

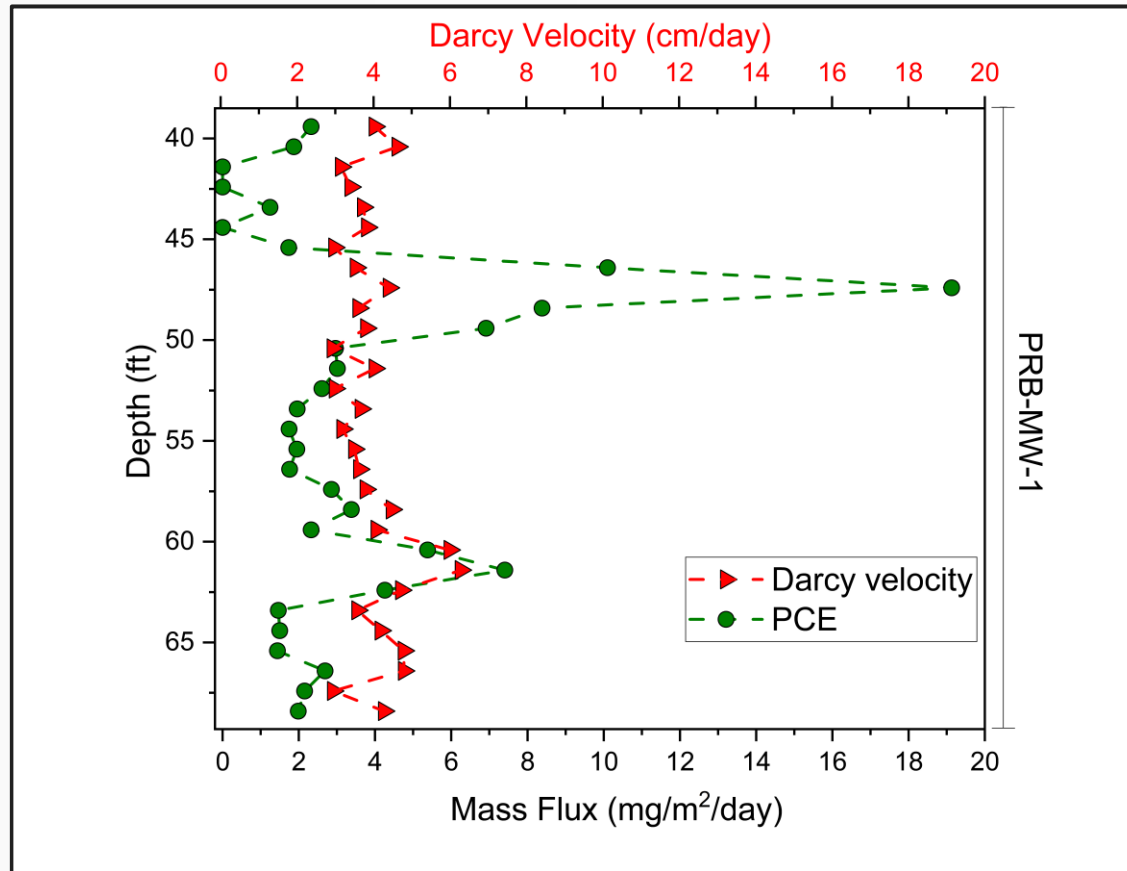
Field Comparison of Contaminant and Water Mass Flux in CVOC- and PFAS-Contaminated Sites to Effectively Build Conceptual Site Models and Design Permeable Reactive Barriers



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October 7, 2026

Presentation Overview



- Flux-based CSM example
- Mass flux measurement
- Two case studies

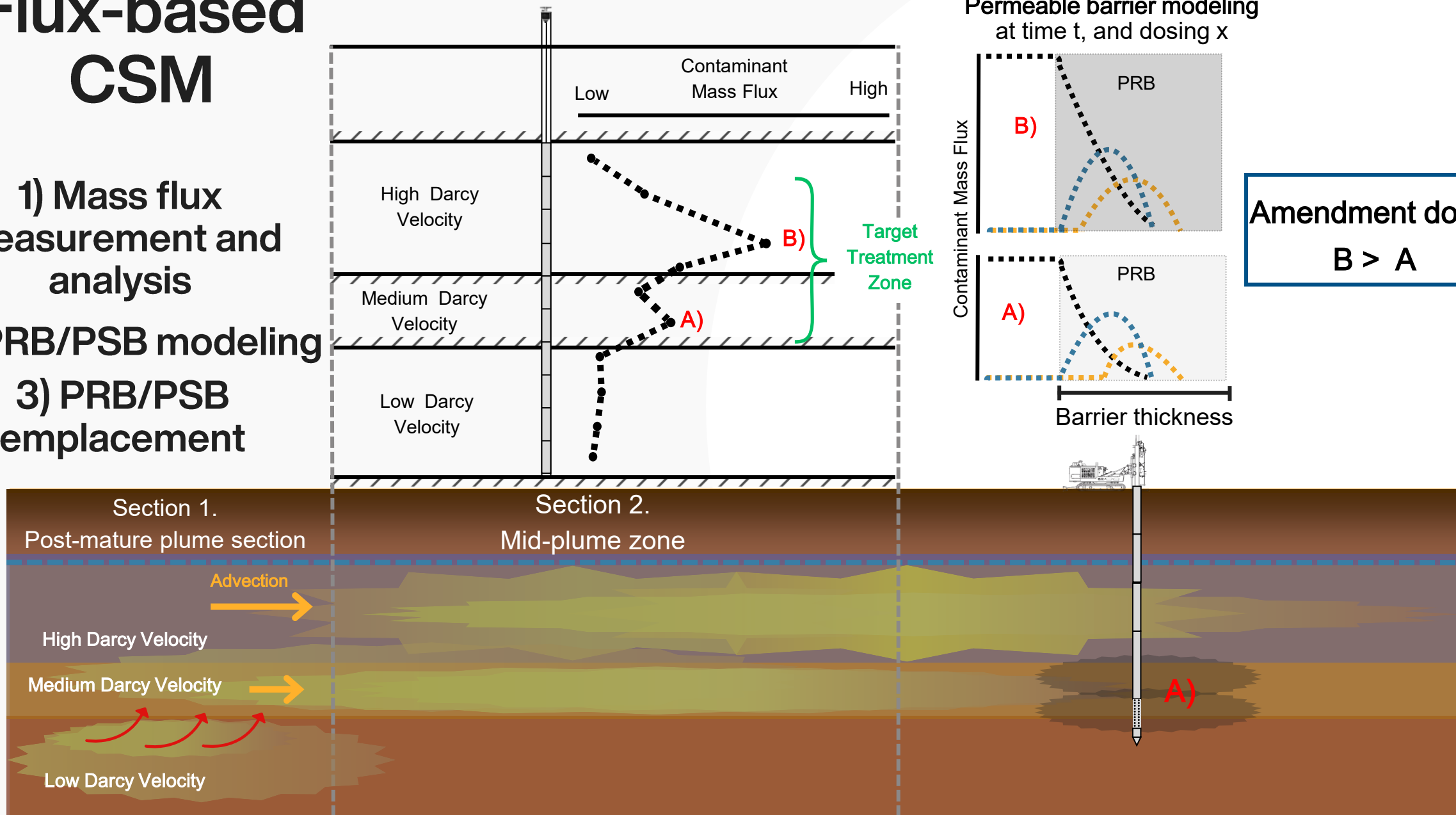
FORMER PCE TANKS
(APPROXIMATE)

Flux-based CSM

1) Mass flux measurement and analysis

2) PRB/PSB modeling

3) PRB/PSB emplacement

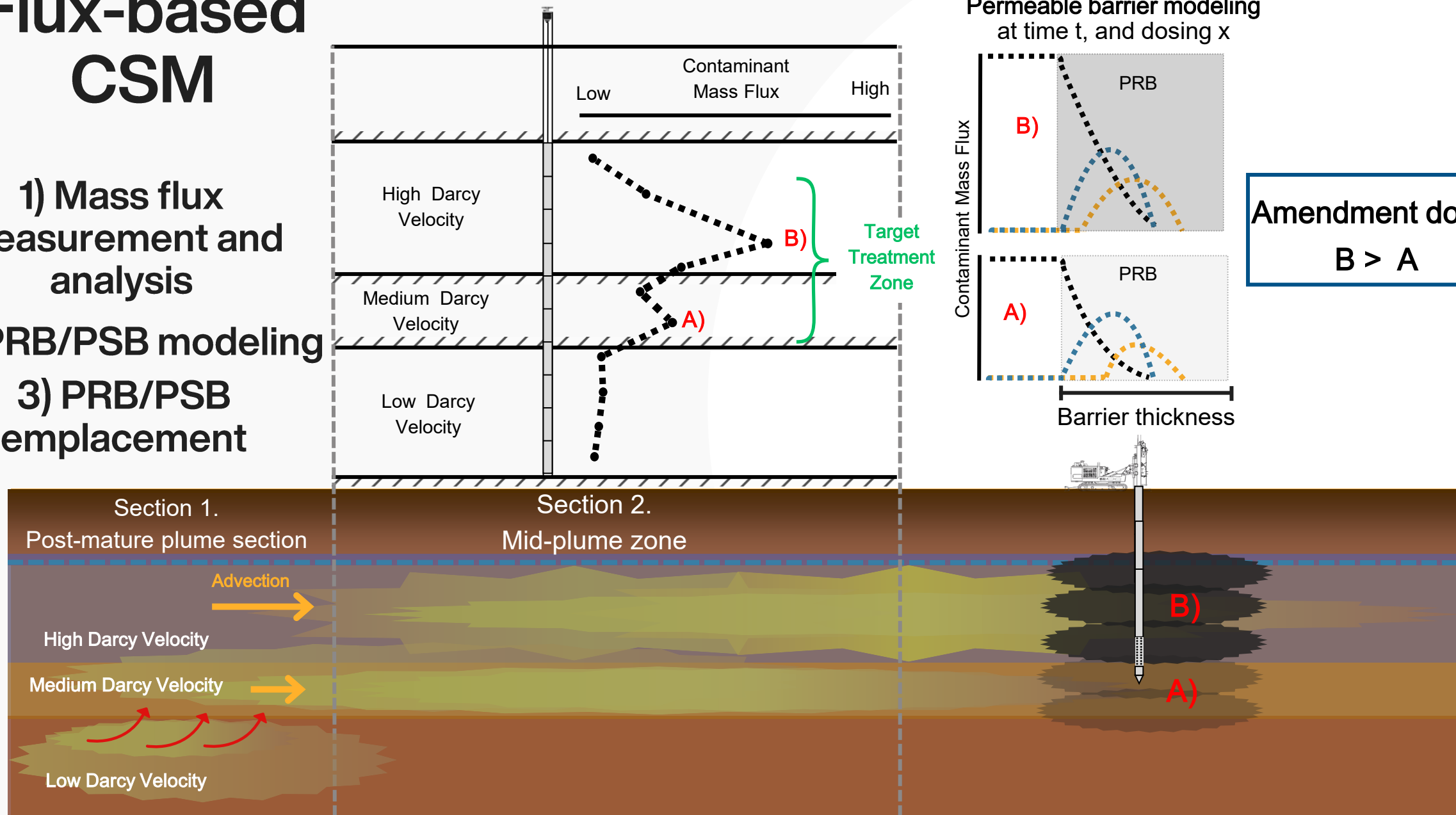


Flux-based CSM

1) Mass flux measurement and analysis

2) PRB/PSB modeling

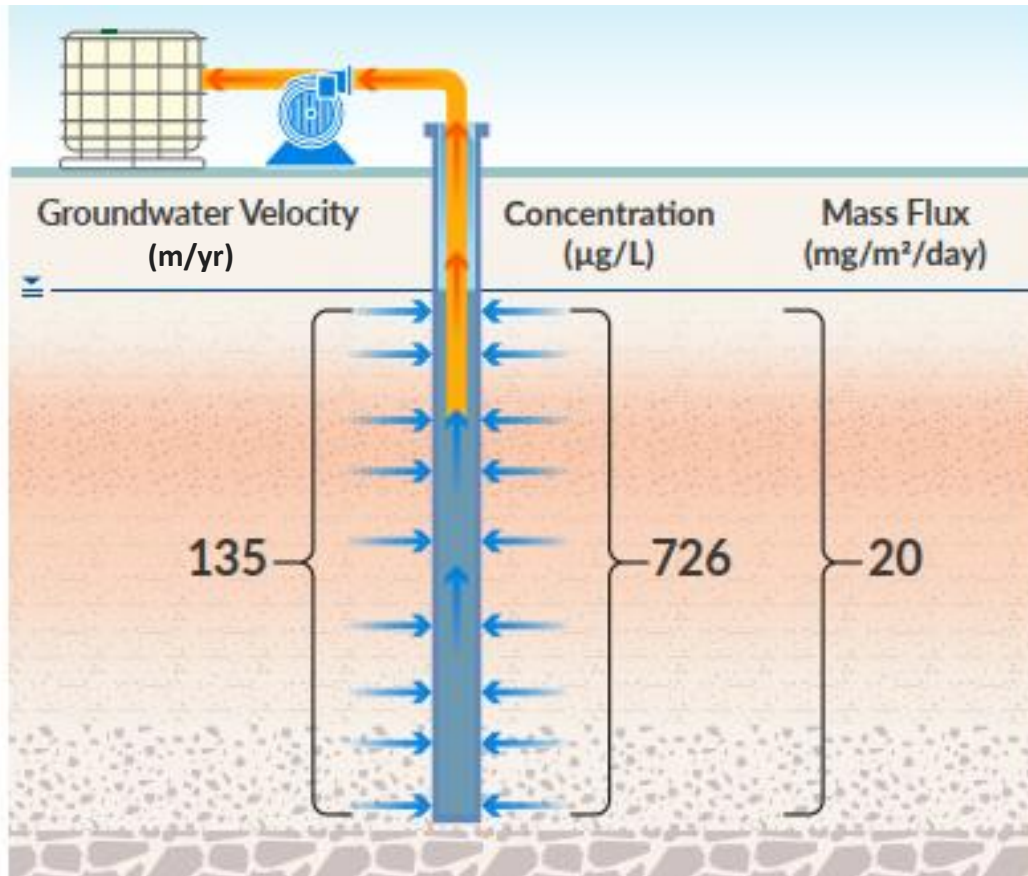
3) PRB/PSB emplacement



Measuring Flux

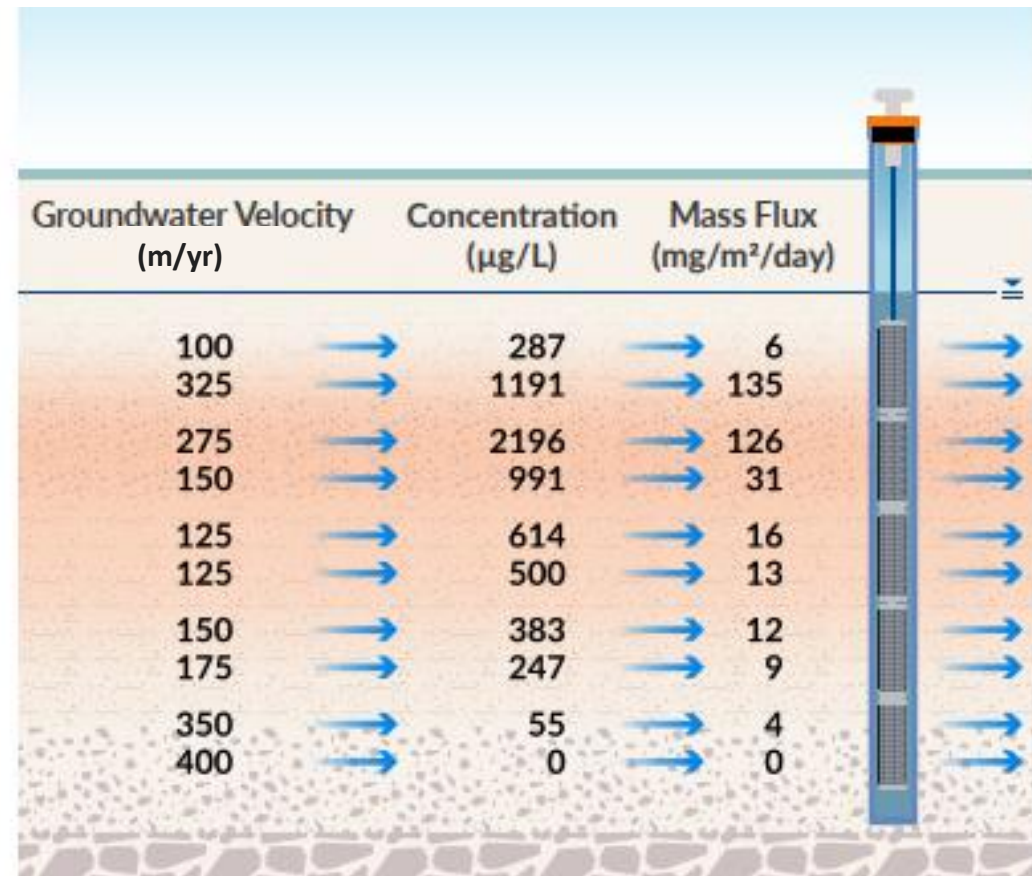
Bulk active methods/indirect flux estimation

- Average measurement across screen section
- No vertical delineation
- Useful for pumping/dewatering and initial characterization

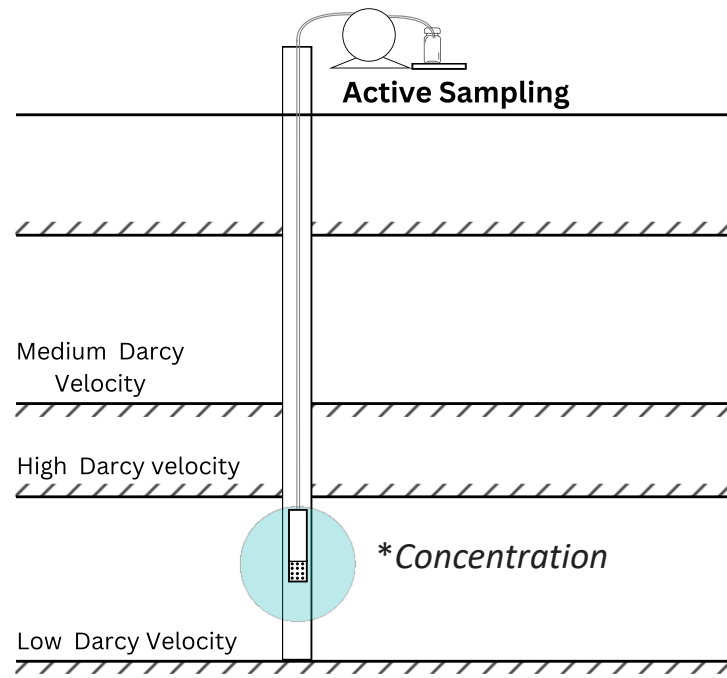


Passive & high-resolution flux measurement

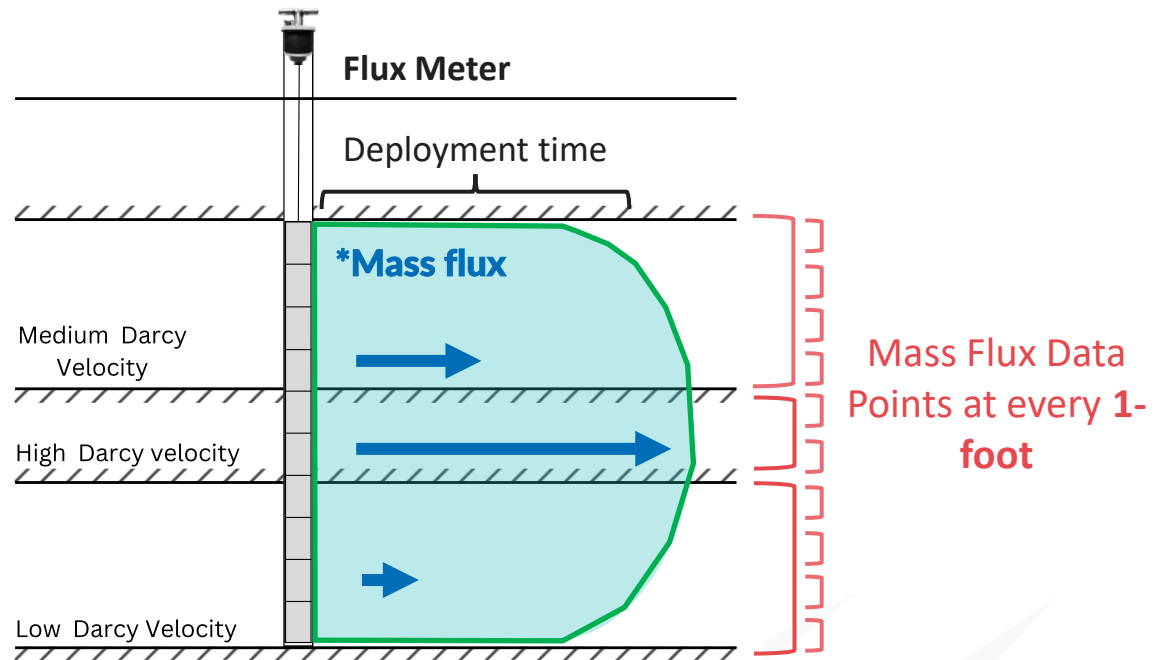
- Identify High and low contaminant flux zones
- Accurate treatment targeting
- Appropriate dosing to flux maxima
- Support conceptual site model (CSM) and remedial design



How can we measure mass flux?



Initial characterization and regulatory tool



Critical for risk assessment and design of barriers



Maximum concentration levels (MCL)



Delineation of contaminant plume

Indirect mass flux estimation

$$\text{Mass Flux} = \text{GW concentration} * \text{Darcy velocity}$$



Temporal representativeness



Vertical resolution

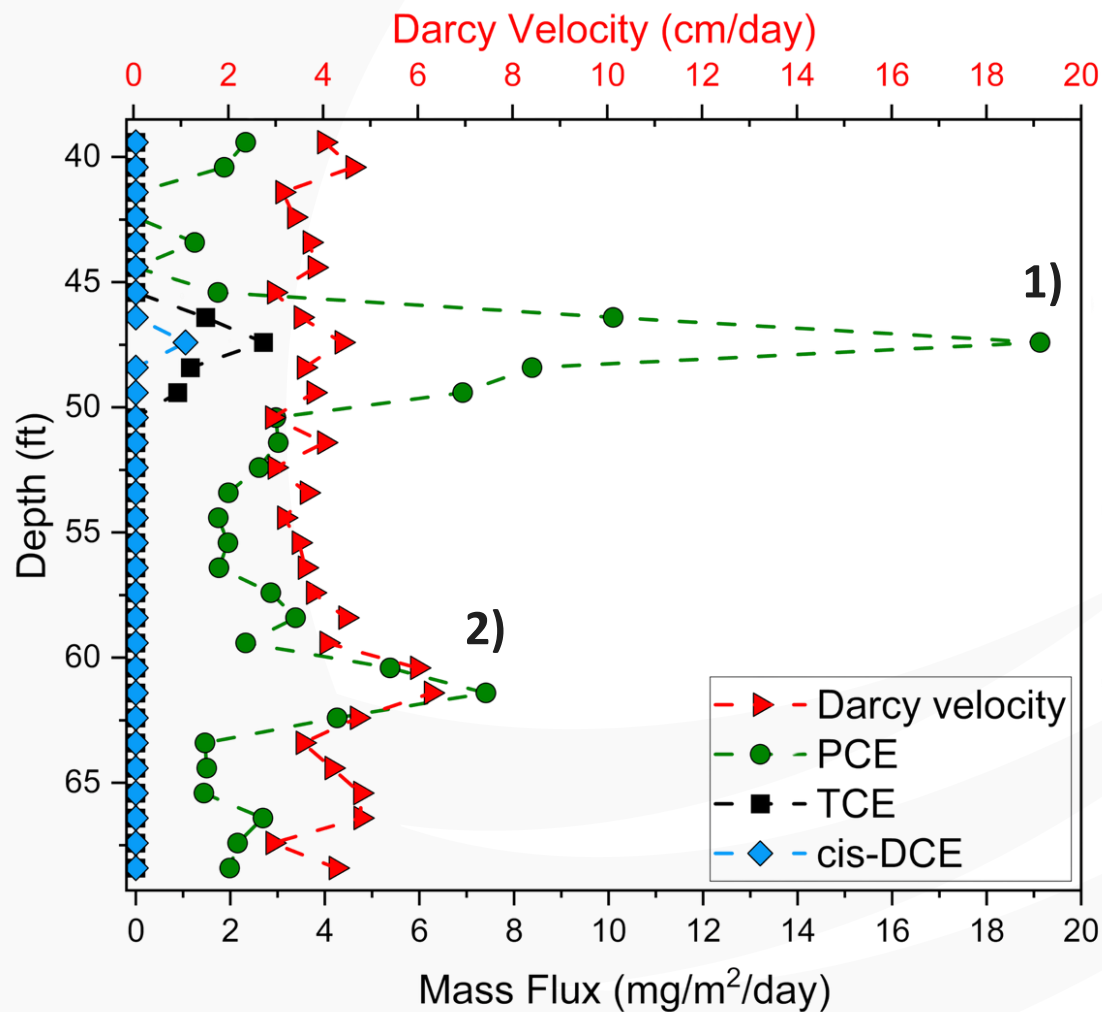
Figure adapted from: Verreydt et al. 2010

Case Studies:

1. La Mirada Site – Variability of mass flux, darcy velocity, and their correlation to lithology to enhance the CSM



Case Study | La Mirada Site



-PCE resulted in the highest mass flux

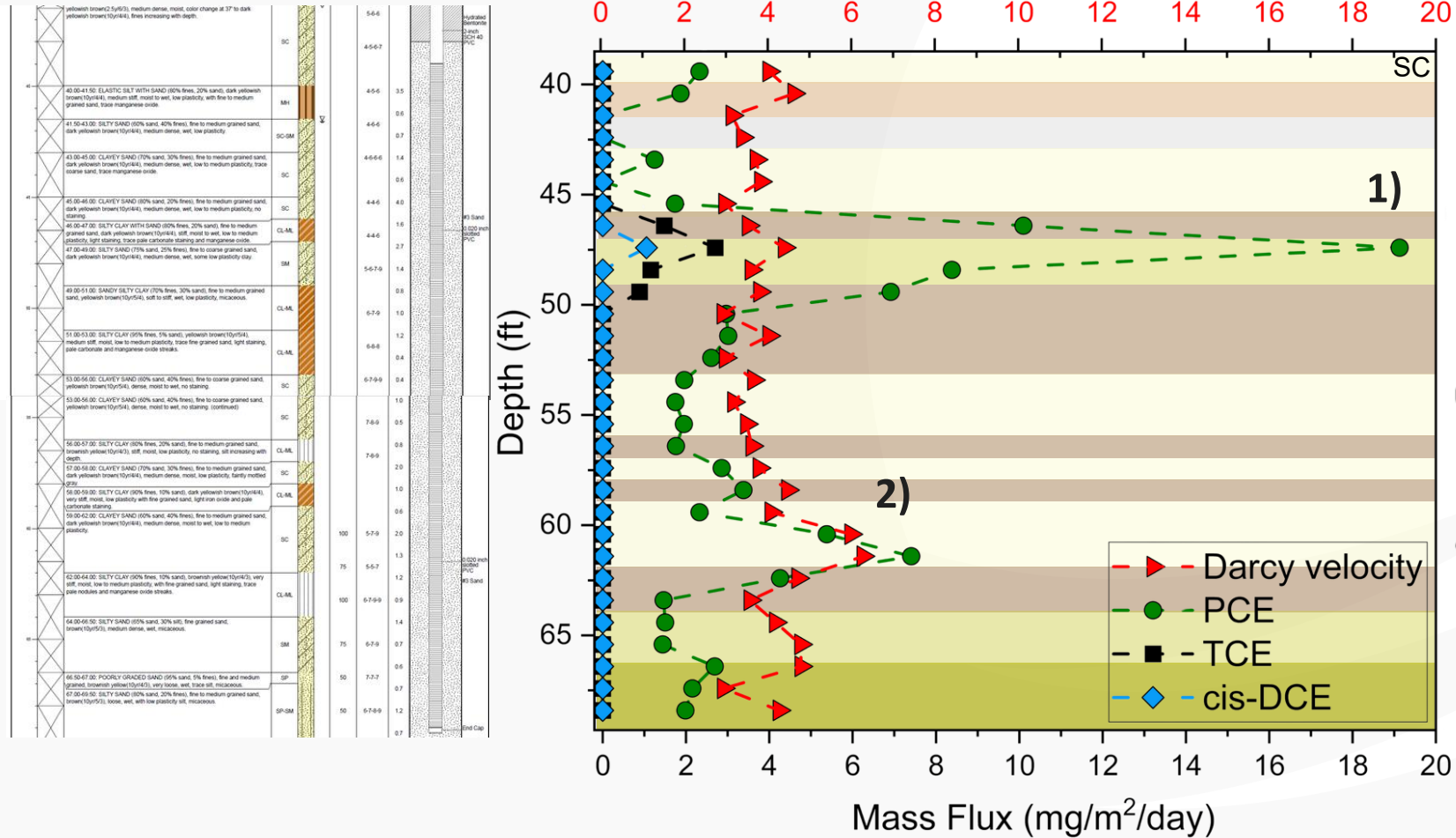
Two peaks observed:

1) 19 mg/m²/day
4 cm/day

2) 8 mg/m²/day
6 cm/day

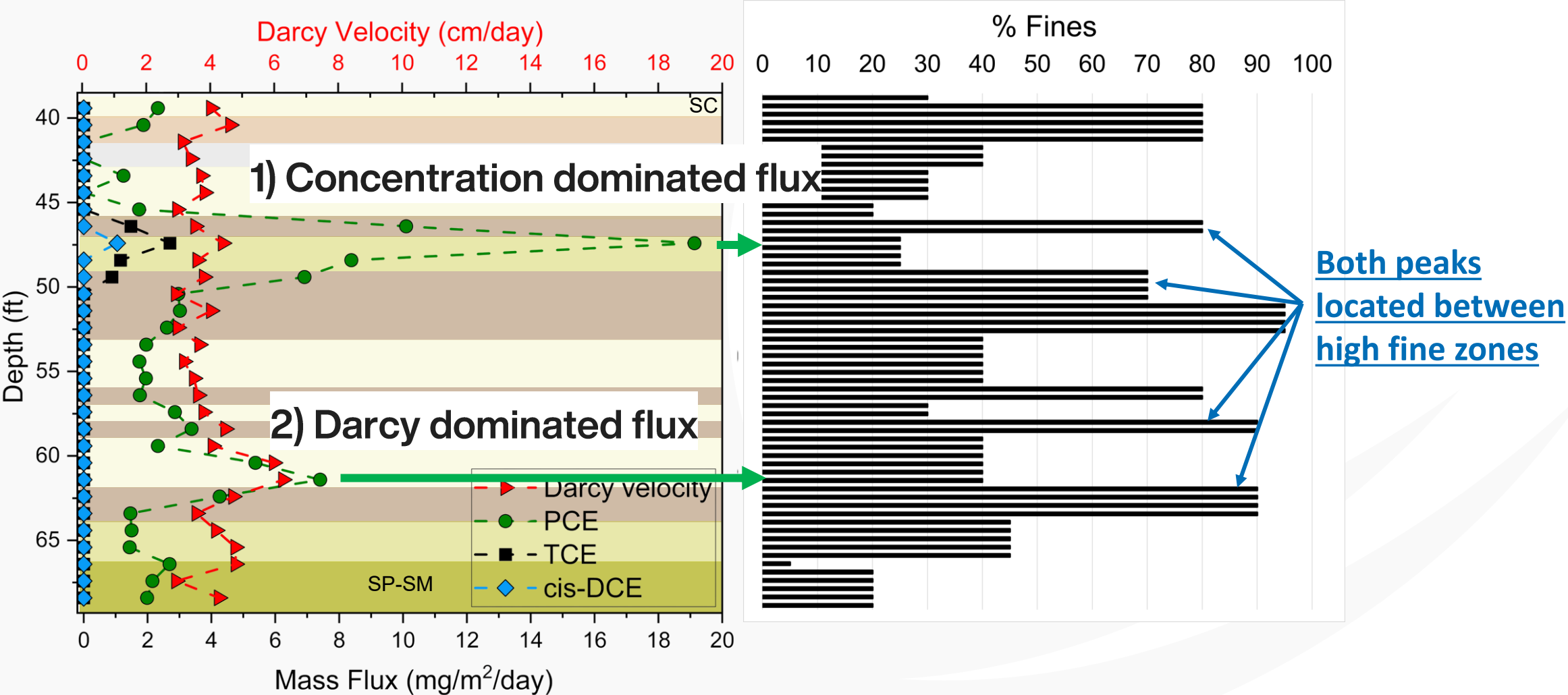
Case Study | La Mirada Site

Soil boring log



- Both peaks are located in sandy units

Case Study | La Mirada Site



Case Studies:

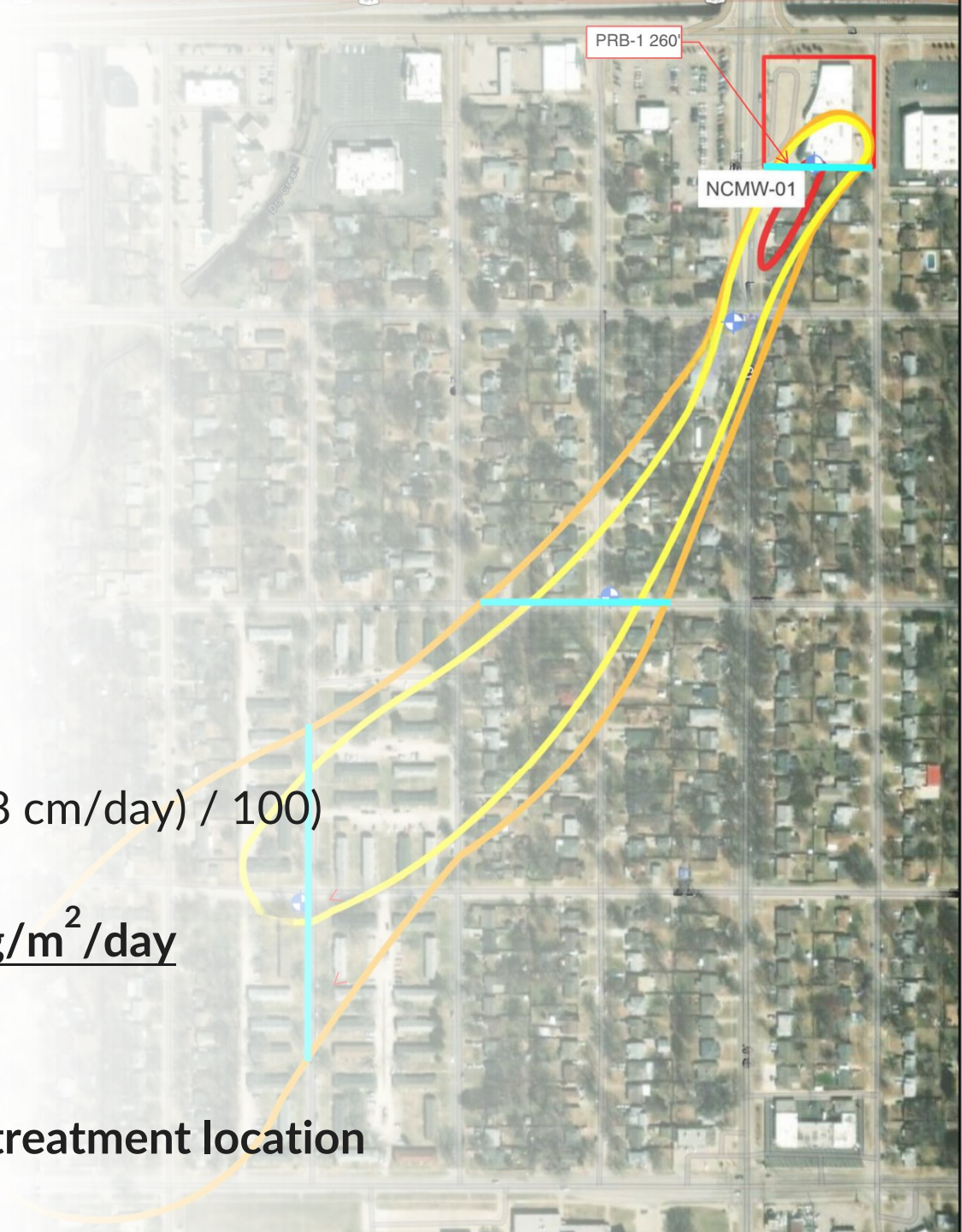
1. La Mirada, CA Site – Variability of mass flux and Darcy velocity, and their correlation to lithology

2. Dry Cleaning Facility – Risks for barrier design with single-depth active sampling

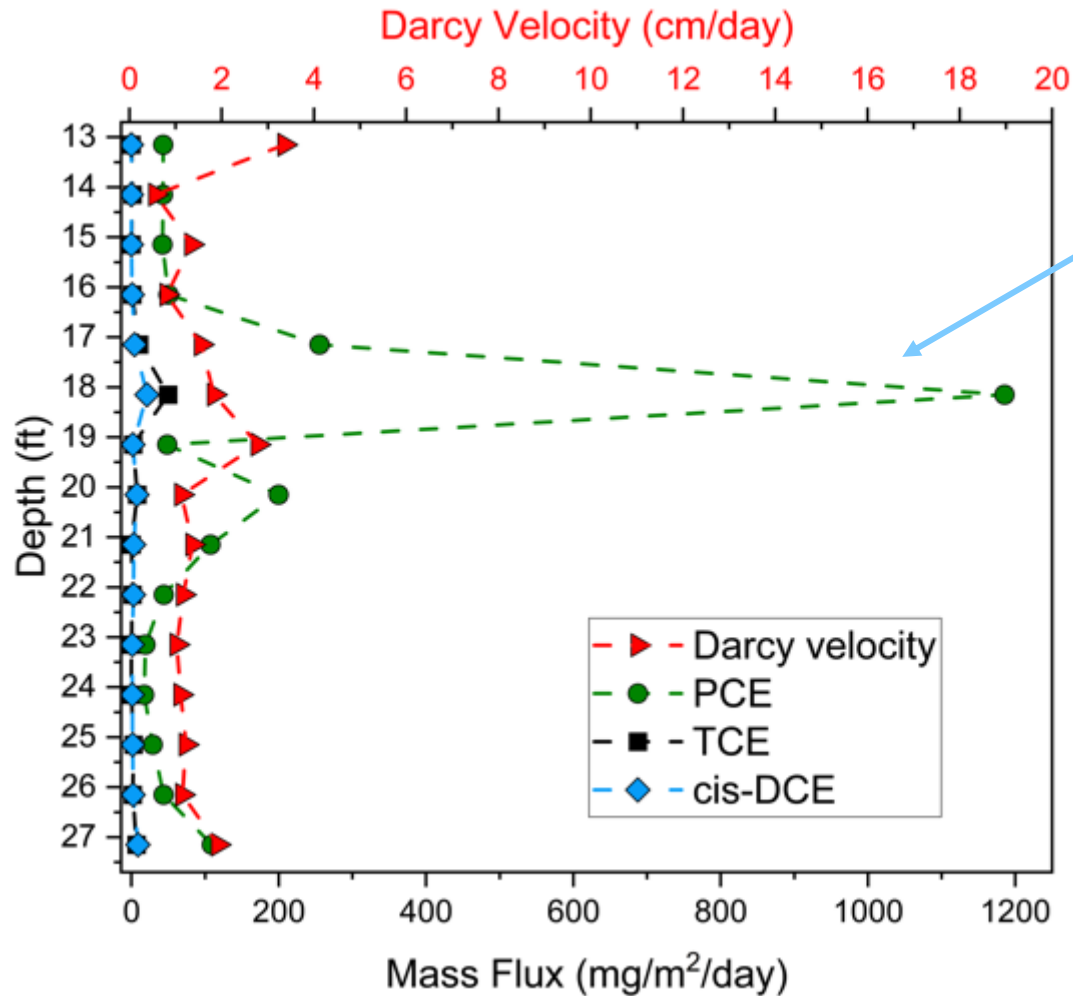


Dry Cleaning Facility

- PCE spill
- Relatively low permeability soils
- Plume egressing site, requiring treatment
- Standard well sampling:
 - PCE concentration = 4,500 $\mu\text{g/L}$
- Regional groundwater flowrate:
 - 2.8 cm/day Darcy velocity
- Therefore, PRB would need to treat $((4,500 \mu\text{g/L} \times 2.8 \text{ cm/day}) / 100)$
=
PCE mass flux of 126 $\text{mg/m}^2/\text{day}$
- **ACTION: Complete Design Verification Testing:**
FluxTracers deployed to measure actual flux in treatment location

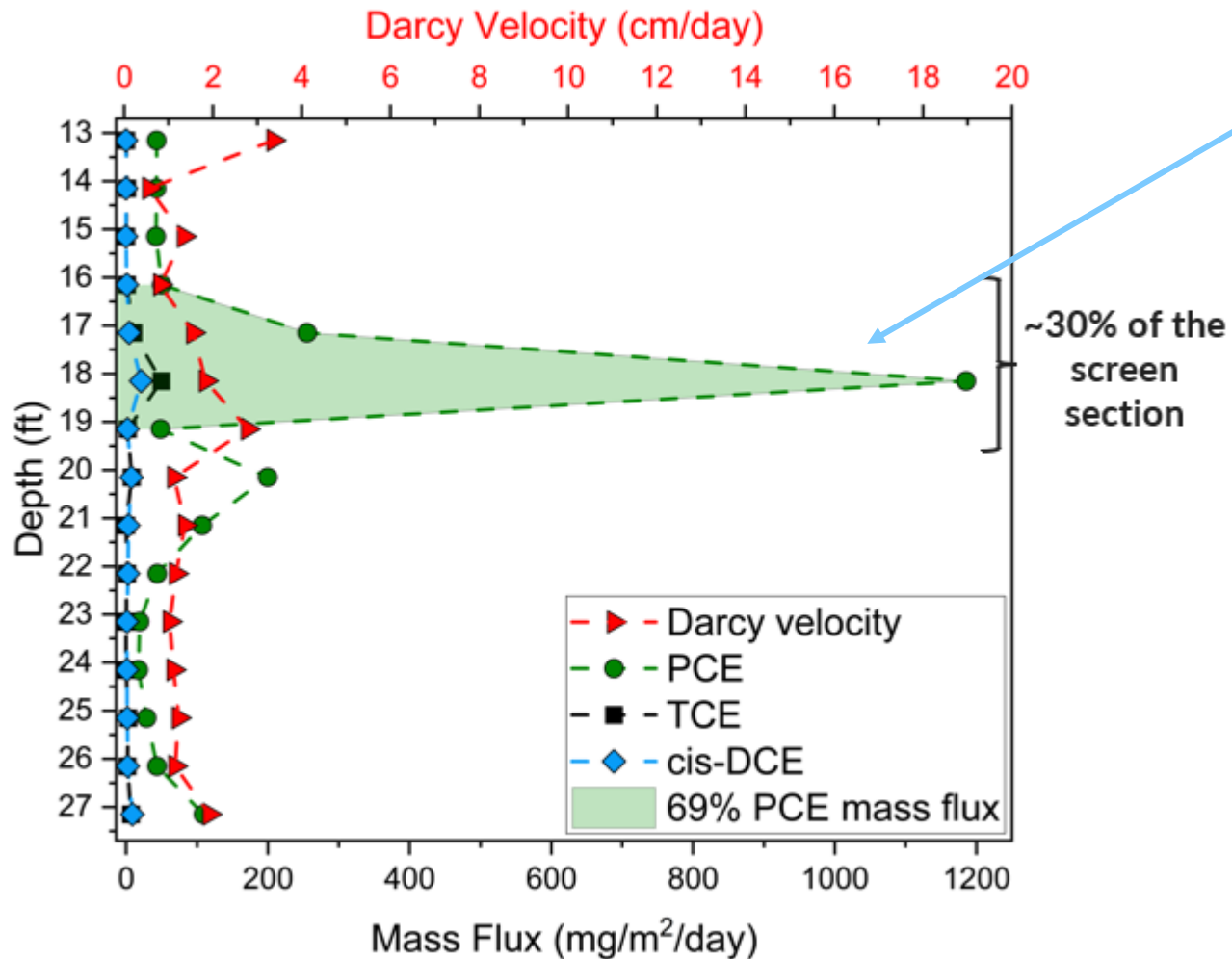


Dry Cleaning Facility



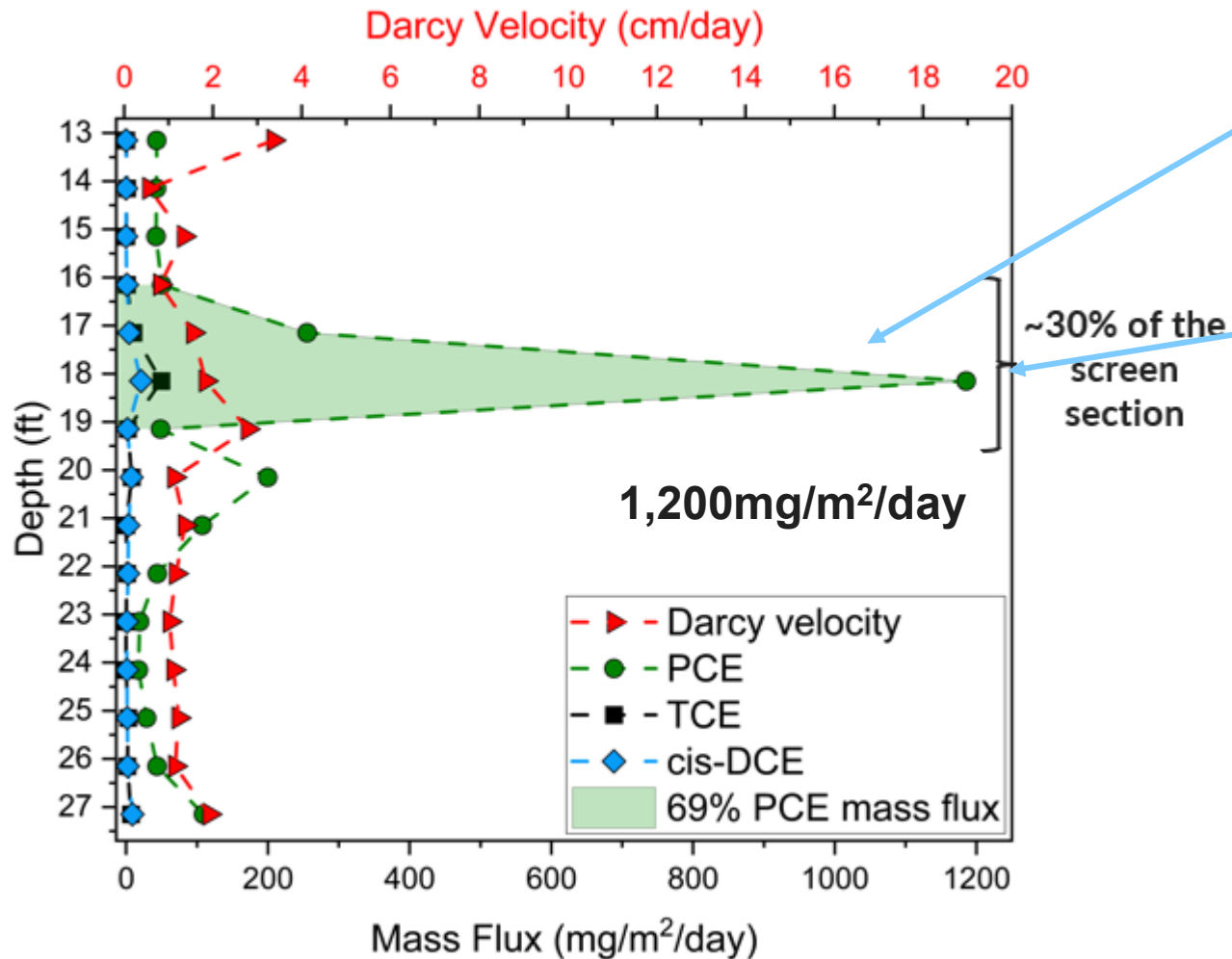
Identify distribution of mass flux:

Dry Cleaning Facility



Identify distribution of mass flux:
Target remedial approach

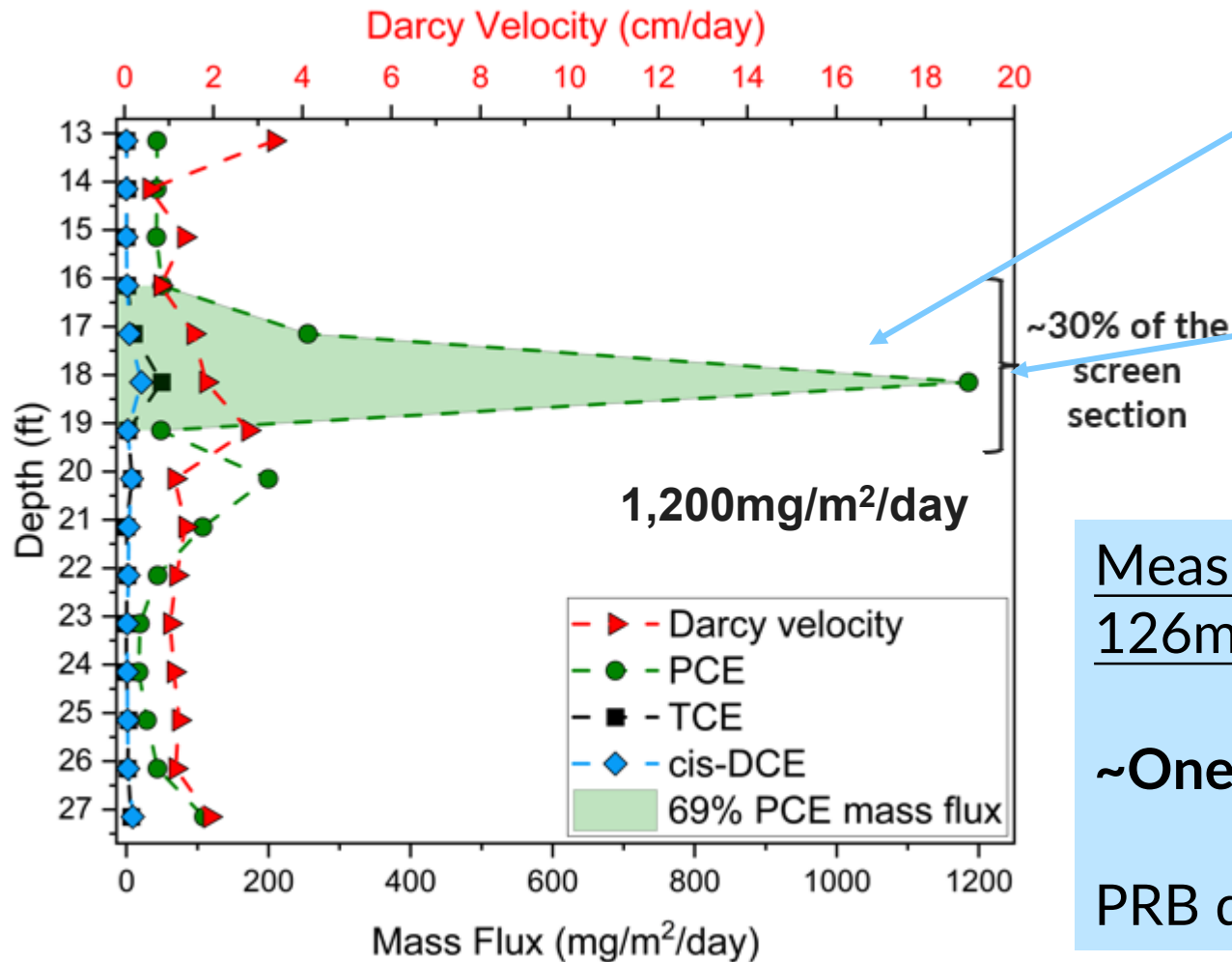
Dry Cleaning Facility



Identify distribution of mass flux:
Target remedial approach

Identify PCE flux maxima:

Dry Cleaning Facility



Identify distribution of mass flux:
Target remedial approach

Identify PCE flux maxima:
Allows accurate dosing for
efficacy and longevity

Measured mass flux is $1,200 \text{ mg}/\text{m}^2/\text{day}$ vs
 $126 \text{ mg}/\text{m}^2/\text{day}$ previously estimated

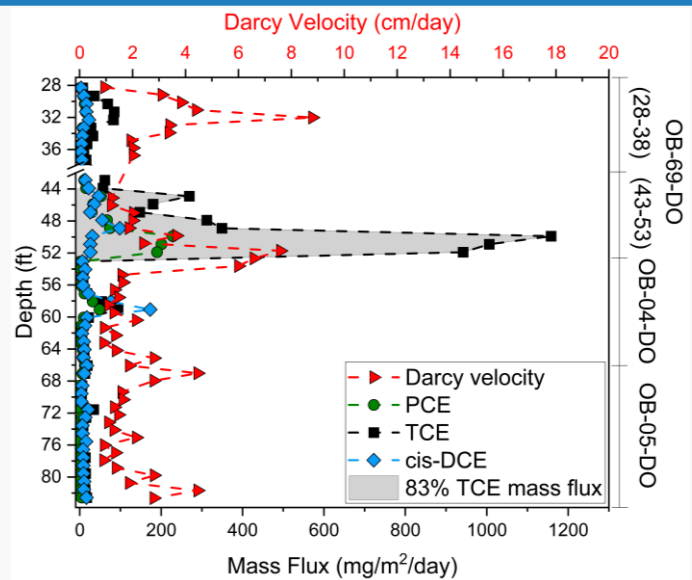
~One order of magnitude difference

PRB design adjusted to match flux

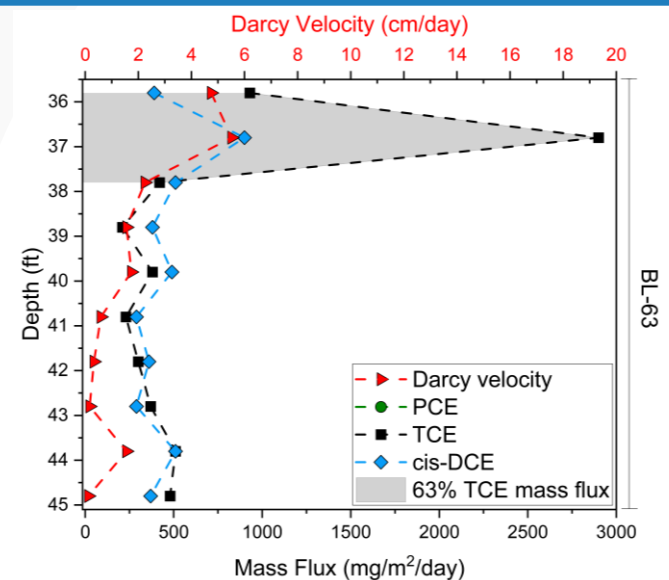
Contaminant Mass Flux Analysis

OVER 80 SITES ANALYZED WITH FLUXTRACERS

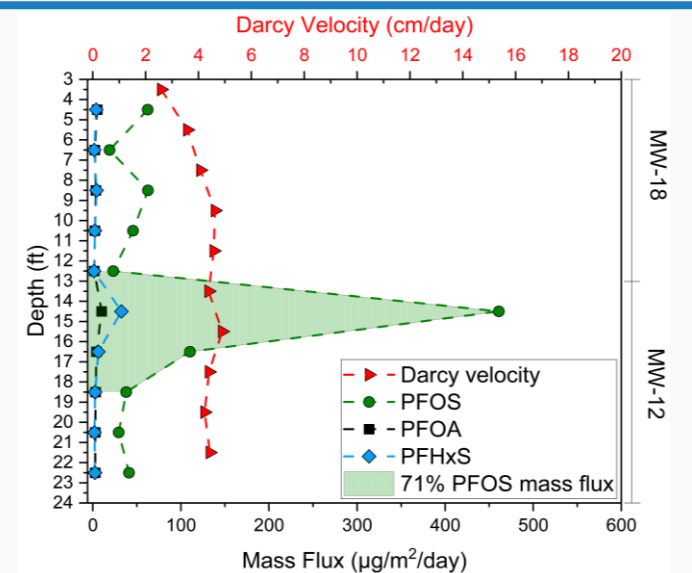
Site #1



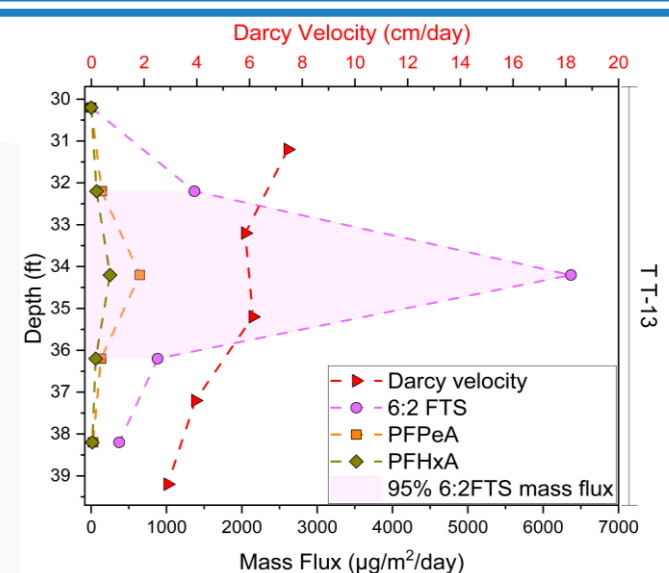
Site #2



Site #3



Site #4



CVOCs

PFAS

Mass flux spikes measured at various sites

Final Remarks

High-resolution mass flux data:

- Enhances CSM by identifying contaminant mass flux distribution and critical treatment zones
- Supports targeted remedial design through accurate delineation of flux maxima and groundwater flow pathways
- Improves permeable barrier dosing, performance, and longevity by matching treatment to actual contaminant loading

Results

Targeted Remedial Approach



Ensure Barrier Dosing & Longevity



Questions?



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