consistency



2009 - Filters System



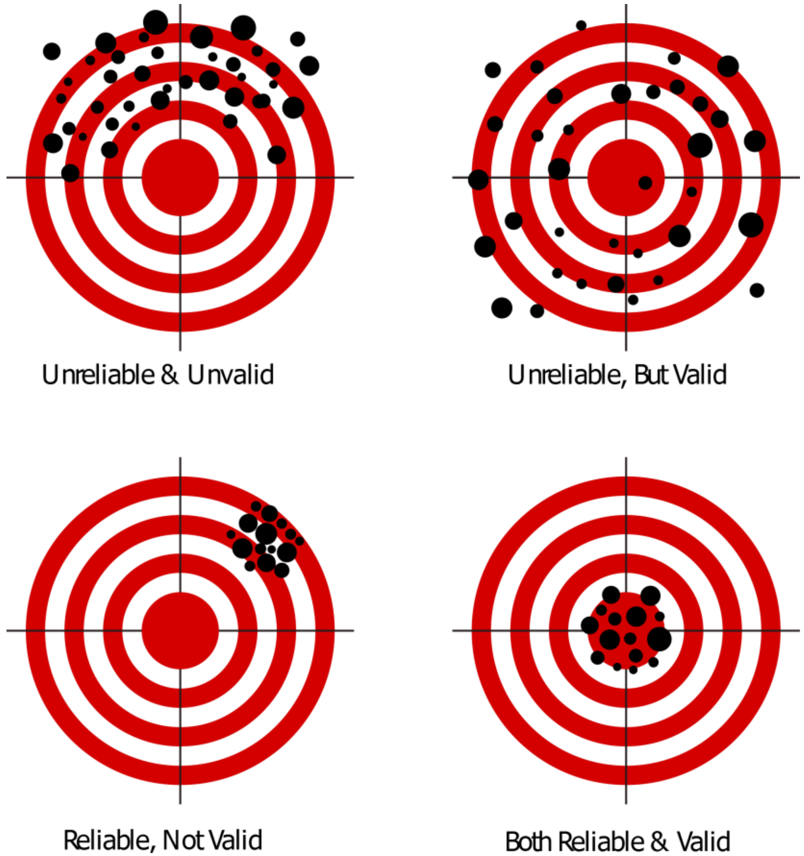
2017 - HydroElec System

World Class SCADA Benefits

Consistency

Predictable

Predictable



World Class SCADA Benefits

Consistency

Predictable

Documented / Traceable

WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA
ENTERPRISE AUTOMATION

Documented

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

World Class SCADA Benefits

Consistency

Predictable

Documented / Traceable

Secure

Promises

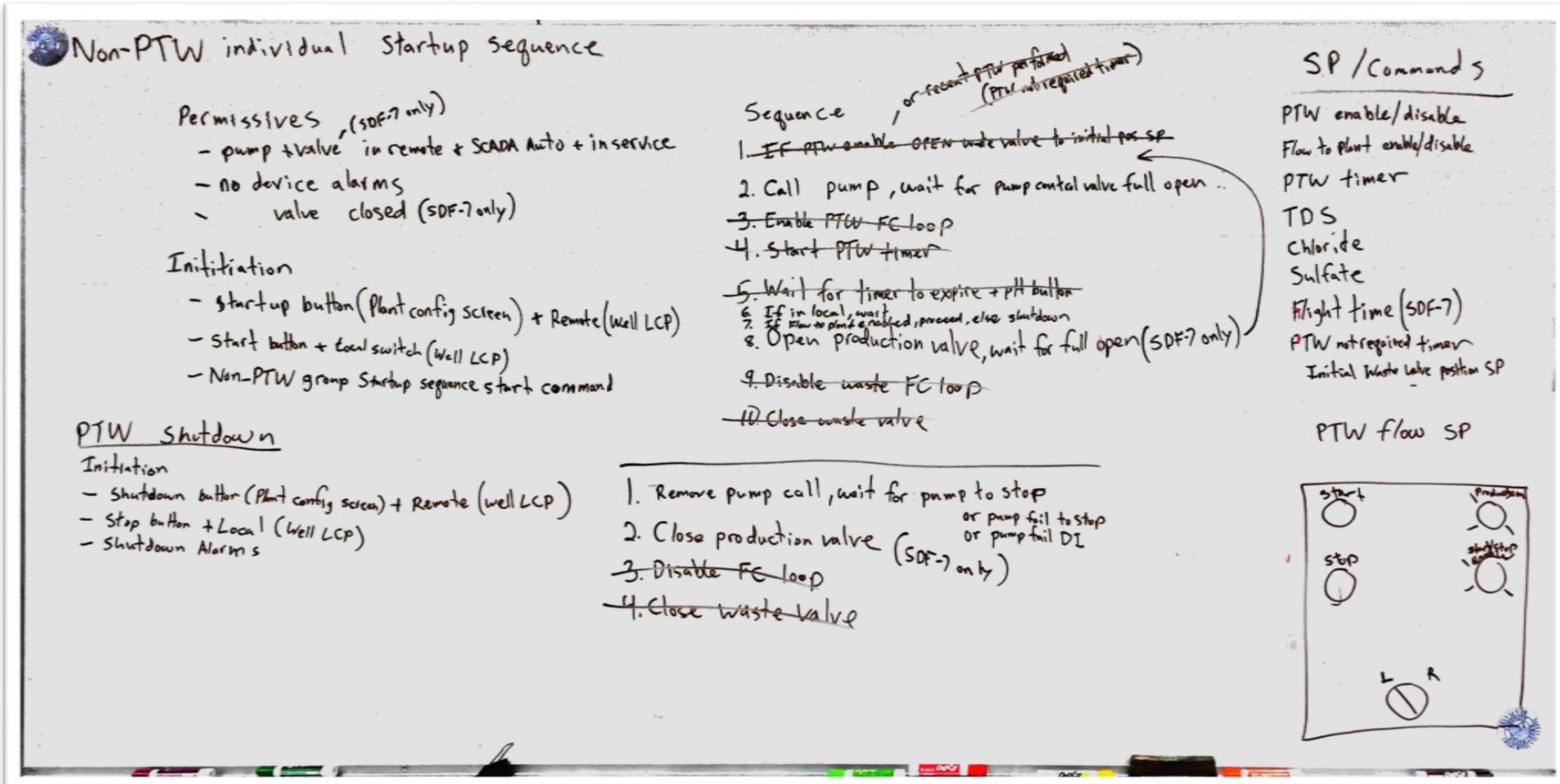
Skeptical? Good!

Road Map to Success

Client Involvement, **both client and integrator need to be working together**

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

1. Client Involvement - Workshops

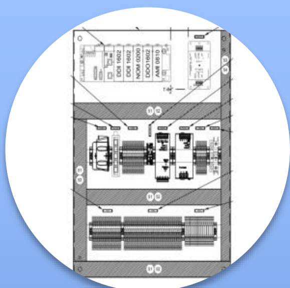


Road Map to Success

Client Involvement, **both client and integrator need to be working in concert**

Document decisions and standards, otherwise things will change

2. Document Standards



Control Panels

Standards

"The way we do things around here…"

Servers,
ecurity,
etworking

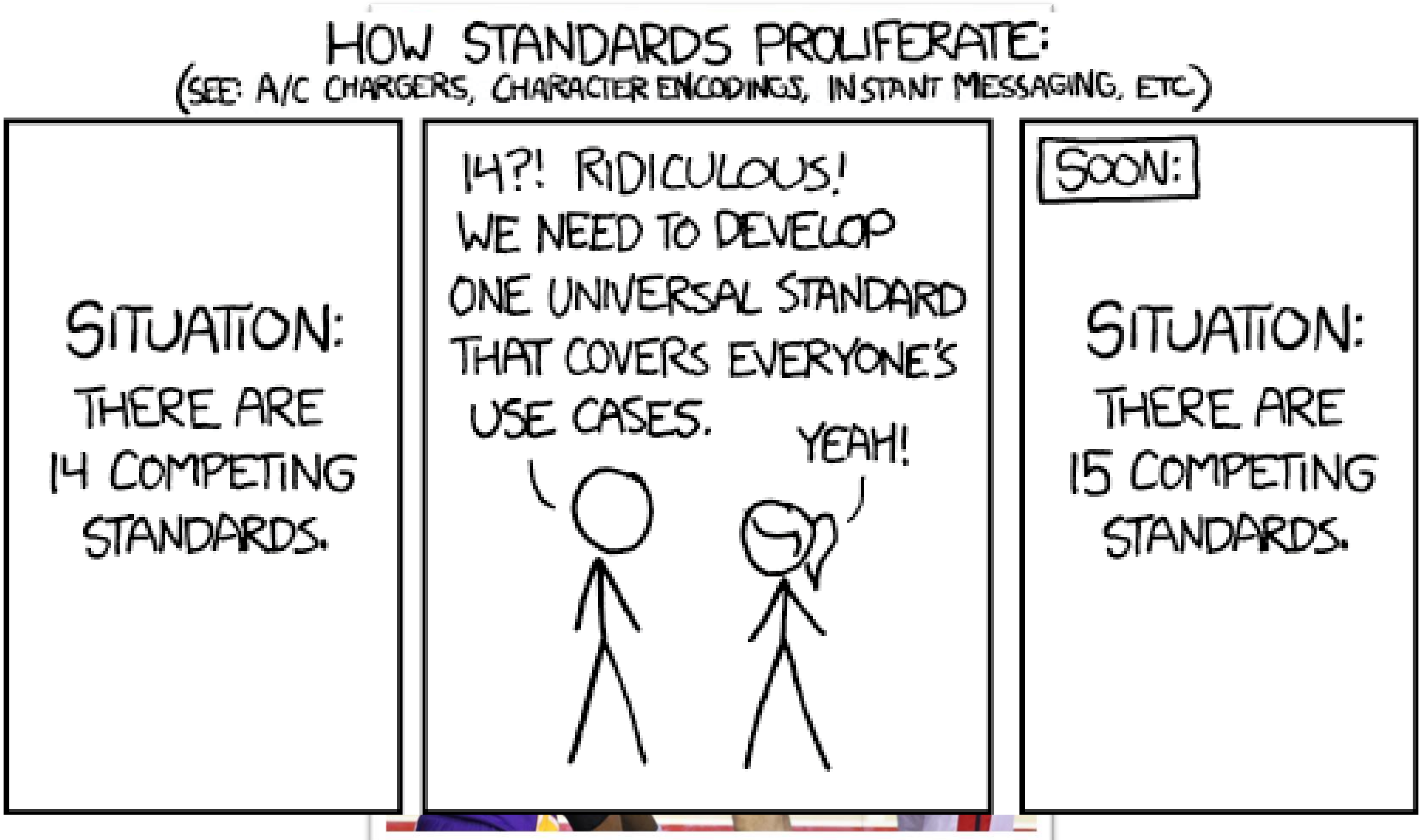
Road Map to Success

Client Involvement, **both client and integrator need to be working in concert**

Document decisions and standards, **otherwise things will change**

Both sides need a champion, **enforcement of decisions is key**

3. Champions


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)
SITUATION: THERE ARE 14 COMPETING STANDARDS.
14?! RIDICULOUS! WE NEED TO DEVELOP ONE UNIVERSAL STANDARD THAT COVERS EVERYONE'S USE CASES.
YEAH!
SOON:
SITUATION: THERE ARE 15 COMPETING STANDARDS.

Road Map to Success

Client Involvement, both client and integrator need to be working in concert

Document decisions and standards, otherwise things will change

Both sides need a champion, enforcement of decisions is key

Project execution

- Defined and Clear Estimate/Scope
- Written Specifications
- QC / Testing
- Real Project Management
- Early Planning

WRD WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

ENTERPRISE AUTOMATION

Questions?

Thank You

For more information visit

www.wrd.org

www.EAintegrator.com

Speaker #5

Ex-Situ Groundwater Remediation Options for Perchlorate

Steve Winners

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Cathy Swanson

Evoqua Water Technologies, Inc.

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EX-SITU GROUNDWATER REMEDIATION OPTIONS FOR PERCHLORATE

Water Replenishment District of Southern California

2017 Annual Groundwater Quality Workshop

August 9, 2017

SPEAKERS

Cathy Swanson, Evoqua
Ms. Swanson received her BS in Chemical Engineering from Northwestern University. Her experience includes, lab technician, facilities engineering, operations, technical service, marketing, account management, and most recently business development. She has spent the past 10 years focused on groundwater cleanup of inorganic constituents especially for drinking water.

Steve Winners, PE, WorleyParsons
Mr. Winners received his BS in Agricultural Engineering from Cal Poly San Luis Obispo. He is a Professional Civil Engineer in the State of California with 20+ years of environmental engineering experience working for two firms in Southern California. He has held both management and technical roles. He has assembled and participated in multi-disciplinary teams of geologists, hydro-geologists, geochemists, toxicologists, and engineers conducting assessment, remediation and management of chemical releases to groundwater.

evoqua WATER TECHNOLOGIES
WorleyParsons resources & energy

AGENDA

PART 1

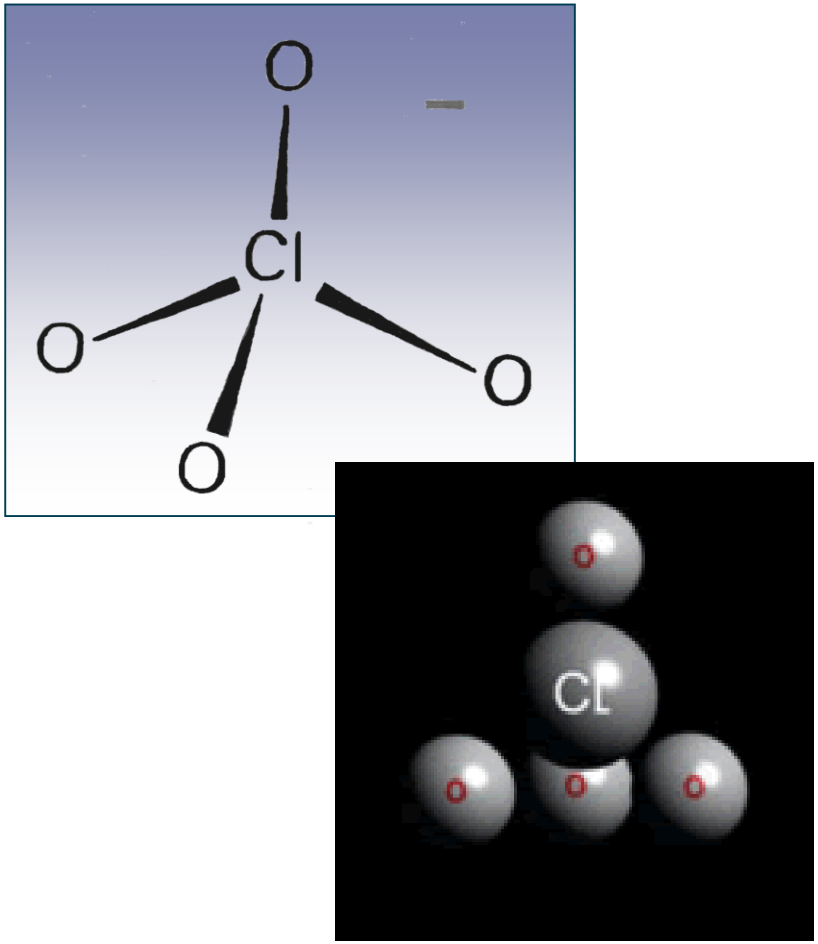
1. Perchlorate Chemistry
2. Natural Sources of Perchlorate
3. Perchlorate Use
4. Perchlorate In The Environment
5. Drinking Water Contaminant History
6. Human Health Considerations
7. Regulatory Update

PART 2

1. Technology Selection Factors
2. Information Needed To Design A System
3. Treatment Technologies Not Applicable to Perchlorate
4. Treatment Technologies Applicable to Perchlorate
5. Ion Exchange
6. Biological

PART 1

PERCHLORATE CHEMISTRY



- Fundamental physical and chemical nature complicates treatment.
- Perchlorate tetrahedron structure of four oxygen atoms surrounding the central chlorine atom.
- Effectively blocks reductants from directly attacking the chlorine.
- Thermodynamically a strong oxidizing agent but kinetically a sluggish species, such that its reduction is generally very slow, rendering common reductants ineffective.

Source: US EPA

EVOQUA WATER TECHNOLOGIES

WorleyParsons resources & energy

NATURAL SOURCES OF PERCHLORATE

- Chilean nitrate deposits
  - Chief source of nitrogen for explosives, fertilizer, and chemical industries from the 1830s to the 1930s.
  - Only significant source of iodine from the 1870s (replacing seaweed) until the mid-20th century (when iodine began to be extracted from oilfield brines).
- New Mexico potash
- Canada potash
- California hanksite
- Bolivian playa (evaporative) crusts

PERCHLORATE USE

- Solid propellant for rockets, missiles, for the defense and aerospace industries.
- Primary oxidizer in matches, road flares, air bag initiators for vehicles, pyrotechnics, ordnance, and explosives.

Source: Water Research Foundation

EVOQUA WATER TECHNOLOGIES

WorleyParsons resources & energy

PERCHLORATE IN THE ENVIRONMENT

- Soluble and very mobile in water systems.
- Resistance to reactions with other available water constituents.
- Can persist in the environment for many decades under typical groundwater and surface water conditions.

Source: US EPA

DRINKING WATER CONTAMINANT HISTORY

- Perchlorate was found to be a contaminant in drinking water supplies for the Western United States in 1997. The issue was triggered when elevated levels of perchlorate were discovered in California drinking water supplies using a new, more sensitive analytical method (US EPA Method 314.0 Determination of Perchlorate in Drinking Water Using Ion Chromatography).

- More recent occurrence studies have found perchlorate contamination in both groundwater and surface waters serving as drinking water sources for more than 16 million people in at least 26 states nationwide, though most often in the southwest.

Drinking water sources with perchlorate detections.

County	Year initially detected									Total No. of Sources	Peak level (µg/L)
	1997	1998	1999	2000	2001	2002	2003	2004	2005		
Los Angeles	54	31	21	13	8	24	7	12	7	177	159
San Bernardino	31	1	1	8	34	8	3	4	5	95	820
Riverside	14	5	5	11	16	19	10	3	1	84	73
Orange	-	20	-	-	1	9	7	-	-	37	11
Sacramento	10	2	-	1	-	1	-	1	9	24	400
Tulare	-	-	-	2	11	1	-	-	-	14	24
Santa Clara	-	-	1	2	1	2	3	-	1	10	8.5
San Diego	-	-	-	-	1	-	-	4	-	5	7
Ventura	-	1	1	-	-	-	-	2	-	4	20
Imperial	-	-	-	-	3	1	-	-	-	4	6
Sonoma	-	-	-	1	-	-	-	-	-	1	5
Stanislaus	-	-	-	-	-	-	1	-	-	1	3.3
TOTAL	109	60	29	38	75	65	31	26	23	456	-

Source: State of California

HUMAN HEALTH CONSIDERATIONS

- Perchlorate is classified as a goitrogen by the United States Environmental Protection Agency (US EPA), because at high levels it can interfere with the thyroid's ability to uptake iodide and thus affect hormone production.
- Thyroid hormones play a vital role in the growth and development of the central nervous system of fetuses and infants.
- According to the National Research Council, pregnant women, infants, children, and people with iodine-deficient diets or preexisting thyroid deficiencies may be more sensitive to perchlorate than the general population.

Source: Water Research Foundation

REGULATORY UPDATE

Source: CA.GOV

- **US EPA** anticipated proposing an MCL but does not currently regulate perchlorate in drinking water.
- **California** and Massachusetts currently regulate Perchlorate in drinking water with maximum contaminant levels **(MCLs)** at **6 µg/L** and 1 µg/L.
- California established an MCL for perchlorate 2007 based on a Public Health Goal (PHG) of 6 µg/L.
- California reduced the PHG from 6 µg/L to 1 µg/L in 2015.
- **California** previously set the detection limit for purposes of reporting (DLR) at 4 µg/L, and in July 2017 recommended **reducing the DLR** to a level closer to, equal to, or less than the PHG of **1 µg/L**.
- If supported by new data at a lower DLR, California **may lower the MCL** to as close to the **1 µg/L PHG** as is **technologically and economically feasible.**

PART 2

TECHNOLOGY SELECTION FACTORS

- **Water Quality Factors**
  - Perchlorate and co-contaminant concentrations
  - Geochemical and other water quality parameters
  - Indigenous Perchlorate-Reducing Microbes (PRM) and substances that inhibit PRM.
- **Water Quantity Factors**
  - Groundwater Remediation (10-100 gpm)
  - Groundwater Production (1,000-10,000 gpm)
- **Waste Disposition Considerations**
  - Brine discharge pipelines and permit
  - Liability of generator
- **End Use Considerations**
  - Direct domestic use
  - Groundwater recharge
  - Recycled water use
  - Storm drain or surface water discharge
  - Publicly owned treatment works (POTW) discharge

Source: Ground-Water Remediation Technologies Analysis Center

INFORMATION NEEDED TO DESIGN A SYSTEM

Description
Operational Flow Rate
Operational Schedule
Daily Volume (average)
Perchlorate
Chloride
Nitrate (as NO3)
Sulfate
Alkalinity (as CaCO3)
pH
TDS

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TREATMENT TECHNOLOGIES NOT APPLICABLE TO PERCHLORATE

- **Standard Granular Activated Carbon (GAC)**
  - Designed to sorb contaminant to a solid
  - Perchlorate has a high solubility and low affinity for sorption to solids
- **Air Stripping**
  - Designed to partition the contaminant from water to air phase
  - Perchlorate is non-volatile
- **Precipitation**
  - Perchlorate will not precipitate at any pH
- **Chemical Reduction**
  - Add a reagent to enhance contaminant degradation
  - Structure blocks reductants from directly attacking the chlorine.

Source: US EPA

TREATMENT TECHNOLOGIES

Most Common Approaches:

- Ion Exchange
  - Single-Pass
  - Regenerable
- Biological Reduction
  - Fluidized Bed Reactors
  - Fixed Bed Reactor
  - Continuously Stirred Reactor
  - Post-treatment required

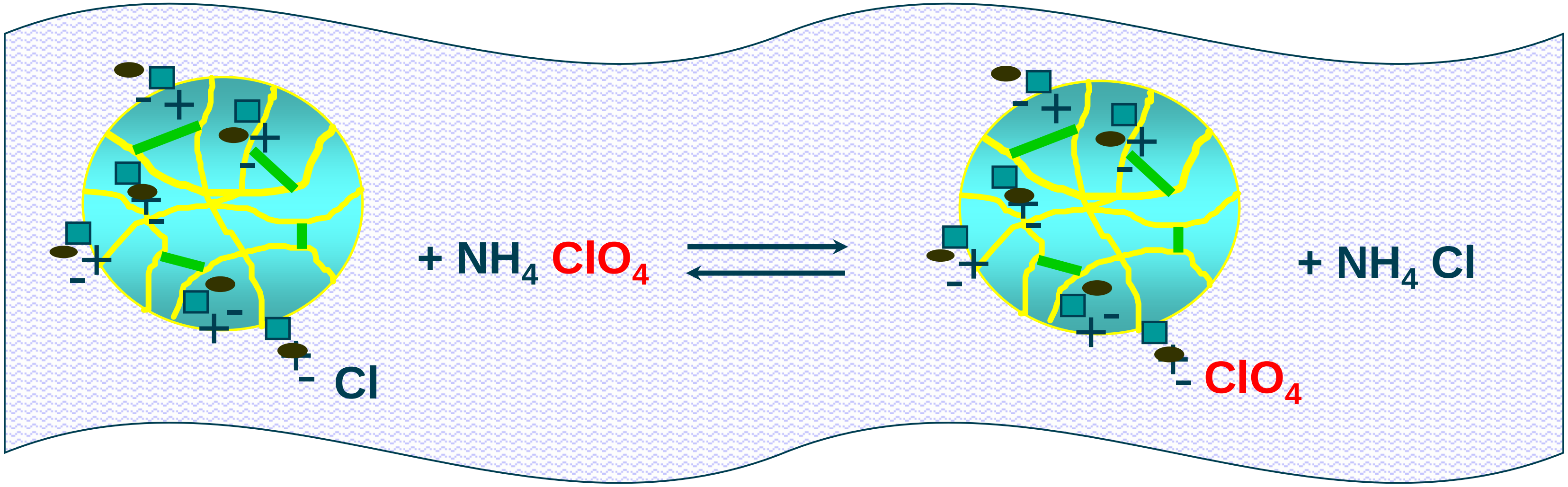
Not Generally Used:

- Membrane Filtration
  - Reverse Osmosis – 25% waste stream to dispose of
- Tailored GAC
  - More expensive than resins
- Chemical Reduction
  - "Expensive and slow"
- Electrochemical Reduction
  - "Slow process"
- Electrodialysis

Source: US EPA

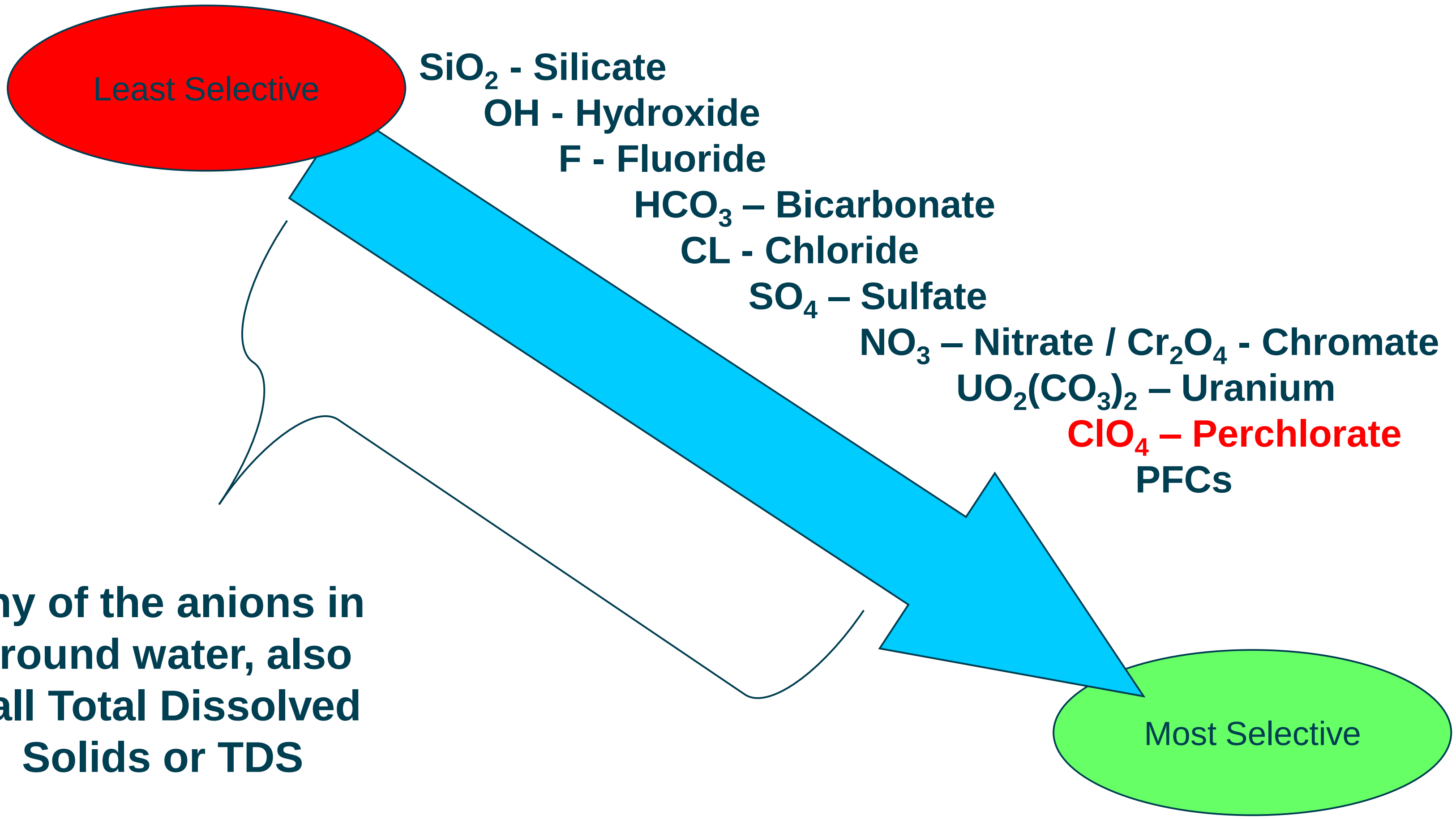
PRINCIPLES OF ION EXCHANGE

- Ion Exchange, or IX, is based on the principle of exchanging a harmless ion for the contaminant
- A reversible exchange of ions between a solid and a liquid in which there is no substantial change in the structure of the solid - the solid being the ion exchange resin.
- Example: R-Cl + NH_4 ClO_4 ⇄ R- ClO_4 + NH_4Cl



  www.evoqua.com

ANION ION EXCHANGE – SELECTIVITY FOR A PERCHLORATE RESIN



Many of the anions in ground water, also call Total Dissolved Solids or TDS

REGENERABLE ION EXCHANGE

- Produces concentrated perchlorate waste brine which generally cannot go to sewer
- Perchlorate is not destroyed, so liability is not severed for the generator

SINGLE PASS ION EXCHANGE

- Most common treatment
- DDW listed best available technology
- Low carbon footprint
- Simple operations – generally runs 6 to 9 months until spent
- Perchlorate is destroyed if resin goes to Waste-to-Energy Facility for incineration where a Certificate of Destruction ends generator liability

SINGLE PASS RESIN SITE CONSIDERATIONS

- Compact design: Treat up to 2000 gpm in 420 sq ft (vessels only)
- Systems run in lead/lag because perchlorate is considered an acute toxin
- Prefiltration is recommended

evoqua WATER TECHNOLOGIES

BIOLOGICAL TREATMENT

- Types:
  - Fixed Bed Reactor
  - Fluidized Bed Reactor
  - Biocatalyst
  - Continuously Stirred Reactor
- Excellent choice when paired with high nitrate levels. Also, chrome VI, selenium
- Requires chemical feeds
- Must meet surface water treatment regulations with post filtration
- Limited number of drinking water applications in US as technology is just starting to gain acceptance

SOURCES OF INFORMATION

- **National Sources**
- United States Environmental Protection Agency (US EPA)
- American Water Works Association Research Foundation (AWWARF)
- Water Research Foundation (WRF)
- Ground-Water Remediation Technologies Analysis Center (GWTRAC)
- Interstate Technology & Regulatory Council (ITRC)
- **State Sources**
- California Environmental Protection Agency (Cal-EPA)
- California State Water Resources Control Board (SRWCB)

THANK YOU!

QUESTIONS?

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Speaker #6

UCMR4 Implementation Strategies for Water Systems

Rick Zimmer

Eurofins Eaton Analytical

RickZimmer@eurofinsUS.com

eurofins

Eaton Analytical



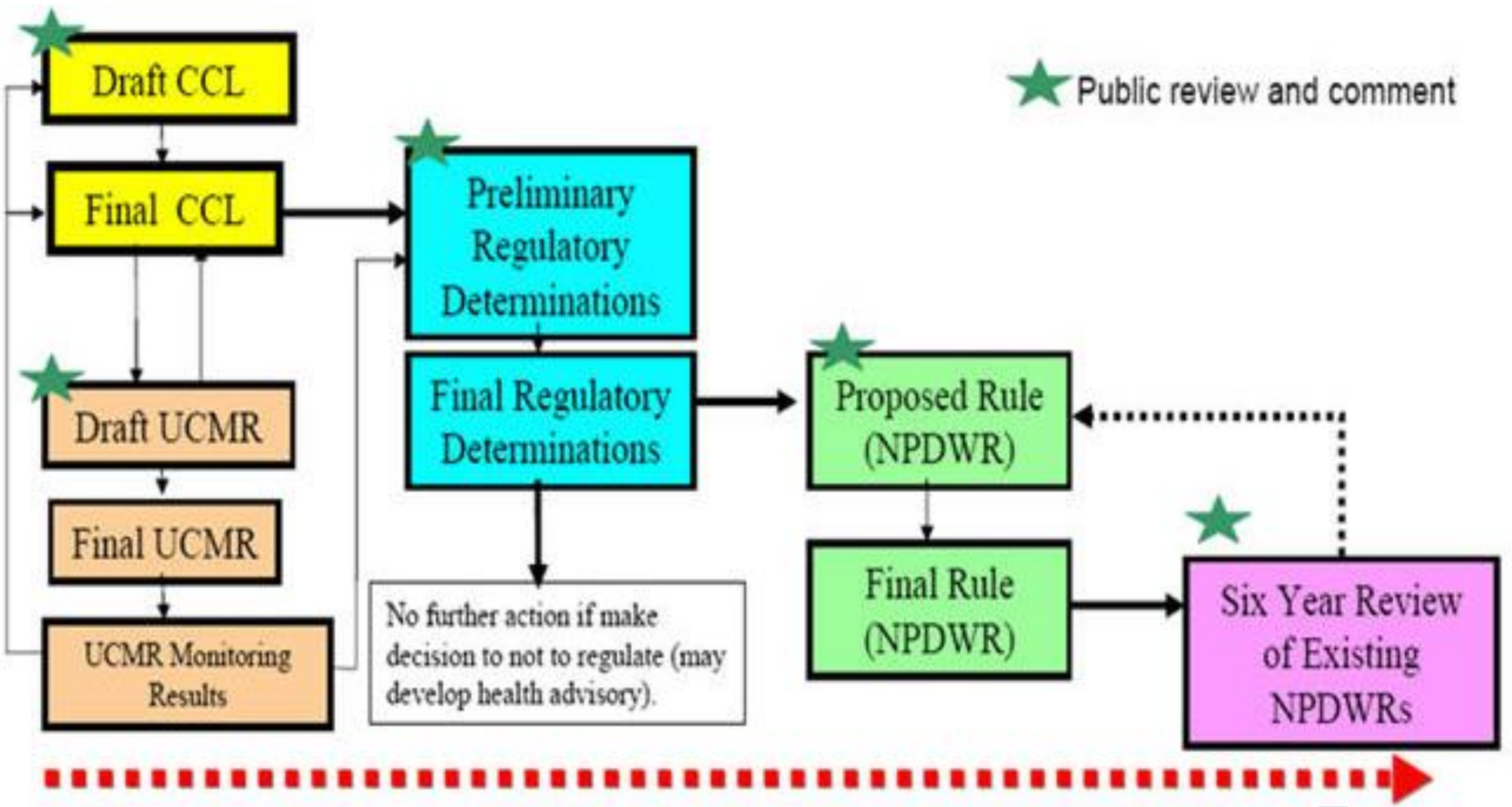
WRD

WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

UCMR4
Implications & Strategies for water systems

August 9, 2017

Purpose of the UCMR



UCMR History

UCMR1	UCMR2
2001 2002 2003	2008 2009 2010

UCMR3	UCMR4
2013 2014 2015	2018 2019 2020

UCMR4 Schedule



2017	2018	2019	2020	2021
After final rule publication: EPA/state primacy authorities (1) develop SMPs (including the nationally representative sample); (2) inform PWSs/ establish monitoring plans; and (3) continuation of laboratory approval	← **Assessment Monitoring** List 1 Contaminants → *All large systems serving more than 10,000 people;* *800 small systems serving 10,000 or fewer people for cyanotoxins;* *800 small systems serving 10,000 or fewer people for the 20 additional contaminants.* Reporting and analysis of data			Complete reporting and analysis of data

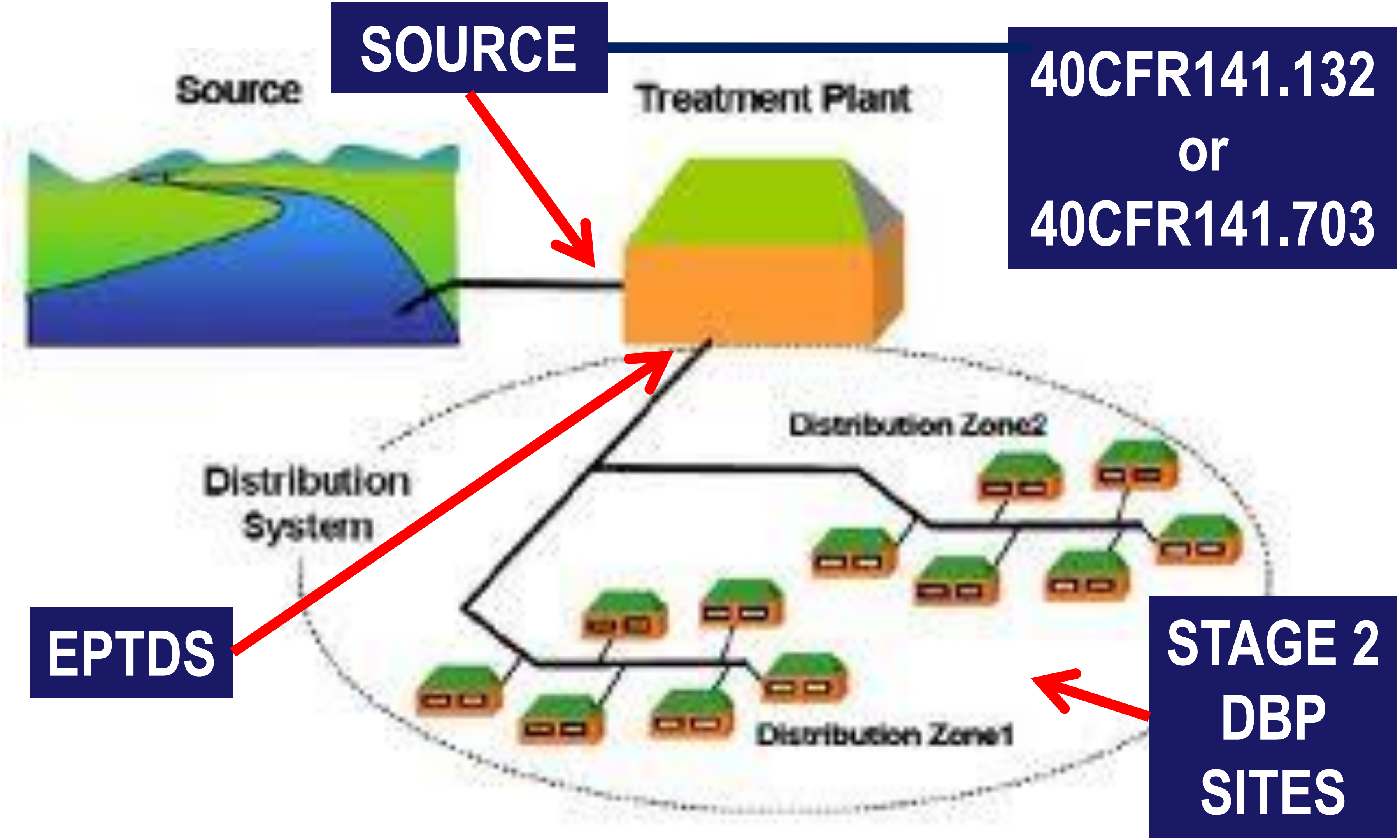
UCMR4 Monitoring Requirements

UCMR4 Requirement	Groundwater Systems	Surface Water and GWUDI Systems	Sample Location
Metals (2) Pesticides (9) Alcohols (3) Semivolatiles (3)	Two Times in 12-Month Period 5-7 Months Apart	Four Times in 12-Month Period 3 Months Apart	EPTDS
Brominated HAA groups (3)	Only Required if conducting DBP Stage 2 Monitoring		DBP Stage 2 HAA Compliance Point
DBP Indicators - TOC, Bromide (2)			Source Water
Total Microcystins (1) Microcystins, Nodularin (7) Anatoxin-a, Cylindrospermopsin (2)	Not Required	8 times (2 weeks apart) in 4-Month Period March - November	EPTDS

<u>DBP Stage 2 Exemption</u> = No DBPs or source monitoring

<u>Consecutive Systems</u> = No source monitoring

UCMR4 Sample Locations



UCMR4 Sample Locations - DBPs

Contaminant/ Disinfectant	Coverage		Stage 2 DBPR
	Source Water	Population	Total Distribution System Monitoring Locations
TTHM/ HAA5	SW and GWUDI (Subpart H)	< 500	2
		500 - 3,300	2
		3,301 - 9,999	
		10,000 - 49,000	4
		50,000 - 249,999	8
		250,000 - 999,999	12
		1,000,000 - 4,999,999	16
		≥ 5,000,000	20
	Ground water	< 500	2
		500-9,999	
		10,000-99,999	4
		100,000-499,999	6
		≥ 5,000,000	8

UCMR4 Chemistry Analytes



Metals: EPA Method 200.8, ASTM D5673-10, SM 3125

Contaminant	MRL (ug/L)	Additional Information
germanium	0.3	Naturally-occurring element;
manganese	0.4	Naturally-occurring element;

Pesticides and a Pesticide Manufacturing Byproduct: EPA Method 525.3

Contaminant	MRL (ug/L)	Additional Information
alpha-hexachlorocyclohexane	0.01	Component of benzene hexachloride (BHC); formerly used as an insecticide
chlorpyrifos	0.03	Organophosphate; used as an insecticide, acaricide and miticide
dimethipin	0.2	Used as an herbicide and plant growth regulator
ethoprop	0.03	Used as an insecticide
oxyfluorfen	0.05	Used as an herbicide
profenofos	0.3	Used as an insecticide and acaricide
tebuconazole	0.2	Used as a fungicide
total permethrin (cis- & trans-)	0.04	Used as an insecticide
tribufos	0.07	Used as an insecticide and cotton defoliant

Alcohols: EPA Method 541

Contaminant	MRL (ug/L)	Additional Information
1-butanol	2.0	Used as a solvent, food additive and in production of other chemicals
2-methoxyethanol	0.4	Used in a number of consumer products, such as synthetic cosmetics,
2-propen-1-ol	0.5	Used in the production flavorings, perfumes and other chemicals

Semivolatile Chemicals: EPA Method 530

Contaminant	MRL (ug/L)	Additional Information
butylated hydroxyanisole	0.03	Food Additive/Anti oxidant
o-toluidine	0.007	Production of dyes, etc.
quinoline	0.02	Pharmaceutical, flavoring agent, component of coal

UCMR4 DBPs

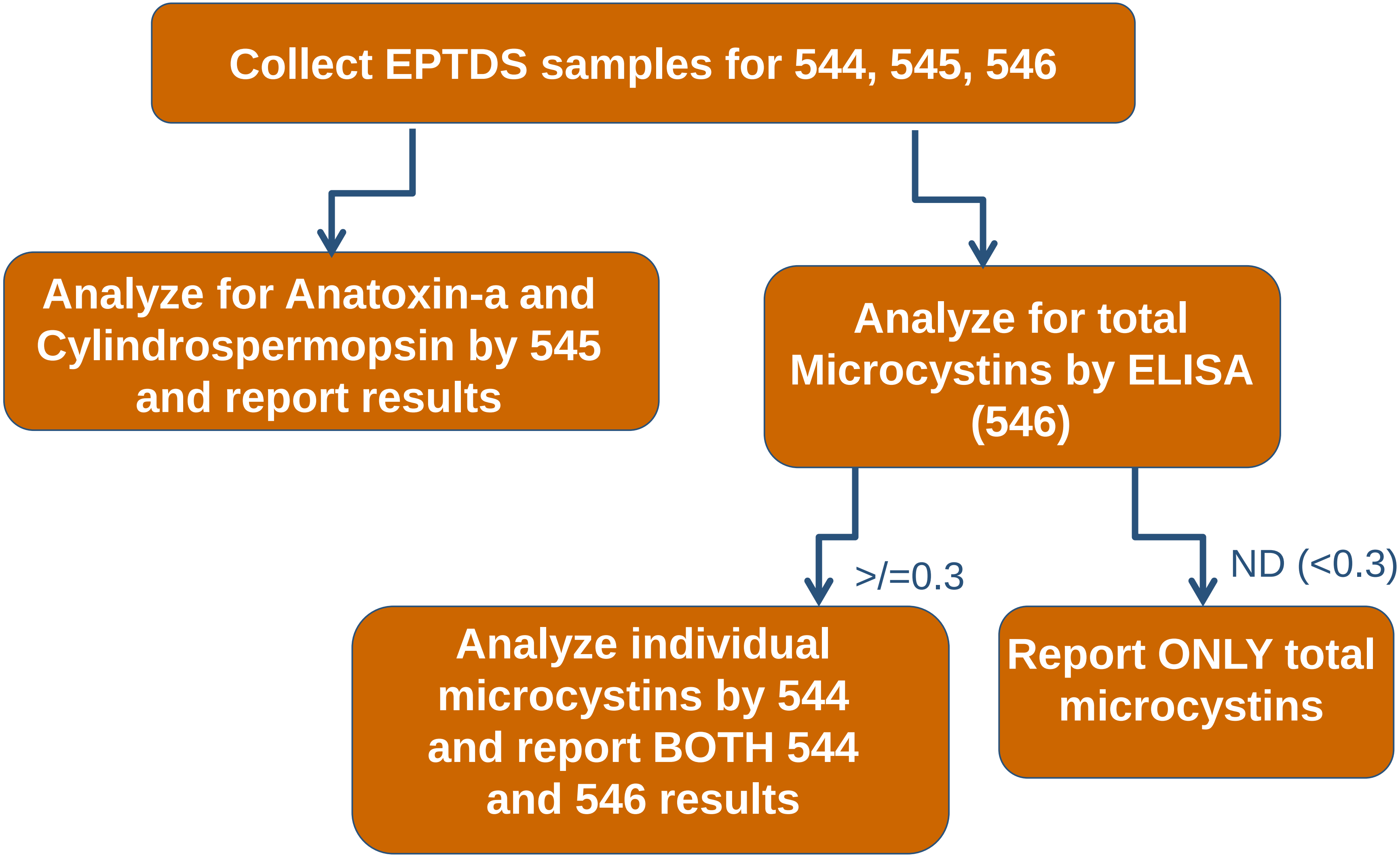
<table>
<tr><th colspan="4">HAA Groups (EPA Method 552.3 or 557)</th></tr>
<tr><td>dichloroacetic acid (DCAA)</td><td rowspan="5">HAA5</td><td rowspan="3"></td><td rowspan="9">HAA9</td></tr>
<tr><td>monochloroacetic acid (MCAA)</td></tr>
<tr><td>trichloroacetic acid (TCAA)</td></tr>
<tr><td>monobromoacetic acid (MBAA)</td><td rowspan="6">HAA6Br</td></tr>
<tr><td>dibromoacetic acid (DBAA)</td></tr>
<tr><td colspan="2">bromochloroacetic acid (BCAA)</td></tr>
<tr><td colspan="2">bromodichloroacetic acid (BDCAA)</td></tr>
<tr><td colspan="2">chlorodibromoacetic acid (CDBAA)</td></tr>
<tr><td colspan="2">tribromoacetic acid (TBAA)</td></tr>
</table>

UCMR4 Algal Toxins



Contaminant	MRL (µg/L)	Method
“total microcystins”	0.3	EPA 546
microcystin-LA	0.008	EPA 544
microcystin-LF	0.006	EPA 544
microcystin-LR	0.02	EPA 544
microcystin-LY	0.009	EPA 544
microcystin-RR	0.006	EPA 544
microcystin-YR	0.02	EPA 544
nodularin	0.005	EPA 544
anatoxin-a	0.03	EPA 545
cylindrospermopsin	0.09	EPA 545

UCMR4 Algal Toxin “Trigger”



UCMR4 Data Elements



Utility Data Entry		Lab Data Entry		
Public Water System Identification (PWSID) Code	Sampling Point Identification Code	Sample Collection Date	Analysis Batch Identification Code	Laboratory Identification Code
Public Water System Name	Sampling Point Name	Sample Identification Code	Analysis Date	Sample Event Code
Public Water System Facility Identification Code	Sampling Point Type Code	Contaminant	Sample Analysis Type	Bloom Occurrence
Public Water System Facility Name	Disinfectant Type	Analytical Method Code	Analytical Results–Sign	Indicator of Possible Bloom – Treatment
Public Water System Facility Type	Treatment Information	Extraction Batch Identification Code	Analytical Result-Measured Value	Cyanotoxin Occurrence
Water Source Type	Disinfectant Residual Type	Extraction Date	Additional Value *(for spikes)*	Indicator of Possible Bloom – Source Water Quality Parameters

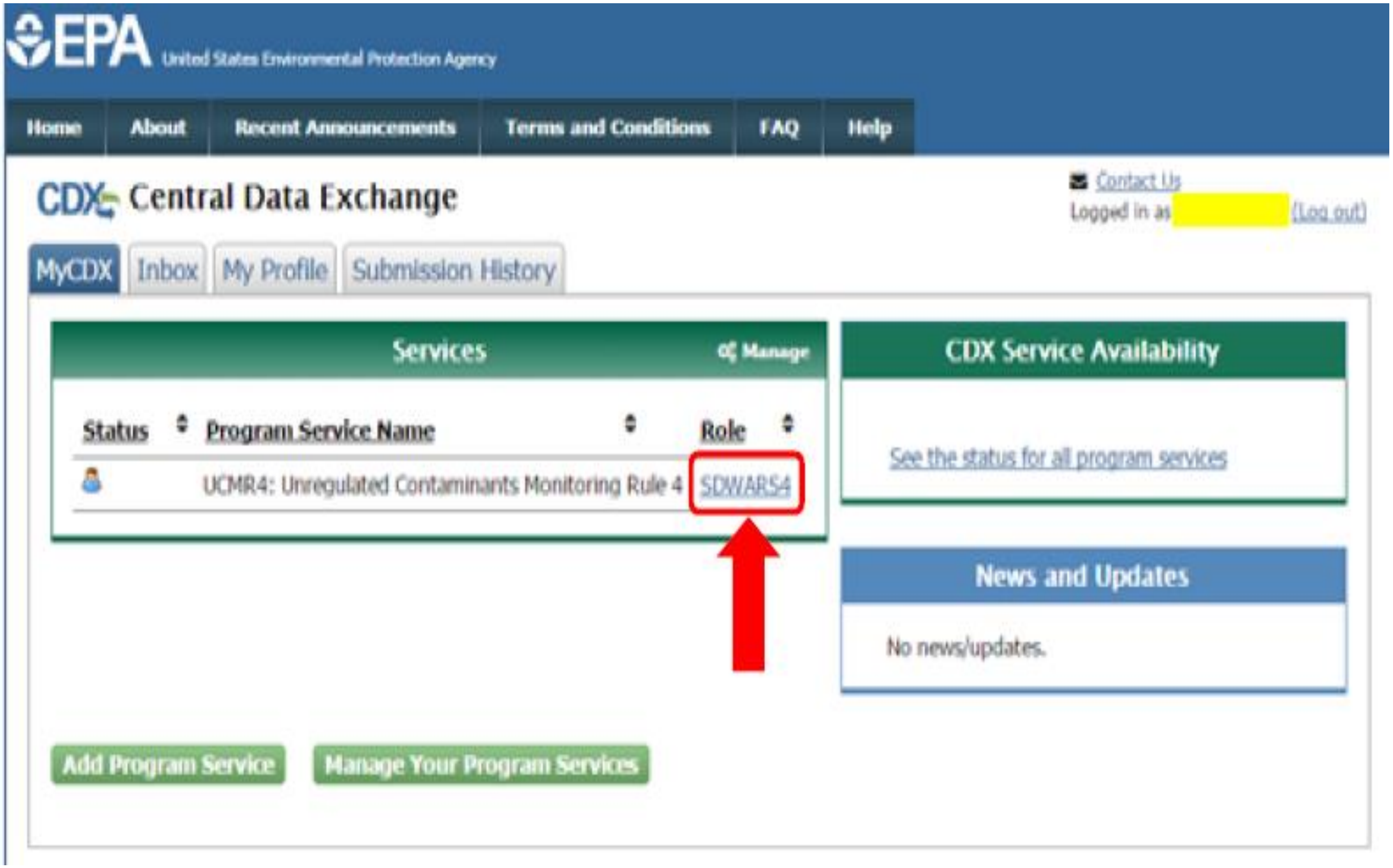
UCMR4 CDX SET UP STEPS

1. CDX Account
2. SDWARS4
3. Profile Settings
4. Notification Letter
5. Add Contacts
6. Add Inventory
7. Confirm Schedule
8. Add Zip Codes
9. Notimate User
10. Confirm & Save

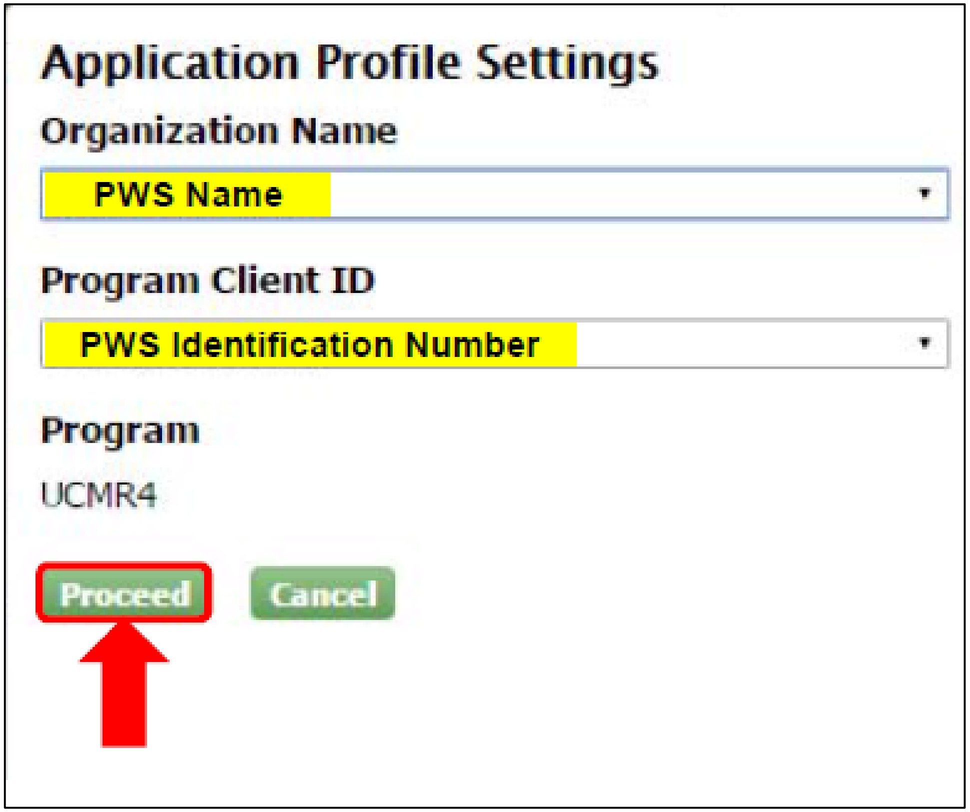
STEP 1 – CDX ACCOUNT

https://cdx.epa.gov/

STEP 2 – SDWARS4



STEP 3 – PROFILE SETTINGS



STEP 4 – NOTIFICATION LETTER

Notification Letter

A PWS user must accept the notification letter

NOTIFICATION LETTER
January 3, 2017

RE: Unregulated Contaminant Monitoring for Surface Water (SW) and Ground Water Under the Direct Influence of Surface Water (GWUDI) Systems Serving over 10,000 Persons

Dear Public Water System:

The purpose of this letter is to notify your public water system (PWS) of its monitoring requirements under the revision to the Unregulated Contaminant Monitoring Rule (UCMR4). The U.S. Environmental Protection Agency (EPA) published the final rule detailing the upcoming monitoring of unregulated contaminants at PWSs on December 20, 2016, establishing a new list of contaminants to be monitored and the conditions for that monitoring. This rule benefits public health by providing EPA and other interested parties with scientifically valid data on the national occurrence of selected contaminants in drinking water. This dataset is one of the primary sources of information on occurrence, levels of exposure and population exposure EPA uses to develop regulatory decisions for contaminants in the public drinking water supply.

Under the UCMR4, all community water systems and non-transient, non-community water systems serving more than 10,000 persons must participate in Assessment Monitoring (AM). **Our records indicate that your surface water system must monitor for all List 1 contaminants: metals, pesticides, semi-volatile organic chemicals (SOCs), alcohols (AM 1), haloacetic acids (HAAs) (AM 2), and cyanotoxins (AM 3).**

What must your PWS complete in SDWARS before December 31, 2017?
Similar to reporting under UCMR3, PWSs will use the Central Data Exchange (CDX) (https://cdx.epa.gov/) to access the updated version of the Safe Drinking Water Accession and Review System (SDWARS4). PWSs are required to:

- enter your official and technical contact information;
- review and, if necessary, update your sample location data by adding missing locations (e.g., Stage 1 and Stage 2 Disinfectants and Disinfection Byproduct Rules sampling locations for the HAAs), indicating ineligible locations or editing basic information about the locations; and
- review and, if you wish, revise your monitoring schedule assigned by the EPA.

What must your PWS do during UCMR4 monitoring?
Your PWS must ensure that samples are properly collected, packaged and shipped to a UCMR4 EPA approved laboratory. Your PWS is also responsible for providing the data elements required for each sampling location (e.g., disinfection type, treatment type etc.) in SDWARS. Once data are posted to SDWARS by your laboratory, your PWS will have **60 days** to review and act upon these results. If you choose not to review these results in this time frame, they will be considered final. Additionally, community water systems are required to address their UCMR monitoring results in their annual Consumer Confidence Report (CCR) whenever unregulated contaminants are detected (https://www.epa.gov/ccr).

Where can I find more information about UCMR4?
EPA recommends that you review the complete rule and supporting reference materials addressing UCMR4 at https://www.epa.gov/dwucmr/fourth-unregulated-contaminant-monitoring-rule.

- The "Revisions to the Unregulated Contaminant Monitoring Rule (UCMR4) for Public Water Systems and Announcement of Public Meeting" [EPA-HQ-OW-2015-0218; FRL-9956–71-OW];
- UCMR4 implementation fact sheets: Metals, Pesticides, SOCs, and Alcohols (AM 1), Haloacetic Acids (HAAs) (AM 2), Cyanotoxins (AM 3) and General Information;
- EPA approved laboratories for UCMR4 (the list will be updated as additional laboratories are approved);
- Outreach materials and announcements for stakeholder meetings and trainings.

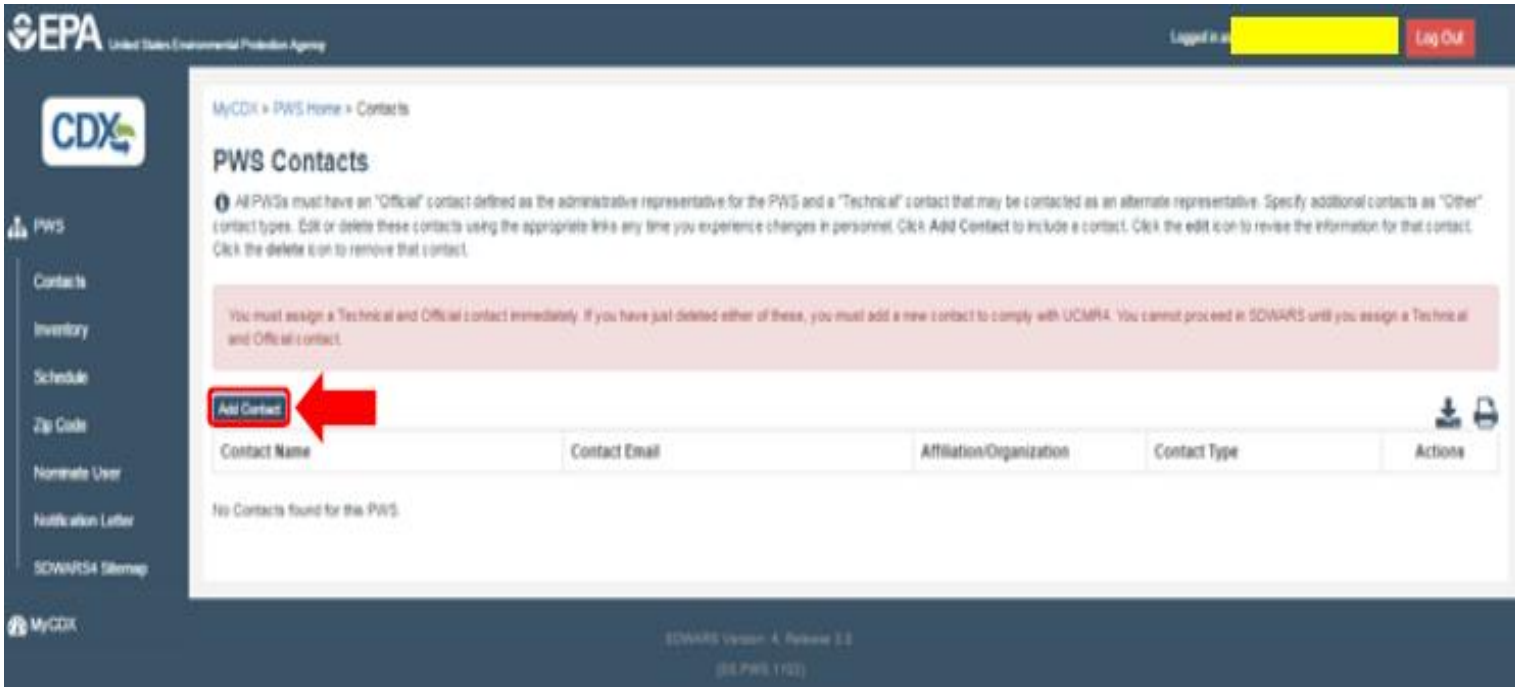
Analytical results from UCMR are publically available in the National Contaminant Occurrence Database (NCOD); for a summary of the NCOD results, tips for querying NCOD, and health effects information please refer to the UCMR Data Summary document.

This notification letter is being sent to you as the official representative of this PWS. If someone else at your PWS needs this information, such as the plant operator, please provide them with a copy of this letter. Your cooperation in meeting these requirements is appreciated.

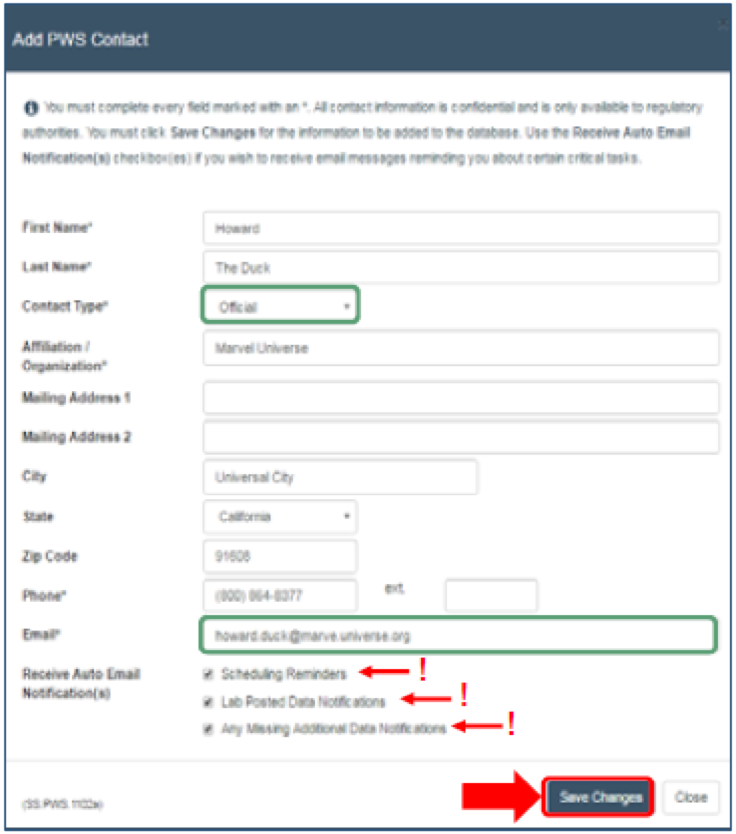
For questions regarding SDWARS or CDX, please contact the CDX Help Desk at 1-888-890-1995. For implementation or general questions, please contact the UCMR Message Center at 1-800-949-1581 or UCMR4@glec.com. Thank you for your cooperation.

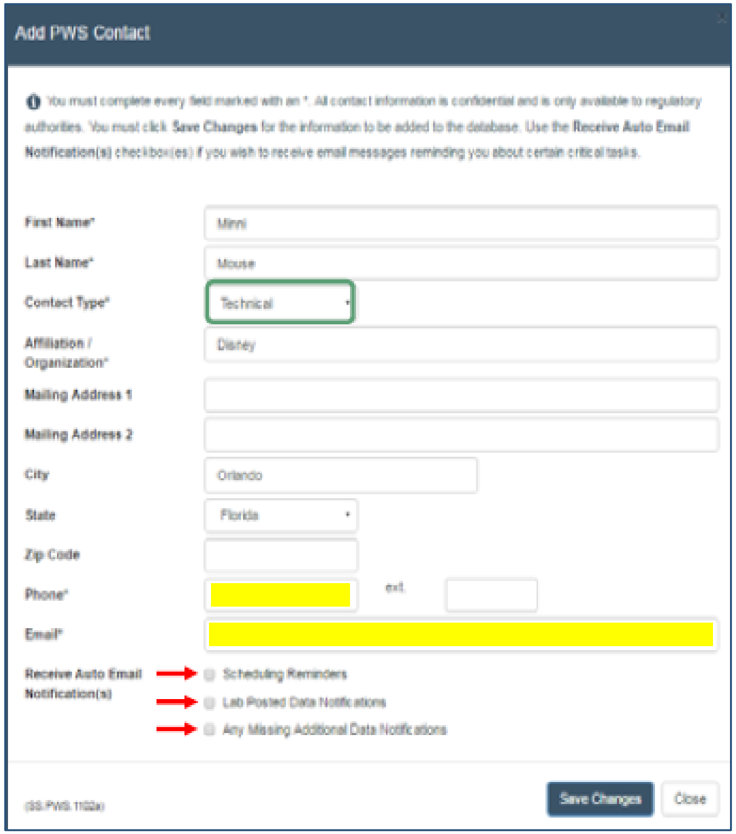
Accept Cancel

STEP 5 – ADD CONTACTS

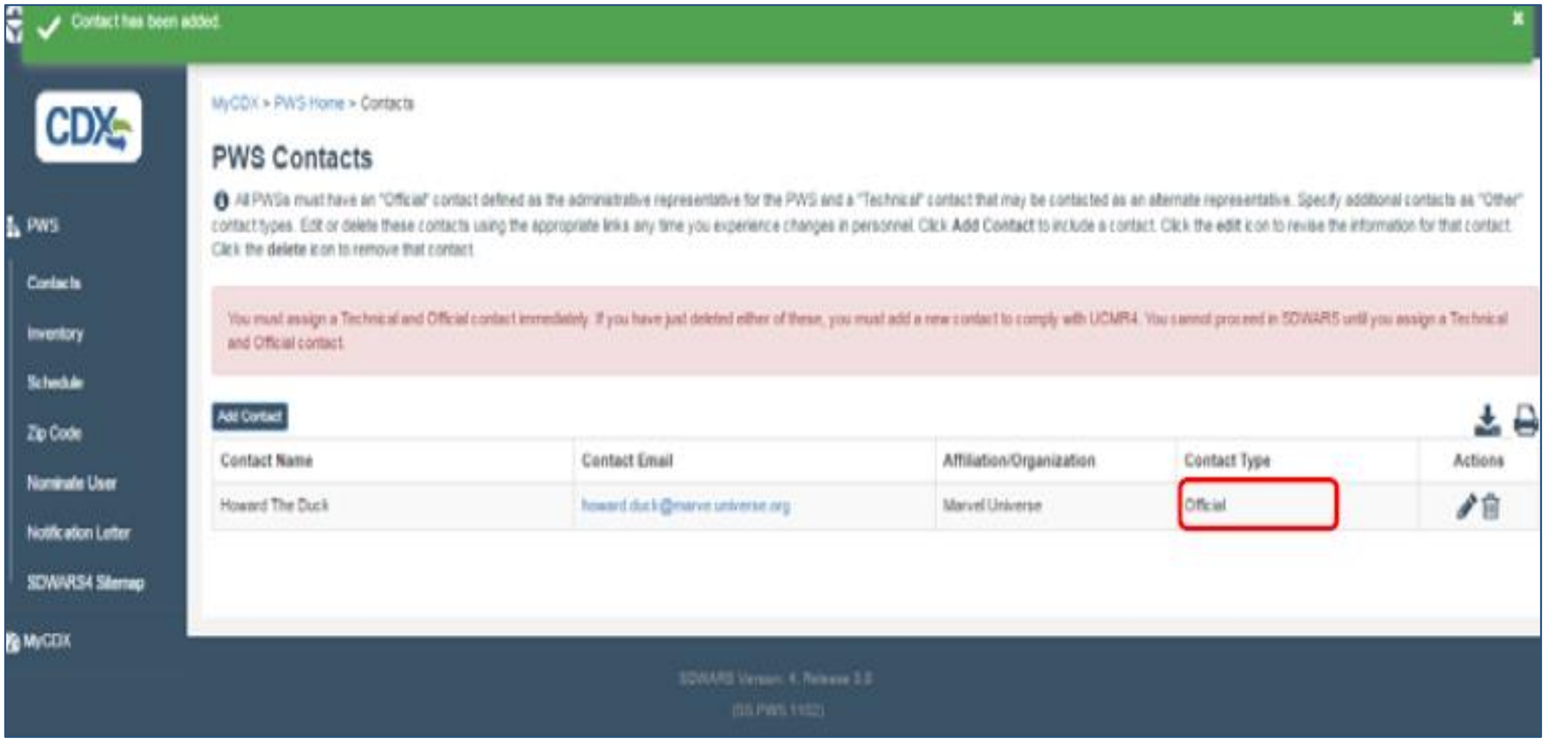


OFFICIAL & TECHNICAL CONTACTS

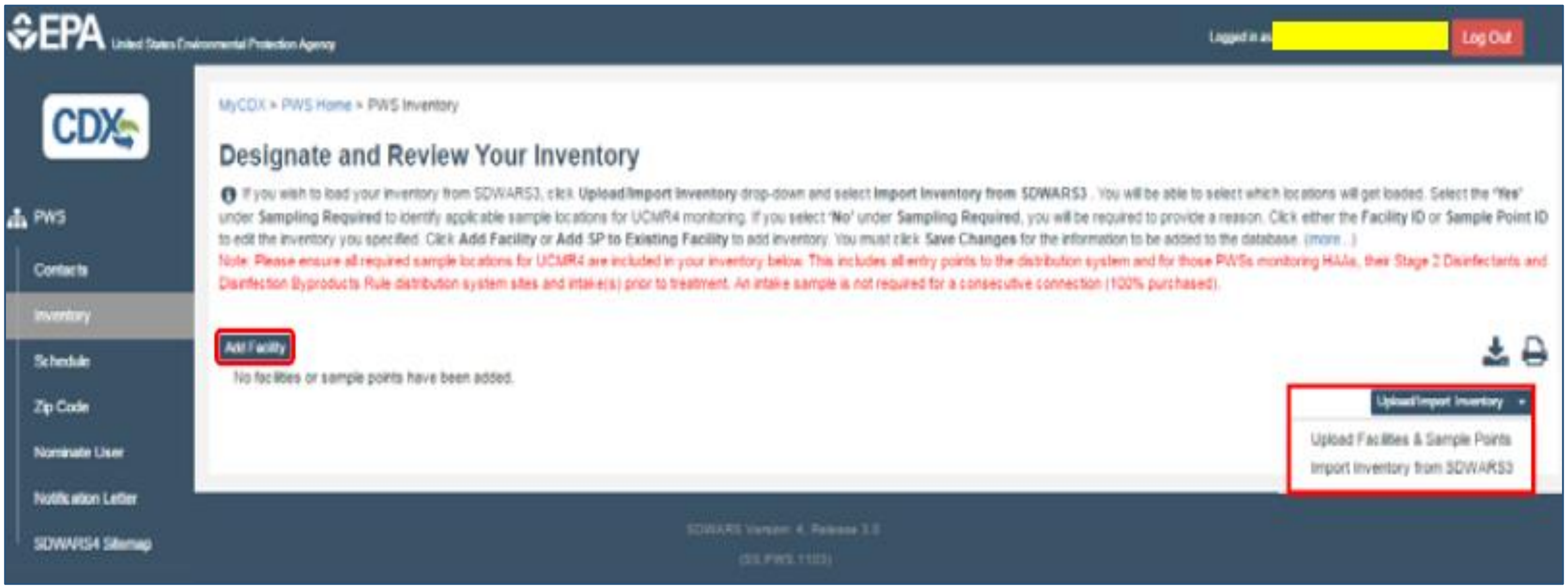




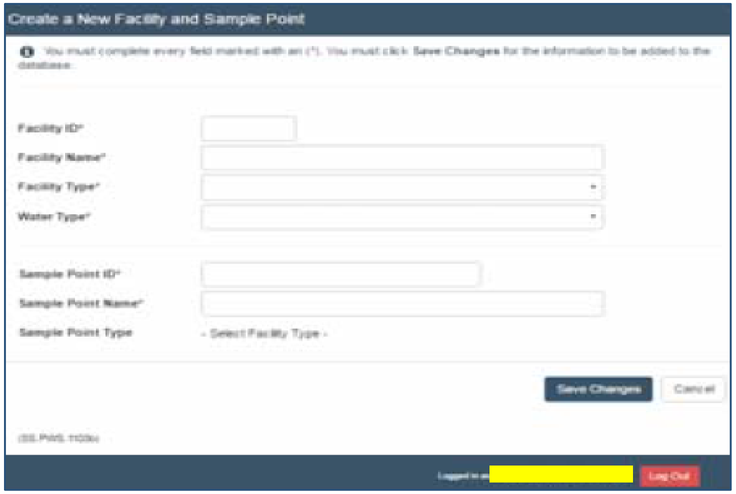
CONFIRM CONTACTS



STEP 6 – ADD INVENTORY



MANUAL OR IMPORT



IMPORT FROM SDWARS3

Import Facilities and Sample Points from SDWARS3

Select the sample locations from SDWARS3 which need to be loaded into SDWARS4. You must click **Next >** button to review your inventory before it is added to the database.

Select All ✔	Facility ID	Facility Name	Facility Type	Water Type	Sample Point ID	Sample Point Name	Sample Point Type
✔	00001	Treatment Plant #1	TP	GW	EP001	EP from TP #1	EP
✔	00002	Treatment Plant #2	TP	GW	EP002	EP from TP #2	EP

SS.PWS.1103f

Next > Cancel

Import Facilities and Sample Points from SDWARS3

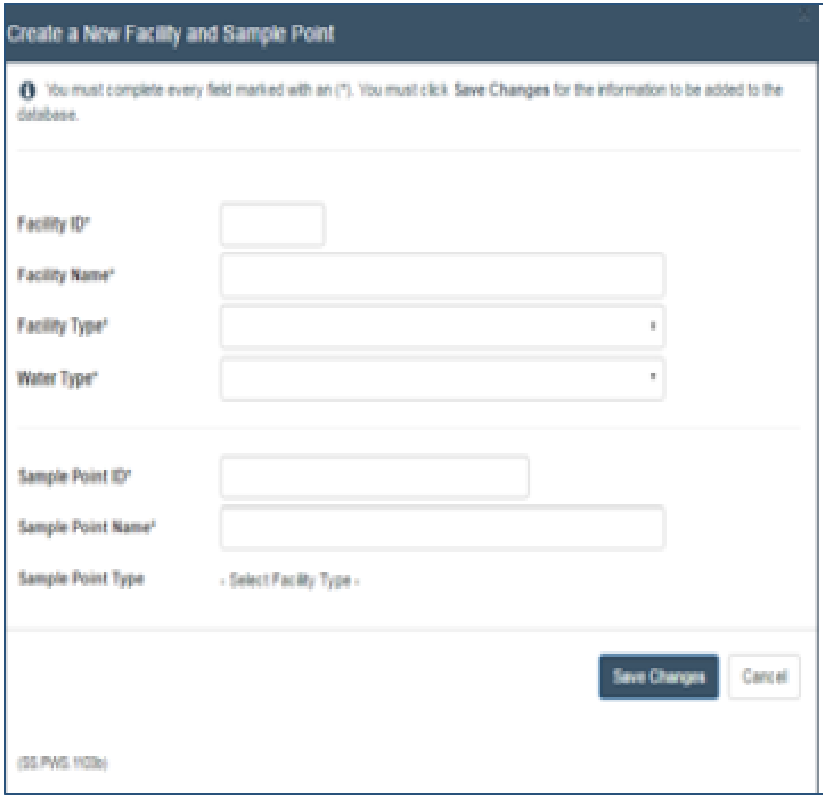
Select the **Import** button to add the inventory to the database.

Facility ID	Facility Name	Facility Type	Water Type	Sample Point ID	Sample Point Name	Sample Point Type
00001	Treatment Plant #1	TP	GW	EP001	EP from TP #1	EP
00002	Treatment Plant #2	TP	GW	EP002	EP from TP #2	EP

SS.PWS.1103g

Back Import Cancel

MANUALLY ADD



Create a New Facility and Sample Point

You must complete every field marked with an (*). You must click **Save Changes** for the information to be added to the database.

Facility ID*

Facility Name*

Facility Type*

Water Type*

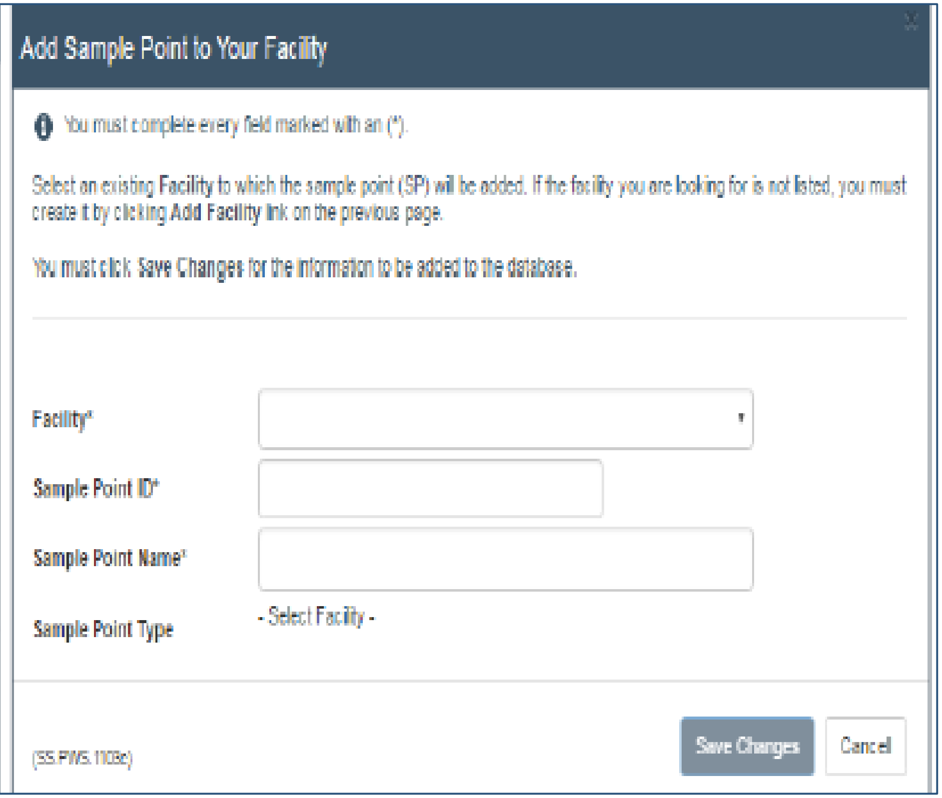
Sample Point ID*

Sample Point Name*

Sample Point Type - Select Facility Type -

Save Changes Cancel

(SS.PWS.1103b)



Add Sample Point to Your Facility

You must complete every field marked with an (*).

Select an existing **Facility** to which the sample point (SP) will be added. If the facility you are looking for is not listed, you must create it by clicking **Add Facility** link on the previous page.

You must click **Save Changes** for the information to be added to the database.

Facility*

Sample Point ID*

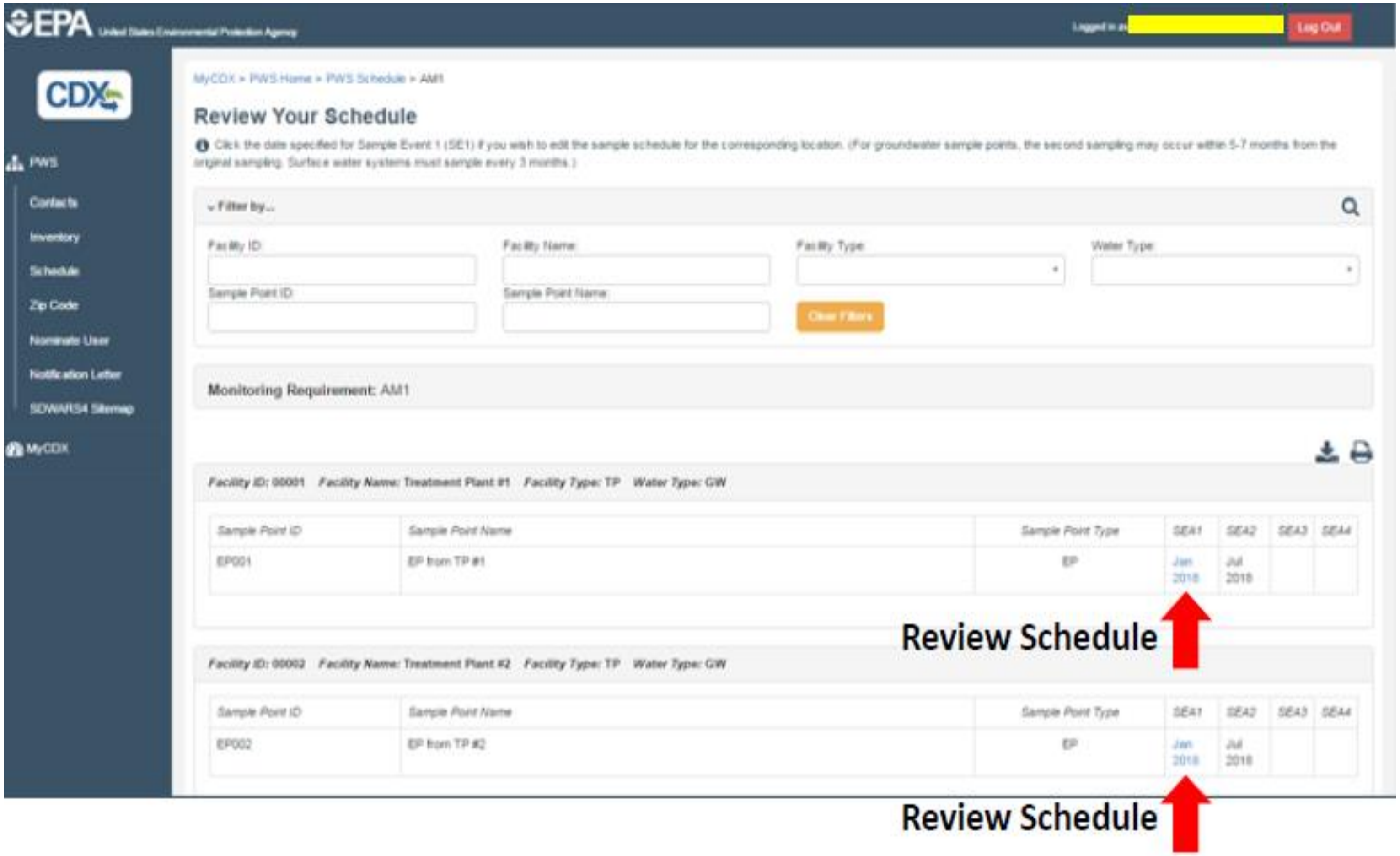
Sample Point Name*

Sample Point Type - Select Facility -

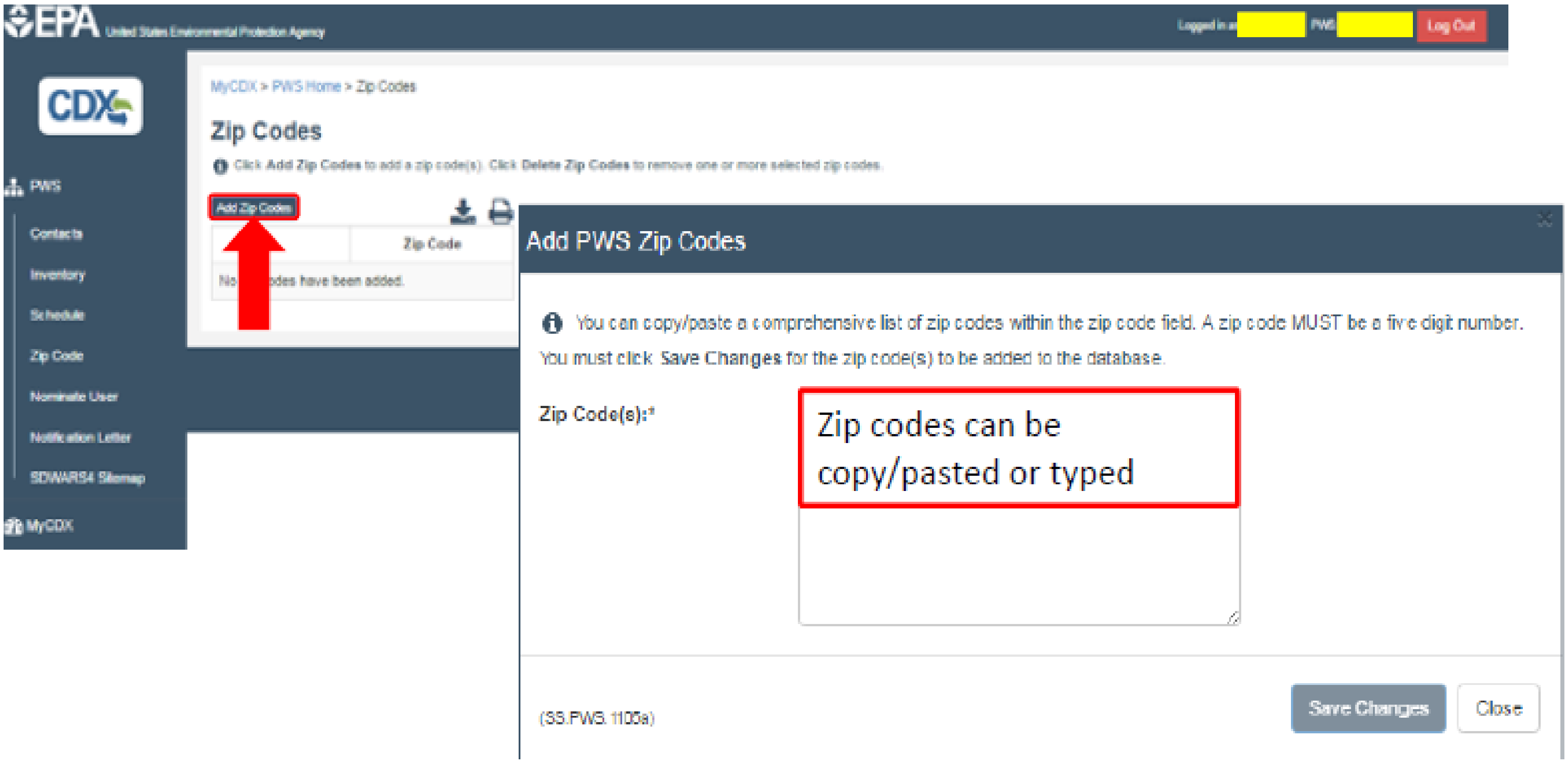
Save Changes Cancel

(SS.PWS.1103c)

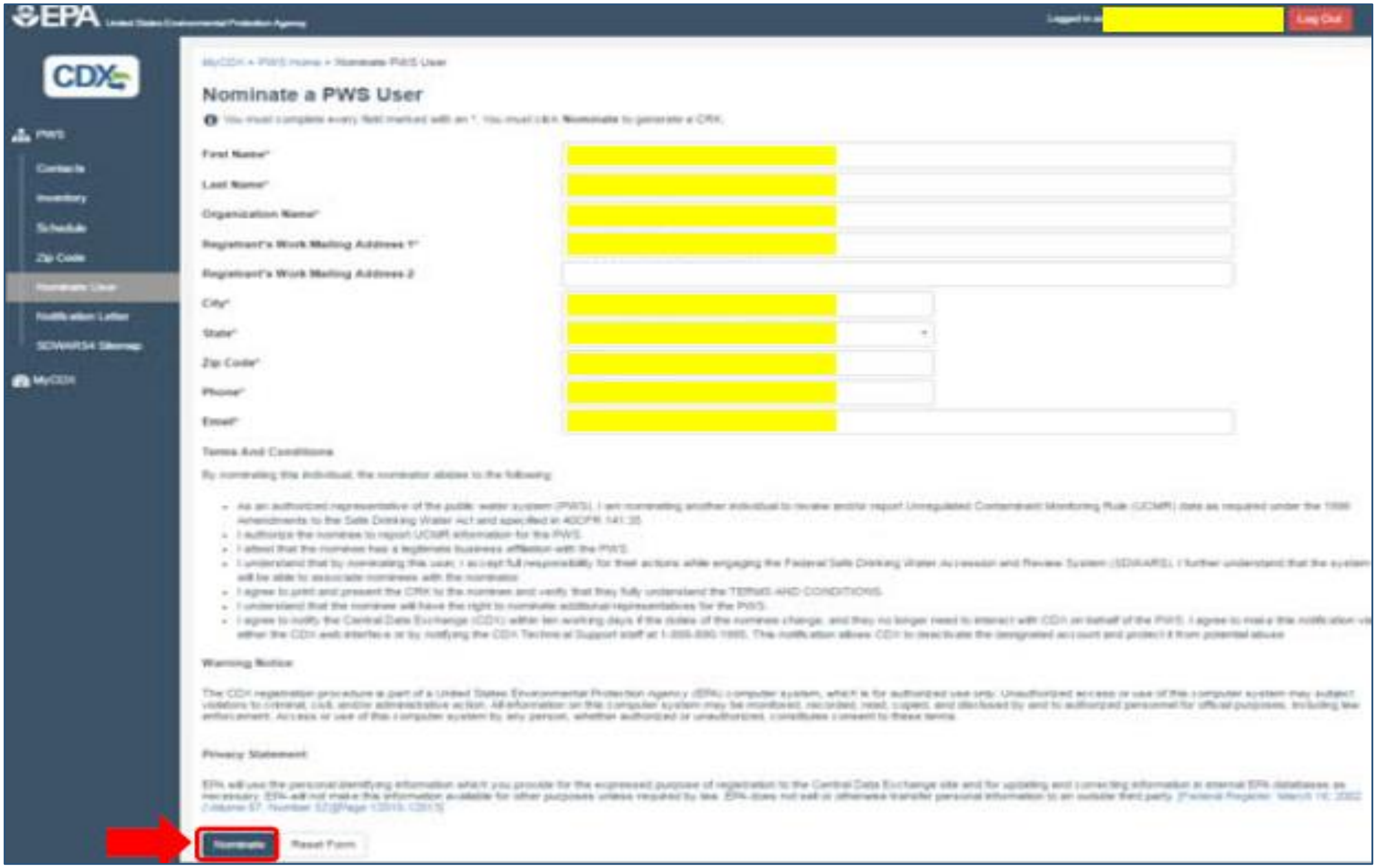
STEP 7 – CONFIRM SCHEDULE



STEP 8 – ADD ZIP CODES



STEP 9 – NOMINATE USER



STEP 10 – CONFIRM & SAVE

***Facility ID:* 91821** ***Facility Name:* Oliver P. Roemer** ***Facility Type:* IN** ***Water Type:* SW**

Sample Point ID	*Sample Point Name*	*Sample Point Type*	*SEH1*	*SEH2*	*SEH3*	*SEH4*				
3610004051	State Project Water	SR	Jan 2018	May 2019	Apr 2018	Aug 2019	Jul 2018	Nov 2019	Oct 2018	Feb 2020

***Facility ID:* 91801** ***Facility Name:* Well 54** ***Facility Type:* TP** ***Water Type:* GW**

Sample Point ID	*Sample Point Name*	*Sample Point Type*	*SEA1*	*SEA2*	*SEA3*	*SEA4*
3610004045	EP #46 - Well 54	EP	Jan 2018	May 2019	Jul 2018	Nov 2019

***Facility ID:* 91813** ***Facility Name:* 213 E. Walnut** ***Facility Type:* DS** ***Water Type:* MX**

Sample Point ID	*Sample Point Name*	*Sample Point Type*	*SEH1*	*SEH2*	*SEH3*	*SEH4*				
3610004601	213 E. Walnut	DS	Jan 2018	May 2019	Apr 2018	Aug 2019	Jul 2018	Nov 2019	Oct 2018	Feb 2020

UCMR4 Key Dates

Key UCMR4 Dates

Jan. 19, 2017	UCMR4 Effective Date
Jan. 23, 2017	1st Proficiency Test Sample issued
Feb. 21, 2017	Laboratory Approval Registration Deadline
April 12, 2017	EPA UCMR4 Webinar
April 19, 2017	Laboratory Approval Application Packages Deadline
April 19, 2017	Groundwater Representative Monitoring Plan Deadline
Aug–Sept, 2017	Last Proficiency Test Sample issued
Dec. 31, 2017	Sample Inventory Location & Schedule Updates Deadline
Jan. 1, 2018	Monitoring Commences
Dec. 31, 2020	Monitoring Concludes

Now 10-31-17

UCMR4 Key Contacts



UCMR4_Sampling_Coordinator@epa.gov

Jake Jenzen
EPA Region 9
415-972-3570
Jenzen.Jacob@epa.gov

Rick Zimmer
SDWA Committee Chairperson
949-466-8266
RickZimmer@eurofinsus.com

Speaker #7

Principles of Efficient Water Well Design

Kevin McGillicuddy

Roscoe Moss Company

kmc@roscoemoss.com

Efficient Water Well Design and Construction

Designing for Optimum Strength and Efficiency

Water Replenishment District of Southern California

August 9, 2017

Kevin McGillicuddy, P.G.
Roscoe Moss Company

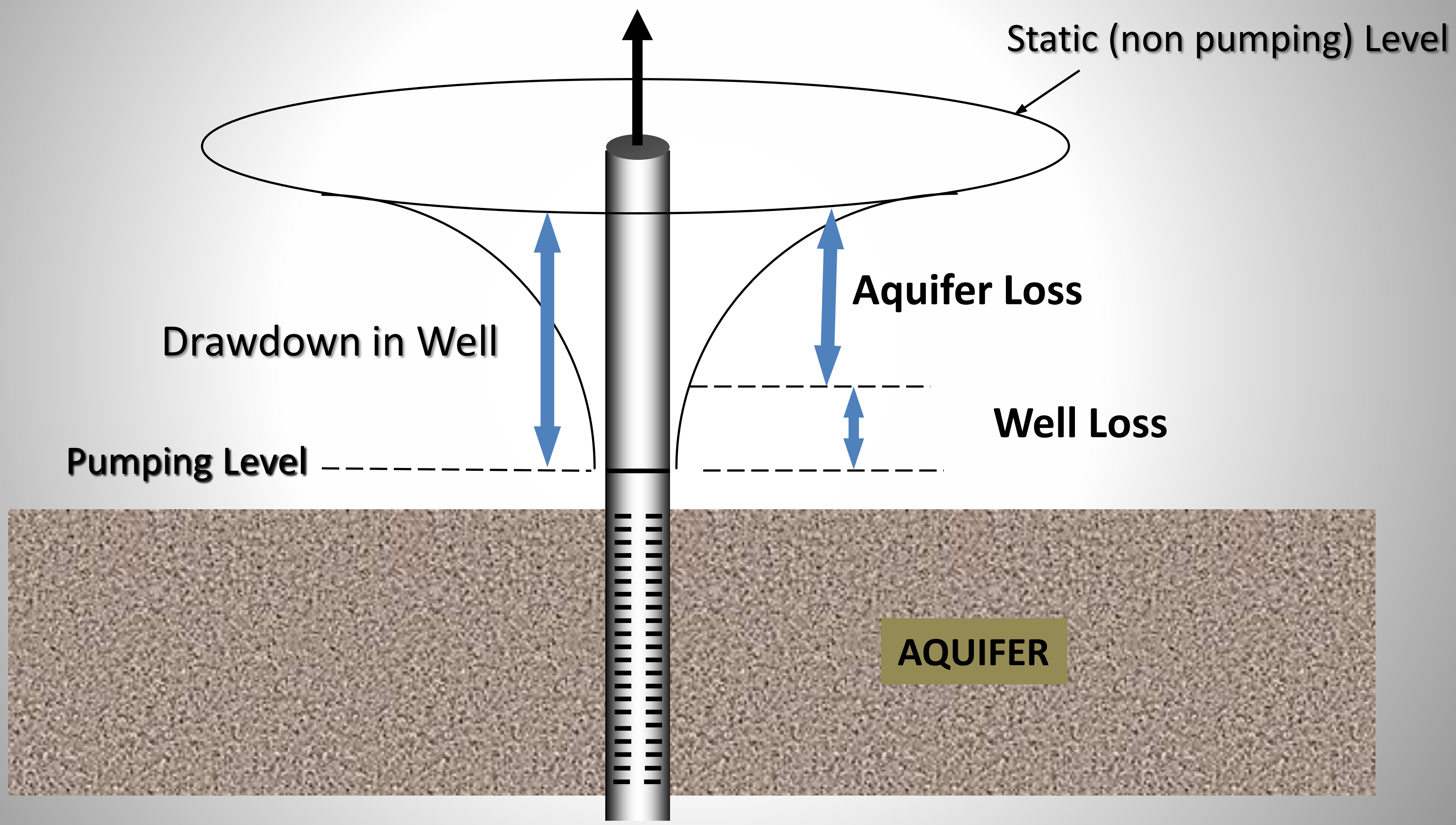
Key To Efficient Well Design

- Goal to construct well capable of producing the maximum rate with the least amount of drawdown and at the lowest energy cost

Well Efficiency

Aquifer Loss

Total drawdown



Cornerstones of Efficient Well Design

Durable Casing and Screen

Proper Gravel Pack Design

Proper Screen Slot Size

Thorough Well Development

Critical Components in Designing Efficient Gravel Envelope Wells - **Steel Casing and Screen**

- Select steel type for the casing and screen that maximizes the working life of the well

- Specify casing and screen wall thickness that:
  - meets physical requirements during construction

    and

  - has capability of withstanding rigorous physical development and rehab methods as the well matures

Commonly Used Steels

Non – Corrosion Resistant

- Mild / Low-Carbon Steel

Corrosion Resistant Steels

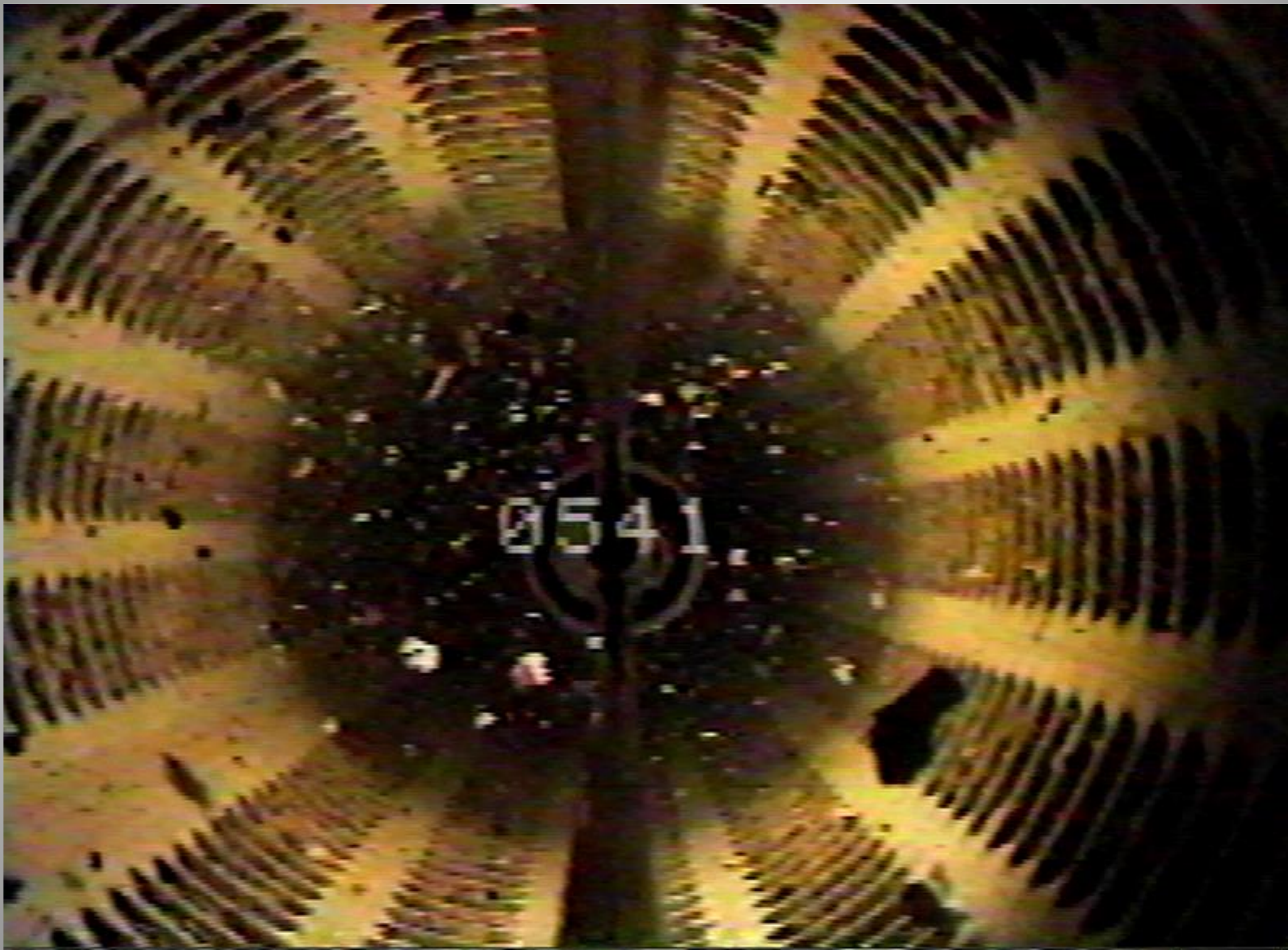
- Copper-Bearing
- High-Strength Low-Alloy (ASTM A606 Type 4)
- Stainless – Types 304 and 316L

Durability and Cost

Steel Type	Metal Loss*	Corrosion Resistance*	Cost Factor
Low Carbon	2.8794 mills/yr	1X	1.0X
0.2% Copper	0.7438 mills/yr	4X	1.6X
HSLA	0.3131 mills/yr	9X	1.9X
SS Type 304	0.0118 mills/yr	244X	4X

* *Source: GEOSCIENCE Support Services, 1999*

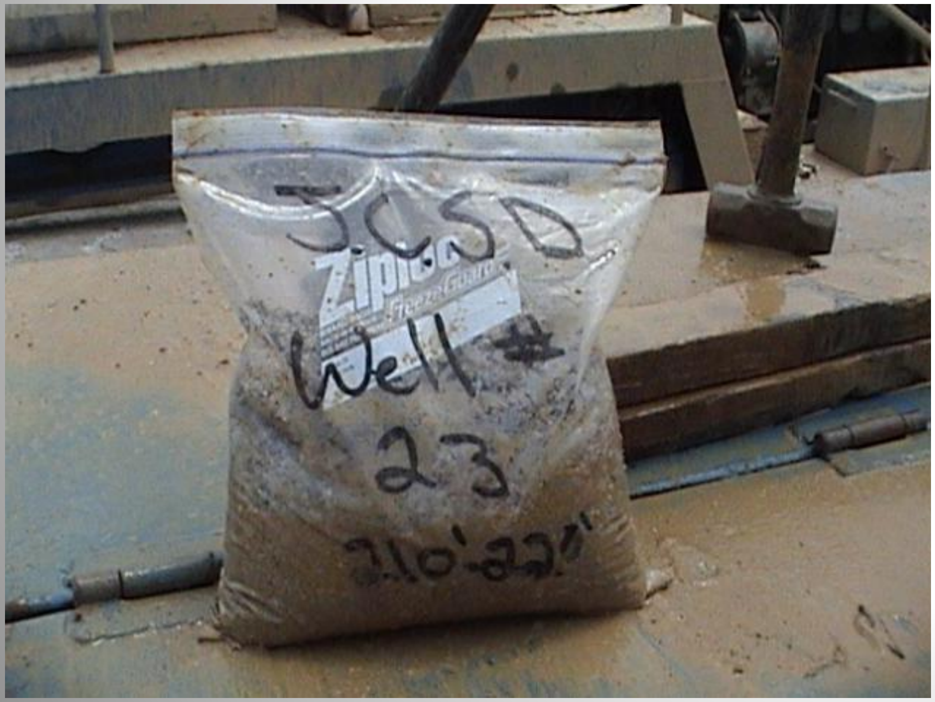
Downhole video of El Paso well constructed in 1955

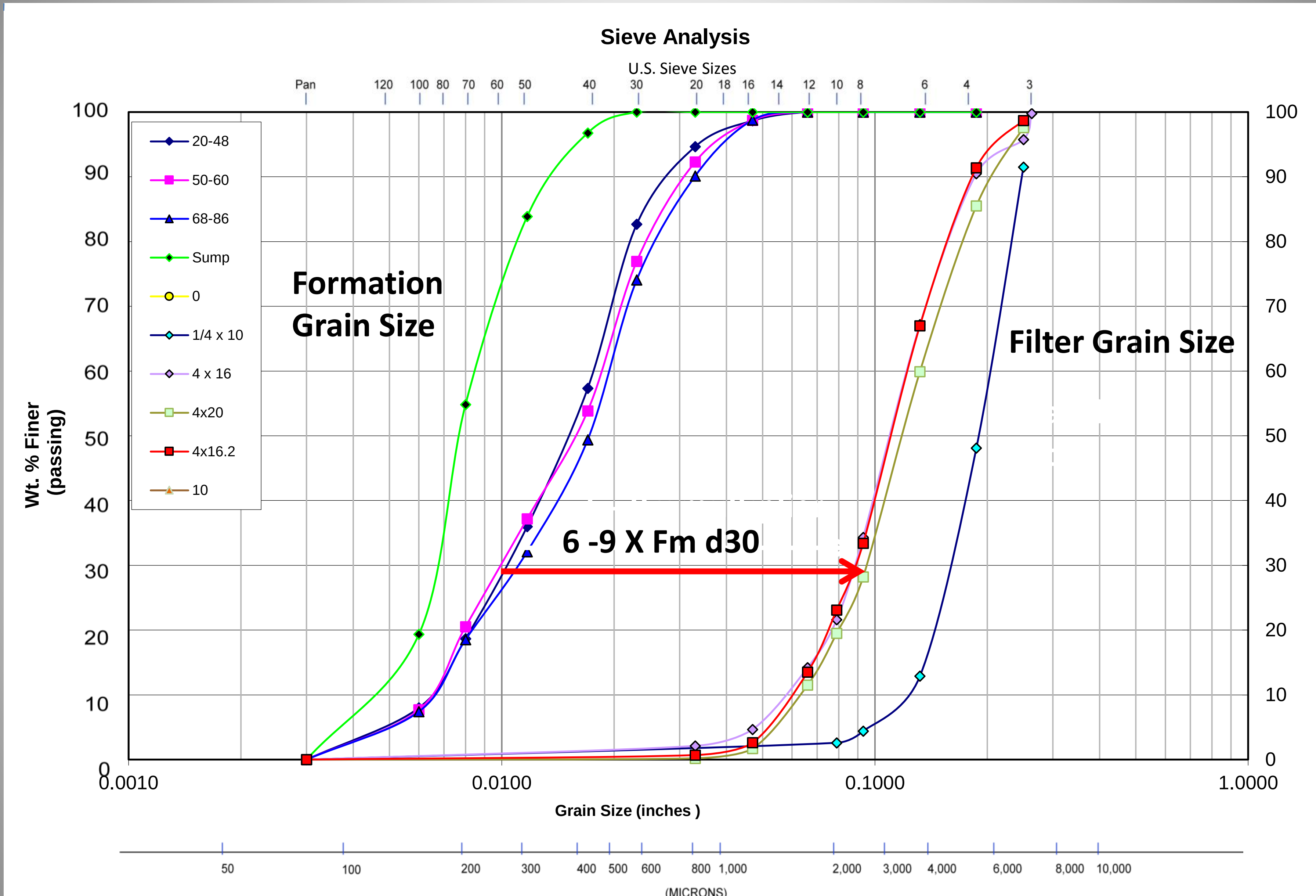

0541

Gravel Pack Selection

- Begin with properly collected formation samples at the drilling site
- Conduct sieve analysis to determine Formation Gradation
- Select Gravel Pack gradation using a multiplier on the Formation Gradation

Determine Gradation of Aquifer Sediments

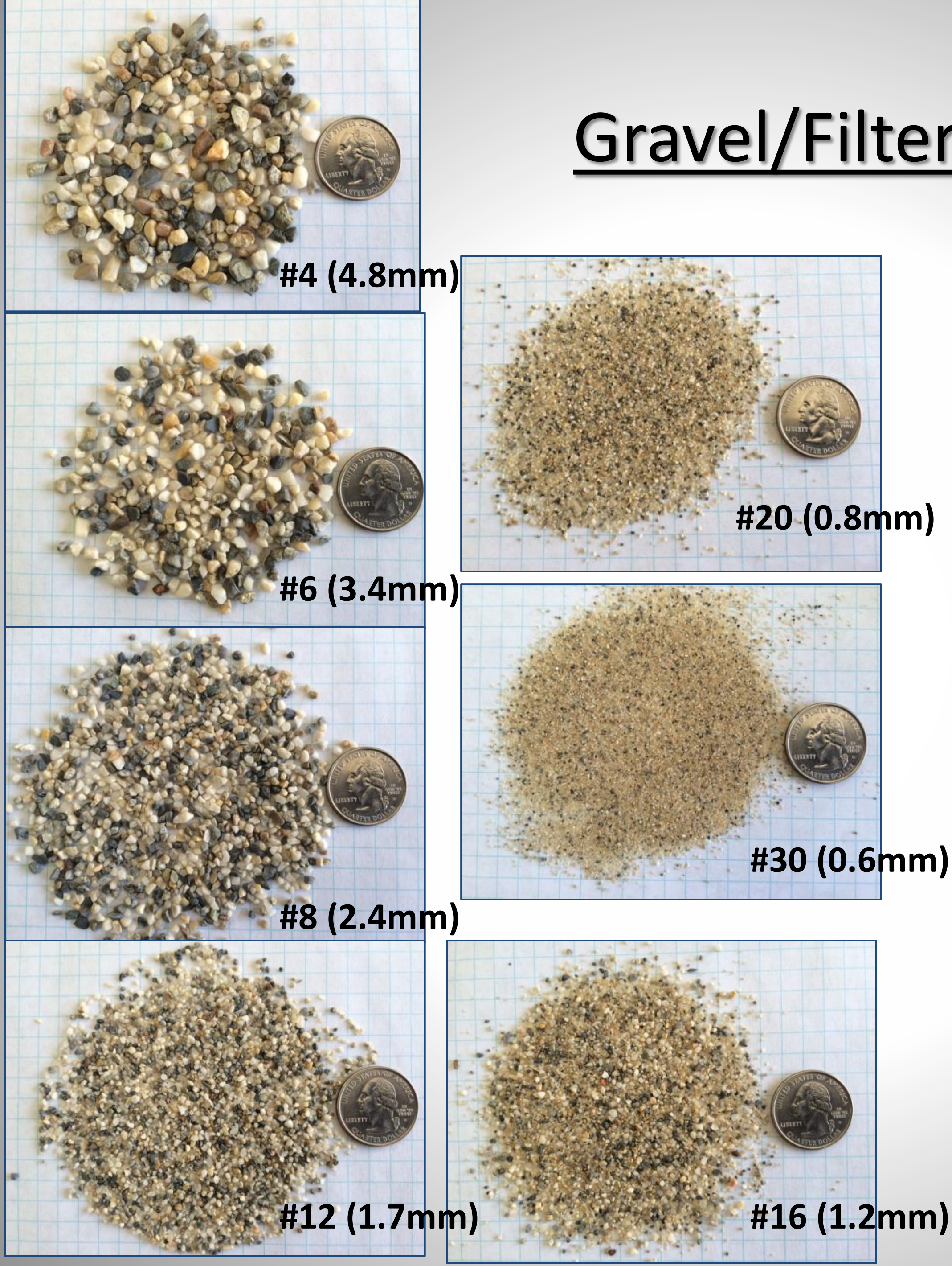




Sieve Analysis
U.S. Sieve Sizes
Pan
120
100
80
70
60
50
40
30
20
18
16
14
12
10
8
6
4
3
Wt. % Finer (passing)
20-48
50-60
68-86
Sump
0
1/4 x 10
4 x 16
4x20
4x16.2
10
Formation Grain Size
Filter Grain Size
6 -9 X Fm d30
0.0010
0.0100
0.1000
1.0000
Grain Size (inches)
50
100
200
300
400
500
600
800
1,000
2,000
3,000
4,000
6,000
8,000
10,000
(MICRONS)


Gravel Pack Selection
6X larger than smallest 30% of Formation
Filter Pack
Aquifer

Gravel/Filter Packs Comparison



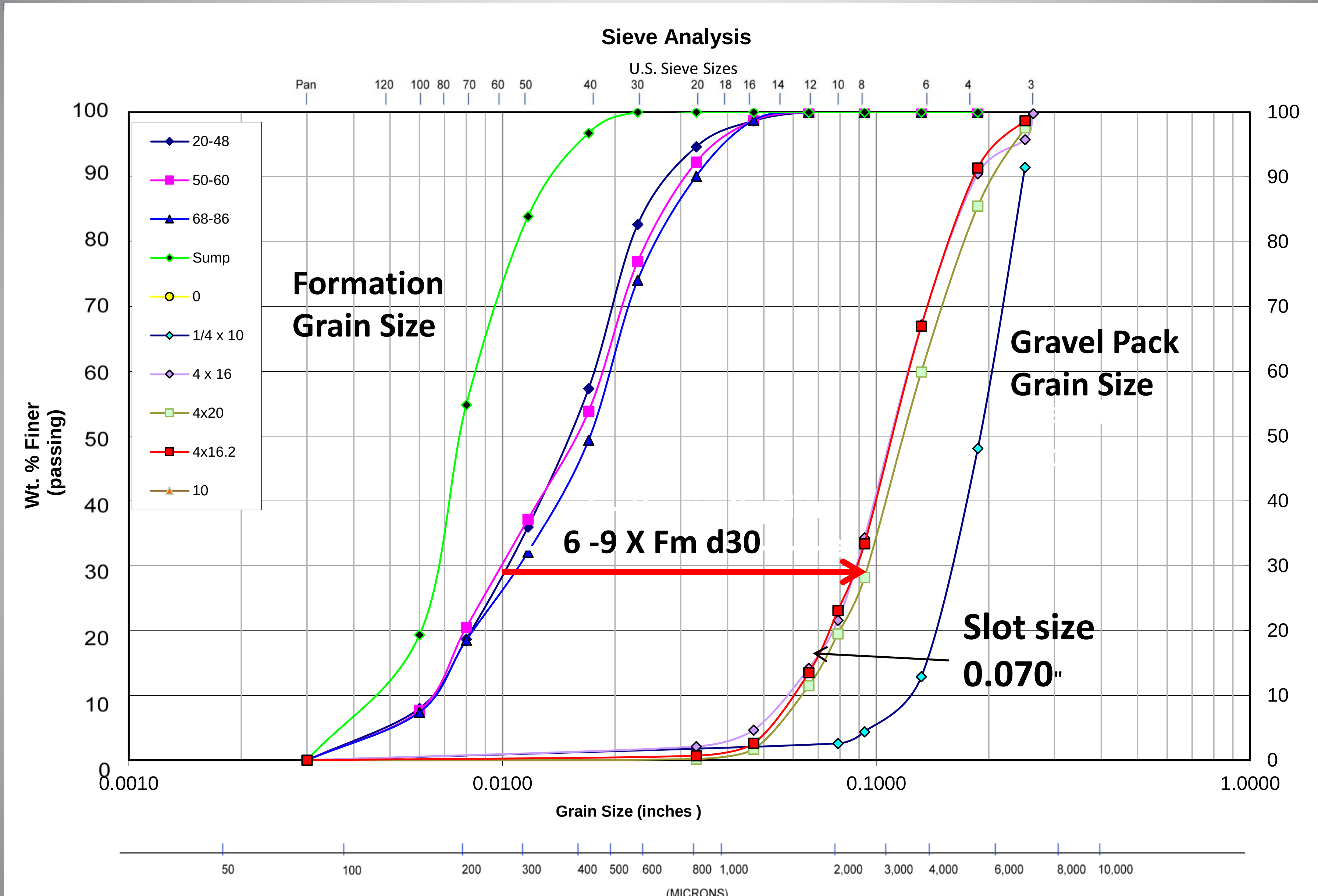
High Silica Content

Well Rounded

Uniform Grain Size

Slot Size Selection

- **Primary function of screen slot is to stabilize the gravel envelope, *not the formation!***
- Sized to pass 10 to 20% gravel pack (retain 90 to 80%)
- <u>Slot size more critical than % open area</u>



Sieve Analysis
U.S. Sieve Sizes
Pan 120 100 80 70 60 50 40 30 20 18 16 14 12 10 8 6 4 3
Wt. % Finer (passing)
100
90
80
70
60
50
40
30
20
10
0
20-48
50-60
68-86
Sump
0
1/4 x 10
4 x 16
4x20
4x16.2
10
Formation Grain Size
Gravel Pack Grain Size
6 -9 X Fm d30
Slot size 0.070"
0.0010
0.0100
0.1000
1.0000
Grain Size (inches)
50 100 200 300 400 500 600 800 1,000 2,000 3,000 4,000 6,000 8,000 10,000
(MICRONS)

Slot Size Selection

- **Use the largest, reasonable slot size**
  - Provides best opportunity for distributing energy required for initial development and future redevelopment / rehabilitation procedures

Well Development

Any process used to improve permeability of an aquifer and repair drilling damage.

Accomplished by removing fines through the gravel pack and well screen.

Must be aggressive and directed.

Must be repeated at regular intervals throughout the life of the well

Phases of Well Development

Pre-development : Controlling drilling fluids during drilling and construction

Preliminary development : swabbing, jetting, flushing, airlifting, and bailing

Final development : pumping, surging, and backwashing

Repair Drilling Damage

Dual Swab Development

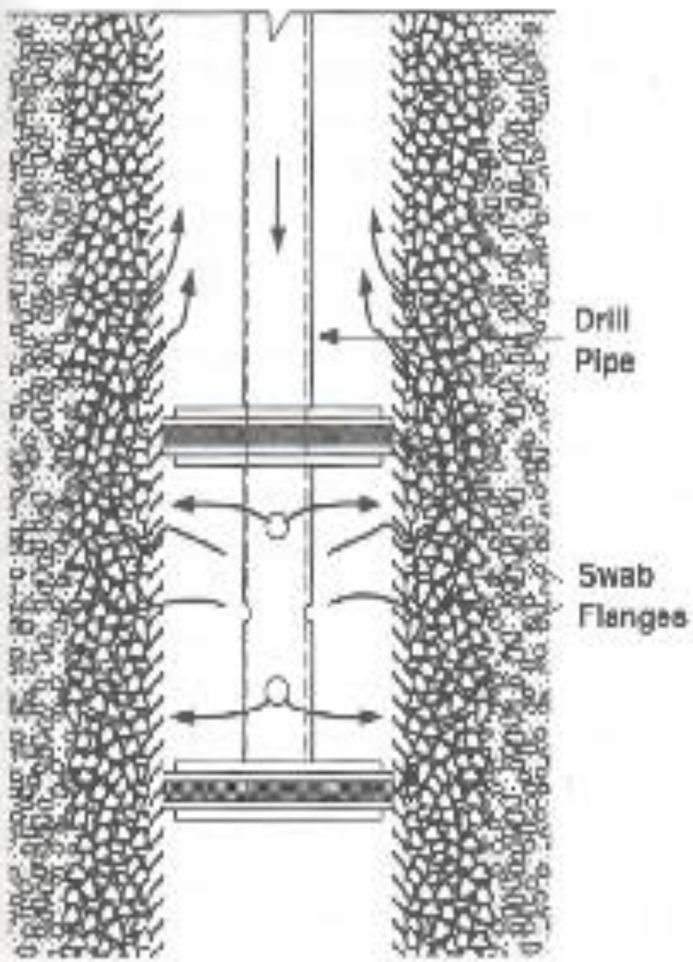


Figure 14.2. Double-flanged swab without bypass.

Dual Swab and Simultaneous Airlift

- The well is mechanically swabbed by raising and dropping the drill pipe equipped with a tight fitting dual swab on the bottom.
- During swabbing, water is airlifted from the well.
- Swabbing is started at the top of the screen to minimize the risk of sand locking the swabs.

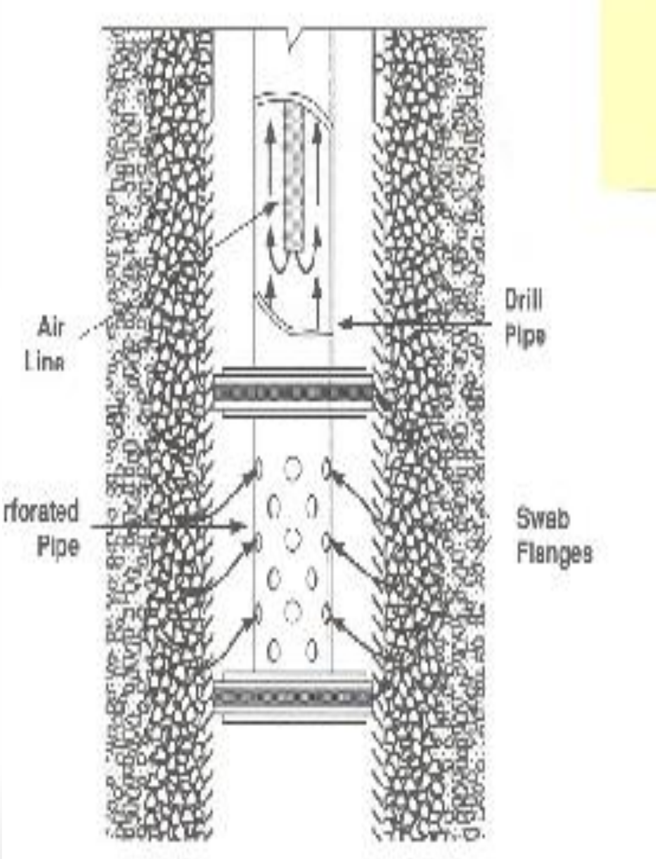
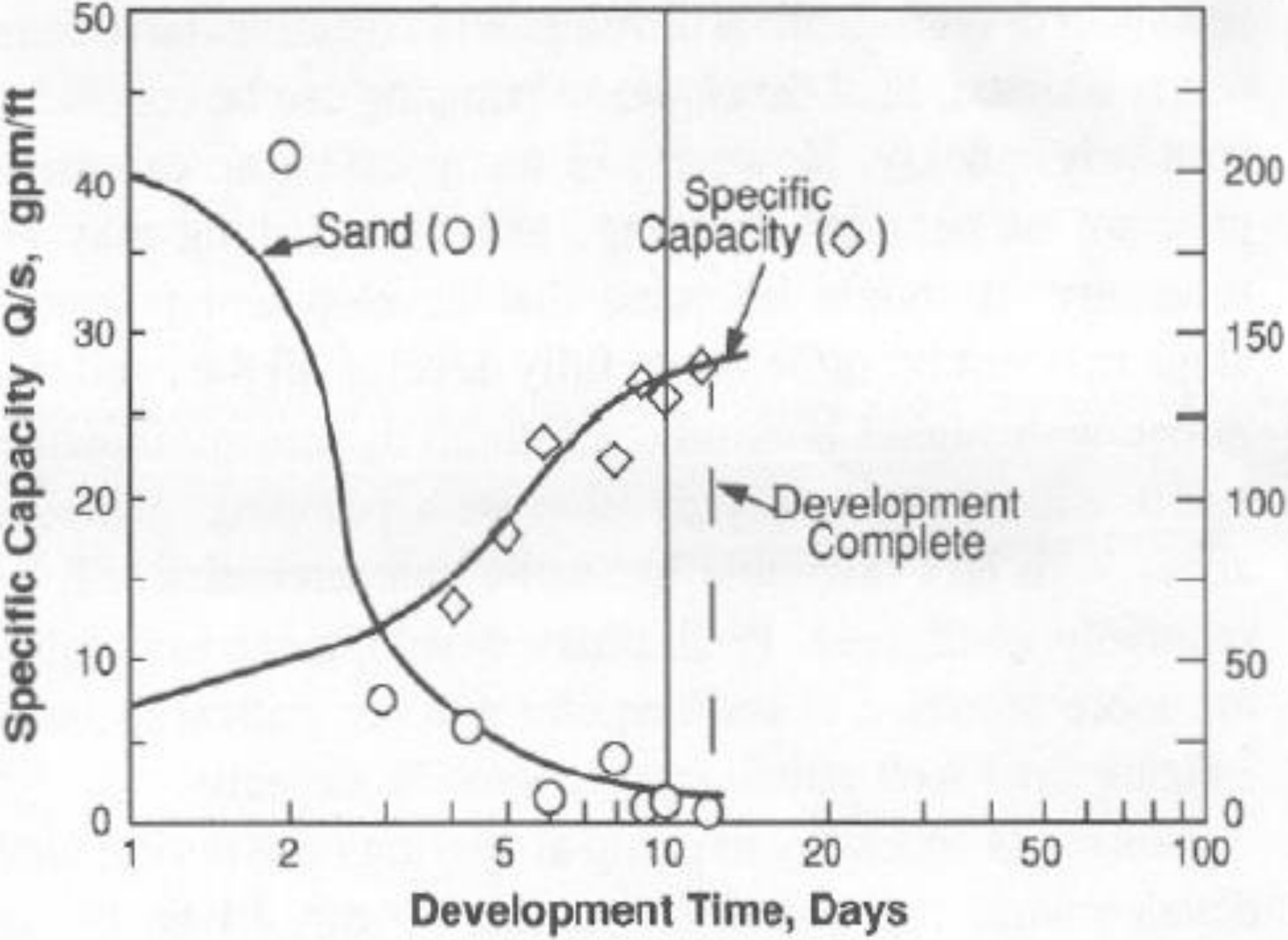


Figure 14.7. Airlift swabbing tool.

Measuring Sand Content using Rossum Sand Tester



Specific Capacity Q/s, gpm/ft
Sand (○)
Specific Capacity (◇)
Development Complete
Development Time, Days
0
10
20
30
40
50
0
50
100
150
200
1
2
5
10
20
50
100


Properly Designed Gravel Envelope &
Screen Slot Size
Well Screen
Filter Pack
Aquifer

SUMMARY

- Corrosion resistant steels have proven effective in extending well life
- Steel and material selection must consider corrosion prevention, potential aggressive well development and rehabilitation procedures
- Life Cycle Cost Analysis demonstrates that payback period for stainless steel is relatively short, 7 – 8 yrs

SUMMARY

- Select appropriate gravel pack gradation to stabilize formation
- Select appropriate slot size to stabilize/retain gravel pack
- Employ rigorous and thorough well development methods
- Monitor the specific capacity and efficiency of the well to determine when rehab is needed and minimize operational costs

Questions?

Kevin McGillicuddy, P.G.
(323) 263-4111
Email:
kmc@roscoemoss.com
Website:
www.roscoemoss.com

Speaker #8

Groundwater Basin Master Plan

Everett Ferguson

Water Replenishment District

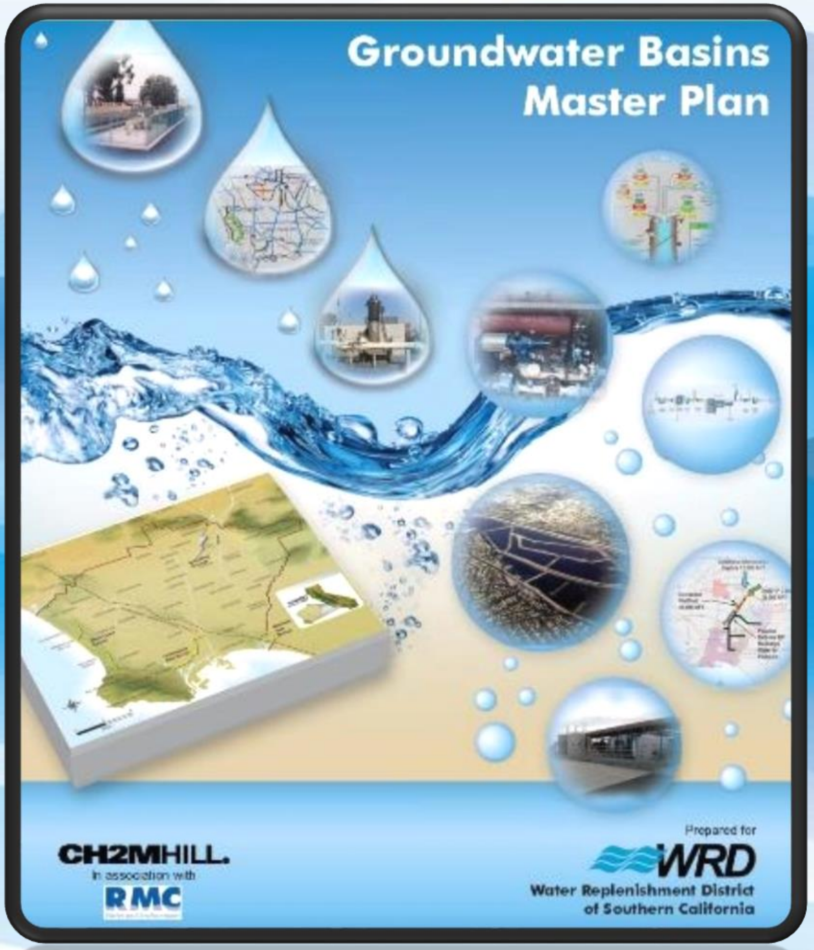
eferguson@wrd.org

WRD

WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

Groundwater Basins Master Plan

Central Basin and West Coast Basin



Everett Ferguson, Senior Hydrogeologist

Acknowledgements

- Central Basin Groundwater Pumpers
- West Coast Basin Groundwater Pumpers
- City of Los Angeles DWP and Sanitation
- County Sanitation Districts of LA County
- West Basin Municipal Water District
- Metropolitan Water District of Southern California
- CH2M and RMC

WRD Service Area:
Central & West Coast Basins

420 square miles

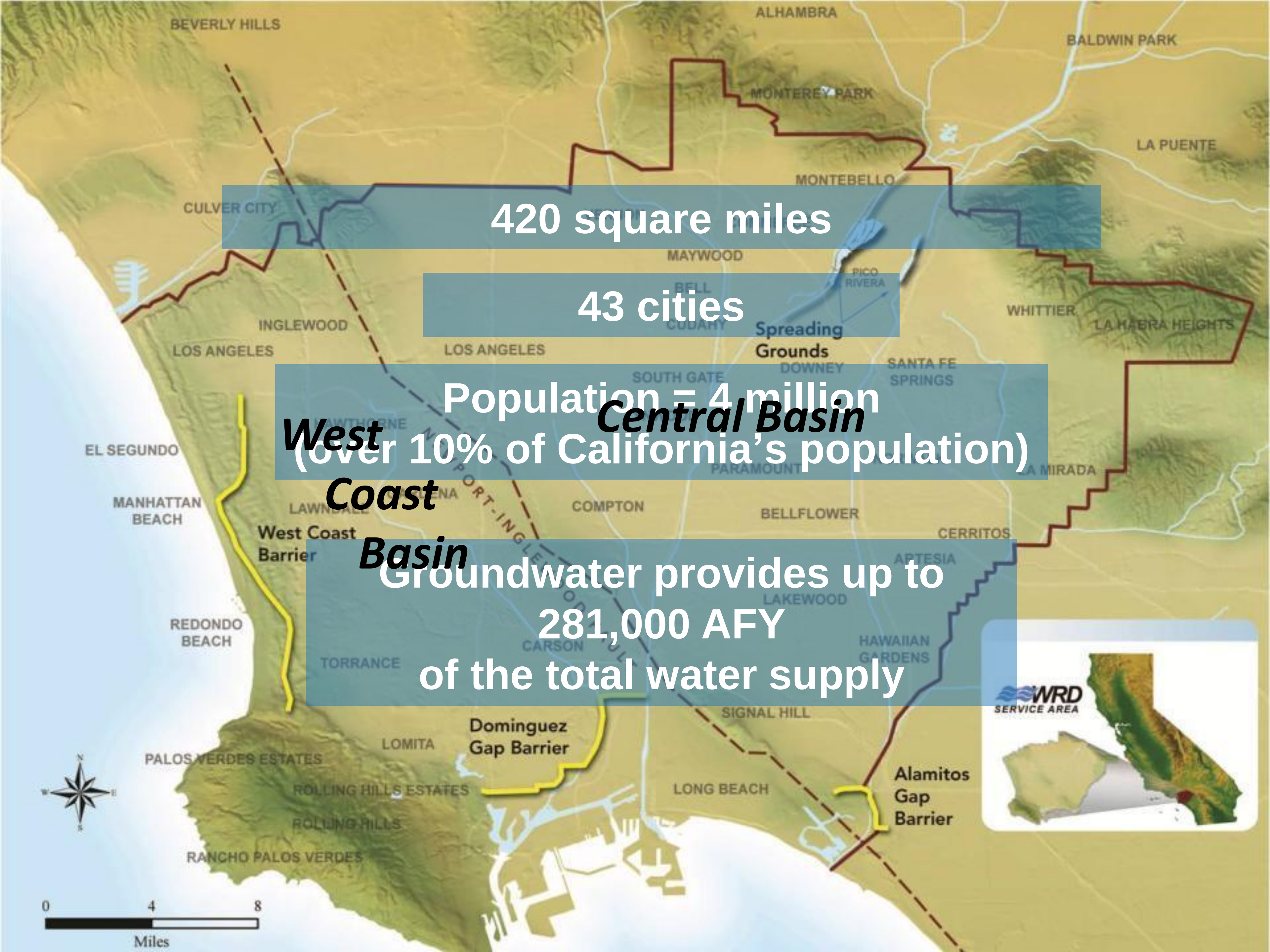
43 cities

Population = 4 million
(over 10% of California's population)

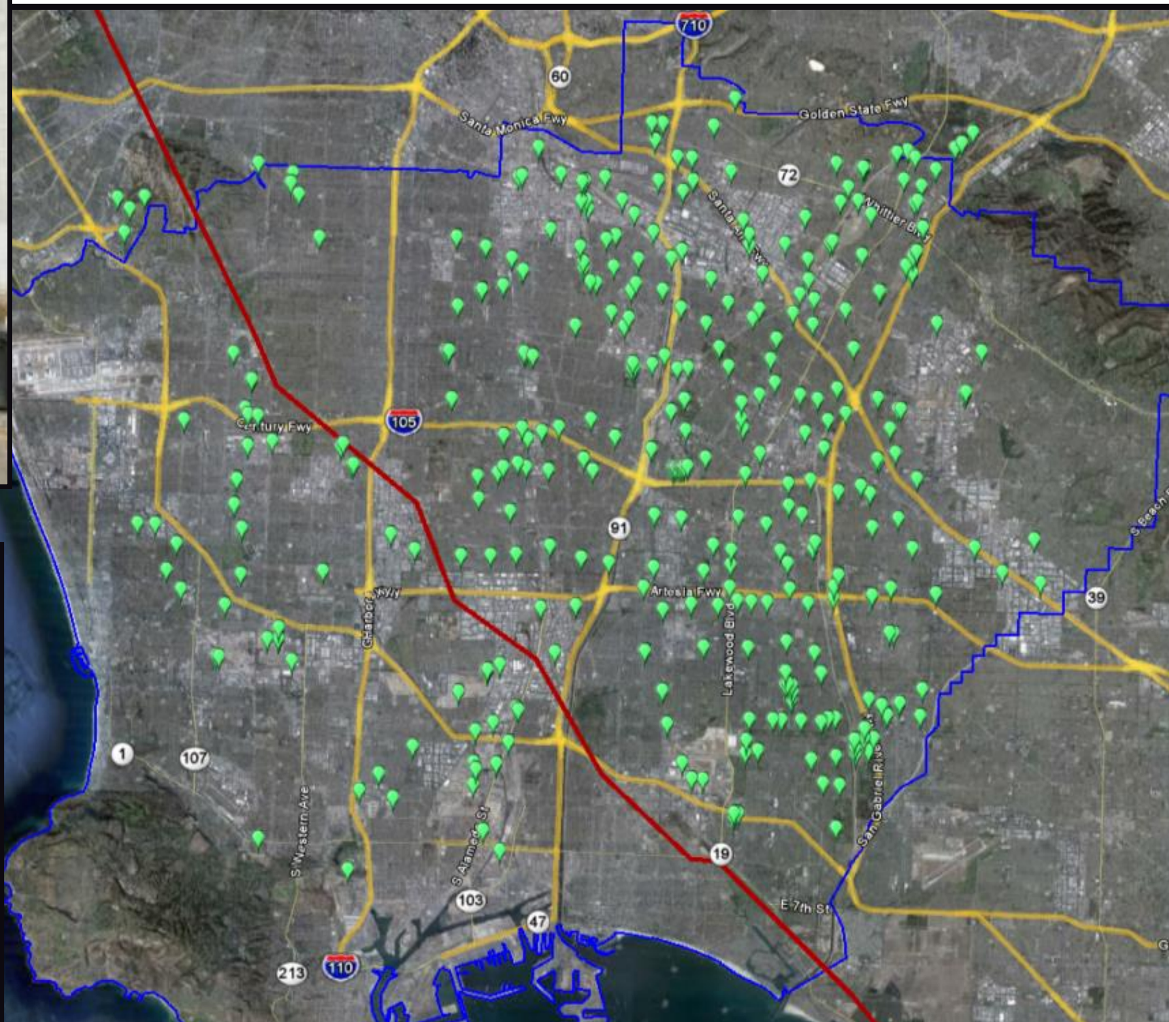
Groundwater provides up to
281,000 AFY
of the total water supply

Central Basin

West Coast Basin



Over 400 Wells Provide Water Supply

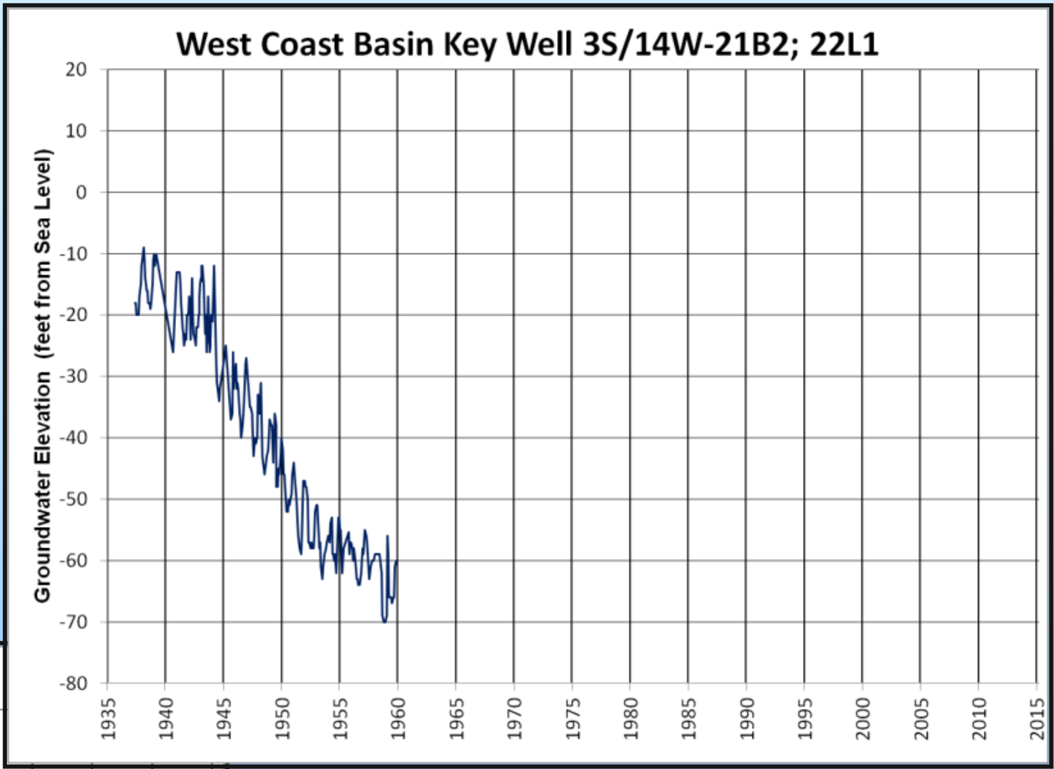


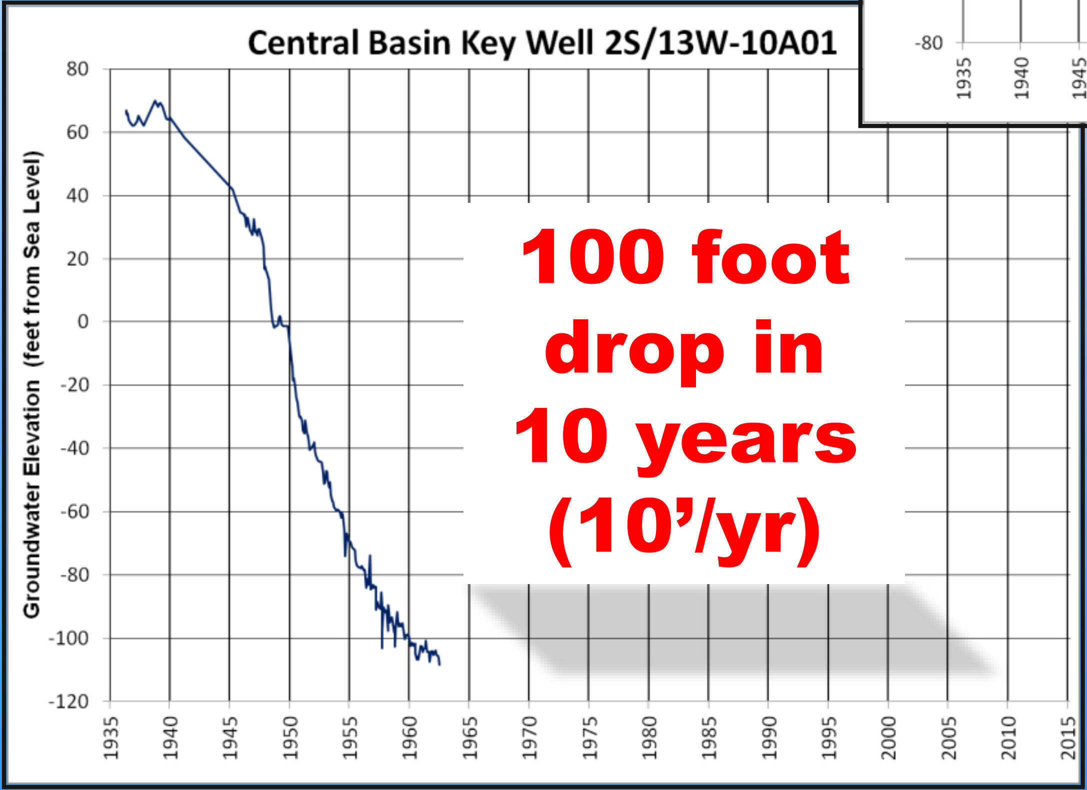
Past History:

1900s-1950s

Pumping Double Natural Replenishment.

OVERDRAFT





- **Plunging Water Levels**
- **Loss of Supply**
- **Wells going Dry**
- **Seawater Intrusion**

Solutions…

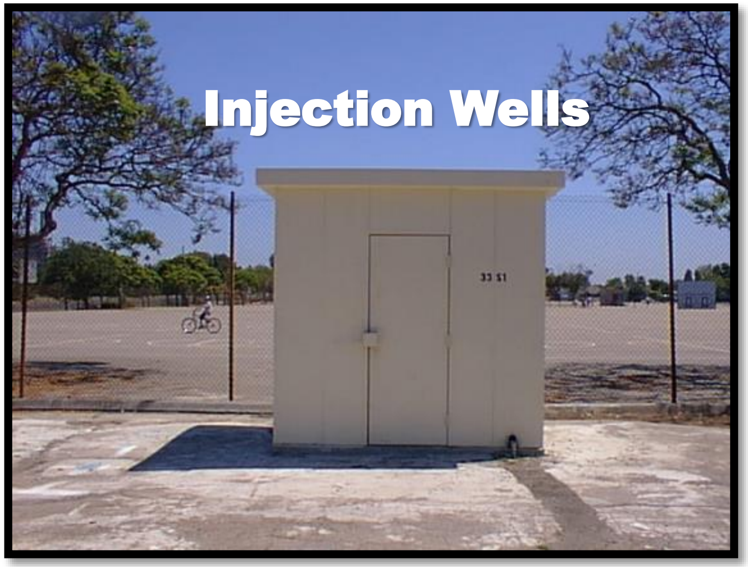
1) WRD formed in 1959 to provide managed aquifer recharge to eliminate overdraft.

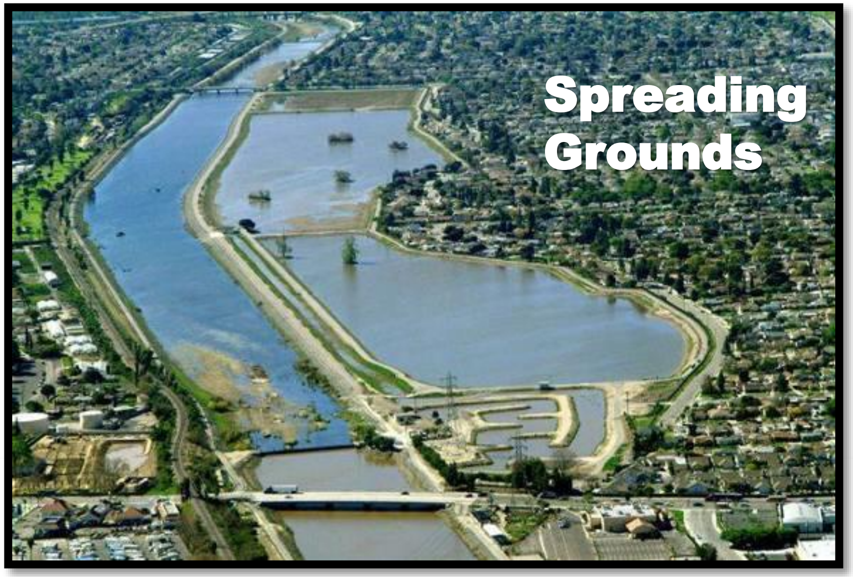
2) Pumping adjudicated at 281,835 acre feet/year. Higher than natural recharge, but WRD makes up the difference.

3) LA County installed 16 miles of wells along the coast to stop seawater intrusion. WRD buys the imported and recycled water used for injection.

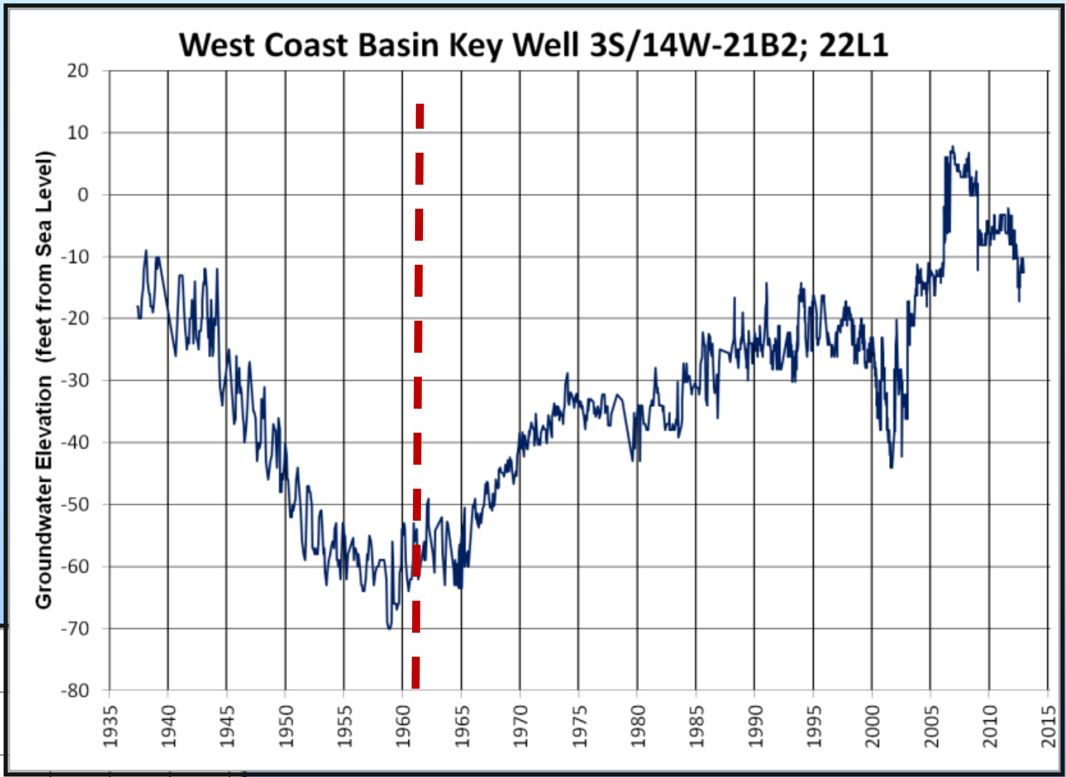
Spreading (infiltration) Basins
West Coast Barrier
Dominguez Gap Barrier
Alamitos Barrier
BEVERLY HILLS
ALHAMBRA
BALDWIN PARK
LA PUENTE
CULVER CITY
VERNON
COMMERCE
MAYWOOD
BELL
CUDAHY
PICO RIVERA
Spreading Grounds
DOWNEY
SANTA FE SPRINGS
WHITTIER
LA HABRA HEIGHTS
INGLEWOOD
LOS ANGELES
LOS ANGELES
SOUTH GATE
LYNWOOD
HAWTHORNE
EL SEGUNDO
NEWPORT-INGLEWOOD FAULT
PARAMOUNT
NORWALK
LA MIRADA
MANHATTAN BEACH
GARDENA
COMPTON
BELLFLOWER
CERRITOS
ARTESIA
West Coast Barrier
LAKEWOOD
REDONDO BEACH
CARSON
TORRANCE
SIGNAL HILL
Dominguez Gap Barrier
LOMITA
PALOS VERDES ESTATES
ROLLING HILLS ESTATES
LONG BEACH
ROLLING HILLS
RANCHO PALOS VERDES
Alamitos Gap Barrier
WRD SERVICE AREA
0 4 8
Miles

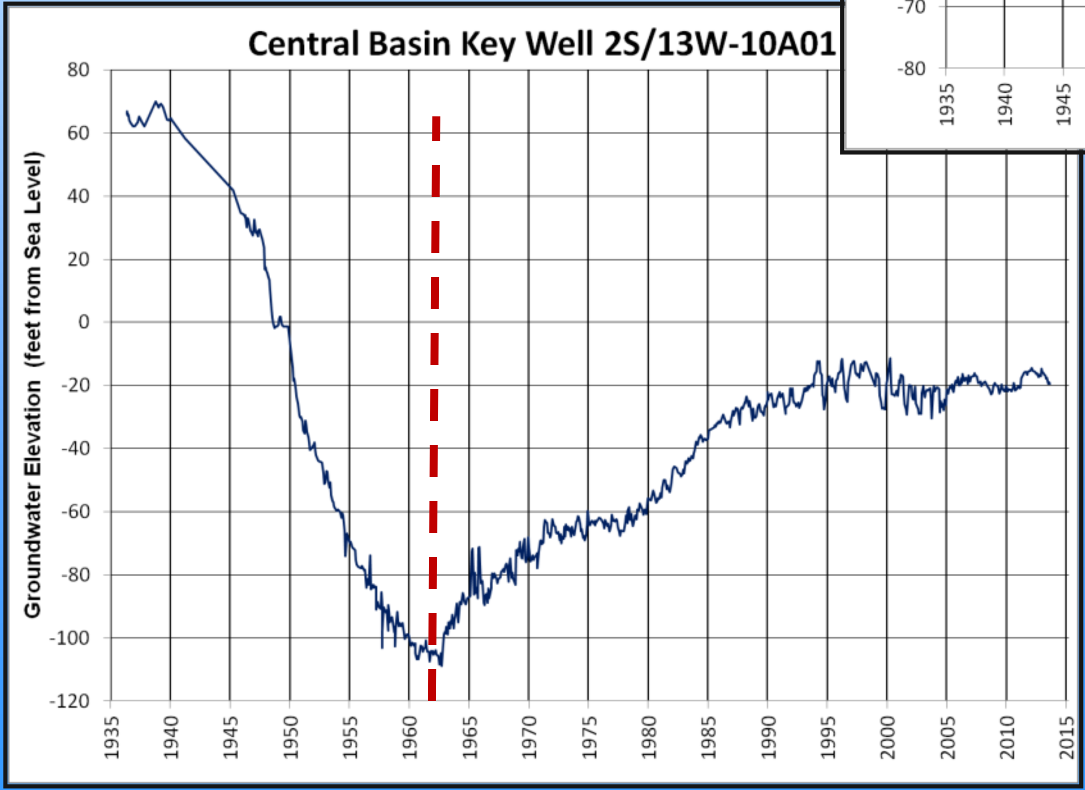
LA County Public Works Recharge Facilities





RESULTS of Groundwater Management …



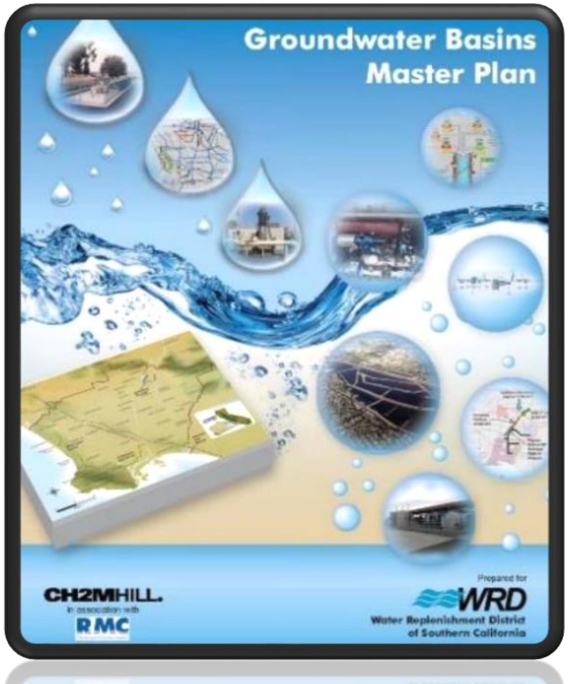


… Rising Water Levels, Drought Protection, Seawater Intrusion Protection

Problem Solved?

No

- **Continued challenges to balance pumping with groundwater replenishment programs in a cost-effective and reliable manner.**
- **2016 WRD completed a Groundwater Basins Master Plan as a roadmap to maximize sustainable groundwater pumping and reduce reliance on imported water.**

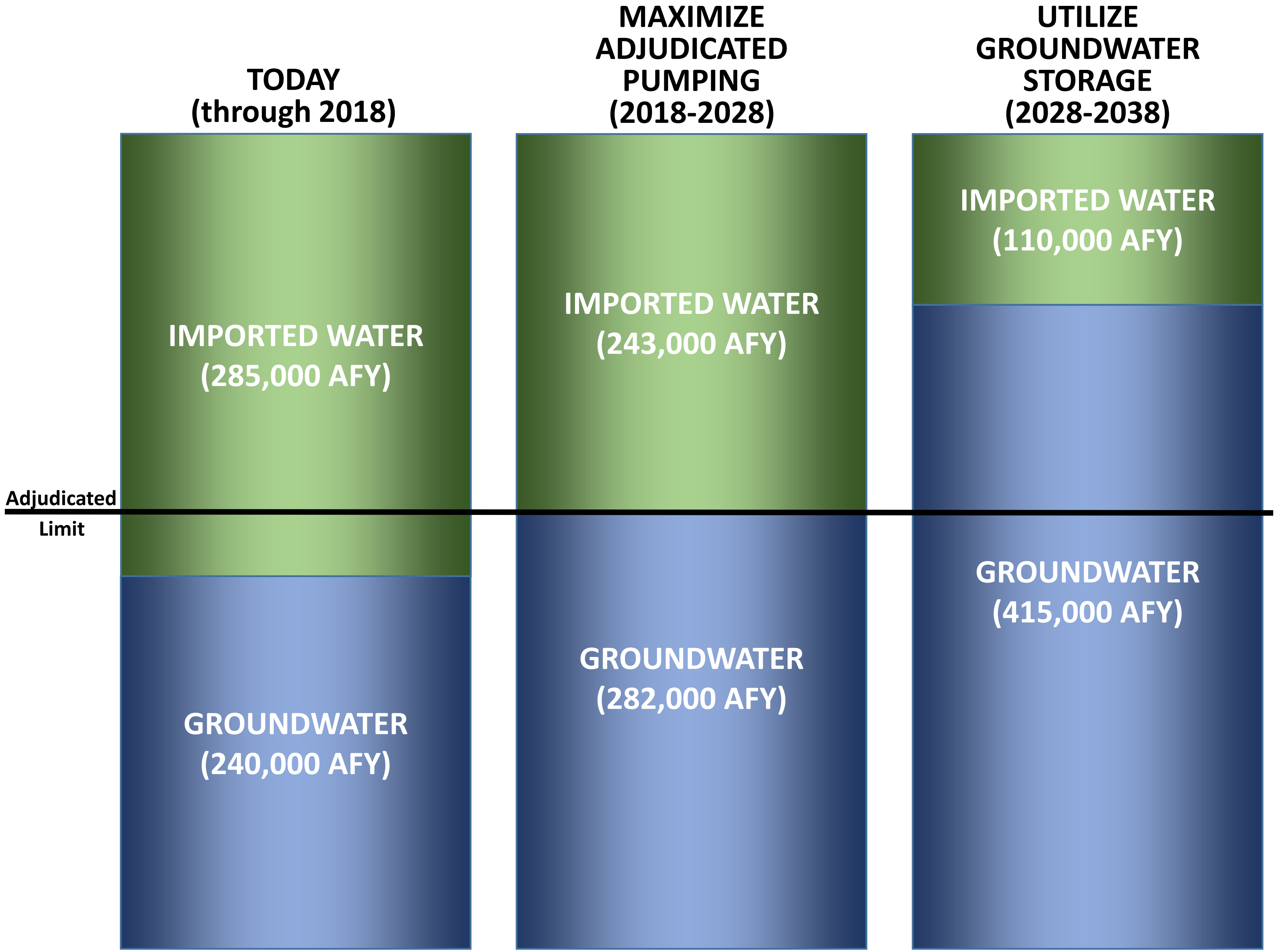


Why A Master Plan For Adjudicated Basins?

- **Pumping in both basins currently below adjudicated limits. Unnecessary purchases of imported water when groundwater could be used.**

- **Recent Judgment amendments to adjudications allow for storage projects for the first time. Need to evaluate alternatives.**

- **Opportunities to replace nearly all imported water demands with groundwater if new recharge facilities and replenishment supplies can be found to offset the increase in pumping.**



TODAY
(through 2018)
MAXIMIZE
ADJUDICATED
PUMPING
(2018-2028)
UTILIZE
GROUNDWATER
STORAGE
(2028-2038)
IMPORTED WATER
(285,000 AFY)
IMPORTED WATER
(243,000 AFY)
IMPORTED WATER
(110,000 AFY)
Adjudicated
Limit
GROUNDWATER
(240,000 AFY)
GROUNDWATER
(282,000 AFY)
GROUNDWATER
(415,000 AFY)

WRD's Goals

- Maximize local water supplies.
- Reduce reliance on imported water.
- Increase water supply sustainability and reliability.
- Mitigate future cost increases of water.
- Partner with local water reclamation agencies to create new sources of water.

Master Plan Process

Phased approach

- Phase 1 – Interviews with basin stakeholders and identification of alternative management scenarios.

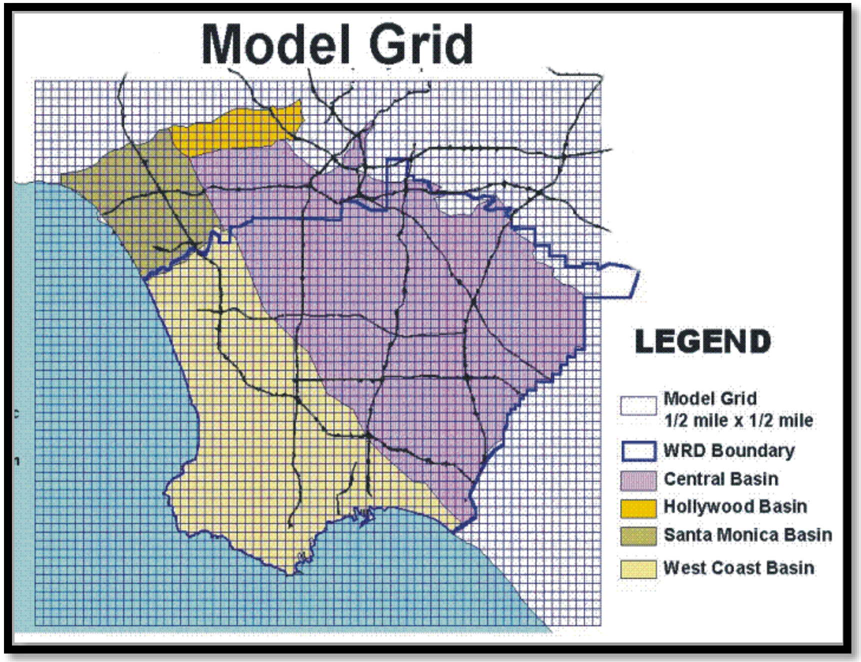
- Phase 2 – Detailed analysis of basin alternatives, including model runs and cost evaluations.

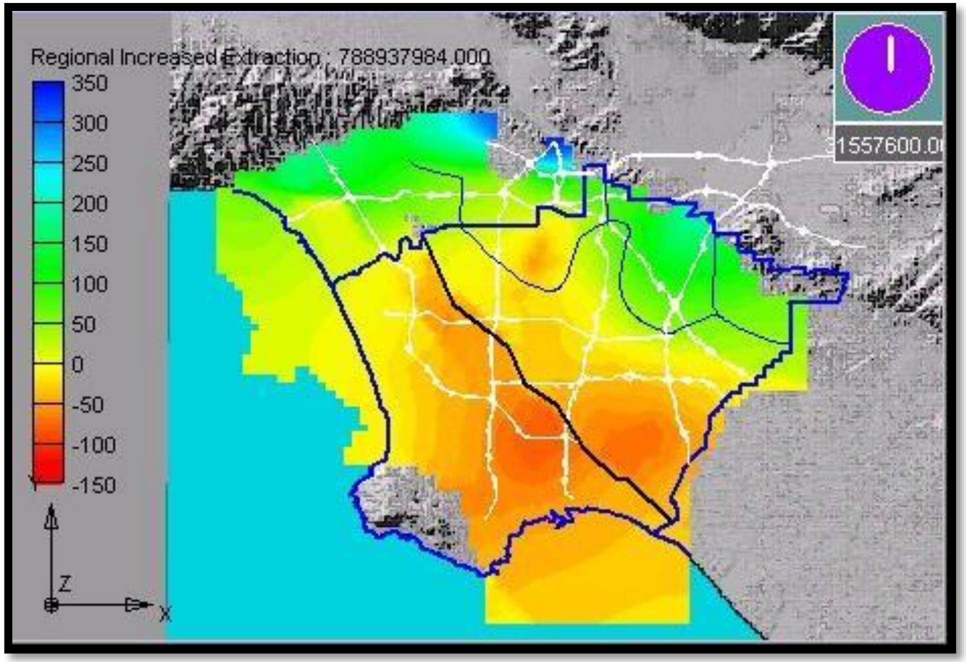
- Programmatic Environmental Impact Report.

COMPLETED

The Groundwater Model Used for Analysis

- Built by USGS using Modflow Groundwater Code.
- Based on extensive hydrogeologic data collection.
- 4 model layers represent major aquifer systems.
- 1/2 mile grids, 67 rows, 70 columns (18,760 model cells).
- 30-Year Calibration Period.
- Well Documented USGS Report (03-4065).



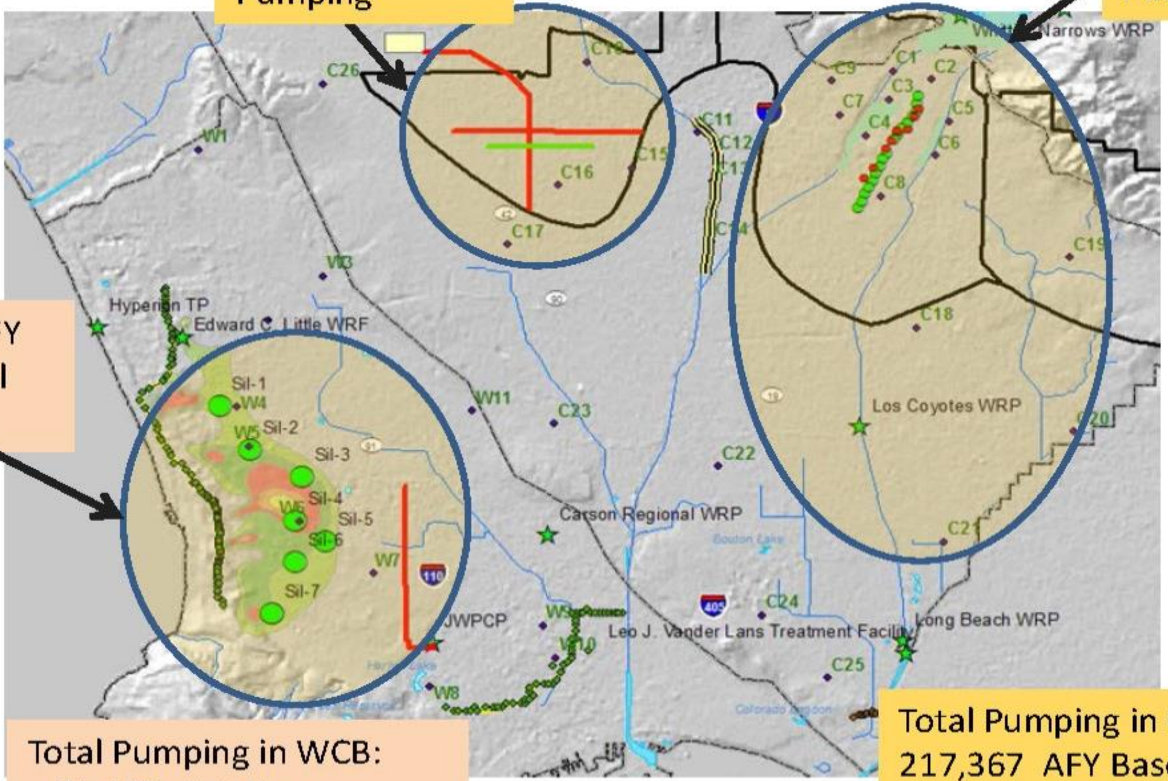


Groundwater Basins Master Plan Concepts

45,480 AFY
Additional
Pumping

57,770 AFY
Additional
Pumping

30,000 AFY
Additional
Pumping

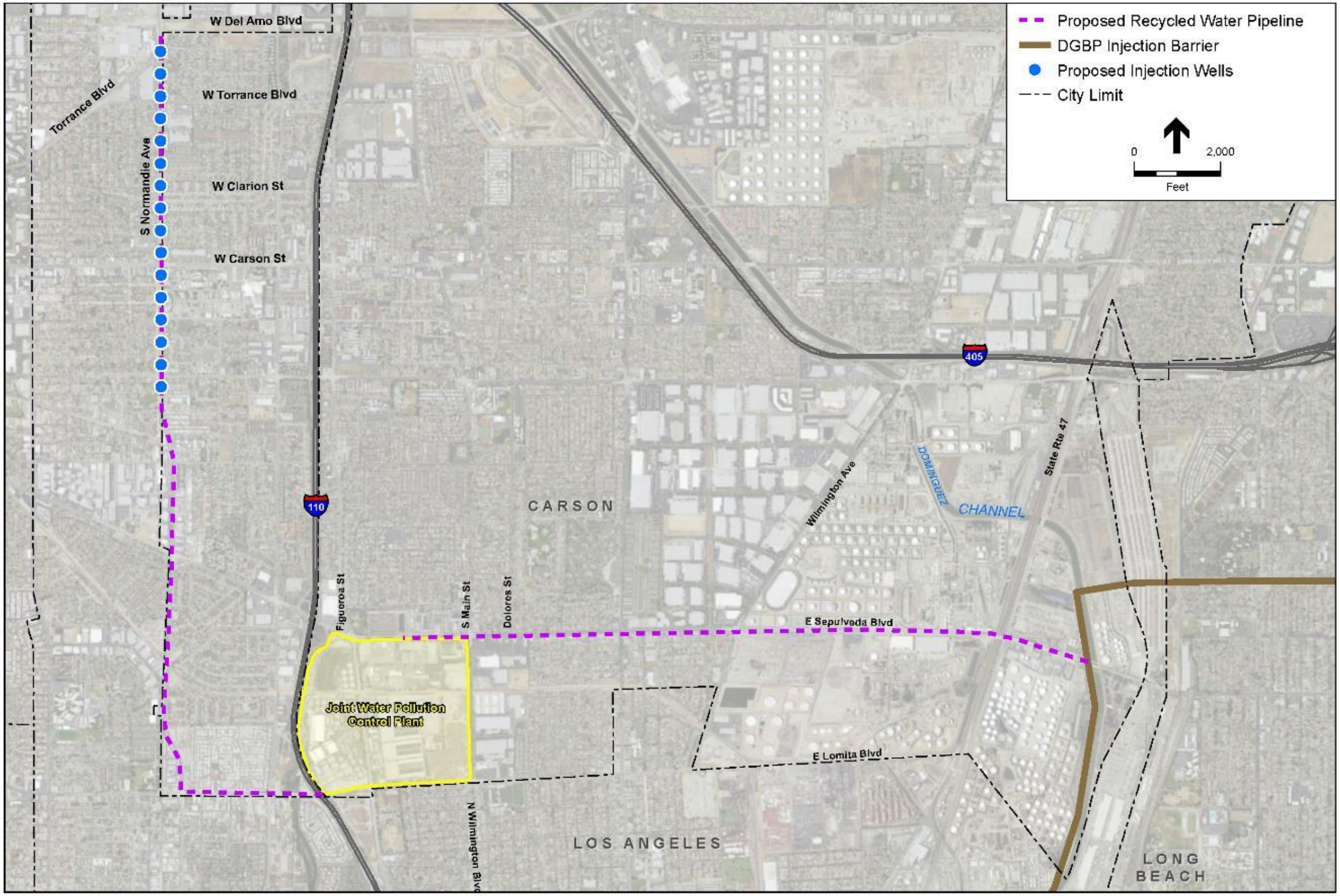


Total Pumping in WCB:
64,468 AFY Base
30,000 AFY Additional
Total = 94,468 AFY

Total Pumping in CB:
217,367 AFY Base
57,770 AFY Additional - MFB
45,480 AFY Additional - LAFB
Total = 320,617 AFY

Notes:
CB = Central Basin
MFB = Montebello Forebay
LAFB = Los Angeles Forebay
WCB = West Coast Basin

West Coast Basin – Inland Injection



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Central Basin – Los Coyotes WRP

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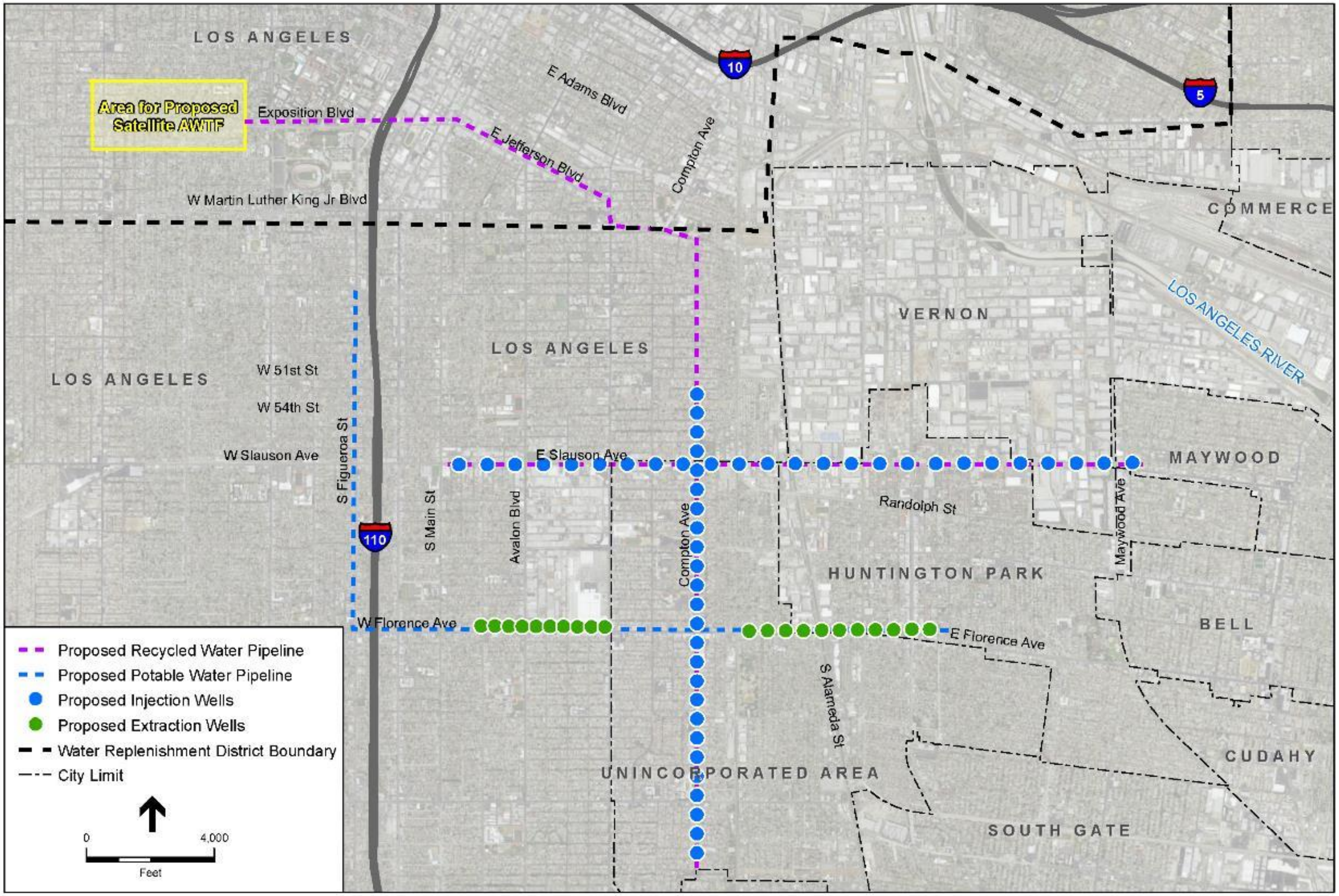
Central Basin – Los Angeles Forebay



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Central Basin – Concept B2
103,250 New Replenishment Supply
320,600 Pumping

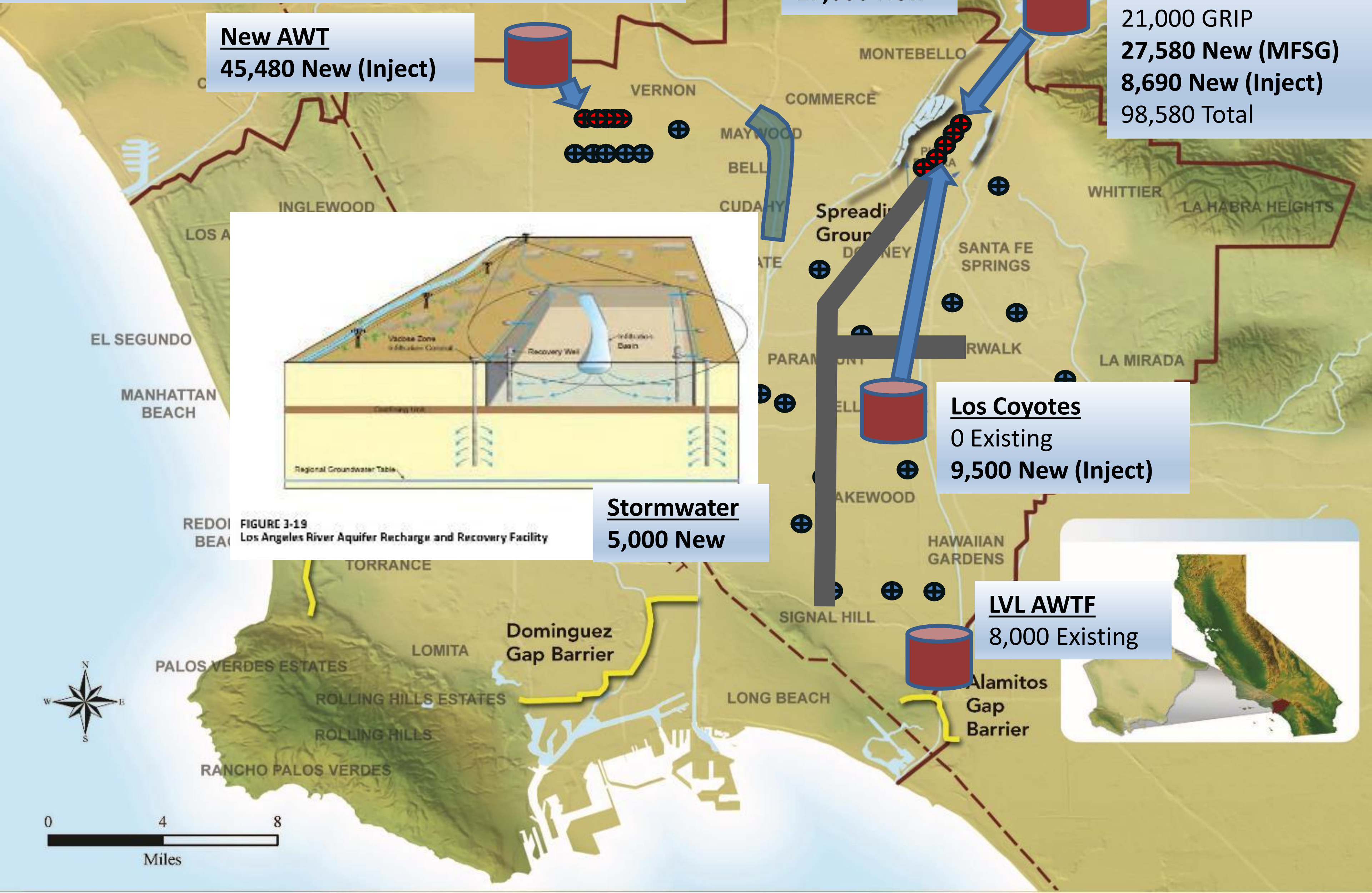
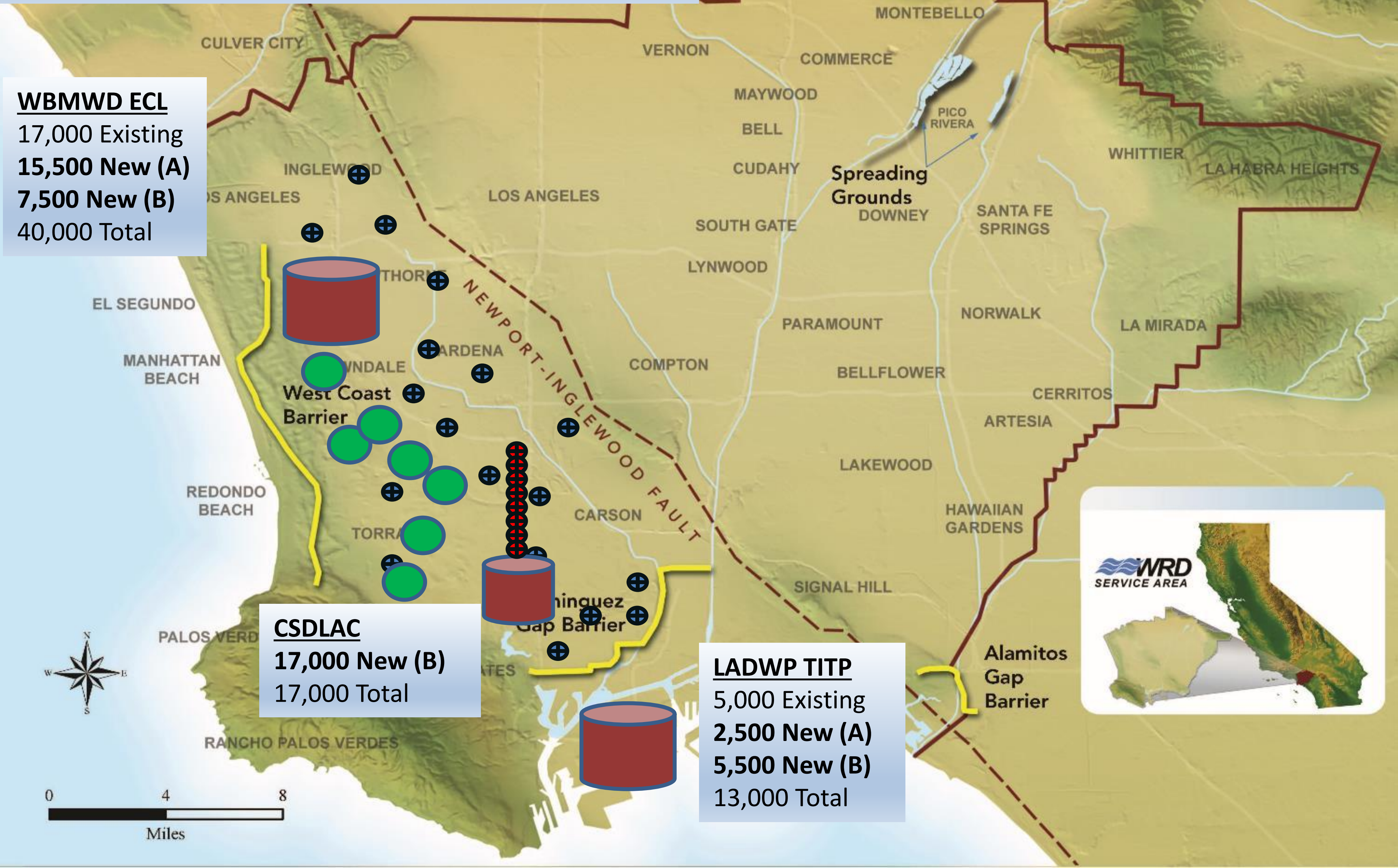


FIGURE 3-19
Los Angeles River Aquifer Recharge and Recovery Facility

West Coast Basin – Concept B
30,000 New Replenishment Supply
94,500 Pumping
Existing pumping patterns



West Coast Basin Yield vs. Costs

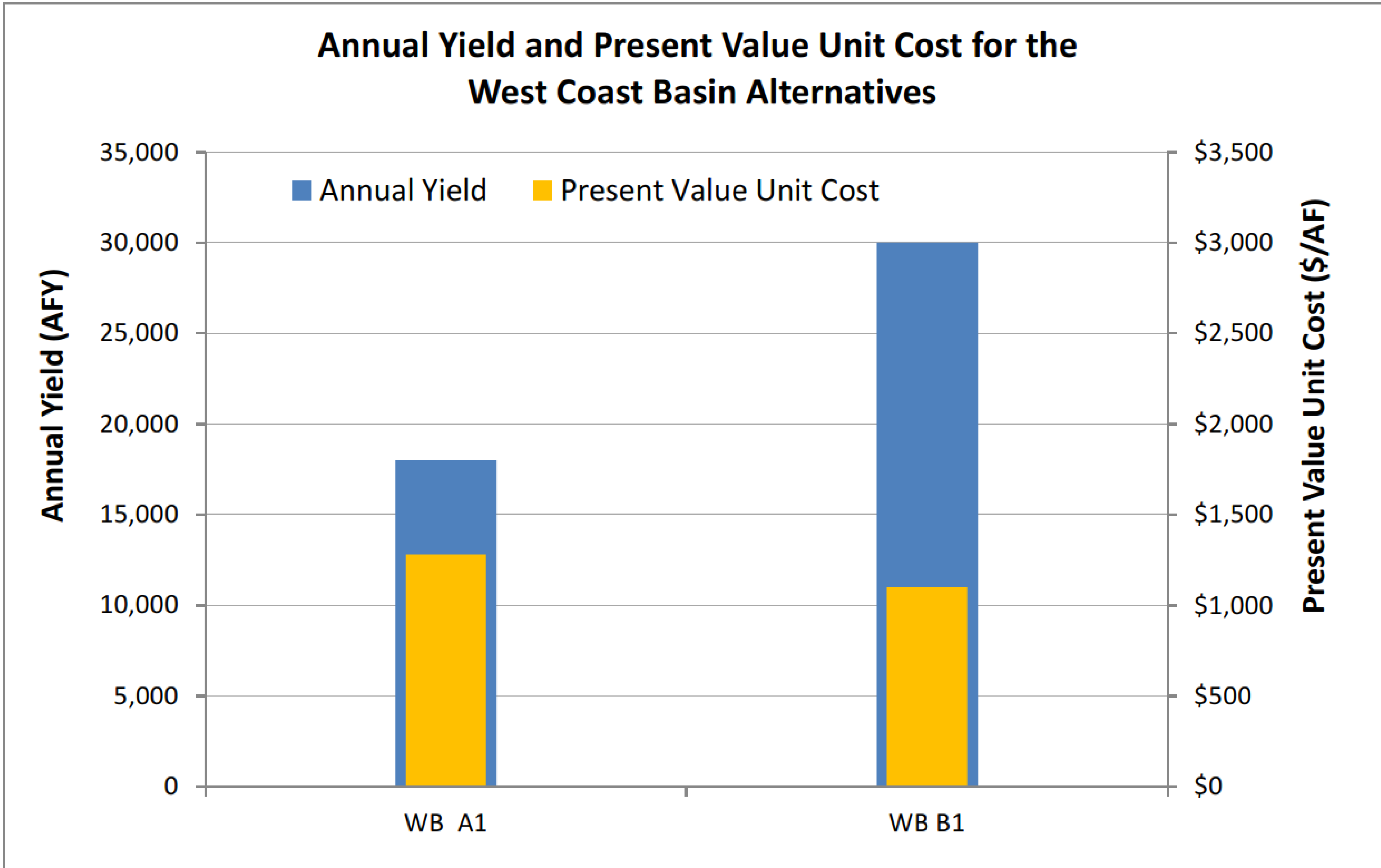


Figure ES-7. Annual Yield and Present Value Unit Cost for the West Coast Basin Alternatives

Central Basin Yield vs. Costs

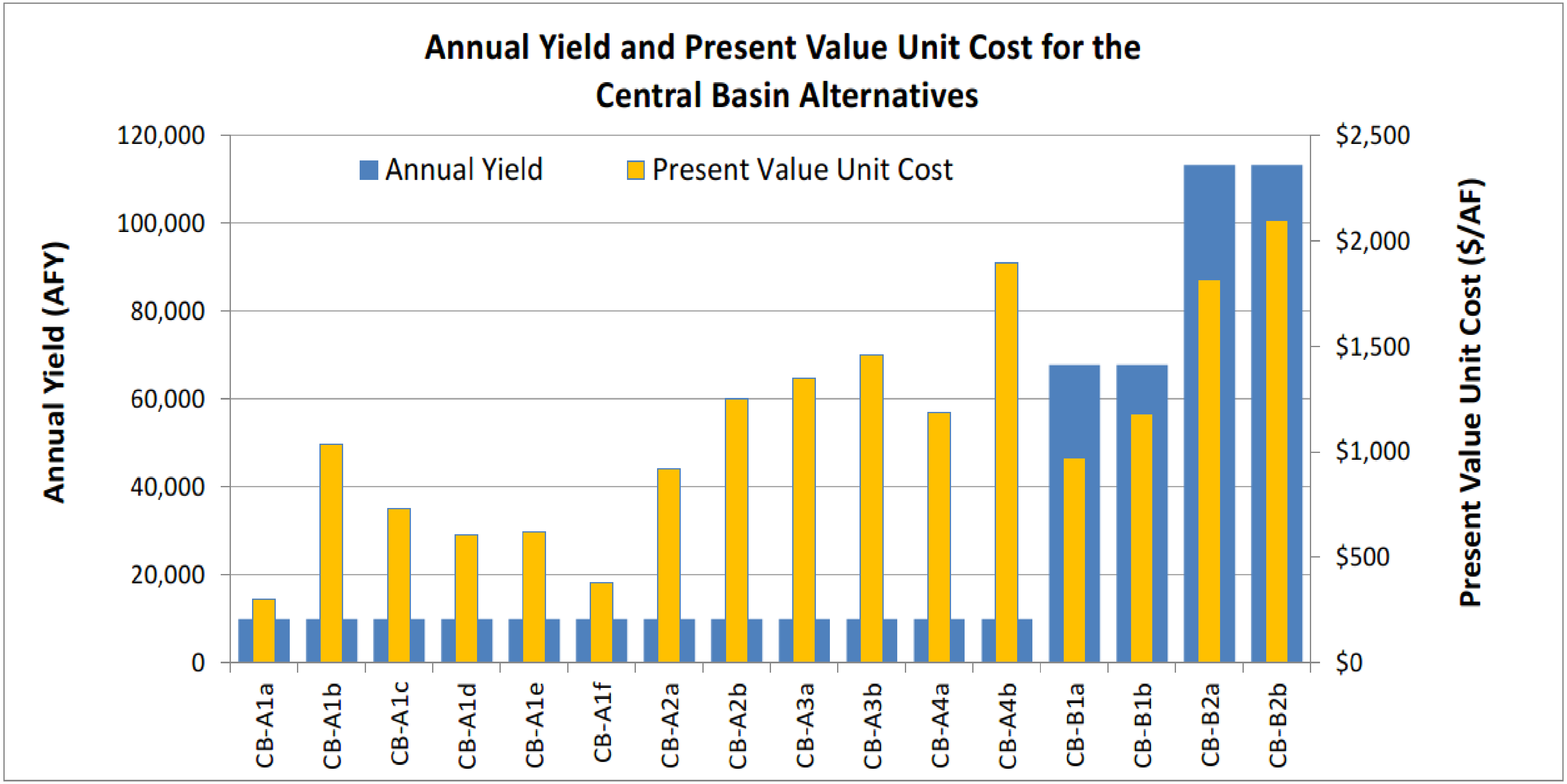


Figure ES-8. Annual Yield and Present Value Unit Cost for the Central Basin Alternatives

Summary

- **Groundwater Basins Master Plan developed as a roadmap to identify ways to increase groundwater pumping that is balanced by increased groundwater recharge.**
- **Provides Central and West Coast Basin stakeholders with options and costs to replace imported supplies with sustainable groundwater pumping.**
- **Next phase is for WRD to work with groundwater producers to facilitate development of projects identified in the Plan.**

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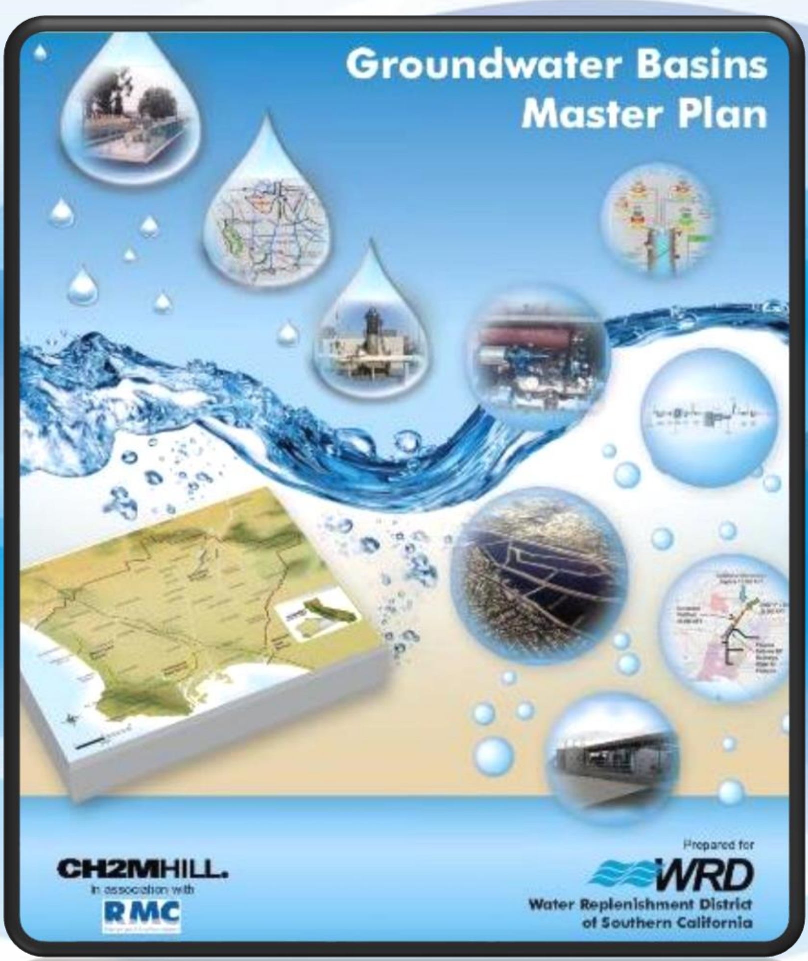
Thank You




WRD
For more information visit www.wrd.org