From the "Ground" Up:
Do Groundwater BMPs Work?

Claudia Listopad, PhD, Applied Ecology, Inc.

Virginia Barker, Brevard County Natural Resources Management

Public Commitment to IRL Restoration

- A decade of severe Harmful Algal Blooms (2011-2020)
- Seagrass losses
- Megalithic fish kill (2016)
- Media attention
- Public outcry
- Save Our Indian River Lagoon ½ cent sales tax (passed 2016)
- Save Our Indian river Lagoon Project Plan (SOIRLPP)
- Science to guide priorities and evaluate success

brevard COUNTY

88 Community Projects Completed!

435 Home Owner Projects Completed!

2024 Save Our Indian River Lagoon Project Status

Progress as of December 31, 2023

190,305 lbs/year of nitrogen load reduced

14,681 lbs/year of phosphorus load reduced

Public Education & Engagement

Budget: $3,530,000
TN Reduction: 33,709 lbs/year
Average Cost/lb TN: $105
Projects Completed: 1
Projects Underway: 4
Projects in the Plan: 7

WWTF Upgrades for Reclaimed Water

Budget: $27,537,049
TN Reduction: 74,139 lbs/year
Average Cost/lb TN: $371
Projects Completed: 3
Projects in Construction: 1
Projects in the Plan: 7

Rapid Infiltration Basin/ Sprayfield Upgrades

Budget: $82,207
TN Reduction: 317 lbs/year
Average Cost/lb TN: $259
Projects Completed: 1
Projects in Construction: 0
Projects in the Plan: 2

Package Plant Connections

Budget: $2,016,627
TN Reduction: 1,442 lbs/year
Average Cost/lb TN: $1,398
Projects Completed: 1
Projects in Construction: 0
Projects in the Plan: 4

Smoke Testing/ Sewer Lateral Repairs

Budget: $1,454,498
TN Reduction: 6,196 lbs/year
Average Cost/lb TN: $235
Miles Smoke Tested: 276
842 of 1,247 Leaks Repaired
Miles in the Plan: 299

Septic to Sewer

Budget: $135,374,605
TN Reduction: 114,440 lbs/year
Average Cost/lb TN: $1,196
Homes Connected: 513
Homes in Construction: 256
Homes in the Plan: 4,822

Septic System Upgrades

Budget: $29,250,000
TN Reduction: 37,981 lbs/year
Average Cost/lb TN: $770
Homes Upgraded: 229
Homes Contracted: 394
Homes in the Plan: 1,625

Stormwater Projects

Budget: $71,559,345
TN Reduction: 249,781 lbs/year
Average Cost/lb TN: $286
Projects Completed: 43
Projects in Construction: 1
Projects in the Plan: 269

Aquatic Vegetation Harvesting

Budget: $2,243,689
TN Reduction: 33,111 lbs
Average Cost/lb TN: $68
Projects Completed: 6
Projects in Construction: 1
Projects in the Plan: 10

Muck Removal

Budget: $133,749,381
TN Reduction: 355,868 lbs/year
Average Cost/lb TN: $376
Projects Completed: 3
Projects in Construction: 2
Projects in the Plan: 21

Interstitial Water Treatment

Budget: $38,761,200
TN Reduction: 519,439 lbs
Average Cost/lb TN: $75
Projects Completed: 2
Projects in Construction: 2
Projects in the Plan: 16

Oyster Bars

Budget: $9,813,625
TN Reduction: 24,747 lbs/year
Average Cost/lb TN: $397
Projects Completed: 9
Projects in Construction: 5
Projects in the Plan: 28

Planted Shorelines

Budget: $126,480
TN Reduction: 527 lbs/year
Average Cost/lb TN: $240
Projects Completed: 8
Projects in Construction: 0
Projects in the Plan: 11

Clam Restoration

Budget: $60,000
TN Reduction: 1,000 lbs
Average Cost/lb TN: $60
Projects Completed: 4
Projects Underway: 1
Projects in the Plan: 10

2017–2023 Revenue = $361.8M

10-Year Revenue Estimate = $585.7M

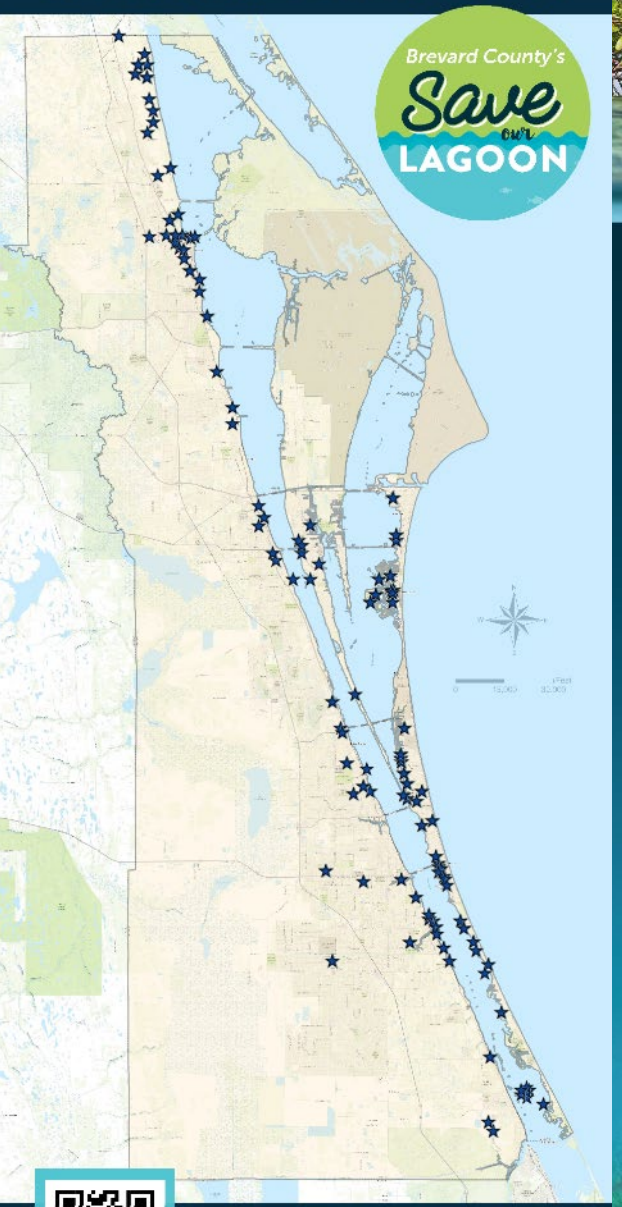
Save our LAGOON

2017–2023 Expenditures = $73.7M

Projects Underway = $324.8M

SAVE OUR INDIAN RIVER LAGOON PROGRAM

COMPLETED PROJECTS



Scan for more project information

Project Progress

27 Under Construction

66 In Design or Permitting

1,816 Homeowner Projects

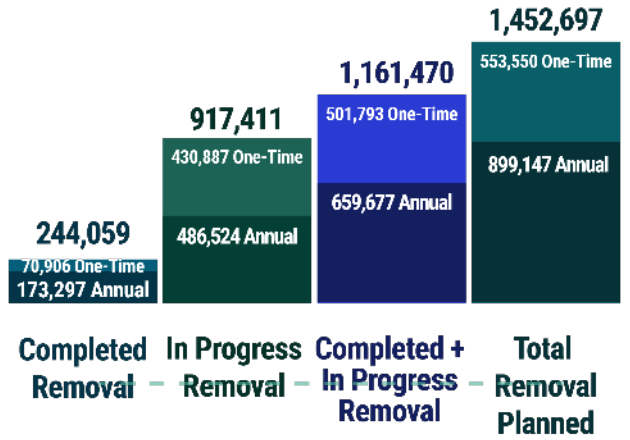
- 360 Quick Connects to Sewer
- 327 Septic Upgrades
- 1,033 Leaky Lateral Repairs

18 Performance Evaluations

- ✓ Quantify Nutrient Removal
- ✓ Update Cost-Effectiveness

5 Public Information Campaigns

Nitrogen (lbs) Removed or Reduced



Phosphorus (lbs) Removed or Reduced

GROUNDWATER MANAGEMENT

- Since 2017, Brevard County & AEI have been monitoring groundwater nutrient concentrations to identify areas where groundwater is most contaminated by wastewater sources.
- Goal is to develop, implement, and evaluate wastewater retrofit strategies to improve GW quality and ultimately quality of receiving waters (the IRL).
- Last summer, AEI presented update of 5 years of data and a preliminary results of two retrofit strategies:
  - Micco Commercial Septic to Sewer Conversions
  - Titusville Osprey Wastewater Treatment Facility Upgrades
- Today, we provide an update on these and other upgrades to demonstrate a groundwater adaptive management approach.

BREVARD COUNTY GW STUDY

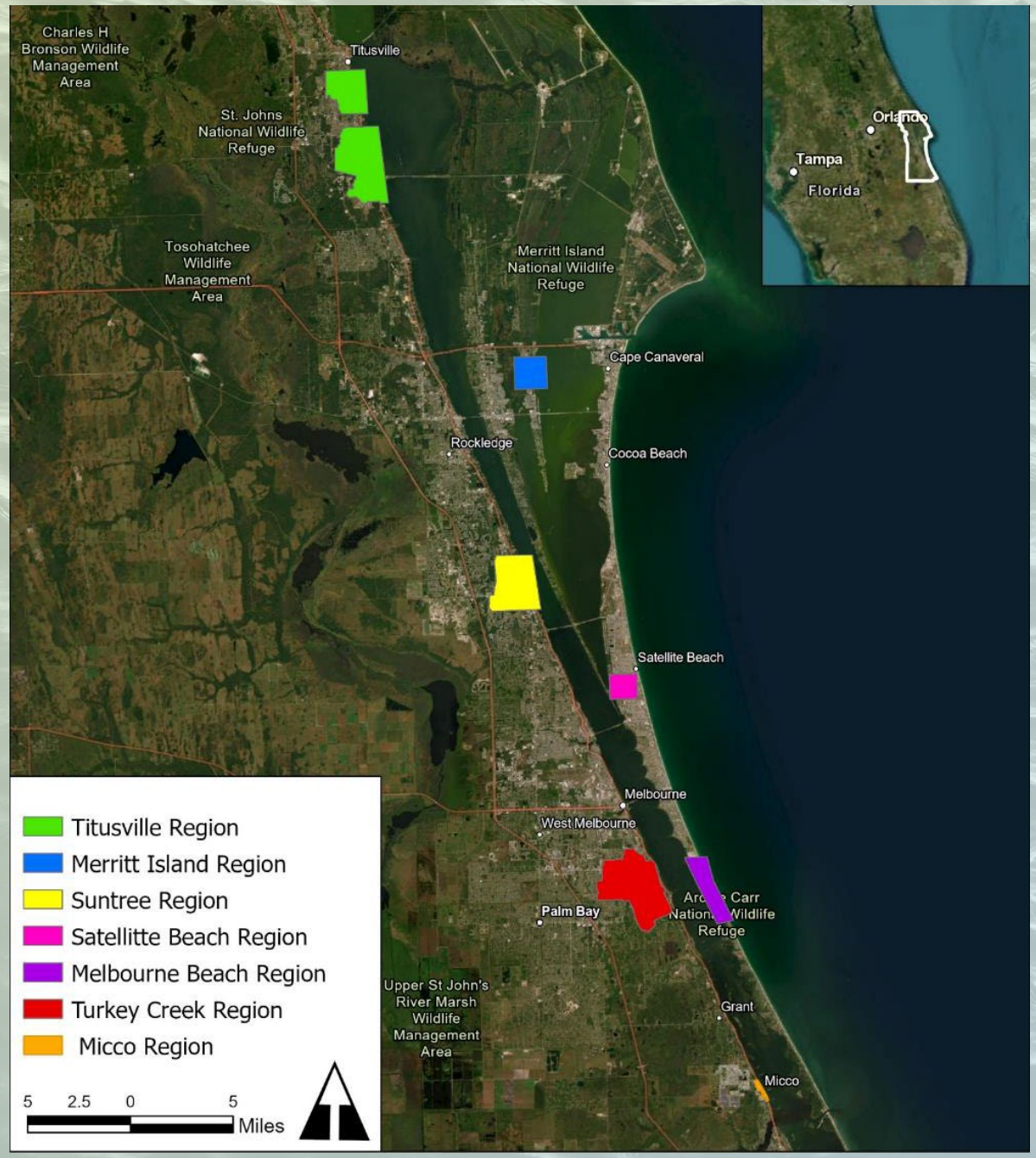
EXPERIMENTAL DESIGN

3 Treatments and a Control (44 wells)

- Septic
- Sewer
- Sewer with Reclaimed Irrigation Water
- Natural Areas (3) as control

6 Regions represent various conditions

- Titusville
- Merritt Island
- Suntree/ Viera
- Turkey Creek
- Beaches (Melbourne & Satellite Beach)
- Micco



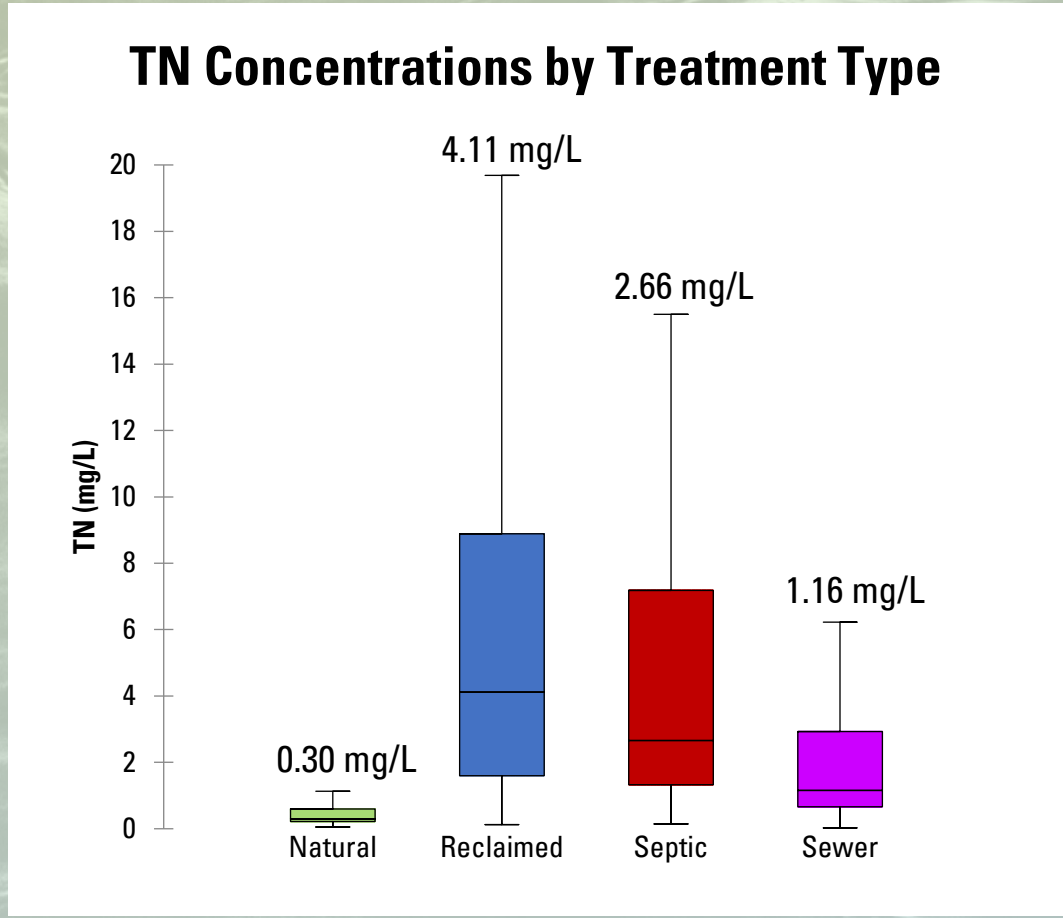
STUDY AREA REGIONS AND TREATMENT TYPES

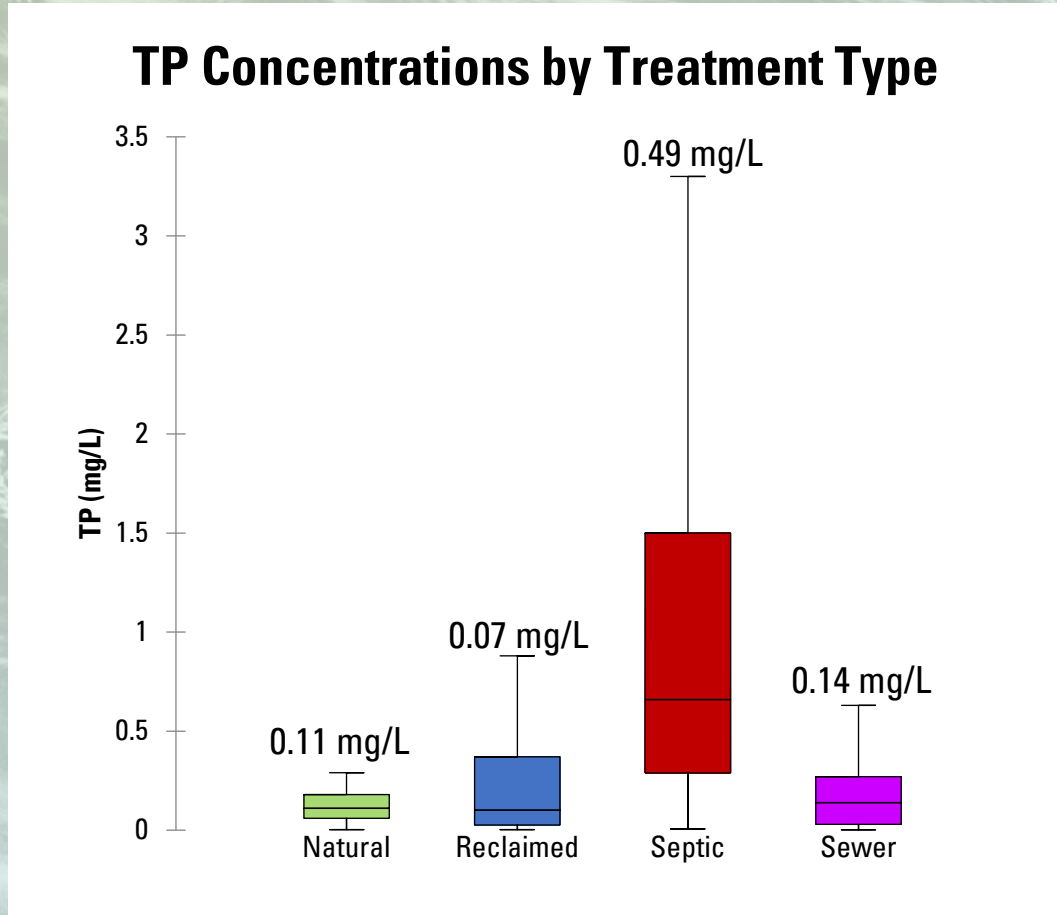
	Titusville*	Merritt Island	Suntree*	Beaches	Turkey Creek	Micco*
Treatments	☐ Septic ☒ Sewer ☒ Reclaimed ☒ Natural	☒ Septic ☒ Sewer ☐ Reclaimed ☐ Natural	☒ Septic ☒ Sewer ☒ Reclaimed ☐ Natural	☒ Septic ☒ Sewer ☒ Reclaimed ☒ Natural	☒ Septic ☒ Sewer ☒ Reclaimed ☒ Natural	☒ Septic ☐ Sewer ☐ Reclaimed ☐ Natural
Monitoring Timeframe	June 2018 - Present	June 2018 - Present	June 2018 - Present	June 2018 - Present	June 2017 - Present	July 2018 - Present
Potential Retrofit	WWTF Upgrade	Septic-to-Sewer	Septic-to-Sewer	Septic Upgrades	WWTF Upgrade	Septic-to-Sewer
Underway	✓		✓		✓	✓

* Presenting results from these two retrofits

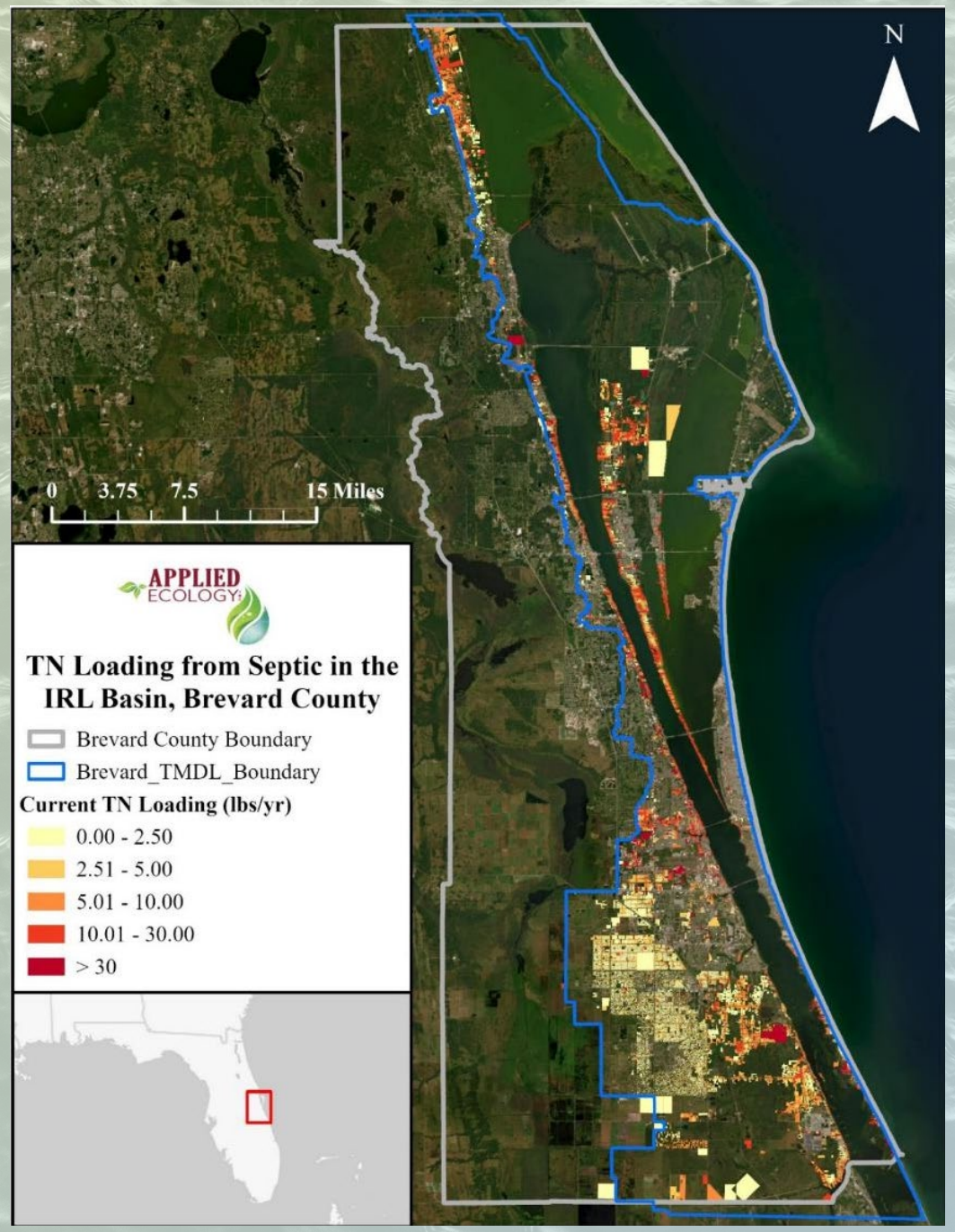
TREATMENT GROUNDWATER NUTRIENT CONCENTRATIONS

PRE-RETROFIT DISTRIBUTIONS & MEDIANS (N=3,276)





SEPTIC-TO-SEWER PROJECTS



PRIORITIZING SEPTIC TANKS

59,438 Septic Systems in the IRL watershed basin

8,203 in high / very high porosity soils

Of those, 5,584 are located within 33 feet (11 yards) of surface water

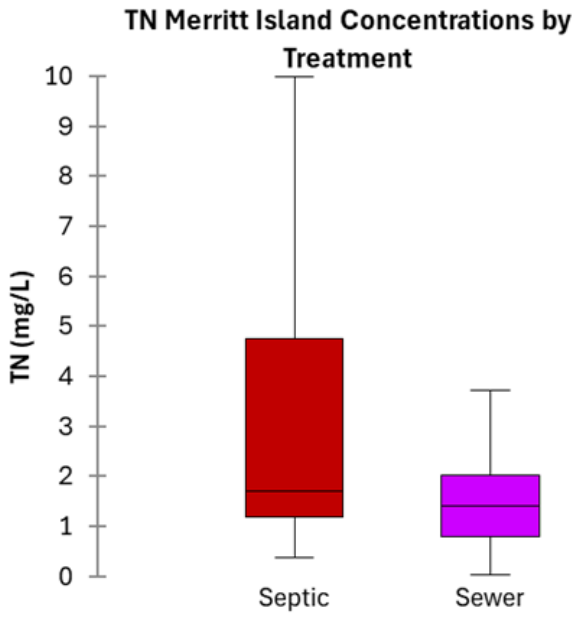
< 10% of the septic tanks are contributing > 30% of the TN load

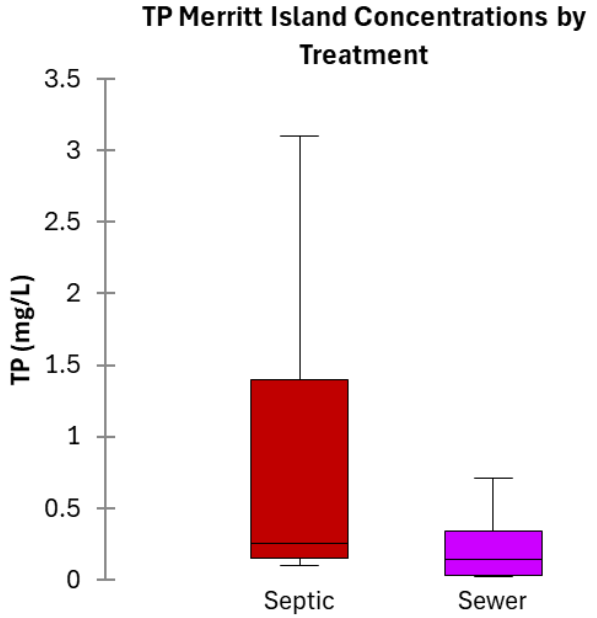
From SOIRLPP 2024 Update

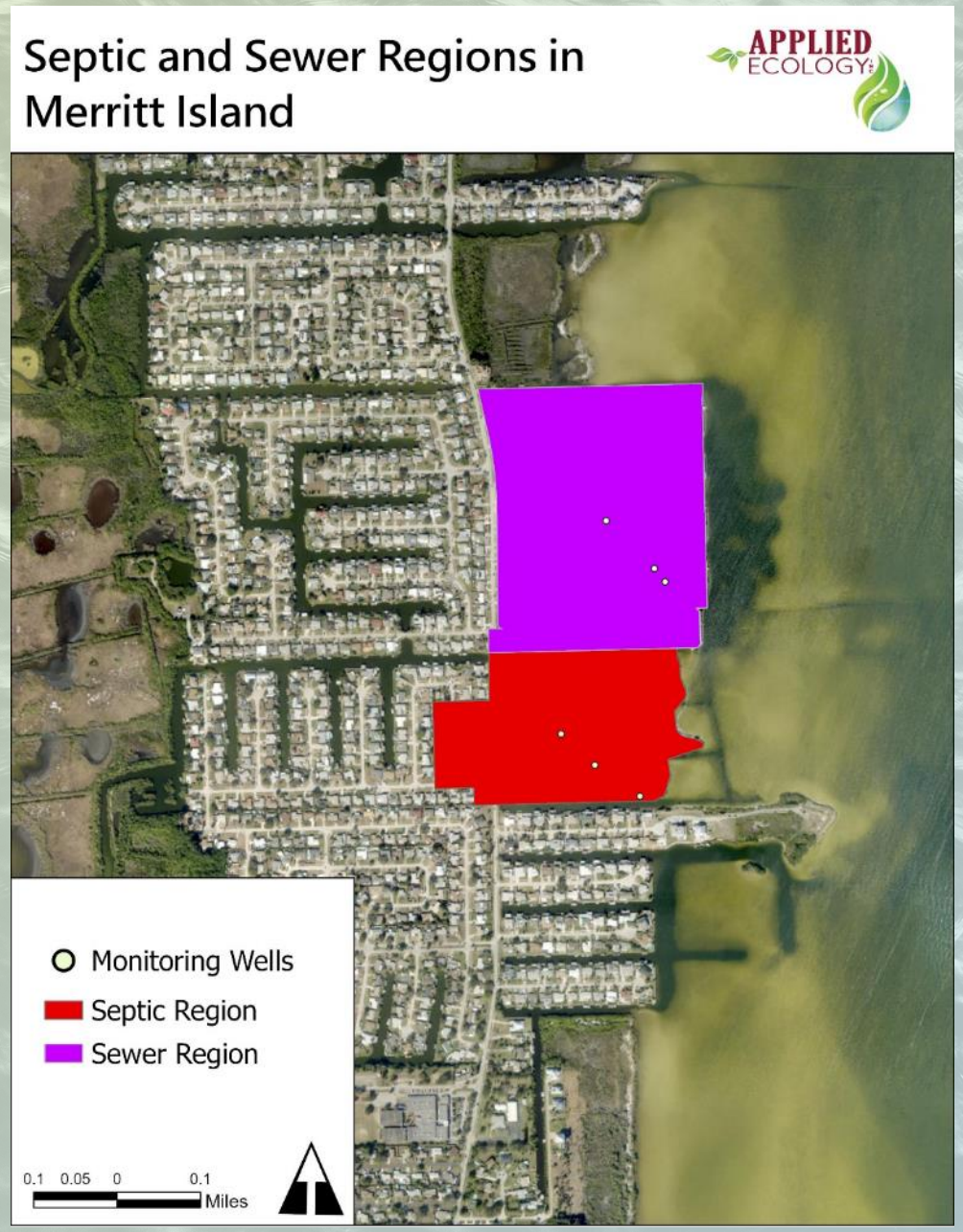
MERRITT ISLAND

SEPTIC & SEWER COMPARISON

- Half of the community hooked up to sewer.
- Half of the community on septic.







SUNTREE

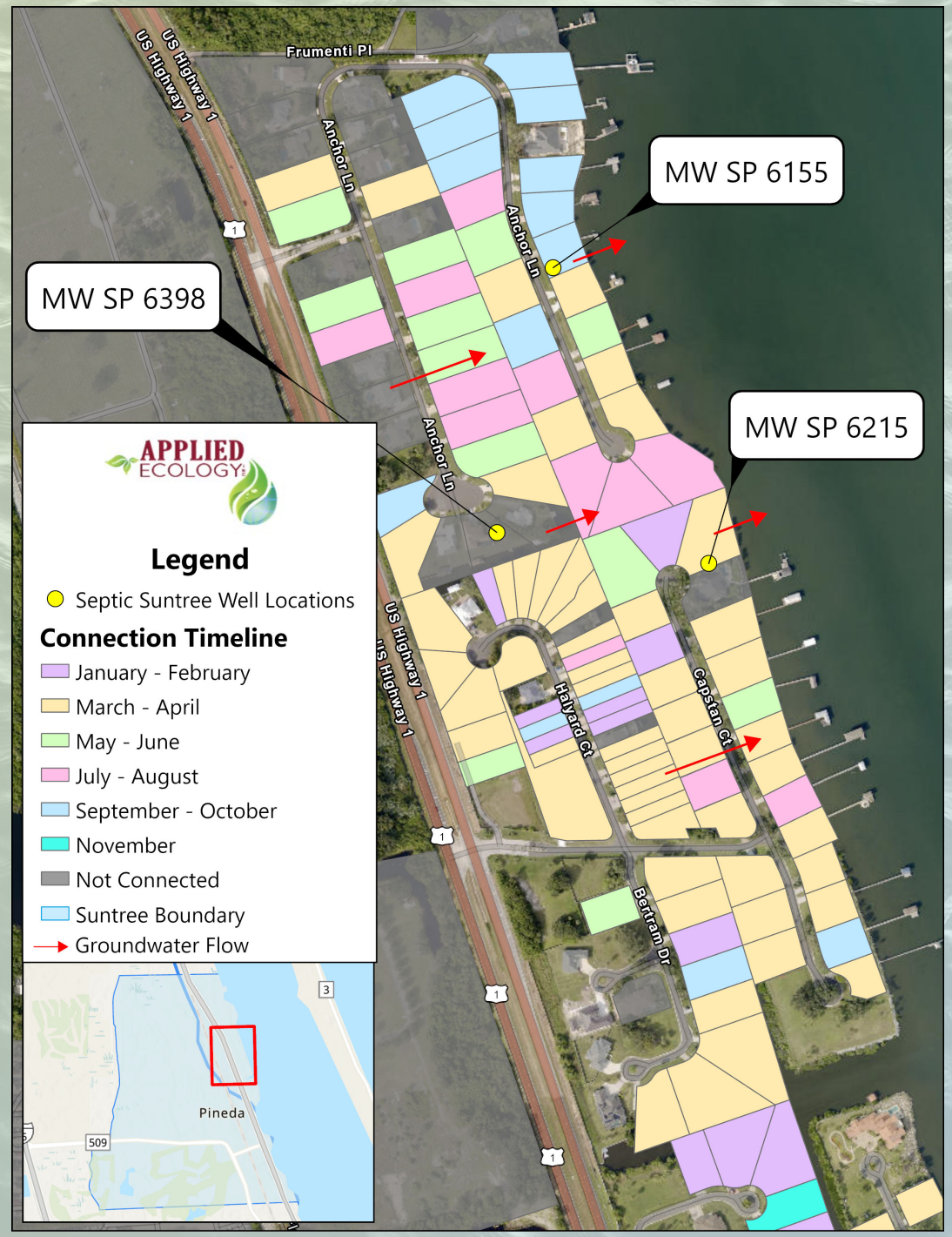
SEPTIC TO SEWER CONVERSION

- In the works!
- Finished construction of main line and most homes are connected.
- Homes being monitored recently connected to sewer or about to be connected
  - MW SP 6215 – April 2024
  - MW SP 6155 – September 2024
  - MW SP 6398 – Pending

SUNTREE

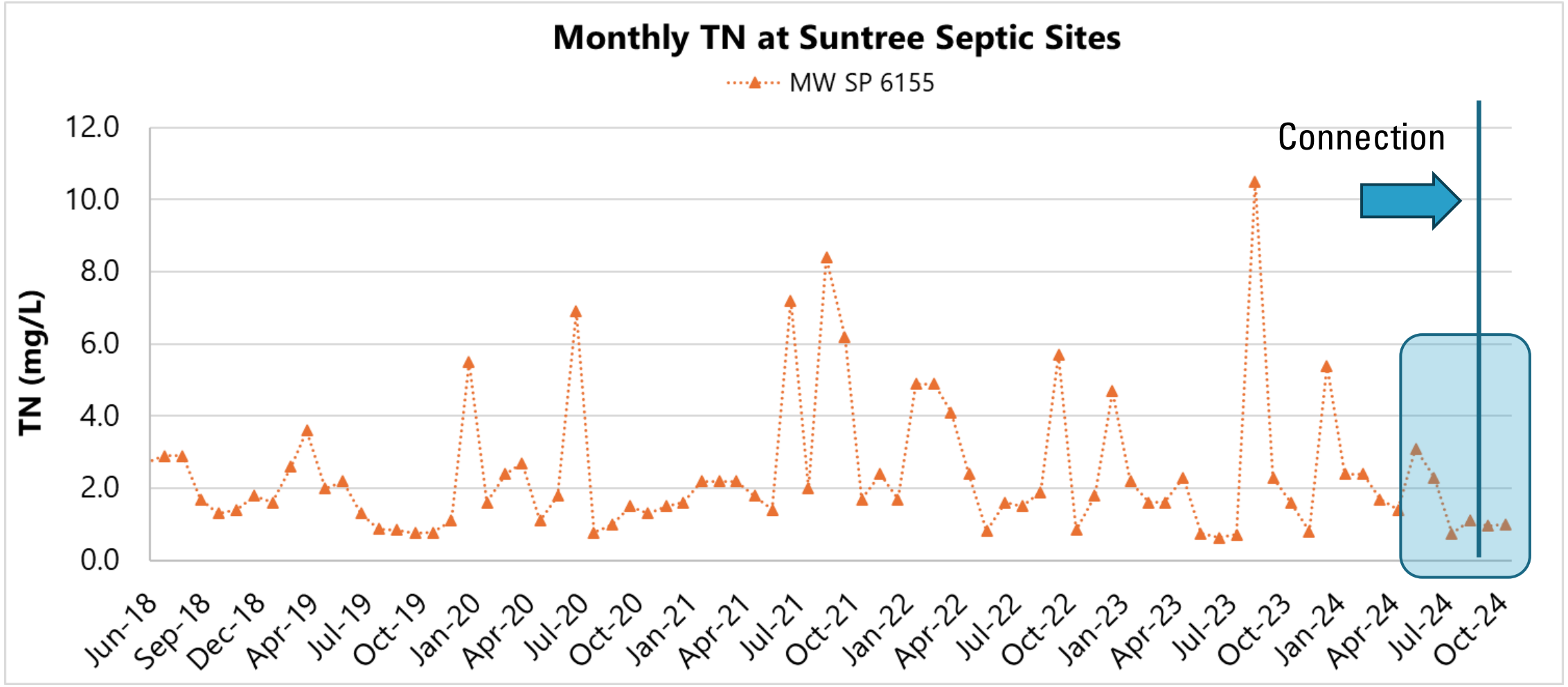
SEPTIC TO SEWER CONVERSION

- Most parcels have been converted to sewer
- Initiated January 2024
- MW SP 6215 – April 2024
  - Surrounding parcels Feb-April 04
- MW SP 6155 – September 2024
  - Surrounding parcels April-Sep 04



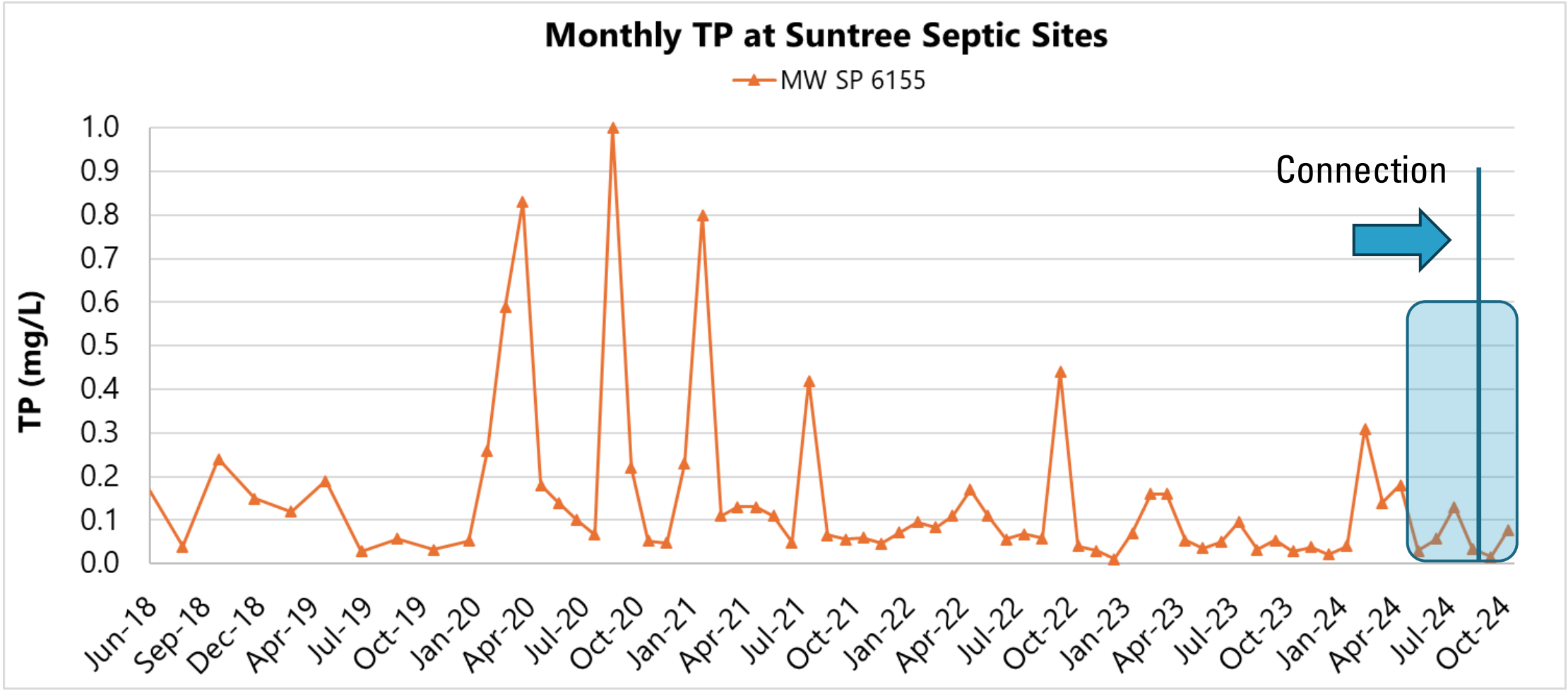
SUNTREE

MW SP 6155 TN CHANGES



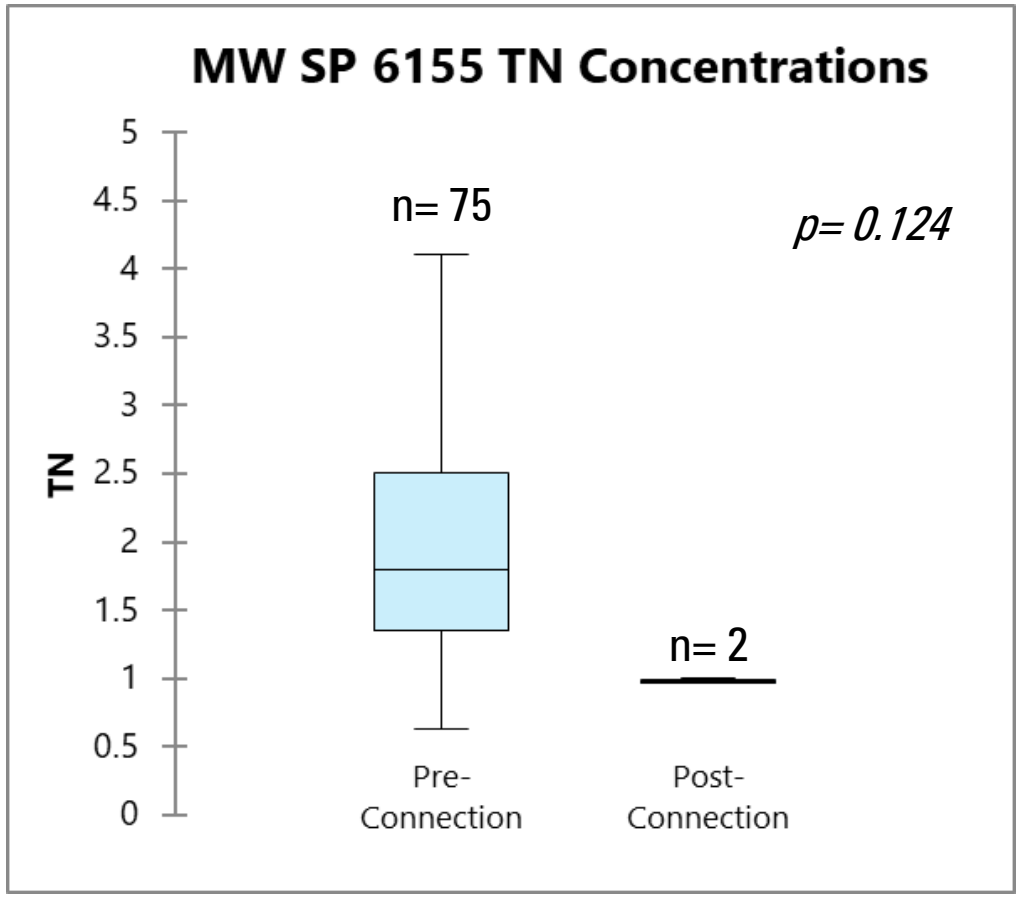
SUNTREE

MW SP 6155 TP CHANGES



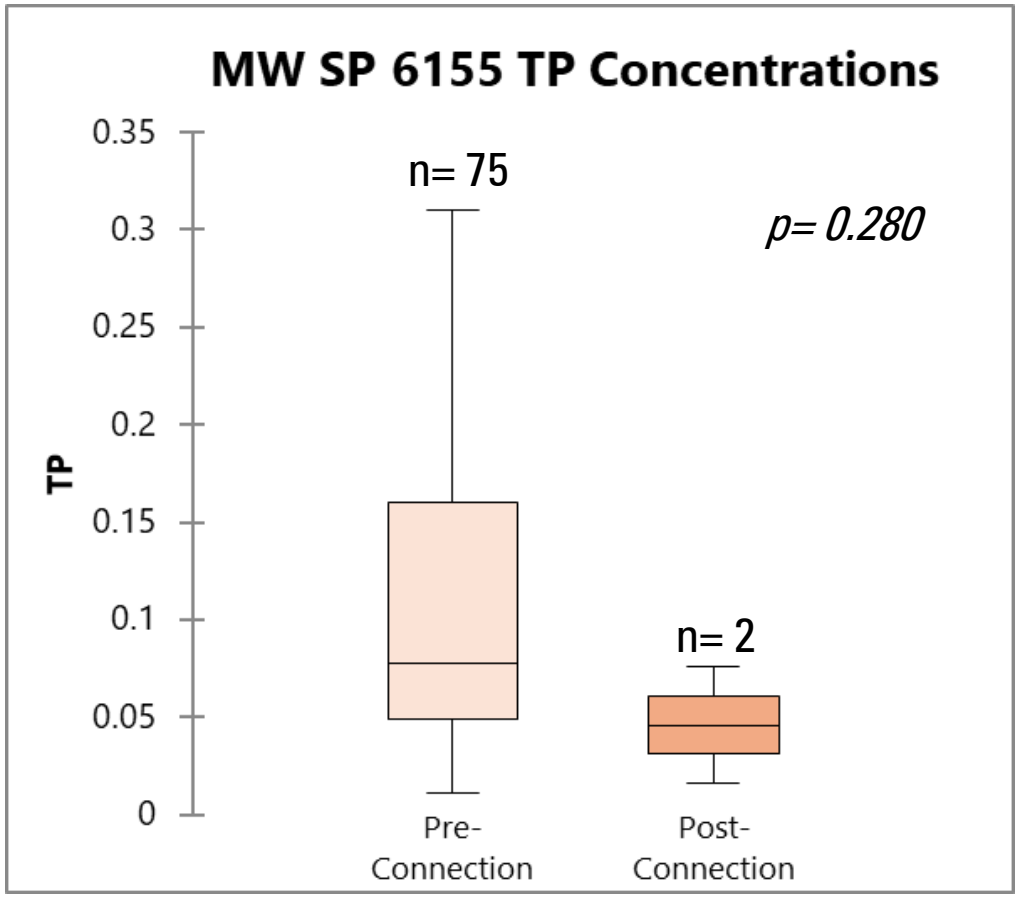
SUNTREE SEPTIC TO SEWER CONVERSION

MW SP 6155



Median went from 1.80 to 0.98mg/L

46% Decrease

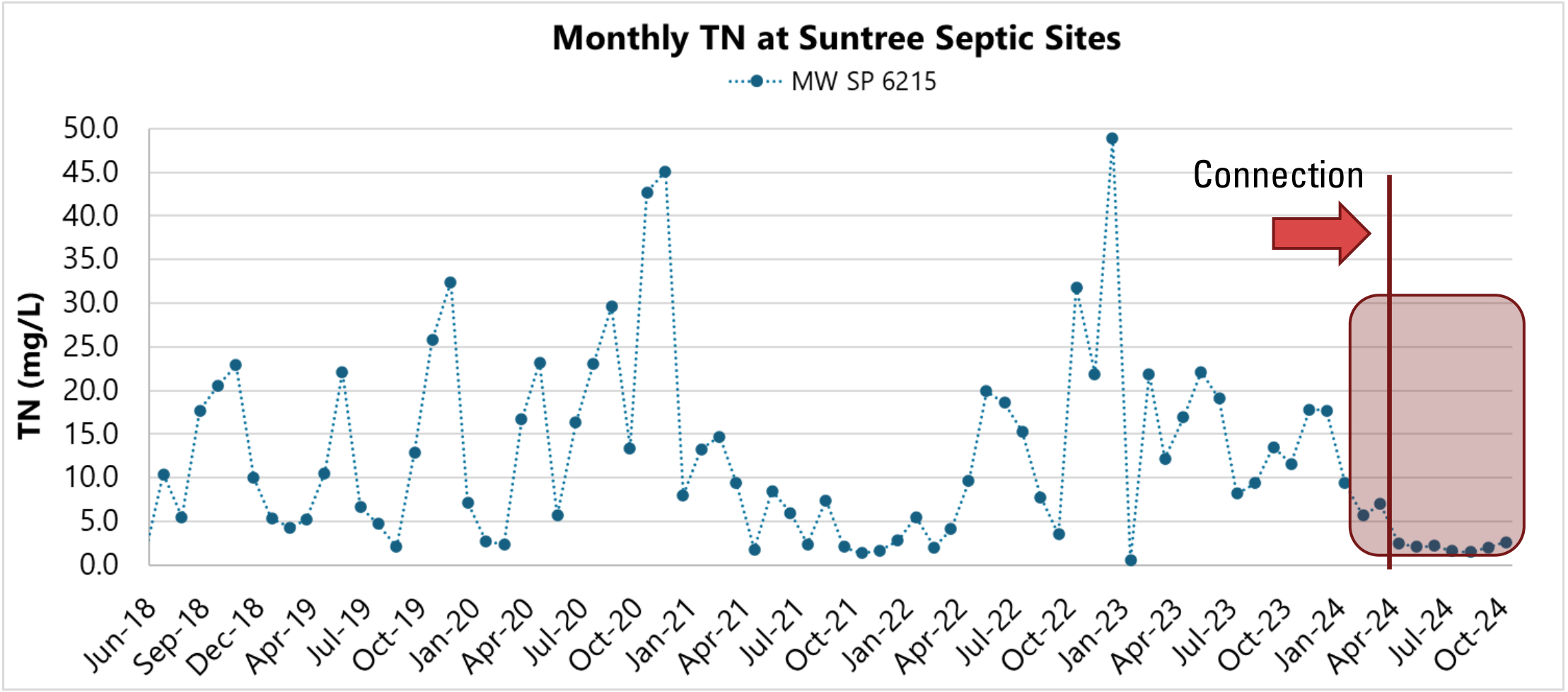


Median went from 0.08 to 0.05 mg/L

38% Decrease

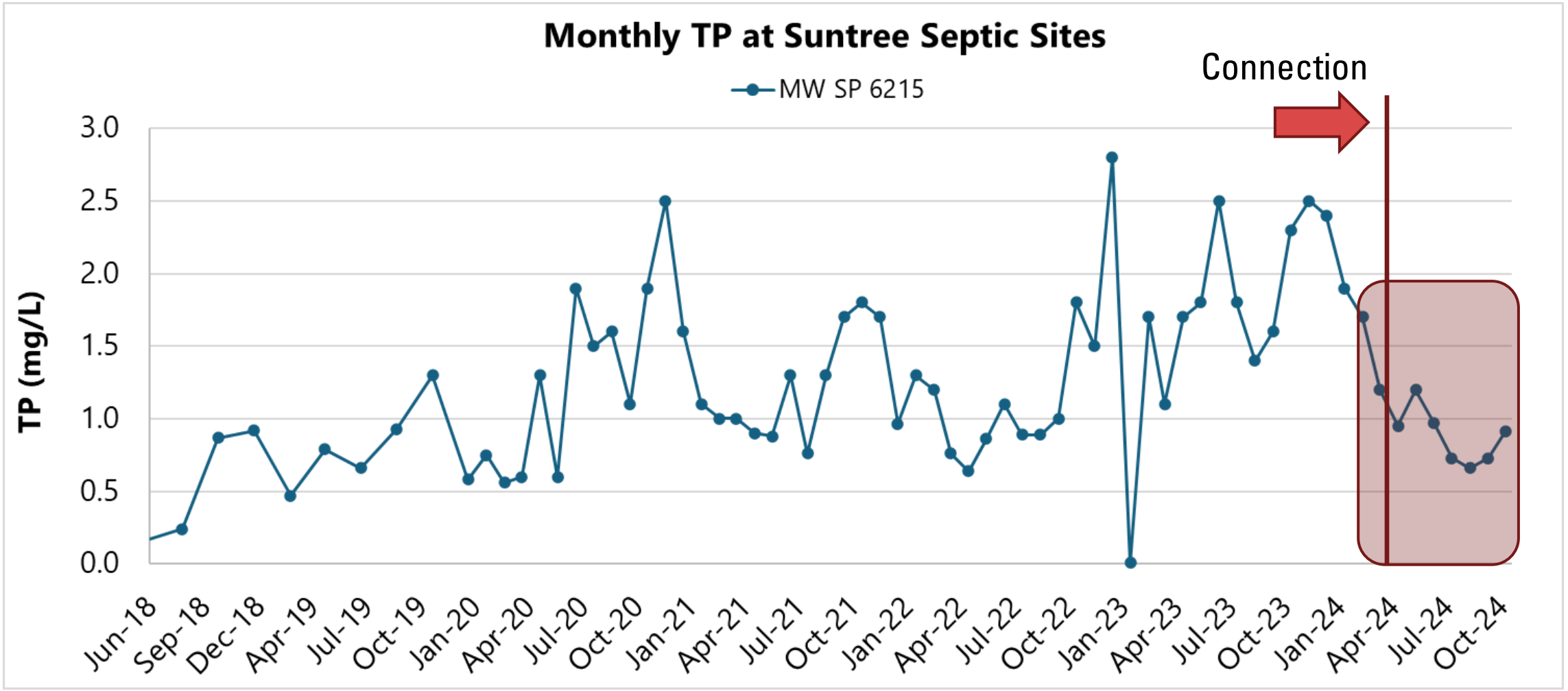
SUNTREE

MW SP 6215 TN CHANGES



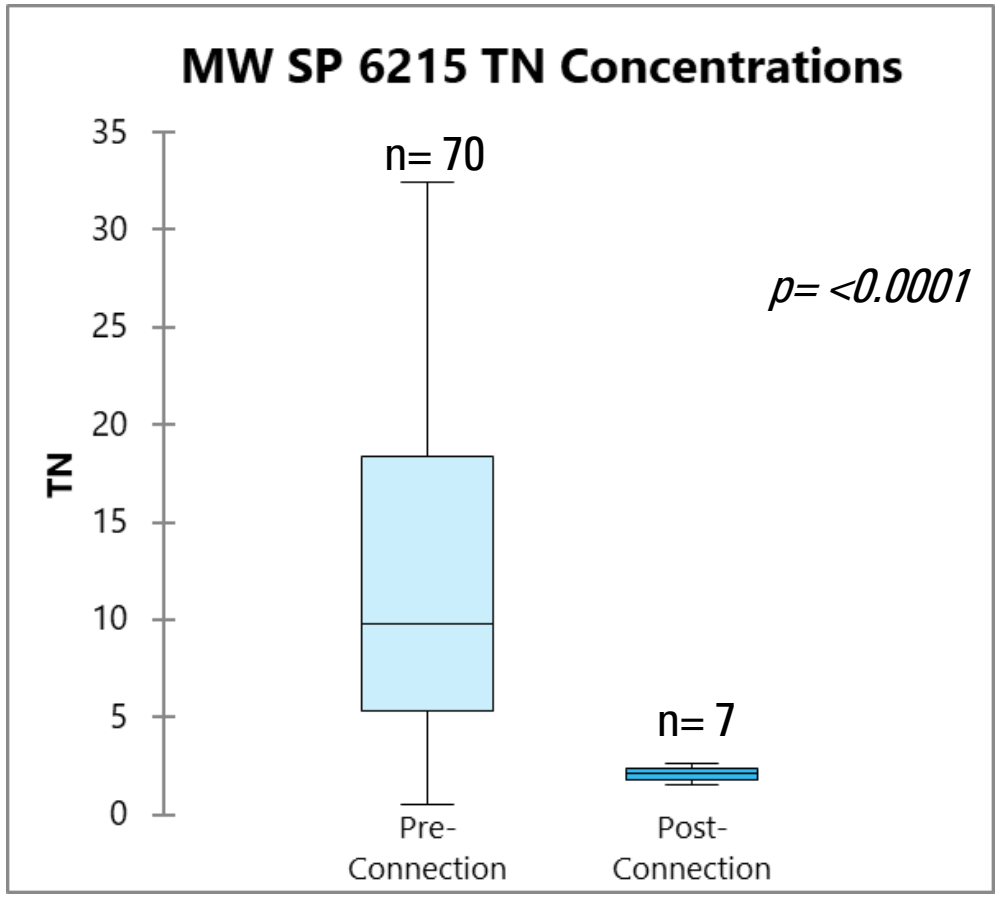
SUNTREE

MW SP 6215 TP CHANGES



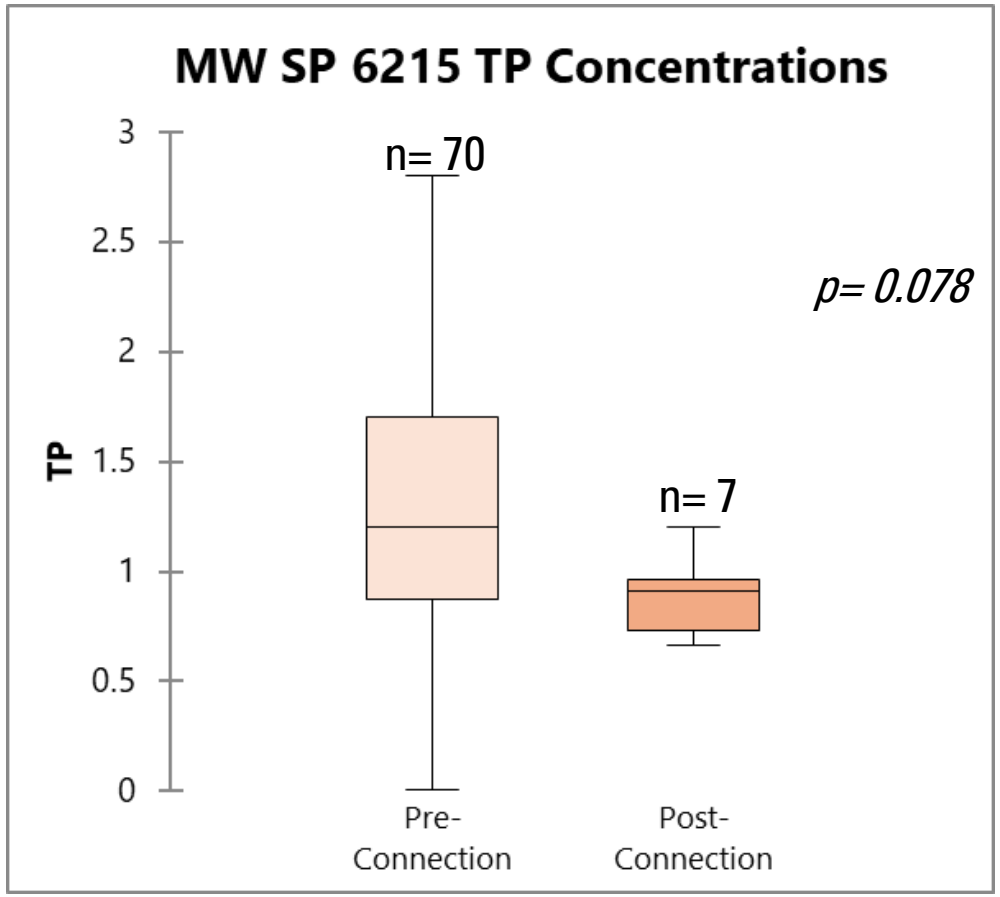
SUNTREE SEPTIC TO SEWER CONVERSION

MW SP 6215



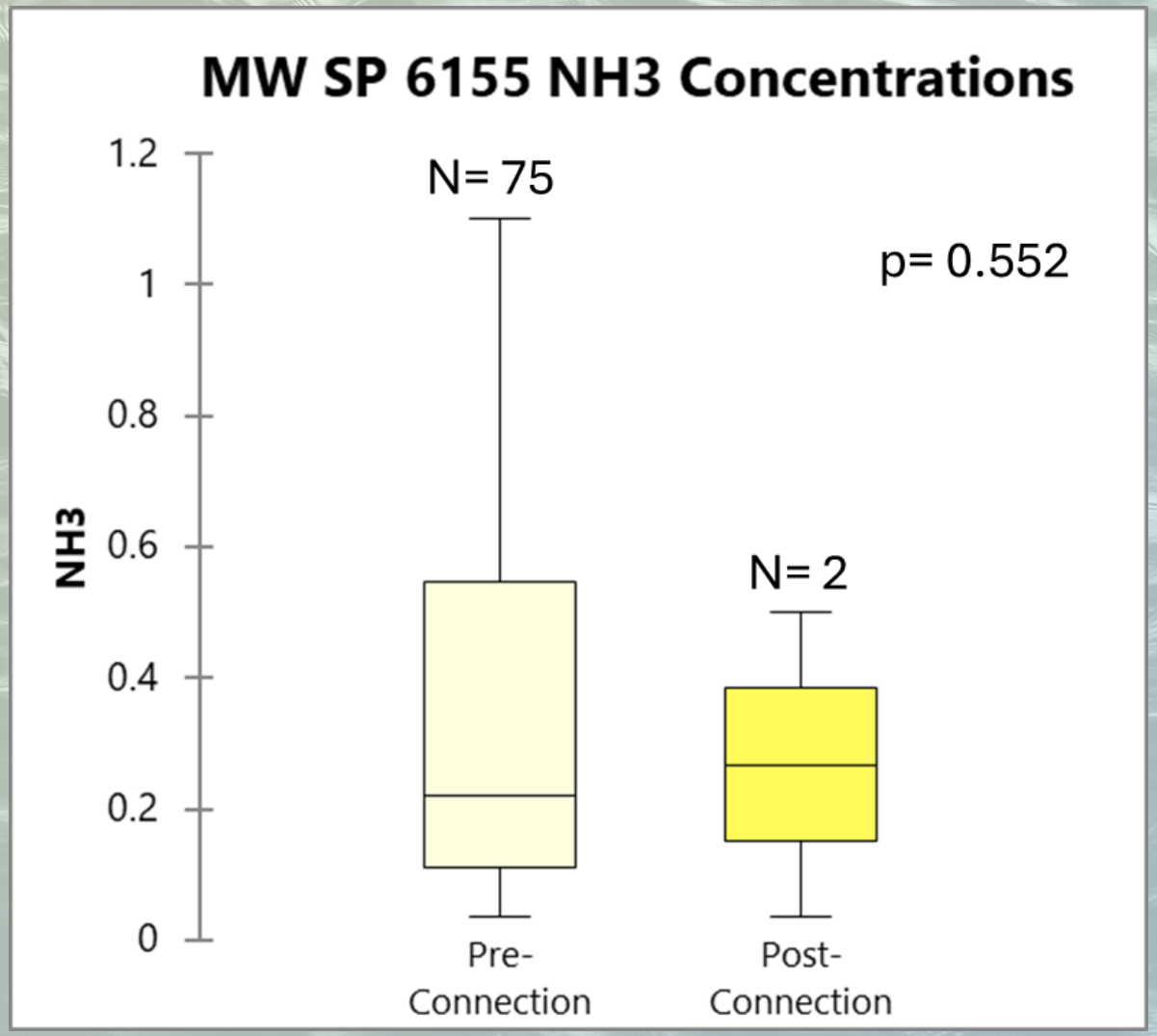
Median went from 9.80 to 2.10 mg/L

79% Decrease



Median went from 1.20 to 0.91 mg/L

24% Decrease



SUNTREE

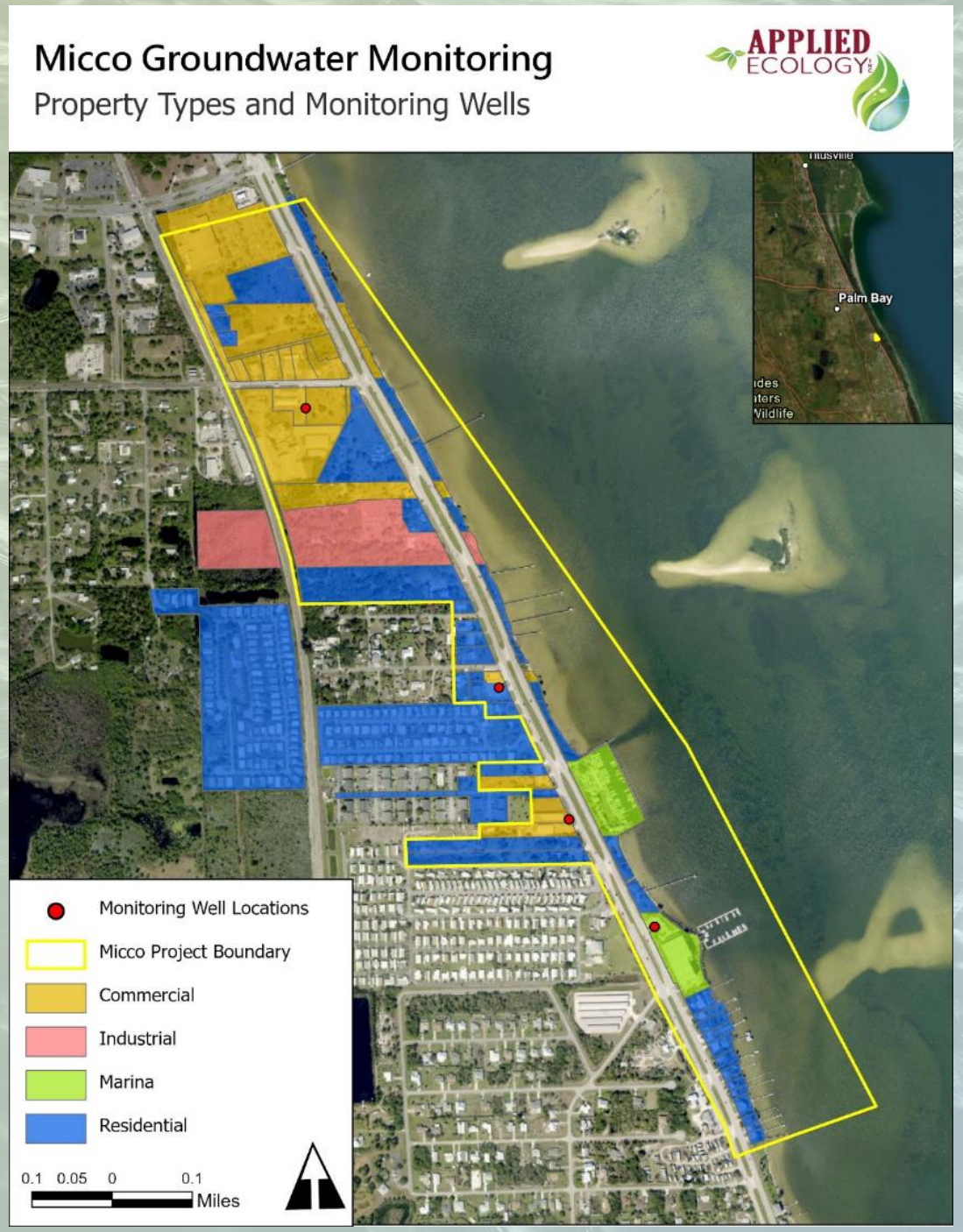
SEPTIC TO SEWER CONVERSION

- Median increased from 0.220 to 0.268 mg/L
- **22% increase in NH3**

MICCO

SEPTIC TO SEWER CONVERSION

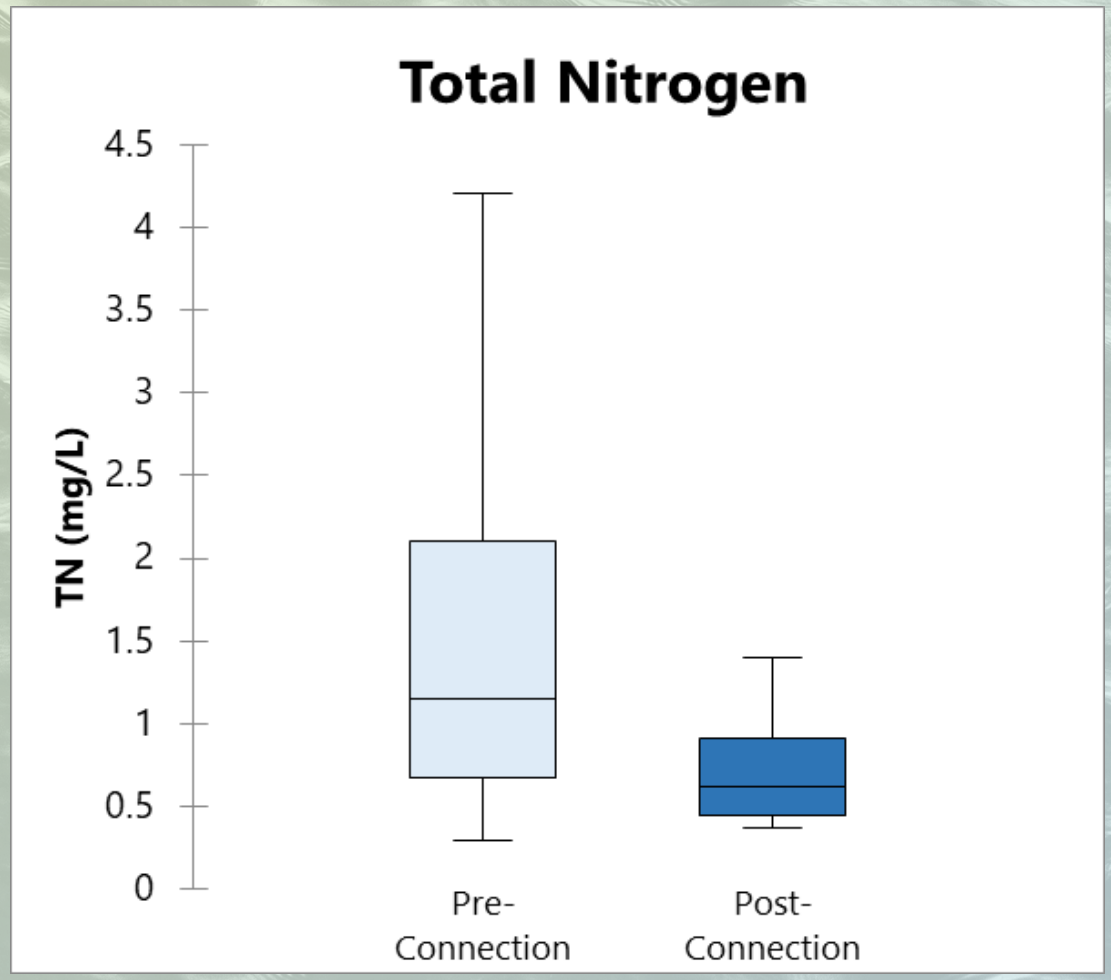
- In the works!
- Commercial septic systems.
- One of the four commercial properties connected to sewer on April 4, 2023.
- Other properties will be connected after FDEP clearance.



MICCO CONVERSION

PRE-POST TN CONCENTRATION COMPARISON

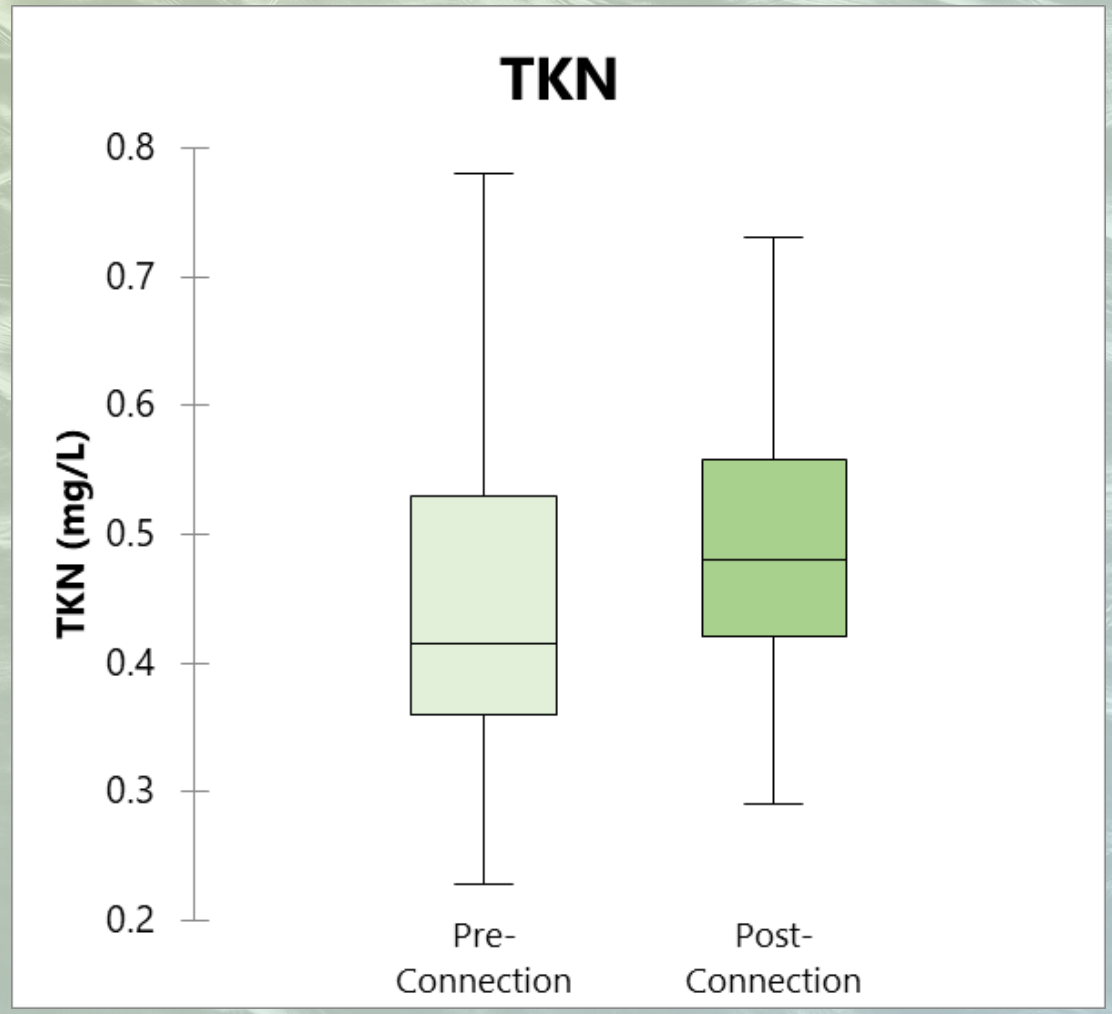
- 18 months of post-connection data for one well MW SP 8685
- TN median significantly decreased from 1.20 to 0.62 mg/L (*p=0.005*).
- **48% reduction in TN!**



MICCO CONVERSION

PRE-POST TKN CONCENTRATIONS

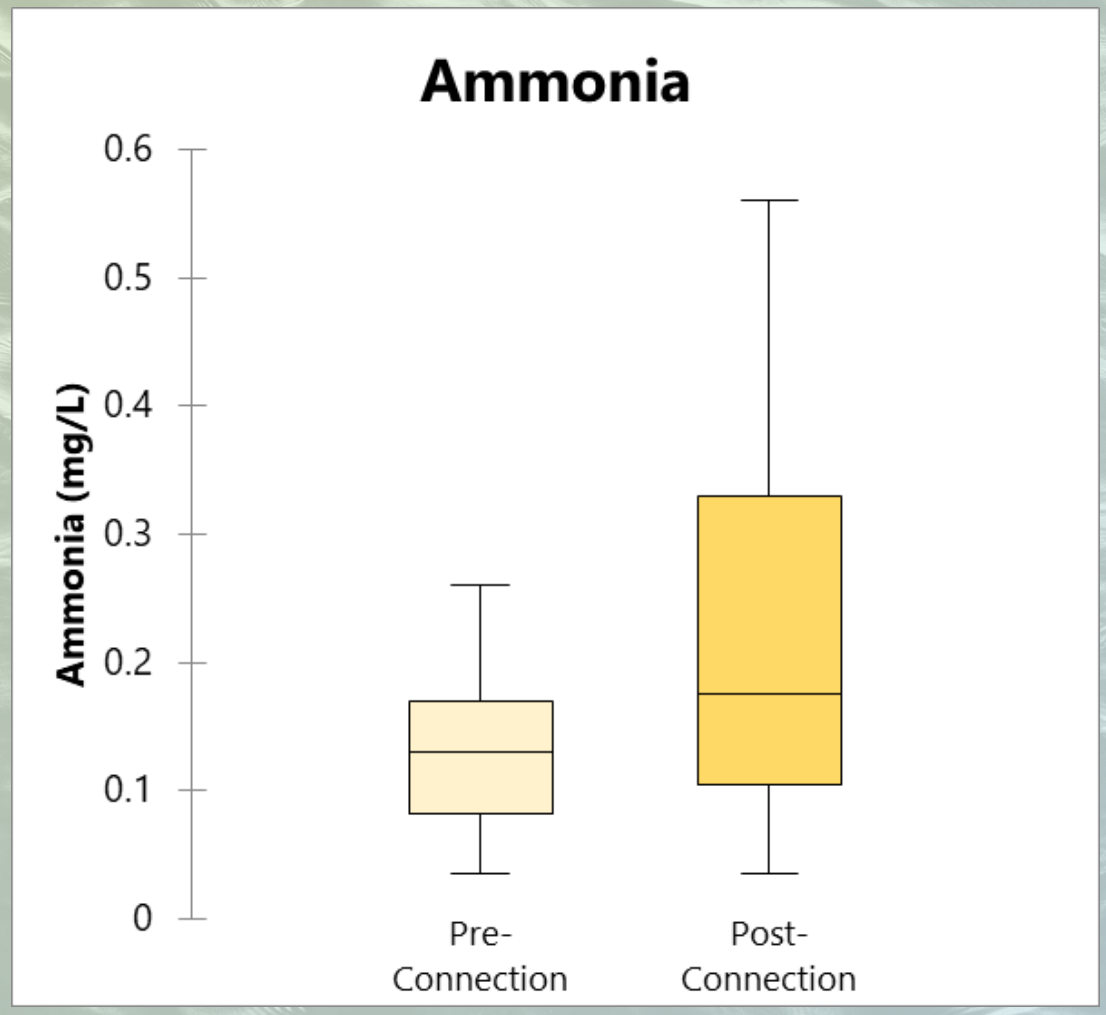
- TKN median slightly increased from 0.42 to 0.48 mg/L (p=0.304).
- **14% increase in TKN.**



MICCO CONVERSION

PRE-POST TKN CONCENTRATIONS

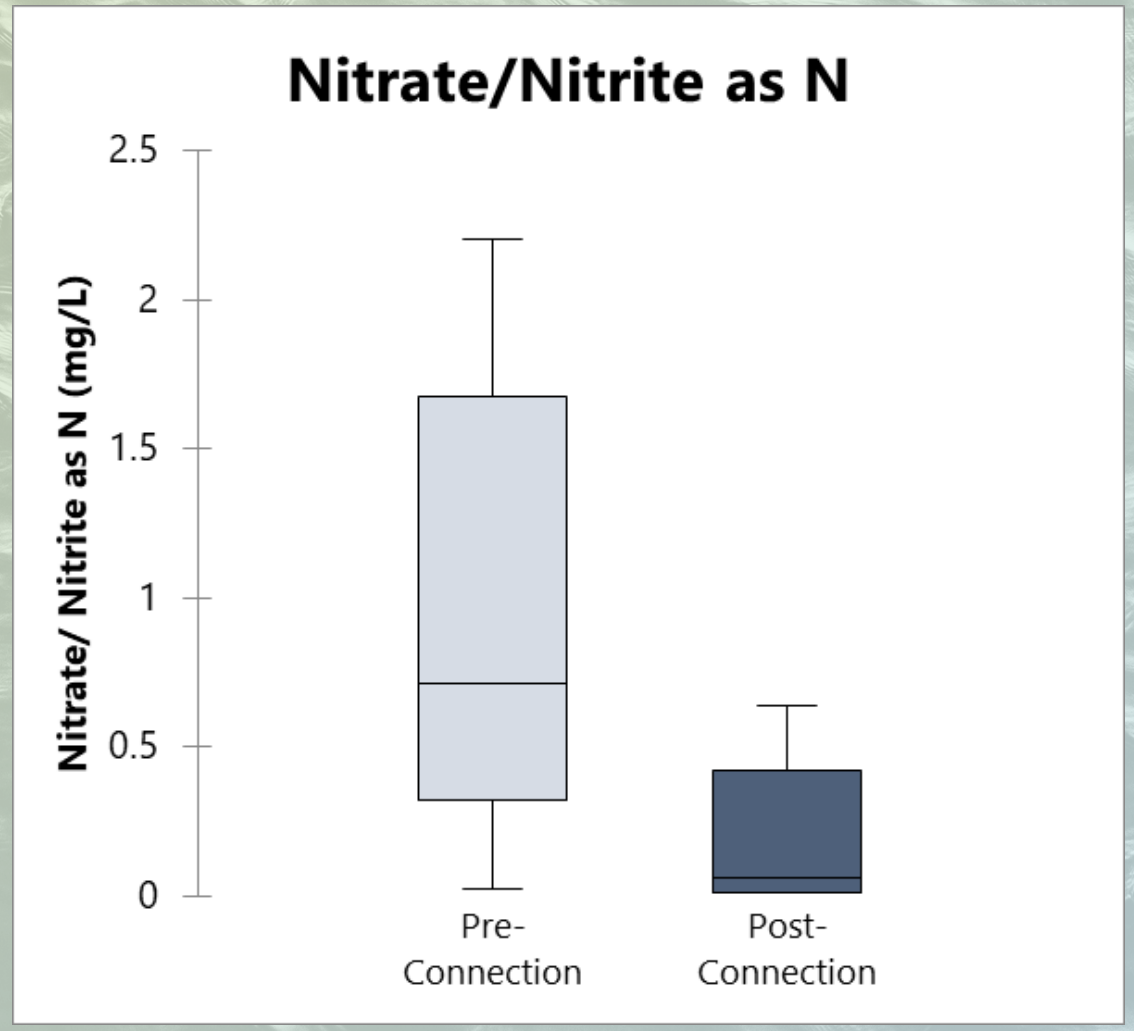
- NH3 median increased from 0.13 to 0.18 mg/L (p=0.066).
- **38% increase in NH3.**



MICCO CONVERSION

PRE-POST NOX CONCENTRATIONS

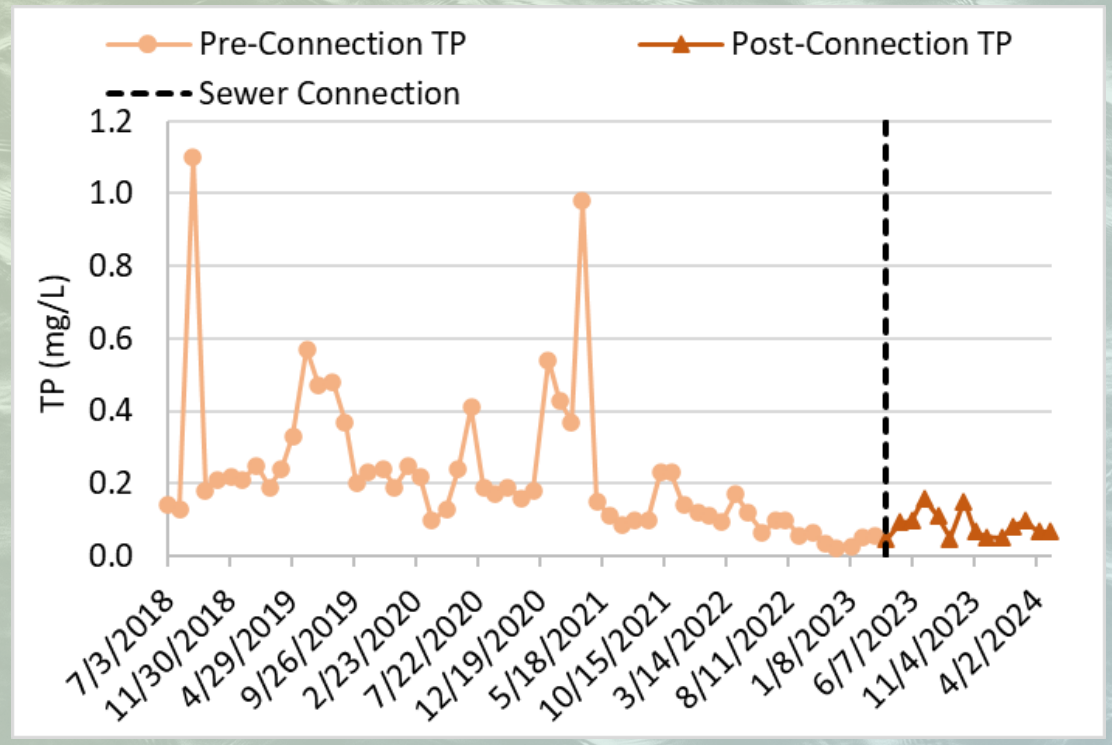
- NOx median significantly decreased from 0.72 to 0.06 mg/L (p=0.0001).
- **92% reduction in NOx!**



MICCO CONVERSION

PRE-POST TP CONCENTRATIONS

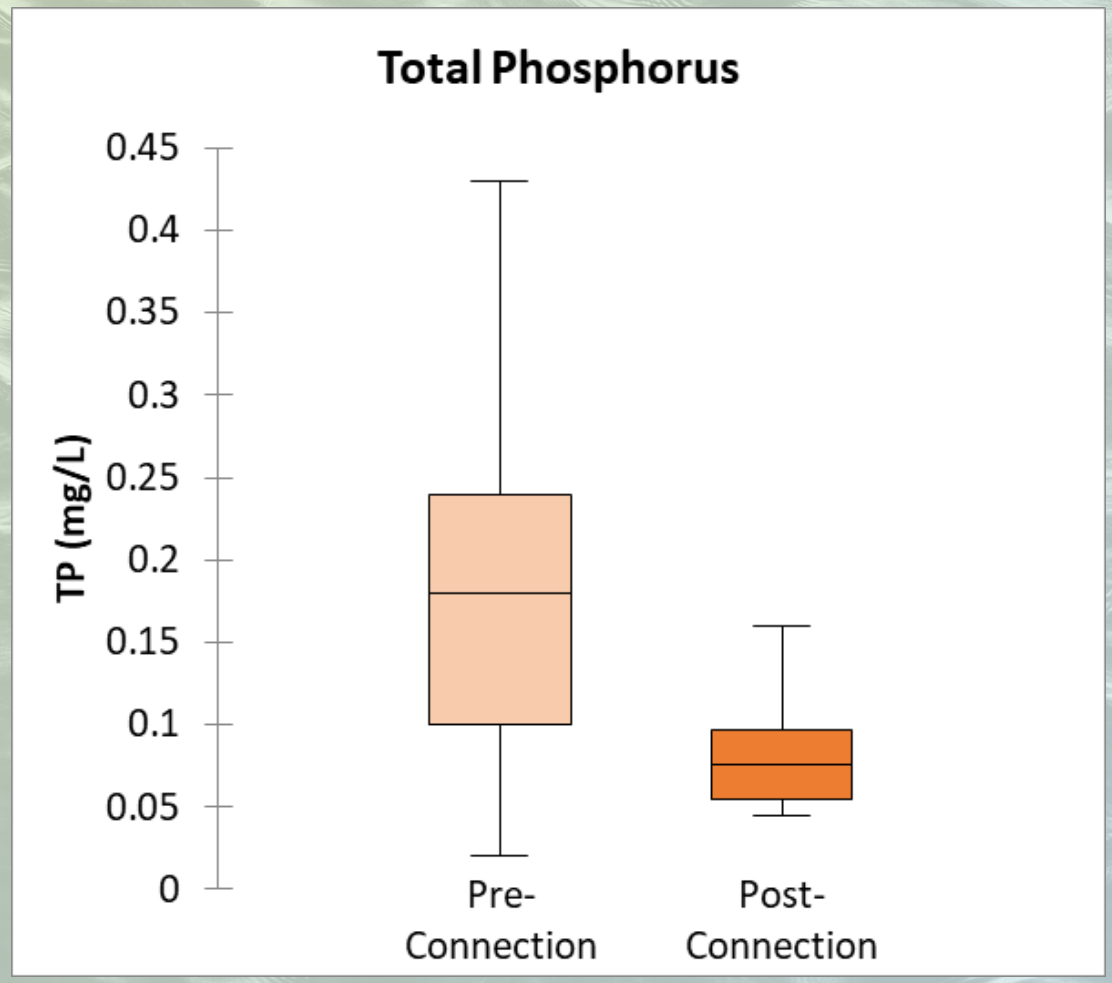
- 18 months of post-connection data for one well.
- TP median significantly decreased from 0.18 to 0.08 mg/L (*p=0.0001*).
- **56% reduction in TP!**



MICCO CONVERSION

PRE-POST TP CONCENTRATIONS

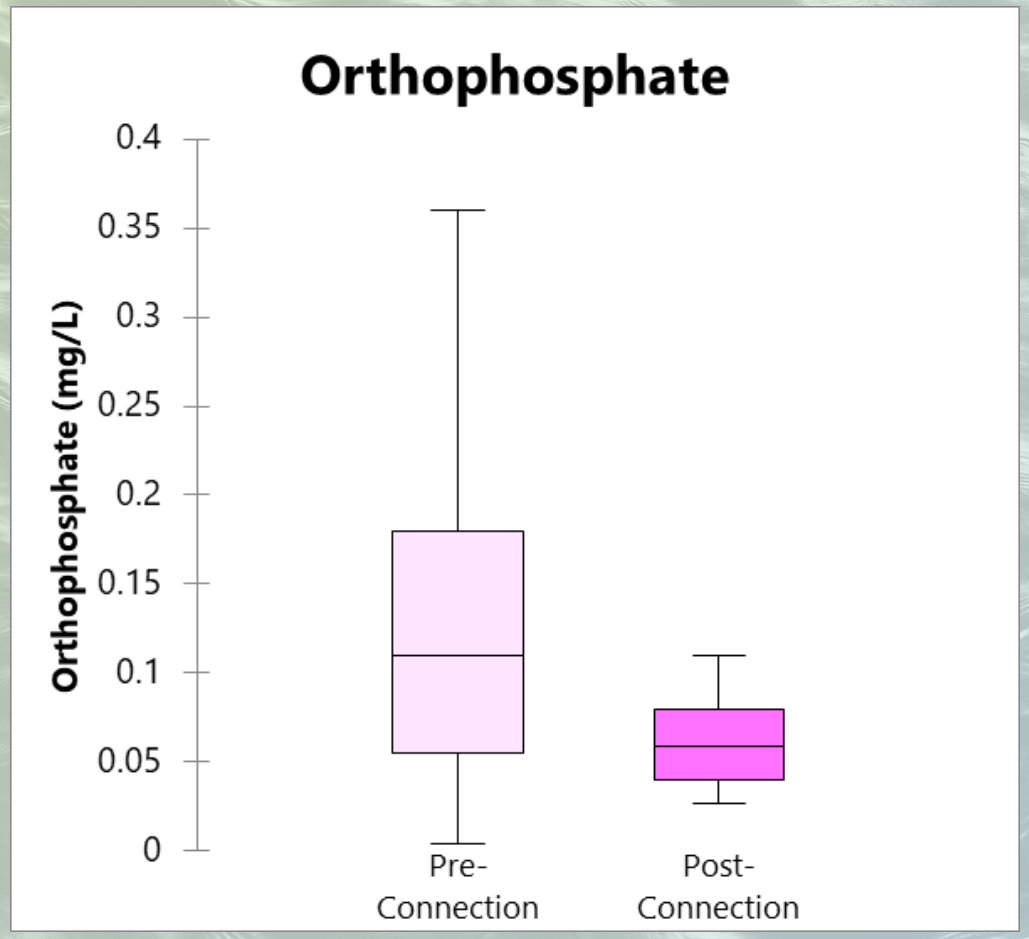
- 18 months of post-connection data for one well.
- TP median significantly decreased from 0.18 to 0.08 mg/L (*p=0.0001*).
- **56% reduction in TP!**



MICCO CONVERSION

PRE-POST OP CONCENTRATIONS

- Ortho-P median significantly decreased from 0.11 to 0.06 mg/L (*p=0.003*).
- **45% reduction in OP!**



POST CONVERSION REDUCTION IN BIOLOGICALLY AVAILABLE FORMS

MICCO: PRE- AND POST-CONNECTION

- Shift in TN composition after connection
- Decrease in biologically available forms

Percent Composition of Nutrient Analytes		
Nutrient	**Pre connection**	**Post Connection**
TKN	44%	**76%**
NO_x	**57%**	24%
PO_4^{3-}	**75%**	70%

SEPTIC TANK CONVERSION SUMMARY

- Suntree initial post-retrofit data show **46-79% reduction in TN** and **24-38% TP** (based on 1-5 months of post-data)
- Micco experienced significant reduction in biologically available forms of N and P, while temporarily increasing concentrations of ammonia and TKN
- Micco post-retrofit data show **48% reduction of TN** and **58% reduction of TP** (based on 18 months of post-data)

WWTF UPGRADES

WWTF UPGRADES & GROUNDWATER MONITORING

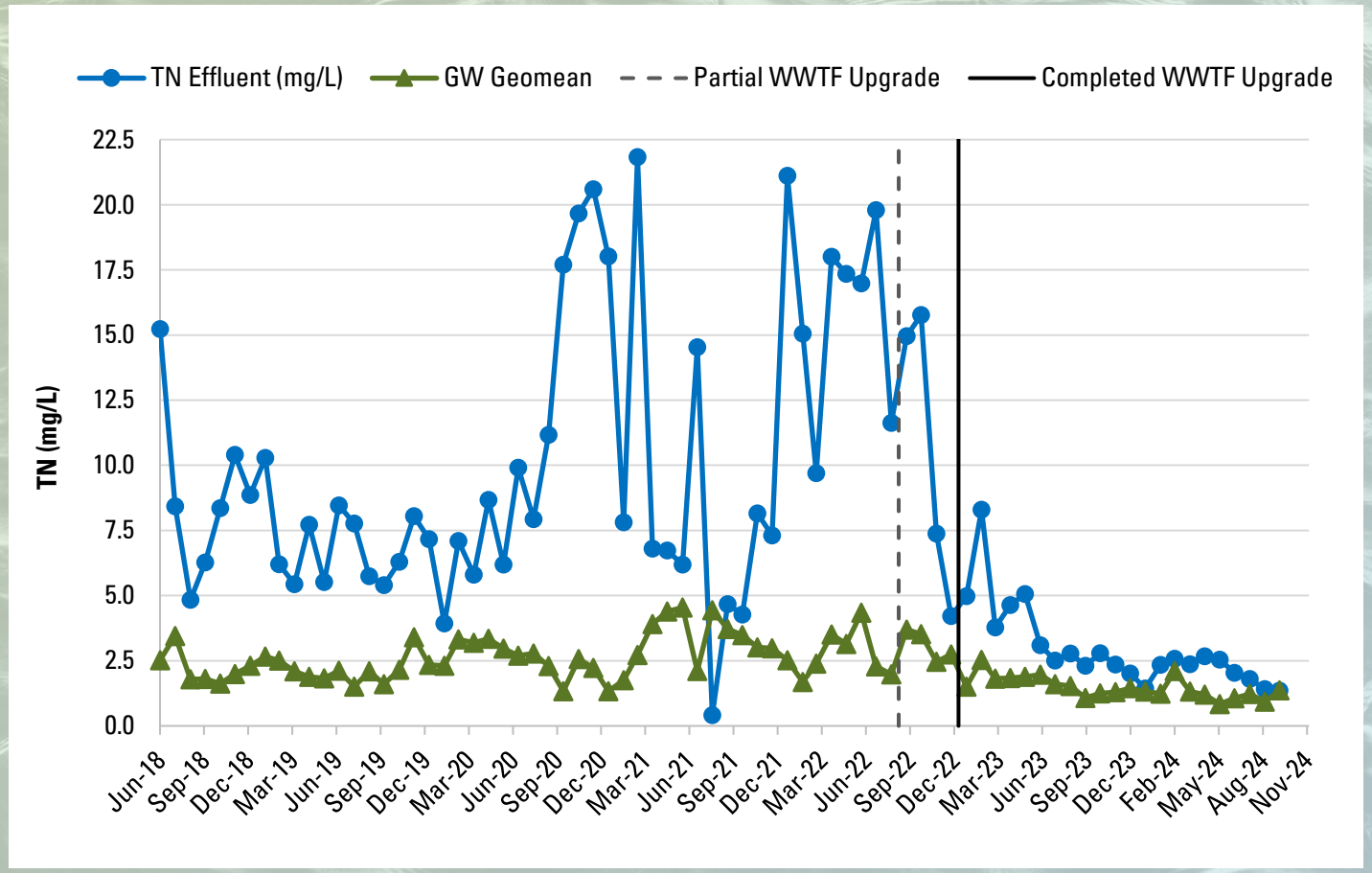
1. The Palm Bay Water Reclamation Facility (WRF)
2. The Titusville Osprey WWTF
3. The South Beaches WWTF
4. The South Central WWTF

Treatment Facility	Palm Bay Water Reclamation Facility	Osprey Wastewater Treatment Facility	South Beaches Wastewater Treatment Facility	South Central Wastewater Treatment Facility
Upgrade Status	• Services Turkey Creek • Began June 2022 • Upgrades Still Ongoing • Not Completed	• Services Titusville • Partial Upgrades August 2022 • Full Upgrades Completed in December 2022	• Services Melbourne Beach • No Upgrades	• Services Suntree/Viera • No Upgrades

OSPREY WWTF UPGRADE

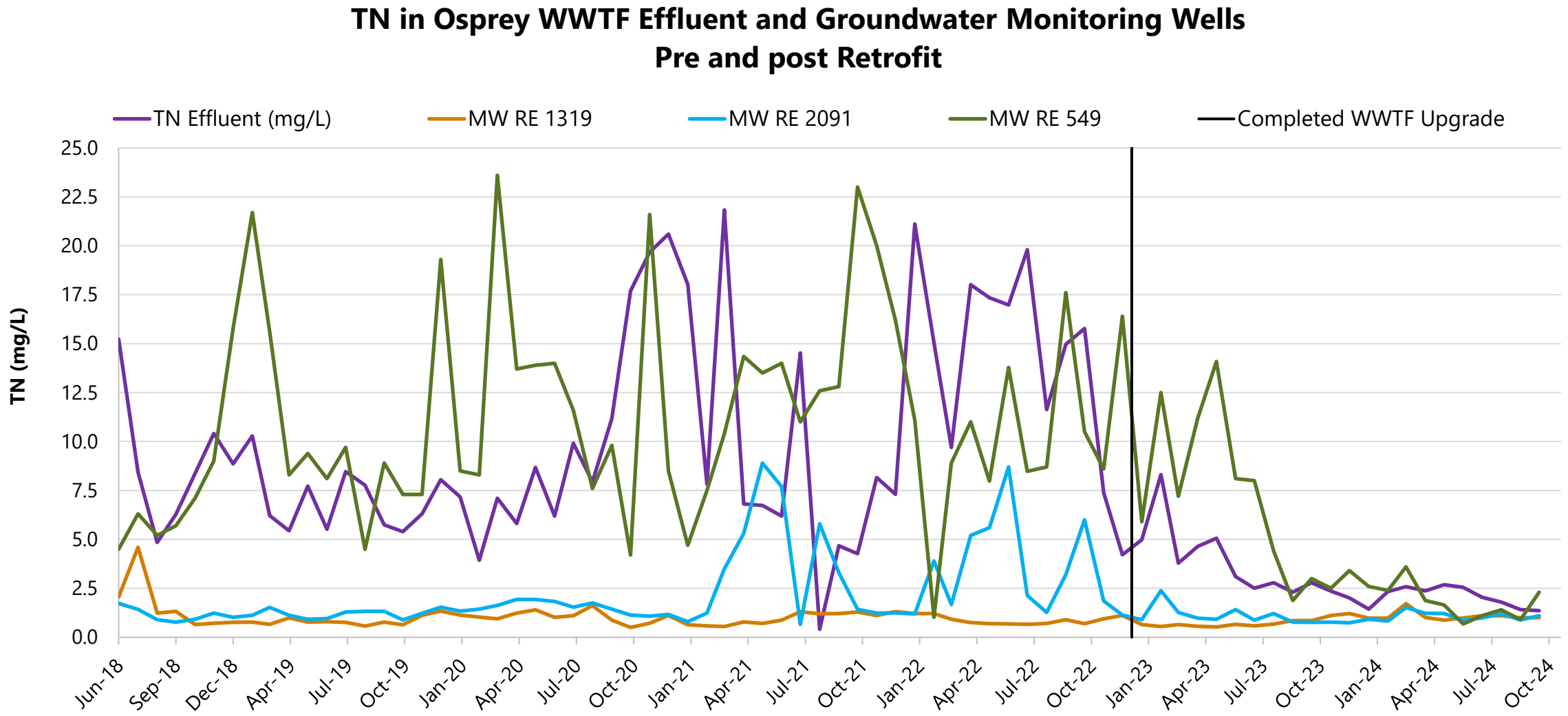
TOTAL NITROGEN REDUCTIONS

- New effluent target: 6.0 mg TN/L
- Effluent TN concentrations significantly decrease after upgrade



***Full Upgrades Completed in December 2022**

RELATIONSHIP BETWEEN IRRIGATION WATER & GW TN CONCENTRATIONS



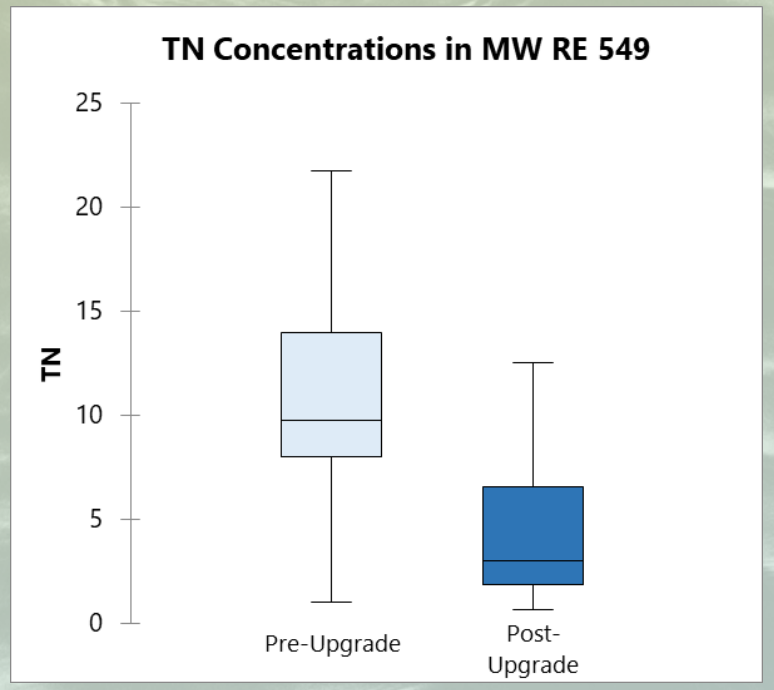
OSPREY WWTF UPGRADE RESULTS: TN

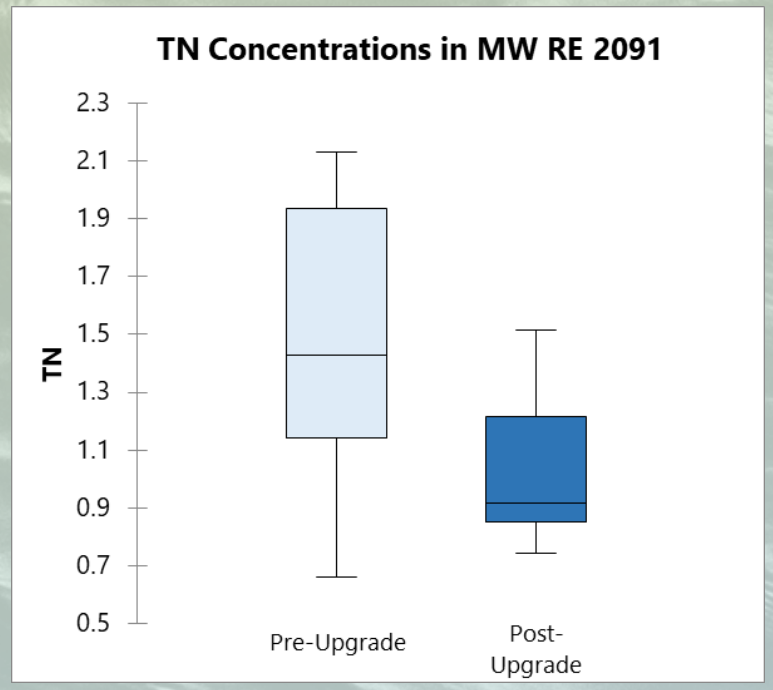
TN increases/reductions at Titusville monitoring wells

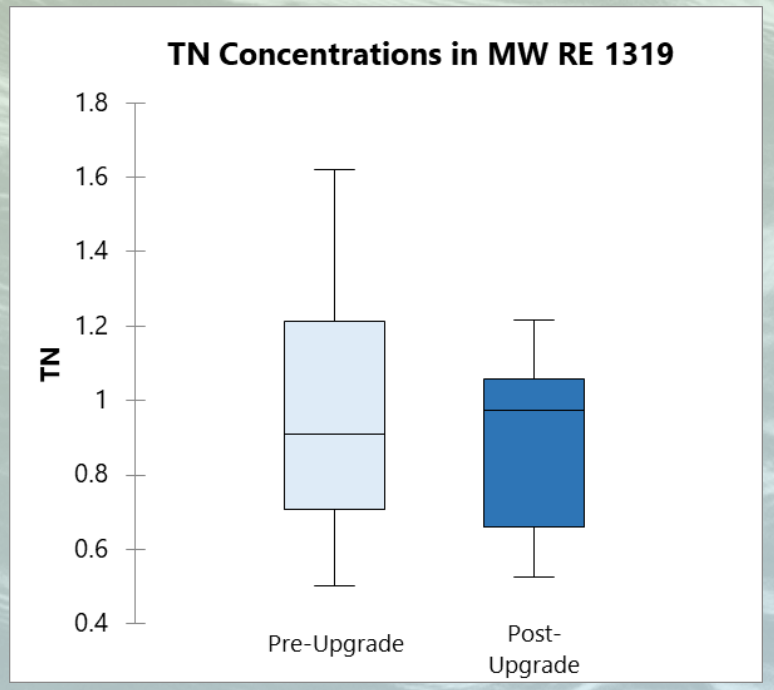
- **MW RE 549** (*p= <0.0001*)
- Median decrease from 9.75 to 3.00 mg/L
- **69% Reduction**

- **MW RE 2091** (*p= <0.0001*)
- Median decrease from 1.43 to 0.92 mg/L
- **36% Reduction**

- **MW RE 1319** (*p=0.32*)
- Median increase from 0.91 to 0.98 mg/L
- **8% Increase**







KEY HIGHLIGHTS

WWTF UPGRADES

- TN started showing clearly declining concentrations 3 months after upgrade.
- TN in groundwater significantly decreased ~ 8 months after upgrade.
  - MW RE 549 - **69% Reduction**
  - MW RE 2091 - **36% Reduction**
- TP meeting new lower targets ~47% of the time after full upgrade.
- **No significant TP reductions** at Titusville reclaimed groundwater monitoring wells so far.

NUTRIENT REDUCTION FROM GROUNDWATER SOURCES

- Residential septic post-connection data is limited (5 months)
- Commercial based on longer term data (18 months) at one site
- Reductions are mostly in biologically forms of nitrogen and phosphorus, especially NOx
- Impact of retrofits has little to no lag time in the studied sites (1-4 months)
- Long-term post-connection data are needed to confirm these results

Type of retrofit	TN Reduction %	TP Reduction %
Septic to Sewer - Residential	46-79%	24-38%
Septic to Sewer - Residential	48%	58%
WWTF Upgrade	0-69%	N/A

IMPORTANCE OF PRIORITIZING COMMUNITIES FOR RETROFITS

- TN and TP reductions much greater for sites with higher initial TN and TP concentrations (for both septic and WWTF upgrades)
- Underscores the critical need to address priority wastewater treatment systems (both on-site septic systems & central WWTFs) and to evaluate their success.

Thank you!

Questions?