Potomac Aquifer Recharge Monitoring Laboratory Update

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Groundwater Impacts of Managed Aquifer Recharge (SWIFT)

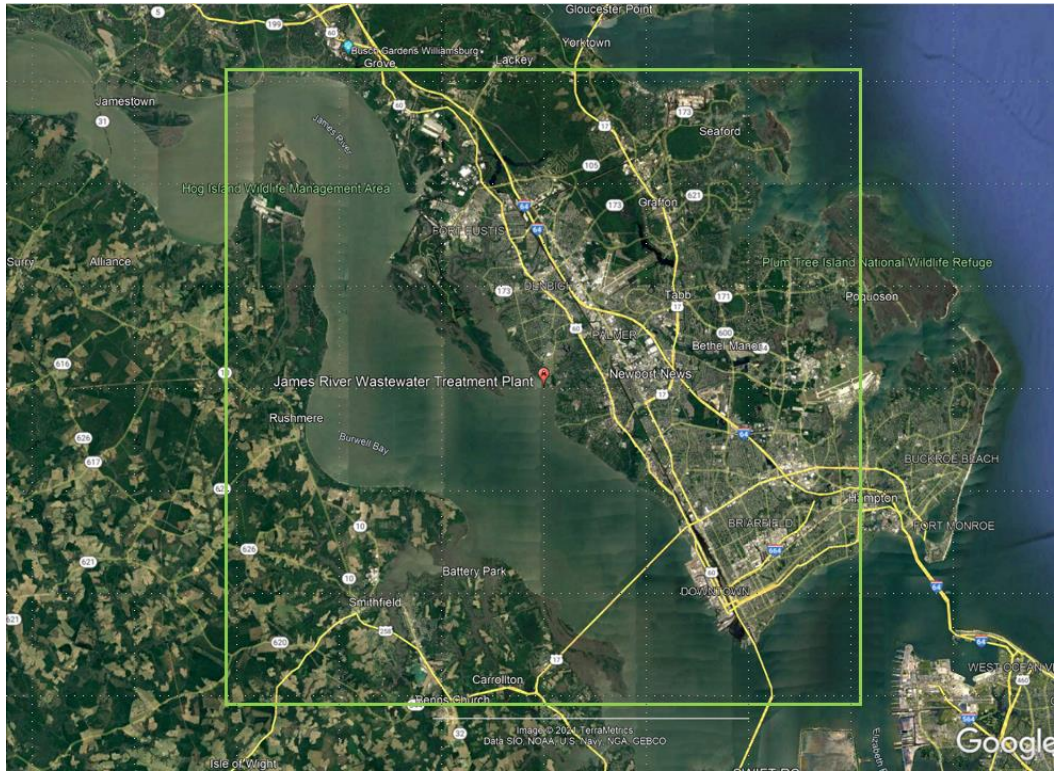
Regional – Aquifer Replenishment

- Water Levels
- Storage

} Spatial and Temporal

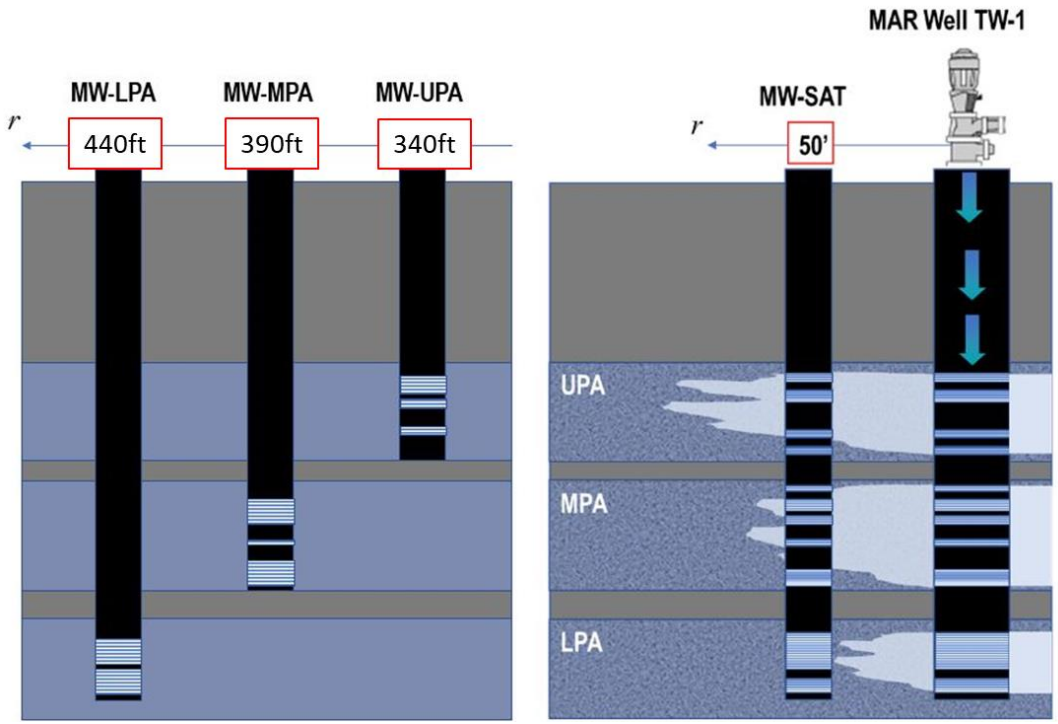
Local – Groundwater Quality

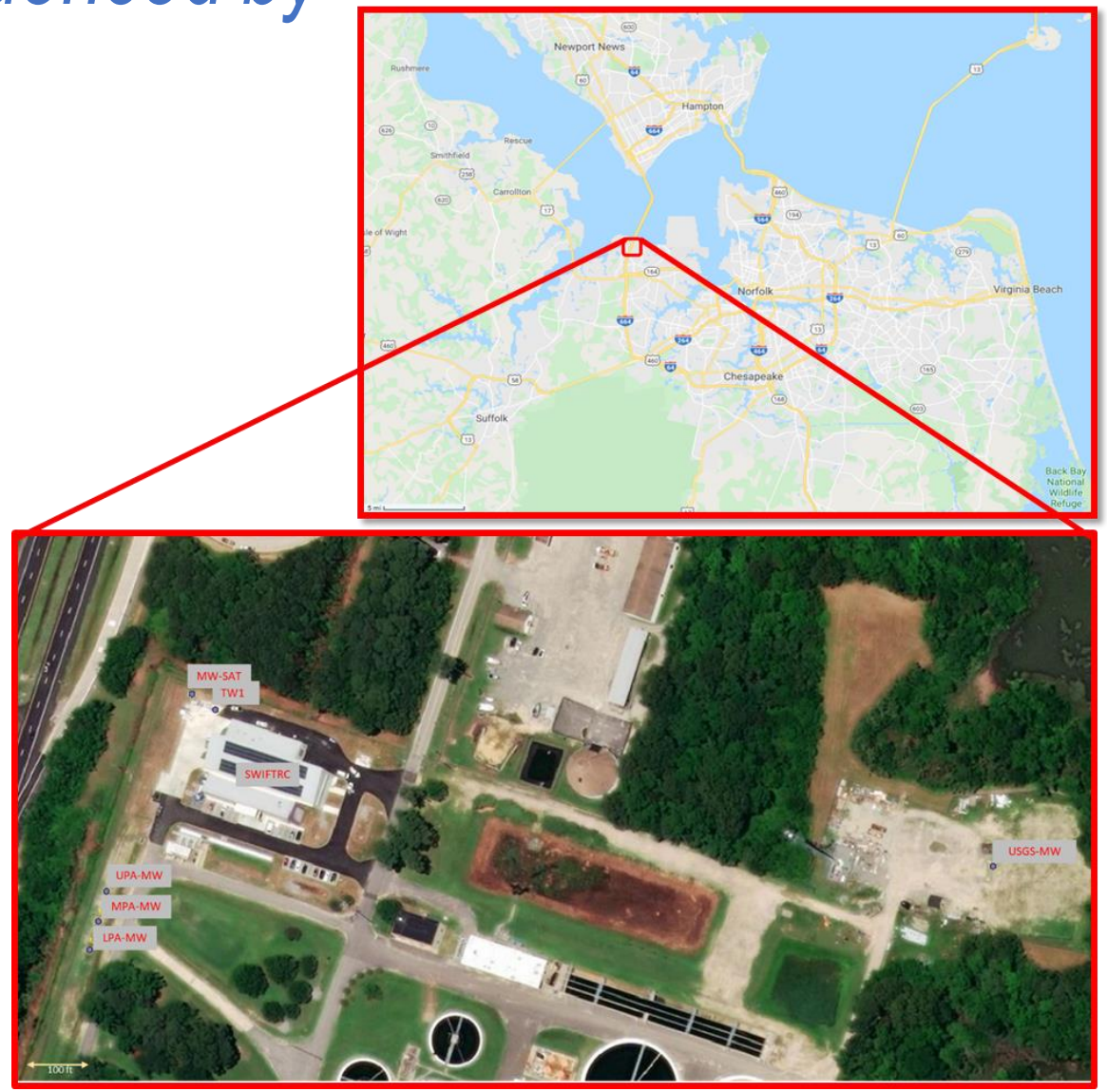
- Chemical concentrations
- Transport – Travel distance and travel time
- Attenuation mechanisms



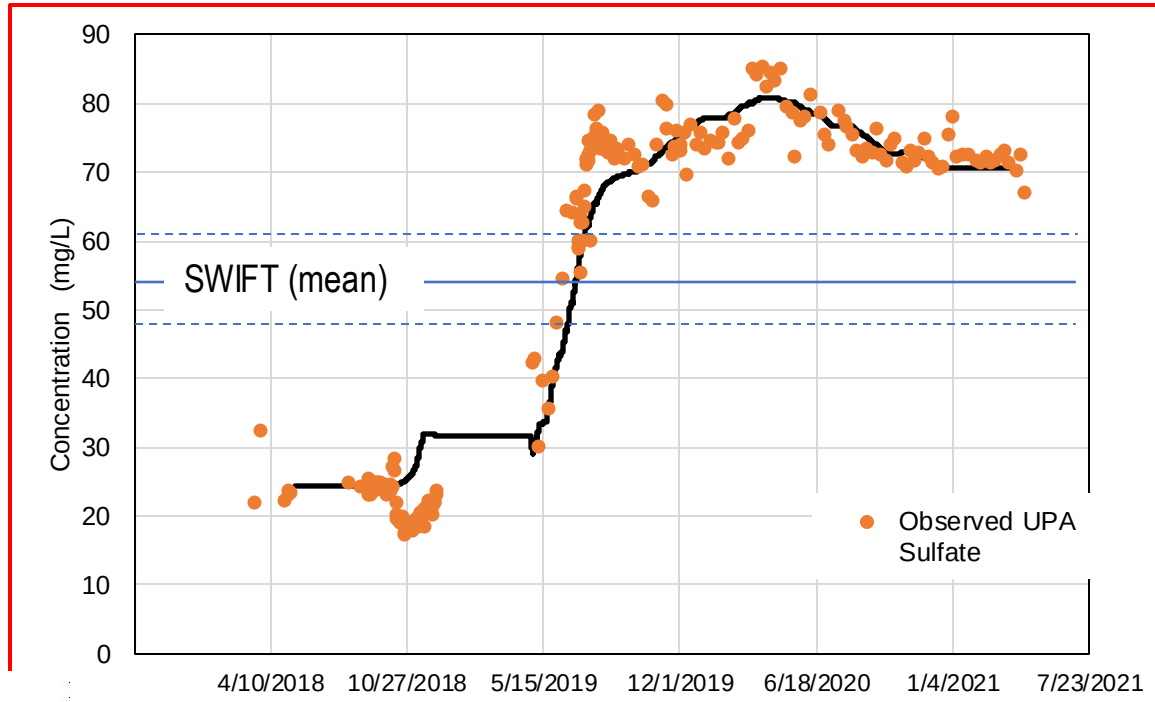
SWIFTRC: *Local Impacts are Influenced by*

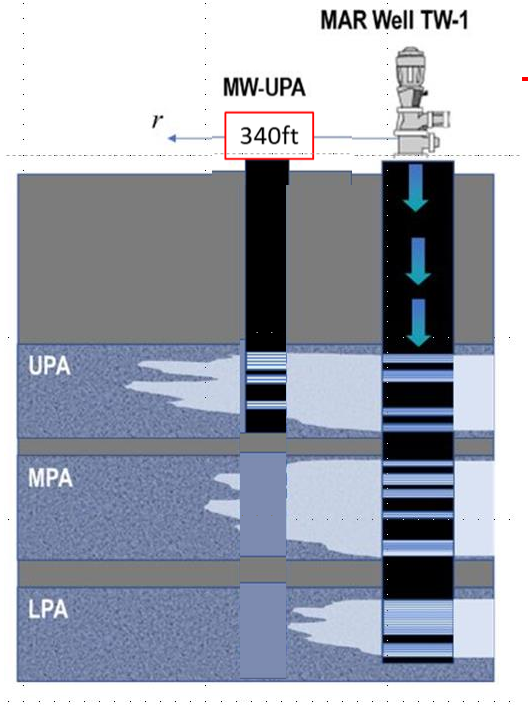
- Aquifer Hydrogeologic Properties
- Well Performance
- SWIFT Treatment Operations





Sulfate Breakthrough – UPA





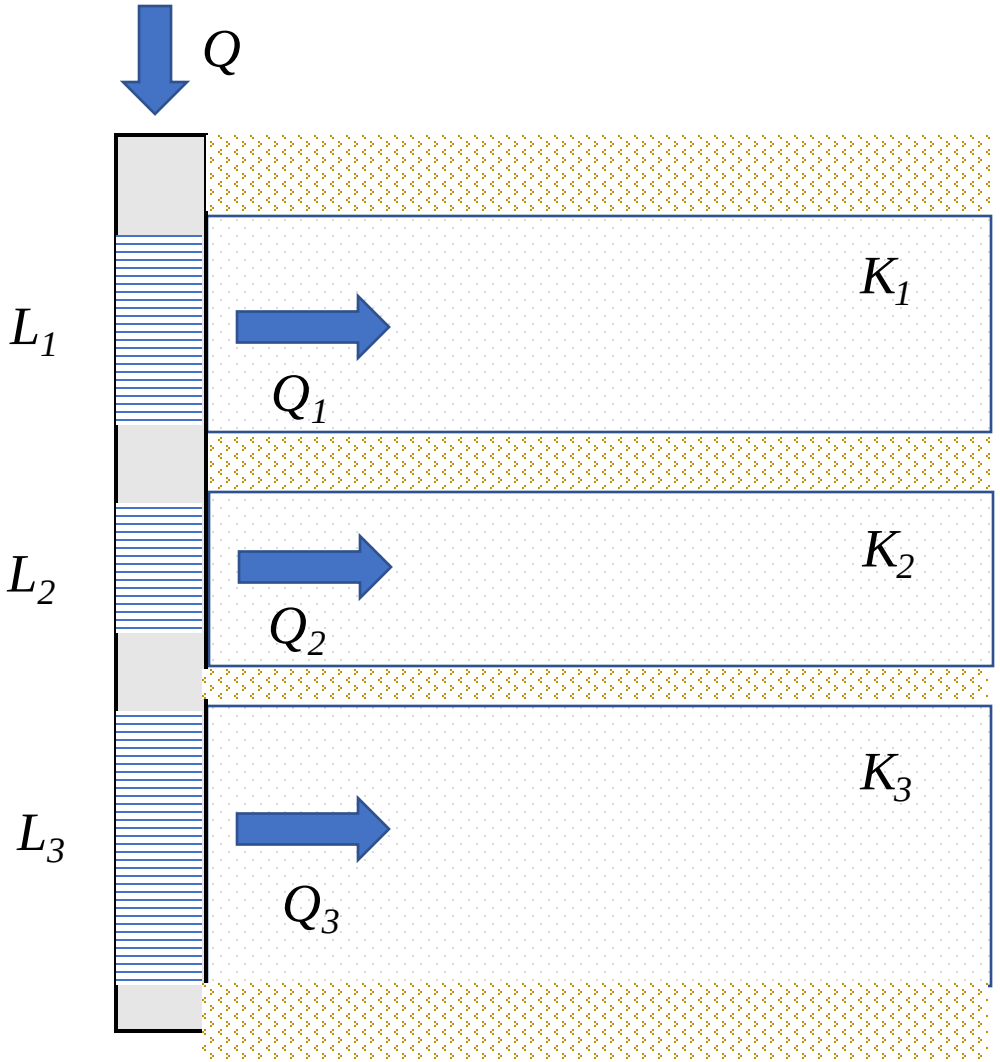
$$C_{Rel,i}(r,t) = \frac{1}{2}\,\mathrm{erfc}\left[\frac{r - R_i^*(t)}{\sqrt{\frac{4}{3}\alpha_{L,i}R_i^*(t)}}\right]$$

$$R_i^*(t) = \sqrt{\frac{V_i{}^*(t)}{\pi n_i b_i}}$$

$$V_i{}^*(t) = [Q_i(\mathrm{t})\Delta t] + V_i{}^*(t - \Delta t)$$

Meredith Bullard Martinez

Advection: Dominant transport mechanism at SWIFTRC driven by *flow rate distribution* at the recharge well (TW-1)

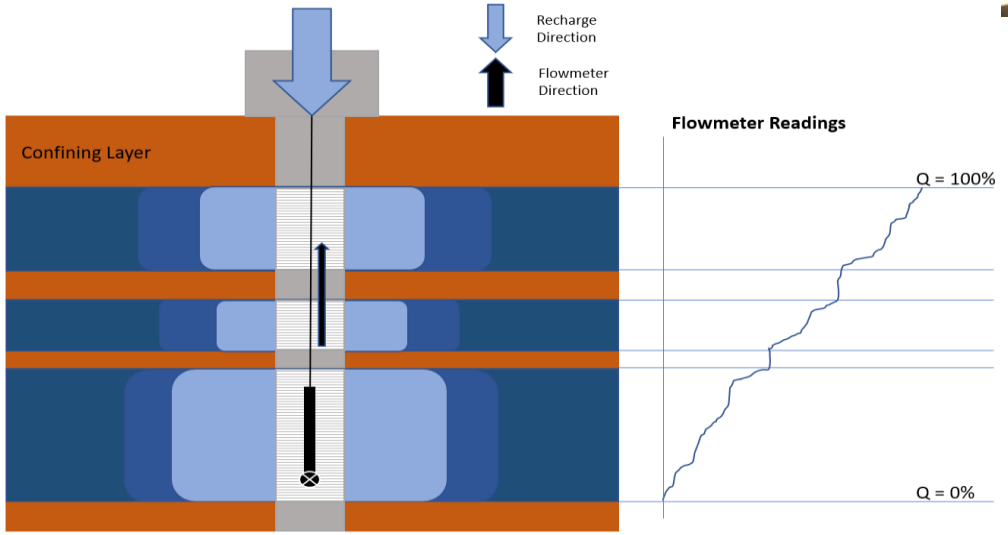


Flow Rate Distribution: Multi-Screen, Multi-Aquifer Well

$$Q_i = Q \frac{K_i L_i}{\sum_1^N K_i L_i}$$

$$Q_i = Q \frac{C_i K_i L_i}{\sum_1^N C_i K_i L_i}$$

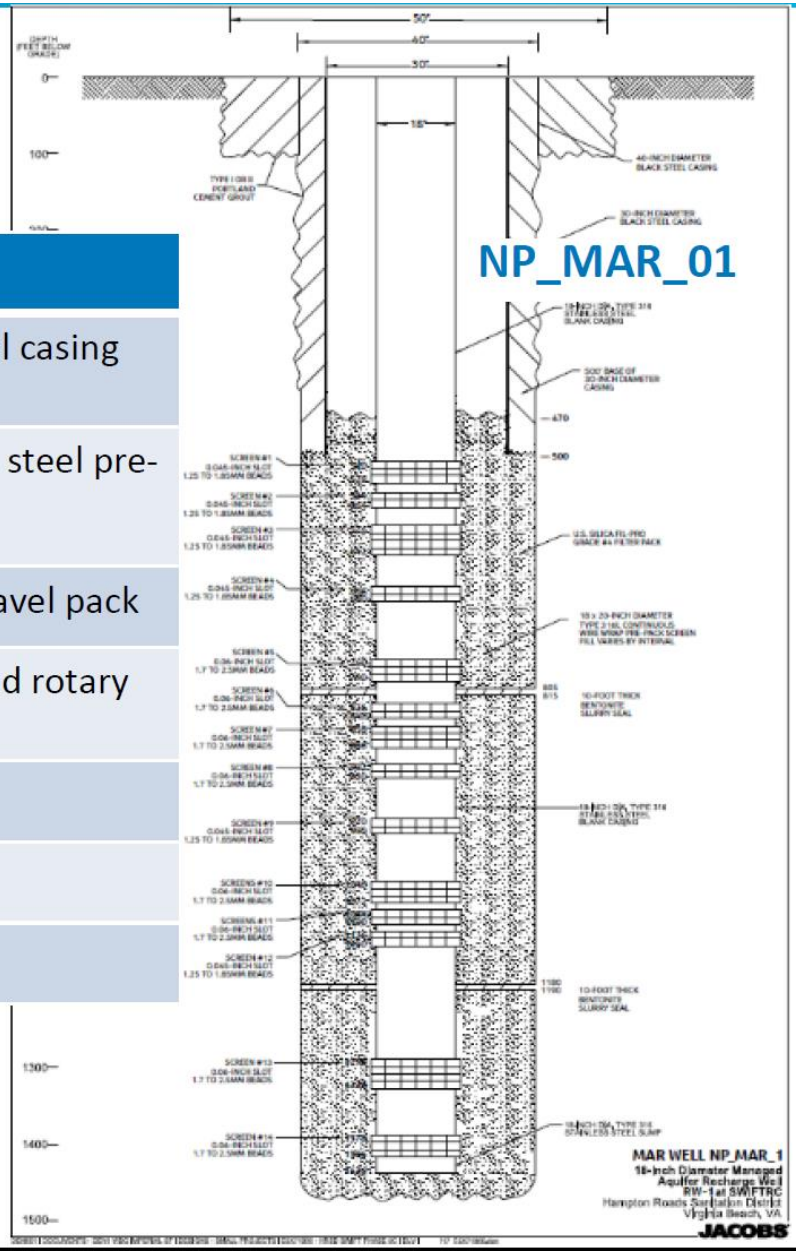
Flow Rate Distribution: In-Situ Flowmeter

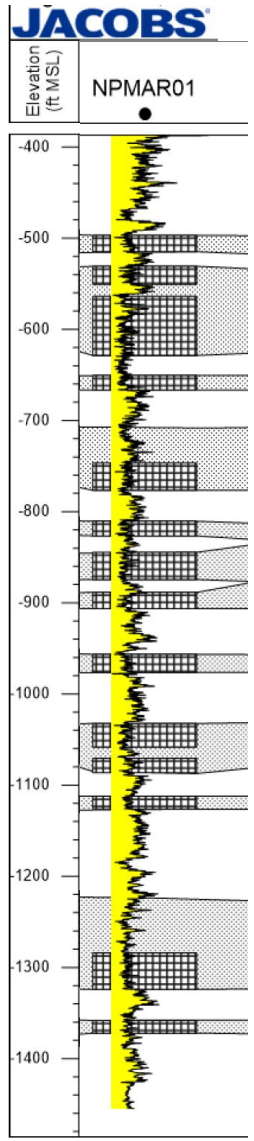


Flowmeter Tests (Jacobs and VT)		
TW-1	Post-Rehab I (2019)	Recharge/Pumping
TW-1	Post-Rehab II (2020)	Pumping only
MAR-01	Pre-Conditioning (2021)	Pumping only
MAR-01	Post-Conditioning (2022)	Pumping only

MAR-01: Multi-Screen, Multi-Aquifer Recharge Well

NP_MAR_01
30” 316L stainless steel casing
18”x20” 316L stainless steel pre-packed screen
Si spherical beads + gravel pack
Reverse circulation mud rotary drilling
Overlap construction
14 screen zones
342’ of screen



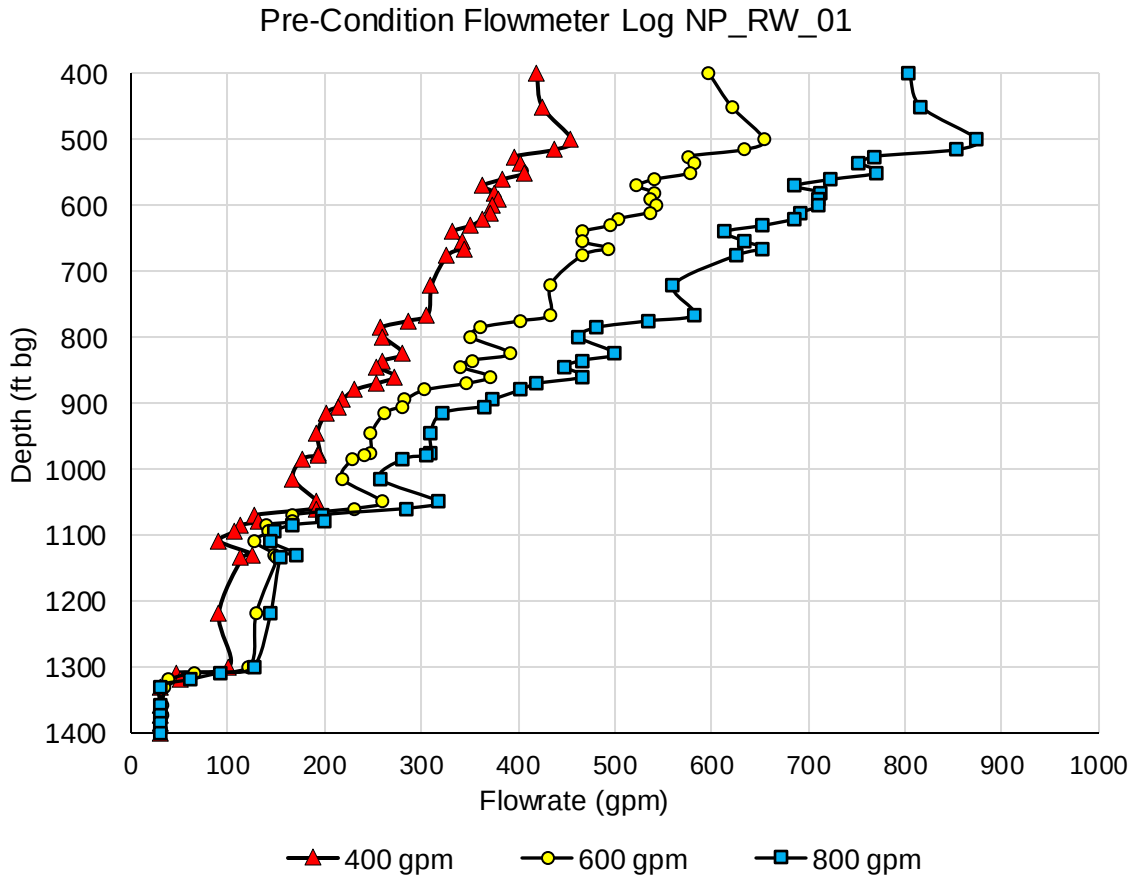


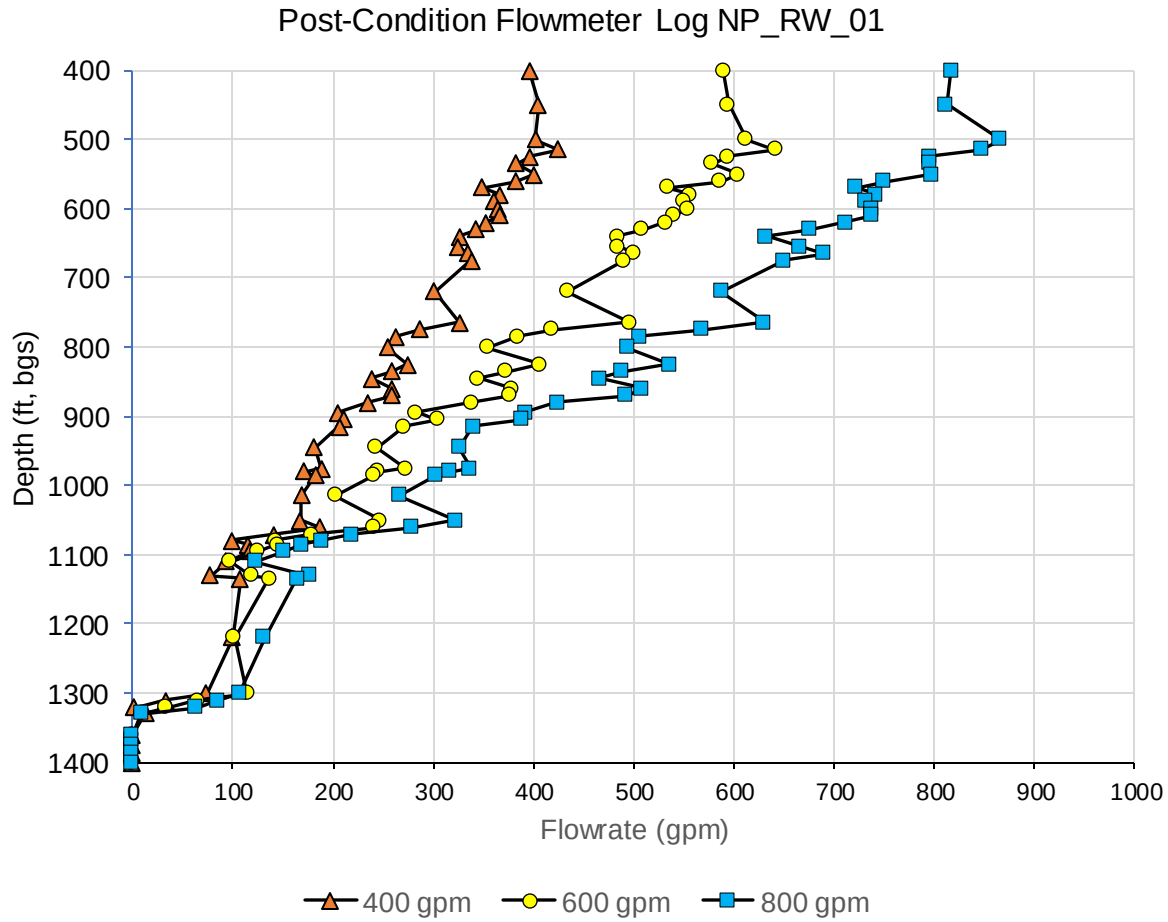
UPA

MPA

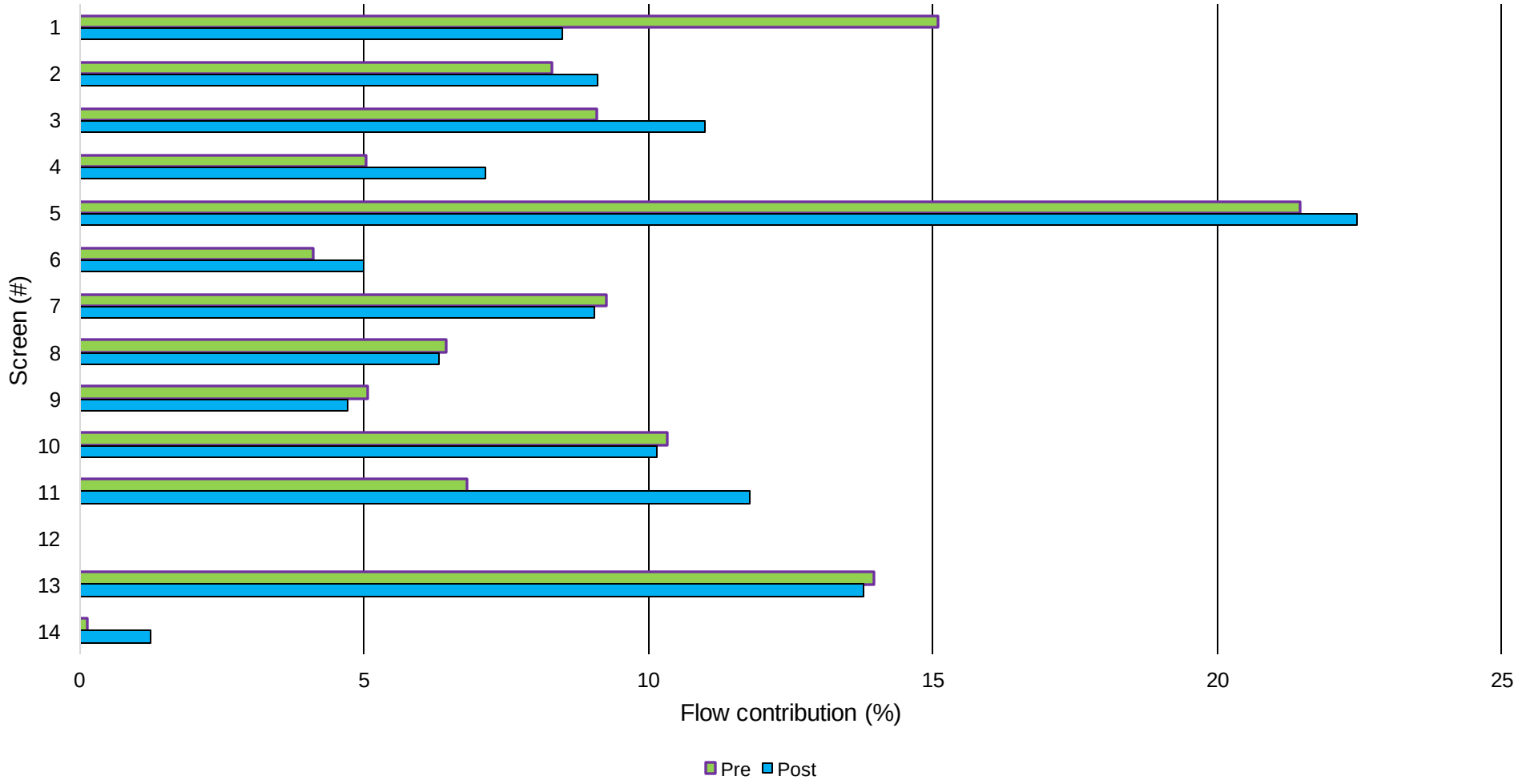
LPA

Flowmeter Results

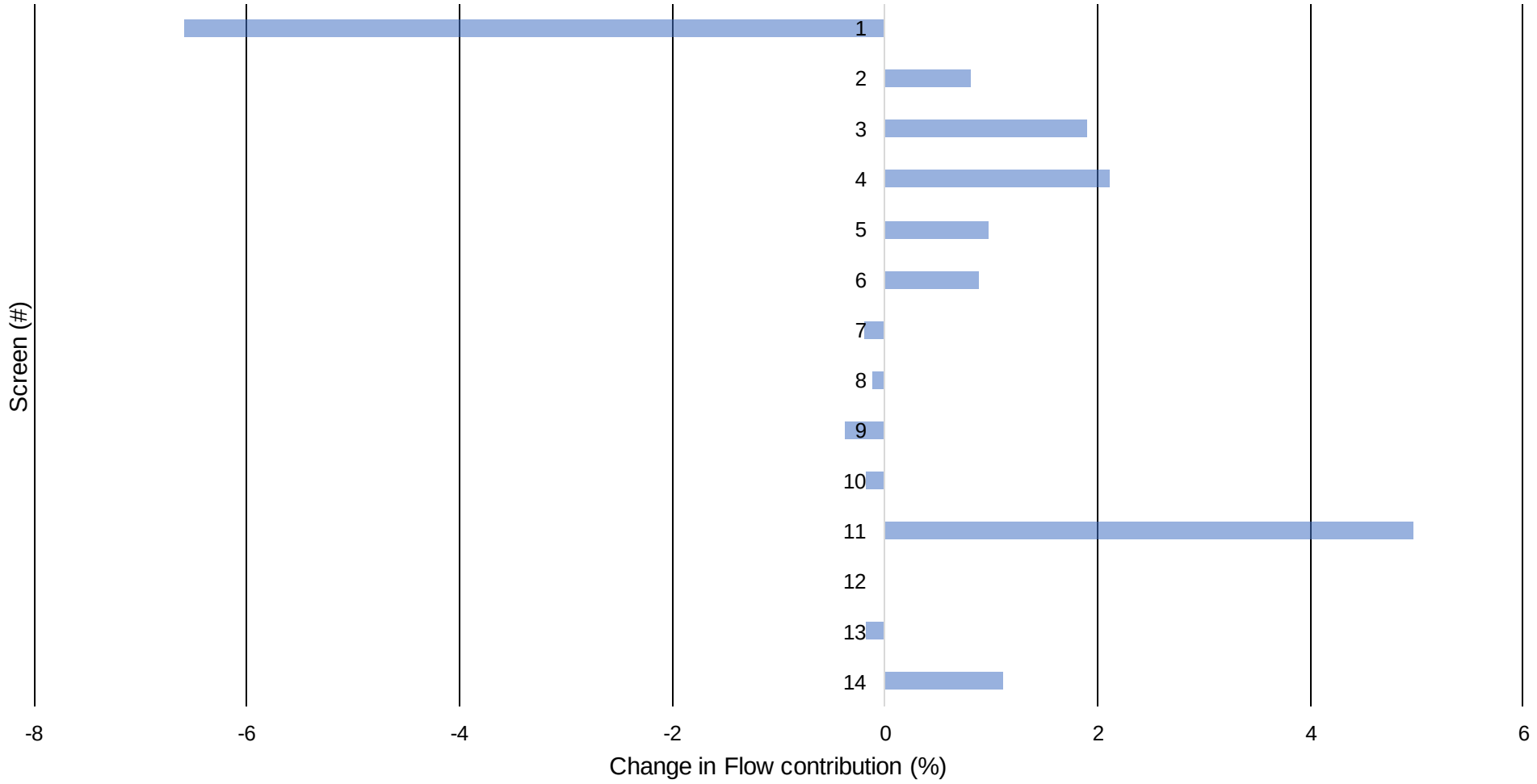




Flowmeter Results



Flowmeter Results



Improved Understanding of Local Impacts to Groundwater

- Flowmeter-measured flow rate distribution is a novel and useful method to directly quantify local impacts.
- Correlation with indirect measurements (e.g., water levels) will be investigated with MAR-01 online (Summer 2022)
- Results derived from SWIFT RC are applicable to full-scale implementation of SWIFT, including James River

Groundwater Research Papers:

- "Managed Aquifer Recharge: Transport and Attenuation in a Coastal Plain Aquifer" (EWRI Conference Proceedings, 2019)
- "Demonstration of Managed Aquifer Recharge in a Coastal Plain Aquifer: Lessons Learned" (*Groundwater*, in press)
- "Evaluating Flow Distribution in a Multiaquifer Recharge Well Using an In-situ Flowmeter" (ready to submit)
- "Multiple Tracers to Evaluate Flow Through a Multi-Layered Aquifer Using a Novel Transport Approximation" (in prep)
- "Forced Gradient Tracer Test in a Multiscreen, Multi-Aquifer Recharge Well" (in prep)

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