



ABSTRACT & POWERPOINT PRESENTATION

Riverbed Filtration System Pilot Project

Adam Hutchinson

Director of Recharge Operations
Orange County Water District
Fountain Valley, California

Managed Aquifer Recharge Symposium
January 25-26, 2011
Irvine, California

Symposium Organizers:

- National Water Research Institute
- Orange County Water District
- Water Research Foundation

www.nwri-usa.org/rechargesymposium2011.htm

The Orange County Water District Riverbed Filtration Pilot Project: Solids and Organic Carbon Removal Using Induced Riverbed Infiltration

Greg Woodside¹, Adam Hutchinson², Adam Canfield², Jason Keller³,
Michael Milczarek⁴, Scott Toland⁵

In an effort to reduce suspended solids and organic carbon loading and to increase long-term groundwater recharge rates at Orange County Water District's spreading basins, a pilot project was conducted to evaluate riverbed filtration as a technology to treat Santa Ana River (SAR) water prior to groundwater recharge. Two-dimensional variably saturated flow modeling of a shallow under-channel lateral drain system coupled with pipe fluid flow calculations were used to guide the design of a riverbank filtration pilot project. Modeling was used to develop the design of a lateral drain collection system by varying drain diameters, spacing intervals, and placement depths in order to estimate the total lateral drain length required to achieve a pumping capacity of 4500 gallons per minute. A shallow under-channel lateral drain system was constructed within a channel adjacent to the SAR to induce riverbed infiltration and capture the increase in infiltrated water. Water captured from the riverbed drain system was recharged into test spreading basins and percolation columns to evaluate recharge rates compared to SAR water without treatment. At the pilot project system, subsurface phreatic levels and temperature were continuously monitored at thirteen points. River water inflow and outflow and drain system pumping rates were also monitored.

Pilot project system pumping was incrementally increased to establish the maximum pumping capacity of the drain system for two different test conditions. Water quality data indicate that riverbed filtration effectively removed all suspended solids and decreased dissolved organic carbon contents. The bulk of water captured by the under-channel drain system was from induced infiltration. The subsurface phreatic levels and groundwater movement within the pilot project area was very sensitive to changes in surface water flow rates and depth, and drain system pumping rates. The pilot test achieved a maximum pumping rate 40 % of that predicted by the model. The discrepancy between predicted and maximum collection capacity is believed to be due to actual groundwater elevations being lower than original model assumptions, and large variability in surface water depth over the system. Nonetheless, the model served as a valuable design tool and can be optimized with pilot study observations to support project scale up. The pilot project results indicate that riverbed filtration is a viable technology for treating surface water prior to recharge operations, however, additional testing and optimization is needed.

¹ Orange County Water District, 18700 Ward Street, Fountain Valley, CA, 92708

² Orange County Water District, 4060 E. La Palma Ave, Anaheim, CA 92807

³ GeoSystems Analysis, Inc., 16 Oak St, Suite 203, Hood River, OR 97031

⁴ GeoSystems Analysis, Inc., 2015 N. Forbes Blvd, Suite 105, Tucson, AZ 85745

⁵ HDR Engineering, 8690 Balboa Avenue, Suite 200, San Diego, CA 92123-1502"



Riverbed Filtration System Pilot Project

Managed Aquifer Recharge Symposium
January 26, 2011

Adam Hutchinson¹, Adam Canfield¹, Michael Milczarek²,
Jason Keller², Scott Toland³

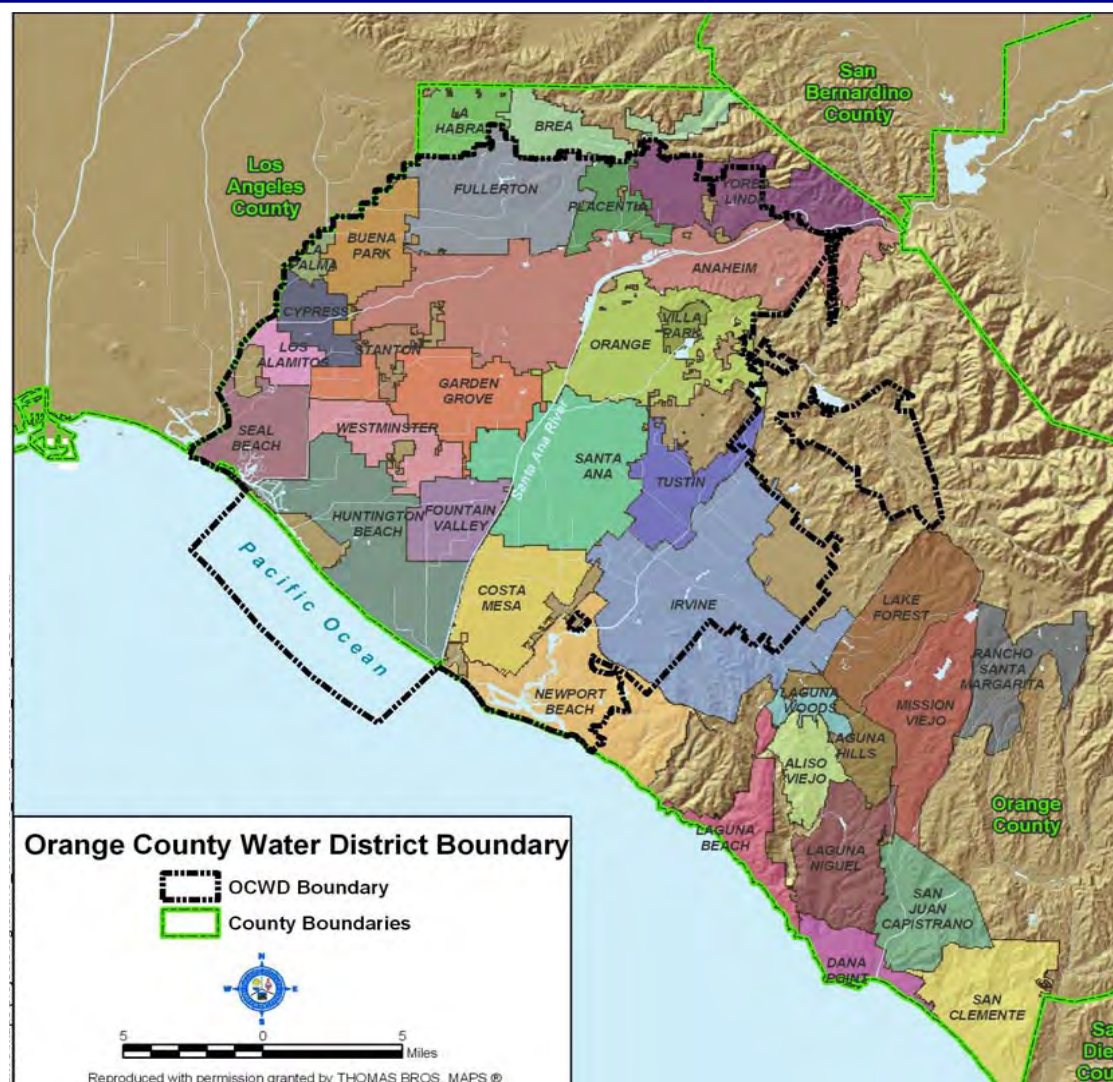
¹Orange County Water District

²GeoSystems Analysis, Inc

³HDR





OCWD manages the groundwater resources in north and central Orange County.



- OCWD formed in 1933
- OCWD encompasses 350 mi² in the lower watershed of the Santa Ana River (SAR)
- Orange County groundwater basin provides water for over 2.5 million people

Orange County Water District Boundary

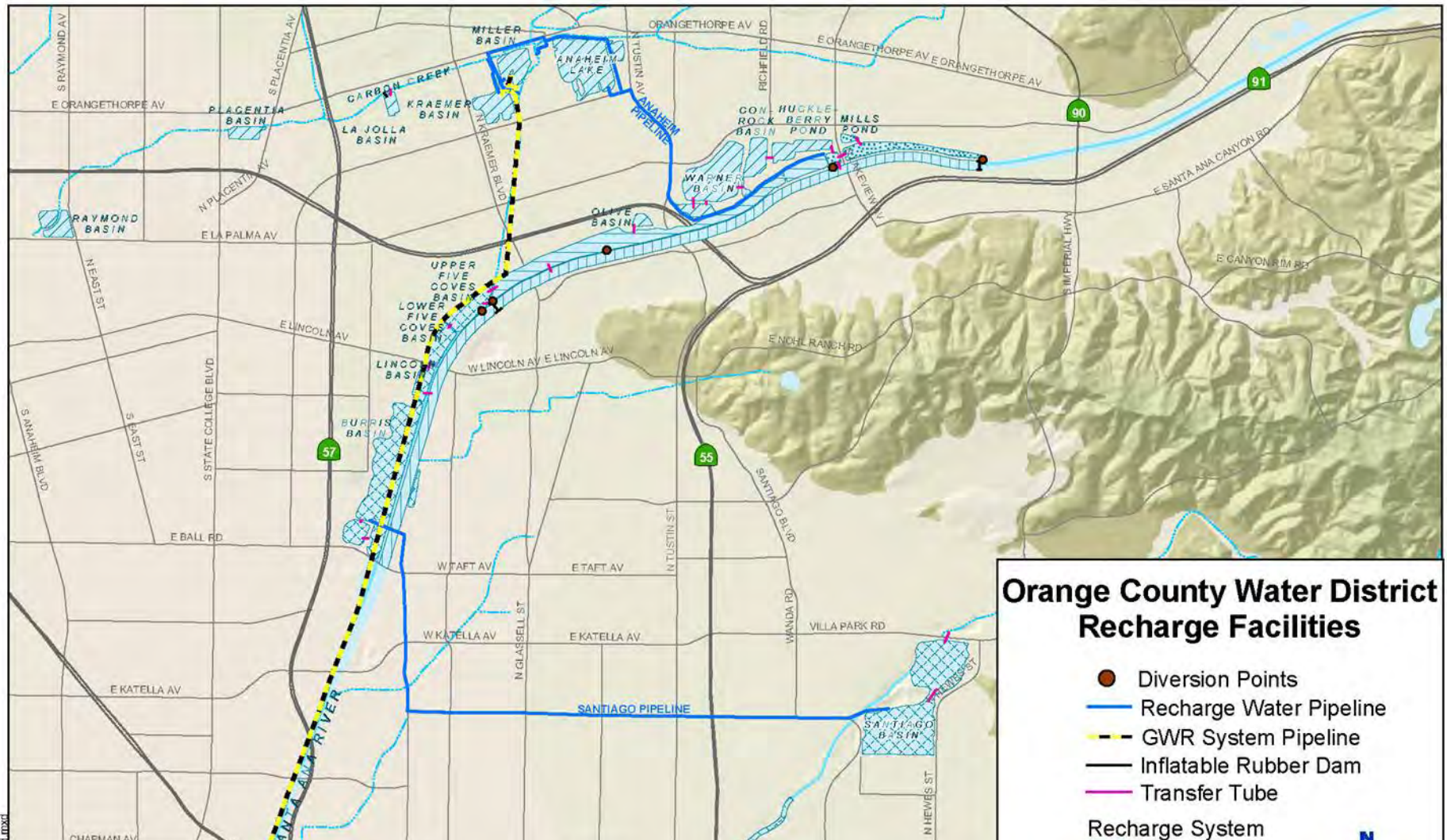
-  OCWD Boundary
-  County Boundaries








5 0 5 Miles



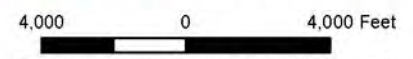
Reproduced with permission granted by THOMAS BROS. MAPS ©



Orange County Water District Recharge Facilities

-  Diversion Points
-  Recharge Water Pipeline
-  GWR System Pipeline
-  Inflatable Rubber Dam
-  Transfer Tube

- Recharge System
-  Deep Basin
 -  Desilting
 -  Off-River
 -  Main River
 -  Burris/Santiago Basin

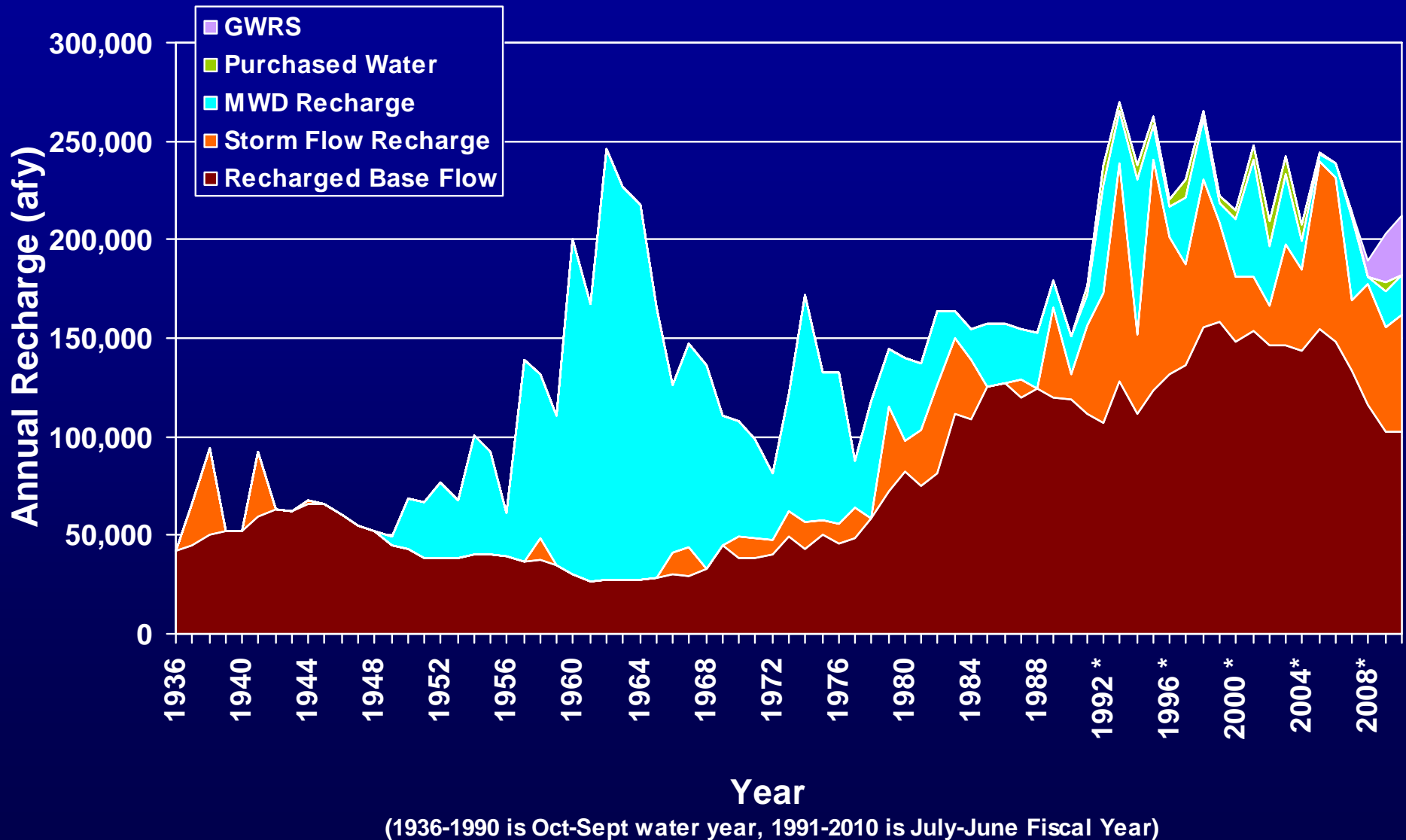


Reproduced with permission granted by THOMAS BROS. Maps ©
© Thomas Bros. Maps. All rights reserved.

Since 1936, OCWD has expanded its recharge system to over 25 facilities covering 1,500 acres.

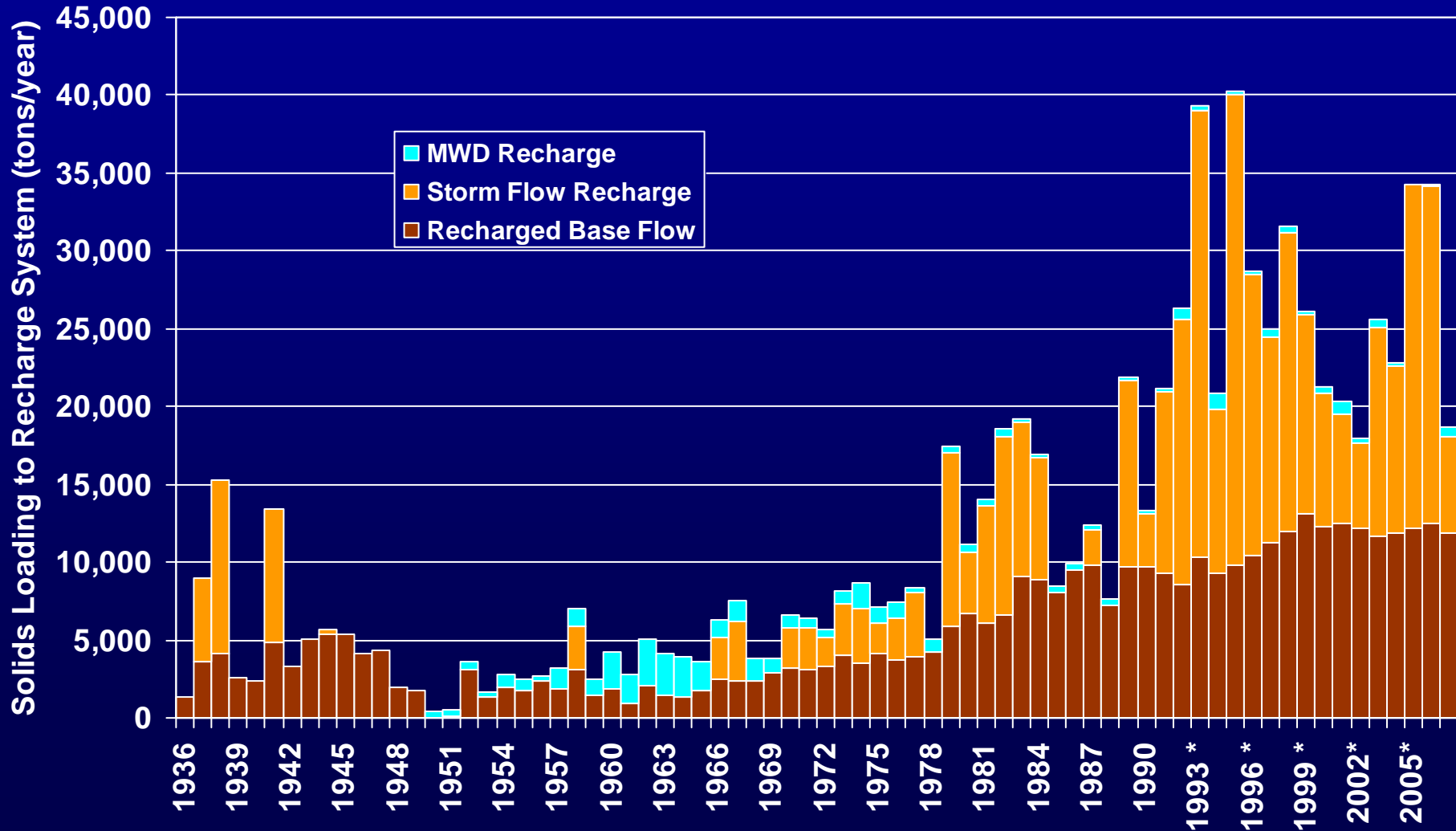


Source waters to the recharge system have changed over the years.





Solids loading has increased more than five-fold since the 1960s due to the shift to recharge of SAR water.



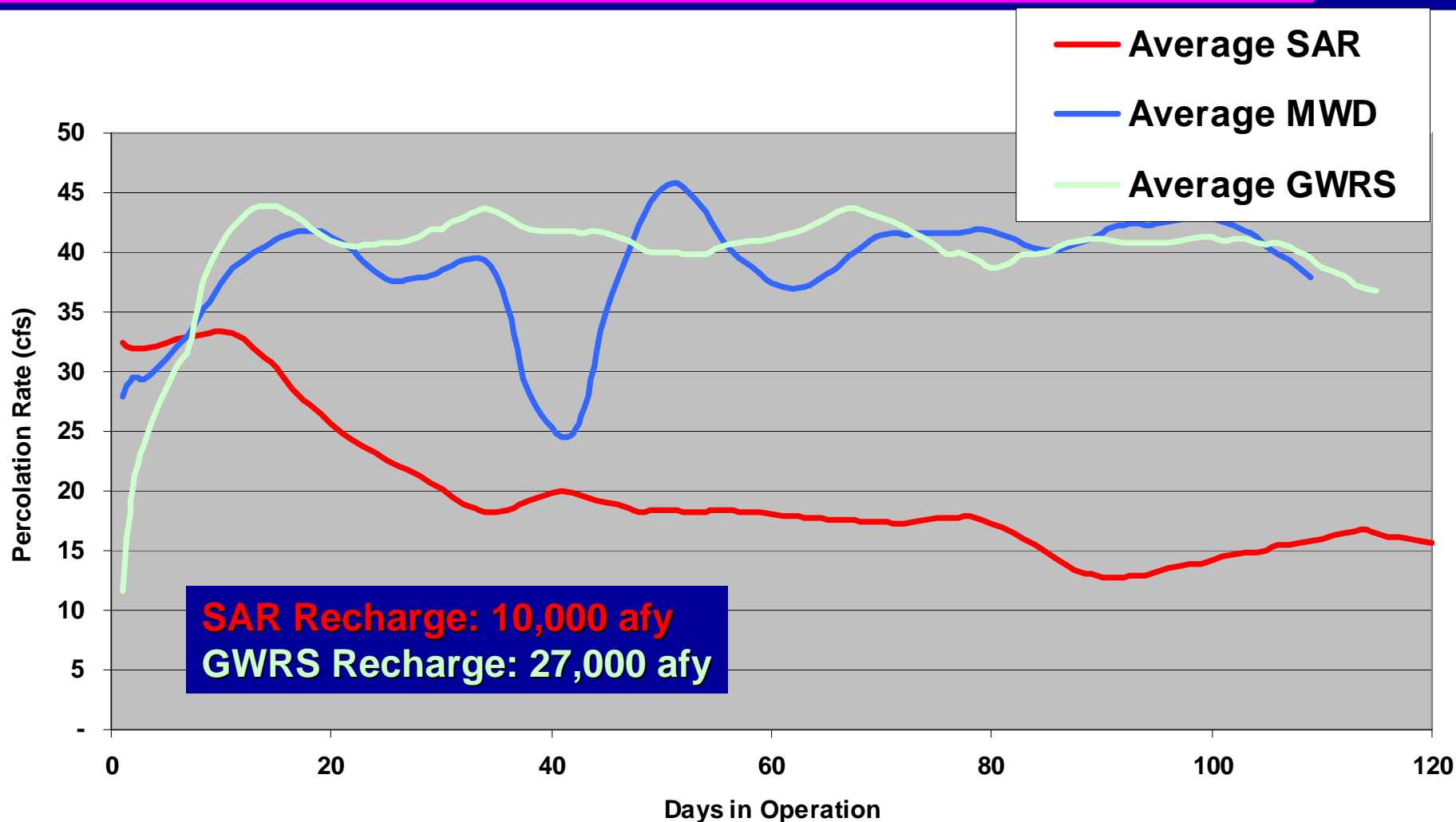
The Santa Ana River is currently the primary source of recharge water.



Winter 2006



Continual recharge with highly treated wastewater (GWRS) has nearly tripled the recharge capacity of the basin.



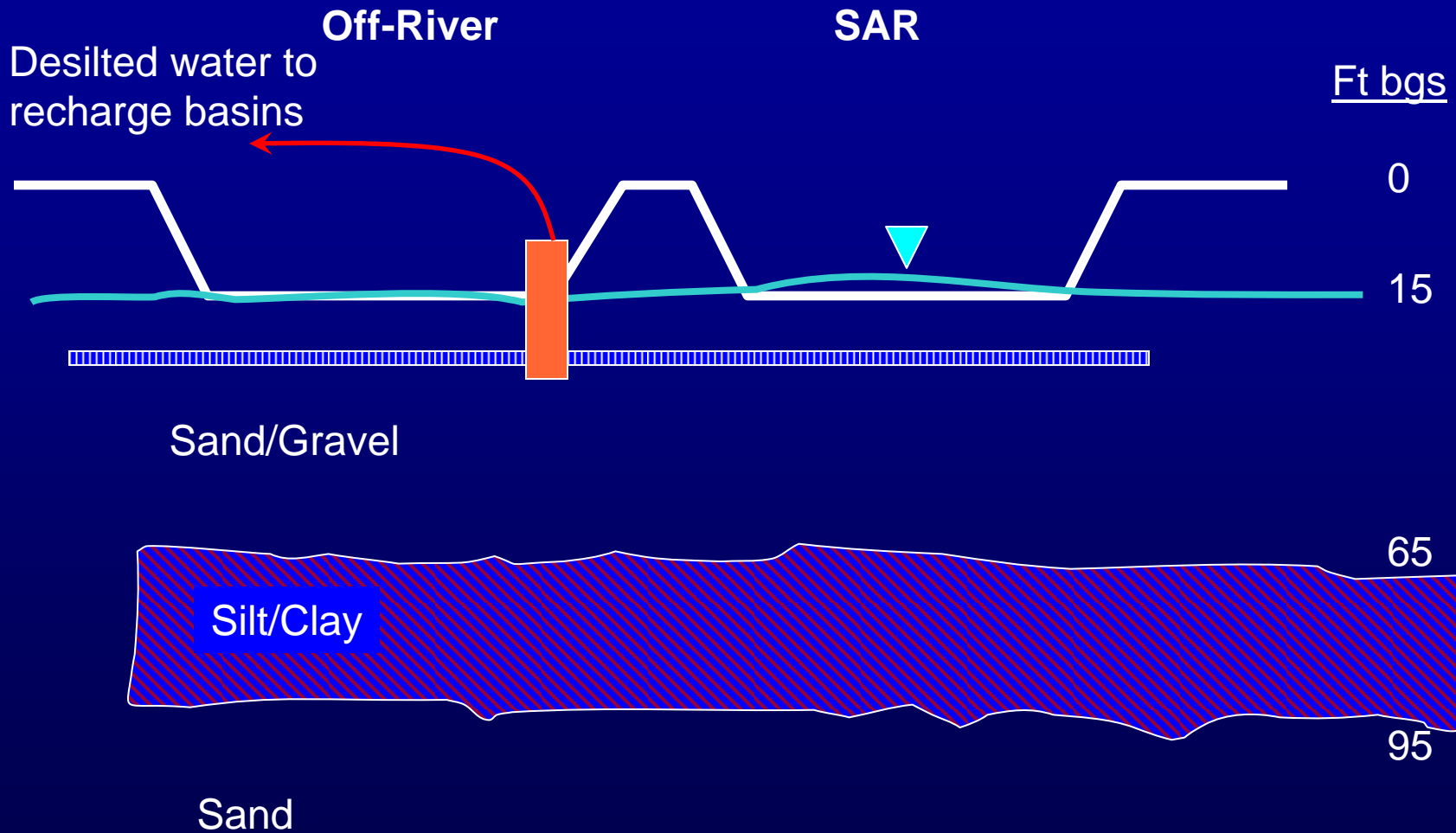


Concept is to use natural processes to remove sediment and ultimately increase the recharge capacity of the receiving basins.

- ◆ **Similar to bank filtration that is used in many places**
 - Use riverbed as sand filter
 - Horizontal collector system may be more effective than vertical system
- ◆ **Benefits**
 - Increased recharge capacity of receiving basins
 - » Frees up recharge capacity of other basins
 - Silt is removed by river flow (no disposal issues)
 - Induce recharge in areas with low recharge rates
 - Other potential water quality benefits



Conceptual Profile of Collector Well Under Off-River and SAR





Pilot riverbed filtration system was constructed to evaluate ability to treat SAR water.

◆ Design elements:

- Variably saturated flow model constructed to assist in design**
- Induce recharge (create more recharge into river)**
- Low tech, low cost (shallow drainfield)**
- 10 cfs capacity (4,500 gpm)**

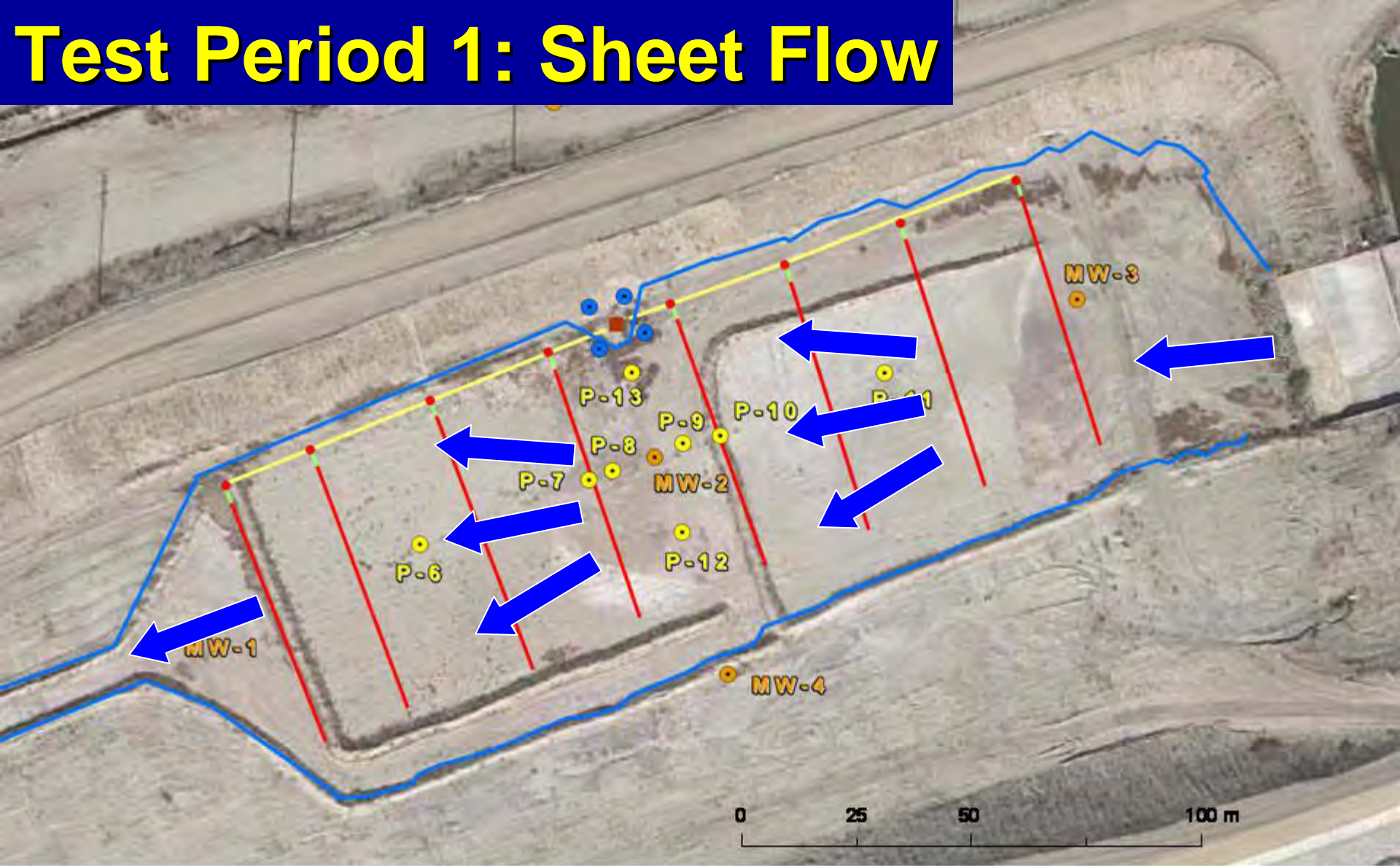
◆ Pilot system constructed in Off-River Channel

- Evaluate and monitor:**
 - » Production capacity**
 - » Clogging rates**
 - » Shallow water level response (13 monitoring wells)**
 - » Induced recharge rates (Flow in – Flow out)**
- Bi-weekly WQ samples of raw source and riverbed filtered water**
- Percolation testing using raw water and riverbed filtered water to evaluate clogging**





Test Period 1: Sheet Flow



Legend

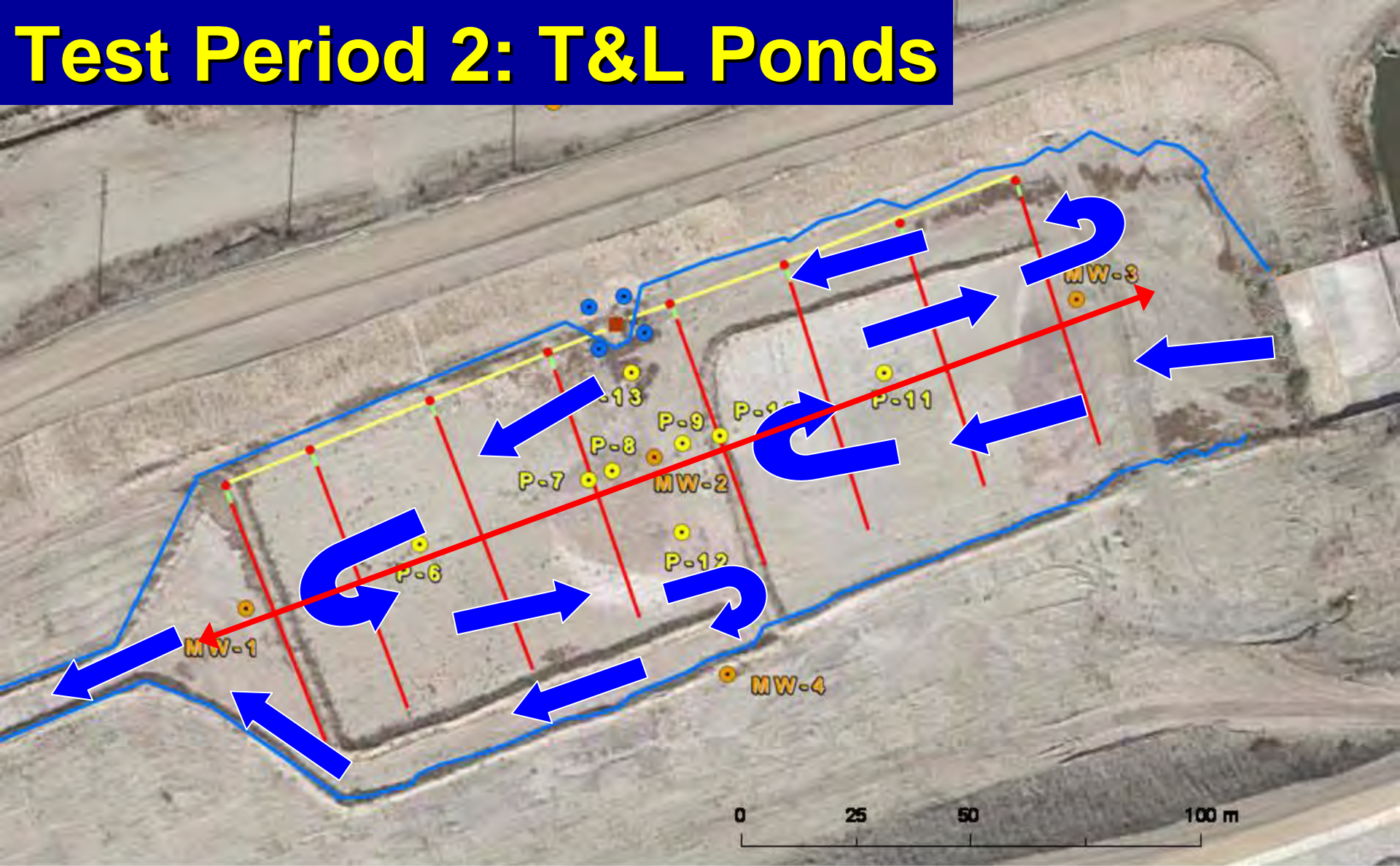
- 36-cm-diam Blank Sch 40 PVC Collector Pipe
- 20-cm diam Blank Sch 40 PVC pipe
- 20-cm-diam Slotted Sch 40 PVC Drain Pipe

- Piezometer
- Monitor Well
- Extraction Wells

- Gate Valve
- Collection Vault
- Approximate Wetted Perimeter 6/1/09



Test Period 2: T&L Ponds



Legend

- 36-cm-diam Blank Sch 40 PVC Collector Pipe
- 20-cm diam Blank Sch 40 PVC pipe
- 20-cm-diam Slotted Sch 40 PVC Drain Pipe

- Piezometer
- Monitor Well
- Extraction Wells

- Gate Valve
- Collection Vault
- Approximate Wetted Perimeter 6/1/09



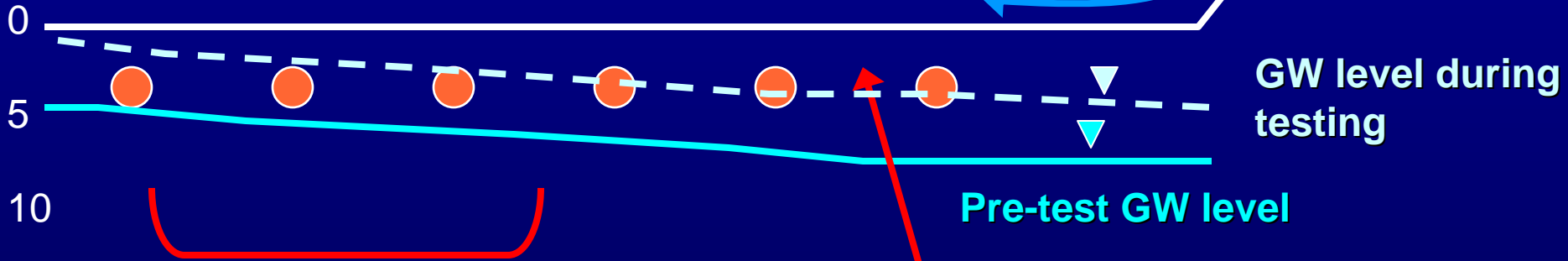


System did not produce as much as expected due to lower water groundwater levels.

Sheet flow: 3 cfs (1,350 gpm)
T&L Ponds: 4.5 cfs (2,000 gpm)
Induced Recharge: 80-100%

Weir 4

Ft bgs



GW level during testing

Pre-test GW level

Most productive part of system due to higher groundwater levels (fully saturated)

Unsaturated conditions reduced capacity of this part of system.



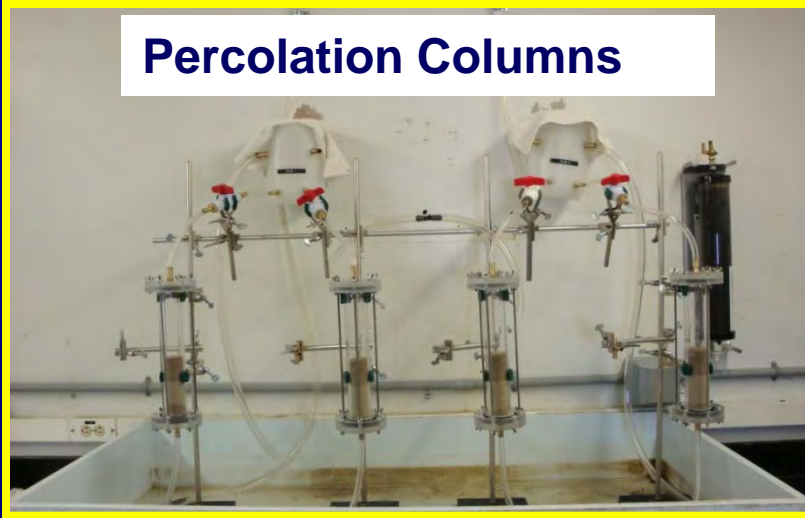
Riverbed filtration provided significant improvements in water quality.

Parameter	Influent Range	Avg. Reduction
Turbidity	8 - 80 NTU	96%
Total Suspended Solids (TSS)	7 - 37 mg/L	>99%
Chlorophyll A	52 - 68 mg/M3	>99%
Total Organic Carbon (TOC)	6 mg/L	47%
Total Kjeldahl Nitrogen (TKN)	0.8 - 0.9 mg/L	>99%
Iron	0.7 - 0.8 mg/L	80%
Manganese	0.06 mg/L	>99%

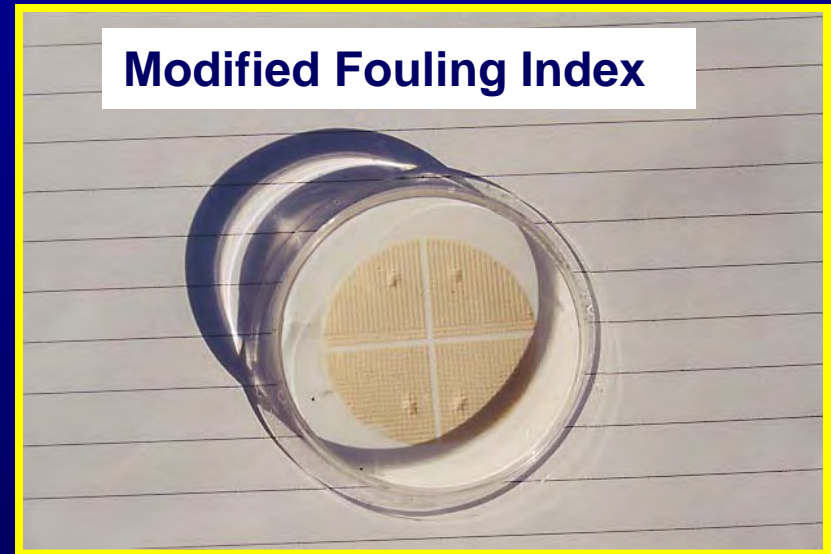


Effect on percolation rate was measured in several ways.

Percolation Columns



Modified Fouling Index

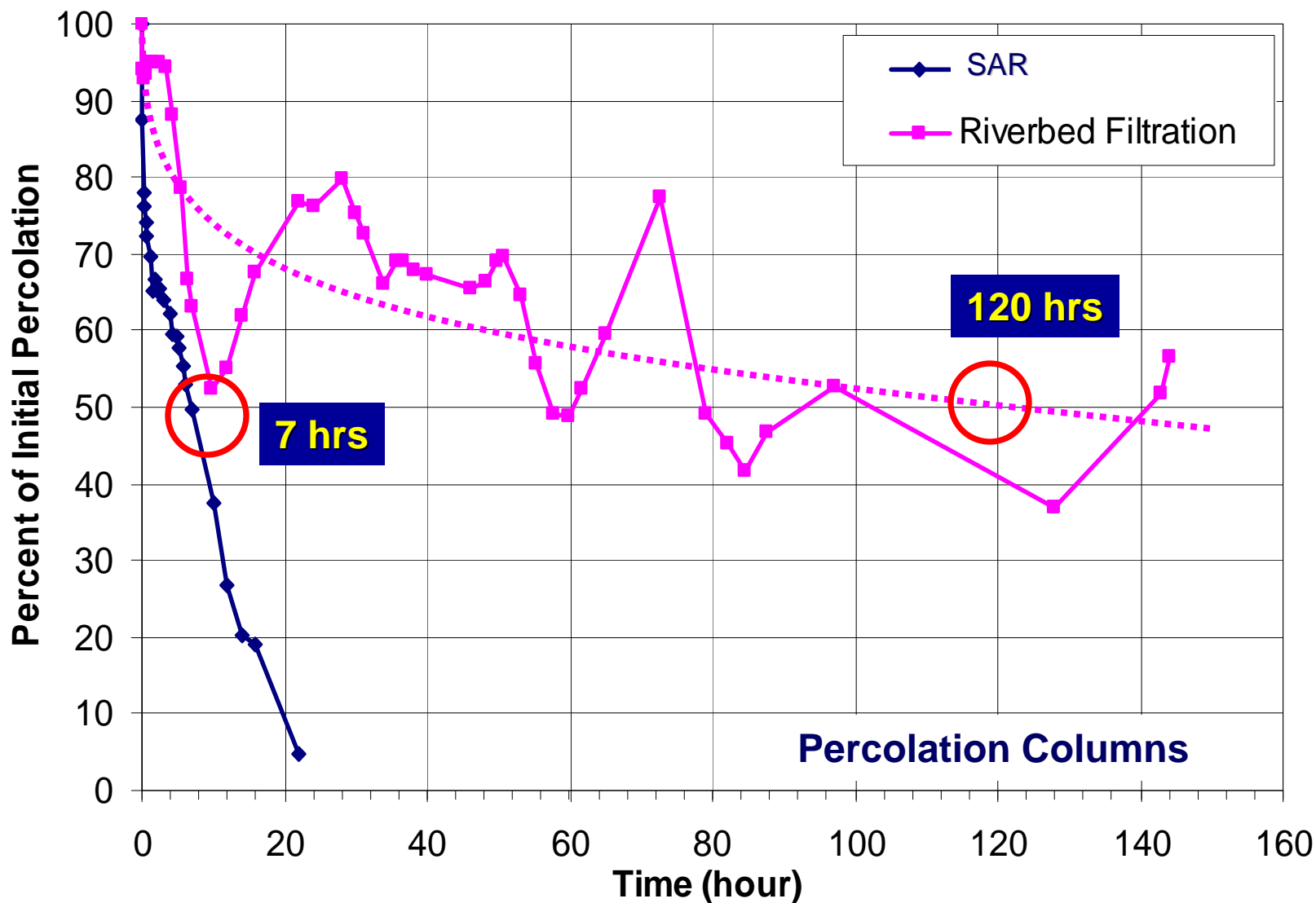


Percolation Test Cells





Clogging with riverbed filtered water was significantly less than with SAR water.

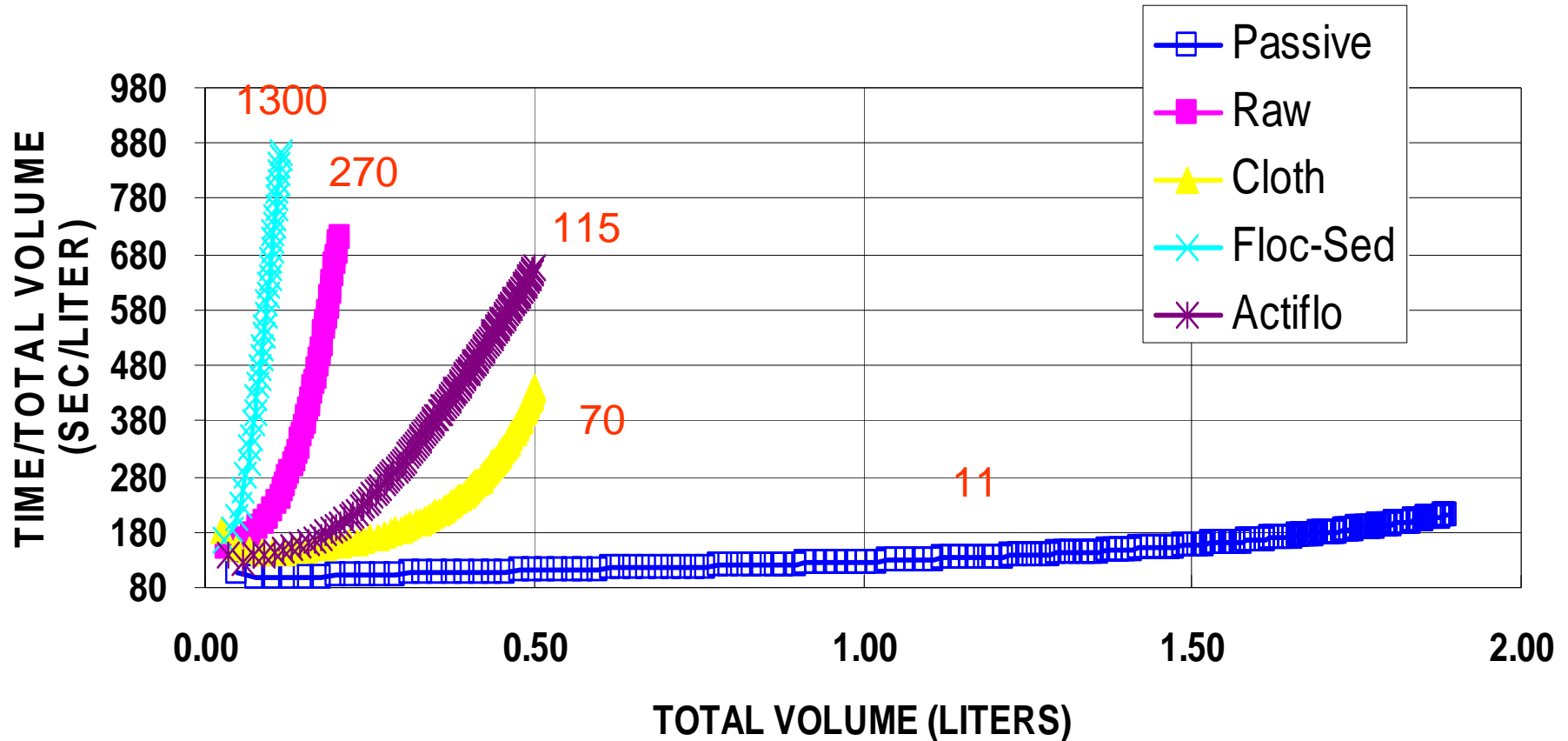




The clogging potential of solids in riverbed filtered water is extremely low.

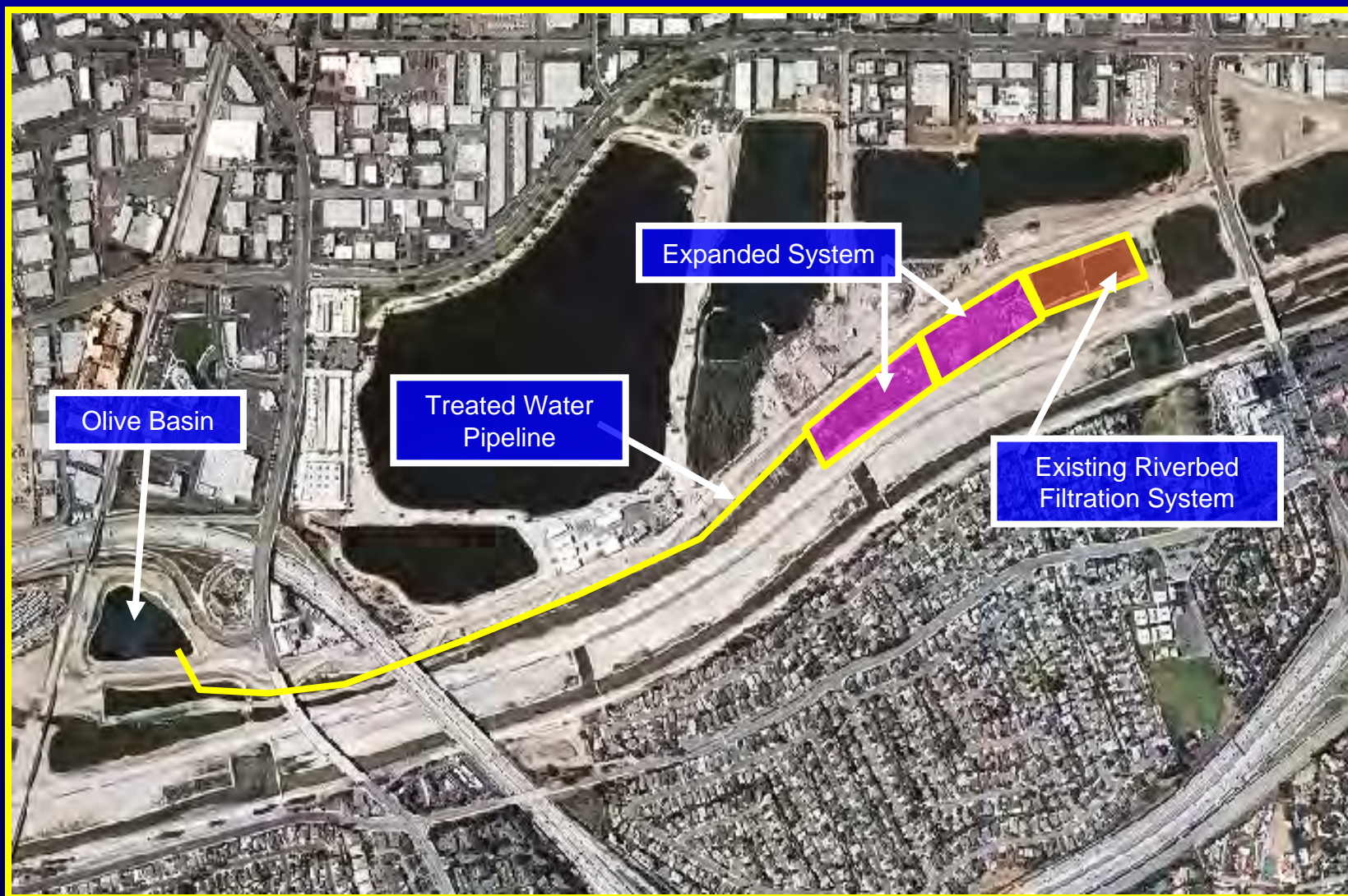
MFI = Modified Fouling Index

MFI Test
Round 4 Testing
3/4/09





The pilot system will be expanded to supply a small recharge basin.



The ultimate project would be constructed in the SAR channel.

Think Big or Go Home!

- 5 miles of river channel
- >200 acres of channel bottom
- Mostly self-cleaning
- No silt disposal issues
- Gravity flow?



End of Presentation
