



# In Tank Treatment

## New Approach to Arsenic Removal From Groundwater

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# Background

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## **Conventional /Baseline Arsenic Removal Technologies**

- Coagulation/Filtration
- Adsorption/Fixed Bed Filtration

# Coagulation Filtration

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Application:  $> 0.5$  MGD  
When Flexibility Required



# Adsorption/Fixed Bed Filtration

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Application:

Typically lower flow rates  
than C/F  
Less O & M





# Estimated Arsenic Treatment Costs

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- **NM Costs: at 10 ppb (Bitner, 2001)**
  - **O&M :\$16 - \$21 million per year**
  - **Capital: \$374-\$436 million**
  - **Consumer monthly costs: \$38 - \$42/month in large systems; \$91/month in small systems**

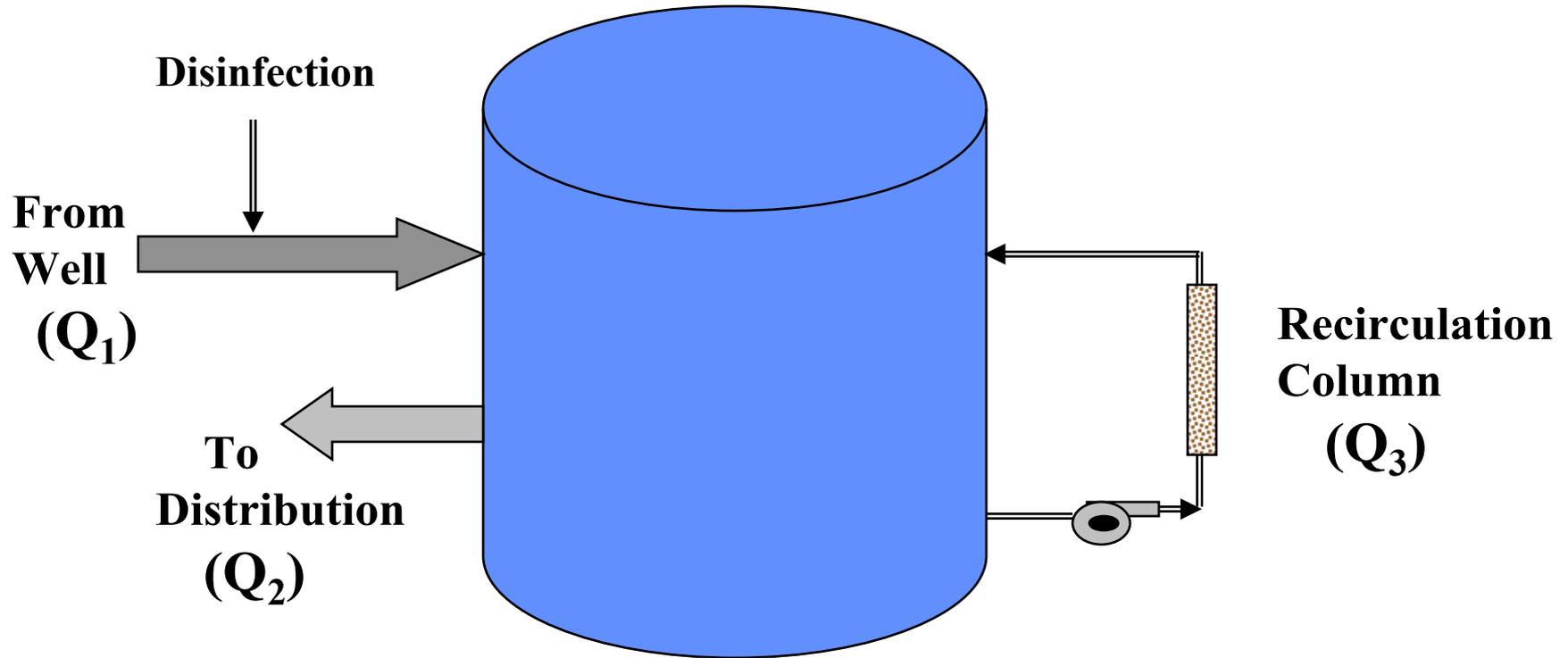


# **In Tank Treatment Concept**

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- 1. Utilize commercially available adsorptive media**
- 2. Circulate storage tank water continuously through Recirculation column (RC)**
  - Water will make multiple passes through RC during low demand periods**
- 3. The velocity of water passing through column is significantly higher than conventional**
- 4. No infrastructure requirements**

# In Tank Concept Schematic



$$Q_1 = Q_2$$

$$\frac{Q_3}{Q_1, Q_2} = 1.5 - 2$$

# What's Different

	Arsenic Removal Technology		
	Conventional Fixed Bed	Coagulation Filtration	In Tank
Media	Commercially Available	Commercially Available	Commercially Available
Treatment	Single Pass through adsorptive bed	Coagulant Addition, precipitant removal	Multiple passes Through adsorptive bed
O & M	Very Low	Med to high	Low
Application	Economical at Lower and Medium flows	Economical at High flowrates (> 0.5 MGD) Difficult water	Very low flows 20,000 gpd
Infrastructure Requirements	Building	Building	Electricity, small pump

# Laboratory Testing

<b>MEDIA</b>	<b>Manufacturer's Suggested</b>		<b>Laboratory Determined</b>	
	<b>Hydraulic Loading Rate (HLR) gpm/ft<sup>2</sup></b>	<b>Empty Bed Contact Time (EBCT), minutes</b>	<b>Hydraulic Loading Rates Tested (HLR) gpm/ft<sup>2</sup></b>	<b>Empty Bed Contact Time (EBCT), minutes</b>
<b>Adedge GFO, AD 33</b>	<b>6</b>	<b>3 - 5</b>	<b>12, 16, 20, 24, 28</b>	<b>1:15, 0:56, 0:45, 0:37, 0:32</b>
<b>Kemiron GFO, CFH 10</b>	<b>6</b>	<b>3 - 5</b>	<b>12, 16, 20</b>	<b>1:15, 0:56, 0:45,</b>
<b>Engelhard GFO, ARM 200</b>	<b>6</b>	<b>3 - 5</b>	<b>12, 16, 20</b>	<b>1:15, 0:56, 0:45,</b>
<b>Resin Tech, ASM 10 HP</b>	<b>6-8</b>	<b>2 - 3</b>	<b>12, 16, 20, 24, 28</b>	<b>1:15, 0:56, 0:45, 0:37, 0:32</b>
<b>Purolite, Arsenex</b>	<b>6 - 8</b>	<b>2 - 3</b>	<b>12, 16, 20, 24, 28</b>	<b>1:15, 0:56, 0:45, 0:37, 0:32</b>
<b>Hydroglobe, Metsorb</b>	<b>8</b>	<b>2 -3</b>	<b>12, 16</b>	<b>1:15, 0:56</b>





# Laboratory Conclusions

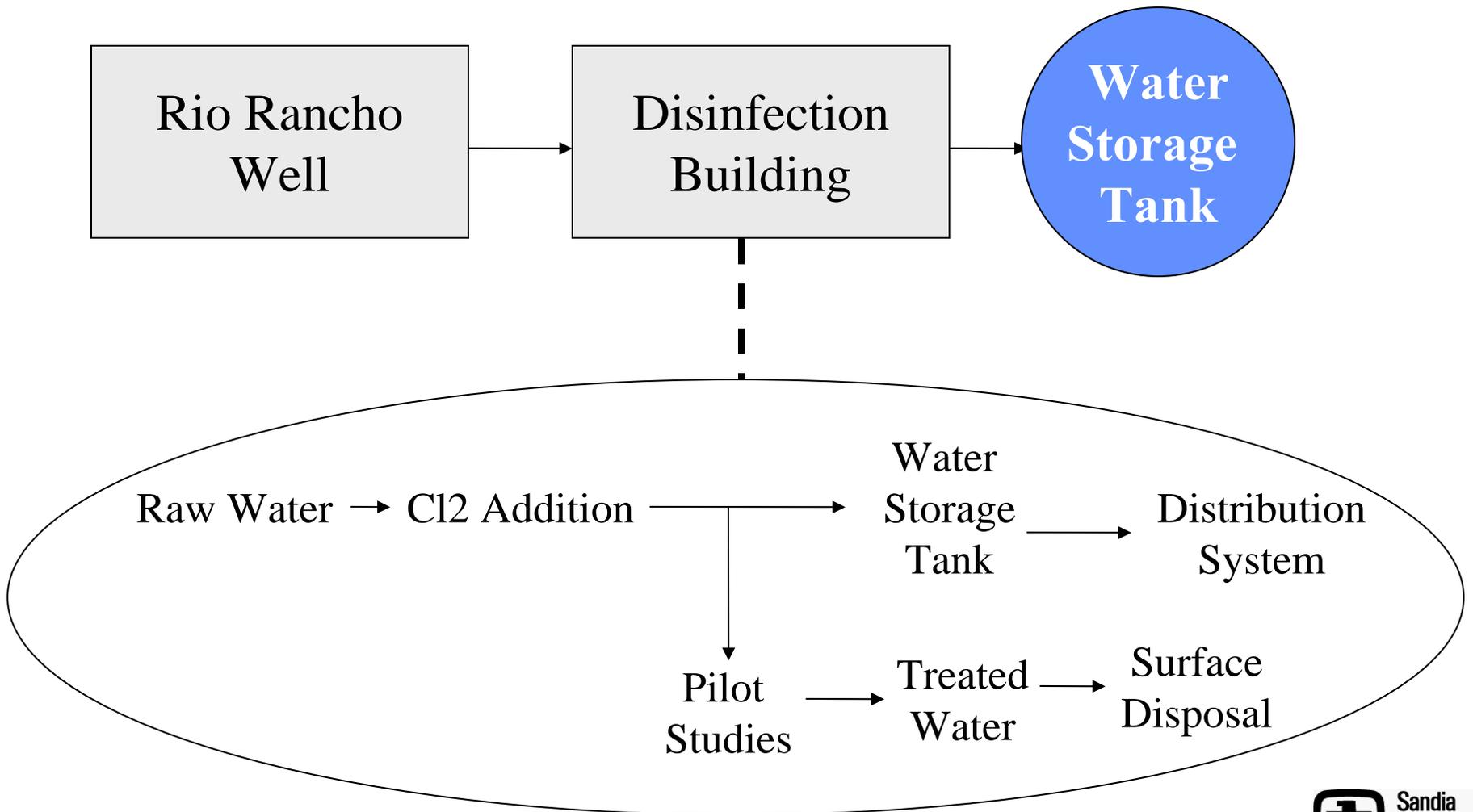
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**All media removed Arsenic initially**

**Hydraulic Characteristics Critical  
Ion Exchange media superior**

**Chose to Pilot test Arsenex (Purolite) media  
superior performance, flow characteristics  
competitive cost  
ease of handling**

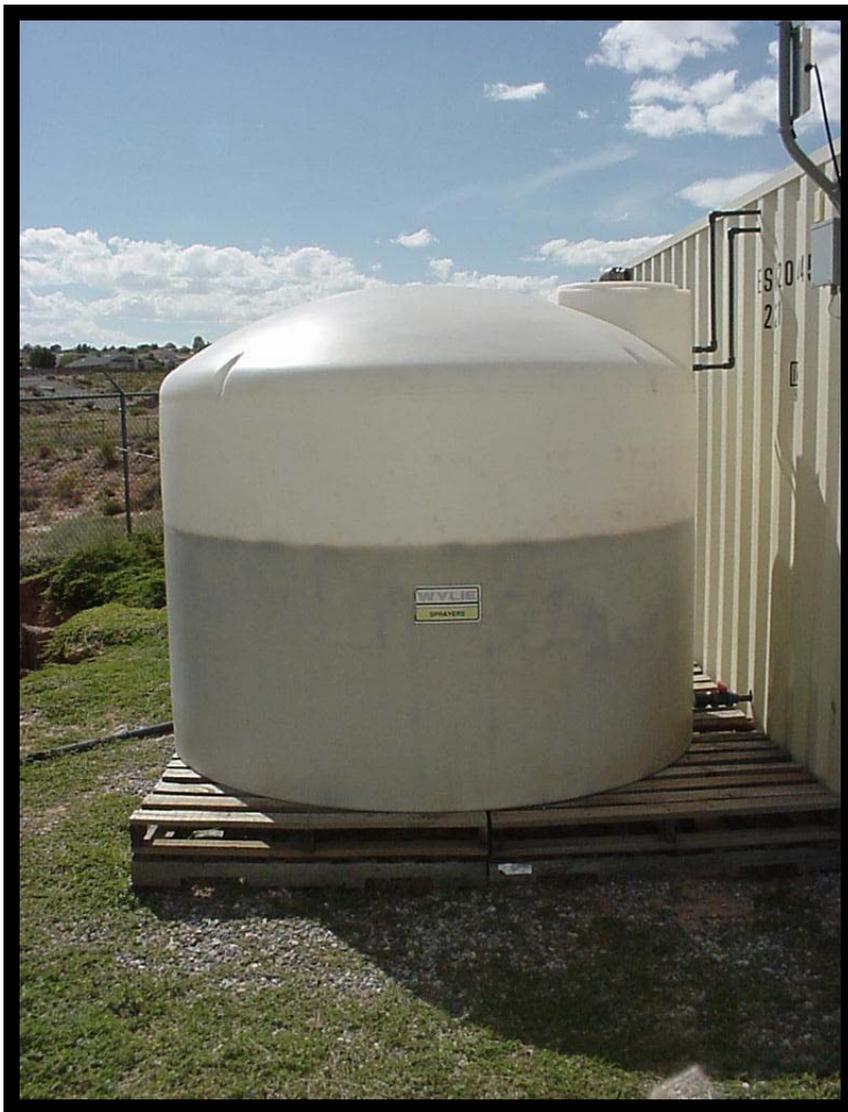
# Pilot Testing



# Pilot Testing



# Pilot Testing



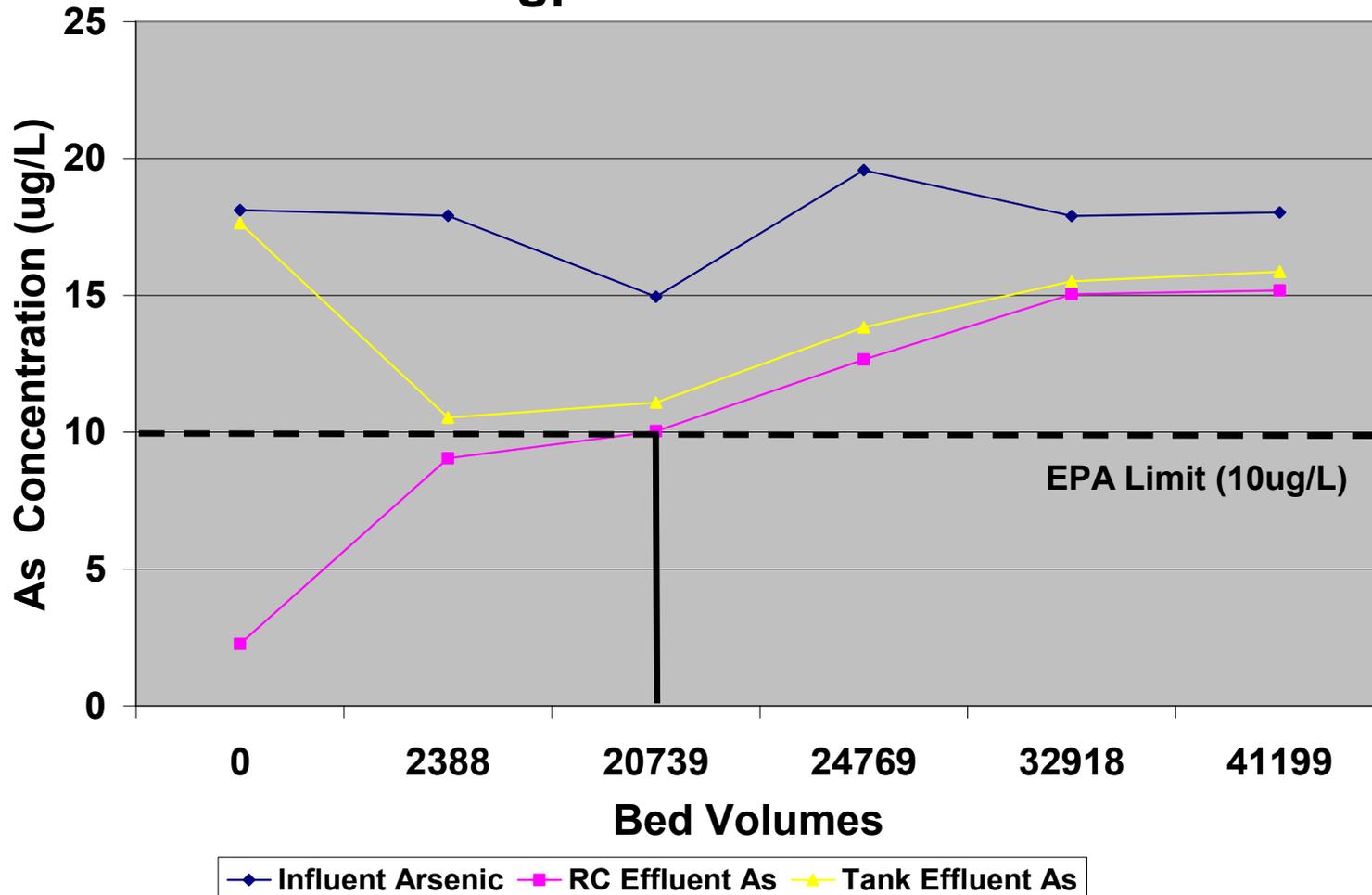
# Pilot Testing



# Pilot Results – Run #1

## Solmetx

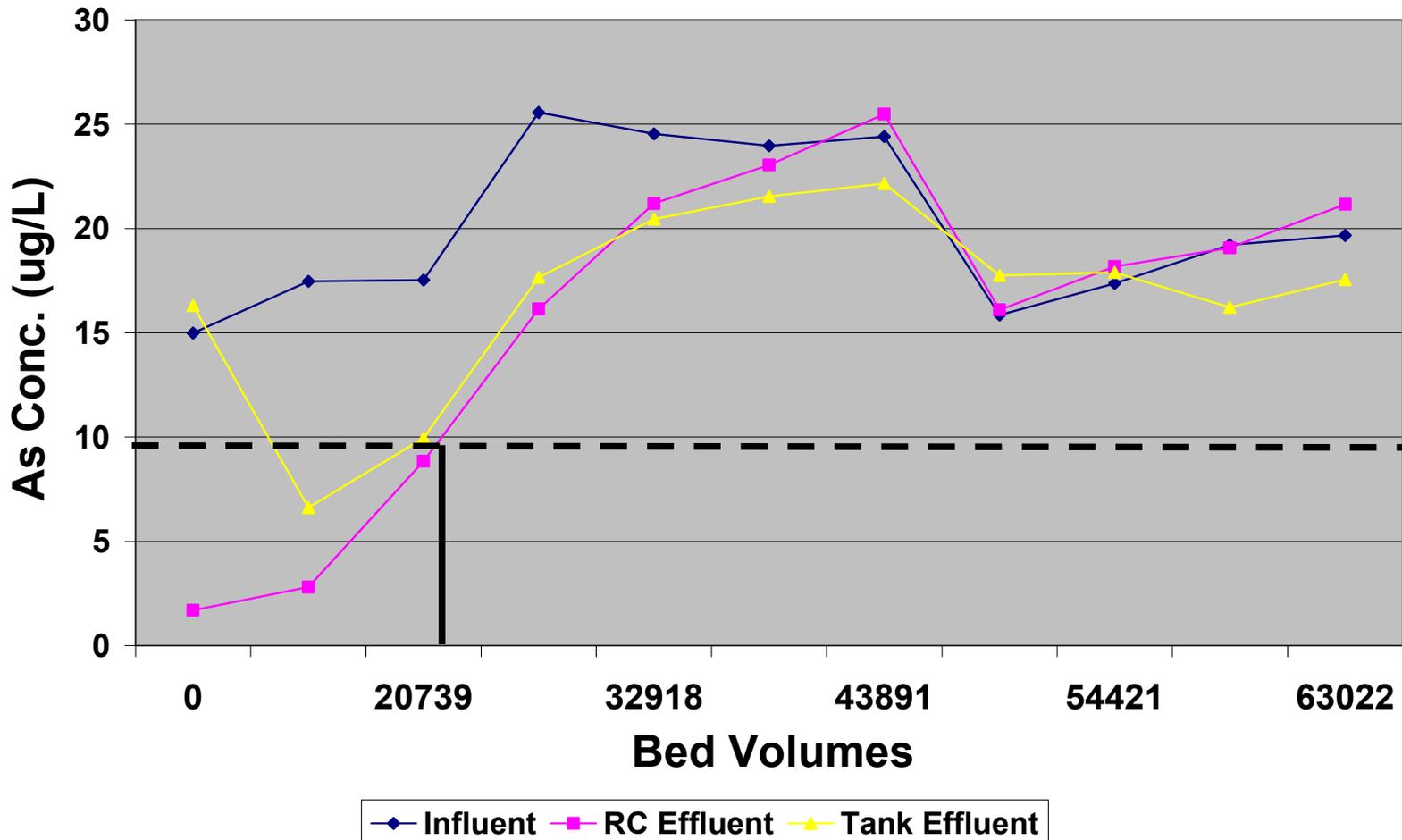
HLR=27 gpm/ft<sup>2</sup> EBCT = 29 sec.



# Pilot Results – Run #2

## Solmetx

HLR = 30 gpm/ft<sup>2</sup> EBCT = 26 sec.

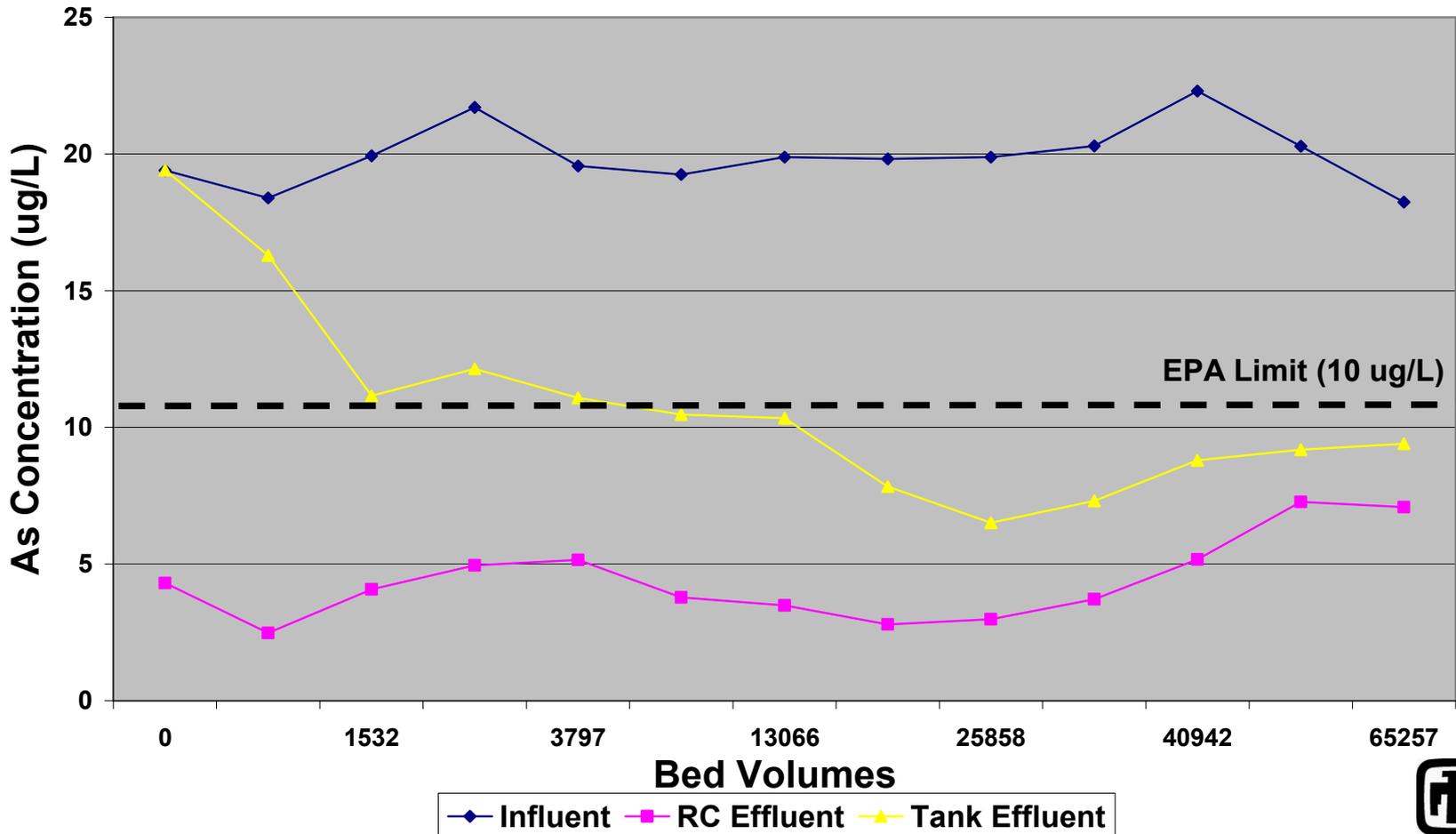


# Pilot Results – Run #3

## Arsenex

HLR = 16.5 gpm/ft<sup>2</sup>

EBCT = 47 sec.





# Pilot Summary

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	Pilot Test Number		
	1	2	3
<b>Media</b>	<b>Solmetx</b>	<b>Solmetx</b>	<b>Arsenex</b>
<b>HLR (gpm/ft<sup>2</sup>)</b>	<b>27.1</b>	<b>29.9</b>	<b>16.5</b>
<b>EBCT (seconds)</b>	<b>29</b>	<b>26</b>	<b>47</b>
<b>BV Water Treated (<math>\leq 10\mu\text{g/L}</math>)</b>	<b>21,000</b>	<b>22,000</b>	<b>&gt; 65,000</b>



# Casa Angelica Deployment

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## In Tank Treatment at an actual site

- **NMED approved treatment operation**
- **Interim Arsenic removal option**
- **Direct Tank connection**
- **Average Daily Water Usage = 10,000 gpd**
- **Treatment Column**
  - HLR = 16.5 gpm/ft<sup>2</sup>**
  - EBCT = 1 min.**

## RESULTS

- **As ↓ from 18 to 13 ppb**



# In Tank Arsenic Treatment Summary

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## LIMITATIONS:

1. Must be direct connection
2. As  $\leq 20$  ppb
3. Daily water use  $\leq 15,000$  gal.
4. As V
5. Chlorine  $\leq 1$  mg/l

# COSTS

	<b>Treatment Technology</b>				
	<b>IX</b>	<b>AA</b>	<b>C/MF</b>	<b>GIM</b>	<b>In tank adsorber</b>
<b>Cost Component</b>	<b>Cost Estimate</b>				
<b>Capital</b>	<sup>a</sup> \$2,144,000	<sup>b</sup> \$2,202,600	<sup>c</sup> \$1,945,300	<sup>d</sup> \$159,020	<sup>e</sup> \$8407
<b>O&amp;M</b>	<sup>a</sup> \$149,875/yr.	<sup>b</sup> \$130,175/yr.	<sup>c</sup> \$122,492/yr.	<sup>d</sup> \$9026/yr.	<sup>e</sup> \$4361/yr.
<b>Life Cycle (period in years)</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>20</b>	<b>3</b>
<b>Equivalent Uniform Annual Cost (EUAC) *</b>	<b>\$306,889</b>	<b>\$292,163</b>	<b>\$265,471</b>	<b>\$20,714</b>	<b>\$7,390</b>

<sup>a</sup>AWWARF Cost curves (Frey, et al. 2000), <sup>b</sup>AWWARF Cost curves (Frey, et al. 2000), <sup>c</sup>AWWARF Cost curves (Frey, et al. 2000), <sup>d</sup>Developed from vendor price estimates, <sup>e</sup>Developed from vendor price estimates using Sandia National Laboratories In-tank column design, \* interest rate = 4%.



# Pilot Conclusions

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**In Tank Treatment Concept is feasible**

**Small communities (< 100 people)**

**Direct Tank (no distribution of water  
upstream of Storage Tank)**

**Two operators required for recirculating  
column change out (140 lbs.)**

**Power at site**