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Improving Performance of Abiotic Destruction and Anaerobic Bioremediation at Multiple Sites Through the Use of Passive Flux Meters

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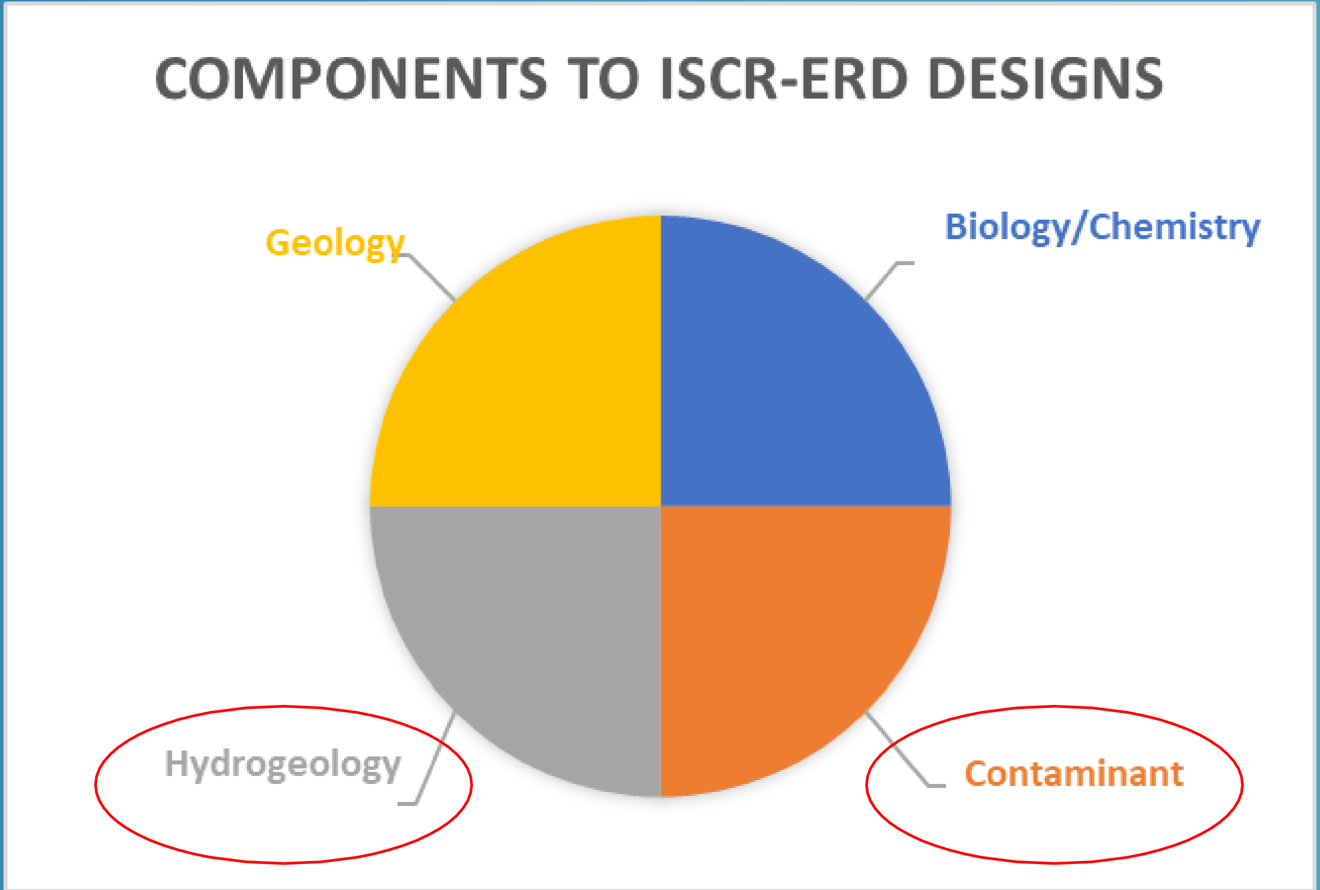
Introduction

- Design Components for ISCR-ERD Designs
- Effect of Groundwater Velocity on Designs
- Two case studies on flux studies lead to key design adjustments

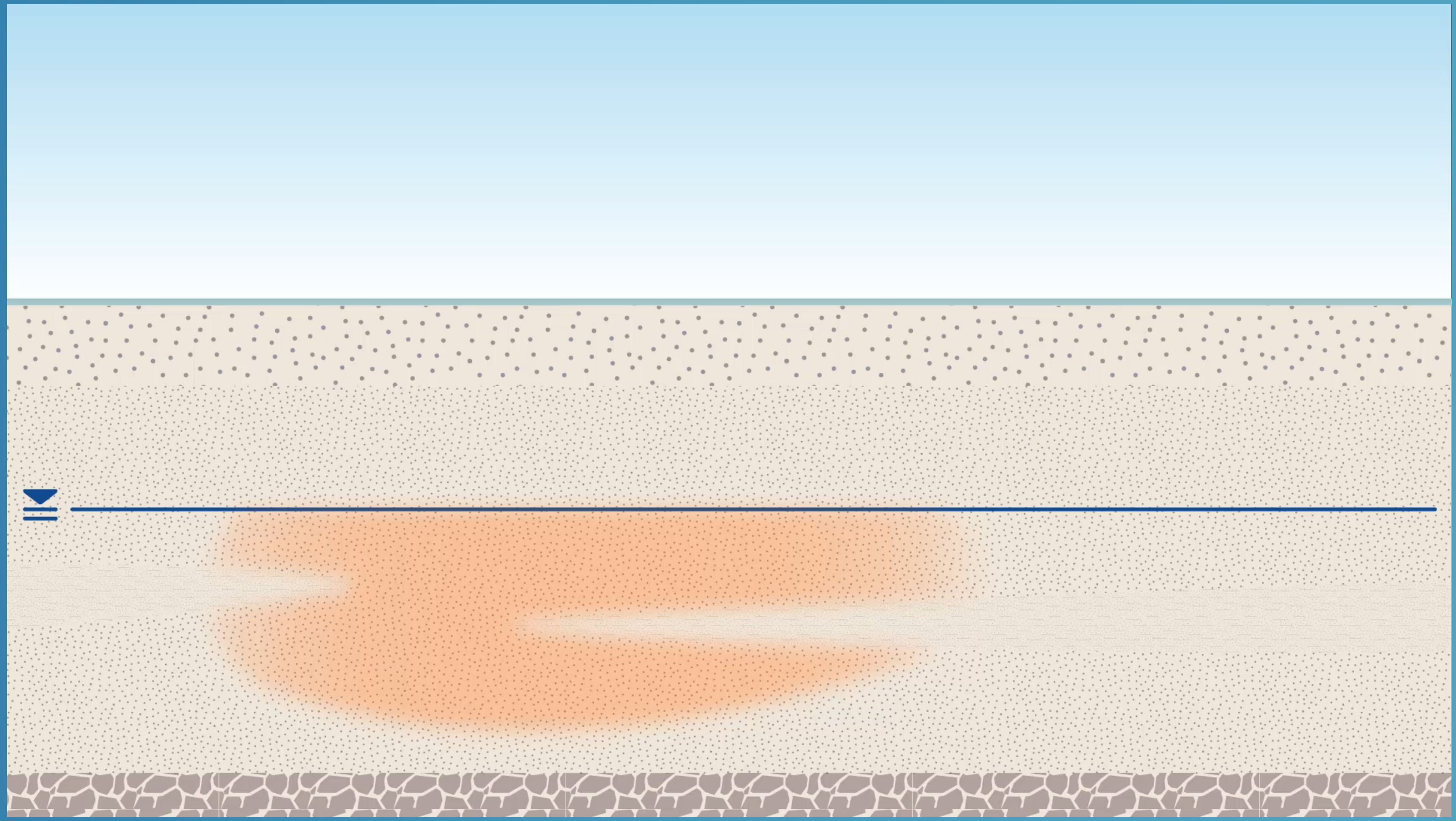
Components to ISCR-ERD Designs

- Essential for permeable reactive barrier designs (PRB)
- Many site remediation plans incorporate a single or multiple barrier design



Groundwater Velocity

- Controls other rates in design process
  - Contaminant mass flux
  - Terminal electron acceptor flux
- Affects product dosing
- Method and accuracy matter!



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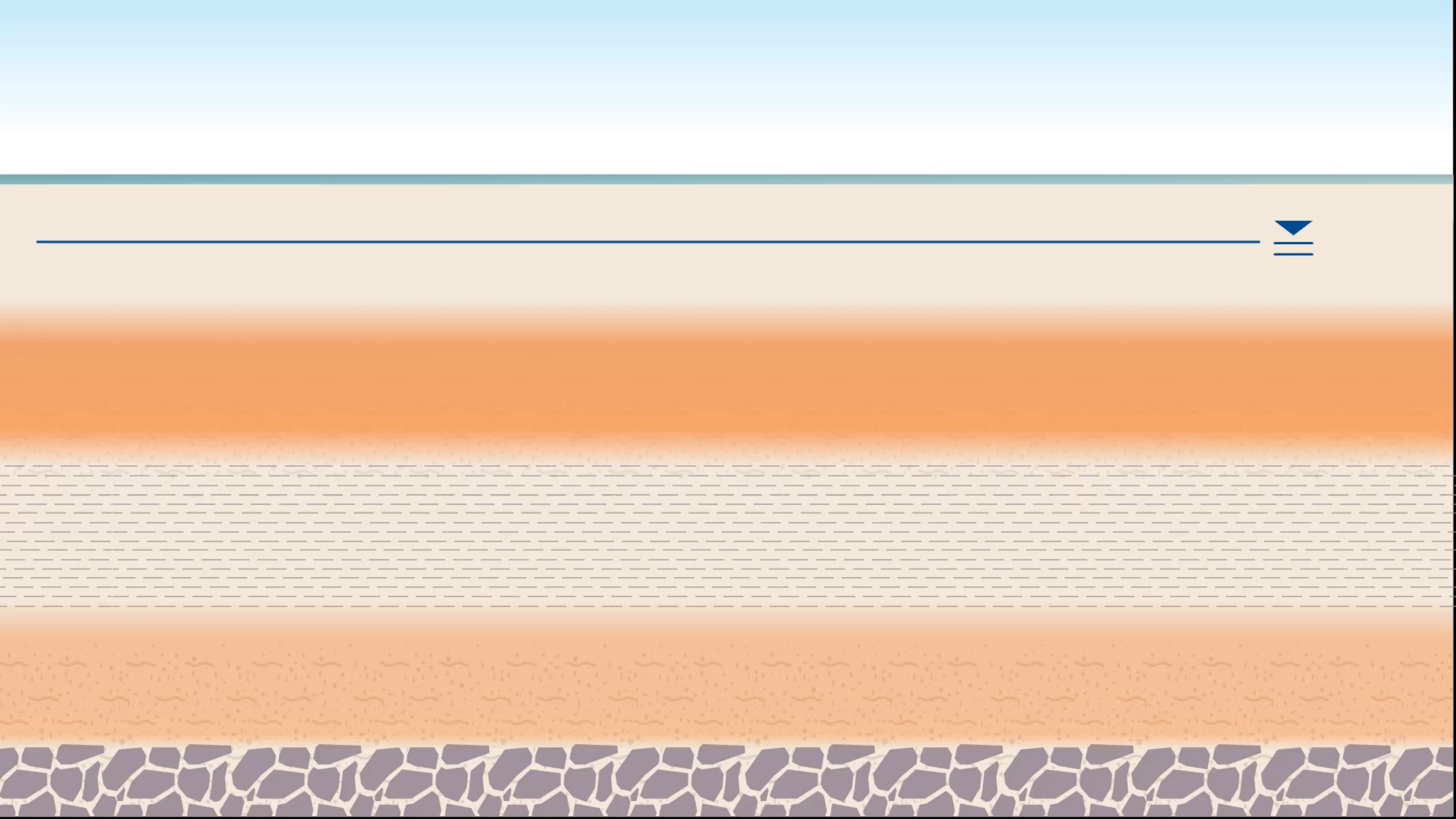
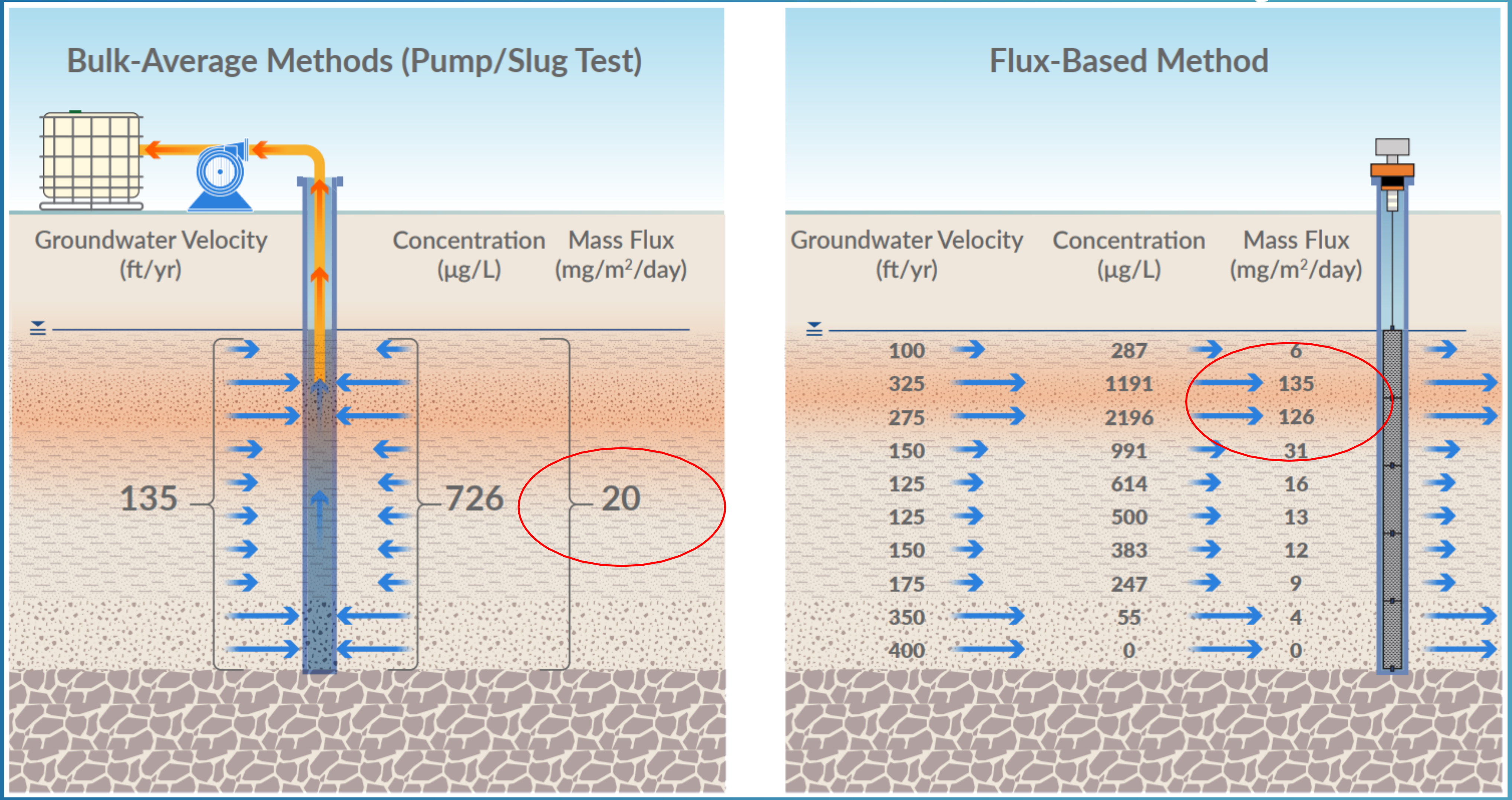


Contaminant Mass Flux & Velocity Profile



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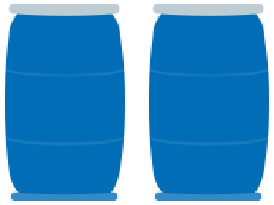
Effects of GW Velocity on Designs

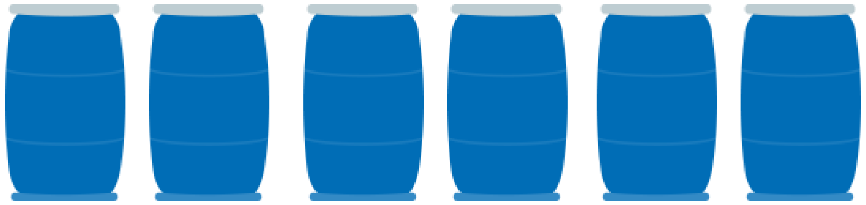
Example 1

- cVOC plume
- 10 ppm PCE
- Aerobic conditions
- Barrier application
- 50 ft/year velocity
- 829 lbs of product needed



Example 2

- cVOC plume
- 10 ppm PCE
- Aerobic conditions
- Barrier application
- 300 ft/year velocity
- 2376 lbs of product needed



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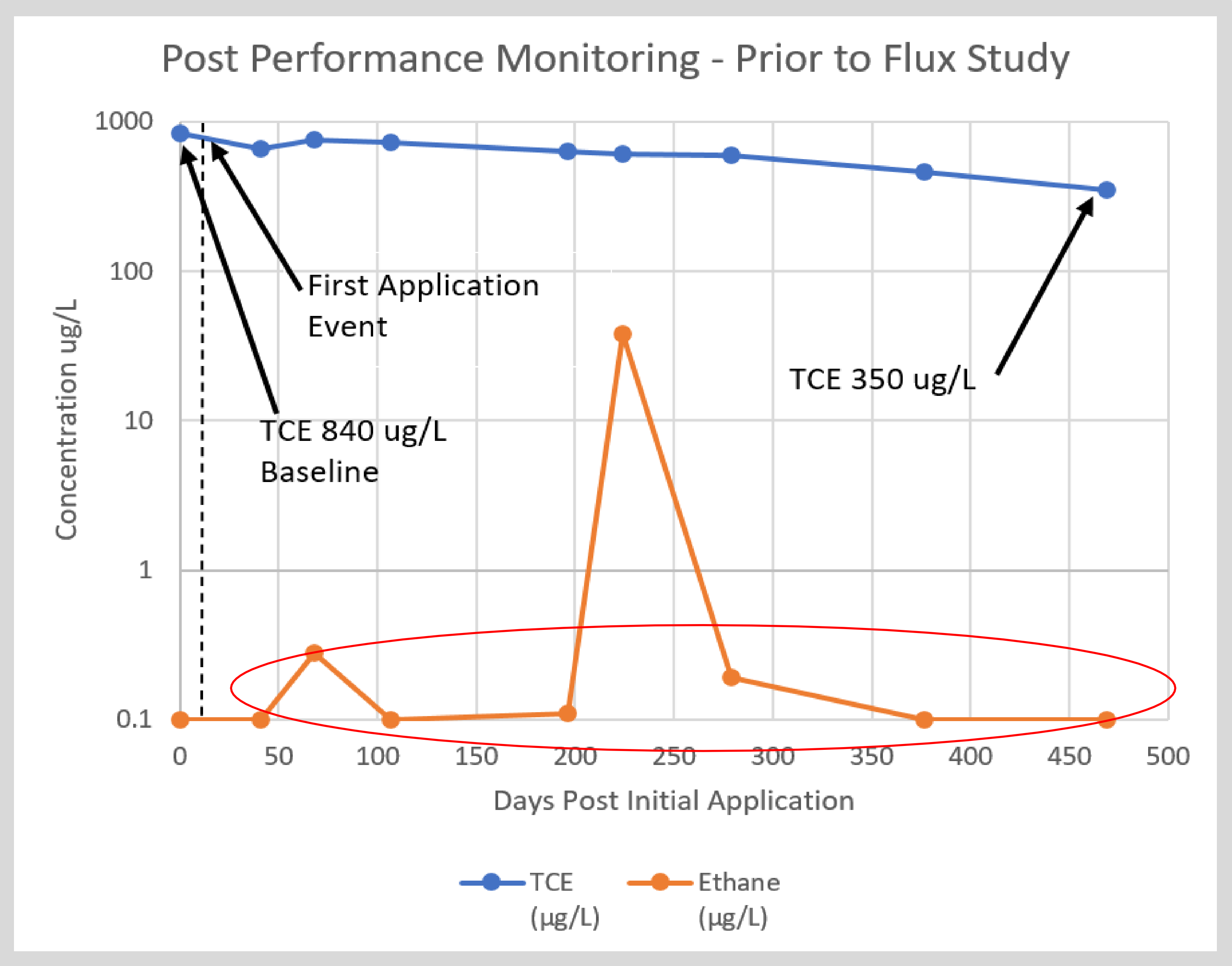
Study Site 1

- ~1 ppm TCE
- Focus on abiotic destruction
- Sulfidated Micron Scale ZVI
- 15-30 ft target zone for application
- DPT application
- Quick turn

Study Site 1

- Detailed monitoring
- Performance evaluation
- How do we improve performance?
- Answer: Flux Study
- $7700



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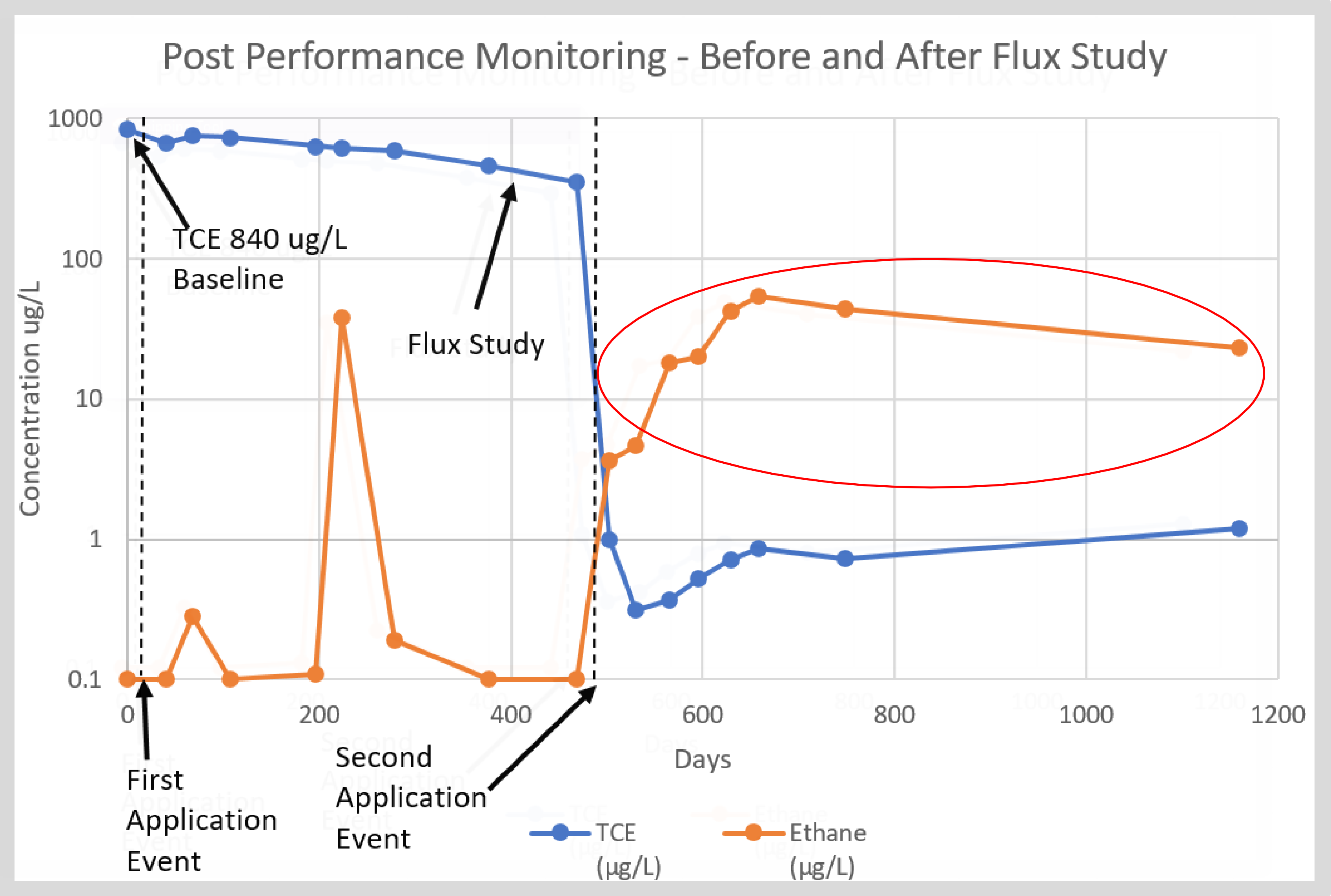
Study Site 1

- 65% of mass in bottom 2 ft
- Adjust product placement
- Treat up to 5 feet below the well

Depth below top of well casing (ft)	Darcy Velocity (cm/day)	TCE (mg/m^2/day)	TCE (ug/L)	Distribution %	Groundwater Velocity ft/yr
19.0	4.5	3.9	86	7.2%	257
21.0	4.1	3.9	93	6.8%	237
23.0	4.8	3.9	81	9.7%	273
25.0	5.4	1.8	32	6.2%	310
27.0	5.5	1.8	33	4.5%	312
29.0	5.9	10.8	182	22.3%	339
31.0	6.3	24.5	391	43.3%	358

Study Site 1

- Reapplication Completed
- Near 100% reduction
- Ethane response
- Sustained performance



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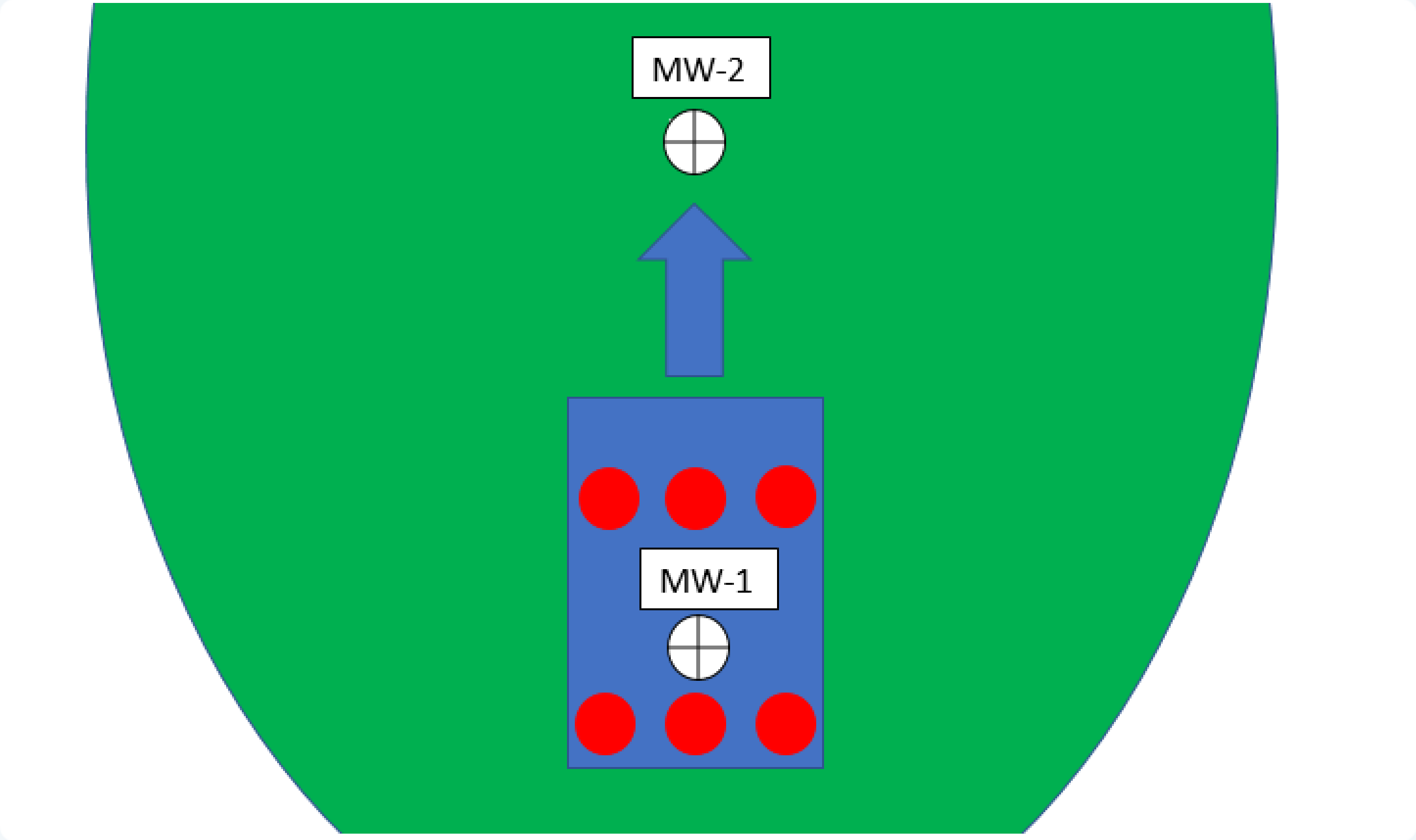
Study Site 2

Generalized Site Map



- 18 ppm of TCE, 1 ppm of Cis 1,2-DCE
- Previously treated with lactate
- 3DME/SMZVI/BDI
- Pilot Test in source area
- Installed flux devices

Study Site 2

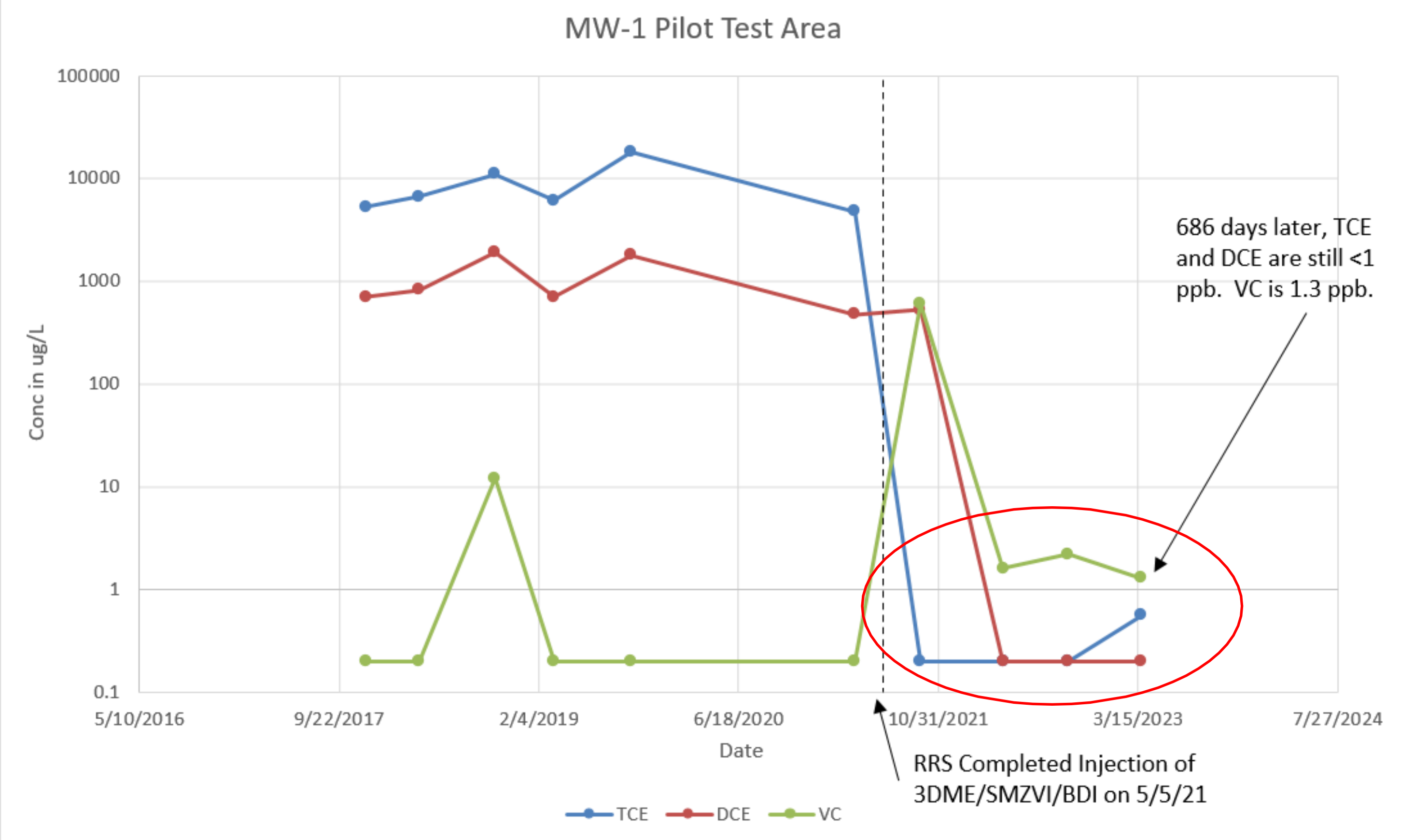
Well ID	Depth (ft)	Darcy Velocity (cm/day)	GW Velocity ft/yr	1,2DCE (ug/L)	TCE (ug/L)	1,2DCE (mg/m^2/day)	TCE (mg/m^2/day)	Total cVOC Flux (mg/m^2/day)	Flux %
MW-1	10.1	3.2	173	50	564	1.57	17.89	19	1.2%
	10.9	3.4	183	121	1319	4.09	44.39	48	3.0%
	11.6	3.9	215	177	1822	6.97	71.97	79	5.0%
	12.5	3.9	214	354	4179	13.90	163.95	178	11.2%
	13.3	4.1	222	413	4916	16.81	200.23	217	13.6%
	14.0	3.5	190	381	5045	13.29	176.25	190	11.9%
	14.8	4.7	257	615	8530	29.04	402.53	432	27.1%
	15.5	3.9	211	412	5483	15.98	212.45	228	14.3%
	16.3	4.5	244	361	4139	16.15	185.15	201	12.6%

- Revisit the design
- Shifted treatment deeper
- Adjust dosing
- No additional cost

Flux Data

Study Site 2

Post Injection Performance Monitoring



- **Rapid performance**
- **Minimal daughter products**
- **2 years and still on-going performance**
- **$45K Turnkey Pilot Test**
- **$11K for Flux Study**

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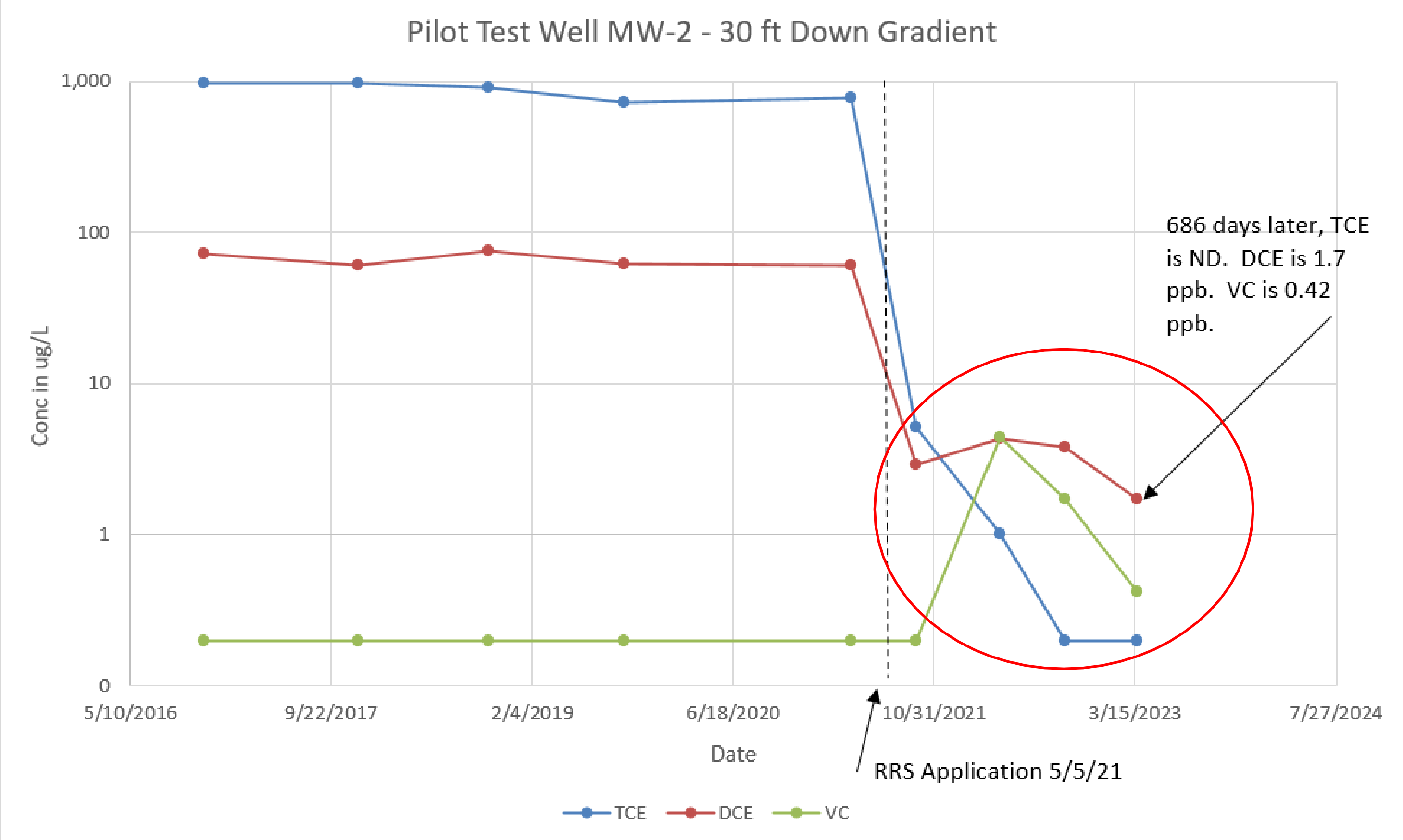
Study Site 2

Post Injection Performance Monitoring



- **Results spread 30 ft down gradient to second monitoring well**
- **Sustained performance**

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Conclusions

- Contaminant mass flux profile is often not characterized, but is essential to success
- The correct groundwater velocity is essential for dosing
- Flux devices provide a great pre or post remediation diagnostic tool
- Flux measurements remove guesswork from designs
- Design adjustments were small yet meaningful
- Look beyond the well screen intervals
- <u>Direct measurement of flux help ensure successful remedial outcomes</u>

Questions?

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