Metropolitan Water Reclamation District of Greater Chicago

Welcome to the July Edition
of the 2025 M&R Seminar Series

NOTES FOR SEMINAR ATTENDEES

- Remote attendees' microphones are muted at entry to minimize background noise. For attendees in the auditorium, please silence your phones.
- A question and answer (Q/A) session will follow the presentation.
- For remote attendees, please use "**Chat**" only to type questions for the presenter. For other issues, please send emails to MnRseminers@mwrd.org. For attendees in the auditorium, please raise your hand and wait for the microphone to ask a verbal question during the Q/A session.
- The presentation slides will be posted on the MWRD website after the seminar.
- This seminar is pending approval by the Engineering Society of Illinois (ESI) for one PDH and pending approval by the IEPA for one TCH. Certificates will be issued only to participants who attend the entire presentation. For PDH certificate seekers, **completing a brief course evaluation and submitting it are required**.

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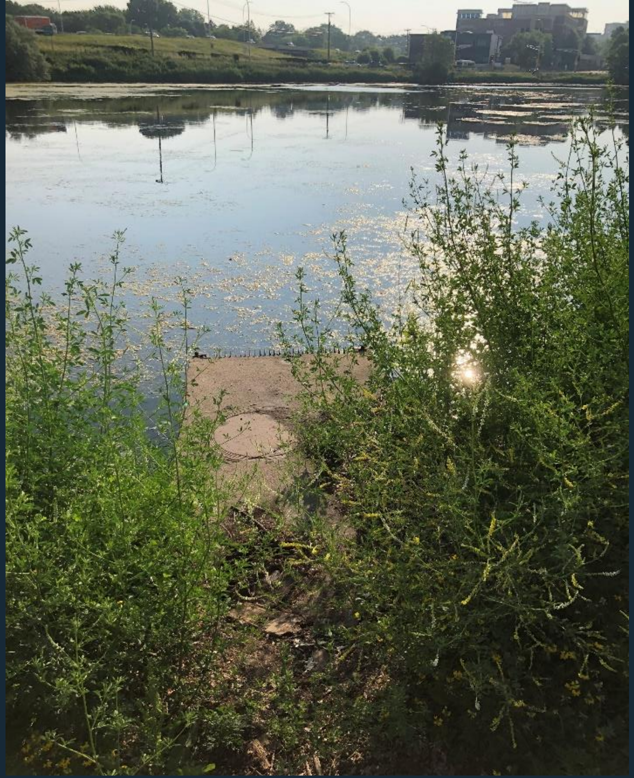
Andy is an environmental engineer at Barr Engineering, based in Minneapolis, Minnesota. He specializes in aquatic chemistry and physical/chemical water treatment. His work spans stormwater treatment, mine water treatment, and water treatment applications for trace organic constituents. He holds a Ph.D. in Civil Engineering from the University of Minnesota-Twin Cities and bachelor’s degrees in Biochemistry and Chemistry from the University of Minnesota-Duluth.

For PDH Certificate seekers,

the course evaluation form and instructions will be emailed to attendees after the seminar.



Phosphorus Removal Filter Performance in an Urban Watershed

Metropolitan Water Reclamation District of Greater Chicago
Monitoring and Research Seminar Series

Andy McCabe
July 25, 2025

9 MILE CREEK WATERSHED DISTRICT

CITY OF EDINA, MINNESOTA

BARR®

Acknowledgements

Funding:

Water Resources Center
University of Minnesota
Driven to Discover℠

9 Mile Creek Watershed District

Clean Water Land & Legacy Amendment

Minnesota Stormwater Research Council

Project Team:

Name	Affiliation	Role
Randy Anhorn	NMCWD	Co-Principal Investigator (Jun. 2022 – Dec. 2023)
Erica Sniegowski	NMCWD	Co-Principal Investigator (Jan. 2024 – Mar. 2025)
Andy McCabe, PhD	Barr Engineering Co.	Co-Principal Investigator
Keith Pilgrim, PhD	Barr Engineering Co.	Co-Principal Investigator
Janna Kieffer, PE	Barr Engineering Co.	NMCWD District Engineer
Ross Bintner	City of Edina	Technical advisor
Nathan Kaderlik	City of Edina	Lead operations and maintenance
Sorel Nelson	Barr Engineering Co.	Lead sampling and data analysis
Terri Olson	Barr Engineering Co.	Data quality specialist
Anna Schneider	Barr Engineering Co.	Data management lead

Agenda

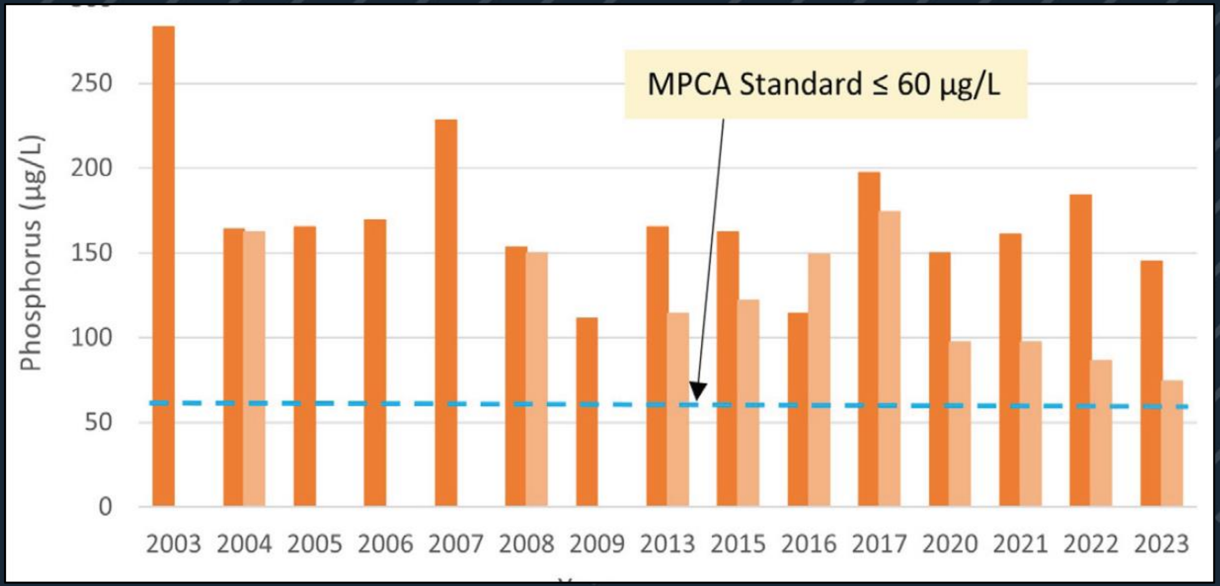
1. Introduction to the Rosland Park Filtration System
2. Research Project Overview – Performance Monitoring Program
3. Operations and Maintenance
4. Cost-benefit and Scalability
5. Closing

Project Location

- 10 minutes west of MSP Int’l Airport
- At the southeast corner of the interchange between MN-100 and MN-62
- The Filtration System is sited northeast of the North Basin of Lake Cornelia in Rosland Park
- Rosland Park (4300 W 66th St in Edina)
  - 22-acre park
  - Lots of amenities (disc golf, playground, community pool, pickleball, 1.1-mi multiuse trail, etc.)

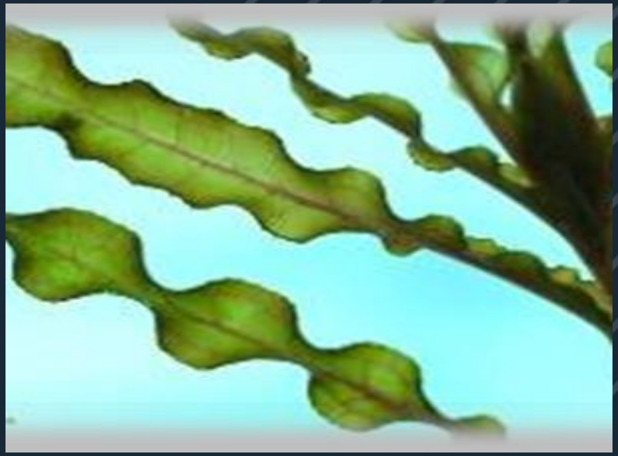
Lake Cornelia

- Lake Cornelia is a shallow urban lake (average depth 3-4 ft)
- Lake Cornelia receives runoff from a highly impervious watershed
- Generally poor water quality
- Frequent blue-green algae blooms
- A 2018 TMDL study identified a phosphorus load reduction goal for North Cornelia



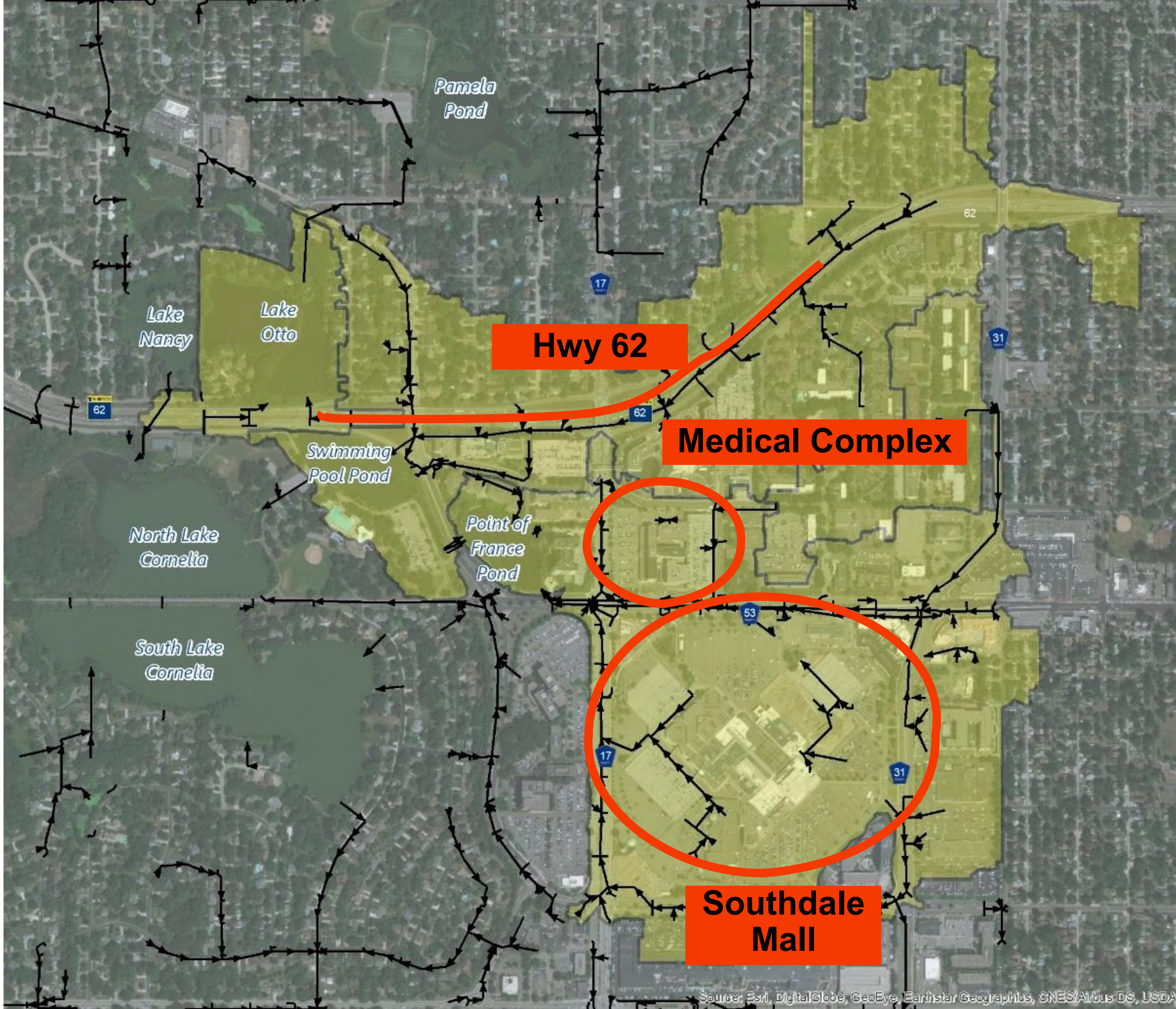
Lake Cornelia Water Quality Improvements

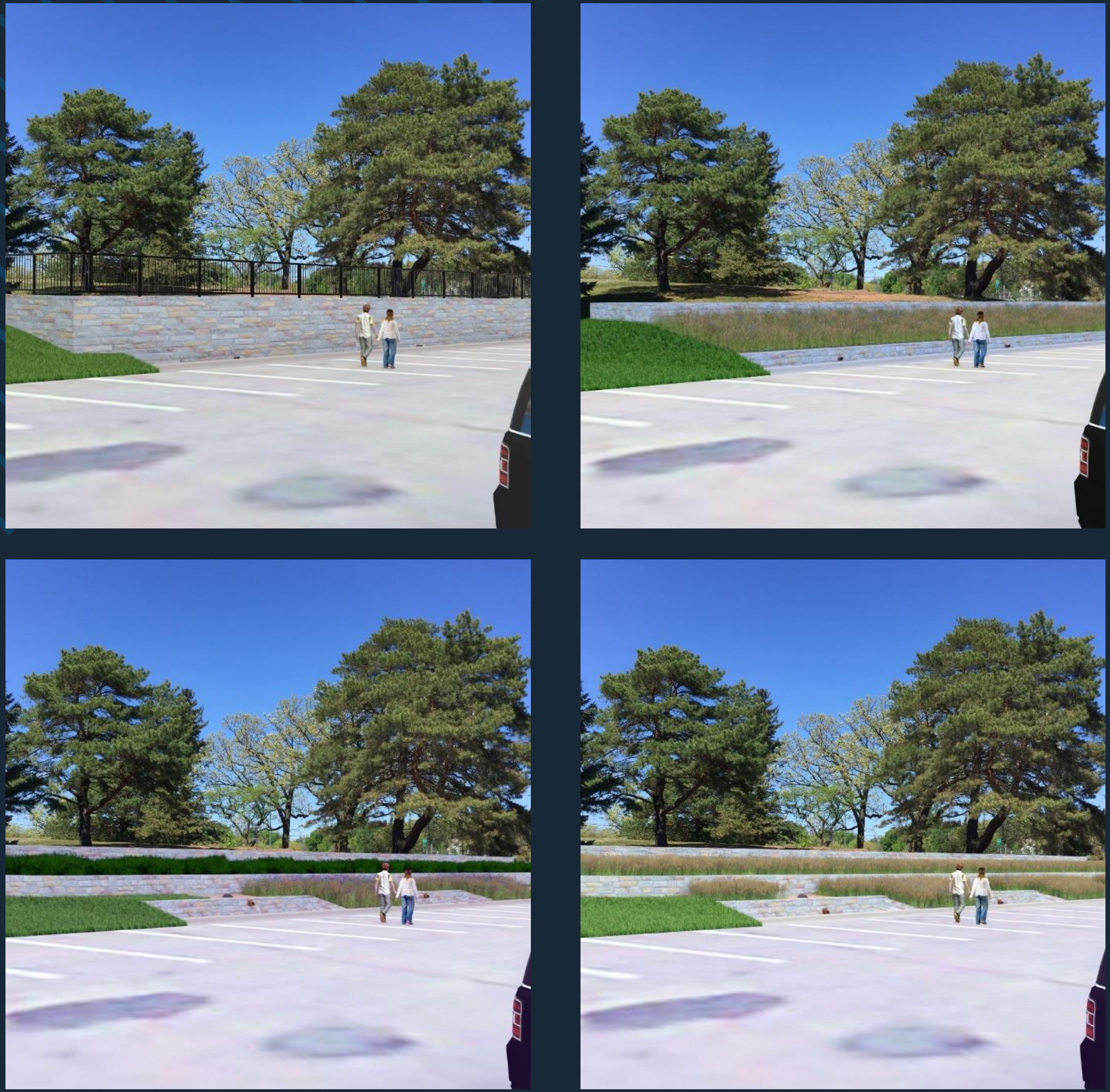
- Primary phosphorus sources to Lake Cornelia include watershed runoff (external sources) and in-lake sources (internal sources)
- Improvements since 2019 to address in-lake phosphorus sources include:
  - alum treatment to minimize sediment P release (spring 2020)
  - curly-leaf pondweed treatments
  - goldfish management
- Enhanced street-sweeping of subwatershed



Swimming Pool Pond

- Receives runoff from 410 acres (shaded in yellow), which represents 47% of the total area tributary to North Lake Cornelia (total of 863 acres)
- Collects much of the runoff from the commercial area to the east, including Southdale Center and the medical complex, and a stretch of Hwy 62





Renderings showing the evolution of Filtration System design

Rosland Park Filtration System

Objectives:

- Address external phosphorus loading to Lake Cornelia
- BMP required a small footprint to preserve greenspace
- Utilize existing storage capacity to provide a (near) continuous source of water

Construction

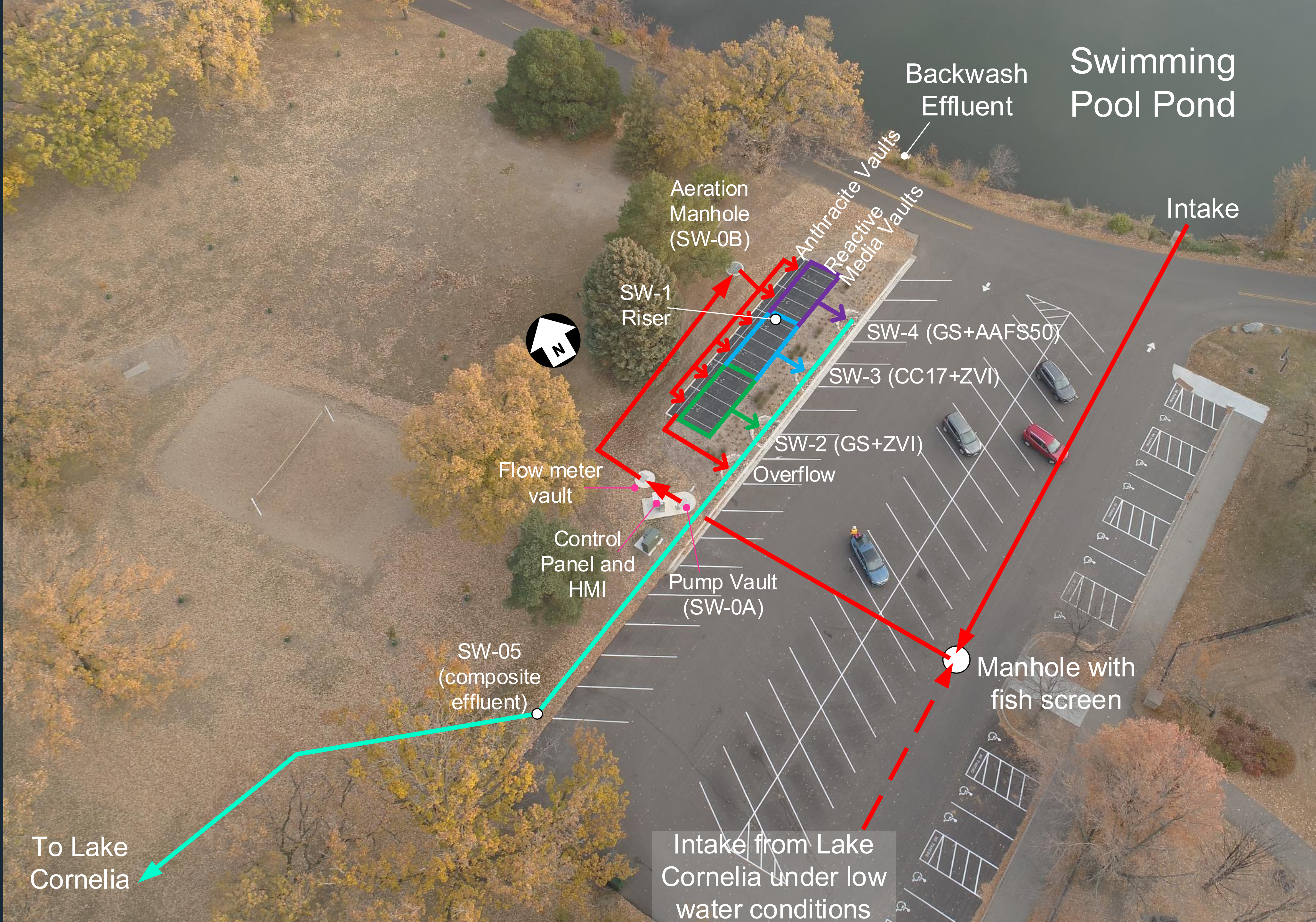
- The System was constructed in 2021 through early 2022
- It was started-up during the summer of 2022
- The monitoring program kicked-off in August 2022, supported by the Minnesota Stormwater Research Council and NMCWD

Hennepin

CLEAN WATER LAND & LEGACY AMENDMENT

MINNESOTA STORMWATER RESEARCH COUNCIL

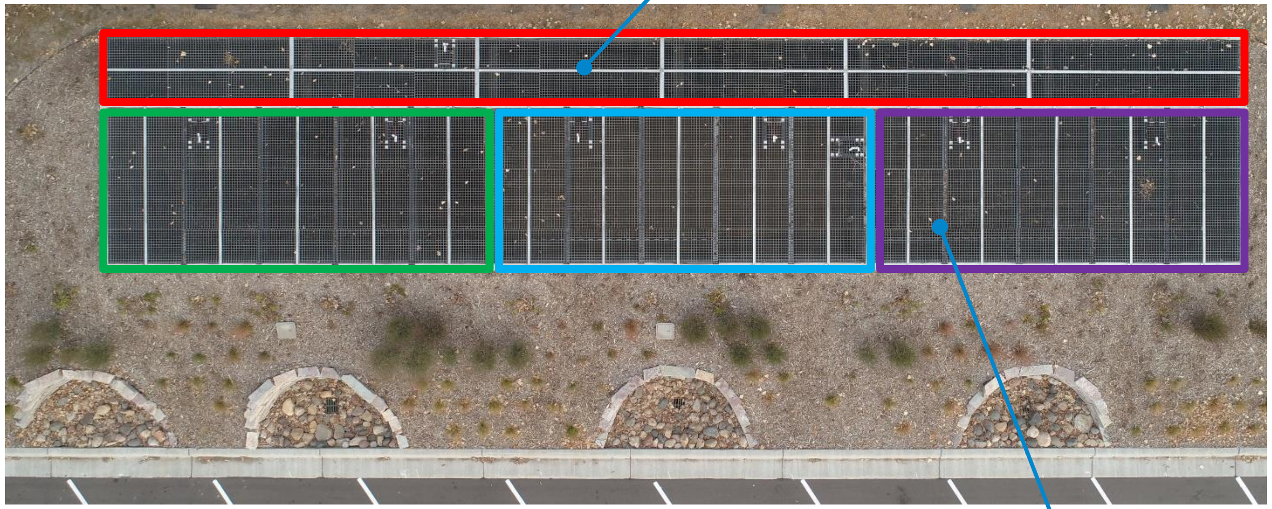
Process Flow Overview



Media Overview

- Cell 1: Anthracite pre-filtration
    - Intended to remove particulate material
    - This cell is backwashable with the backwash water sourced and returned to Swimming Pool Pond
- Cell 2: Granite Sand + Zero Valent Iron (ZVI)
    - Mixed at a 5% by weight ratio
    - ZVI sourced from Connelly GPM
- Cell 3: CC17 + ZVI
    - CC17 is a coarse calcium carbonate material
    - Mixed at a 5% by weight ratio
    - CC17 sourced from Superior Minerals, in Savage (ask for “beak and bone”)
- Cell 4: Granite Sand + Composite Media AAFS50
    - Mixed at a 10% by weight ratio
    - AAFS50 is a composite of activated alumina and iron oxide
    - Sourced from Delta Adsorbents

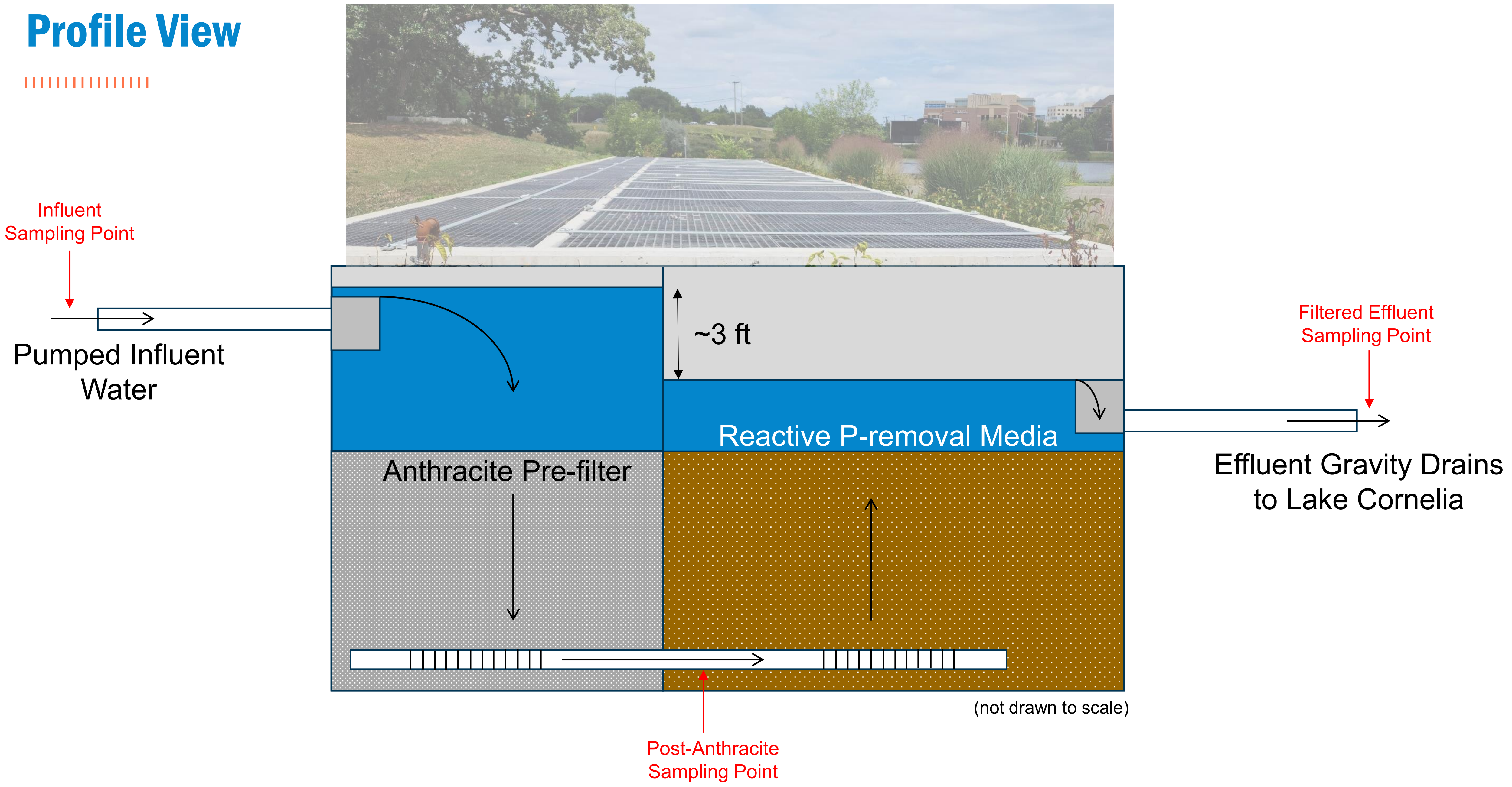
Cell 1 is split into 6 chambers to facilitate backwash



Overhead drone photo of the filter cells.

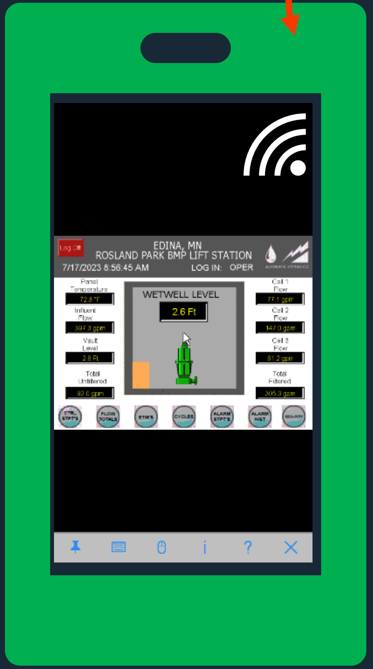
Cells 2, 3, & 4 operate in parallel

Filter Vault Profile View



System Operations

- The pump operates automatically depending on the water level in the wet well
- Pump controlled via a local HMI (‘Human Machine Interface’) or mobile app
- Provides readout of:
  - Wet well level
  - Influent flow
  - Effluent flow for Cells 2, 3, and 4



Remote HMI

Local HMI

Routine Maintenance

Anthracite prefilter backwashing

- Each of the 6 cells is backwashed individually with the forward flow pump
- Manual operation which takes about 2 hours
- Frequency is dependent on algae growth
  - 1 time a week in the spring and fall
  - 2 times a week (or more) in the summer

Fish screen

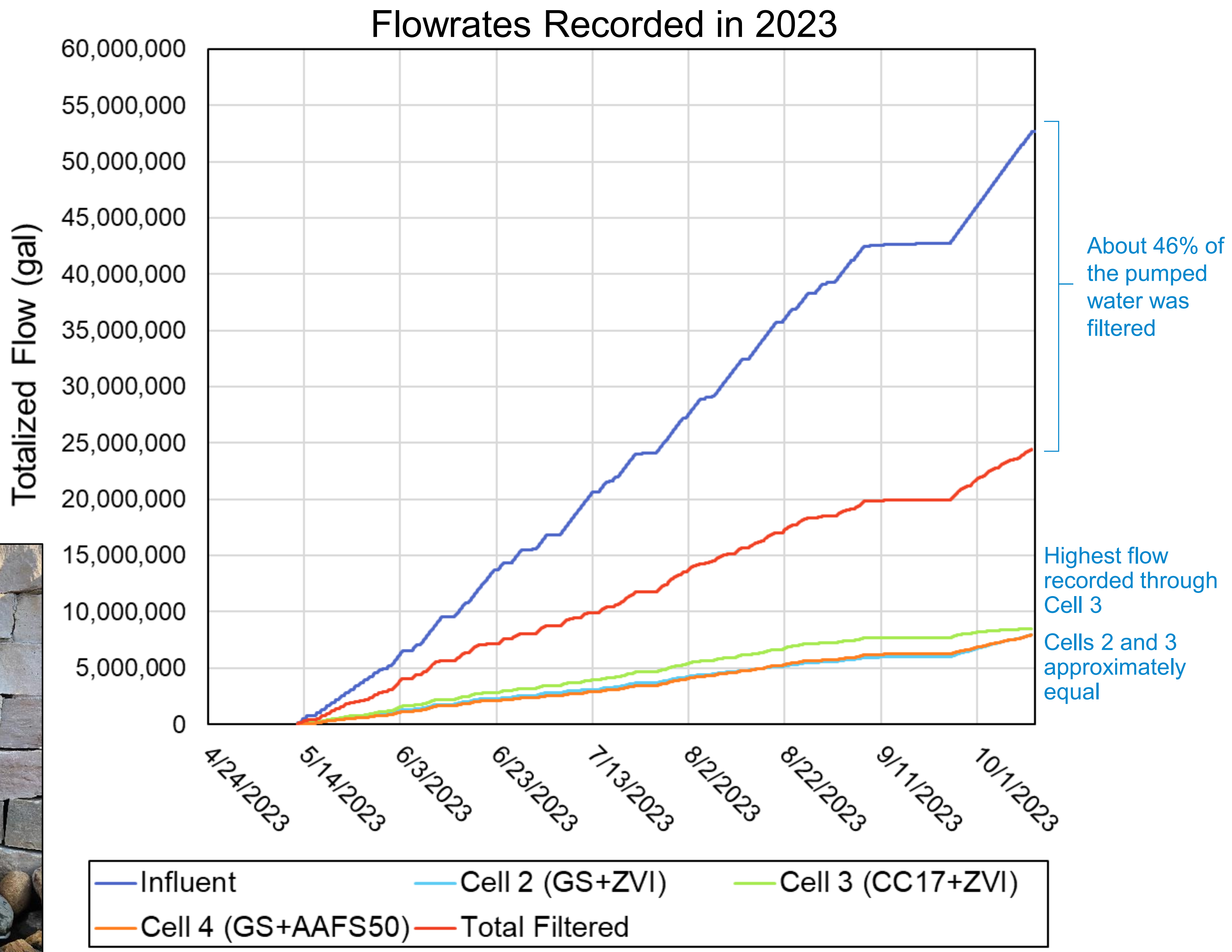
- Prevents fish and large debris from entering the pump wet well
- Needs to be cleaned on the same frequency as the backwash (or more)

Monitoring Program

- 23 sampling events between start-up in July 2022 and the end of the treatment season in 2024
- Routinely analyzed constituents include
  - Field parameters such as pH, ORP, temperature, specific conductance, and turbidity
  - Total phosphorus (TP)
  - Total dissolved phosphorus (TDP)
  - Orthophosphate
  - Total dissolved solids (TDS)
  - Total suspended solids (TSS)
  - Ammonia nitrogen
  - Total Kjeldahl nitrogen (TKN)
  - Nitrate and nitrite nitrogen
- Constituents analyzed on a reduced frequency:
  - Total alkalinity
  - Total metals (calcium, magnesium, iron, zinc, and aluminum)

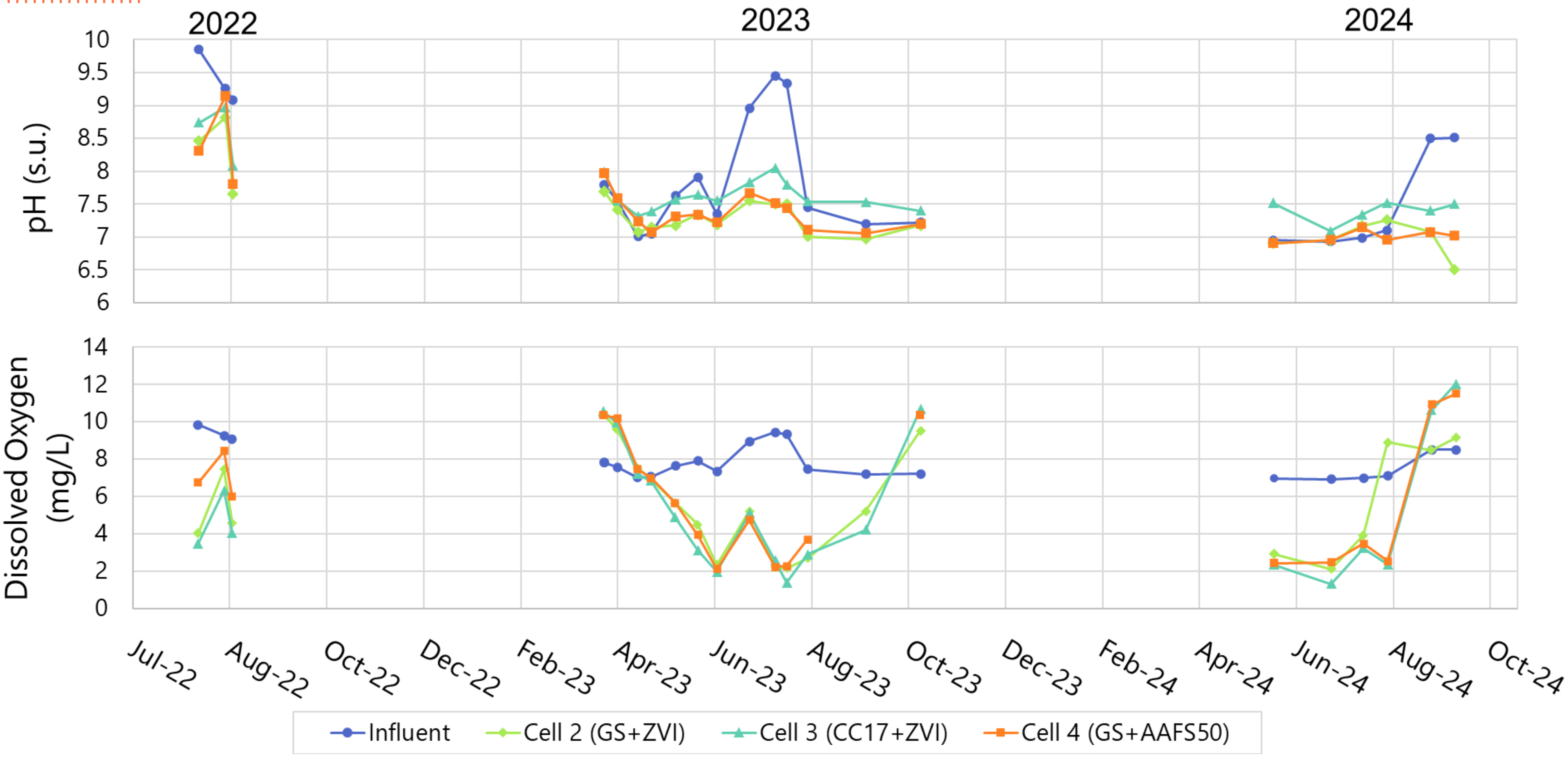
Water Flowrates

- System commissioned in July 2022
- Approx 90 million gallons pumped since July 2022
- 46% of pumped water was filtered
- Average flow to the filter ranged between 350 and 420 gpm



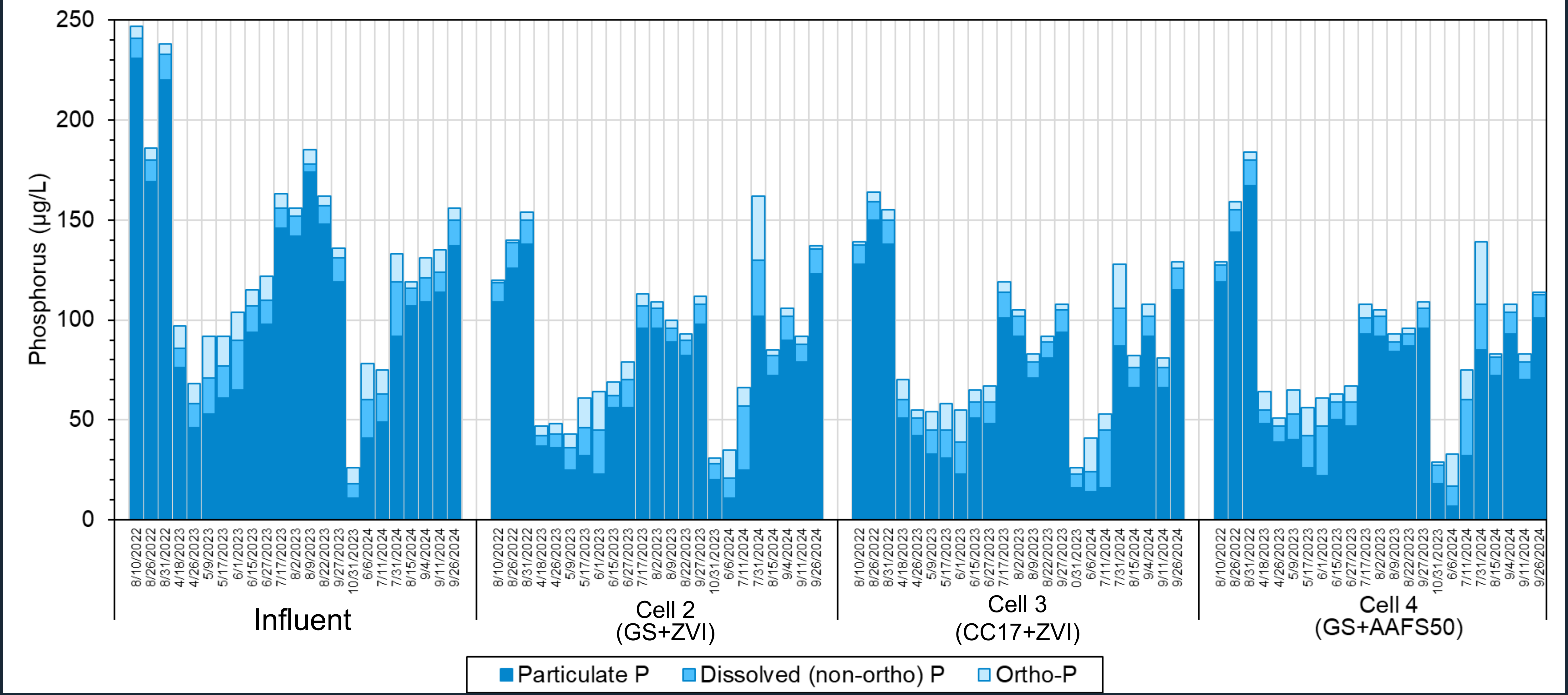
Field Water Quality Parameters

Despite times of low DO and high pH, our data suggest system is still being effective



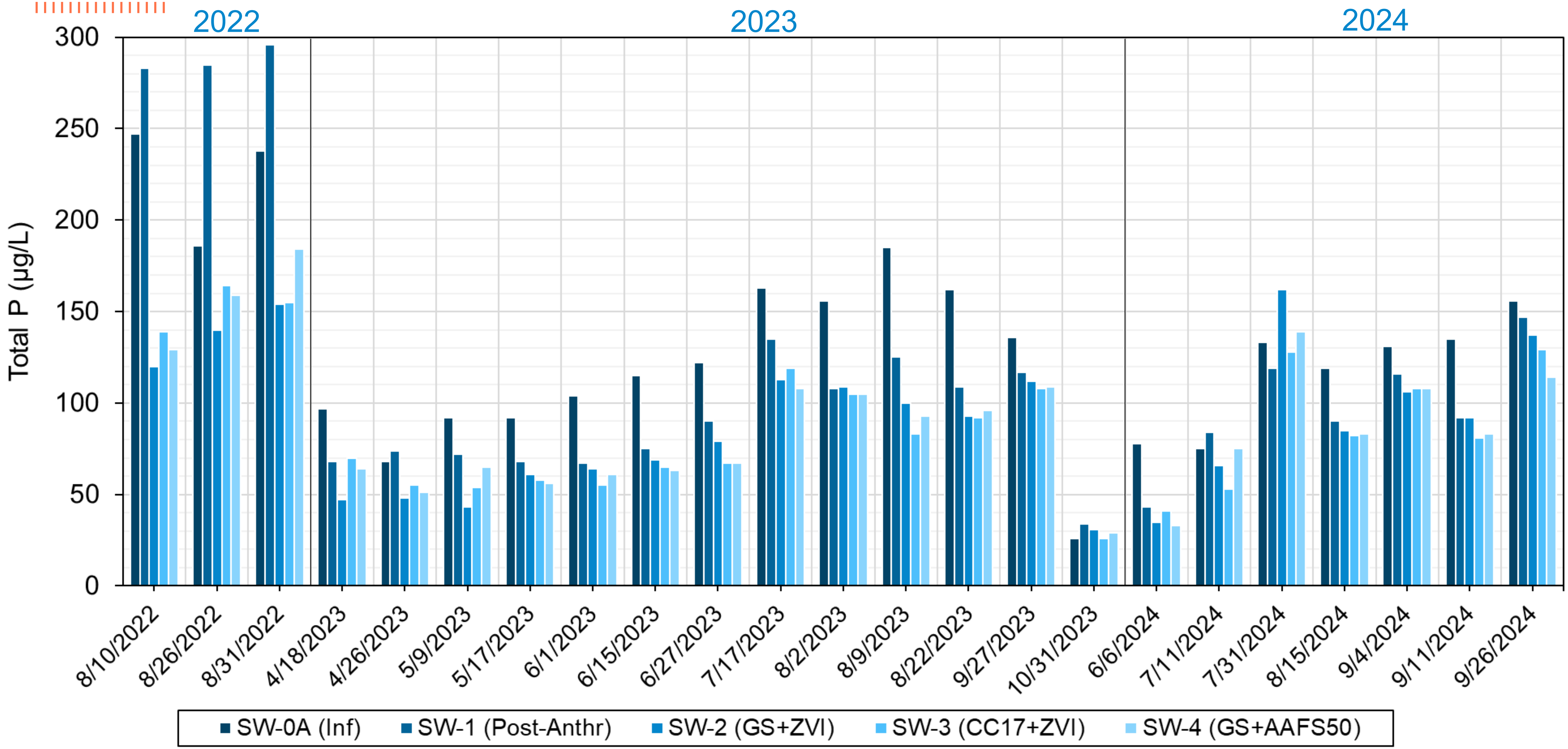
Forms of Phosphorus

- 40-90% of influent P is particulate-phase
- The rest is about evenly split between dissolved, non-ortho P and Ortho P



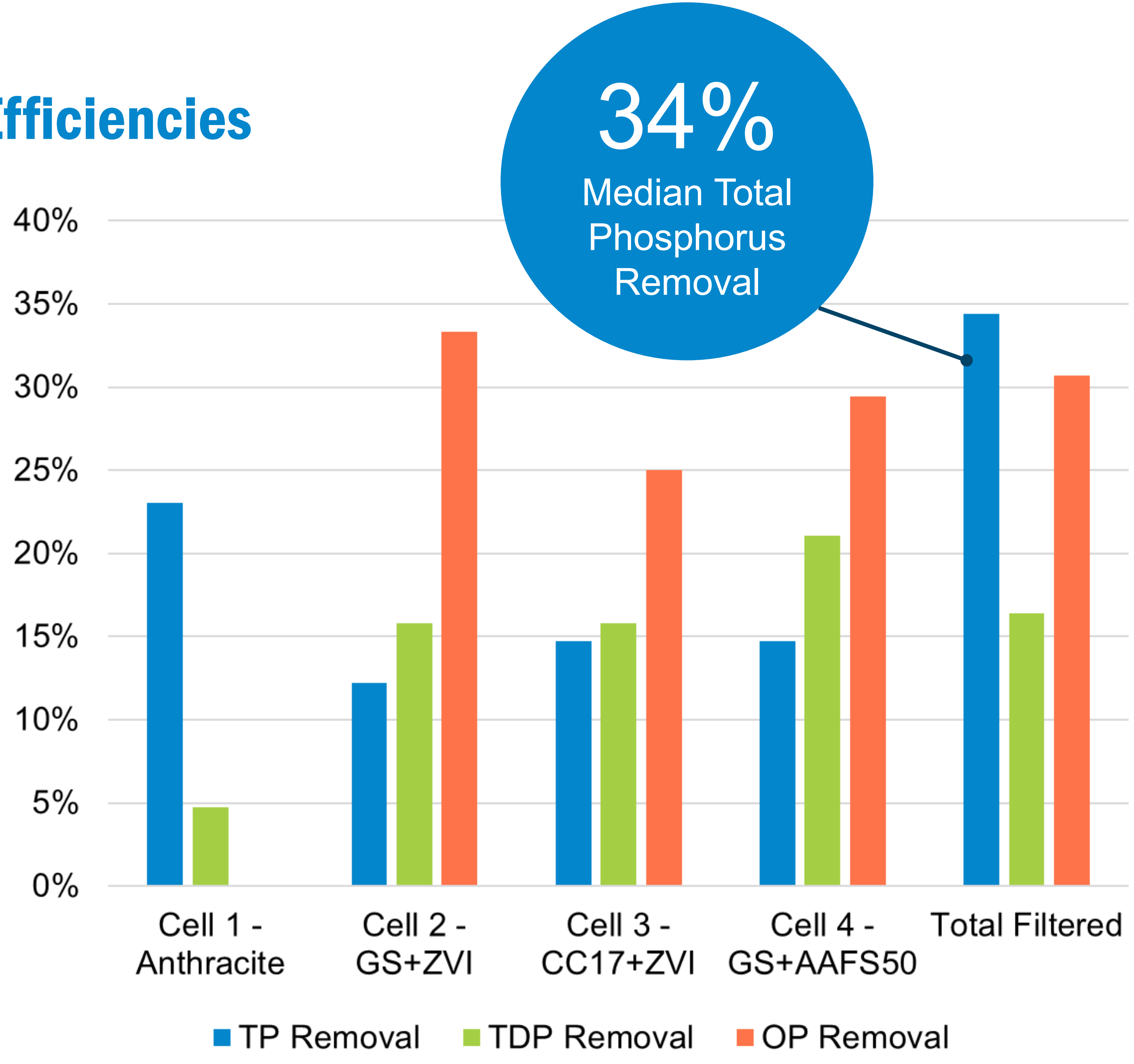
Total Phosphorus Concentrations through the System

Most of the P removal occurs through the anthracite filter because we have the highest load of particulate bound P when we operate.



Median Phosphorus Removal Efficiencies

- Total Phosphorus (TP)
  - 23% removal through Cell 1 (anthracite)
  - 12-15% removal through sorption media
  - Lower removal of TP through Cell 2 (Granite sand+ZVI), likely due to iron fusing
- Total dissolved phosphorus (TDP)
  - Almost no removal through Cell 1
  - 16-21% removal through sorption media
- Orthophosphate (OP)
  - No removal through Cell 1
  - 25-33% removal through the sorption media filters



Operational Troubleshooting

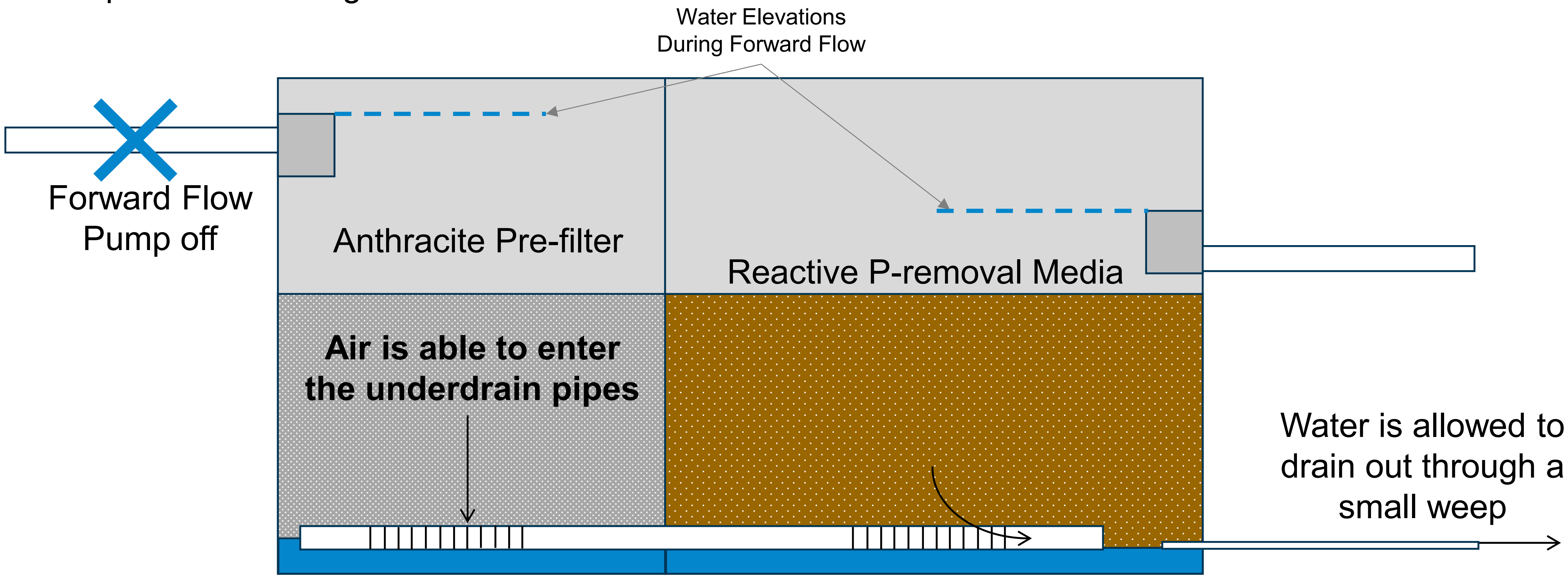
- **Backwashing effectiveness**
  - ➢ Backwash process not resulting in uniform cleaning of anthracite material
- **Up-flow filter cells**
  - ➢ Fusing of the iron-based filter media in up-flow filter cells
  - ➢ Causing preferential flow paths, especially along wall
- **Air entrapment**
  - ➢ Air "locking" in pretreatment media reduces flow to up-flow filters
  - ➢ Observed more frequently with 12-hour on/off cycles

Planned Improvements

- **Installing a higher capacity pump** with a variable frequency drive (VFD) to control pump speed
  - More effective backwash cycles
  - Key design consideration: Temperature of the influent water
  - Challenge: Where to draw 700 gpm of flow?
- **Address media fusing**
  - Hand tools (like shovels and electric chisel) are not practical
  - Tiller on the surface won't mix the entire bed depth (2')
  - Tentative plan to use backhoe/mini-excavator to break-up the fused media

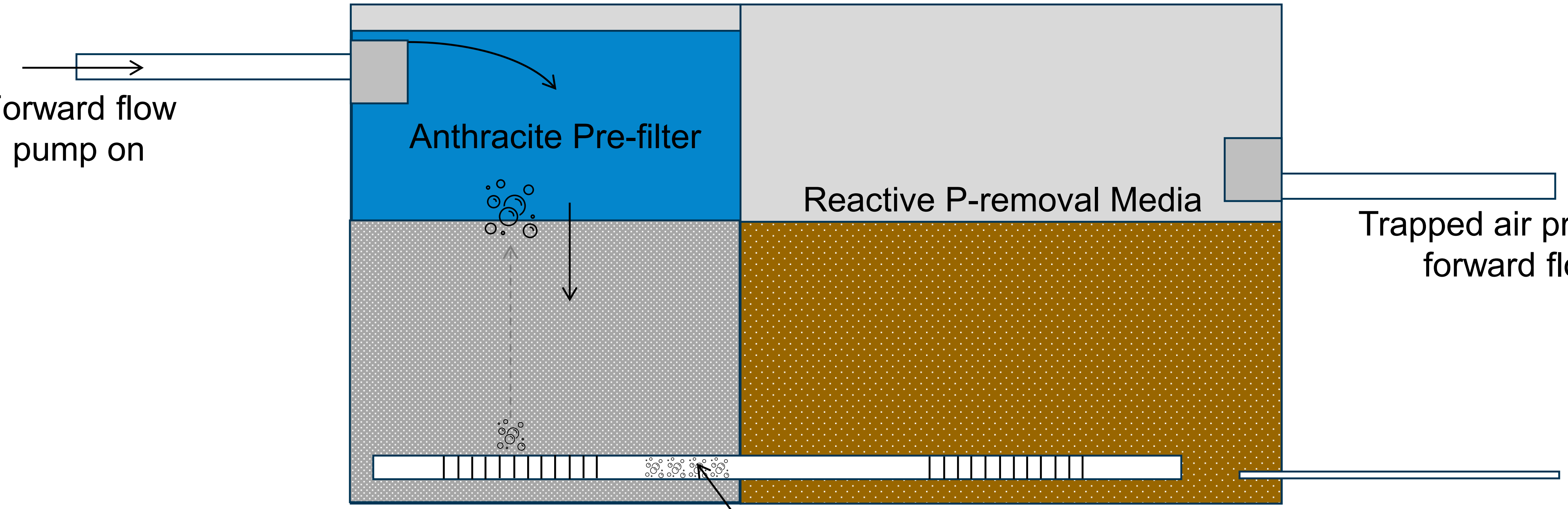
Planned Improvements cont.

- Air entrapment: How air gets in



Planned Improvements cont.

- Air entrapment: What causes the issue



<u>Planned improvement</u>:
add air relief valve to
underdrain piping

Cost Estimates

Item	Cost
Construction	$1.5 million
Annual Maintenance	$19,600/year
Annual Operating	$10,800/year
Total Annualized cost over 30 years at 3% interest	$106,900/year

Scaling by flow, this is about $4.50 per 1,000 gallons treated

Maintenance includes:

- Anthracite media replacement (from wear and tear and loss during backwash) – labor and media
- Phosphorus filter media replacement (assumed every 5 years)
- Pump maintenance and other equipment/facility maintenance

Operating Costs include:

- Routine O&M (e.g., backwashing and cleaning fish screen)
- Non-routine troubleshooting
- System electricity

Cost Benefit

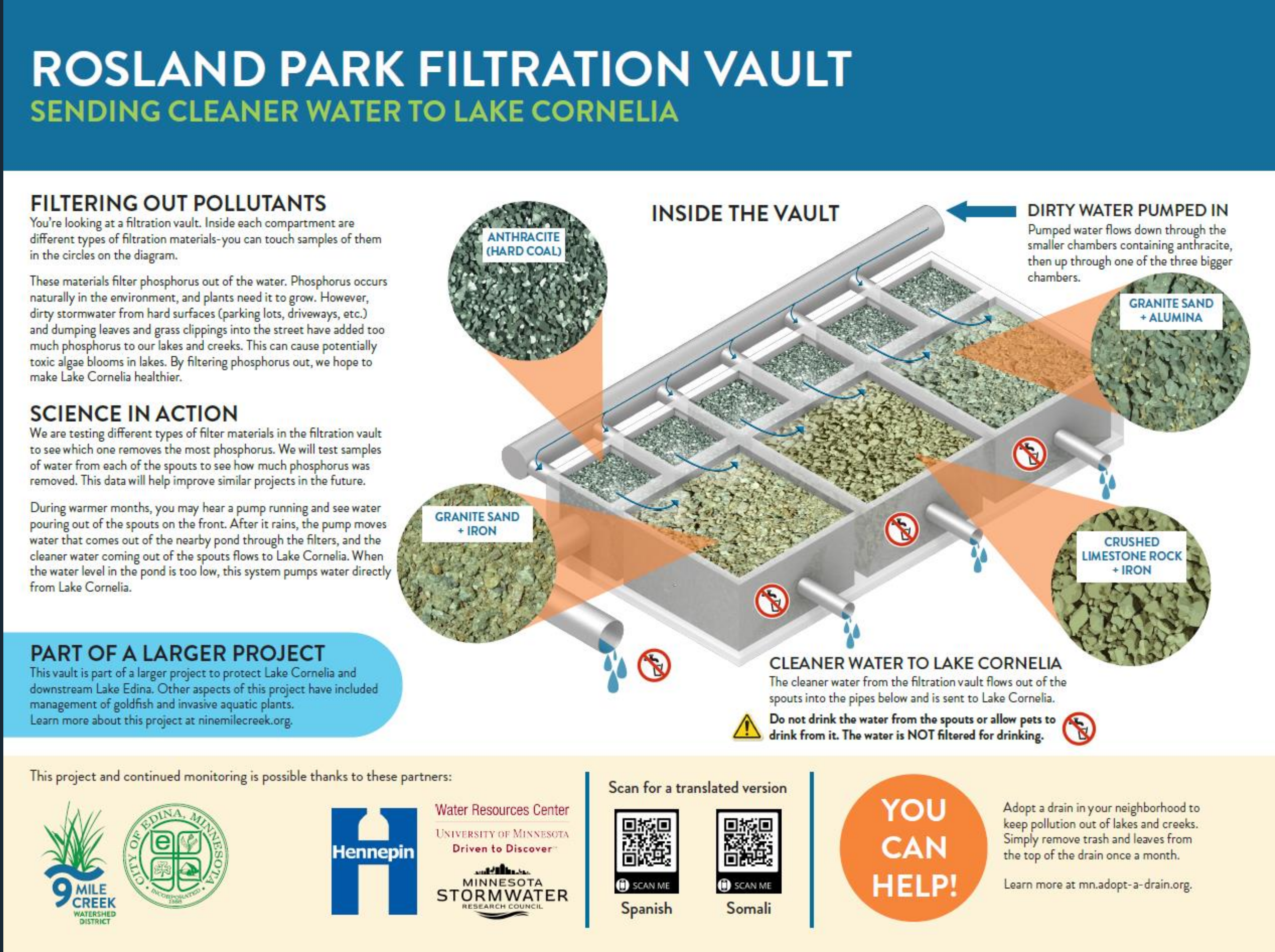
- Current: **$9,638/lb-P**
  - Based on 11.1 lbs removed in 2023
  - 14 lbs removed since start-up in July 2022

- Potential future cost-benefit: $5,400/lb-P
  - Assuming:
    - Increase filtered flow by 70% through operation optimizations
    - Increase TP removed through Cell 2 (granite sand + ZVI)

  → Equates to 19.7 lb-P/year

Come see it in action!

The System is a great ambassador to the public on urban surface water quality issues



Thank you!

Learn more:

ninemilecreek.org
& wrc.umn.edu/filter-media-p

Reach out:

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