Charlotte Water Reclaimed Water System

MALLARD CREEK WRF

MALLARD CREEK WRF

Mallard Creek WRF

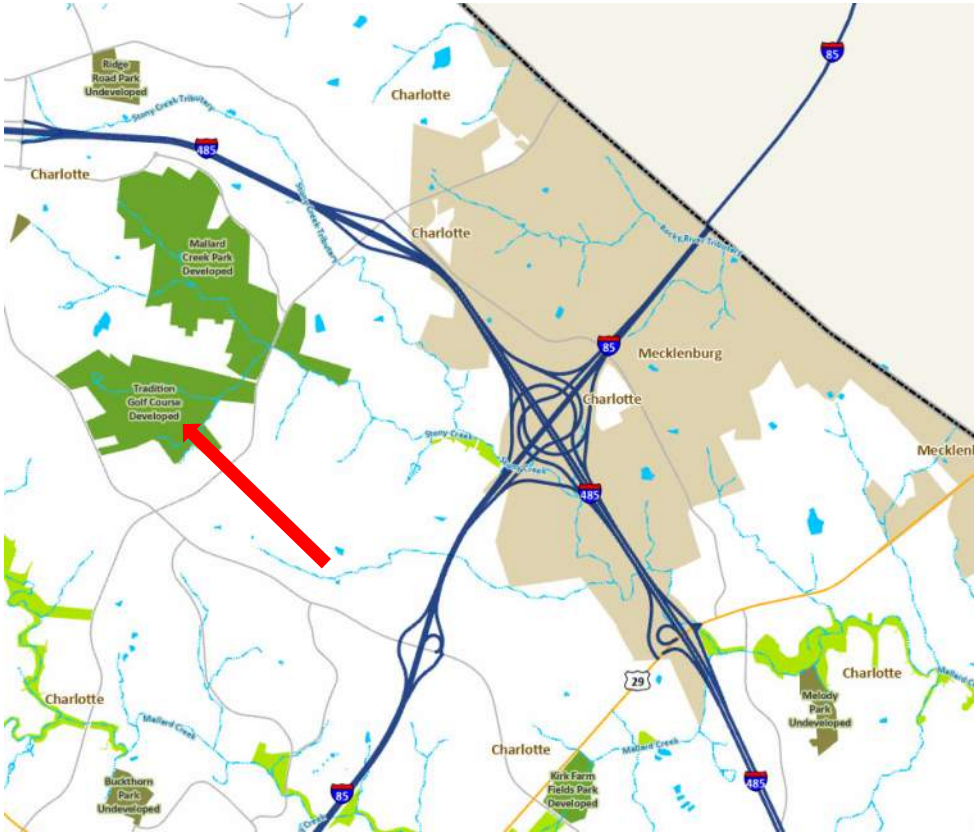
- Located near Charlotte Motor Speedway
  - Within 2 miles of the Speedway
- 4 MGD Reclaimed Permit
  - 13.1 MGD
  - Average flow 10.7 MGD
- Started in 1996
  - Pipeline started for Mecklenburg County Parks
    - *Mallard Creek Park ~ 7 miles*
    - *Tradition Golf Course ~ 6 miles*

Permitted Parameters

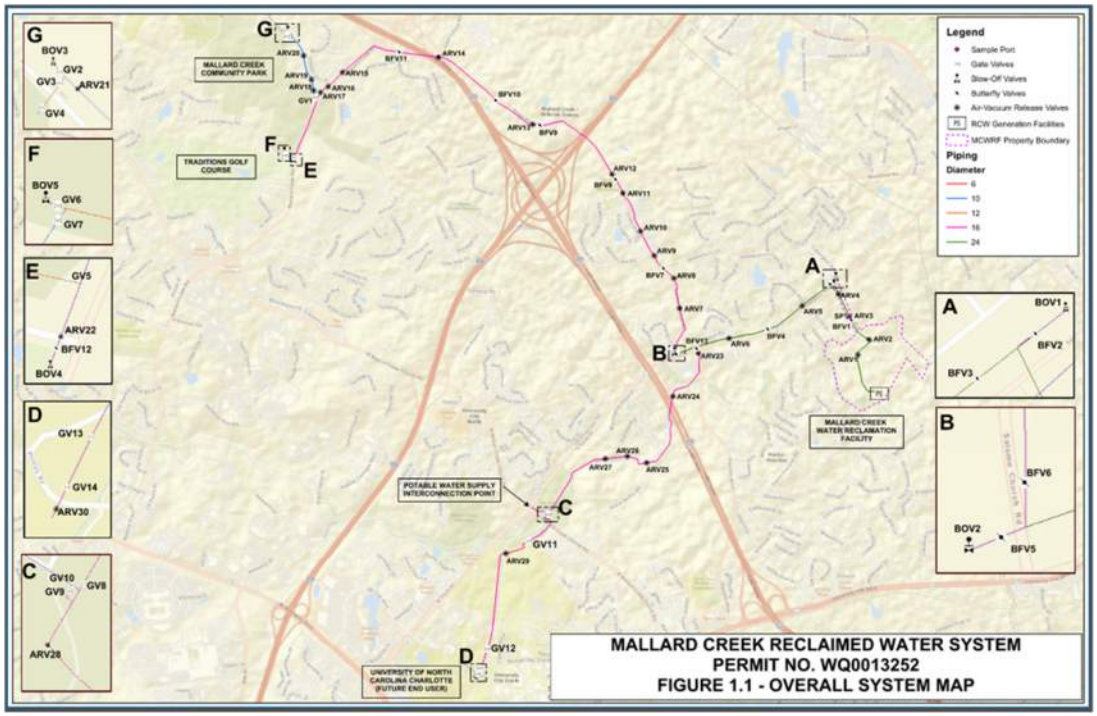
Mallard WRRF		Summer	Winter
Flow	13.1 MGD		
NH3		1.0 M / 3.0 W	2.0 M / 6.0 W
Fecal	200 M / 400 W		
Reclaimed			
Flow	4.0 MGD		
NH3	4.0 M / 6.0 D		
Fecal	14 M / 25 D		
Turbidity	***10 ntu Daily Max***		

Tradition Golf Course

- 2025 – 14.5 Million Gallons
- Savings $1.91 - $3.43 per ccf
- Reclaimed water offsets potable demand



Illicit Discharge of Polychlorinated Biphenyls (PCB's)



- 2014 – Operator notices oil substance
- Reclaimed water shut down
- Restarted Summer 2024

Life before Shutdown vs Life After

- ORC responsible from Cradle-to-Grave
- End Users have become permitted through NCDEQ

Education Program

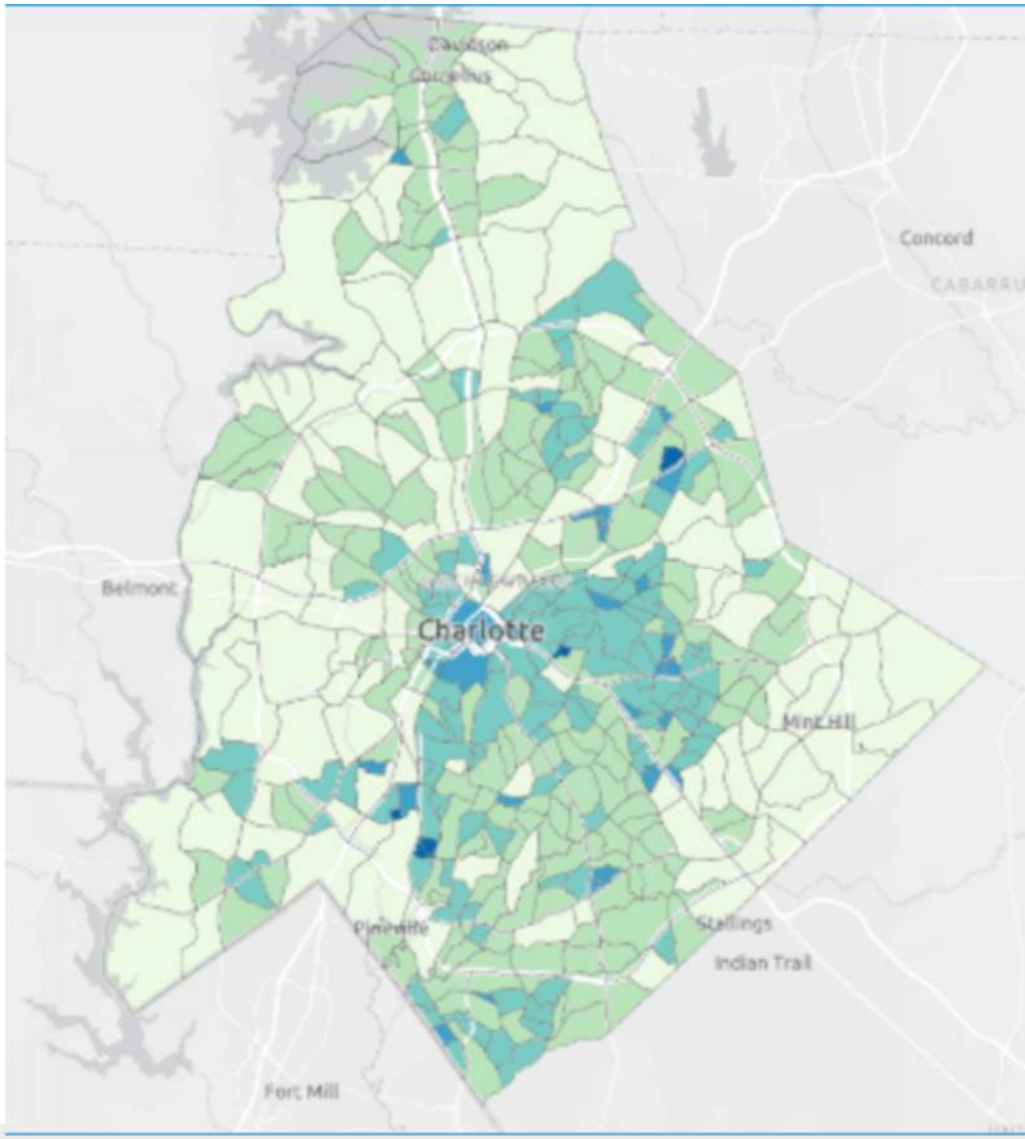
6.3 Reclaimed Water Education Program

The Reclaimed Water System Permit requires that CLTWater maintain an educational program for the purpose of ensuring knowledge about reclaimed water, its hazards, and its proper use are disseminated to end users who are under CLTWater's reclaimed water permit. This education program is required for end users whose systems are covered under CLTWater's RCW System Permit. The permit requirements for such a program are fairly general in nature, including only the following specific direction:

- Inform end users (including employees) about the proper use of reclaimed water.
- Provide educational materials to all facilities (including residents if applicable) provided with reclaimed water consistent with the nature of those facilities' reclaimed water use(s).
- Notify the public and/or employees of End Users, in a language they can understand, that reclaimed water is in use and is not potable.

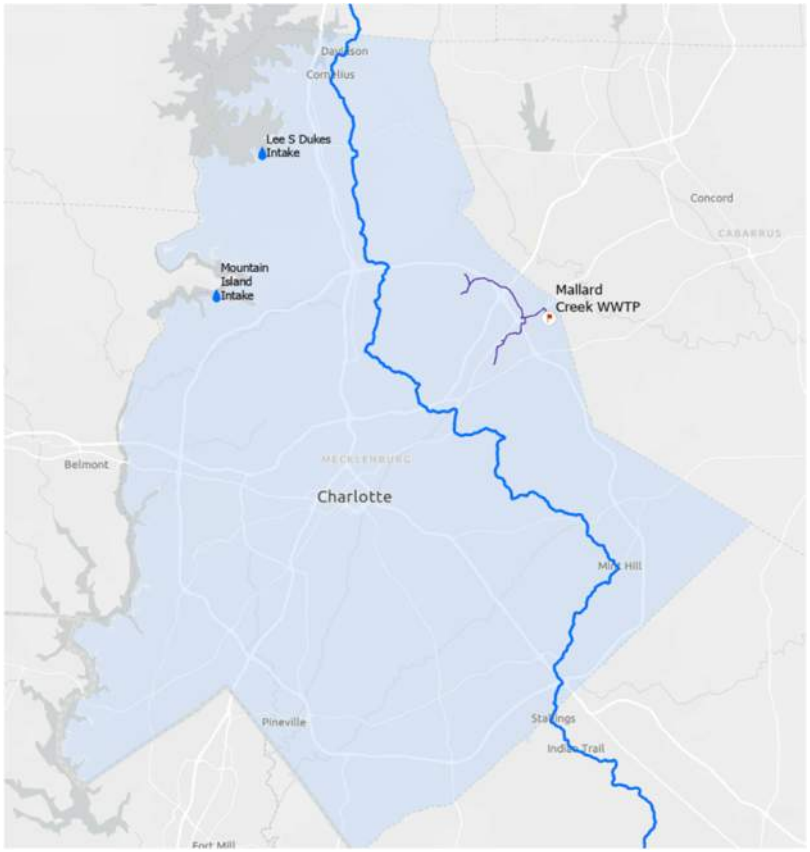
Population Density

- Population Density to Map



Inter-Basin Transfer (IBT)

- 33 MGD IBT certificate (Catawba to Rocky River Basin)
- Reclaimed water offsets potable demand



New Connection – UNC Charlotte

UNCC - Student Union

- UNCC 3rd largest University in NC
- Fall 2025 – 32,207 students
- UNCC 3rd largest University in NC

University of North Carolina at Charlotte

- 30 Yr Agreement
  - $5M investment by CLT WTR
  - Installed 15,000 feet of pipeline
  - 53,000,000 MG per year
  - UNCC Payments are twice per year with simple interest

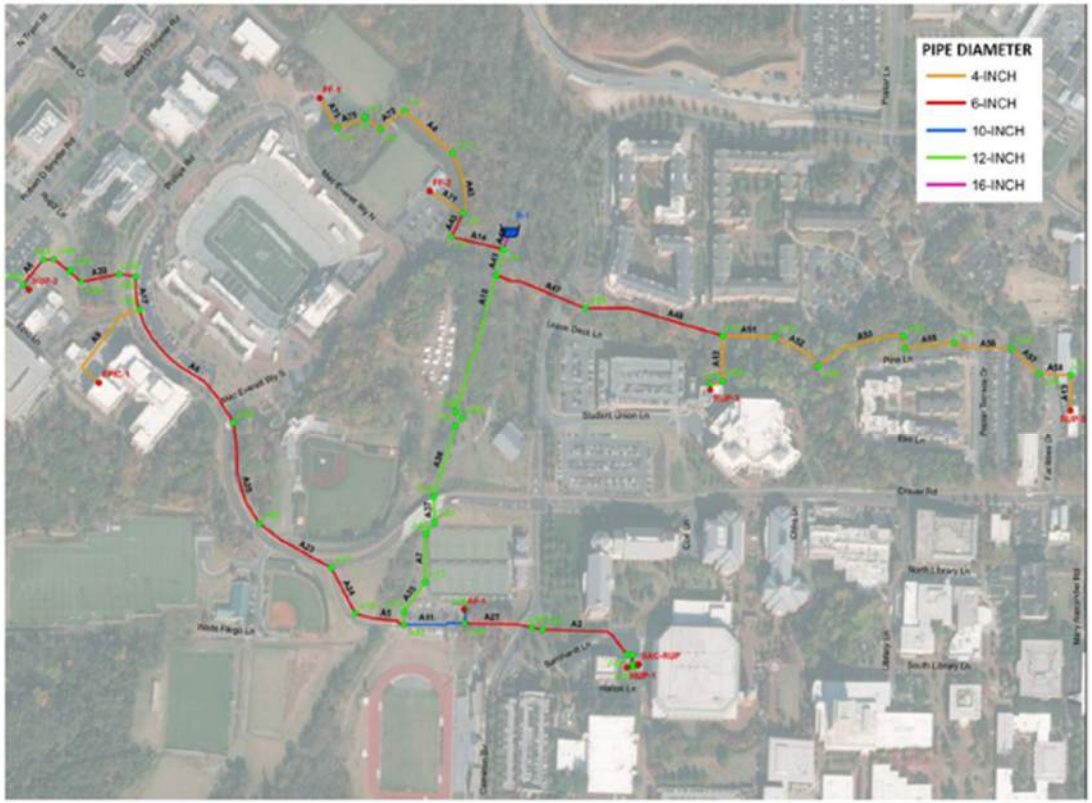


Figure 2.17 – Proposed UNCC Reclaimed Water Distribution Network

University of North Carolina at Charlotte

- Uses
  - Irrigation
  - Cooling water for regional utility plants or RUP

Increasing Permit Garver

- 8 MGD expansion
  - 3-year project with Garver Engineering
  - Filter Systems
  - Ground Storage
- Potential New Users
  - Data Center

Challenges

- Pumping
- Reclaimed used for Irrigation vs Cooling Towers


CHARLOTTE
WATER
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CHARLOTTE

QC Water

CHARLOTTE WATER'S RECYCLED WATER DEMONSTRATION PROJECT

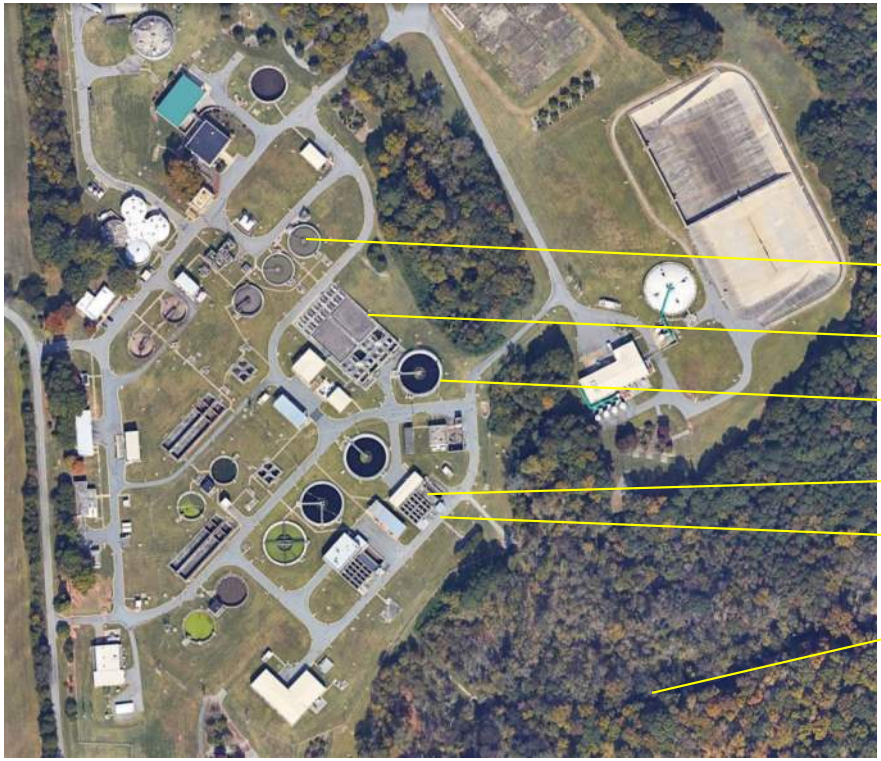
MARCH 27, 2026

QC Water

- **Charlotte Water's recycled water potable reuse demonstration**
- **Wastewater effluent**
- **Tested for more than 150 possible contaminants**
- **Meets Safe Drinking Water Act standards**

QC WATER

McDowell Creek Wastewater Treatment Plant



- **Permitted for 12 MGD**
  - Averages 6.3 MGD
- **Treatment Steps**
  - Primary Clarification
  - Secondary / Biological Treatment
  - Secondary Clarification
  - Tertiary Sand Filtration
  - UV Disinfection
  - Outfall to McDowell Creek

Technology & Process Steps to Produce QC Water

McDowell Creek WWTP

Carbon Filtration

QC Water

Water Production & Testing

Ozone & UV Disinfection + Carbon Filtration

Reverse Osmosis

Partnership

- **Charlotte Water**
  - QC Water
  - City of Charlotte
- **Xylem**
  - QC Water finishing
- **Lenny Boy**
  - Kombucha Brewer
- **Town Brewing**
  - Beer Brewer
- **Yellow Duck**
  - Marketing Support

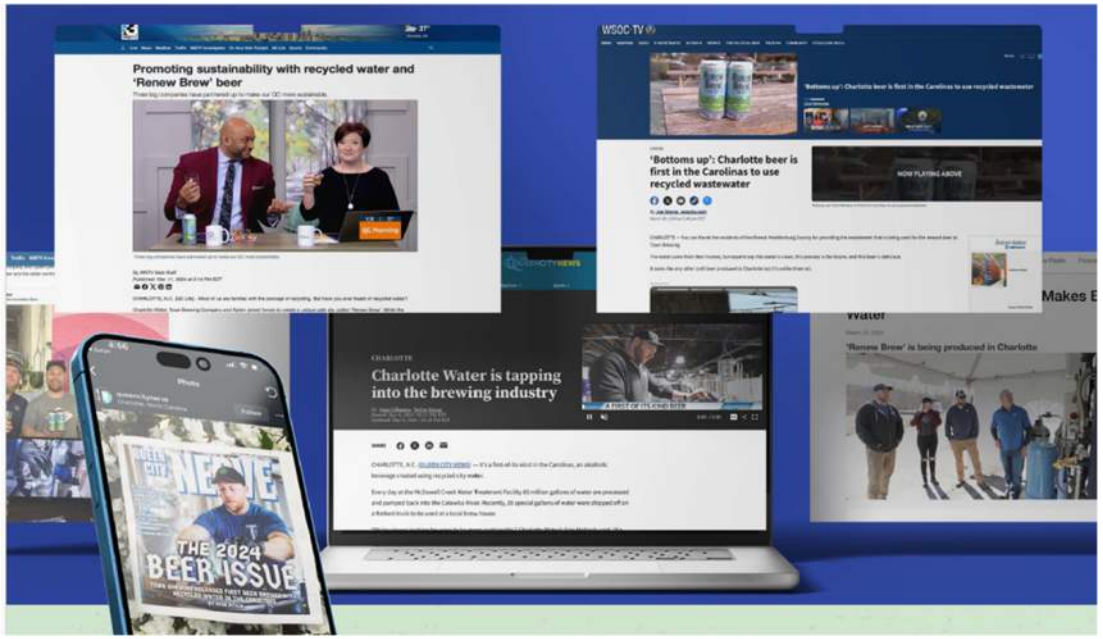
Three Demonstration Batches

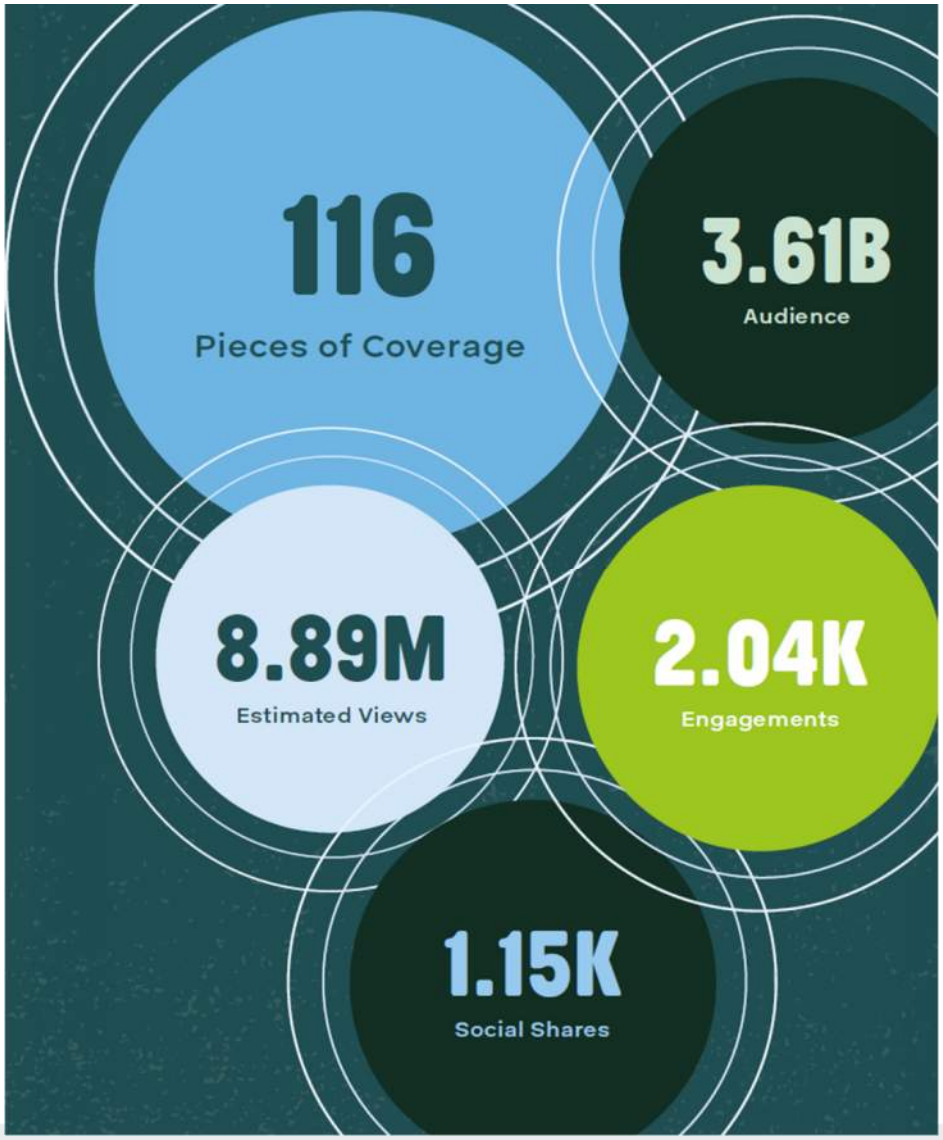
- **February 2024**
  - 500 Gallons QC Water
  - Beer – no retail
- **August 2024**
  - 1,000 Gallons QC Water
  - Beer – retail
- **July 2025**
  - 700 Gallons QC Water
  - Beer & kombucha

Third Batch Products

- **ReNew Brew – Fall Edition**
  - Town Brewing
  - Marzen-style beer like an Oktoberfest
- **Crown Bucha**
  - Lenny Boy Brewing
  - Raspberry, ginger and lemon kombucha
  - Kombucha is a fermented, sweetened tea drink
  - FDA requirements
  - First utility in the country to make with recycled water

Positive Feedback & Media Coverage



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CHARLOTTE WATER | CITY OF CHARLOTTE

MOB at Sugar Creek

FULL-SCALE NUVODA DEMONSTRATION AT CHARLOTTE WATER

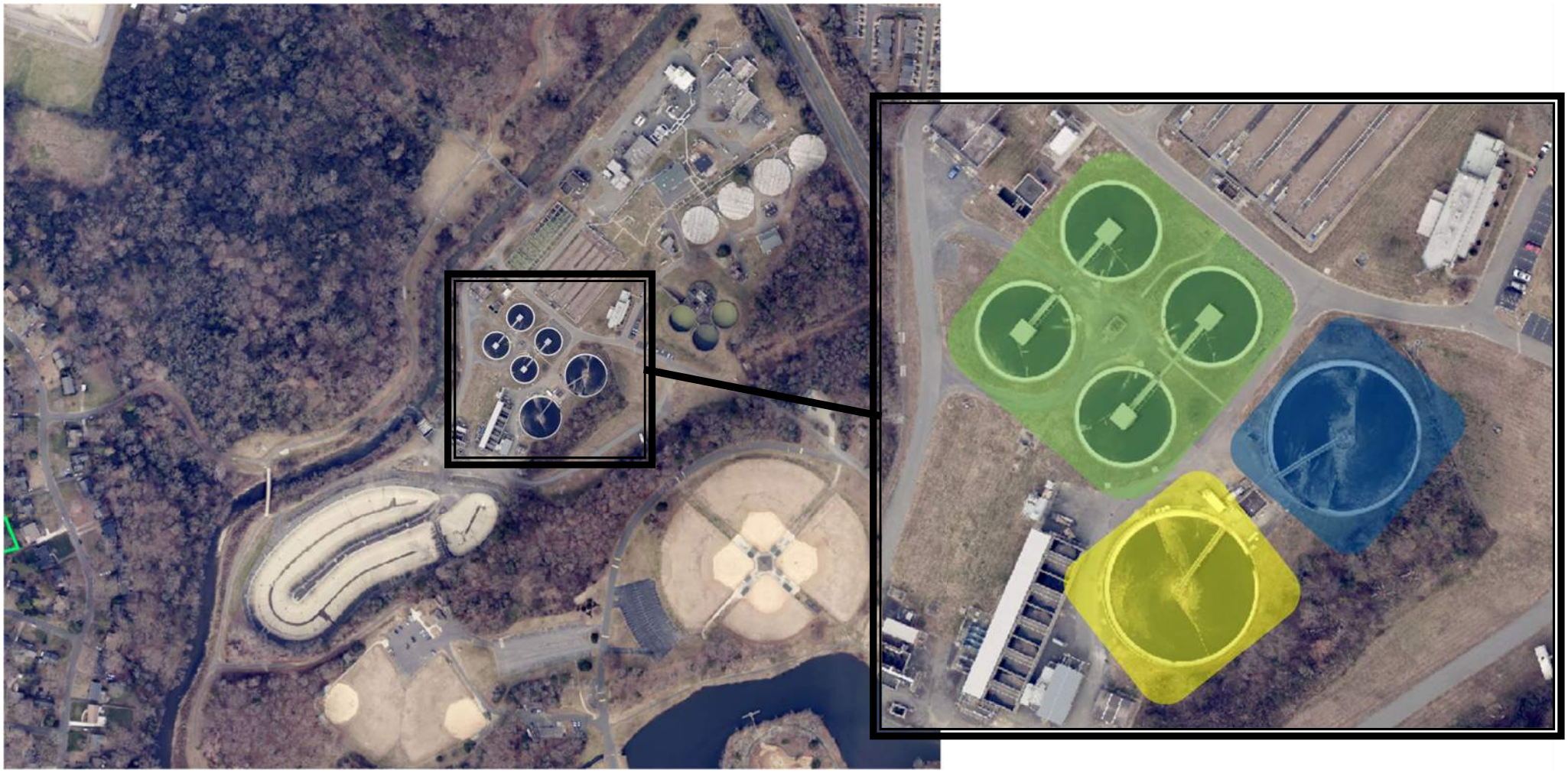
MARCH 27, 2026

Sugar Creek WRRF

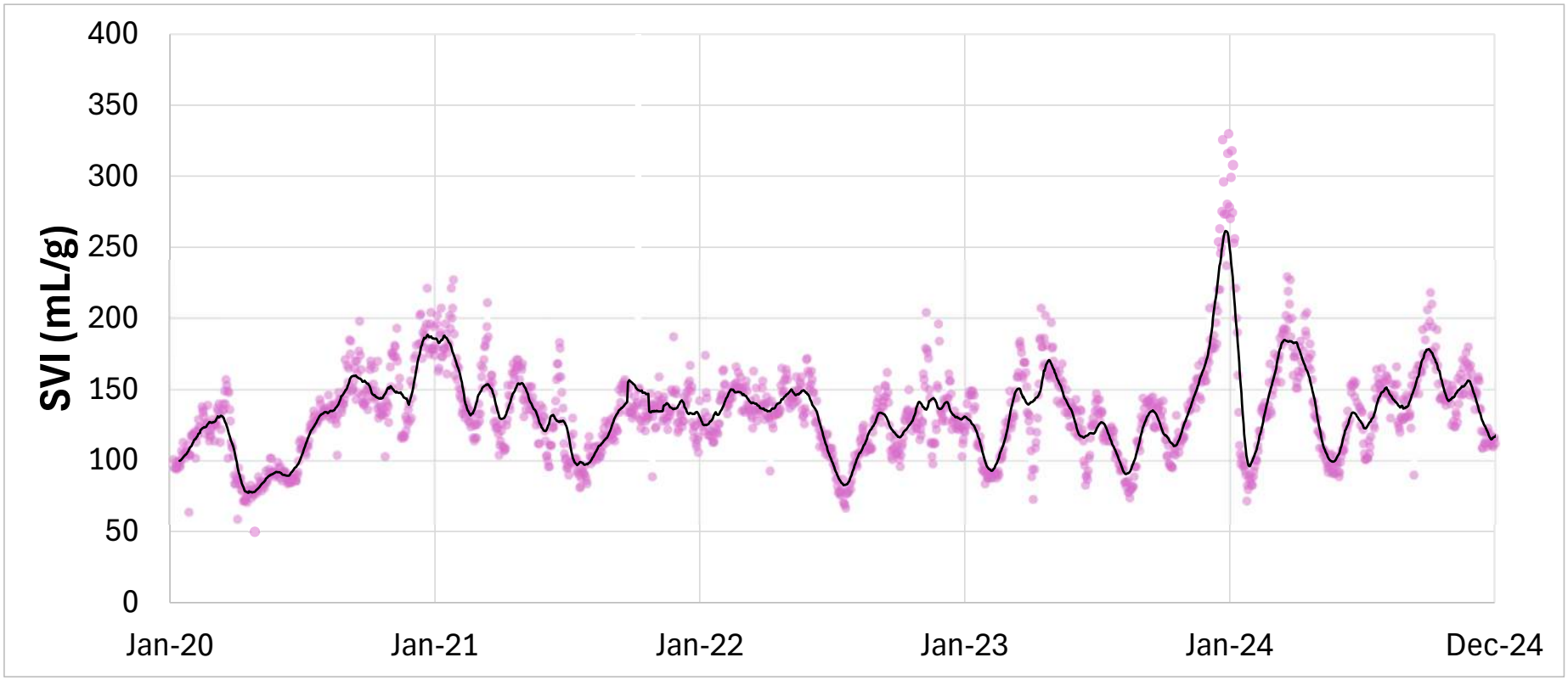
- Originally built 1927
  - Permitted 20 MGD
    - *Converted to MLE (2020)*
- Challenges
  - Poor settling
  - Winter nitrification
- Planned expansion
  - 8 MGD additional
    - *Maintain footprint*

MOB Process – Pilot Objectives

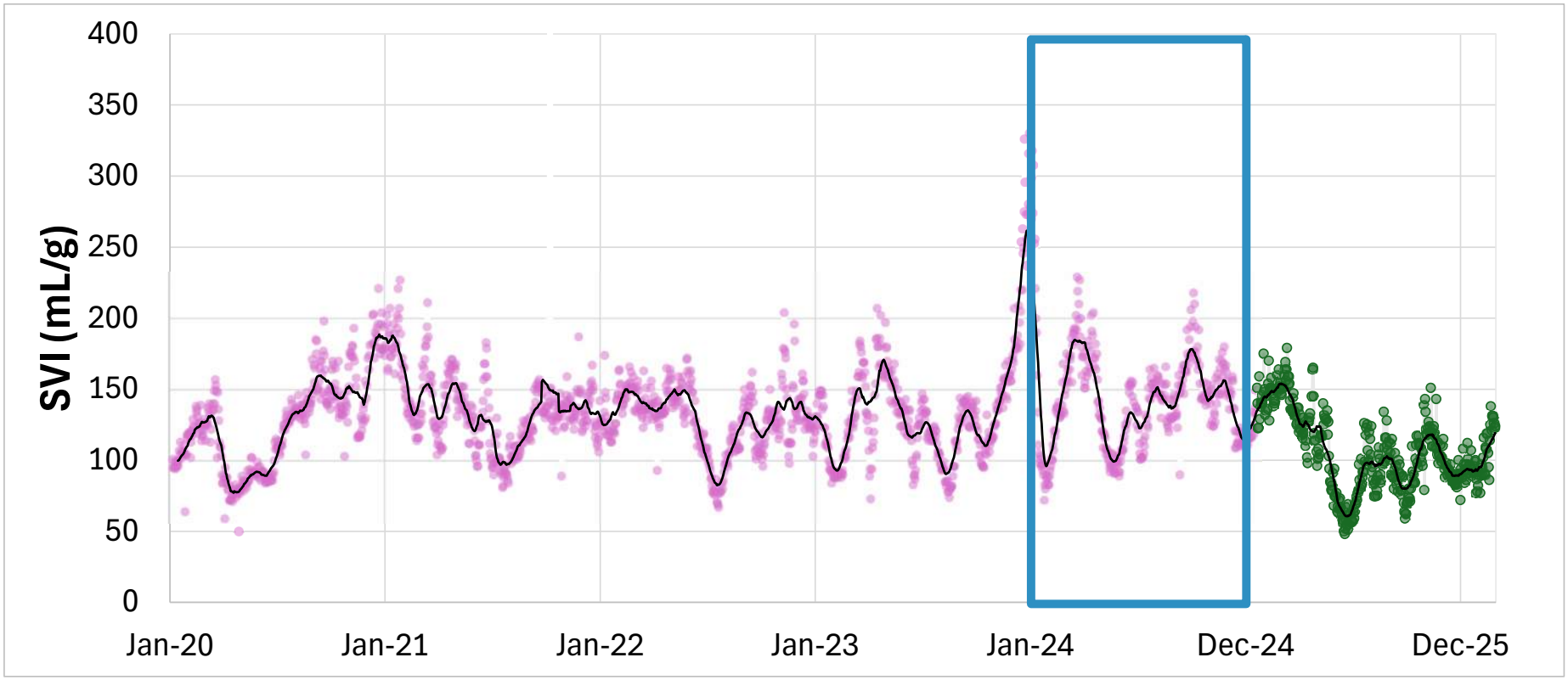
Objective	Metrics of Evaluation	Determination of Success
Demonstrate improved settleability	- SVI	- Maintain a monthly average SVI <120 mL/g
Demonstrate reliable nitrification during winter (Nov – Mar)	- Effluent NH3-N	- Maintain permit compliance
Determine plant throughput	- Flow bypassed to McAlpine (current flows, winter) - State point analysis (future capacity)	- All influent is treated at Sugar - BONUS – All influent is treated at Sugar with small FCs out of service
Establish maintenance requirements and operability of Media Retention Screen and MOB process	- Downtime of Media Retention Screen - Operator/Mechanic experience during pilot	- Subjective metric aimed at determining adding staff time required vs existing process



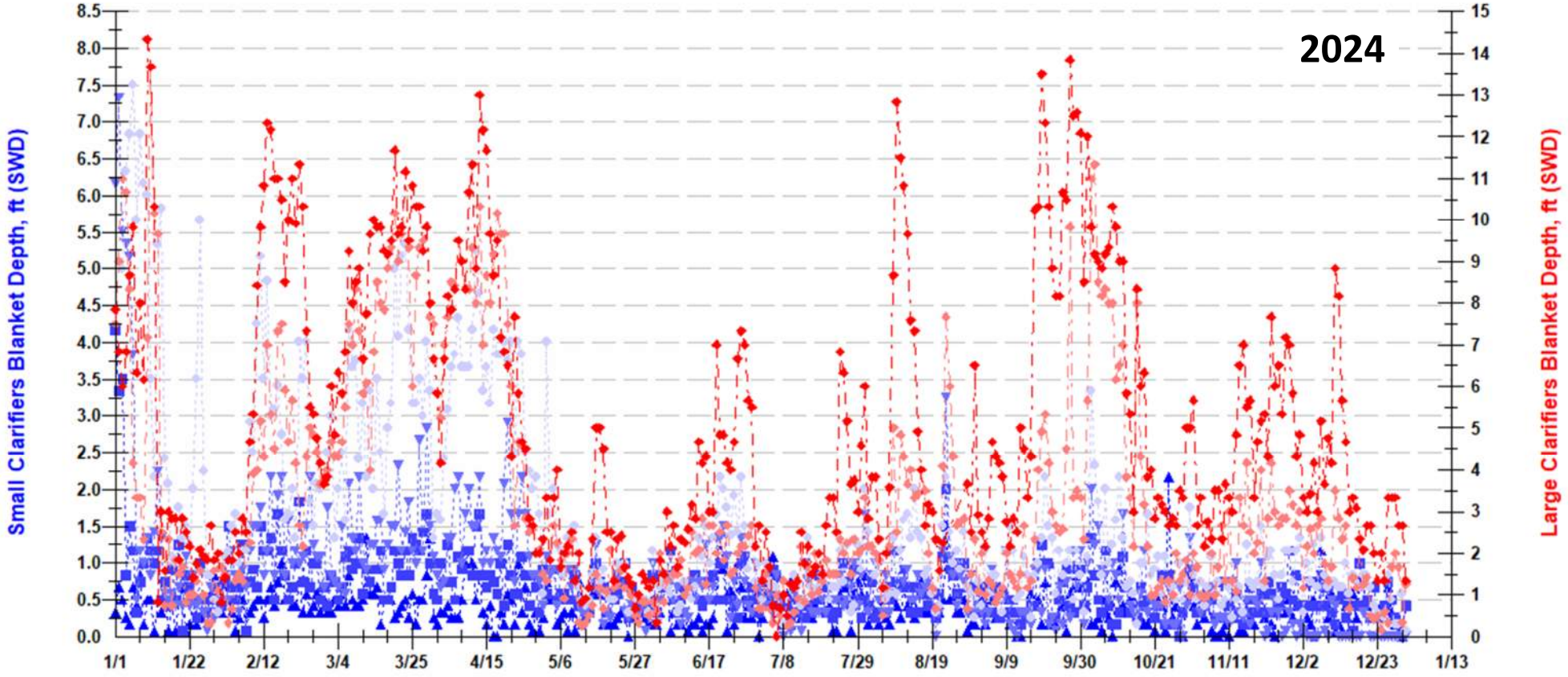
Pre-MOB Settleability



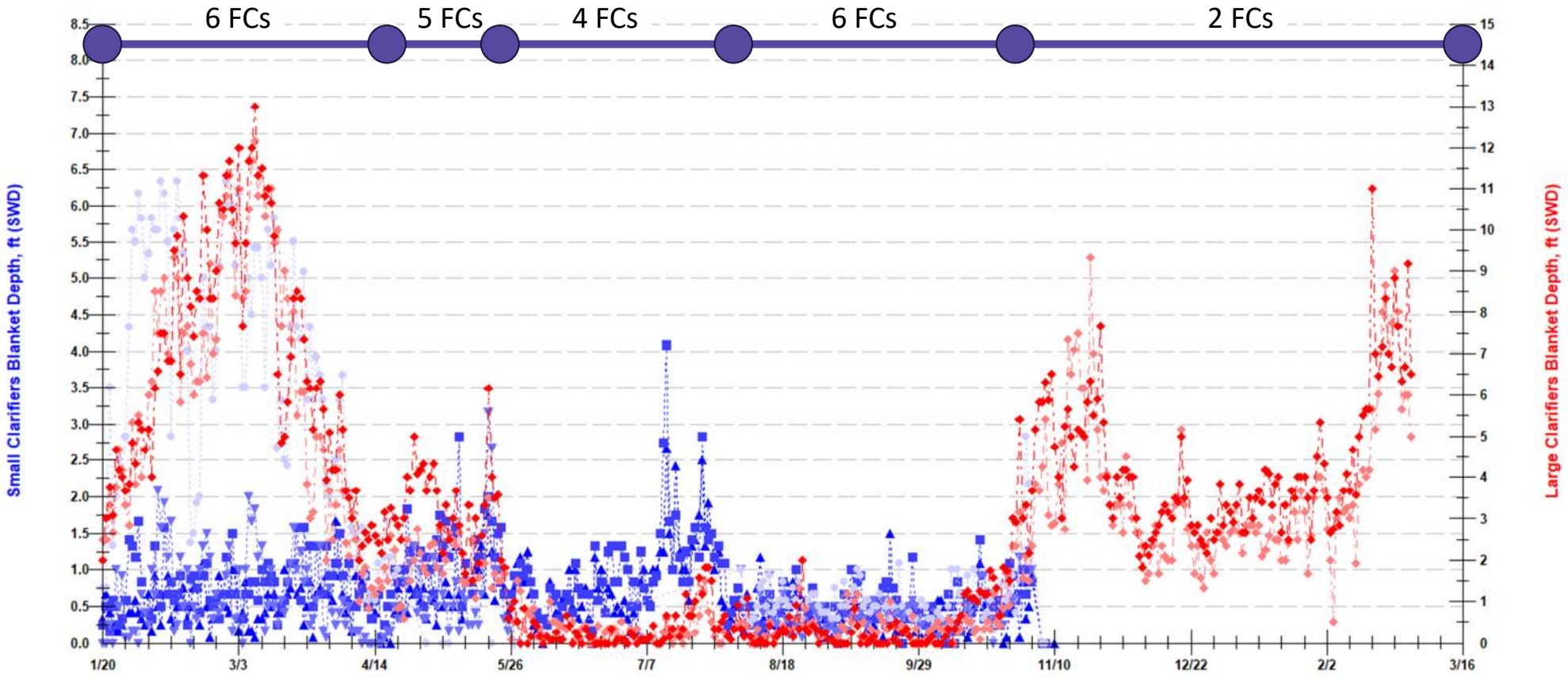
Settleability with MOB



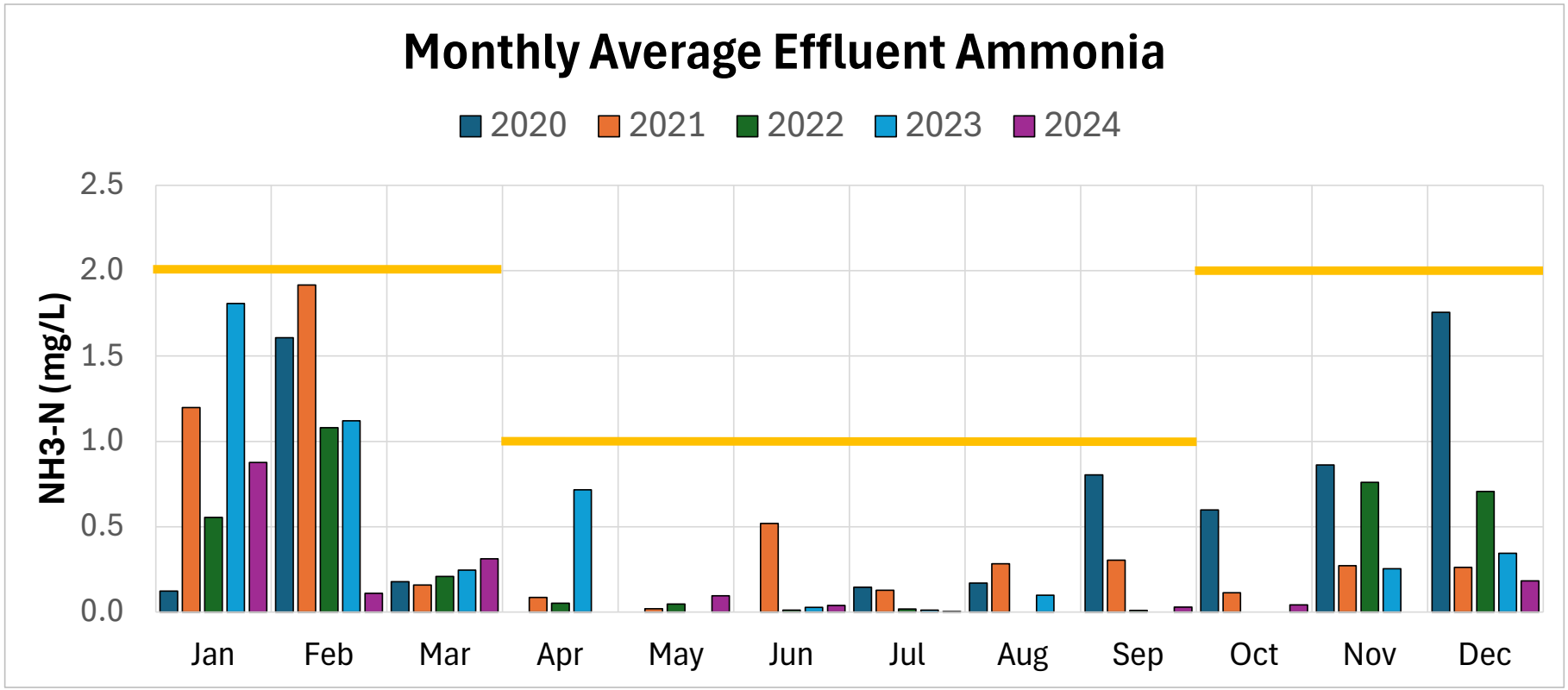
Pre-MOB Settleability



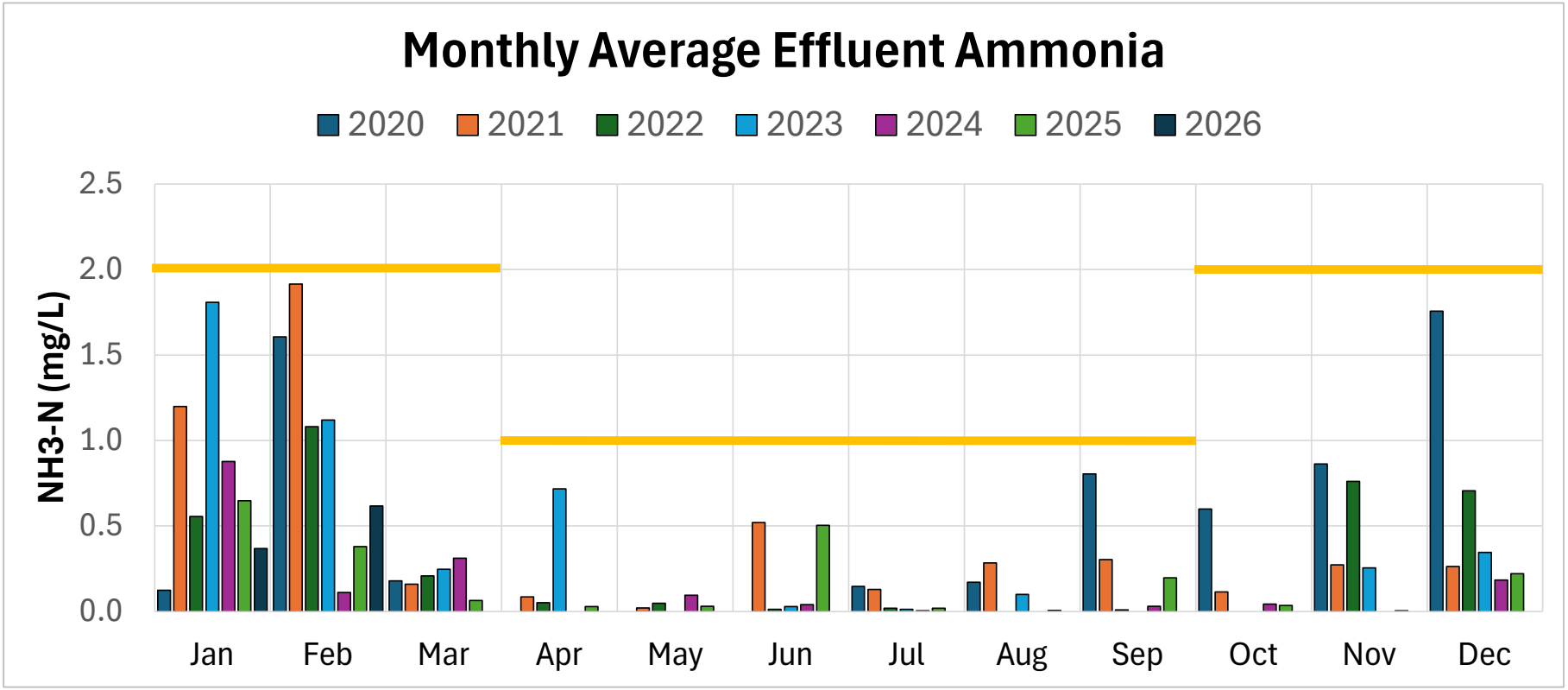
Settleability, Throughput with MOB



Pre-MOB Nitrification



Nitrification with MOB



Operations and Maintenance

- Representative sampling
  - Suspended growth MLSS
  - Media volume
- Media addition
- Maintenance minimal (with the right screen)
- Consider screen location
  - Media re-introduction
  - Spray water

MOB at Sugar Creek

Jan 2025
- Startup
- Media added

Jun 2025
- VFD on media return pump installed

Aug – Sep 2025
- Screen replaced
- Media added

Sep – Oct 2025
- Media pump replaced
- Media added

Jan 2026
- Screen replaced
- Media added

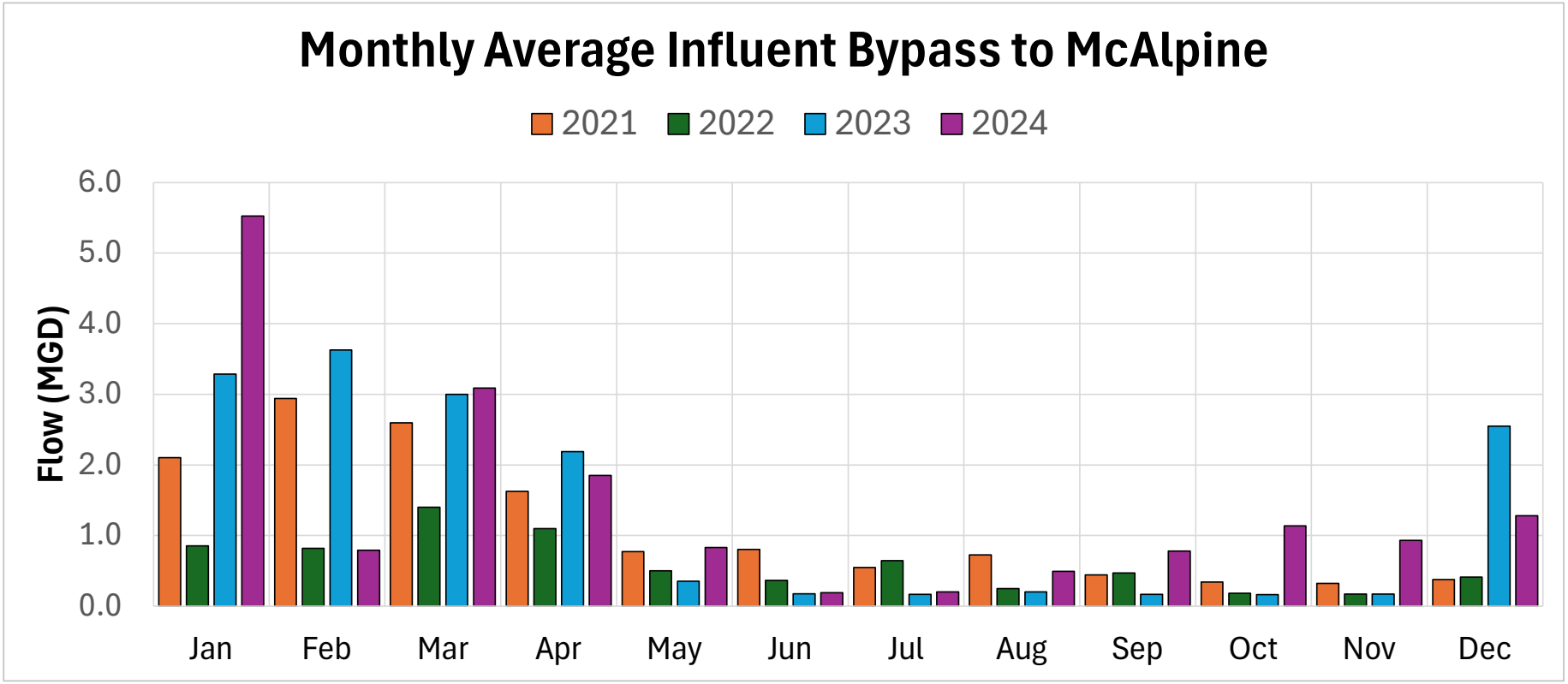
Apr 2026
- Demobilization

MOB Process – Pilot Objectives

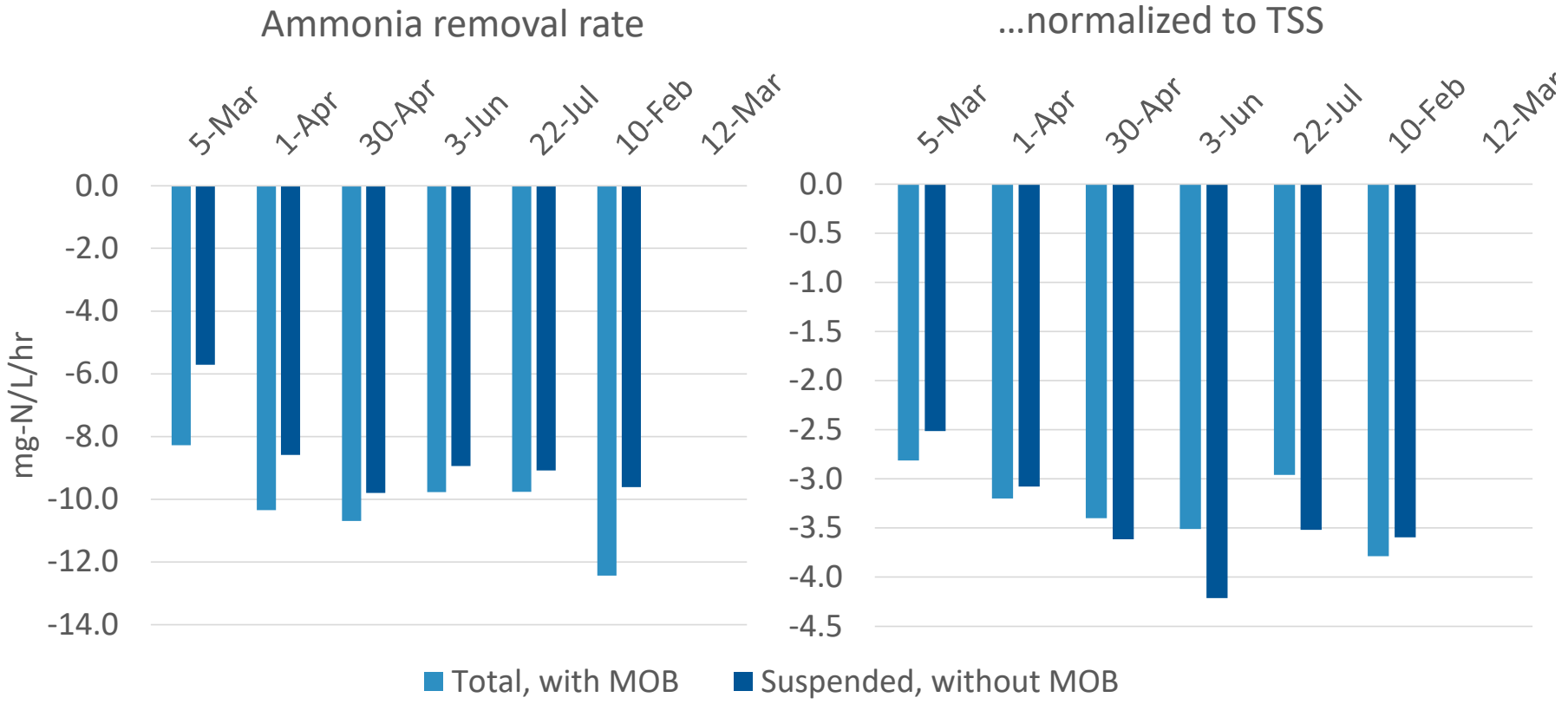
Objective	Determination of Success	Outcome
Demonstrate improved settleability	- Maintain a monthly average SVI <120 mL/g	- **Monthly average SVI <120 mL/g since May 2025**
Demonstrate reliable nitrification during winter (Nov – Mar)	- Maintain permit compliance	- **Well below permit limit for NH3-N** - **Max monthly average = 0.65 mg/L**
Determine plant throughput	- All influent is treated at Sugar - BONUS – All influent is treated at Sugar with small FCs out of service	- **Success at influent SP of 22 MGD with 6 FCs online** - Hydraulic (not process) limitation with small FCs out of service
Establish maintenance requirements and operability of Media Retention Screen and MOB process	- Subjective metric aimed at determining adding staff time required vs existing process	- Identified design improvements for permanent installation to minimize maintenance needs - Process control sampling considerations identified

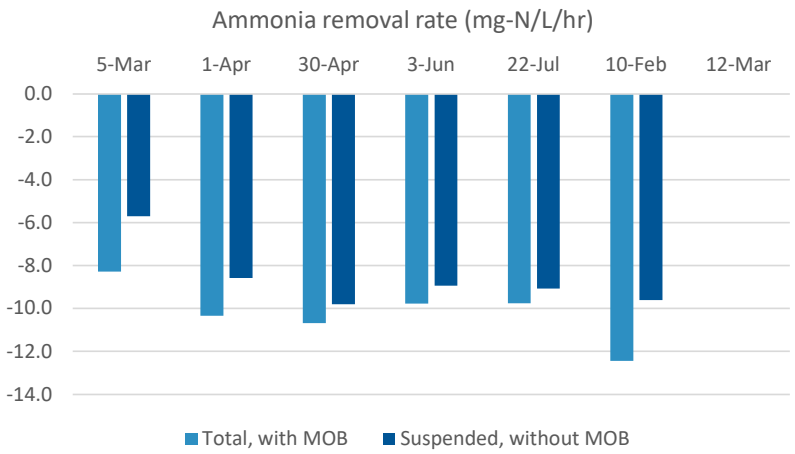
Muriel.Steele@CharlotteNC.gov

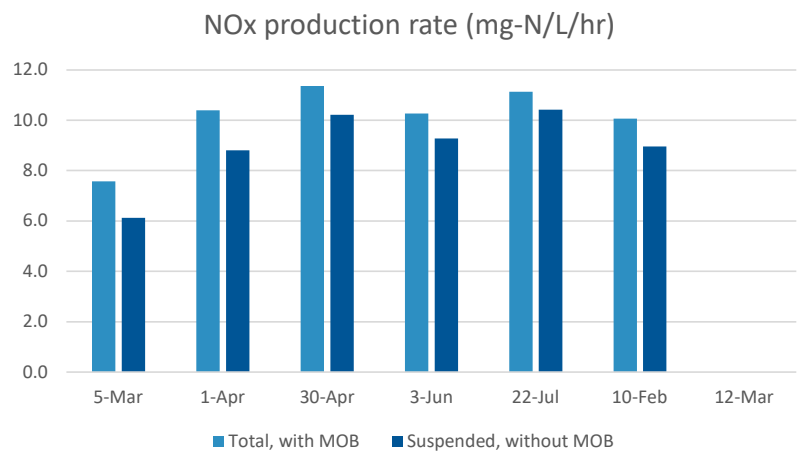
Pre-MOB Plant Throughput

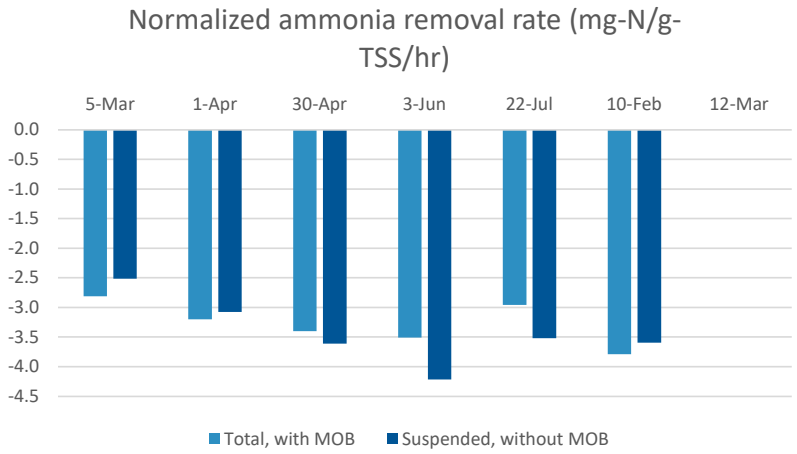


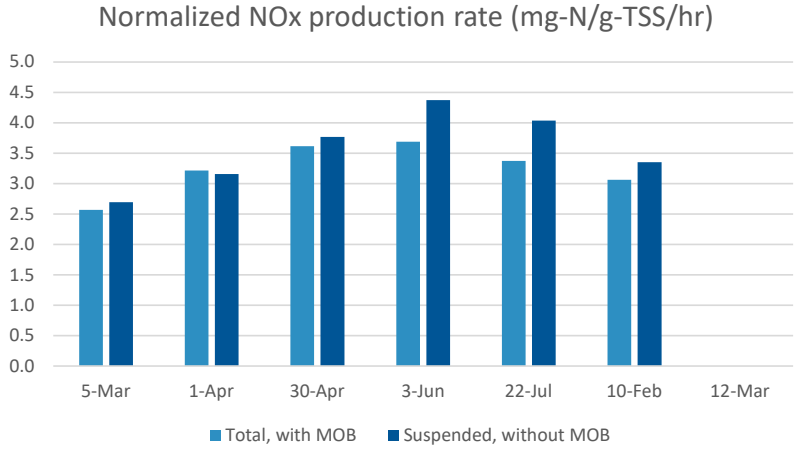
Nitrification Rate Testing with MOB




Ammonia removal rate (mg-N/L/hr)
5-Mar
1-Apr
30-Apr
3-Jun
22-Jul
10-Feb
12-Mar
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
Total, with MOB
Suspended, without MOB


NOx production rate (mg-N/L/hr)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
5-Mar
1-Apr
30-Apr
3-Jun
22-Jul
10-Feb
12-Mar
Total, with MOB
Suspended, without MOB


Normalized ammonia removal rate (mg-N/g-TSS/hr)
5-Mar
1-Apr
30-Apr
3-Jun
22-Jul
10-Feb
12-Mar
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
Total, with MOB
Suspended, without MOB


Normalized NOx production rate (mg-N/g-TSS/hr)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5-Mar
1-Apr
30-Apr
3-Jun
22-Jul
10-Feb
12-Mar
Total, with MOB
Suspended, without MOB

Circular Water Economy with Mobile Organic Biofilm

NUVODA MOB Process

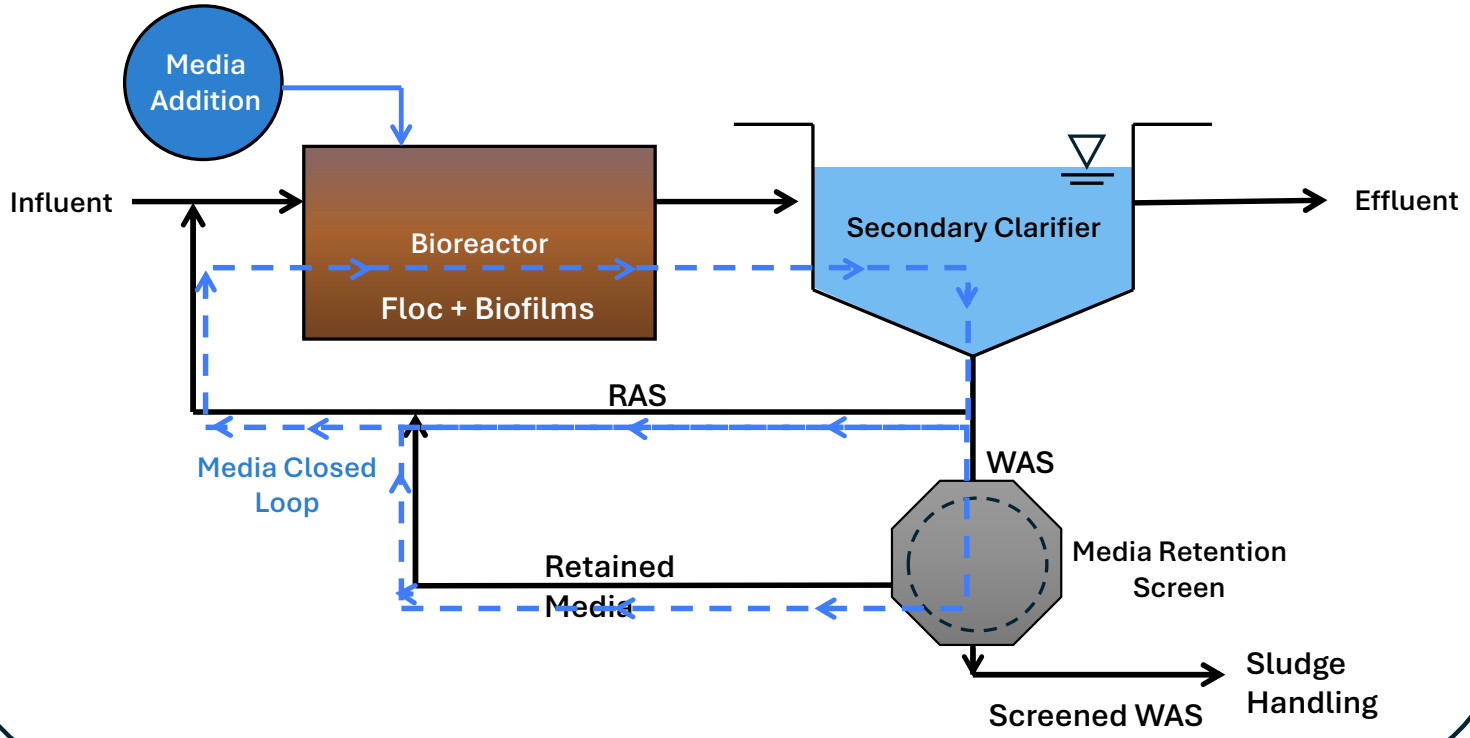
CHARLOTTE WATER

MOB Process At Charlotte Water Sugar Creek

NUVODA MOB Process

CHARLOTTE WATER

MOB System ™



NUVODA MOB Process

CHARLOTTE WATER

Media Addition

NUVODA MOB Process

CHARLOTTE WATER

Media Recirculation and Retention

NUVODA MOB Process

CHARLOTTE WATER

Biosolids Application to Kenaf Farm

NUVODA MOB Process

CHARLOTTE WATER

Circular Water Economy with MOB

Biosolids from Charlotte WWTP are applied to farm to grow Kenaf

Kenaf is grown at Nuvoda Farm

MOB Process is installed at Charlotte WWTP

BioKarrier Media is Produced from Kenaf Plant

CHARLOTTE WATER | CITY OF CHARLOTTE

Residuals & Biosolids Program Overview

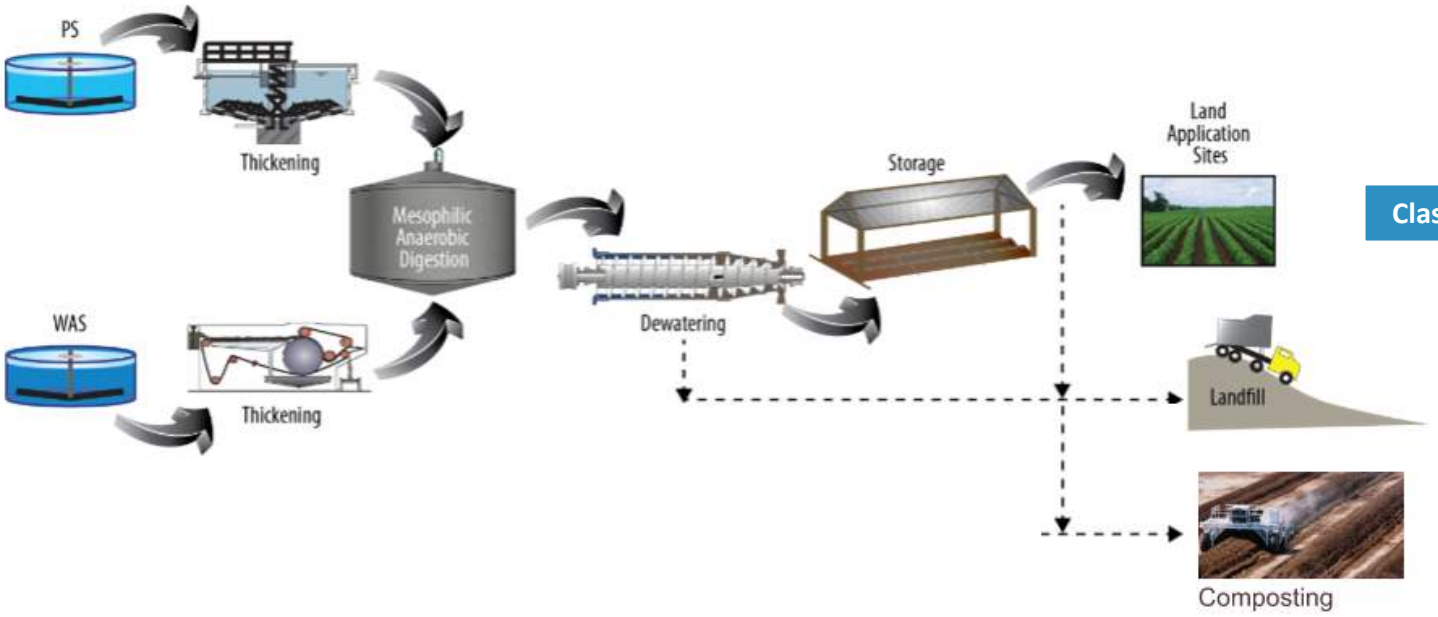
Largest Public Water/ Wastewater Utility in the Carolinas

- **Serves 1.2 million customers**
- **3 Water Treatment Plants**
  - 174 MGD Capacity
  - 118 MGD Average Flow
- **5 Major Water Resource Recovery Facilities**
  - 124 MGD Capacity
  - 86 MGD Average Flow
  - 6th WRRF currently under construction

One of the Largest Class B Programs in the Southeastern US

- **Alum residuals produced at 3 WTPs**
  - Belt filter press
  - ~25% solids
- **4 WRRFs have anaerobic digestion and dewatering**
  - Belt filter press or centrifuges
  - 12-22% solids
- **Approximately 120,000 wet tons of Class B biosolids and water residuals produced annually**

Residuals & Biosolids



Class B Cake

Non-conforming biosolids / Unfavorable Weather Conditions

New alternative being explored

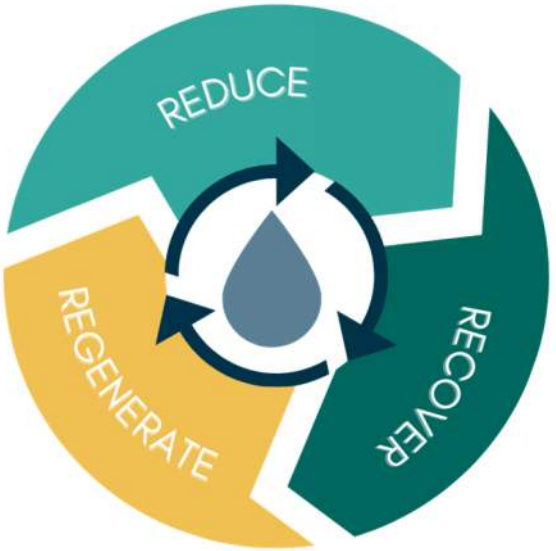
- **Based on recent historical data, CLT Water has land applied 60% of the residuals/biosolids produced**
  - In 2025, CLTWater achieved 75% of land application
- **10,000 acres of agricultural land permitted in SC and NC**

Land Application Program

- **CLT Water has had a contractor managing land application program for over 25 years.**
- **Each facility has different permit requirements that dictate pad management.**
- **Program is continuous operation. Need 40 truckloads removed per day to keep up with production and available storage.**

Circular Water Economy Benefits – Biosolids Programs

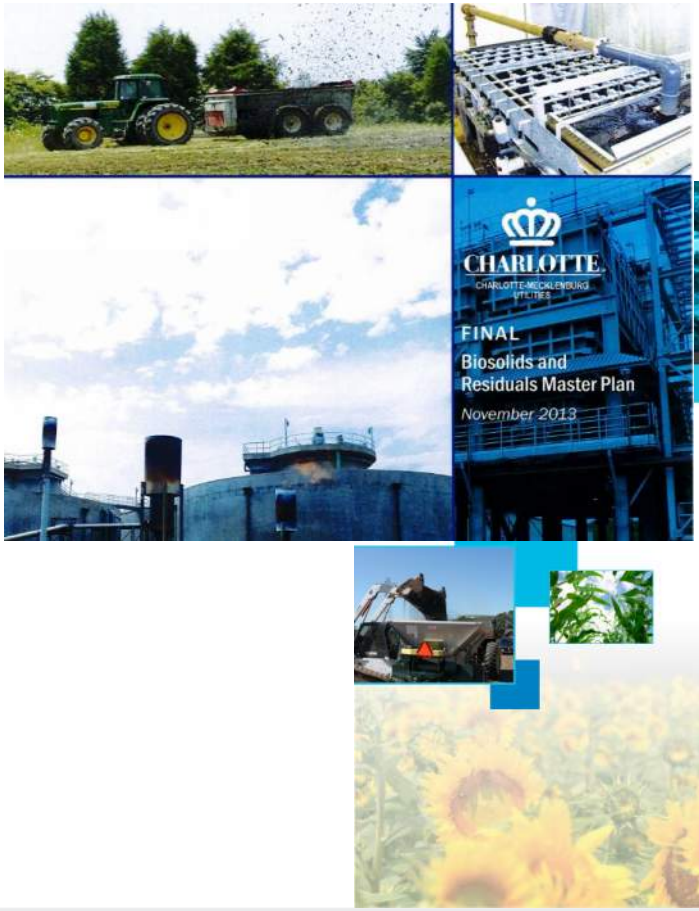
- Diverting organic waste out of landfills
  - 85,500 WT of biosolids land applied in 2025
  - 450,000 lbs of N recycled into soil and agriculture
- Reducing the need of chemical fertilizers
- Carbon sequestration in soil
- Generation of renewable energy
- Improvement of soil health
  - Organic carbon content, water holding capacity, soil structure, microbial activity

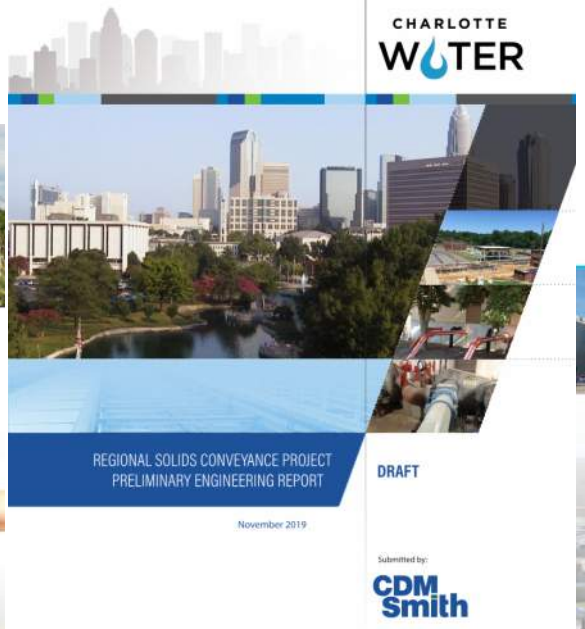


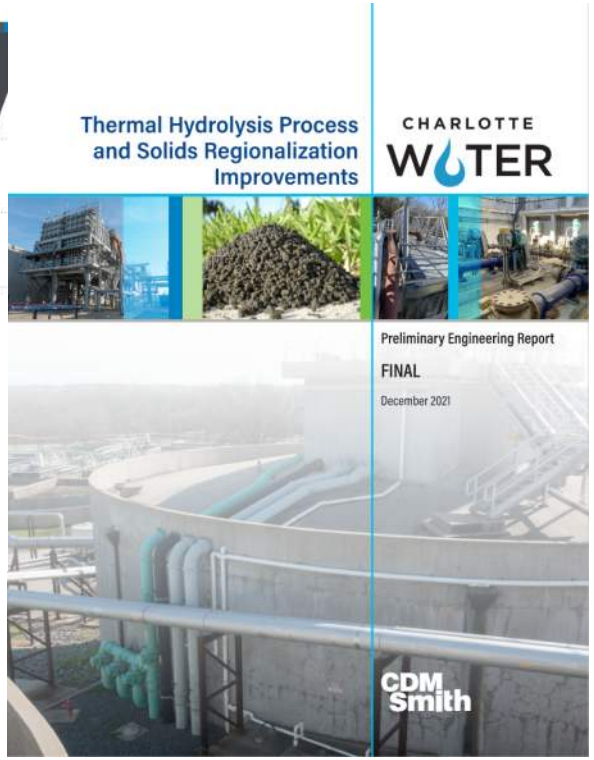
Nothing is Perfect and We Have Our Challenges

- **Existing facilities – aging infrastructure, capacity limitations**
- **Operations performance – Fecal regrowth, dewaterability**
- **Public Opinion – Health and safety**
- **Contaminants of Concern – PFAS, microplastics**
- **Limited Outlets – Landfill availability and reliability, no product diversity**
- **Class B biosolids limitations – site restrictions**

Biosolids Program History







Key Drivers of Master Planning

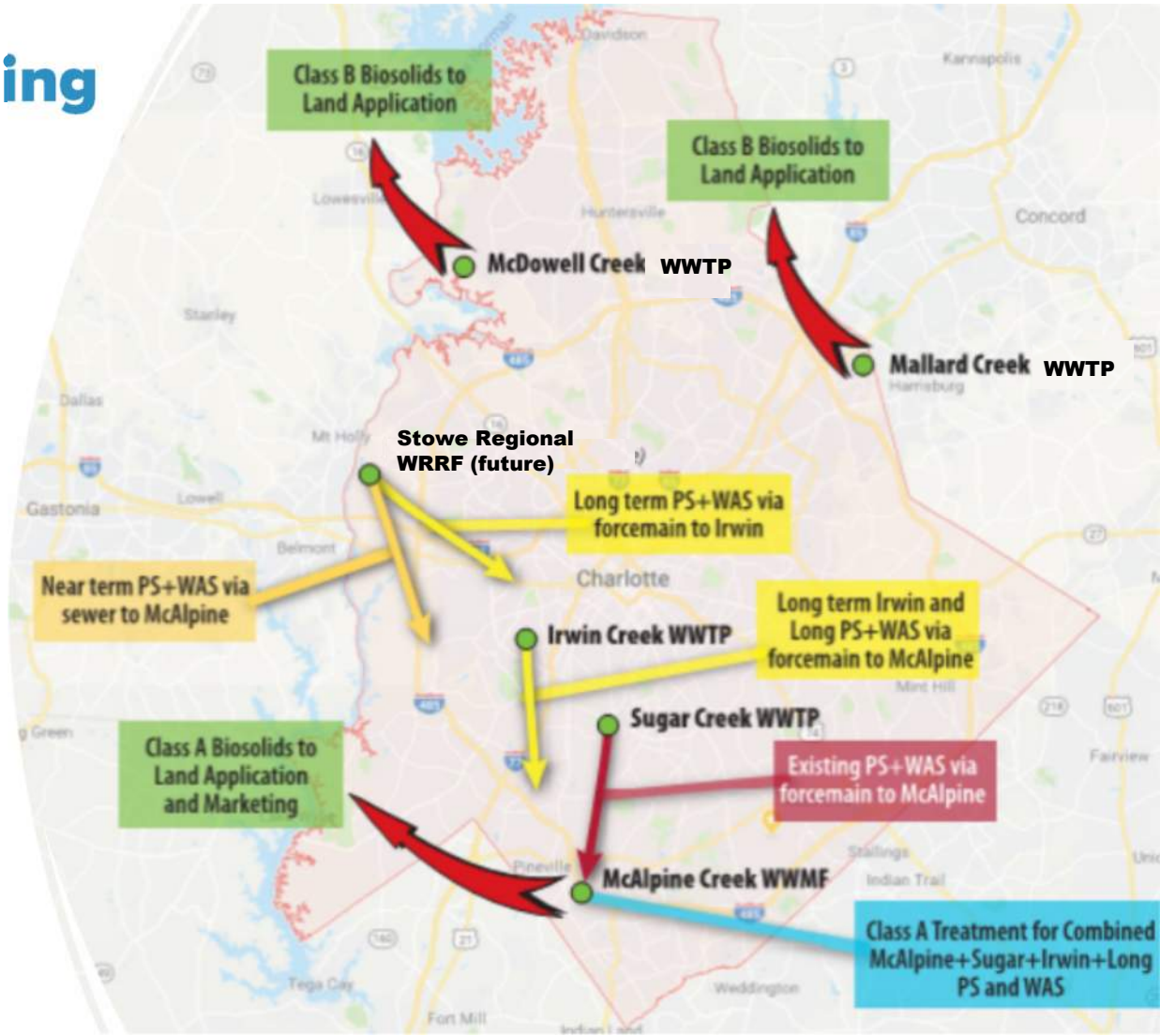
- **Develop a well balanced, flexible, and sustainable plan**
- **Allow for diversification of biosolids beneficial use and disposal options – risk mitigation**
- **Optimize resource recovery and beneficial use**
- **Consider public perception of end products and management strategies**
- **Explore collaboration with other entities**

Technologies Screening and Assessment

- **Comprehensive evaluation of different technologies and configurations**
- **Multifaceted evaluation criteria**
  - Sustainability
  - Reliability
  - Ease of Operation
  - Public perception/acceptance
  - Ability to create partnerships/regionalization
  - Capital cost
- **Recommended Pathway Forward**
  - Regionalized Solids Treatment at McAlpine Creek WWMF
  - Thermal Hydrolysis Process (THP)

Key Benefits of Centralizing Solids Processing at McAlpine Creek WWMF

- **Resource recovery optimization**
- **Taking advantage of existing infrastructure**
- **Avoiding additional O&M costs**



Key Benefits of Thermal Hydrolysis at McAlpine Creek WWMF

- **Increased organic loading to digesters**
- **Increased biogas production**
- **Decreased final biosolids volumed to be managed**
- **Class A biosolids**

Product	% Solids	WT/year	CY/year	Trucks/day
Class B (Anaerobic Digestion)	17%	120,600	148,900	17
Class A (THP)	Min 30%	71,500	88,300	10

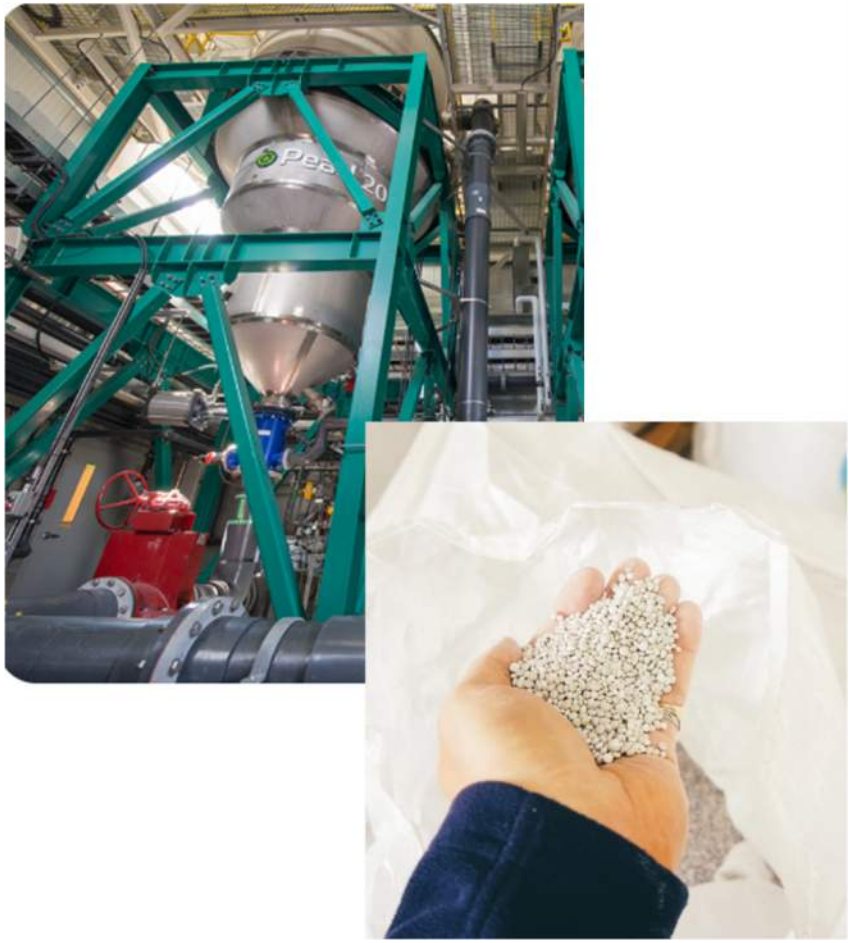
Liquid Treatment Train Impacts

- **Additional nutrient loading (P and TKN)**
  - Risk of permitted TP limit violation
  - Struvite formation
  - High chemical costs

- **Nutrient Harvesting**
  - Ostara Pearl reactor
  - Nitrogen removal

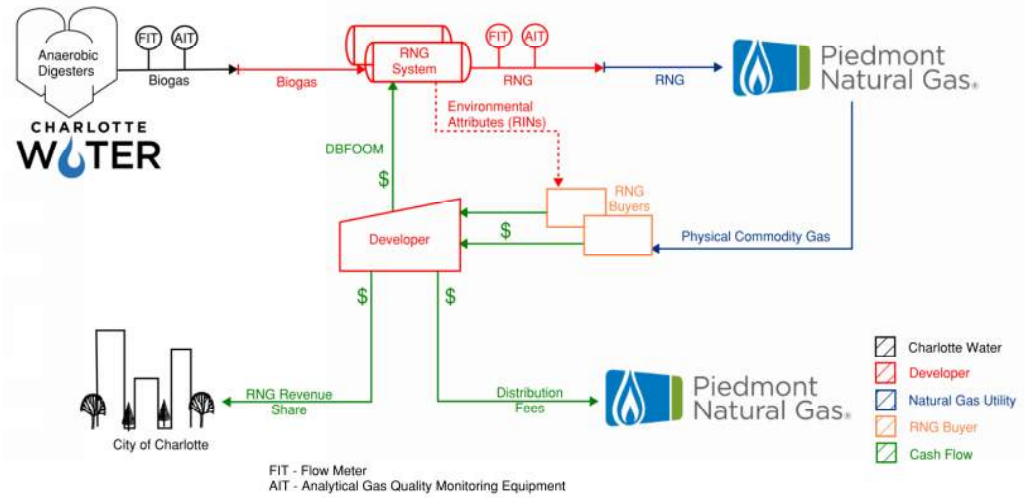
Nutrient Harvesting – Ostara Pearl

- Project is currently under construction at McAlpine Creek WWMF
  - Estimated completion end of 2027
- Main objectives
  - Reduce chemical usage
    - *And its associated carbon footprint*
    - *Offsetting traditional P mining requirements*
  - Reduce P loading into the biological process removal process
  - Produce marketable P rich nutrient supplement



Biogas to Renewable Natural Gas

- **Biogas production**
  - 600 – 1,200 scfm
- **Biogas Utilization Alternative Analysis**
  - Biogas to RNG selected
  - Alternative delivery method recommended
- **Request for Proposals**
  - Turn-key solution
  - Partner to design, build, own, maintain, and operate facility



Vision: Biosolids Management in a Circular Economy

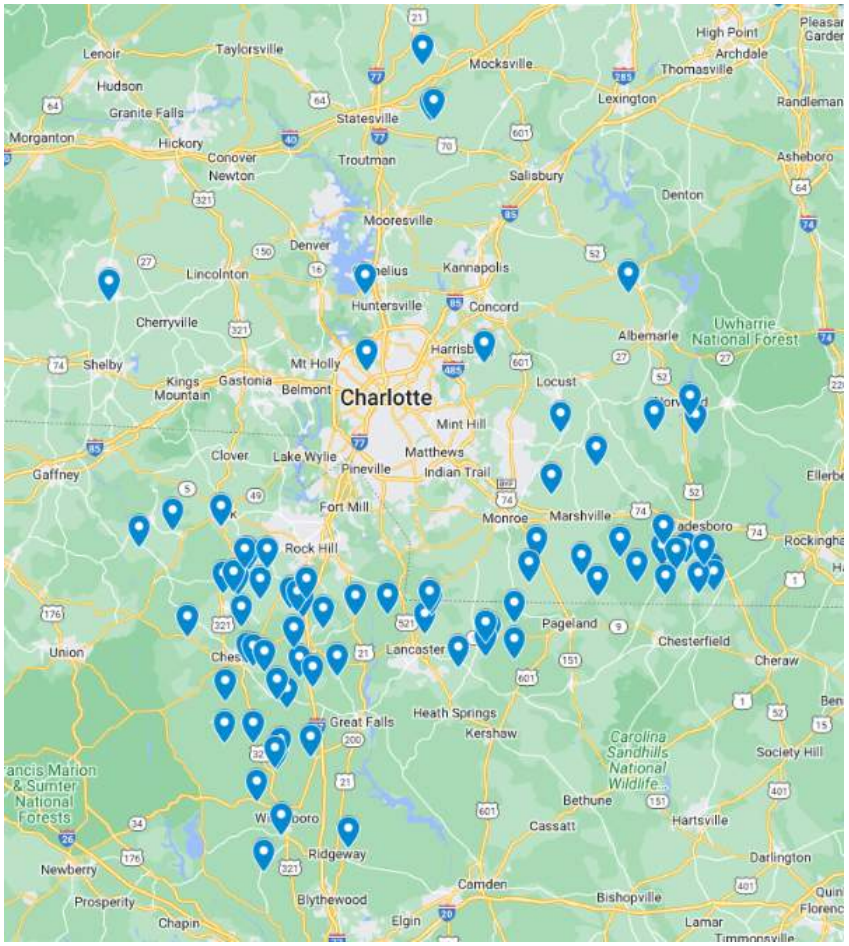
CHARLOTTE WATER | CITY OF CHARLOTTE

Thank You!

CLT Water Biosolids Garden

Charlotte Water Biosolids Program

- 10,000 total permitted acres in NC and SC
- 80 permitted sites
- Over 500 permitted fields
- Mostly clay and sand soils
- Crops
  - Fescue and Bermuda
  - Corn, cotton, soybeans
- Plays a big role as a part of Circular Economy in terms of improving soil health



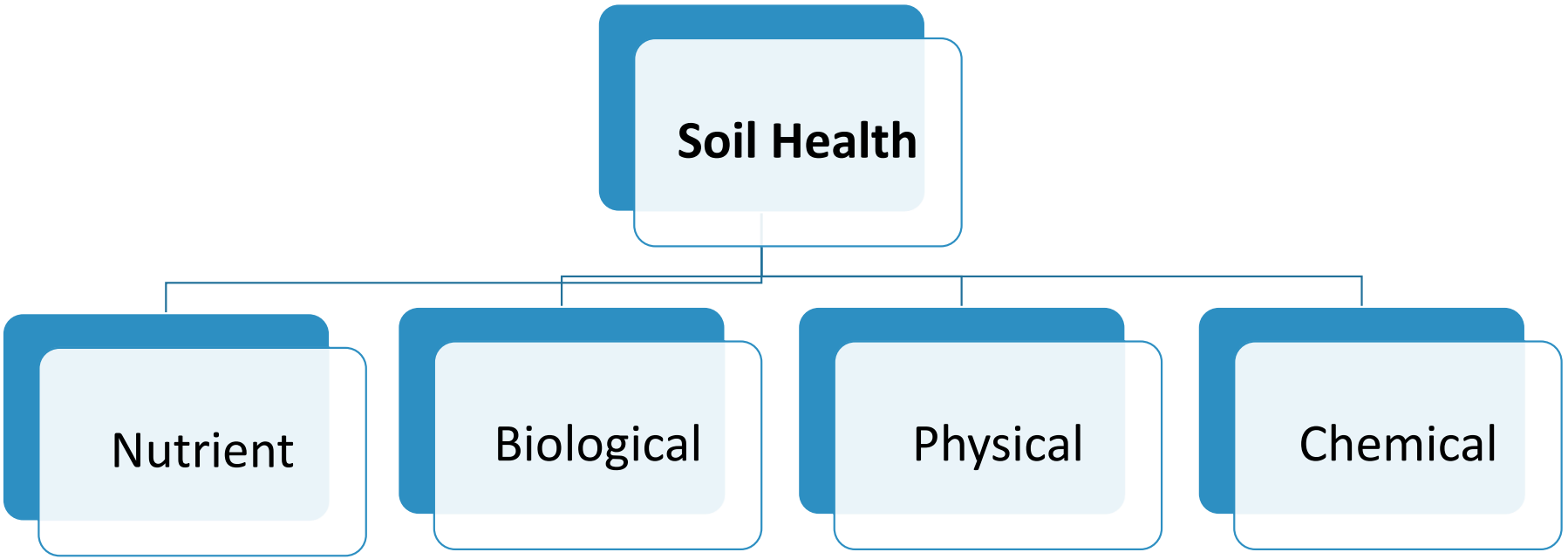
Irwin Creek WRRF
Biosolids Garden

- Irwin Creek WRRF: Class B Biosolids
- Retired Sludge Drying Beds
- Bee hives located nearby
- Native Plant/Pollinator Garden
- Goal: Track soil and plant health with biosolids application for native plant habitat
- Brought different groups together:
  - Plant staff
  - Resource Recovery Group
  - Bee keepers
  - Local nurseries

What is Soil Health?

The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans (USDA NRCS)

Soil Health Parameters



- Plant Available N
- Plant Available P

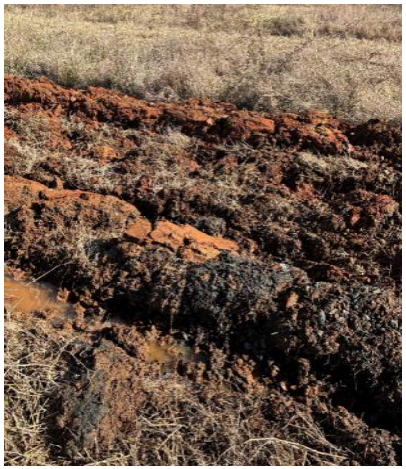
- Soil Organic Carbon
- Microbial Biomass C
- Potentially Mineralizable Nitrogen
- B-glucosidase activity

- Bulk Density
- Wet Aggregate Stability

- pH
- Electrical Conductivity

Liptzin (2022); Bagnall (2022); Bagnall (2023), Ippolito (2021)



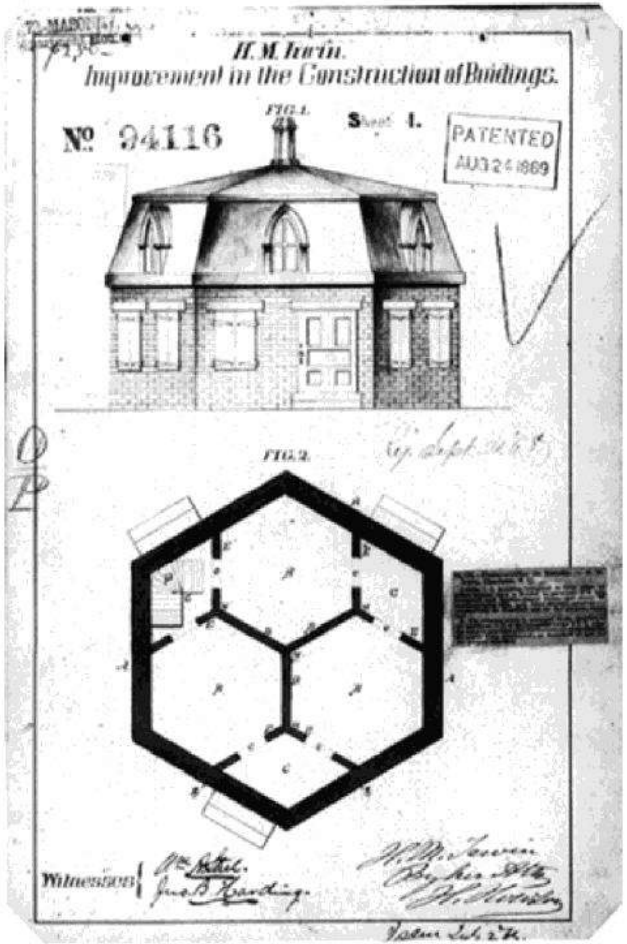



Where we started in terms of “soil health”



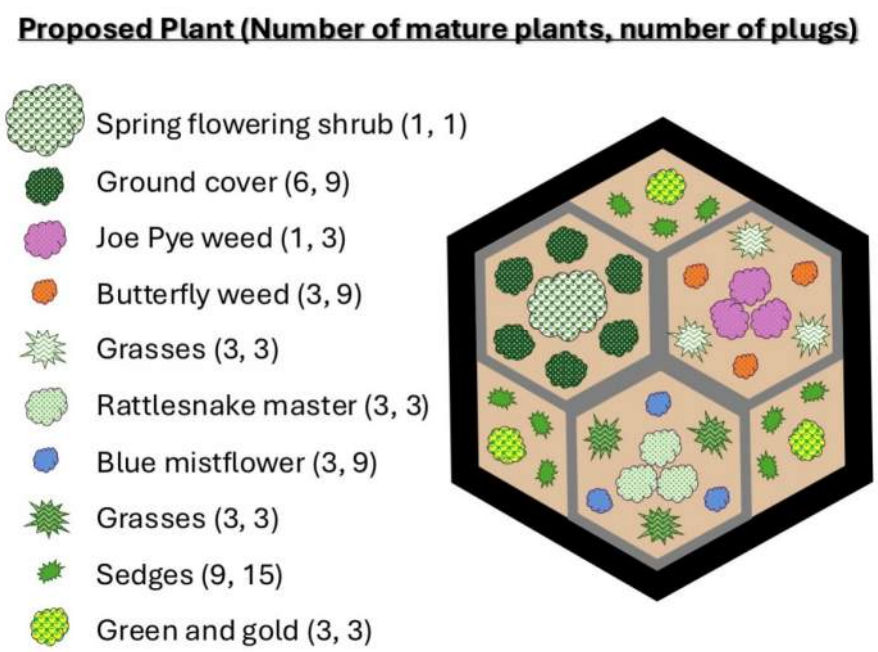

Irwin Creek WRRF
Biosolids Garden Inspiration

- Charlotte Water Beehives
- Harriet Morrison Irwin (1828-1897) of Charlotte, NC
  - Nation's first woman to patent an architectural design for hexagonal house in 1869.



Irwin Creek WRRF
Biosolids Garden

- N-based application for grassland/meadow
  - Control – No Biosolids
  - Low Rate Application
  - High Rate Application
- Soil samples were taken as a baseline, not to determine the N-application rate



Irwin Creek WRRF Biosolids Garden Prep

Irwin Creek WRRF Biosolids Garden Land Application

Irwin Creek WRRF Biosolids Garden Planting

Plants

- Purple Coneflower *(Echinacea purpurea)(K)*
- Black Eyed Susan *(Rudbeckia hirta)* (K)
- Lanceleaf Coreopsis (*Coreopsis lanceolata*) (K)
- River Oats (*Chasmanthium latifolium) (K)*
- Joe Pye Weed (*Eutrochium purpureum) (K)*
- Cup Plant (*Silphium perfoliatum) (K)*

K:Keystone Species for Ecoregion 8
N: Nectar Plant
H: Species Specific Host Plant

Plants

- Sweet Goldenrod (*Solidago odora*) (K)
- Butterfly Weed (*Asclepias tuberosa)* (H/N)
- Virginia Mountain Mint (*Pycnanthemum)* (N)
- Bee Balm, Wild Bergamot *(Monarda fistulosa*) (N)
- Anise Hysop (*Agastache Lamiacea) (N)*

K:Keystone Species for Ecoregion 8
N: Nectar Plant
H: Species Specific Host Plant

Irwin WRRF Biosolids Garden

- Ongoing care – weeding, mulching, and more planting
- Ongoing soil monitoring
- Developing educational posters for different audience segments
- Developing new planting areas with different plantings (shrubs, row-crop trials, etc.)

Thank you!