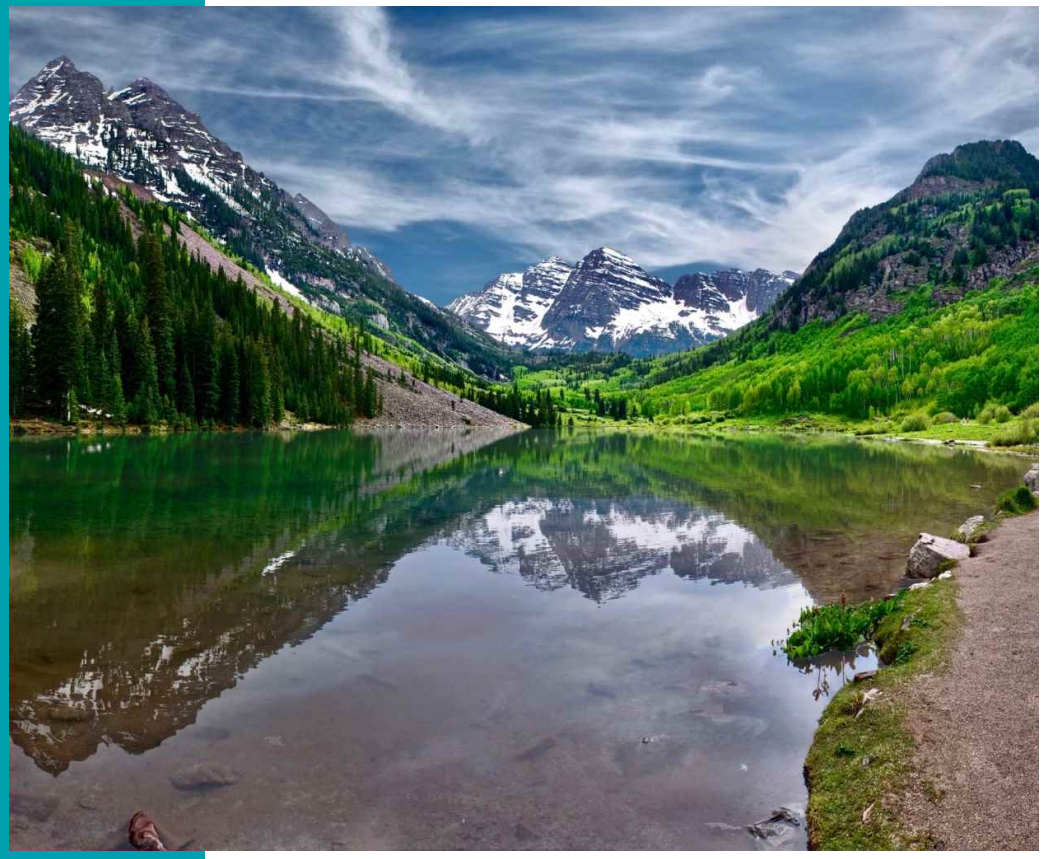
Geosyntec consultants

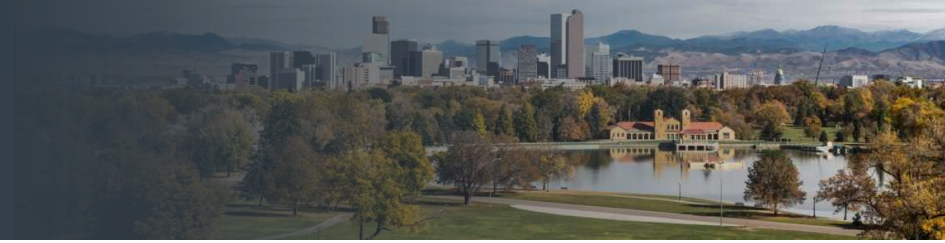
CREATIVE THINKING
EXCEPTIONAL SOLUTIONS



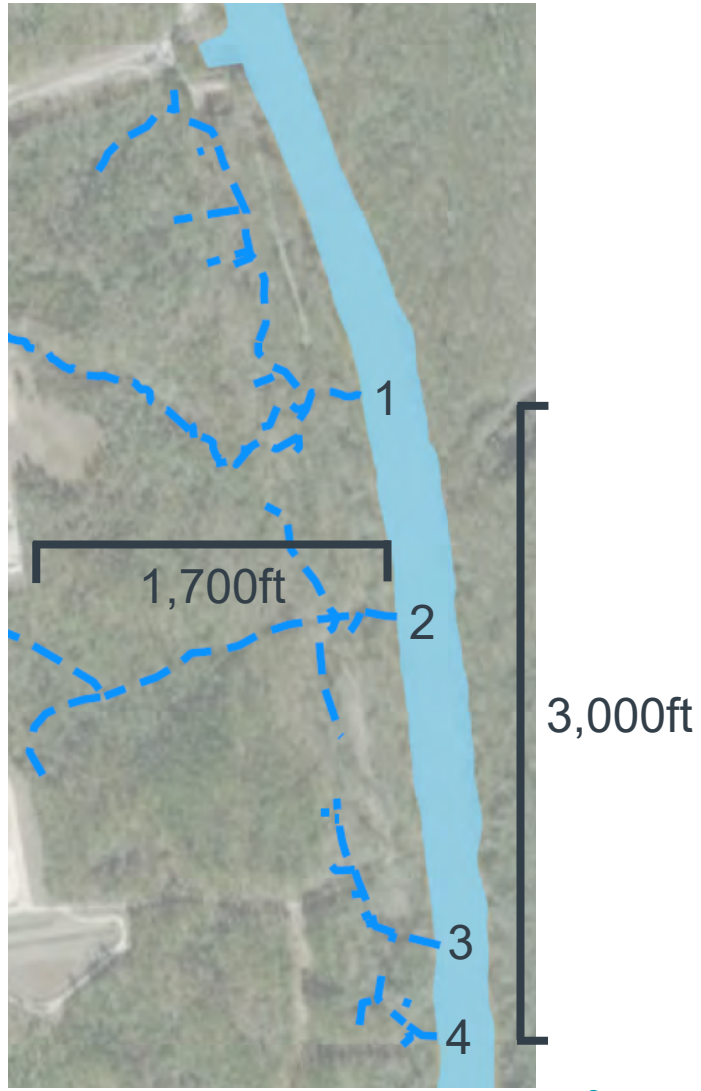
Time-Critical Gravity-Powered PFAS Remediation of Groundwater Seeps

Chris Shores, P.E. (NC)

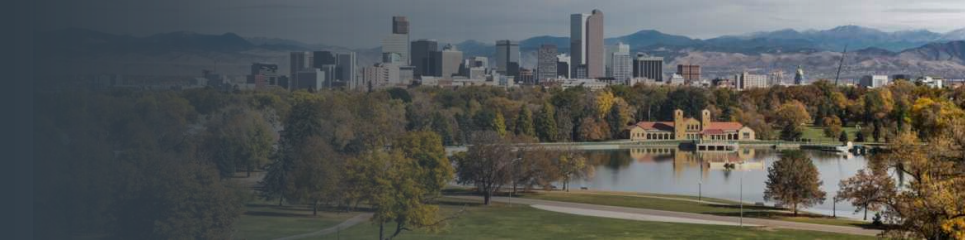
Problem Statement



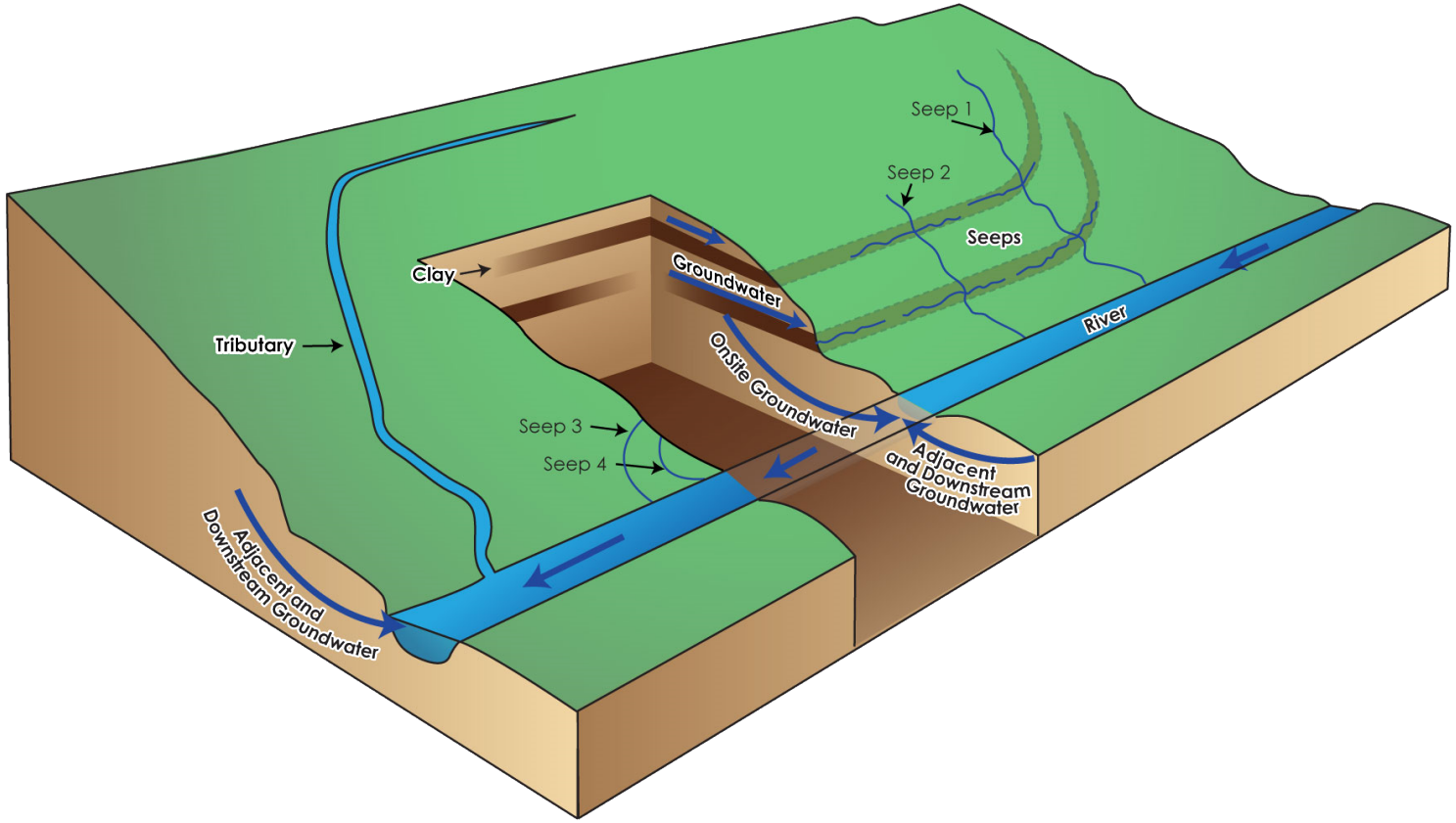
- PFAS-impacted groundwater seeps coalesce into creeks
- Creeks discharge to river, a source of drinking water
- Interim remedy needed within 6 months



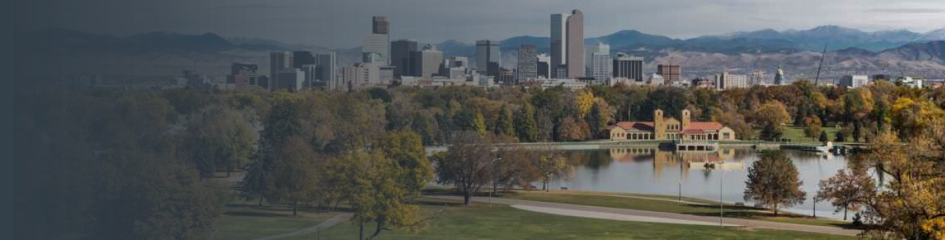
Building the CSM
PFAS Pathways to River



- 100 ft elevation drop
- Three groundwater zones
  - Upper two coalesce into creeks (largest PFAS load)
  - Deepest contacts river



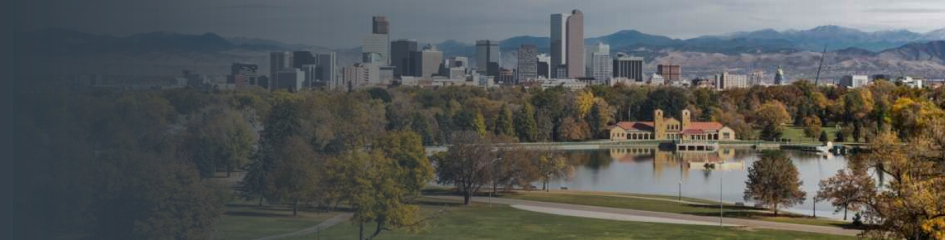
Building the CSM
Quantitatively Assessing Seeps

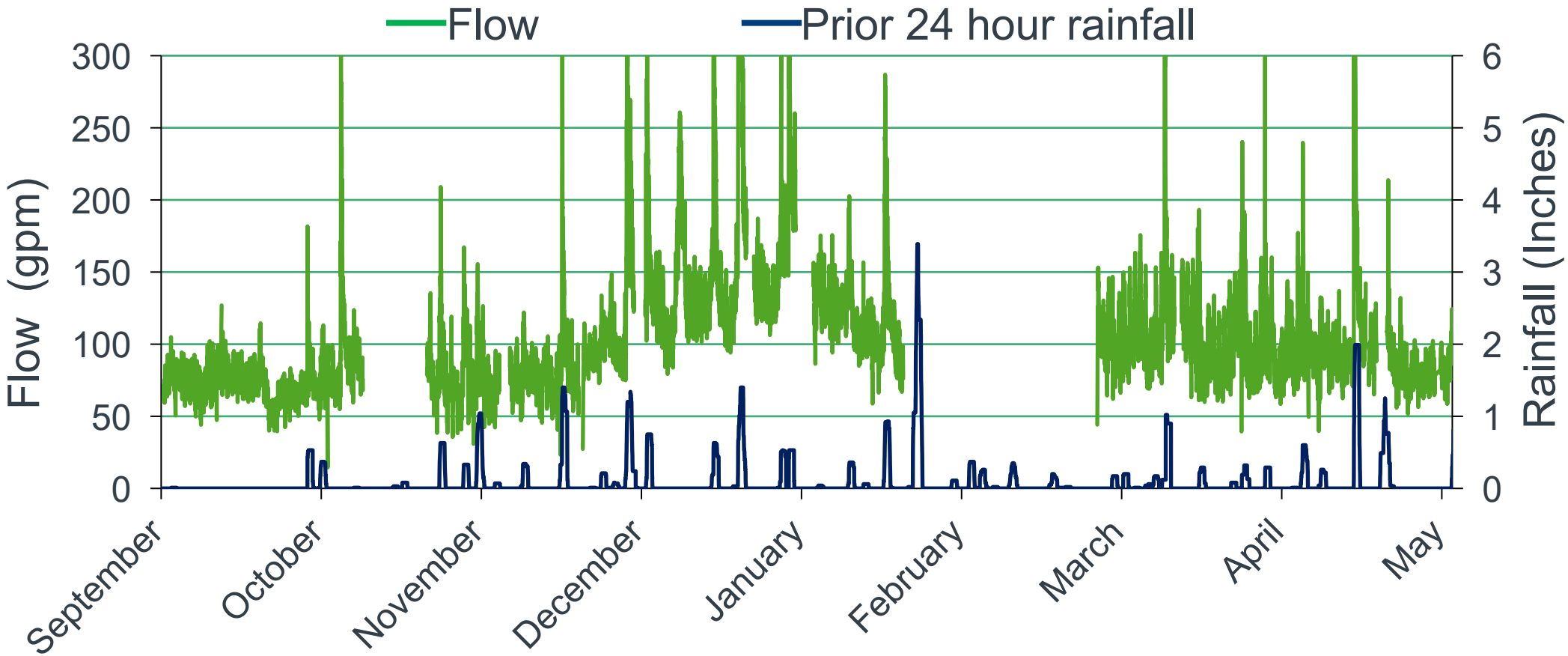


Measuring flow

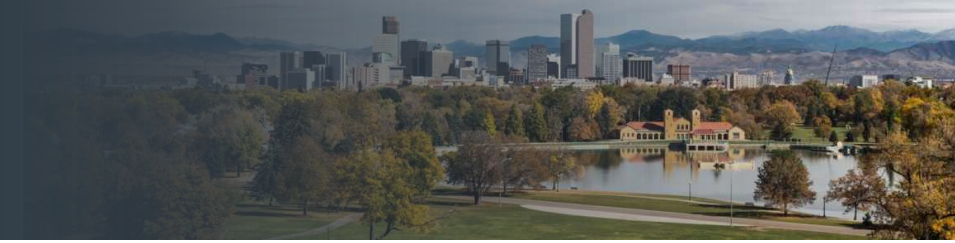
- Weirs
- Flumes
- Salt dilution gauging
- Surface water point velocity measurements
- Volume collection over time

Building the CSM
Seasonal Quantification





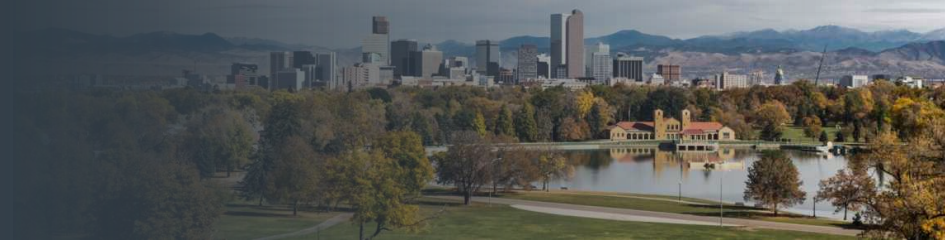
Building the CSM
As a Basis for Design



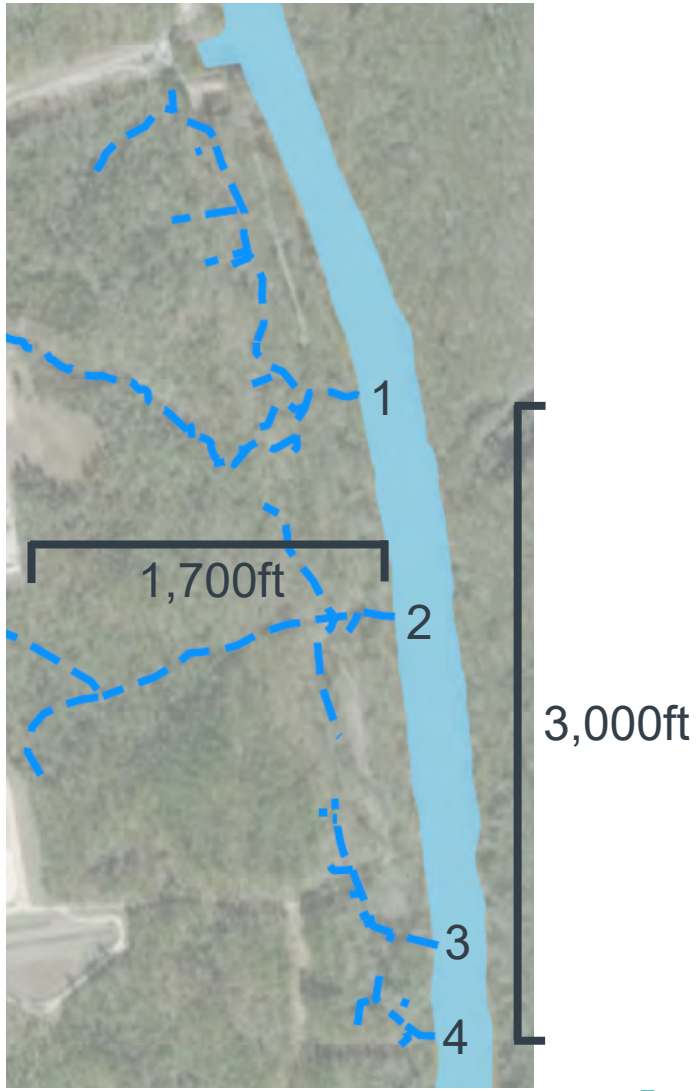
Seep flowrates and concentrations

Seep	95th Percentile of Dry Weather (gpm)	PFAS Concentration (µg/L)
1	76	124
2	205	196
3	226	228
4	183	108
Total	**690**	

Remedy Evaluation



- Migration of mobile, persistent chemical
  - Four discrete discharges
  - Available infrastructure is distant
- Compressed schedule
  - Six months to design, permit, build, and operate
- Solution
  - In situ
  - Gravity-powered

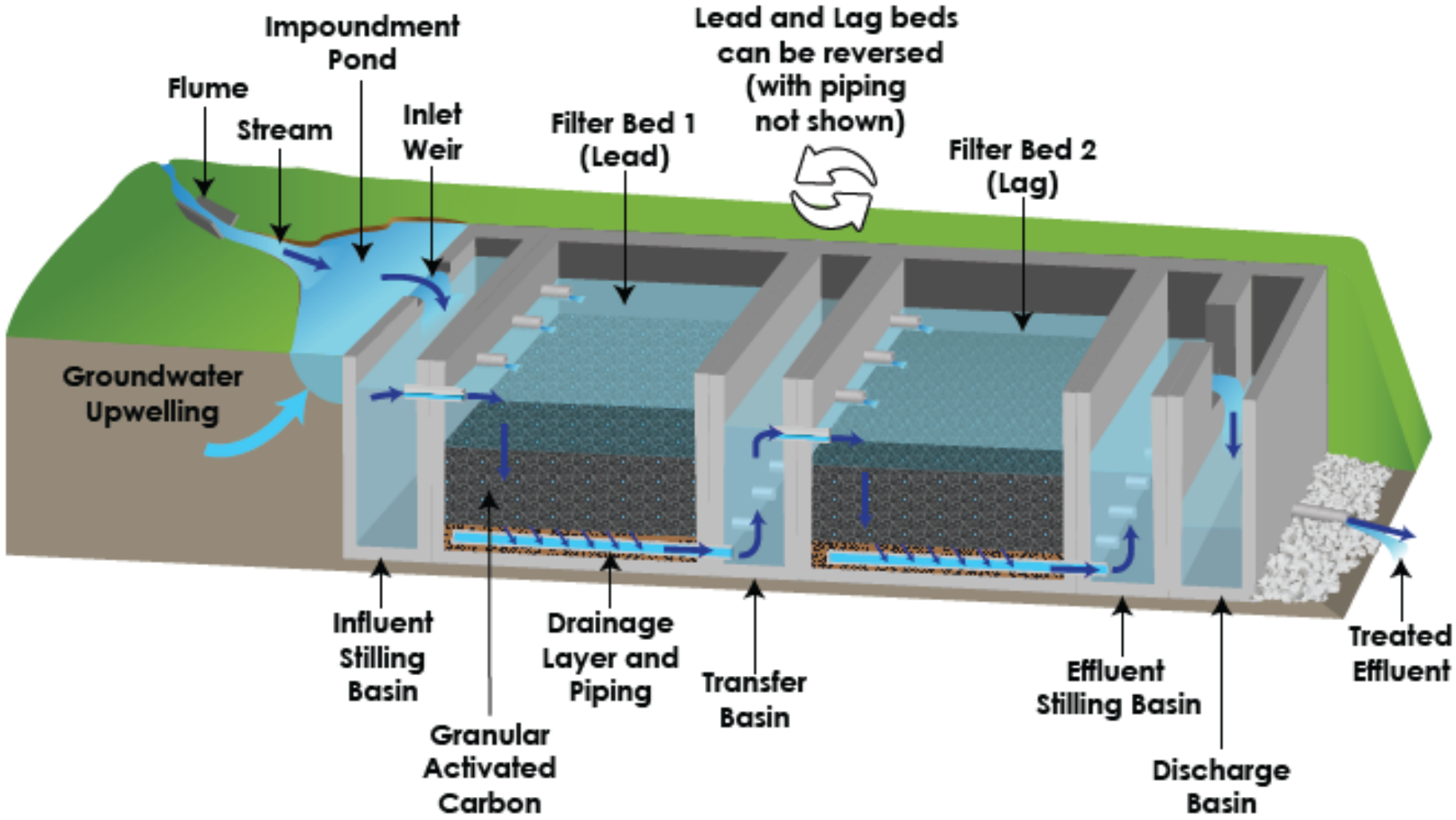


Gravity Flow through GAC

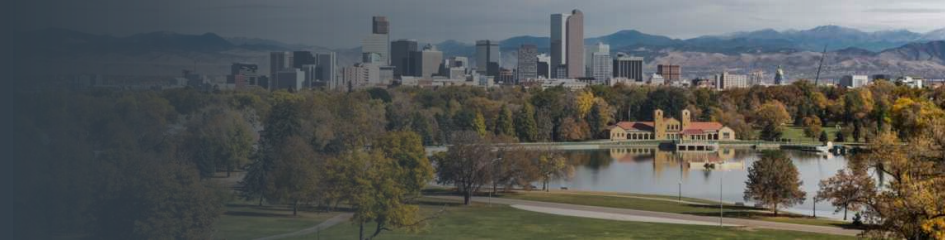
- Isotherms → Adsorbent utilization rates
- Head loss in GAC is non-trivial in gravity application
- Solution
  - Impound flow to develop hydraulic head

Treatment Objectives/Process Flow

- Requirements
  - 80% reduction in dry weather baseflow
- Solution
  - Series treatment
  - Manifolding to alternate duty cycles



Basic Power Requirements



- Exclusively battery-powered
- Level/Flow:
  - Transducers
- Concentration:
  - ISCO composite samplers

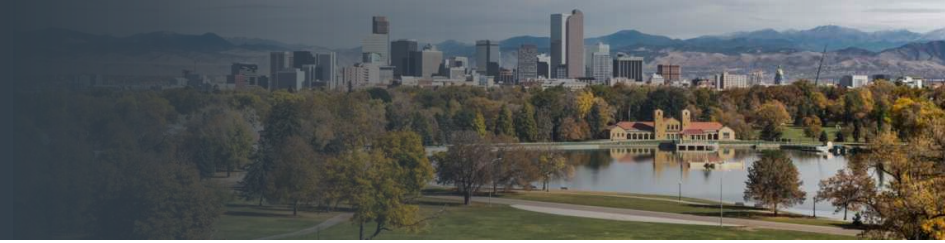
Operability

- Concrete pad for GAC changeouts
- Fiberglass grates for operators

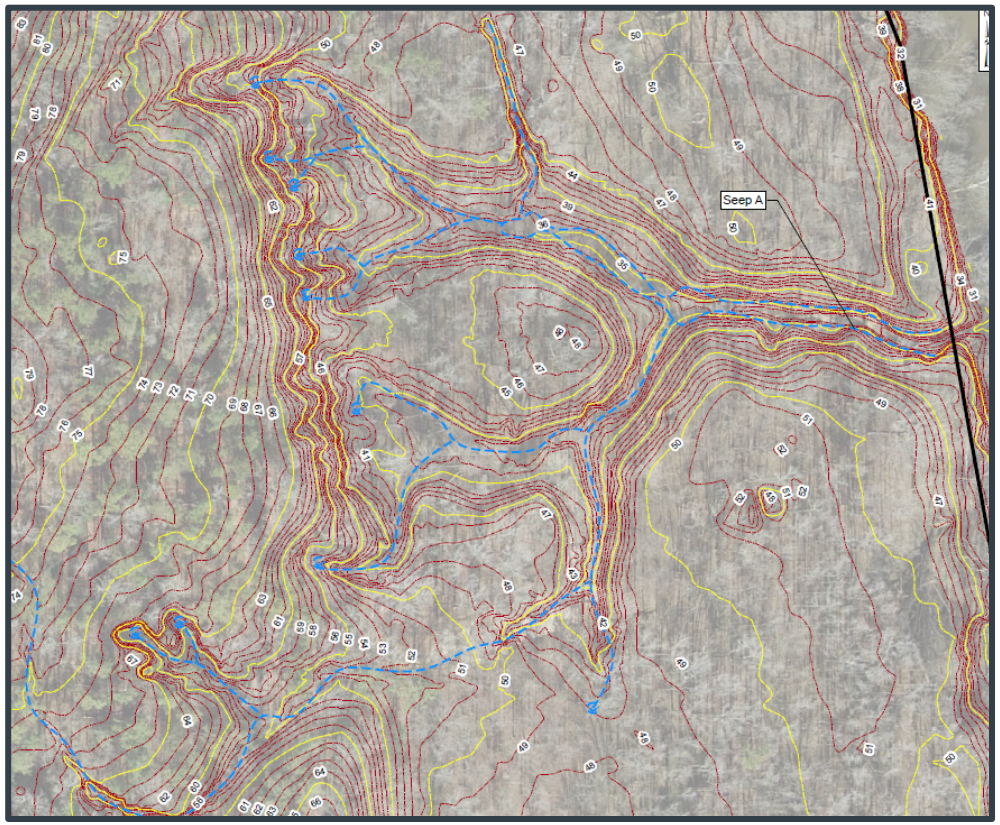
Stormwater Bypass

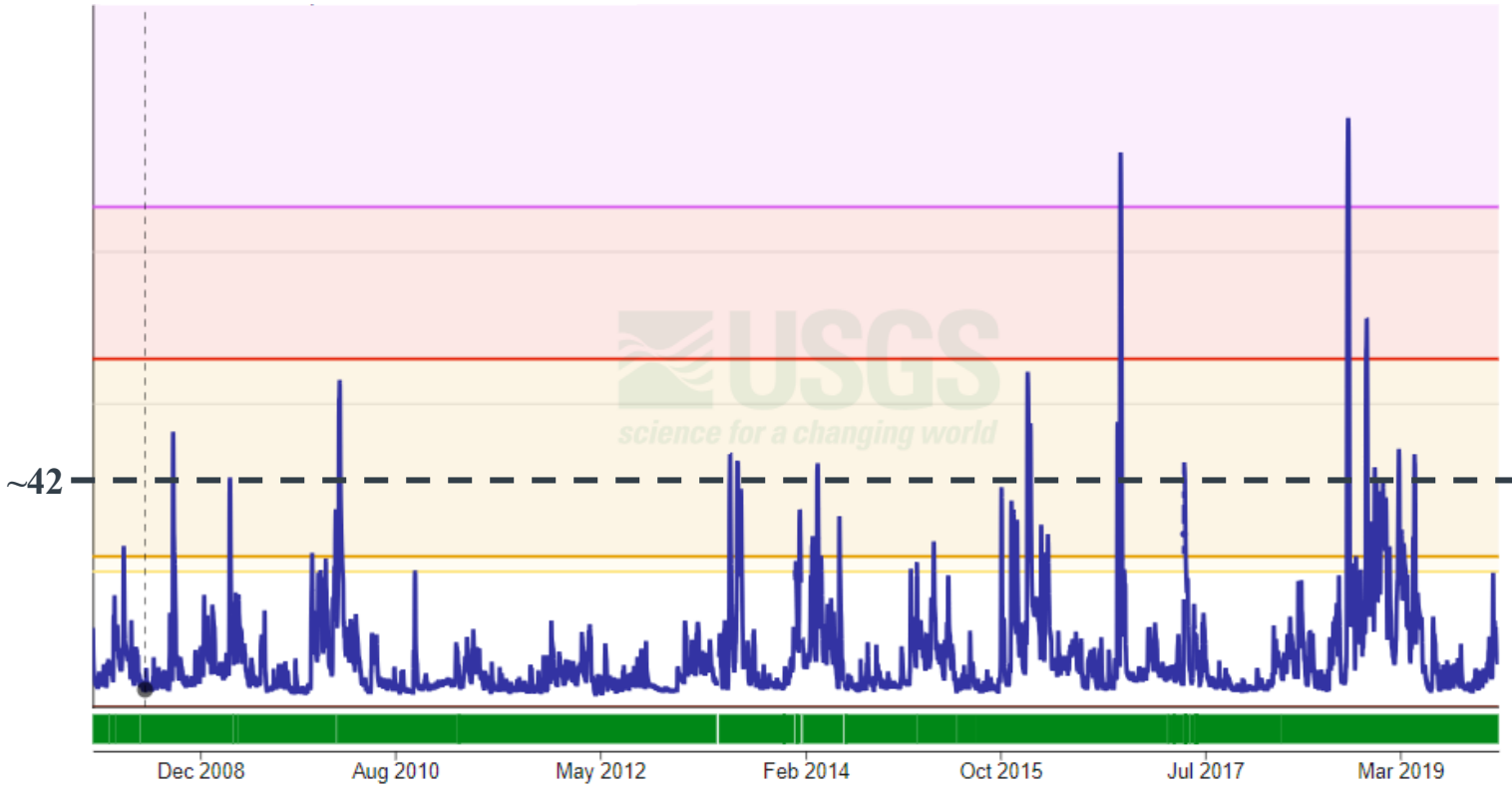
- Bypass spillway installed adjacent to system
  - Reduces sediment loading and GAC consumption

Design Elevations

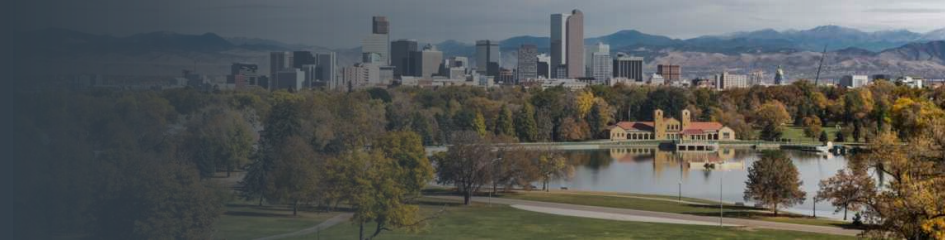


- Site LIDAR and nearby USGS river gage utilized to calibrate design
- Top of wall elevation set to the 1% occurrence of a flood (2007-2020 dataset)



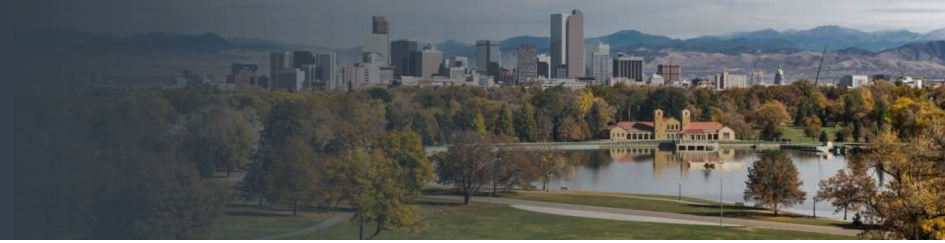


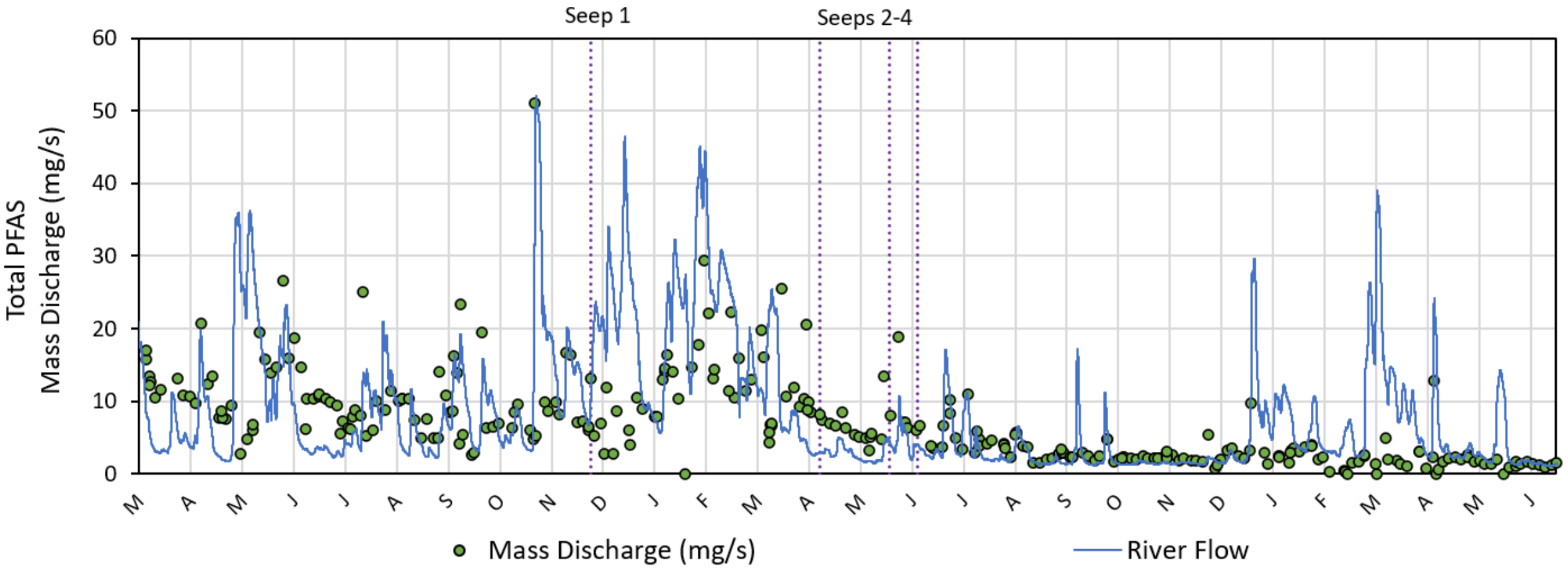
PFAS Removal 2020 - 2023



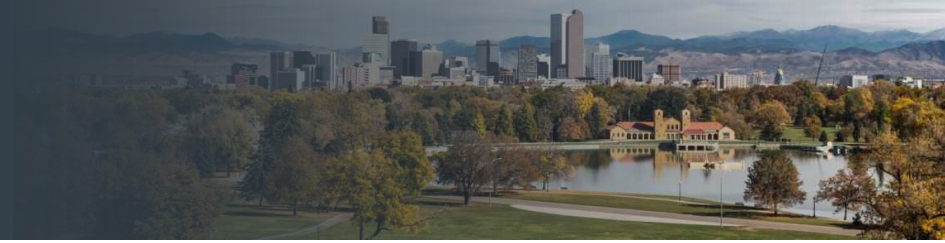
Seep	Days of Operation	Average Influent Total PFAS (µg/L)	Average Effluent Total PFAS (µg/L)	Average Removal Effectiveness	PFAS Removed (pounds)
1	1,109	110	1.2	99.0	90
2	976	210	3.3	98.4	170
3	935	260	0.3	99.5	210
4	919	100	0.052	99.5	80
				Total	**550 lbs**

Reduced Loading to River





PFAS Remedy Takeaways



- Quantitative CSM enabled timely, right-sized remedy
- Design constraints can lead to innovation
- In situ, gravity-powered remedies:
  - Technically viable for mobile, persistent compounds
  - Scalable (modular and form-to-fit)
  - Improve implementation schedules
  - Simplify infrastructure burden

NGWA Award 2023

Outstanding Groundwater Remediation Project