

Nutrients, wastewater tracers, and the insecticide imidacloprid in the watershed of a north Florida lake



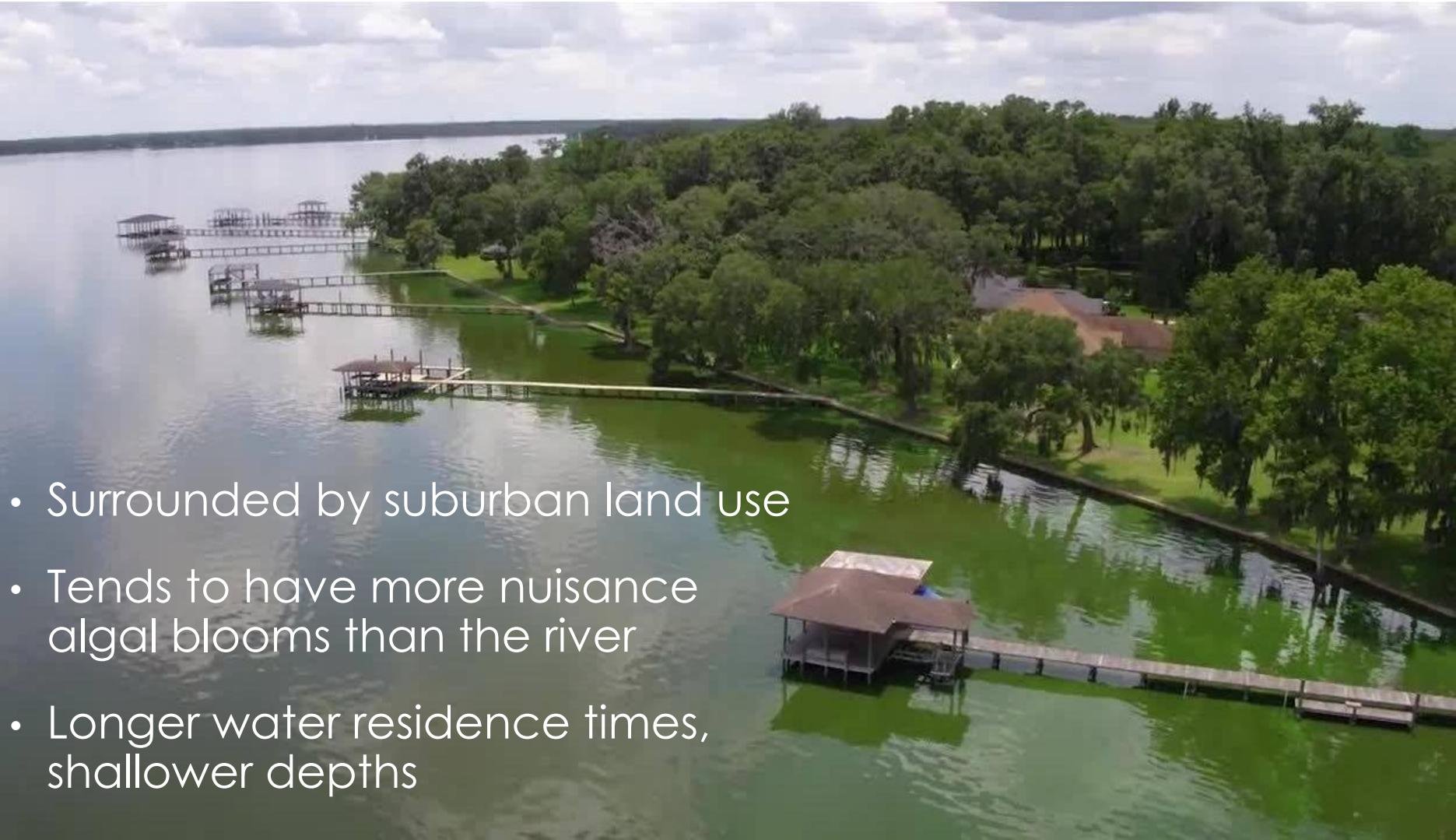
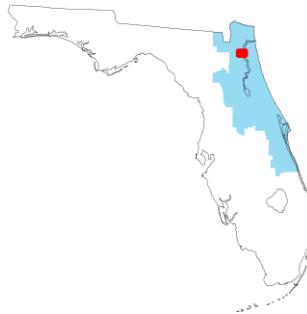
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Chounghyun Seong, John Hendrickson

Aug. 29, 2019

St. Johns River Water Management District

Doctors Lake

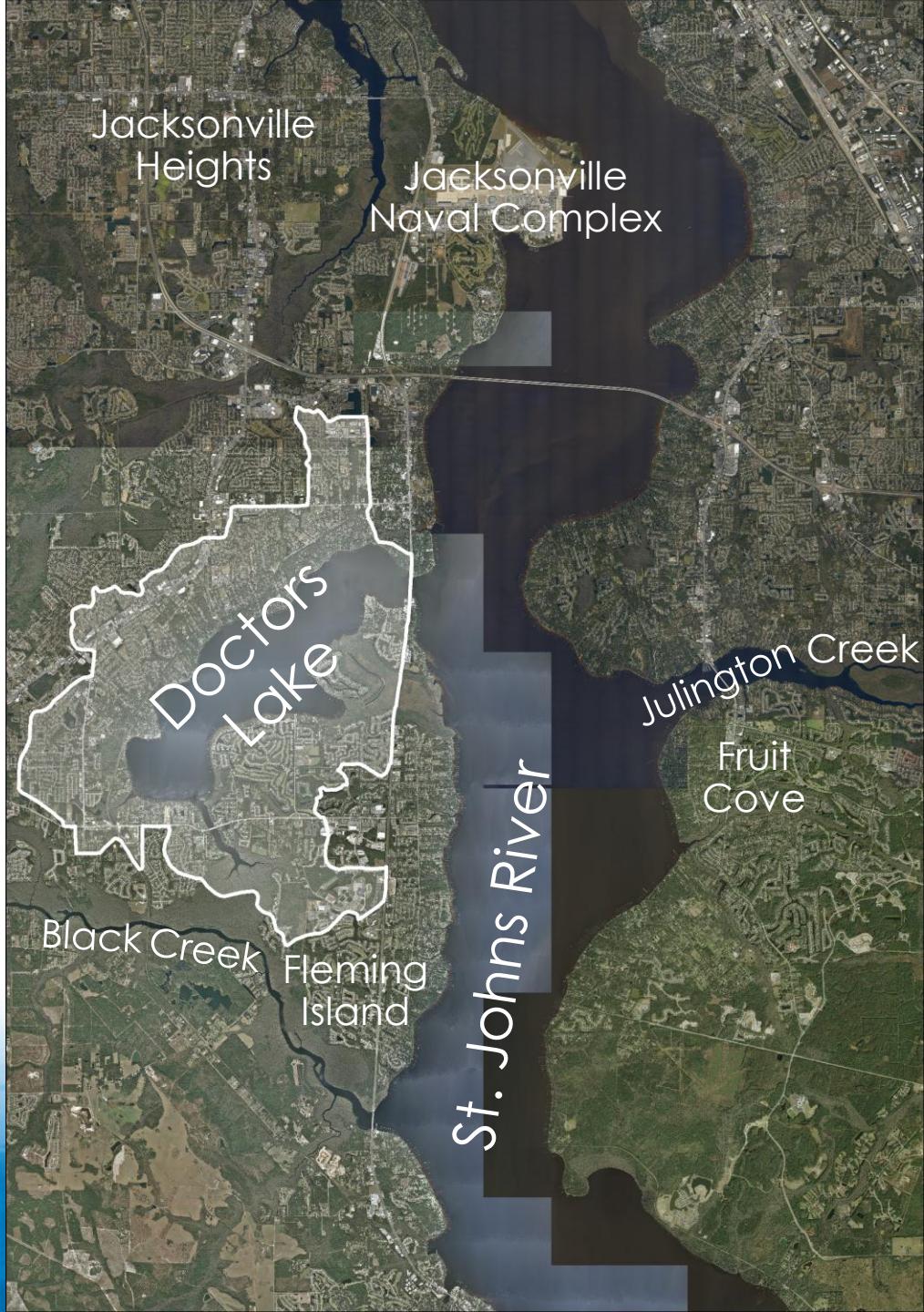
- Located south of Jacksonville, connected to the St. Johns River



- Surrounded by suburban land use
- Tends to have more nuisance algal blooms than the river
- Longer water residence times, shallower depths

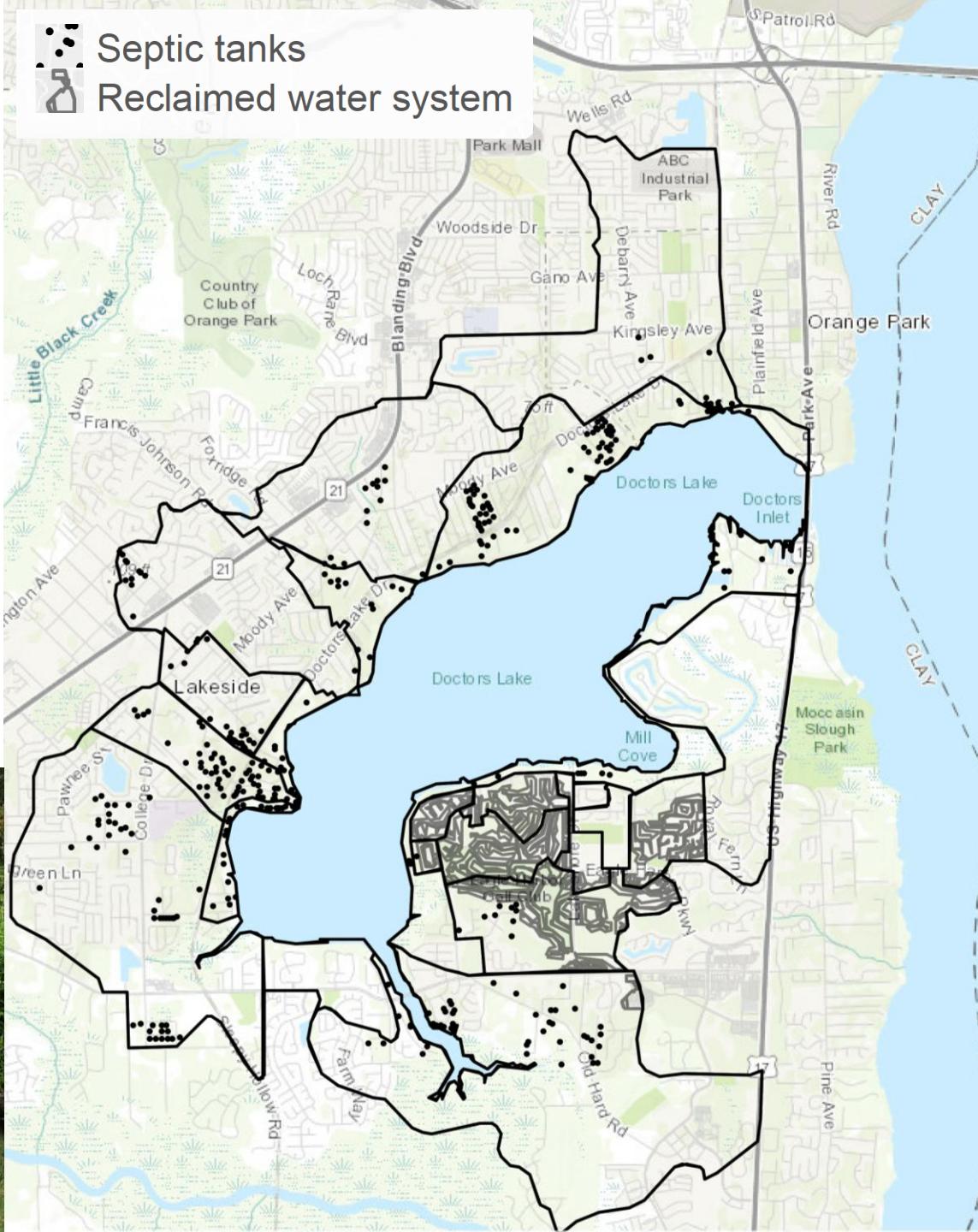
Doctors Lake

- What nutrient loads are ...applied to the watershed?
...delivered to the lake?
- Where/how could nutrient loads be reduced?
- Field sampling
 - Nutrients
 - Nitrate isotope sampling
 - Wastewater tracers



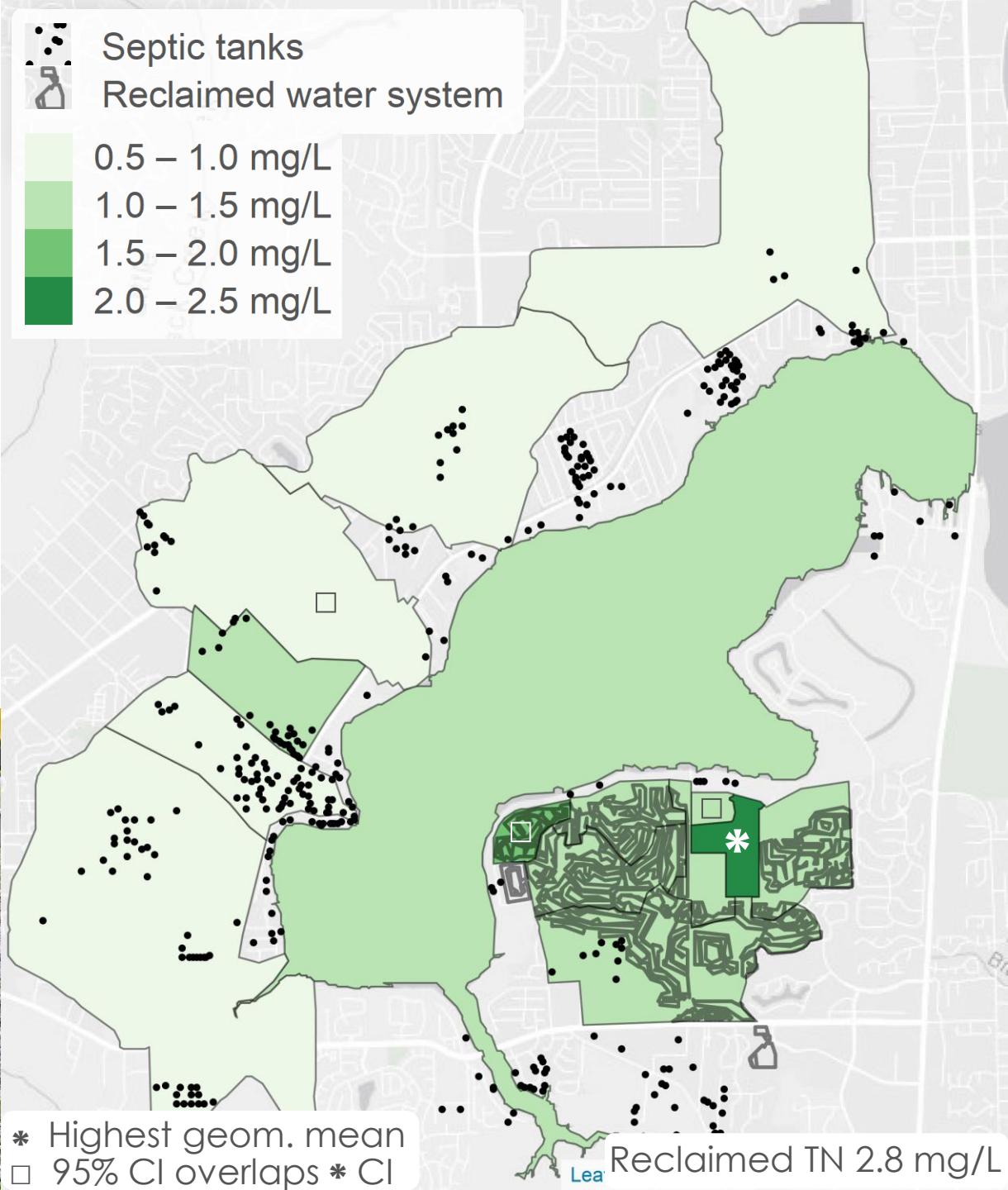
Field sampling

- April 2018–2019
 - Storm runoff
 - 14 locations, near outlet of each watershed →
 - 4–7 dates
 - 1–3 tracer dates
 - Reclaimed water
 - 6 locations, 2 dates



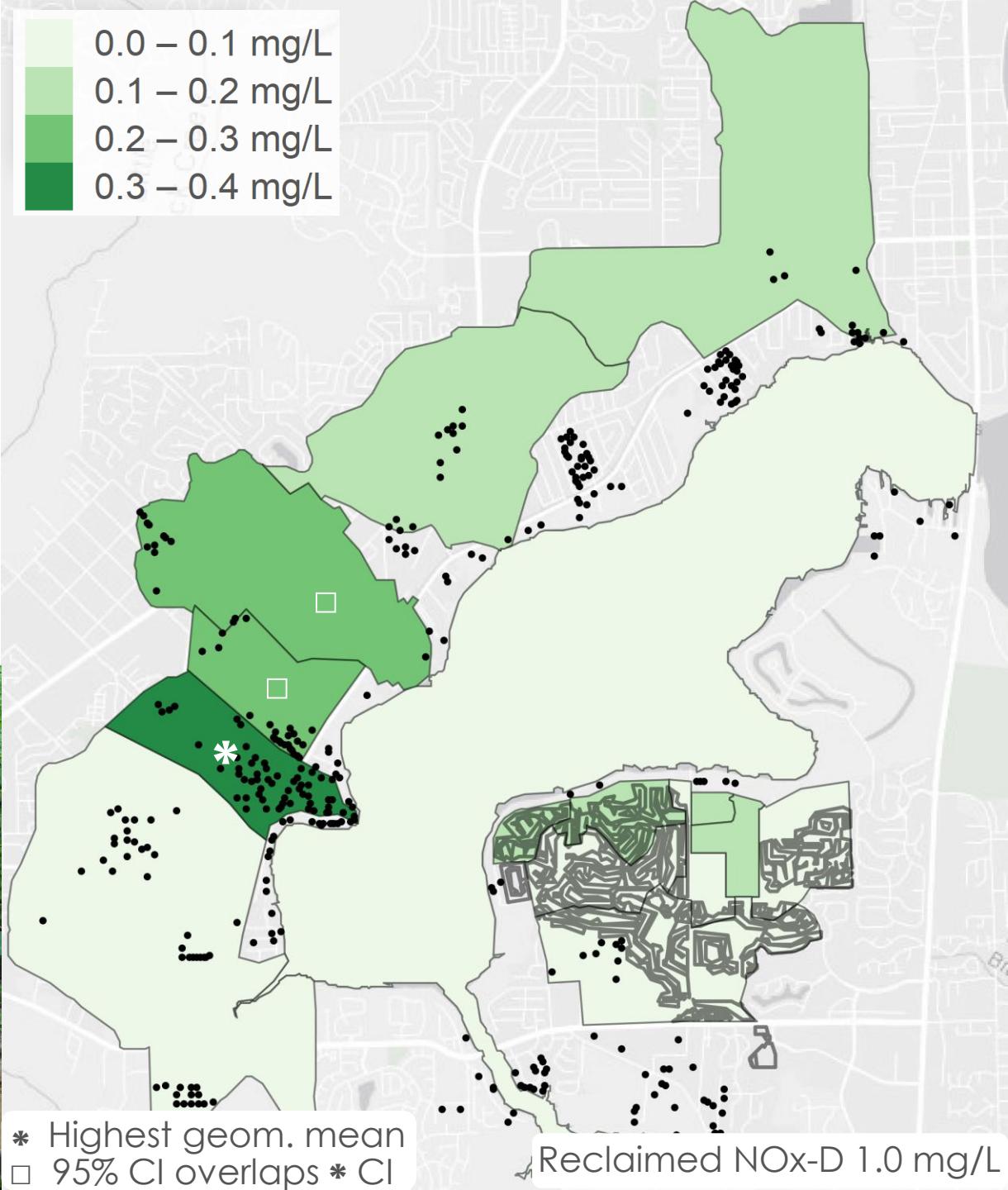
Total nitrogen concentrations

- NW watersheds generally had **lower** TN concentrations than the lake



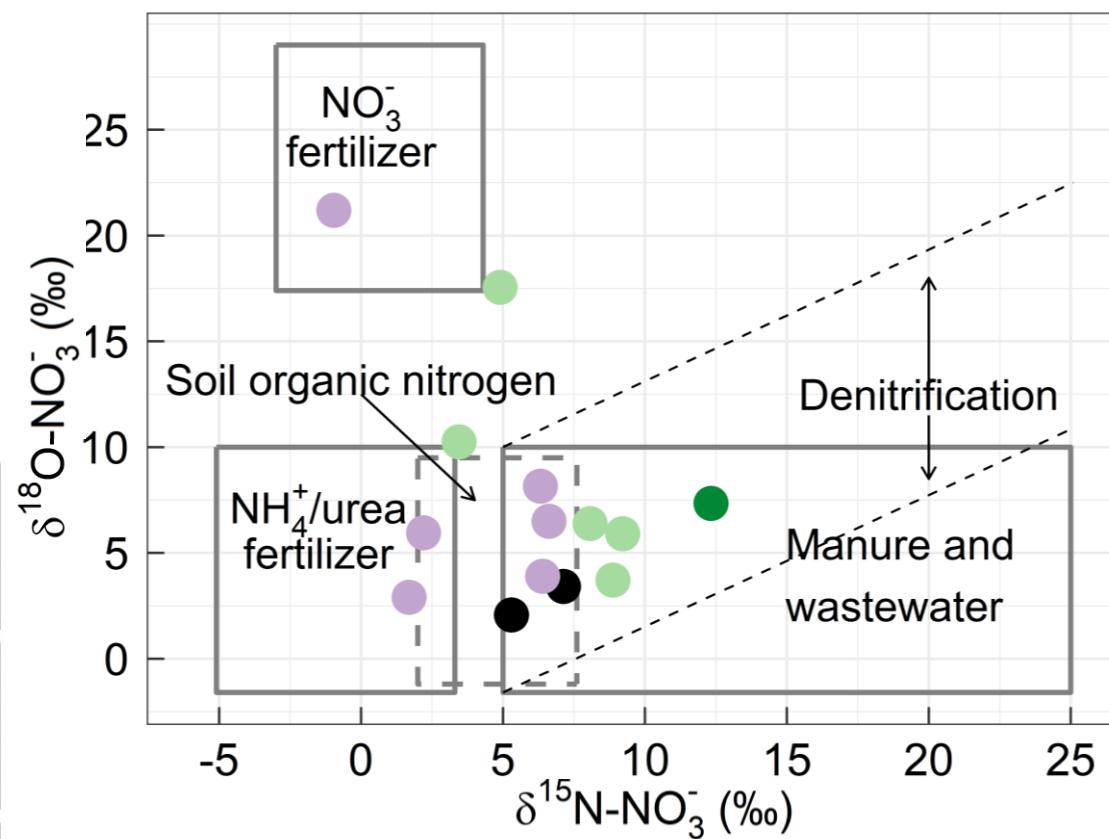
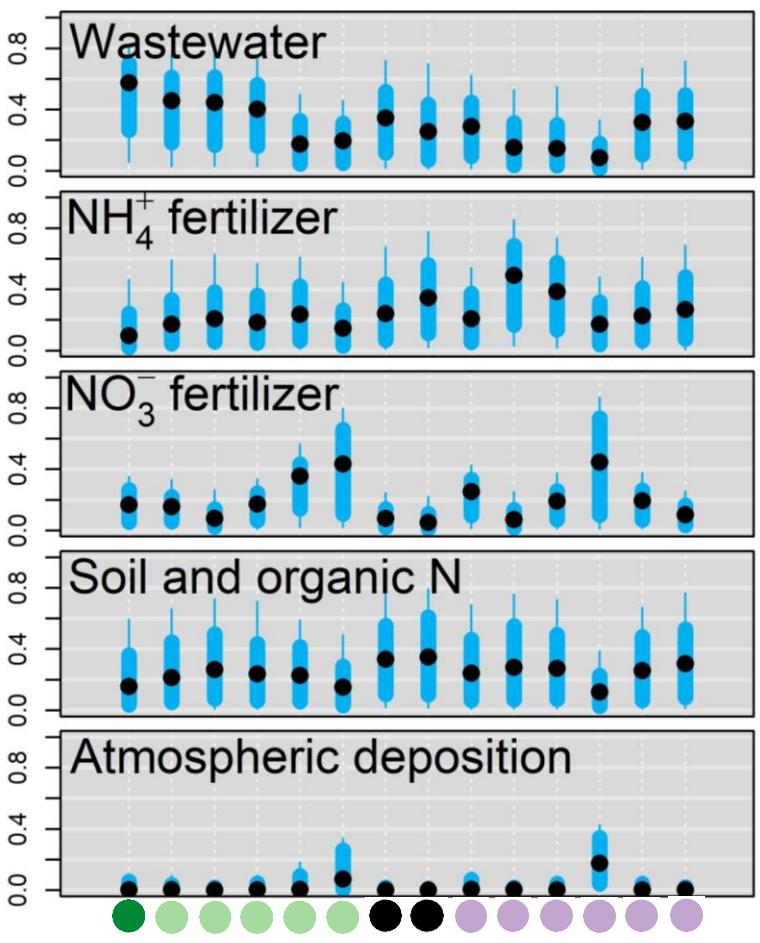
Nitrate-nitrite concentrations

- NW watersheds had more septic tanks, and also generally had **higher** nitrate-nitrite concentrations



Nitrate isotope analysis

Fractional contribution to nitrate

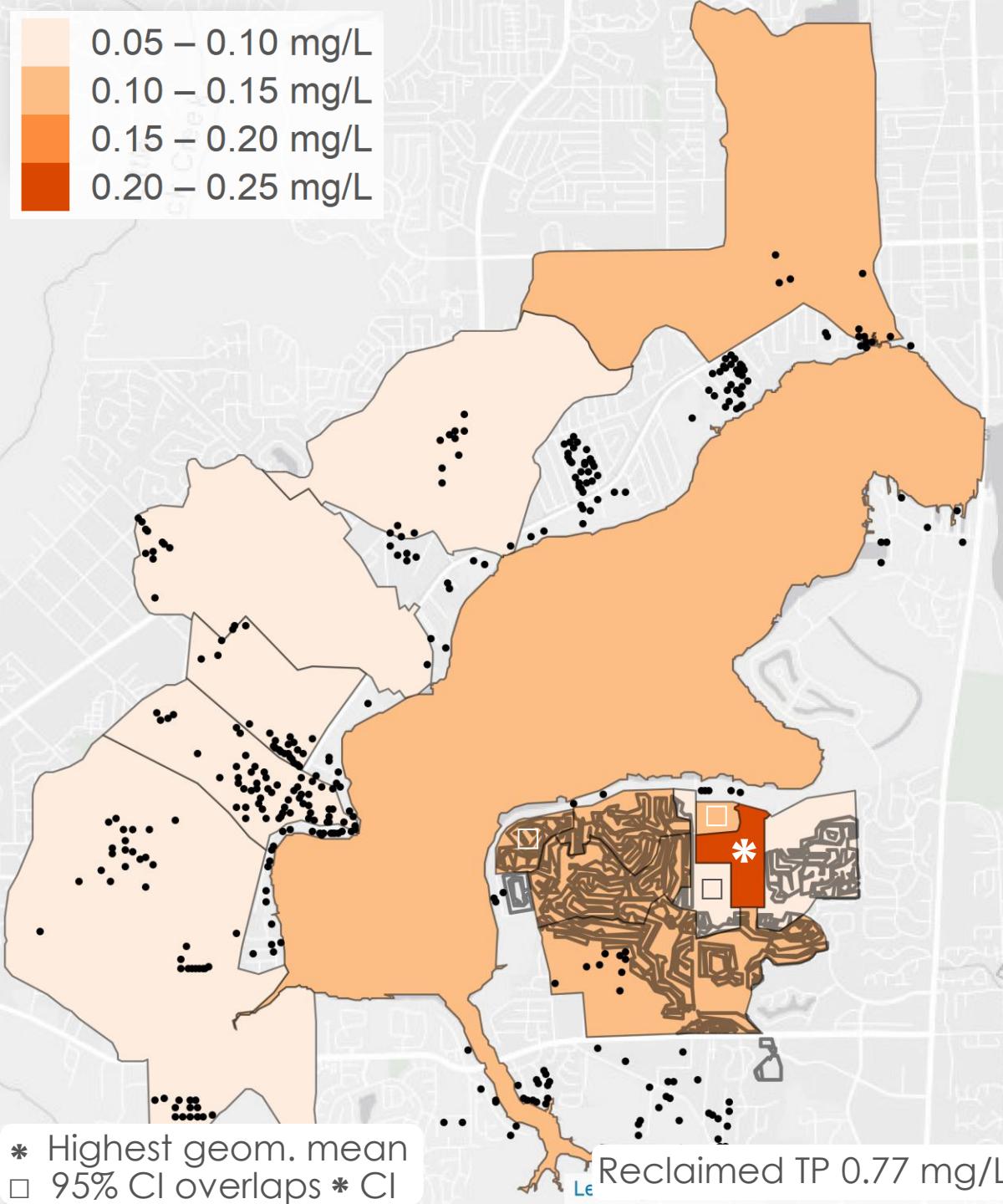


- Many septic, no reclaimed
- Some septic, no reclaimed
- Few septic, some reclaimed
- No septic, no reclaimed

The average wastewater contribution to nitrate was higher from areas with more septic tanks

Total phosphorus concentrations

- NW watersheds generally had **lower** concentrations than the lake



Total nitrogen loads to the watershed

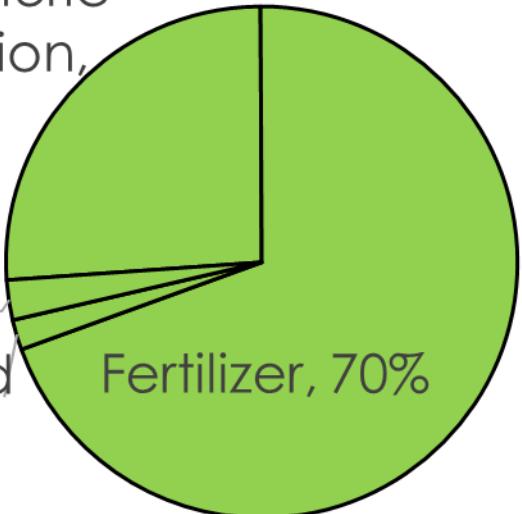
- Nutrient source → land

Atmospheric deposition,

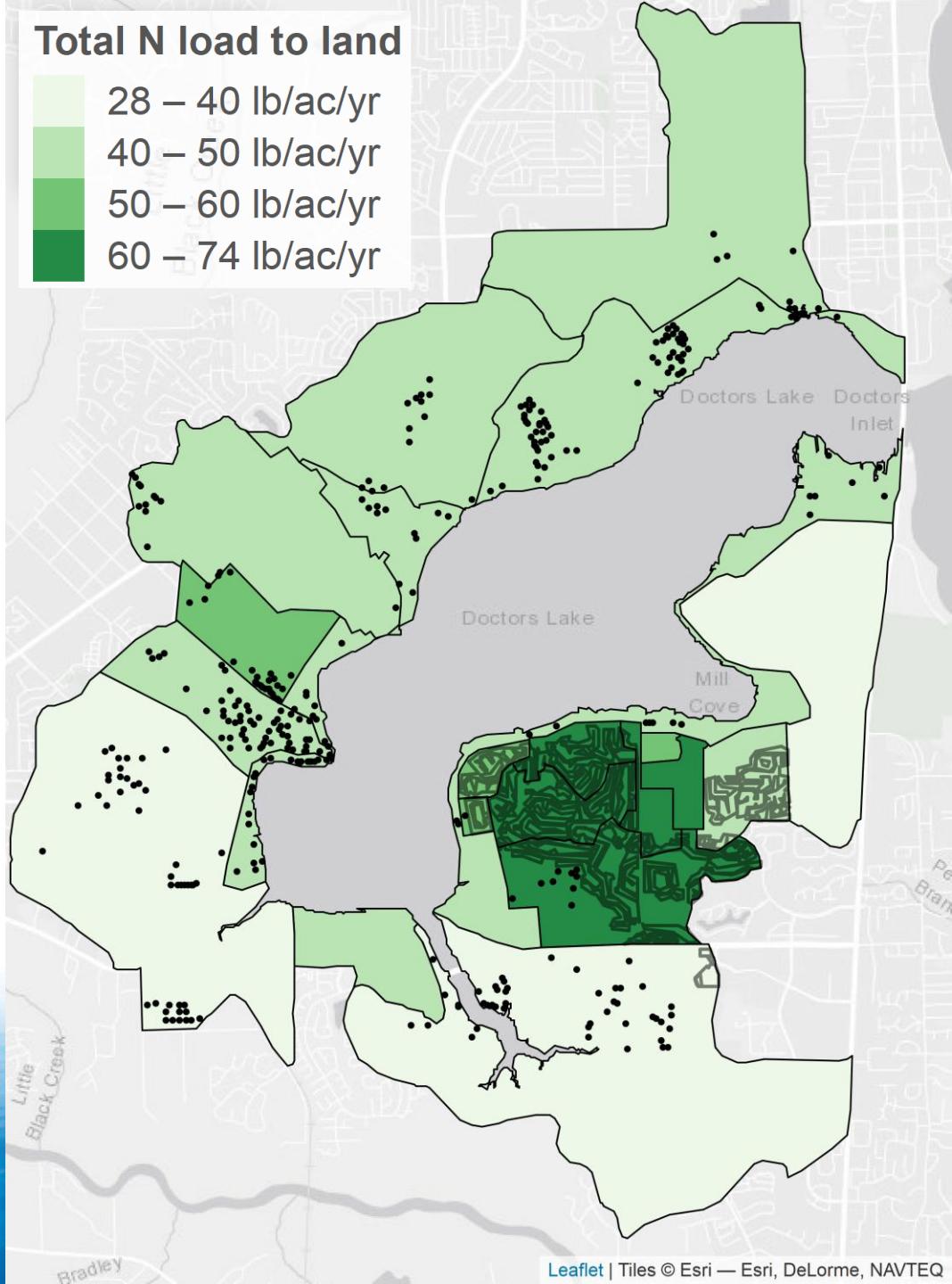
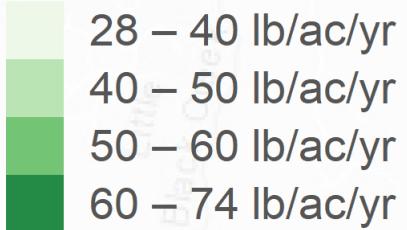
26%

Septic tanks, 3%

Reclaimed use, 2%

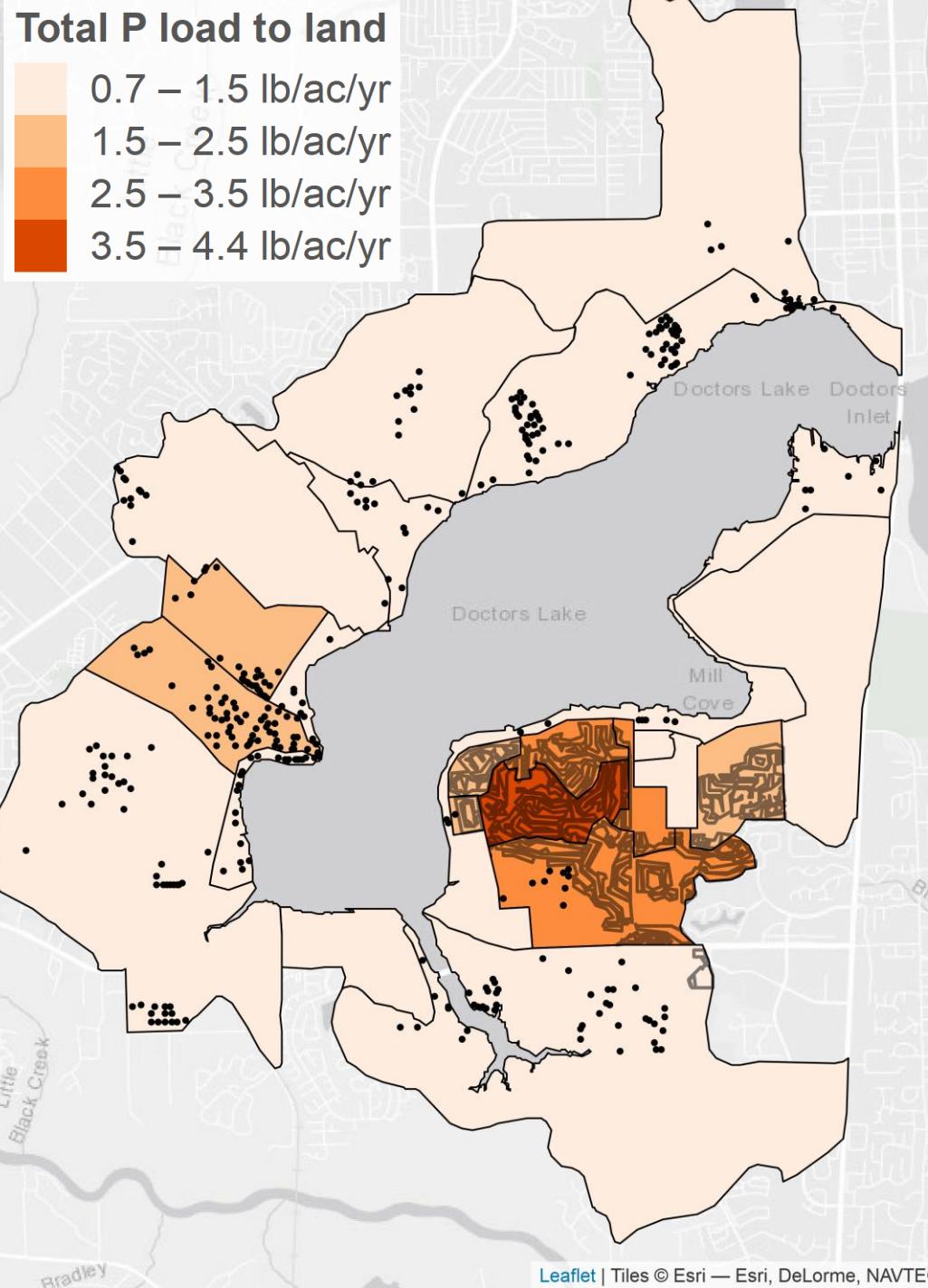
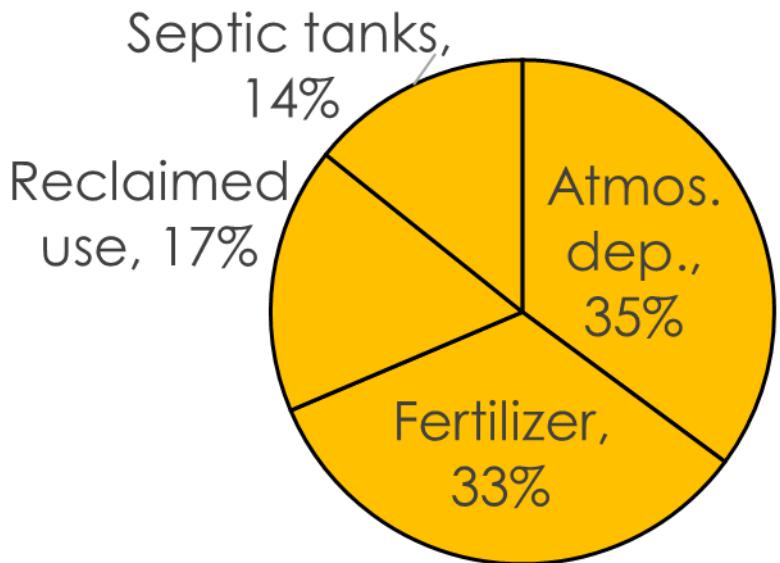


Total N load to land



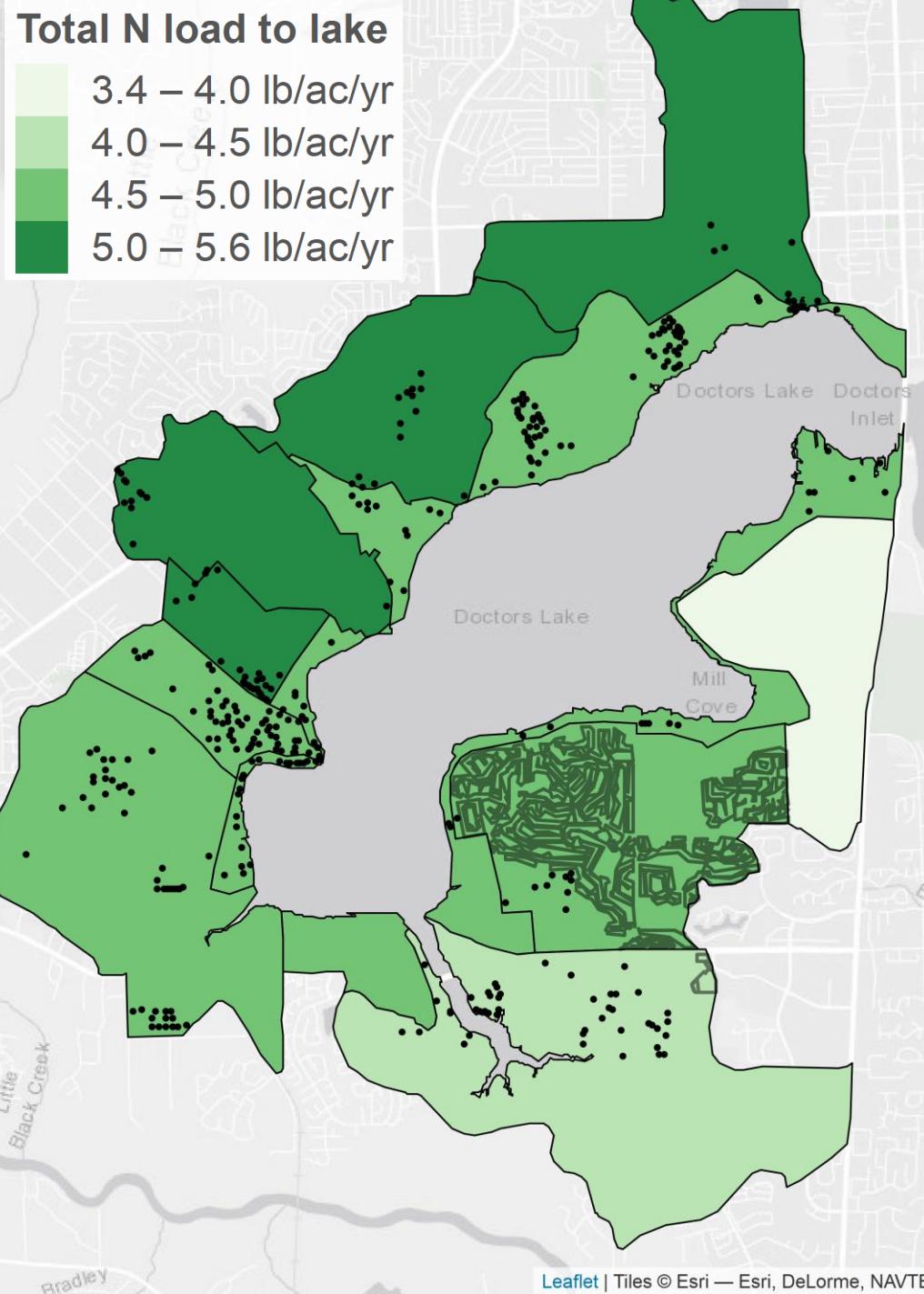
Total phosphorus loads to the watershed

- Nutrient source → land



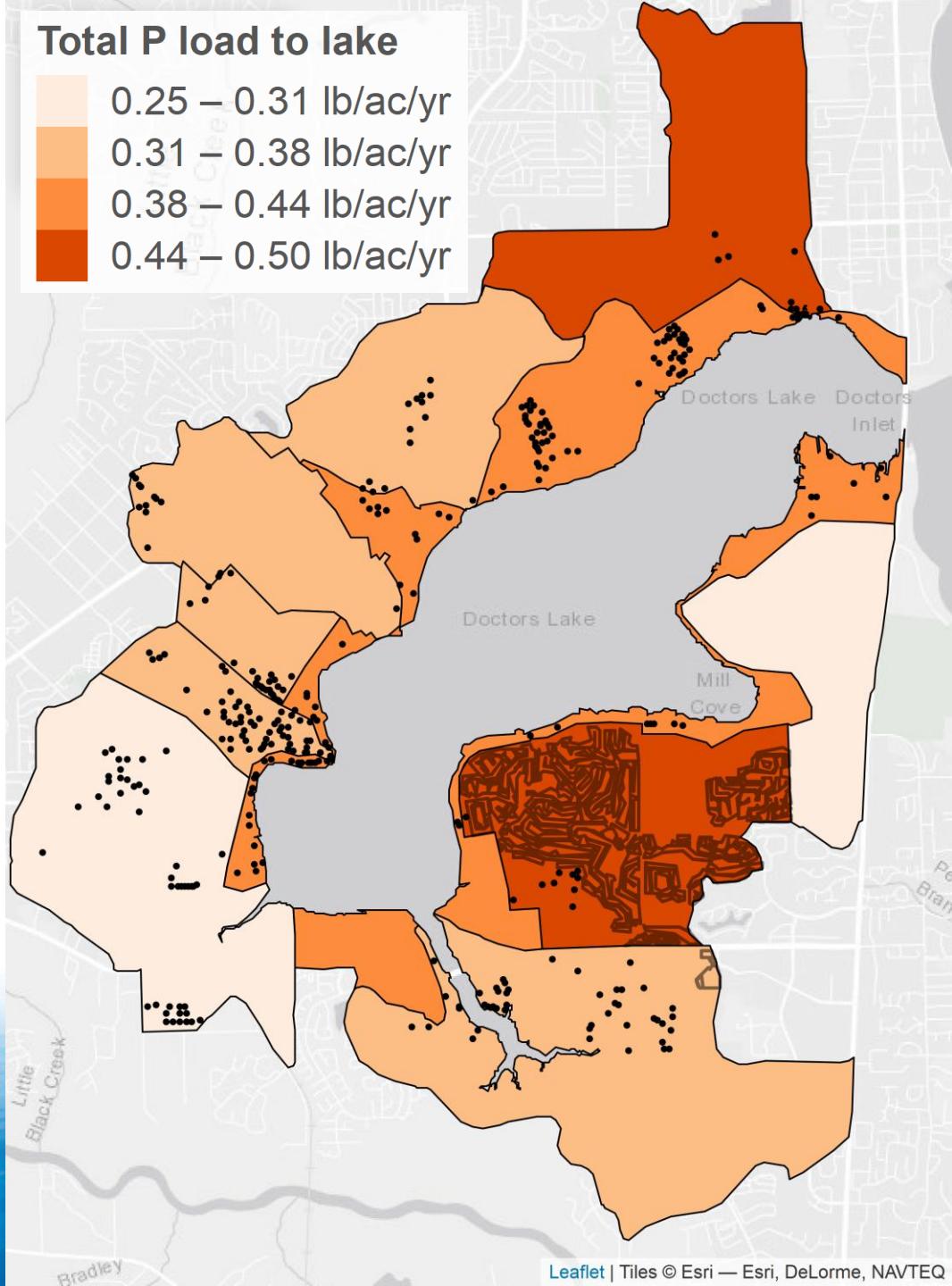
Total nitrogen loads to the lake

- Land → lake
- Hydrologic model (HSPF)
- Loads estimated from simulated discharges × measured concentrations



Total phosphorus loads to the lake

- Land → lake
- Hydrologic model (HSPF)
- Loads estimated from simulated discharges × measured concentrations



Wastewater tracers

- All sugar substitutes and pharmaceuticals were well below EPA benchmarks
 - Not high enough to affect plants, insects, or animals

Other tracers

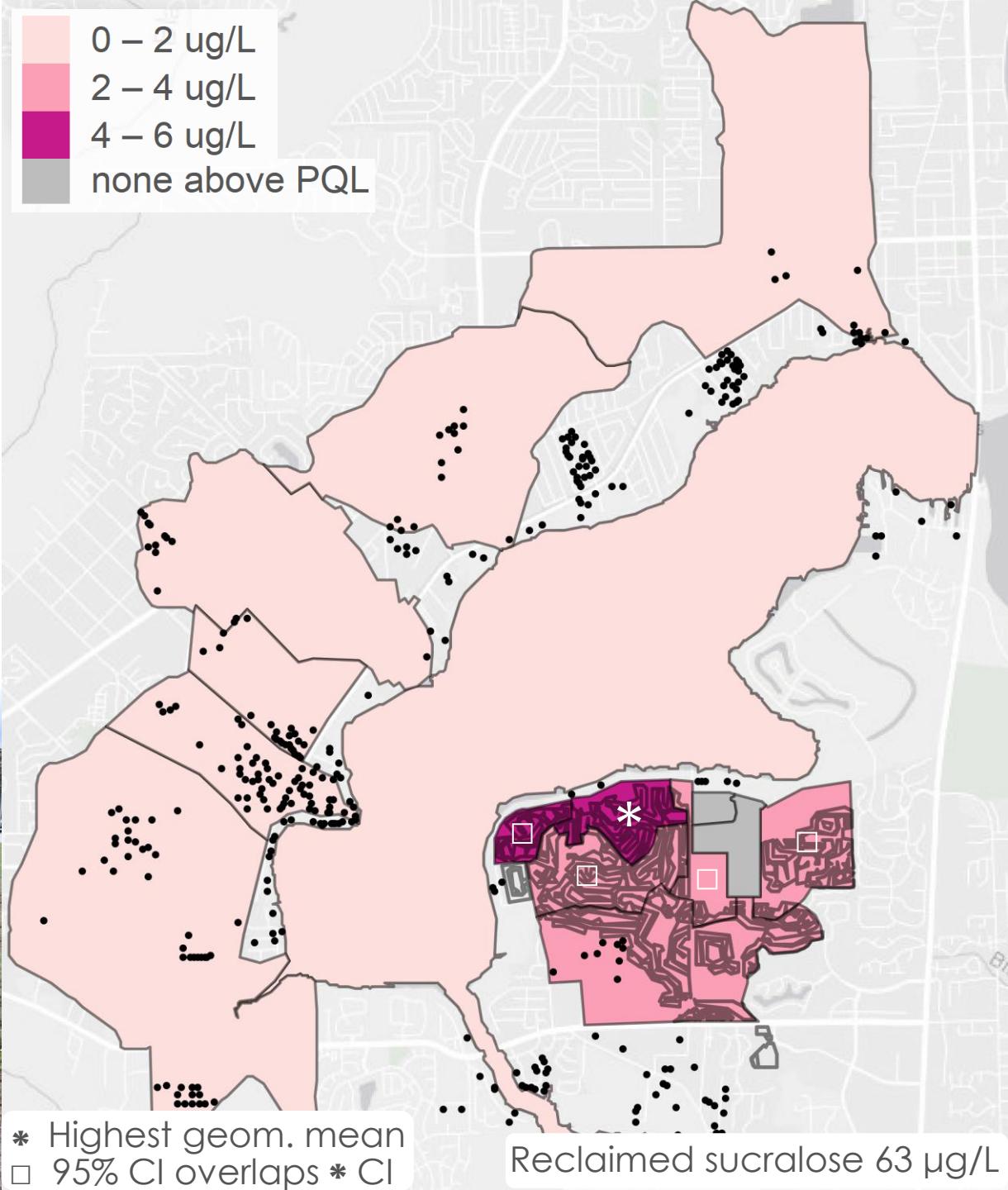
- Herbicides
 - Many present, but all below EPA benchmarks
- Insecticide

Sucralose (sugar substitute)

Indicator of untreated
or treated wastewater

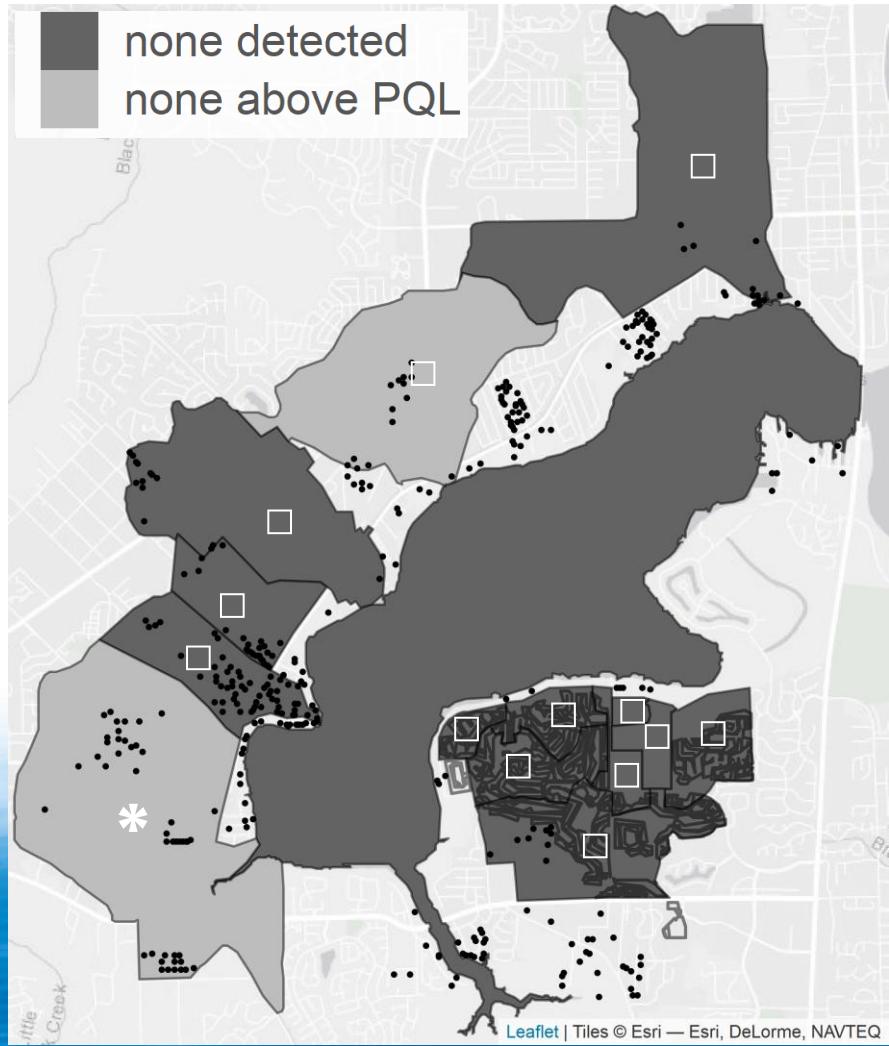
Found in all sampling
locations

Highest near
reclaimed water use

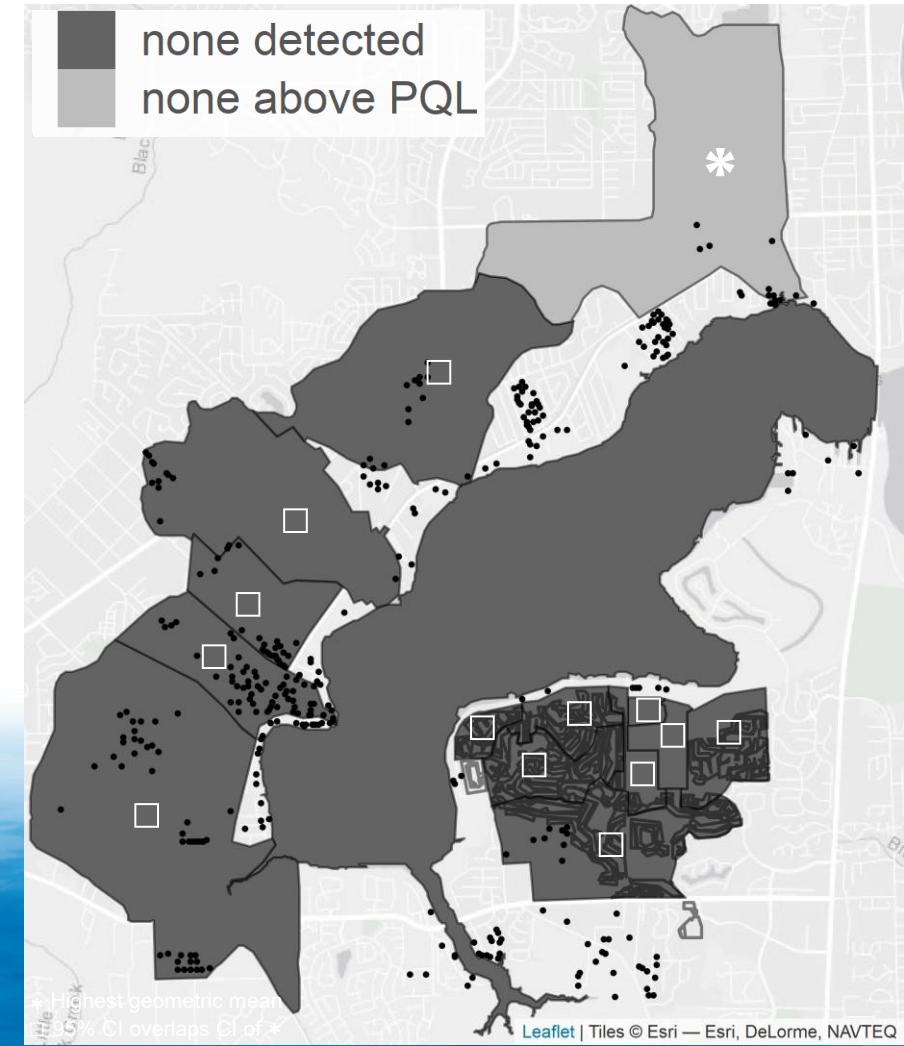


Ibuprofen

- Both were very low
- If higher, would indicate untreated/poorly treated wastewater



Acetaminophen



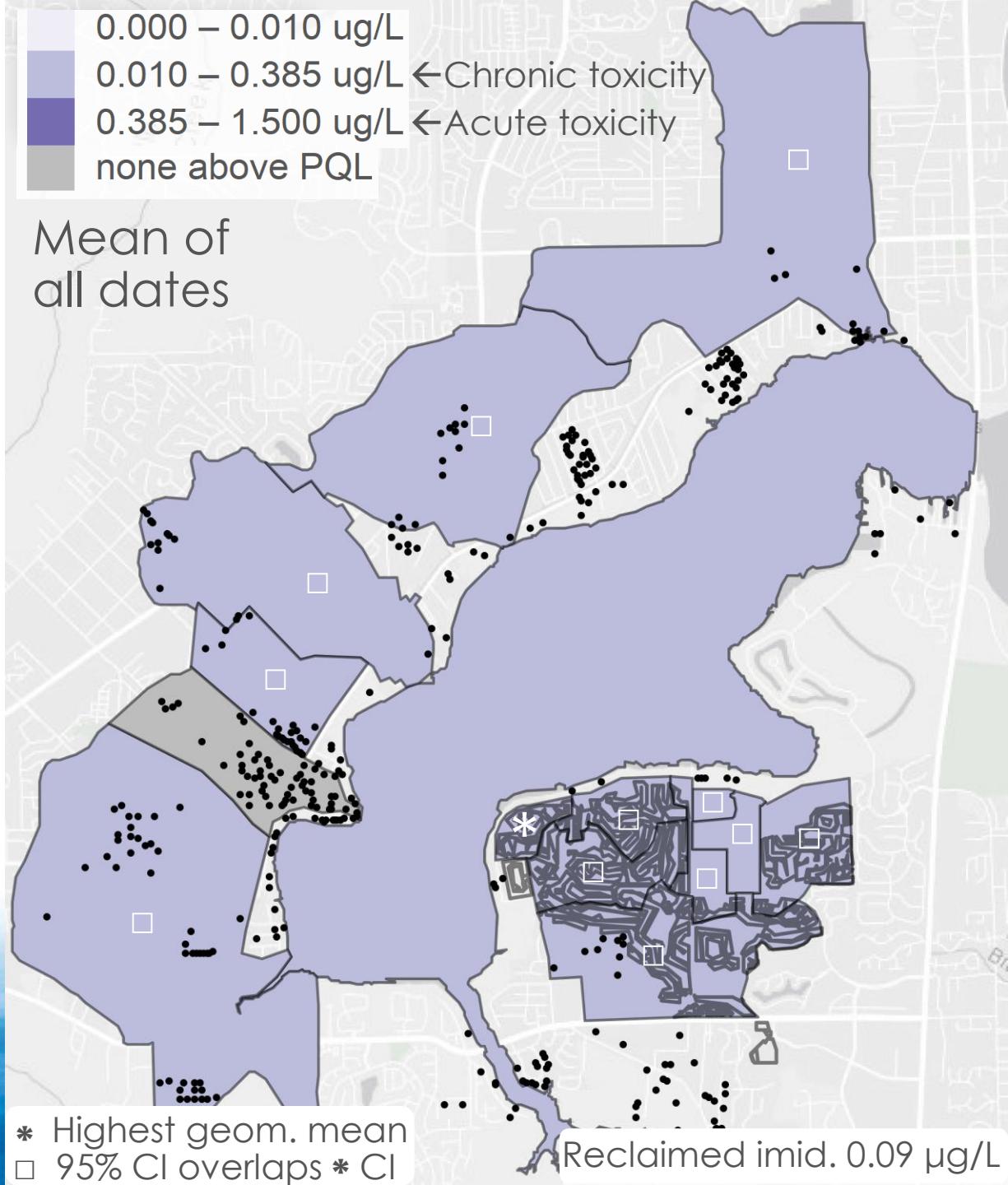
Imidacloprid (insecticide)

Low toxicity to
humans

High toxicity to some
aquatic
invertebrates

Above EPA aquatic
life benchmarks

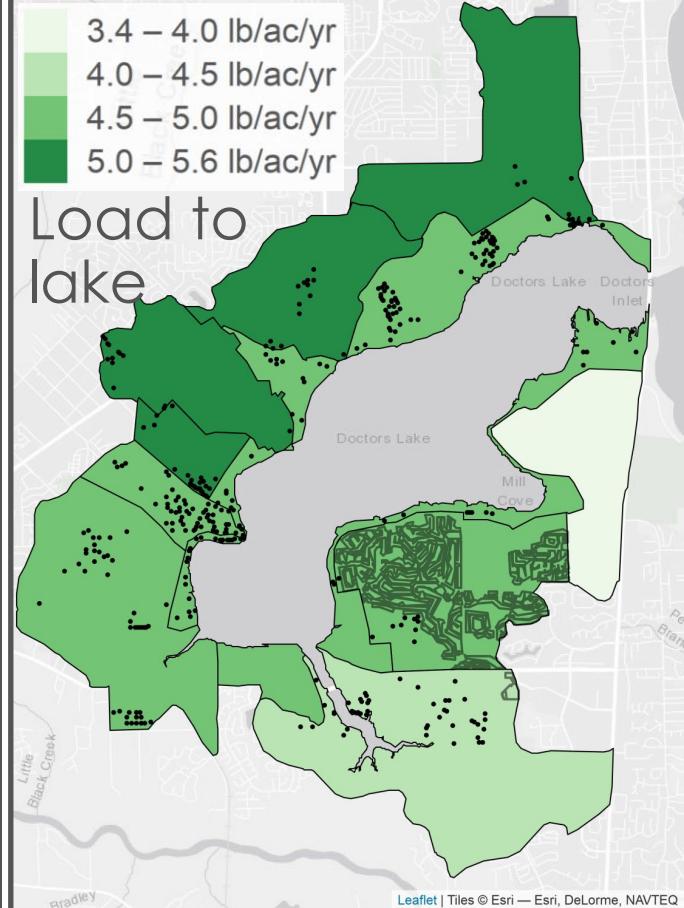
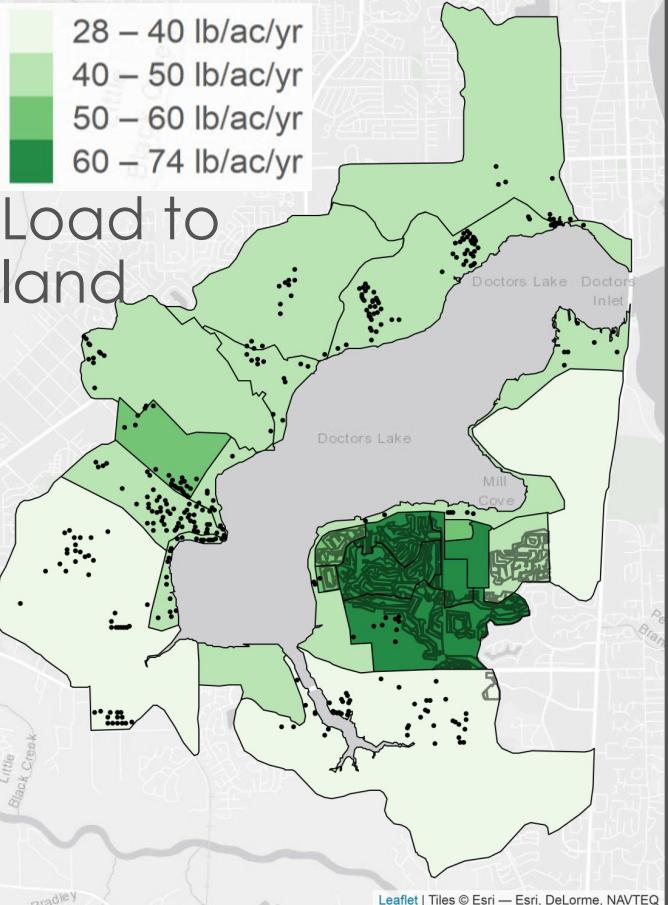
Not unique, DEP
found similar results
statewide



* Highest geom. mean
□ 95% CI overlaps * CI

Reclaimed imid. 0.09 µg/L

Conclusions (Total Nitrogen)

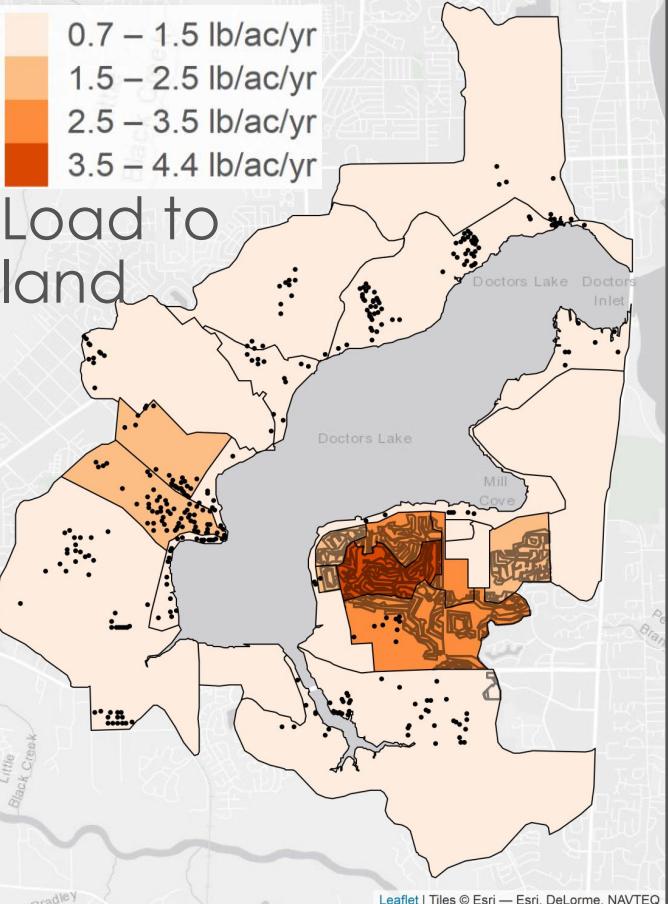
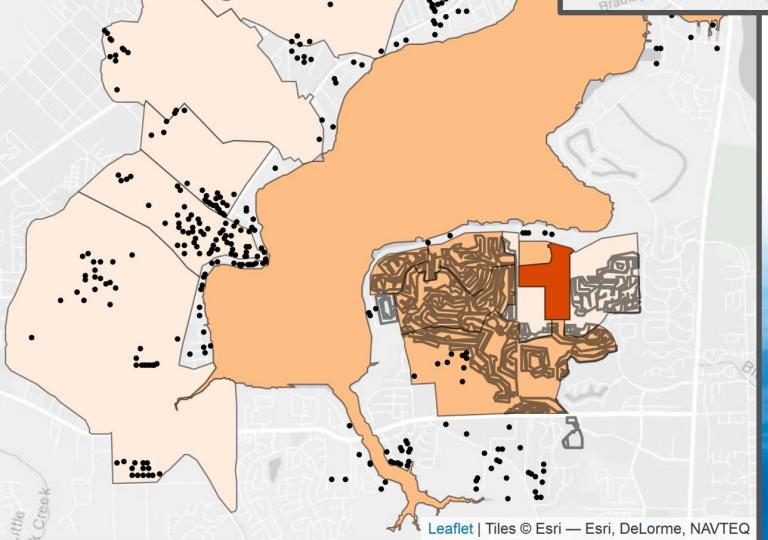


- Reducing nitrate from NW could benefit lake, but important to not reduce flows (high flows with low N might somewhat help dilute/flush lake)

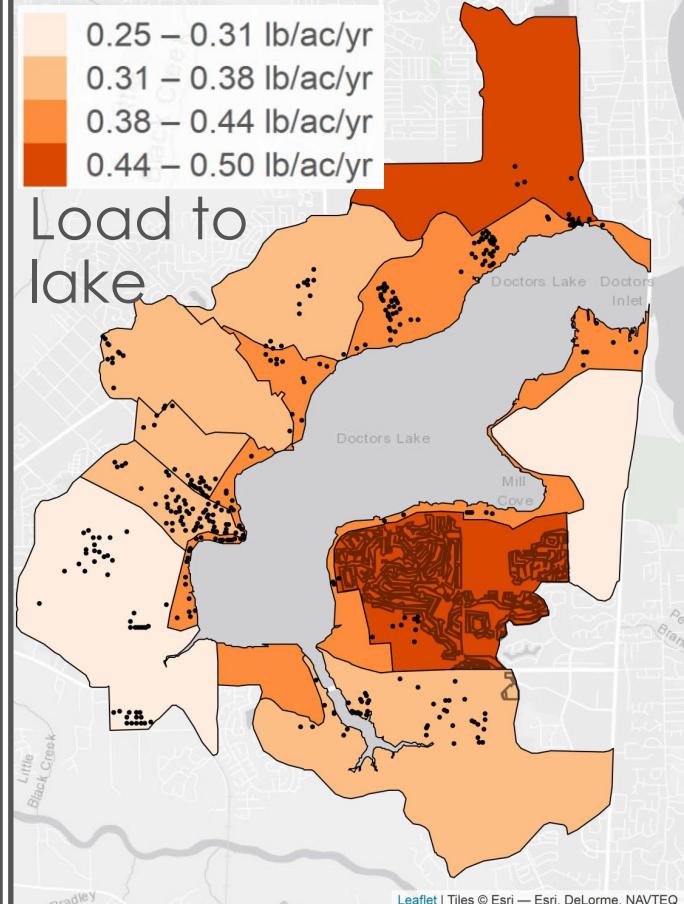
Conclusions (Total Phosphorus)



Concentration



Load to land



Load to lake

- Very high concentrations and loads-to-land (SE watershed) result in high loads-to-lake despite low flows.

Conclusions

- Improvement opportunities throughout watershed
 - Fertilizer use
- Reclaimed use is part of phosphorus load
 - Project funded to reduce phosphorus in reclaimed water

- Nitrogen
 - TN conc. (and flows) from SE reduced by retention ponds
 - Nitrate conc. from NW may be from septic tanks
 - Septic tank project funded
- Imidacloprid levels could potentially impact food web
 - Used for many reasons, not removed by typical water treatment



Questions?



Doctors Inlet Bridge on US-17, confluence of
Doctors Lake and the St. Johns River

Imidacloprid (pesticide)

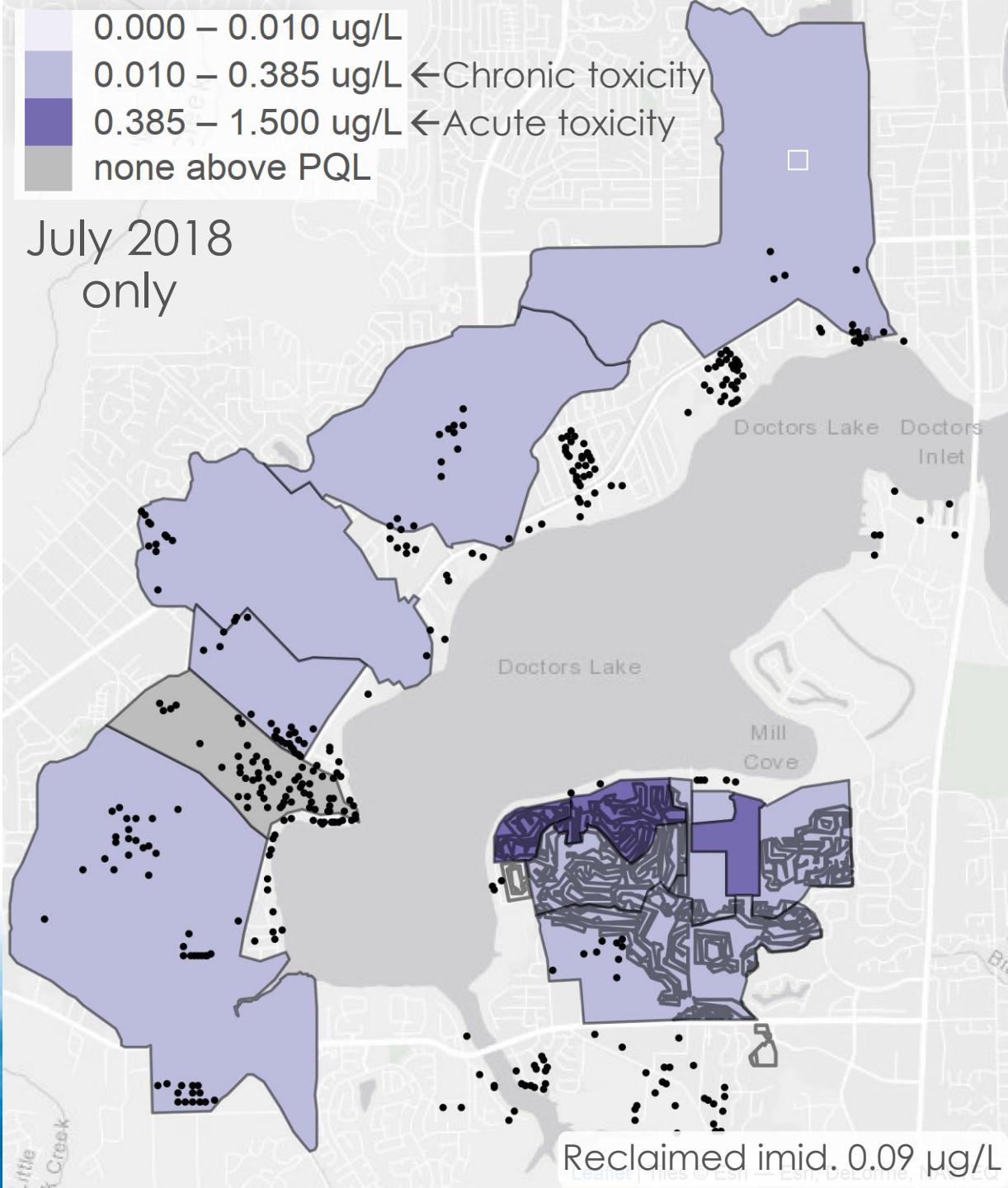
Low toxicity to
humans

High toxicity to some
aquatic
invertebrates

Above EPA aquatic
life benchmarks

Not unique, DEP
found similar results
statewide

Even higher on July
sampling date



Loads to the watershed

- Nutrient source → land

Source	Land use	Total N lb ac ⁻¹ yr ⁻¹	Total P lb ac ⁻¹ yr ⁻¹	Based on
Atmospheric deposition	All	10.9	0.45	^N : NADP website, 2000–2015 average ^P : Redfield (2002) urban midpoint
Reclaimed use	Residential	3.0–5.3	0.9–1.5	Usage data from utility and measured concentrations
	Comm.	0.2	0.1	
	Golf course	44.6	12.2	
Septic tanks		33.6 lb tank ⁻¹ yr ⁻¹	5.8 lb tank ⁻¹ yr ⁻¹	Typical usage ^N : Florida Health (2017) ^P : Florida Health (2013)

Loads to the watershed

Fertilizer	Total N	Total P
	lb ac ⁻¹ yr ⁻¹	
Residential		
Density		
Low	16.0	0.2
Med.	48.8	0.7
High	37.6	0.6
Comm.	26.1	0.4
Pasture	50.0	0.0
Golf	130.7	1.9

Based on fertilizer surveys
(MACTEC 2010) and IFAS
recommendations,
adjusted to account for
impervious surfaces

