Optimized Treatment of 1,4-Dioxane in Extracted Groundwater and Reinjection for Aquifer Replenishment

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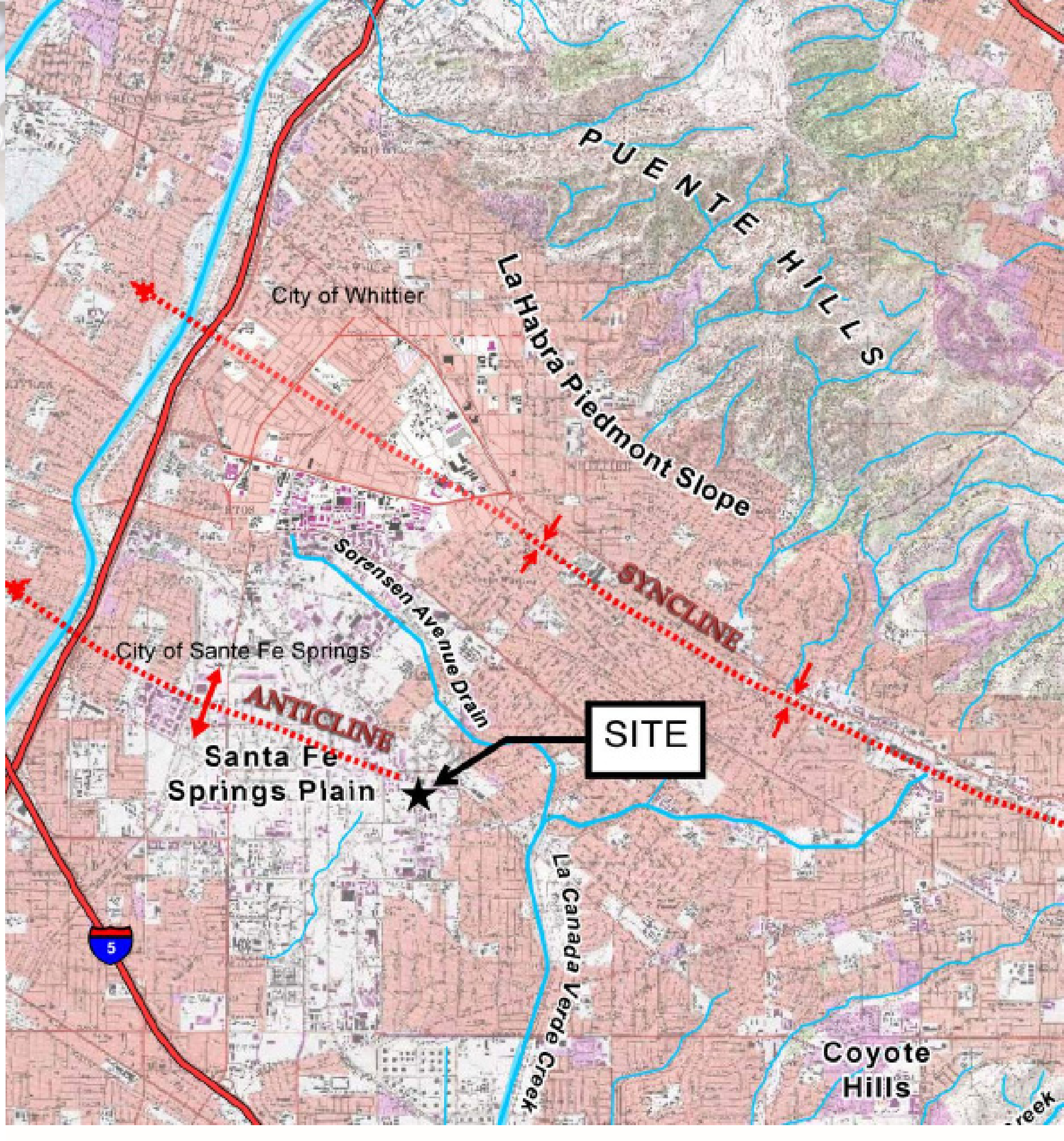
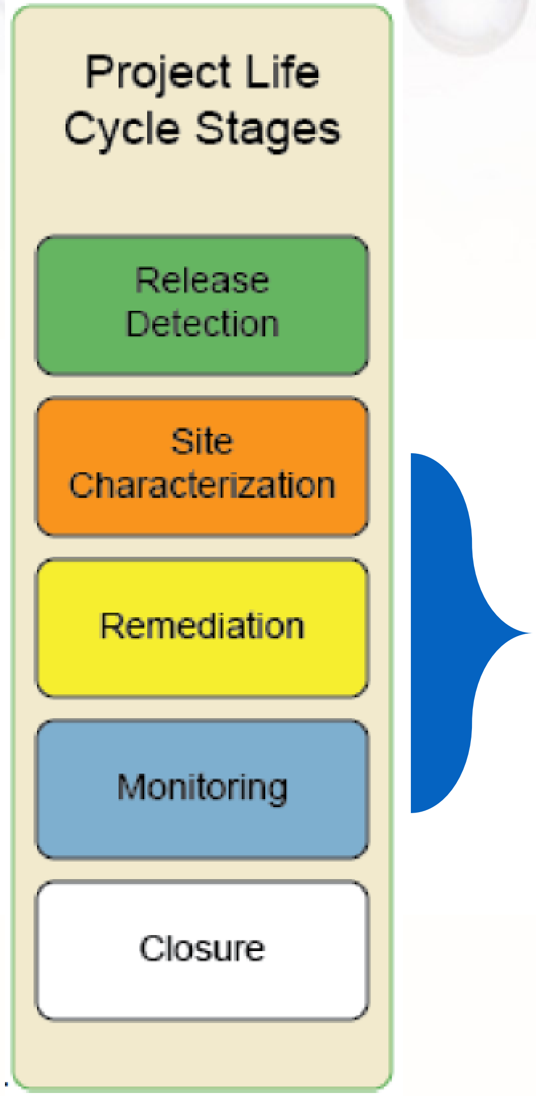
President

Project location



Groundwater remediation lifecycle



Current Status

Remediation timeline

1988: *Initiate Groundwater Extraction* and Treatment with Thermal Oxidation/Carbon Adsorption

1996: Initiate Soil Vapor Extraction and Air Sparging

2001: Regulatory NFA for Soil Vapor Extraction/Air Sparging

2003: *Convert Groundwater Treatment System to Bioreactor/Air Stripper/sand filter/Carbon Adsorption*

2004: Regulatory NFA for Soil Impacts

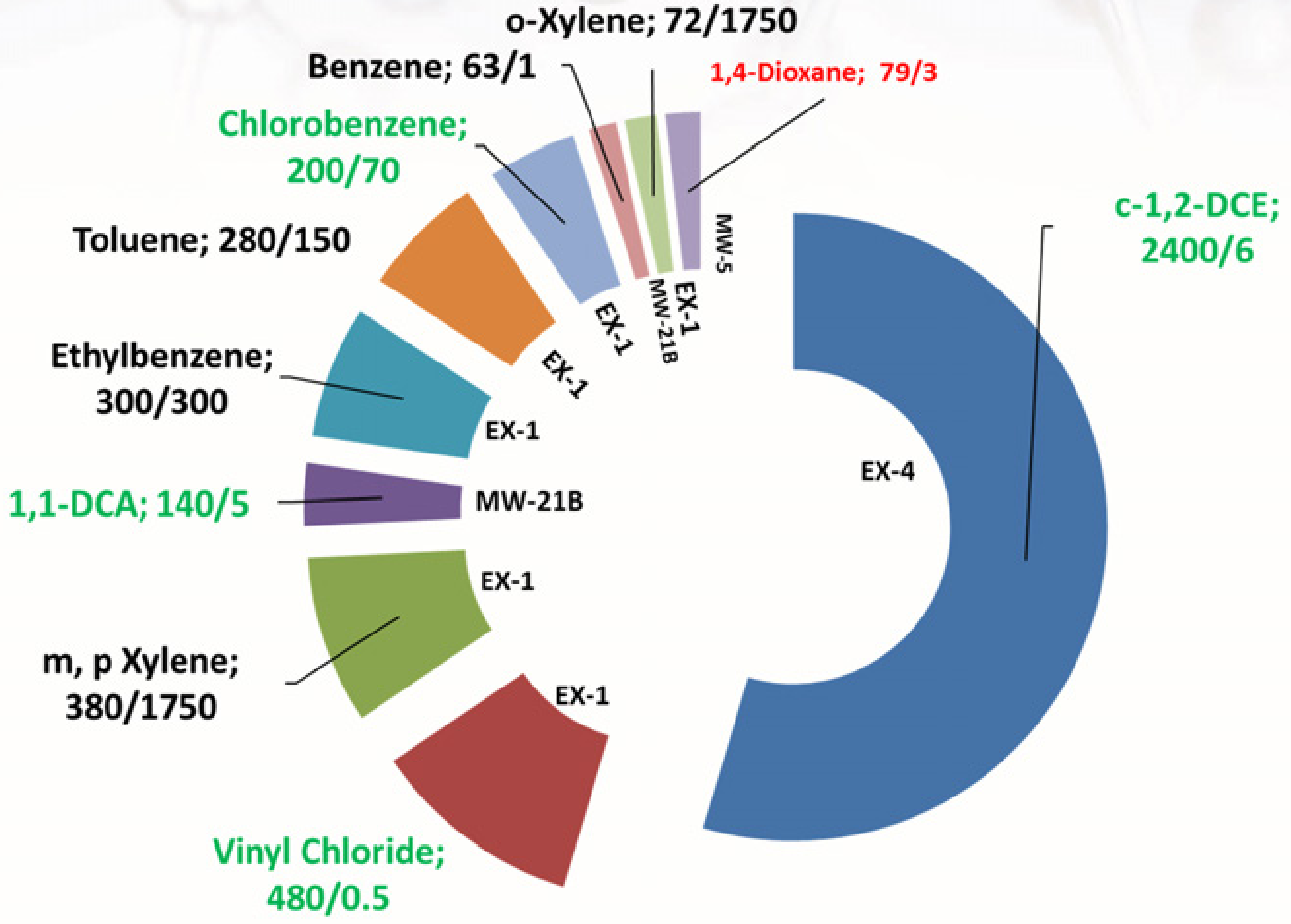
2008: *Convert Groundwater Treatment System to Advanced Oxidation Process (HiPOx®)/Carbon Adsorption*

2011: Regulatory NFA for Soil Vapor Intrusion

2015: WDR permit issued for full-scale *reinjection of treated groundwater*

2016: *Convert Groundwater Treatment to Synthetic Media System using AMBERSORB™ 560*

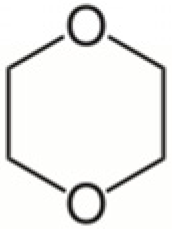
What's being treated in groundwater?



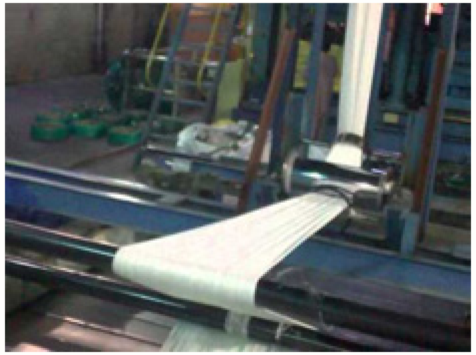
max concentration / discharge limit in µg/L

Treatment complex

1,4-dioxane

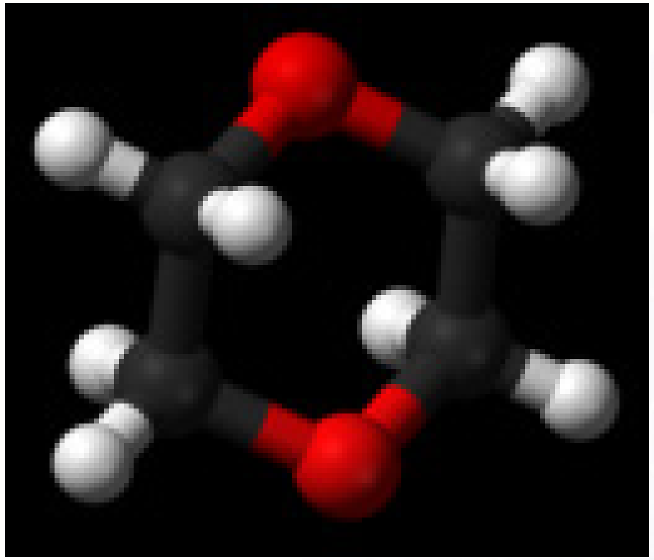


- Stabilizer for chlorinated solvents, e.g. 1,1,1-TCA
- Wetting agent for polyester and paper processing
- Residue in cosmetics, shampoos, automotive coolants, fumigants



Quick refresher:
Why is 1,4-dioxane such a challenge to treat?

- Miscible in water
- Low volatility, low sorption
- Difficult to measure
- Difficult to remediate (recalcitrant)
- Travels rapidly in subsurface; plume often extends beyond extraction wells
- **Once discovered, often the driver for cleanup**



Installed bioreactor/air stripper/GAC in 2003

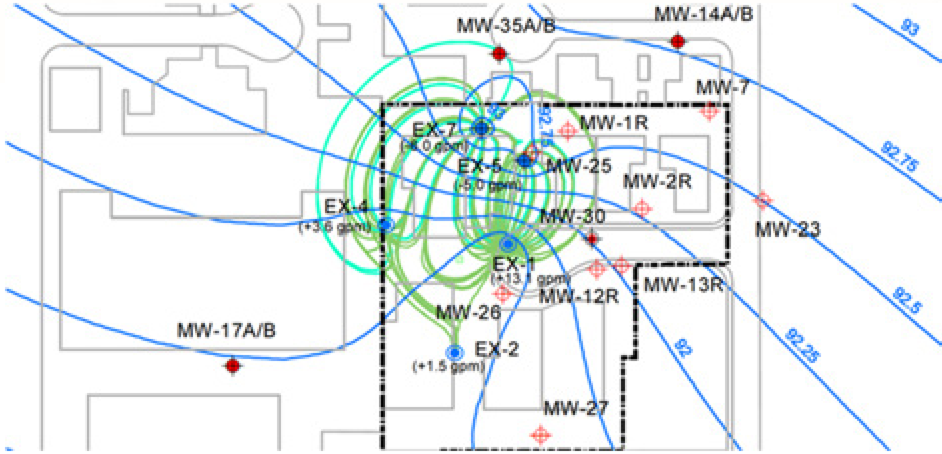
Converted to HiPOx in 2008

Outside view of HiPOx system

Inside view

Reinjection goals (year 2015)

- Maintain higher sustainable extraction rates during drought conditions (extraction yield dropped to < 5 gpm)
- Increase contaminant mass removal by enhanced soil flushing.
- Reduce contaminant mass/concentrations around the extraction well locations.
- Bypass NPDES monitoring for storm drain discharge



Challenges with AOP system

- Desorption of 1,4-dioxane from GAC polish vessels
- Drought conditions had caused reduced flowrate: 50 → 7 gpm
- High O&M costs – eventually became prohibitive
- Needed a new oxygen/ozone generator
- Wanted to get away from chemical use

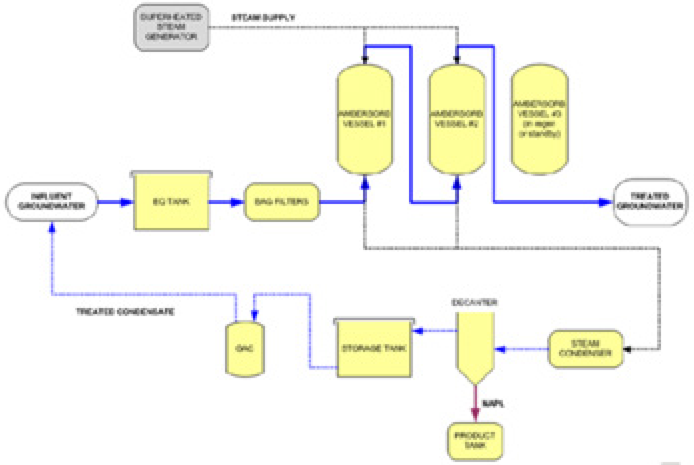
Project objectives

- Perform lifecycle cost analysis of HiPOx upgrade/replacement options:
  - Upgrade existing HiPOx system
  - Replace with UV/Ox
  - Replace with Ambersorb
- Select best alternative
- Install/startup/operate for 8 to 12 more years

Synthetic media treatment system upgrade

AMBERSORB™ 560 (Ambersorb) adsorption system

- Carbonaceous resin with exceptional sorptive properties
- Removes 1,4-dioxane consistently to < 0.3 ppb
- Simple, low-maintenance system
  - Two media vessels in series (lead-lag operation)
  - Lead vessel periodically regenerated with steam
- No vapor discharge (eliminate AQMD permit)
- No carbon polish (eliminates desorption issue of 1,4-dioxane)

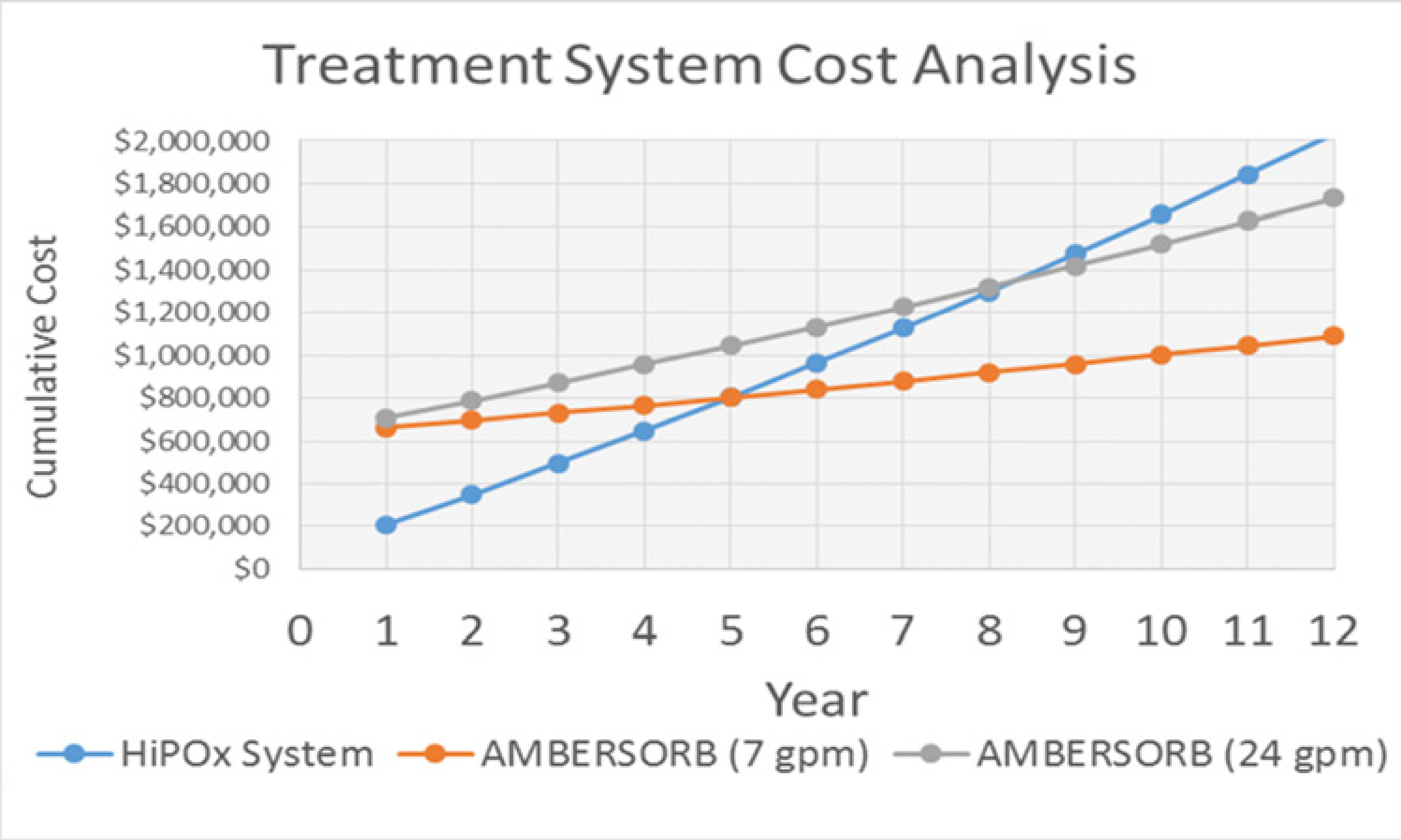


Ambersorb system design basis

Parameter	Design Condition	Effluent Limits
Average Flow Rate	2-24 gpm	--
Total VOCs	1,364 µg/L	Varies
1,4-dioxane	8.2 µg/L	≤ 3.0 µg/L
BTEX	642 µg/L	Varies
Influent Water Temp.	68-70˚F	≤ 100˚F
Regeneration Frequency	@ 7 gpm: Every 45 Days	--
	@ 24 gpm: Every 9 Days	--

Lifecycle cost analysis: Ambersorb vs. HiPOx

- Projected System Operations (~8 to 12 yrs)
- 7 gpm payout at 5 yrs
- 24 gpm payout at 8 yrs



Results and discussion

Ambersorb system first year operations

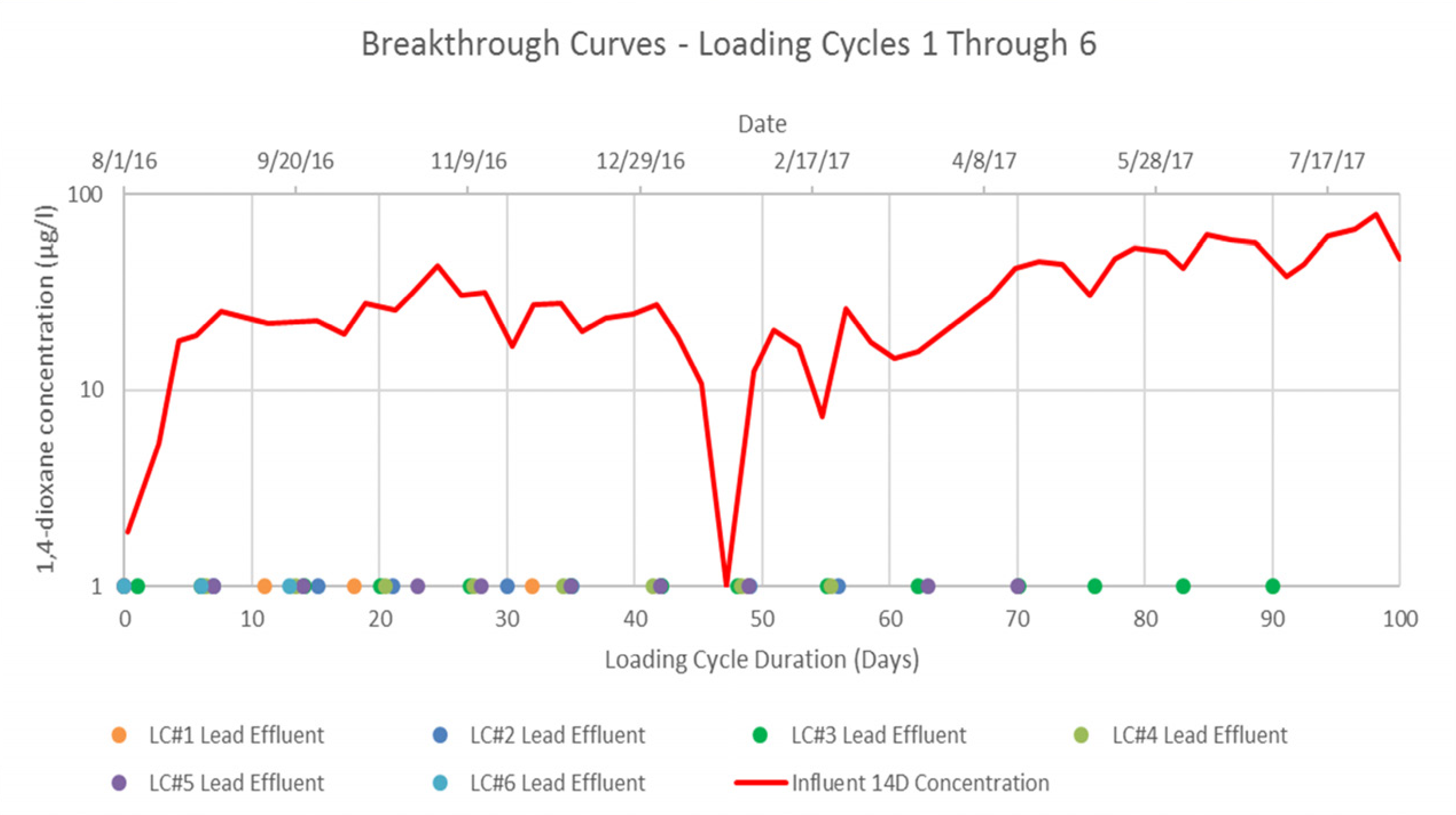
Parameter		Results
Flow	Cumulative	850,000 gallons
	average	4 gpm
1,4-dioxane Conc.	range	<1.0 µg/L to 79 µg/L
	average	31 µg/L
Influent Water Temp.	range	56˚F to 98˚F
	average	77˚F
Regeneration Frequency	range	~45 days to ~90 days
	average	~60 days to ~90 days
Note: All discharge conditions were well within permit limits.		

Ambersorb Treatment System Module

Ambersorb system discharge compliance

February 2018 Summary

Monitoring Parameter	Discharge Limits	Units	Results
Total Dissolved Solids	1,700	mg/L	1,100
Chloride	270	mg/L	150
Sulfate	720	mg/L	330
Boron	1.0	mg/L	0.57
pH	6.5-8.5	SU	7.4
VOCs	Varies	ug/L	Non-Detect (all)
1,4-dioxane	3.0	ug/L	Non-Detect



Breakthrough Curves - Loading Cycles 1 Through 6
Date
8/1/16
9/20/16
11/9/16
12/29/16
2/17/17
4/8/17
5/28/17
7/17/17
100
10
1
1,4-dioxane concentration (µg/l)
0
10
20
30
40
50
60
70
80
90
100
Loading Cycle Duration (Days)
LC#1 Lead Effluent
LC#2 Lead Effluent
LC#3 Lead Effluent
LC#4 Lead Effluent
LC#5 Lead Effluent
LC#6 Lead Effluent
Influent 14D Concentration

Summary of results / lessons learned

- Groundwater extraction/reinjection has been maintained at 2 to 10 gpm with minimal system maintenance.
- Ambersorb regeneration frequency has been low (typically 2 months between regens)
- Treatment has been fully effective (no effluent detections)
- O&M savings as projected
- Reinjection water is not fully captured by extraction wells
  - Response action includes temporary conversion from reinjection (WDR) to storm drain (NPDES)

Questions?

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