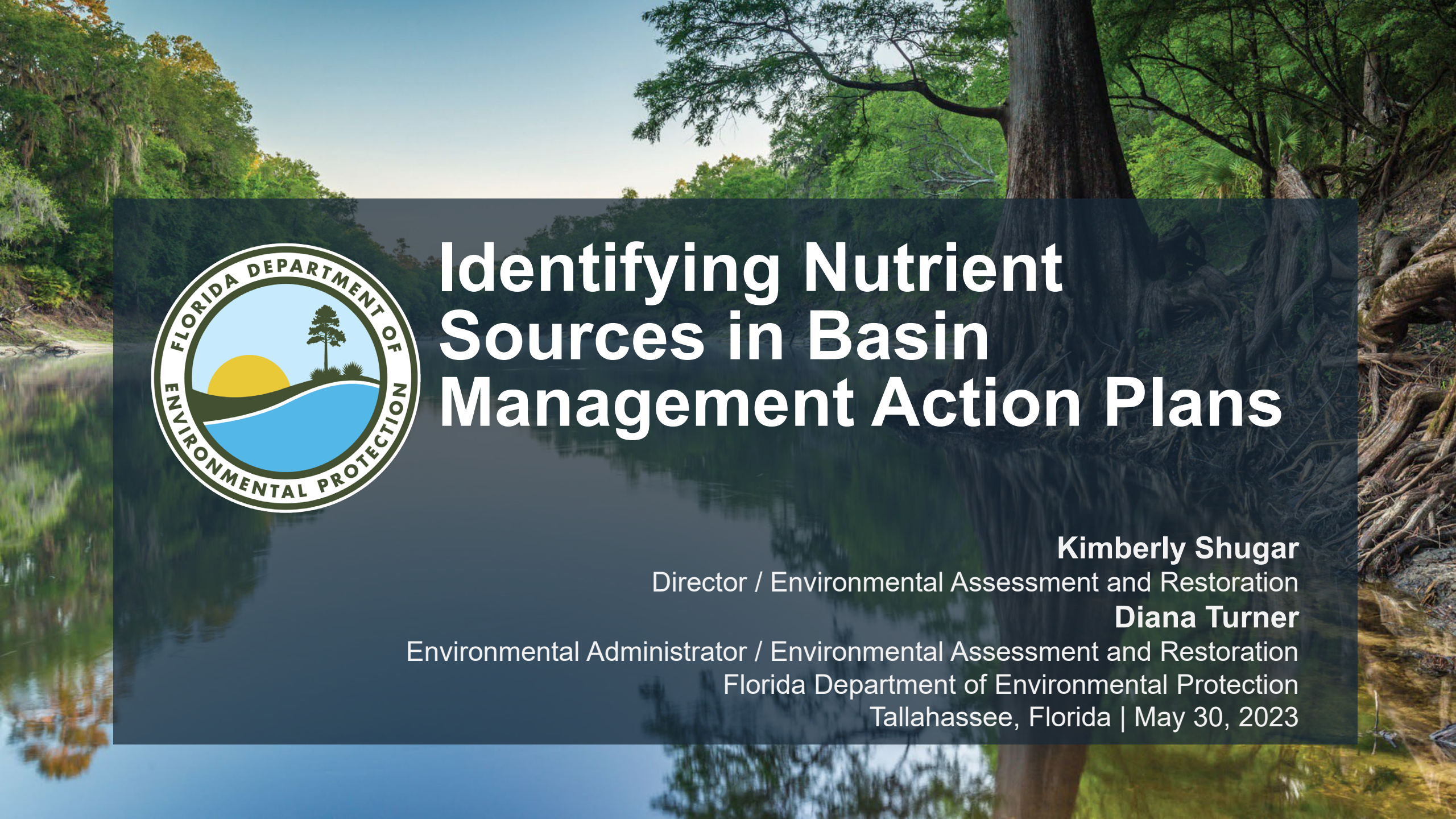


Identifying Nutrient Sources in Basin Management Action Plans

Kimberly Shugar
Director / Environmental Assessment and Restoration
Diana Turner
Environmental Administrator / Environmental Assessment and Restoration
Florida Department of Environmental Protection
Tallahassee, Florida | May 30, 2023

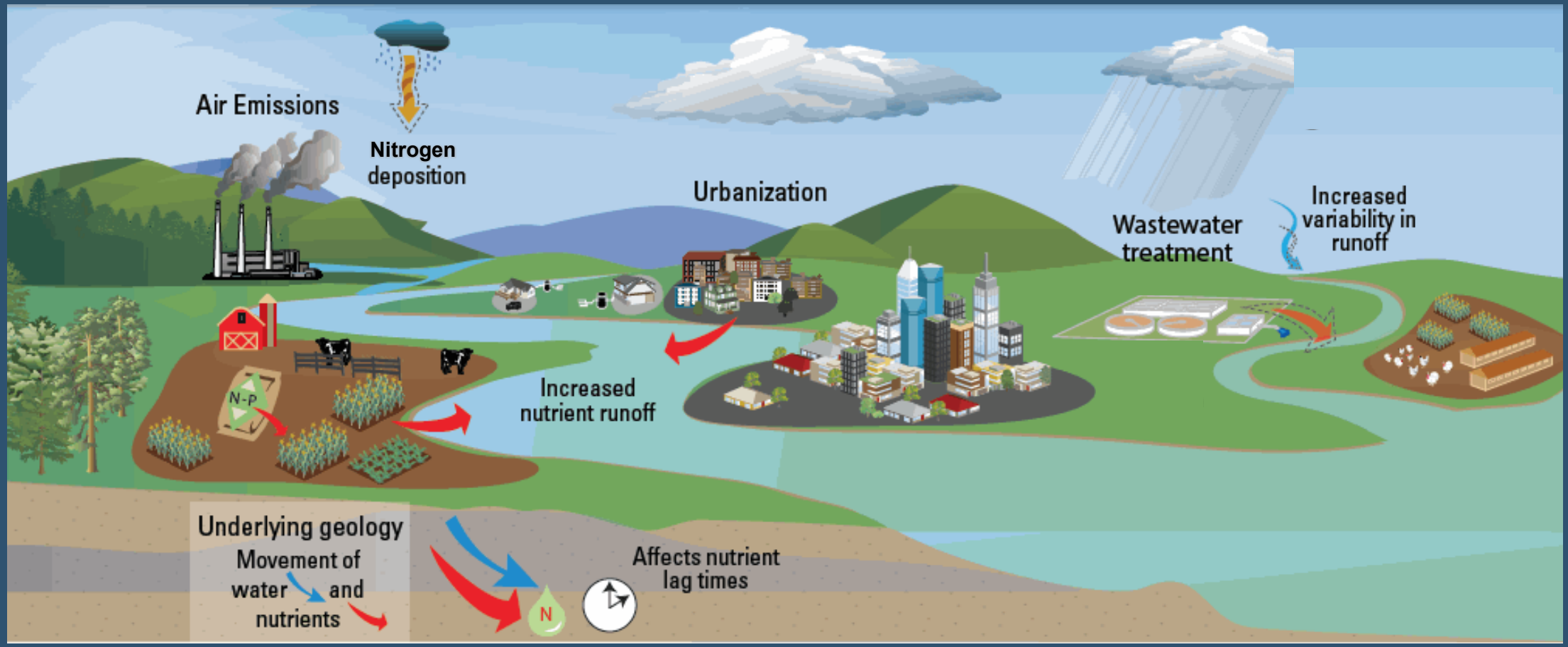
KEY BMAP COMPONENTS

SECTION 403.067, FLORIDA STATUTES

- Total maximum daily loads (TMDLs) being addressed.
- Area addressed by the restoration plan.
- Identify sources. ←
- Restoration plan.
- Future growth impacts.

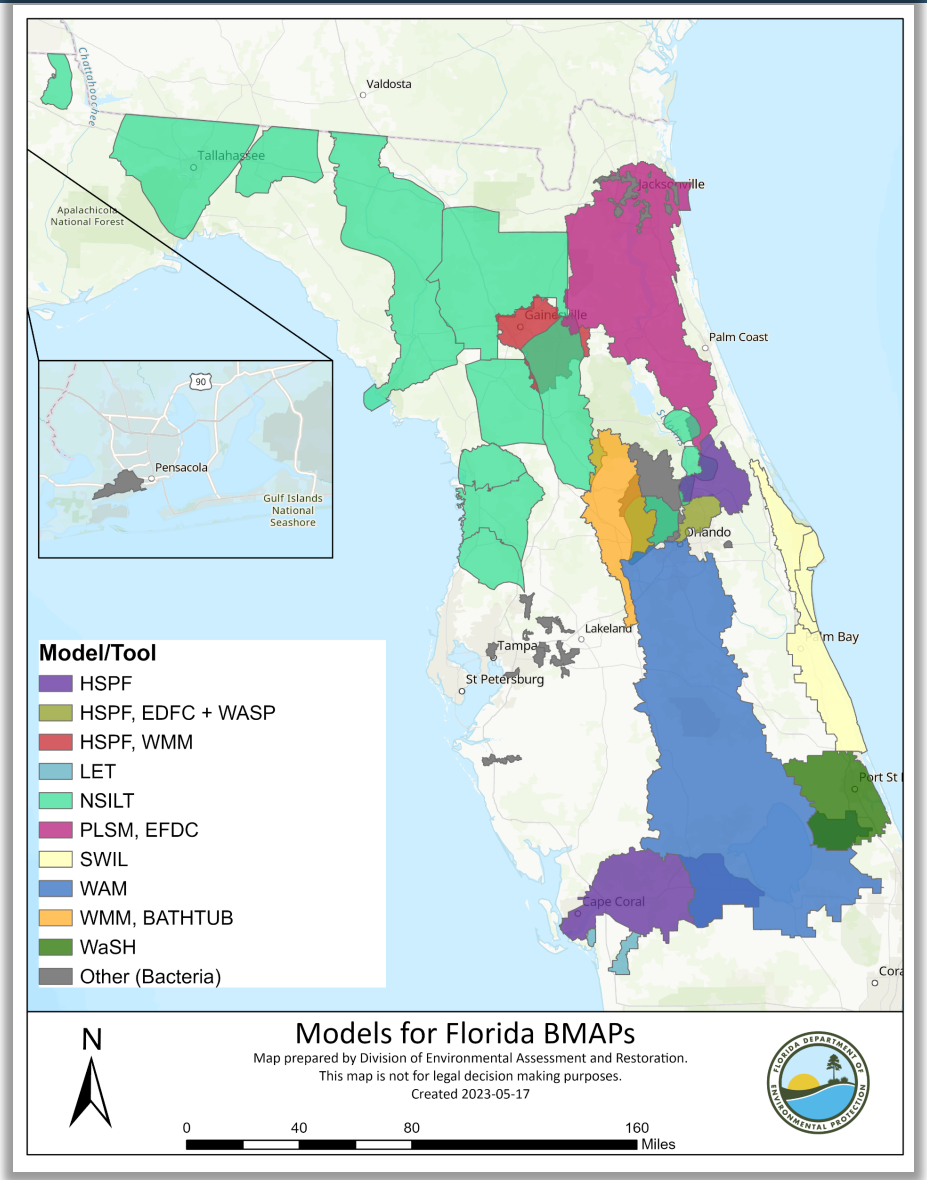
- **Projects to achieve the TMDL:**
  - Implementation timeline.
  - Commitment to projects.
  - Expected water quality improvement from projects and management strategies.
- **Process to assess progress towards achieving the TMDL:**
  - Monitoring plan.
  - Project reporting.
  - Periodic follow-up meetings.
  - Water quality analyses.

SOURCES OF NUTRIENTS



BMAP MODELS / TOOLS

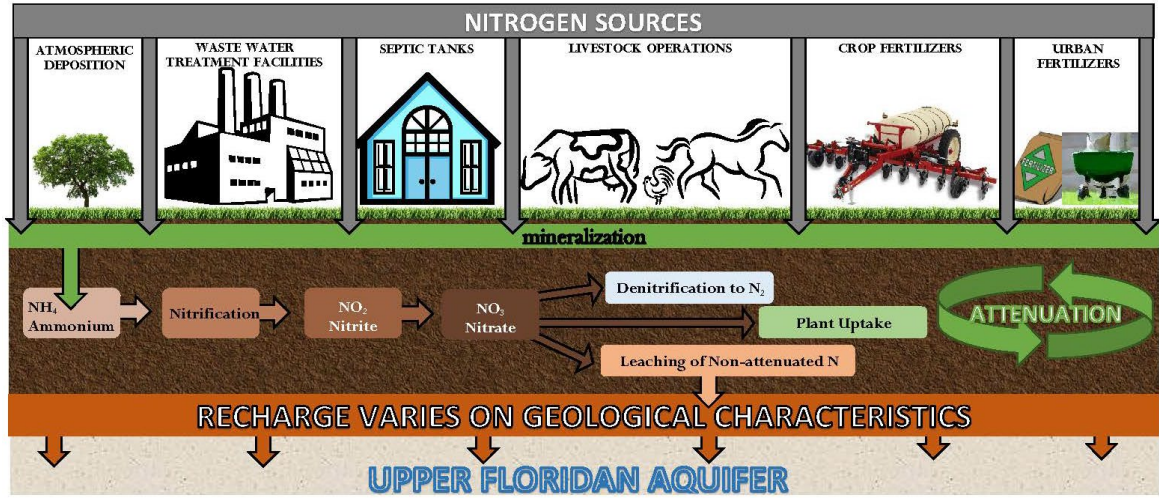
- **HSPF –** Hydrological Simulation Program – FORTRAN.
- **EFDC –** Environmental Fluid Dynamics Code (Model).
- **WASP –** Water Quality Analysis Simulation Program.
- **WMM –** Watershed Management Model.
- **LET –** Load Estimation Tool.
- **NSILT –** Nitrogen Source Inventory Loading Tool.
- **PLSM –** Partial Least Squares Model.
- **SWIL –** Spatial Watershed Iterative Loading (Model).
- **WAM –** Watershed Assessment Model.
- **BATHTUB –** Lake Eutrophication Model.
- **WaSH –** Watershed Water Quality Simulation (Model).

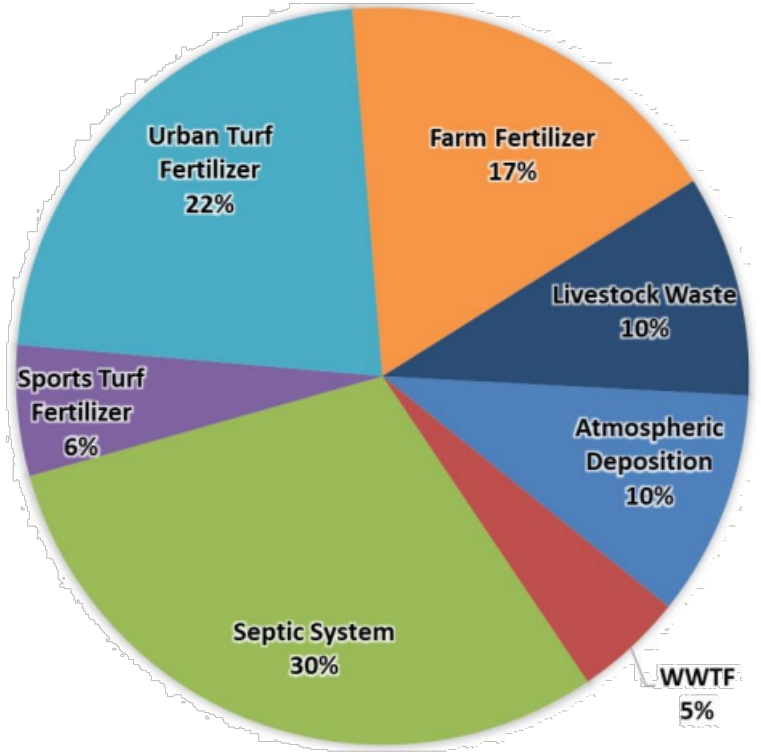


Nitrogen Source Inventory Loading Tool (NSILT)
SPRINGS

The NSILT is a geographic information system (GIS) and spreadsheet-based tool:

- Estimates nitrogen loads to groundwater from major sources of nitrogen in groundwater in the spring contributing area.
- Accounts for the transport pathways and processes affecting the various forms of nitrogen as they move from the land surface through the soil and geologic strata.



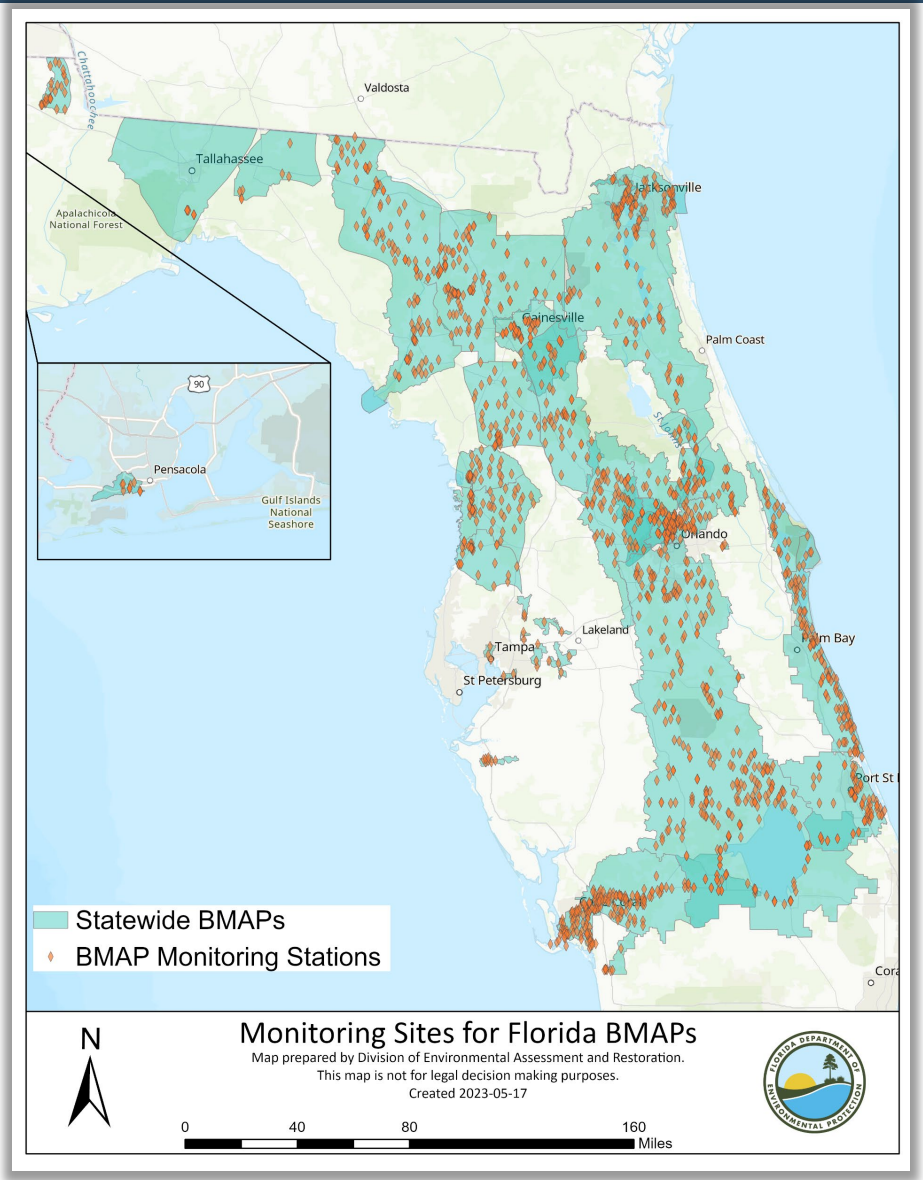


Loading to groundwater by source in Weeki Wachee BMAP area.

DATA ANALYSES / EVALUATION IN BMAPs

- **Water quality evaluation.**
  - Water quality trend analyses.
  - Hot spot analysis.

- **Groundwater well data evaluation.**
  - To be completed for BMAP updates.



SOURCE TRACKING
MARKERS AND TRACERS

- **Desktop mapping exercises.**
- **Strategic monitoring plan design for discrete areas.**
- **Multiple lines of evidence.**
- **Reveal how to reduce loading by identifying:**
  - Source type.
  - Location of the origin of the pollutant.
  - Primarily used with fecal indicator bacteria. Additionally useful for total nitrogen.
- **Resource intensive.**
- **Complicated.**

Chemical tracers of human waste:

- Acetaminophen.
- Ibuprofen.
- Naproxen.
- Hydrocodone.
- Sucralose.
- Carbamazepine.

qPCR markers used to detect waste from specific source types:

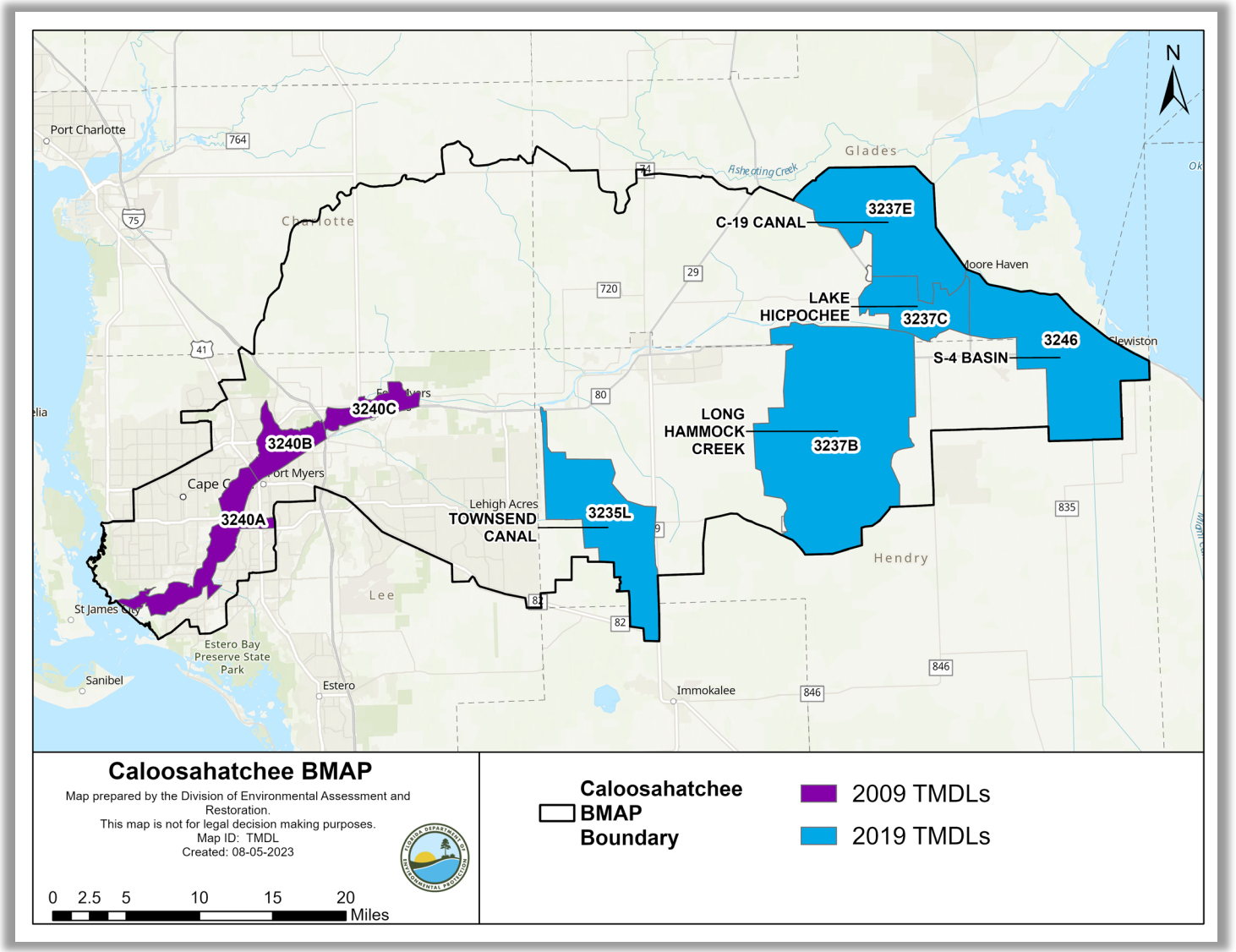
- Human waste marker - HF-183.
- Ruminant waste marker – BacR.
- Dog waste marker - DG3.
- Bird waste markers - Gull2 & GFD.

IDENTIFYING NUTRIENT SOURCES EXAMPLE

CALOOSAHATCHEE RIVER AND ESTUARY BMAP

- Caloosahatchee River and Estuary BMAP first established in 2012 to address total nitrogen (TN) impairment in estuary.

- 2020 update expanded BMAP to cover full watershed and new tributary TMDLs.



WATERSHED MODEL

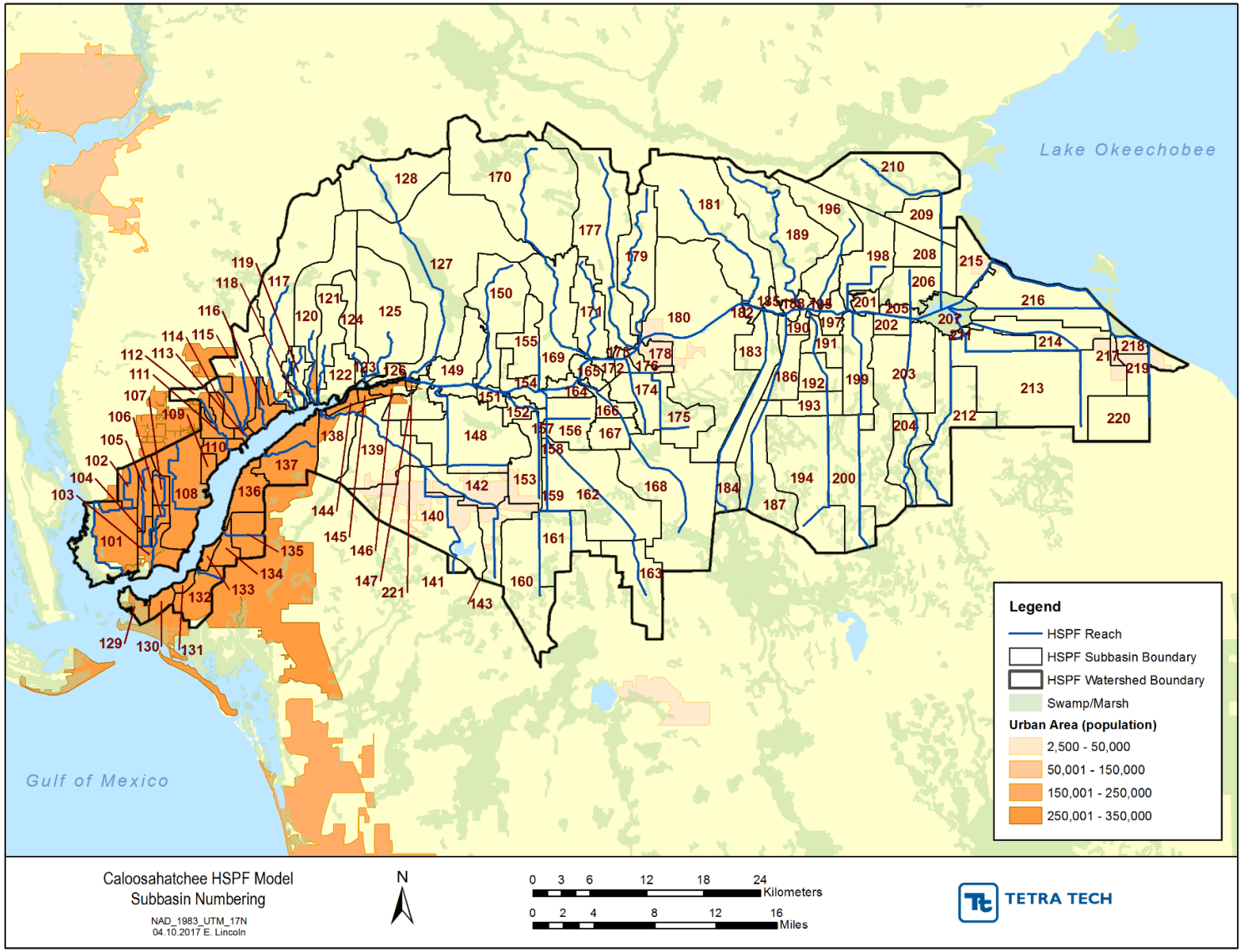
HYDROLOGICAL SIMULATION PROGRAM – FORTRAN (HSPF)

- **Used to model hydrology and water quality in the Caloosahatchee River and Estuary Watershed.**
- **Continuous rainfall and other meteorological records simulate land surface processes.**
  - Runoff and associated water quality is then integrated with in-stream hydraulic and sediment-chemical interactions.
- **Model is supported and maintained by both the United States Environmental Protection Agency (USEPA) and the United States Geological Survey (USGS).**
- **Consists of a set of modules for continuous simulation of hydrologic and water quality processes:**
  - PERLND – runoff and water quality constituents from pervious land area.
  - IMPLND – runoff and water quality constituents from impervious land area.
  - RCHRES – runoff water and chemical processes that occur to associated instream water quality constituents.

WATERSHED MODEL
BASIN DELINEATIONS

Delineated watershed into 121 basins:

- Adjusted boundary based on Lee County input.
- Added basins for four flow stations.
- Added basins for areas with agricultural pumping.



DATA SOURCES
METEOROLOGICAL

- **Next Generation Radar (NEXRAD) data provided by SFWMD used for model simulation period (January 1, 1996 – December 31, 2014).**
  - Estimate the amount of precipitation in an area based on radar measurements.
  - Provide estimates of the spatial and temporal distribution of rainfall.
- **Compared to ground surface rainfall gauges from the National Climatic Data Center (NCDC) and Lee County.**
  - Determined NEXRAD data had the best spatial and temporal resolution and were similar to NCDC and Lee County data.
- **Climate data from Weather-Bureau-Army-Navy (WBAN).**
  - Air temperature, dew point temperature, wind speed, cloud cover and solar radiation.
- **Evapotranspiration data from the Agricultural Field-Scale Irrigation Requirements Simulation (AFSIRS) model.**

DATA SOURCES
LAND USE

- Combination 2008-2009 SFWMD and 2008 SWFWMD coverage.
- 2011 National Land Cover Database (NLCD) impervious coverage.
- Water quality unit loading based on Harper (1994) and Soil and Water Engineering Technology (SWET) (2004).

HSPF Land Use Code	Land Use Description	Total Acreage
01	Low Density Residential (Pervious)	74,606
02	Developed Open Space / Disturbed (Pervious)	21,587
03	Medium Density Residential (Pervious)	31,118
04	High Density Residential (Pervious)	6,162
05	Commercial / Institutional / Transportation (Pervious)	8,234
06	Industrial / Extractive (Pervious)	7,408
07	FDOT Right-of-Way (Pervious)	4,300
08	Sugar Cane	90,632
09	Row and Field Crops	13,753
10	Nurseries / Ornamentals / Vineyards	3,670
11	Citrus Groves / Other Groves	91,032
12	Improved Pasture	128,792
13	Rangeland / Unimproved Pasture / Woodland Pasture / Shrub	102,272
14	Upland Forests	121,115
15	Wetlands	133,590
16	Water	13,963
01	Low Density Residential (Impervious)	4,691
02	Medium Density Residential (Impervious)	9,924
03	High Density Residential (Impervious)	3,760
04	Commercial / Institutional / Transportation / Industrial / Extractive (Impervious)	7,017
05	FDOT Right-of-Way (Impervious)	844
06	Agriculture (Impervious)	699
07	Other (Impervious)	1,242
N/A	Total	880,408

DATA SOURCES
SEPTIC SYSTEMS

- **Lee County GIS coverage for unincorporated county.**
- **2016 Florida Department of Health (DOH) GIS coverage.**
  - Parcels with “known septic” and “likely septic.”
- **Cape Coral actively removing septic systems.**
  - Used the 2013 DOH coverage for the city since systems missing from the 2016 GIS coverage.
  - 2013 DOH coverage included septic systems the city removed between 2002 and 2008. Removed from the HSPF model to better represent conditions as recommended by the city.
- **Percolate concentrations and decay rates from USEPA used as starting point.**
  - DOH reviewed and provided suggested modifications to be specific to the Caloosahatchee River and Estuary Watershed.

DATA SOURCES
NPDES AND REUSE FACILITIES

- **Used permit and discharge monitoring report (DMR) data for:**
  - 3 domestic and industrial NPDES wastewater treatment facilities with surface water discharges in the watershed.
  - 11 reuse facilities with permitted discharges greater than 0.09 million gallons per day in the watershed.
  - 5 domestic and one industrial NPDES facilities discharging directly to the EFDC model (not watershed model).
- **Summarized the observed average flow and water quality results for each facility for model period of record.**
  - Measured data were used in the HSPF model to determine the total loading.
  - Facility data were used to fill short- and long-term gaps in the data records.
- **Measured data were not available for all parameters, specifically for the reuse facilities.**
  - Default assumptions were used for the NPDES facilities and reuse facilities based on available data from all facilities in the watershed, and information obtained from reclaimed and reuse studies conducted in south Florida.

DATA SOURCES
AGRICULTURAL WATER USE

- **Updated model to apply agricultural irrigation directly to the land surface**
  - Developed irrigation time series using crop water demand, growth coefficients, and evapotranspiration data.
- **Crops requiring irrigation were classified into four categories.**
  - Correspond to crop classifications in the 2010 Florida Statewide Agricultural Irrigation Demand (FSAID) report and geodatabase.
  - Pasture areas shown as irrigated in the FSAID report were not included in the model based on FDACS input.
- **Associated monthly crop evapotranspiration coefficient was determined using information provided by FDACS.**
- **AFSIRS model provided irrigated and total root depths, water use coefficients, and allowable water use depletions.**
- **Irrigation water demand time series were developed for each crop type and NEXRAD precipitation.**
  - Input into the model at a daily time step.

DATA SOURCES
ATMOSPHERIC DEPOSITION

- **Specifies wet deposition of pollutants as concentrations:**
  - Applied to precipitation falling on the land and streams/waterbodies.
- **Dry deposition represented as a mass flux to both land surfaces and directly to streams/waterbodies.**
- **Data available for nitrogen but not phosphorus deposition.**
  - Atmospheric deposition of nitrogen was explicitly represented in the model.
  - Phosphorus was implicitly represented through parameterization as sediment-sorbed.
- **Wet deposition of nitrogen data from the National Trends Network (NTN) of the National Atmospheric Deposition Program (NADP).**
  - Provided as monthly precipitation-weighted average concentrations.
- **Dry deposition of monitoring data from USEPA's Clean Air Status and Trends Network (CASTNET).**
  - Provided as seasonal three-month totals.

REDUCING NUTRIENT POLLUTION

CALOOSAHATCHEE ESTUARY TOTAL NITROGEN REDUCTIONS

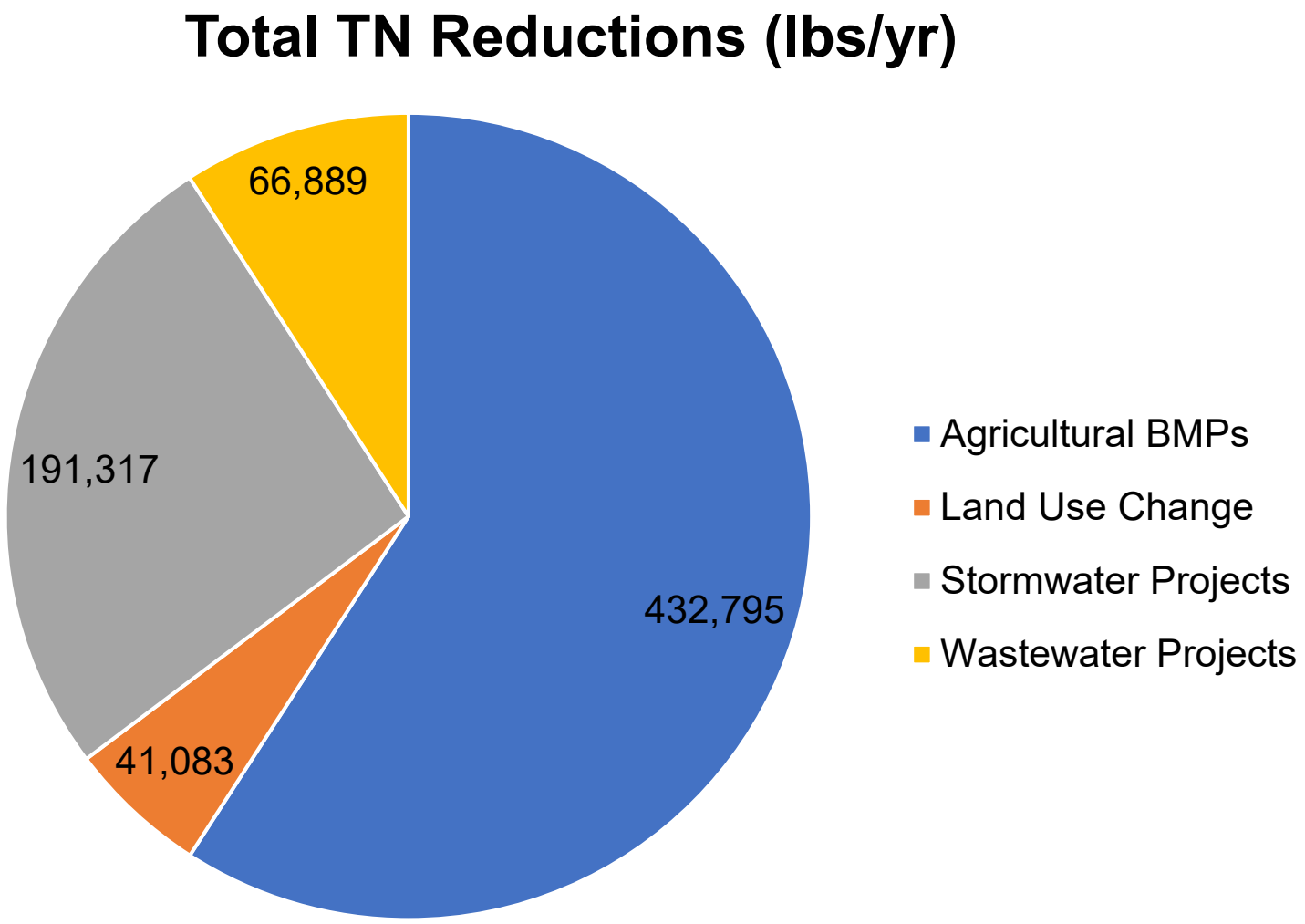
Entity	TN Reductions to Date (lbs/yr)	TN Required Reductions (lbs/yr)	TN Reductions Still Needed (lbs/yr)	Percent Required Reductions Achieved
Agriculture	432,795	707,723	274,928	61%
Lee County	147,416	59,229	(88,187)	249%
Lehigh Acres MSID	37,132	40,791	3,659	91%
City of Cape Coral	81,285	38,965	(42,320)	209%
City of Fort Myers	18,234	19,493	1,259	94%
Hendry County/Port LaBelle CDD	-	16,132	16,132	0%
Glades County	1,564	7,149	5,585	22%
FDOT District 1	11,546	6,358	(5,188)	182%
Charlotte County	1,272	5,816	4,544	22%
City of LaBelle	-	2,950	2,950	0%
City of Clewiston	298	1,955	1,657	15%
River Hall CDD	-	1,676	1,676	0%
City of Moore Haven	175	-	-	N/A
Lucaya CDD	4	-	-	N/A
Portico CDD	66	-	-	N/A
Verandah East CDD	117	-	-	N/A
Verandah West CDD	180	-	-	N/A
Totals	**732,084**	**908,236**	**176,152**	**81%**

REDUCING NUTRIENT POLLUTION

CALOOSAHATCHEE TRIBUTARIES TOTAL PHOSPHORUS (TP) REDUCTIONS

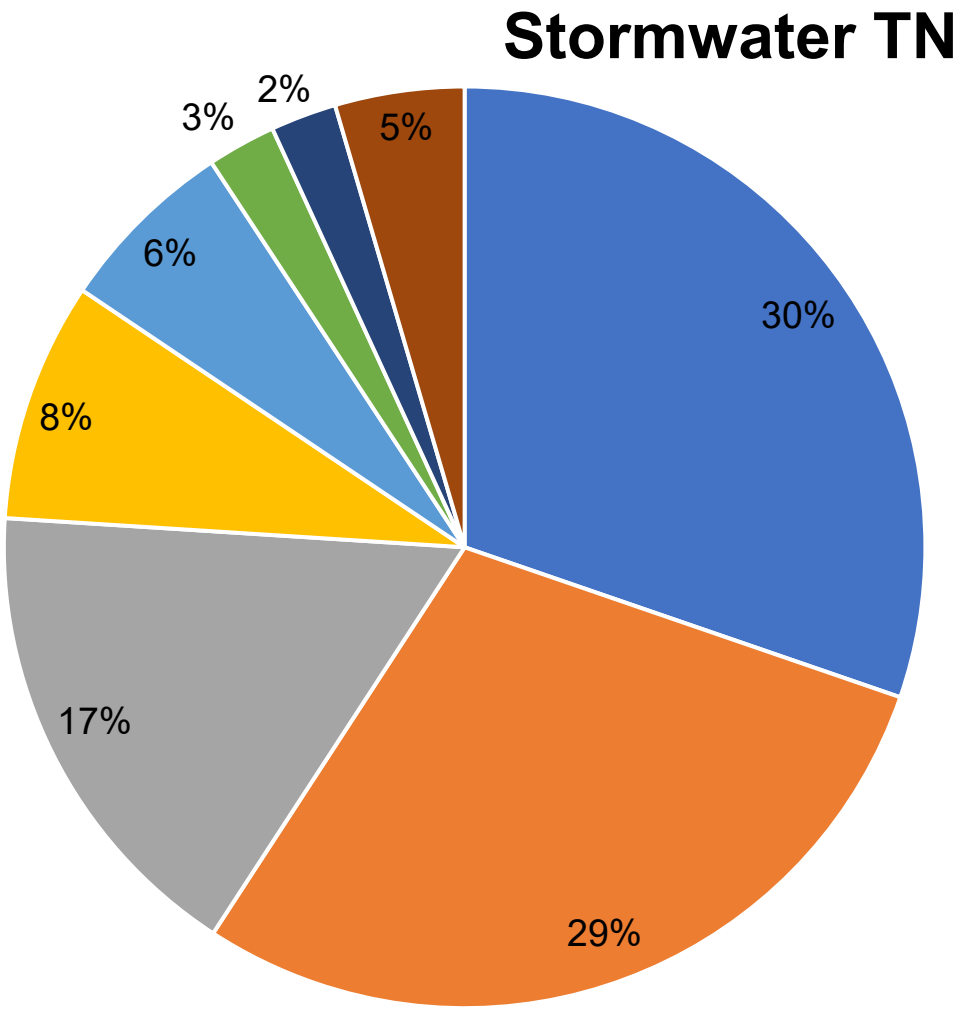
Entity	TP Reductions to Date (lbs/yr)	TP Required Reductions (lbs/yr)	TP Reductions Still Needed (lbs/yr)	Percent Required Reductions Achieved
City of Clewiston	98	316	218	31%
FDACS	6,574	22,811	16,237	29%
FDOT District 1	48	232	184	21%
Glades County	66	386	320	17%
Hendry County/ Port Labelle CDD	-	1,235	1,235	0%
Collier County	0.4	6	5.6	7%
Totals	**6,786**	**24,986**	**18,194**	**27%**

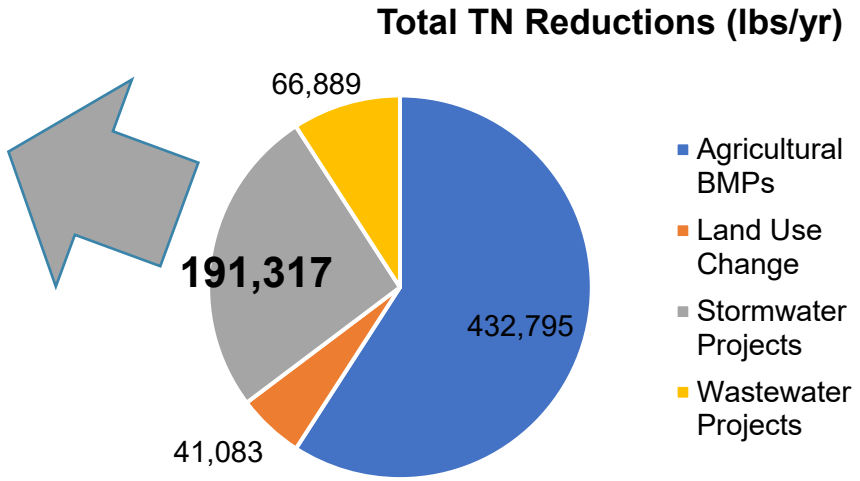
REDUCING NUTRIENT POLLUTION
PROJECT IMPLEMENTATION



REDUCING NUTRIENT POLLUTION
PROJECT IMPLEMENTATION

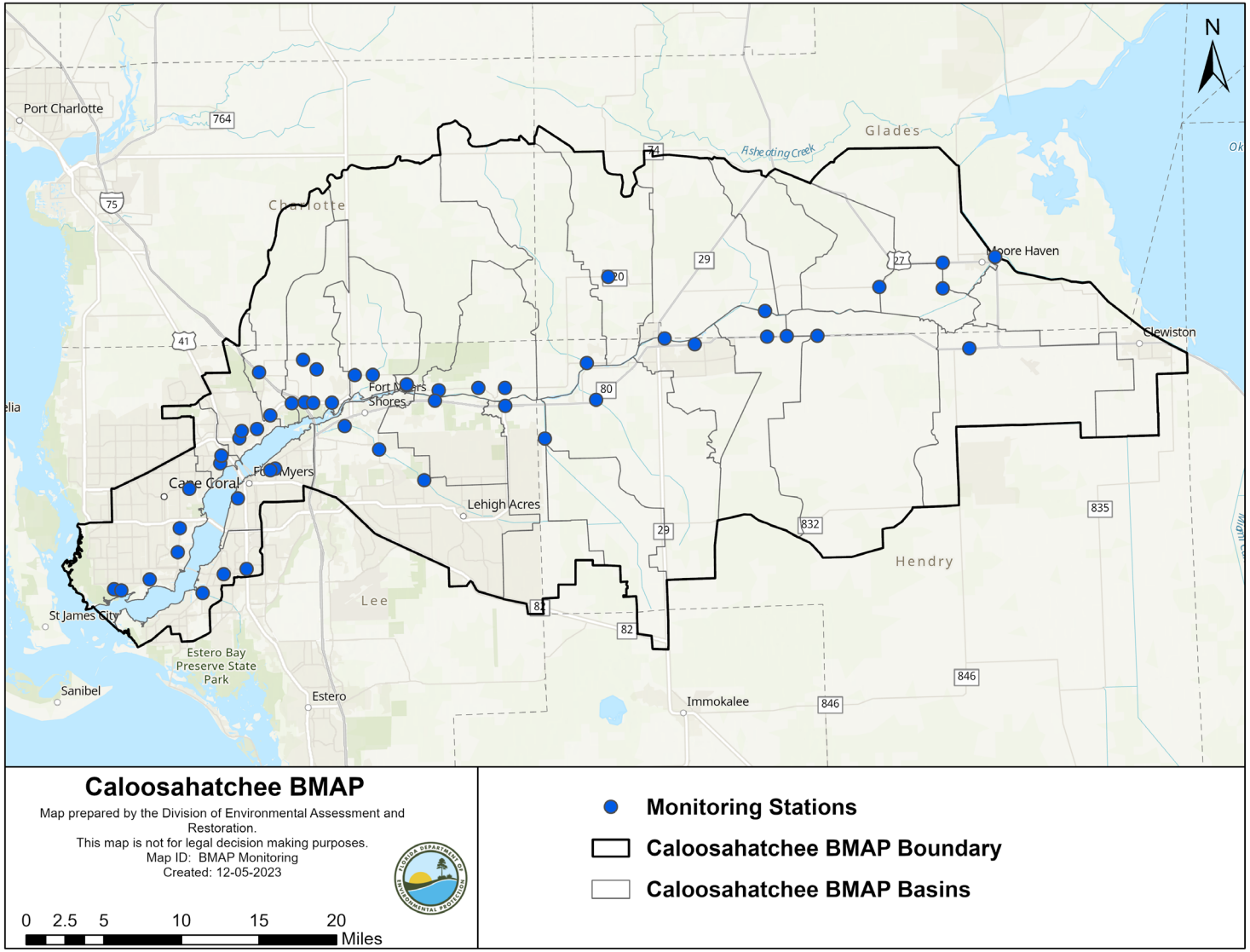
- Control Structure
- Hydrologic Restoration
- Education Efforts
- Constructed Wetland Treatment
- Stormwater Treatment Areas (STAs)
- Grass swales without swale blocks or raised culverts
- Wet Detention Pond
- Other





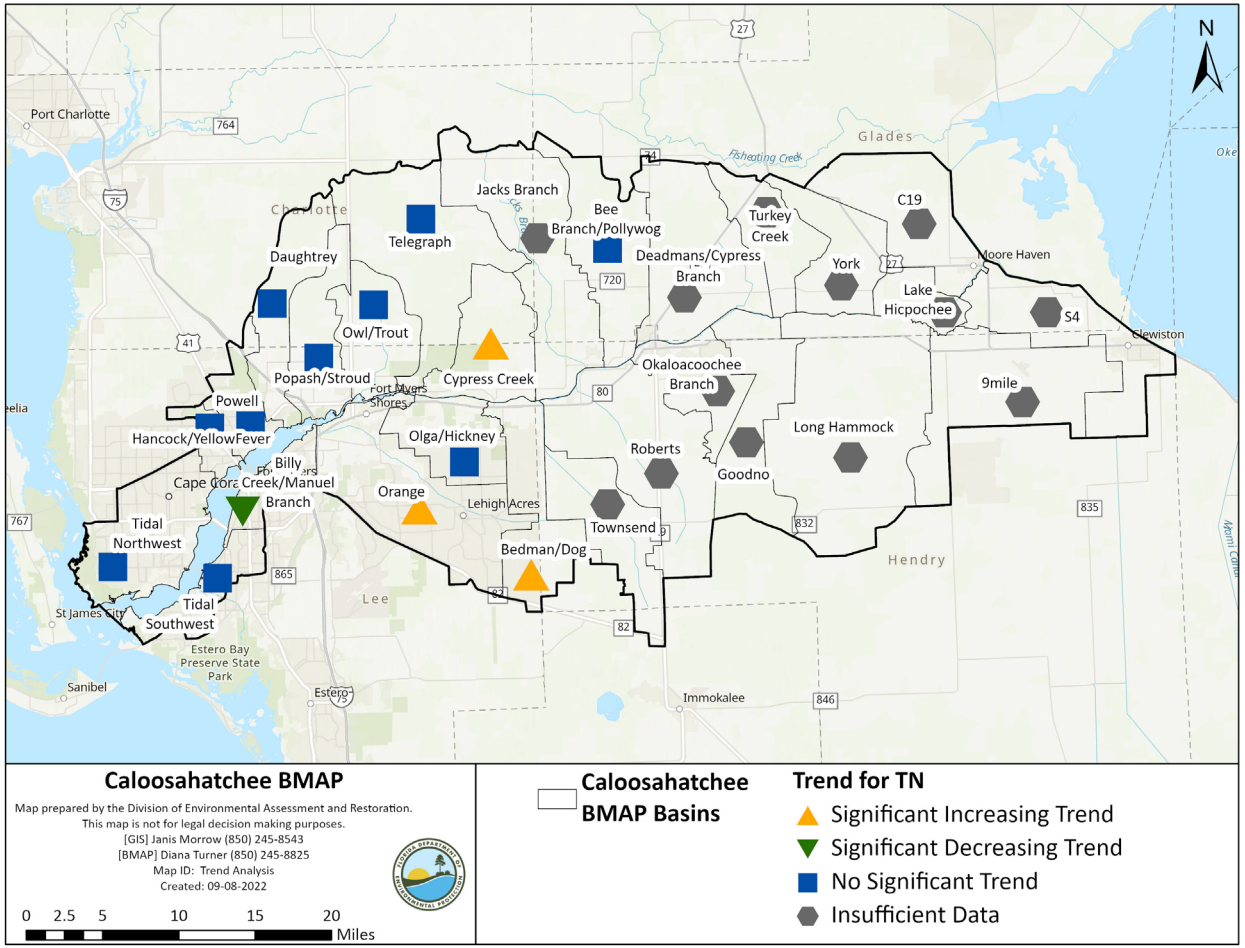
CALOOSAHATCHEE WATER QUALITY MONITORING

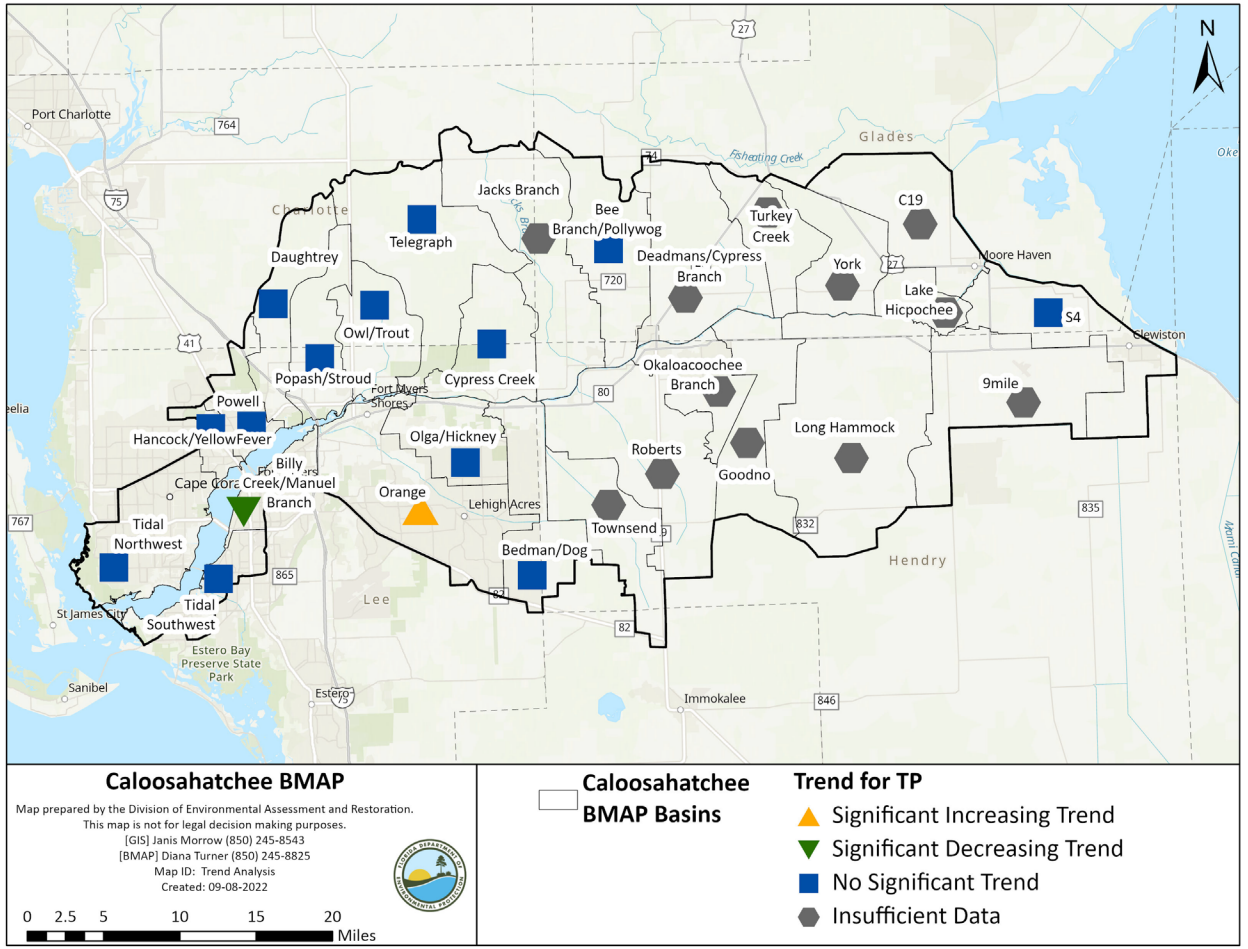
BMAP WATER QUALITY MONITORING STATIONS



CALOOSAHATCHEE WATER QUALITY ANALYSES

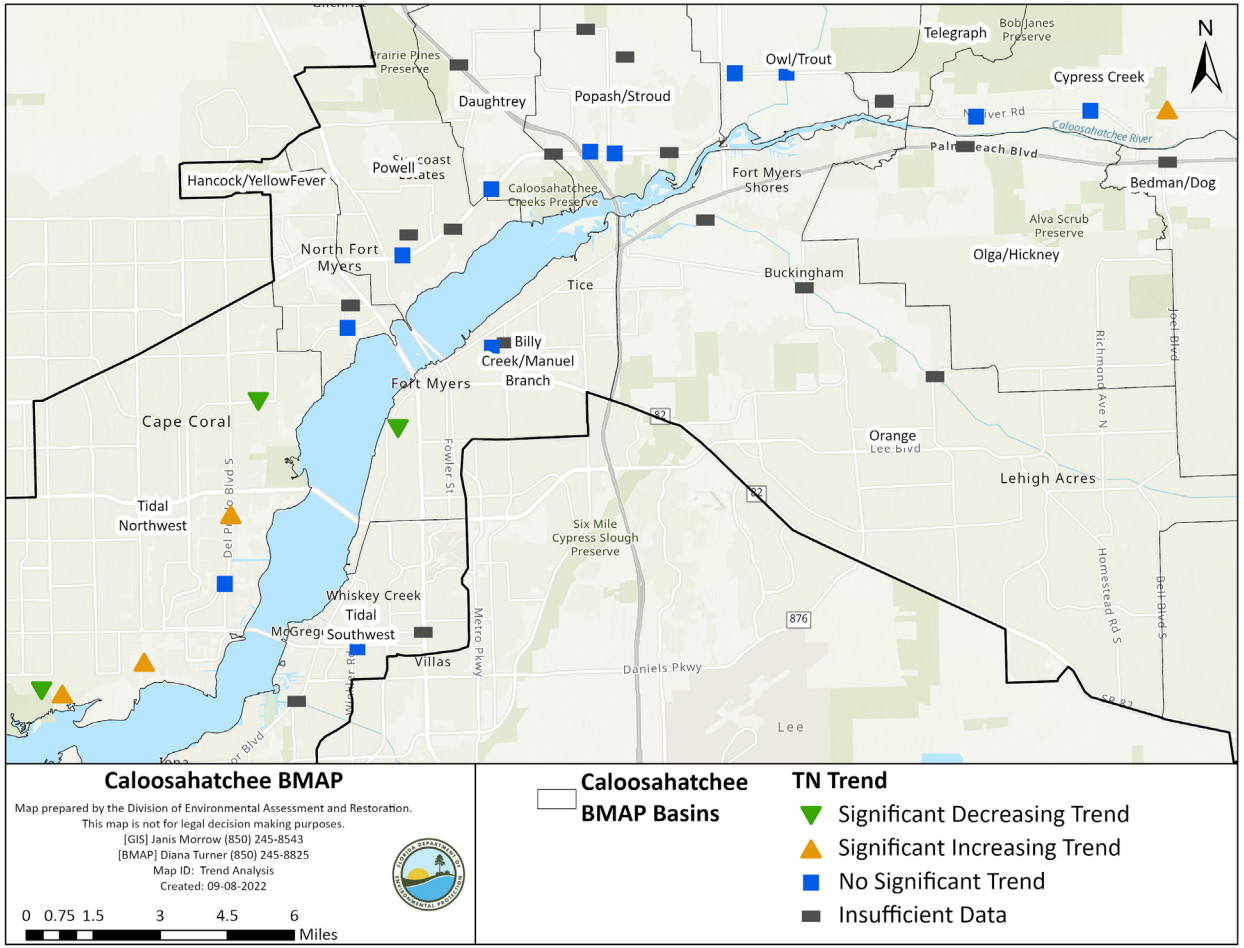
BASIN TREND ANALYSIS

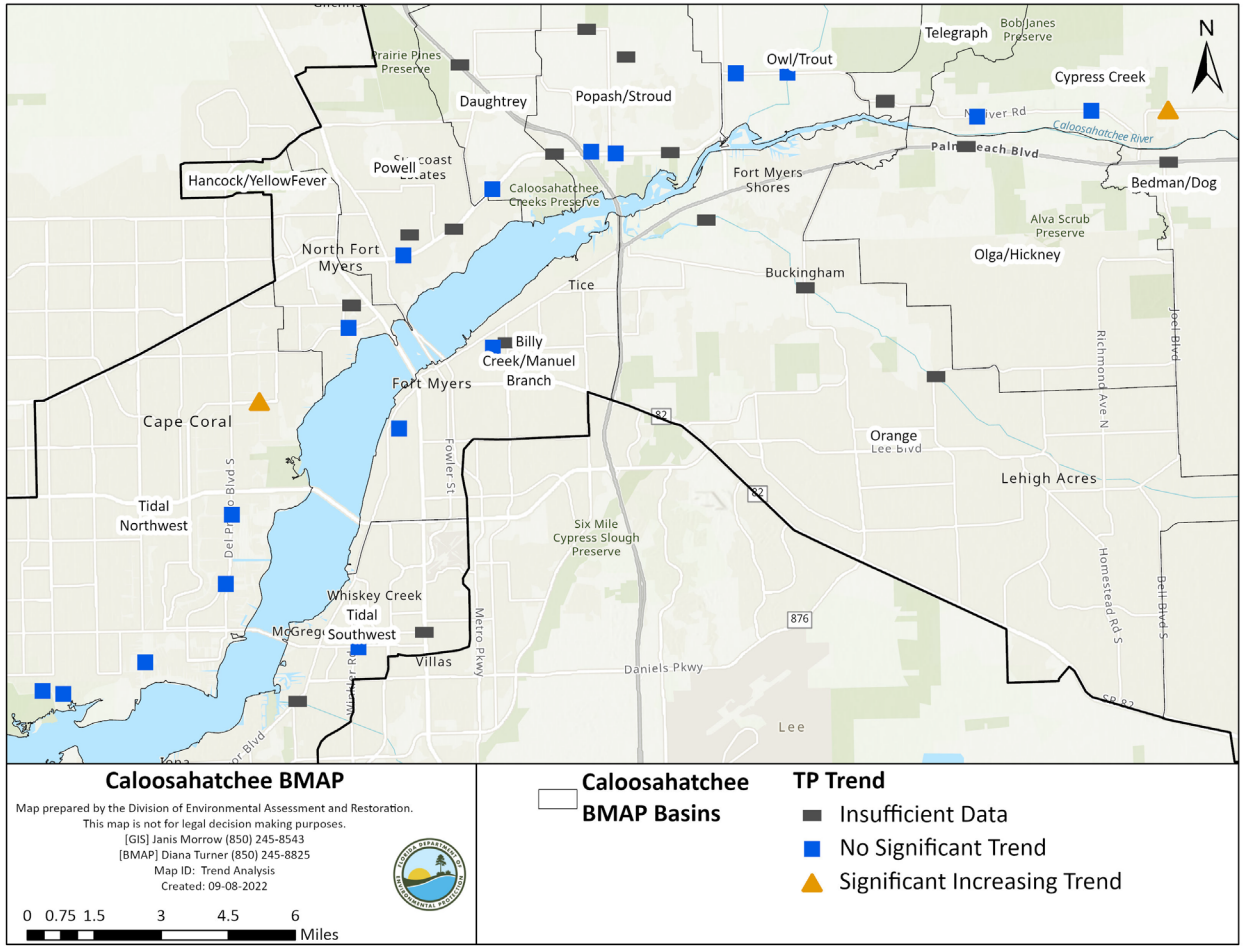




CALOOSAHATCHEE WATER QUALITY ANALYSES

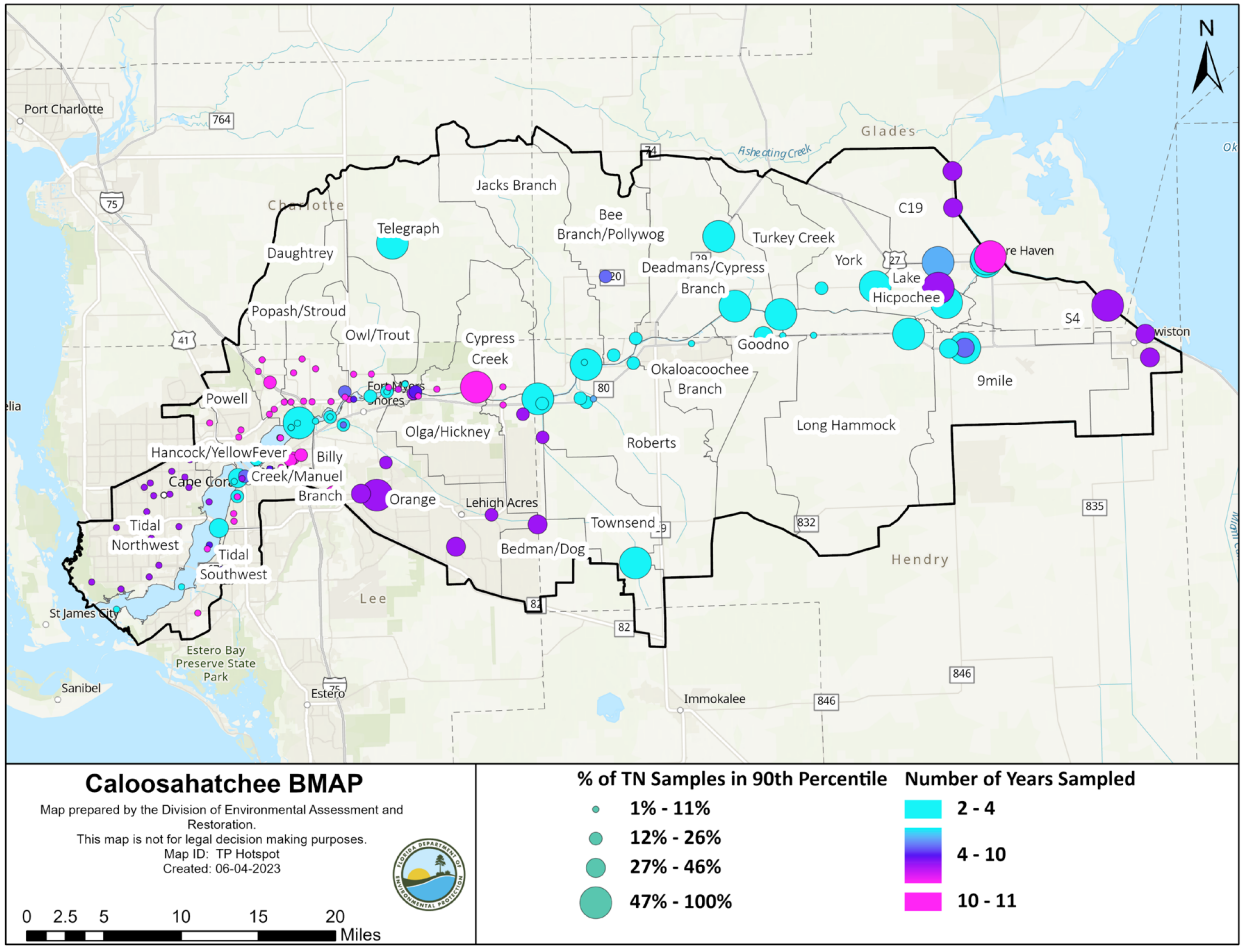
STATION TREND ANALYSIS

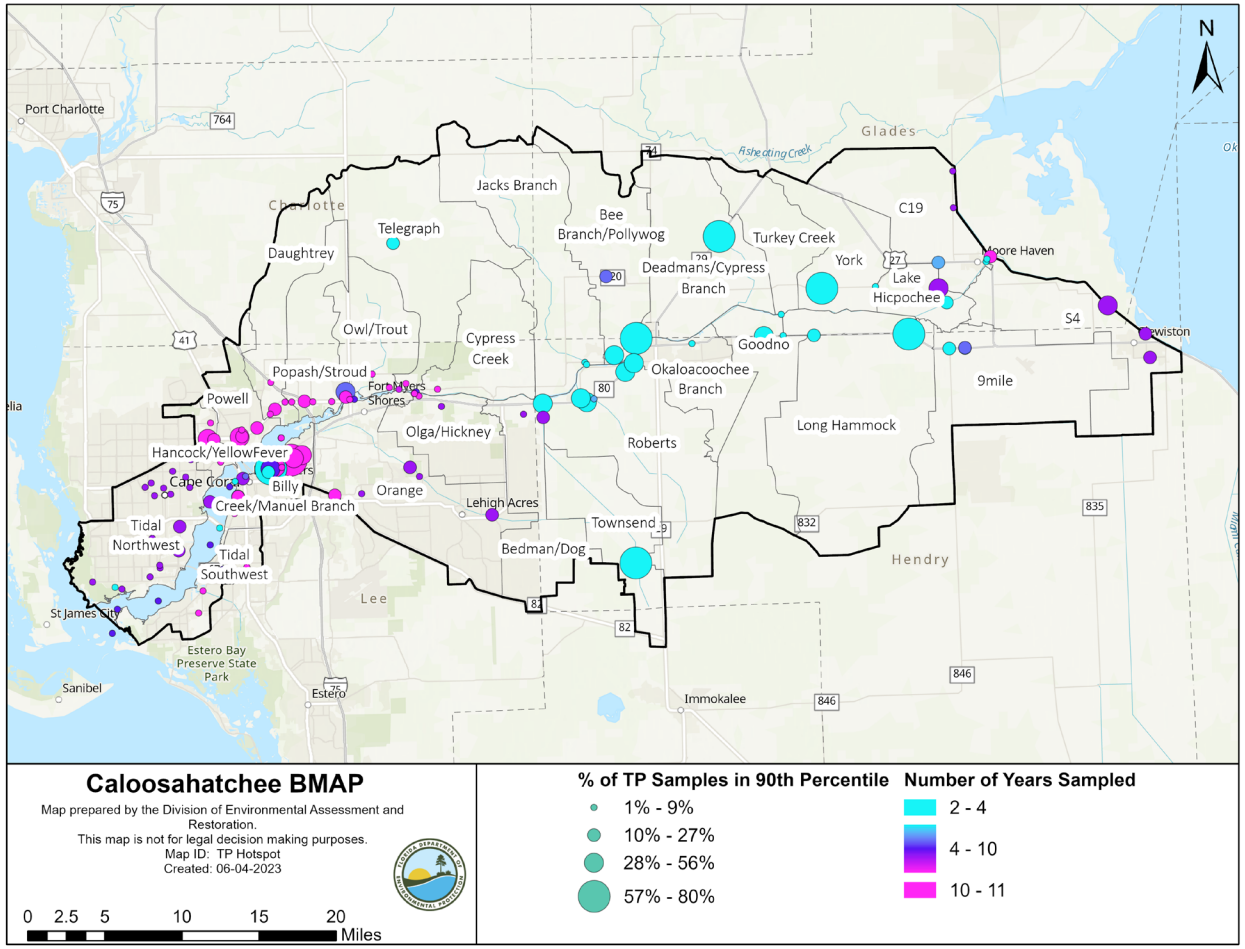




CALOOSAHATCHEE WATER QUALITY ANALYSES

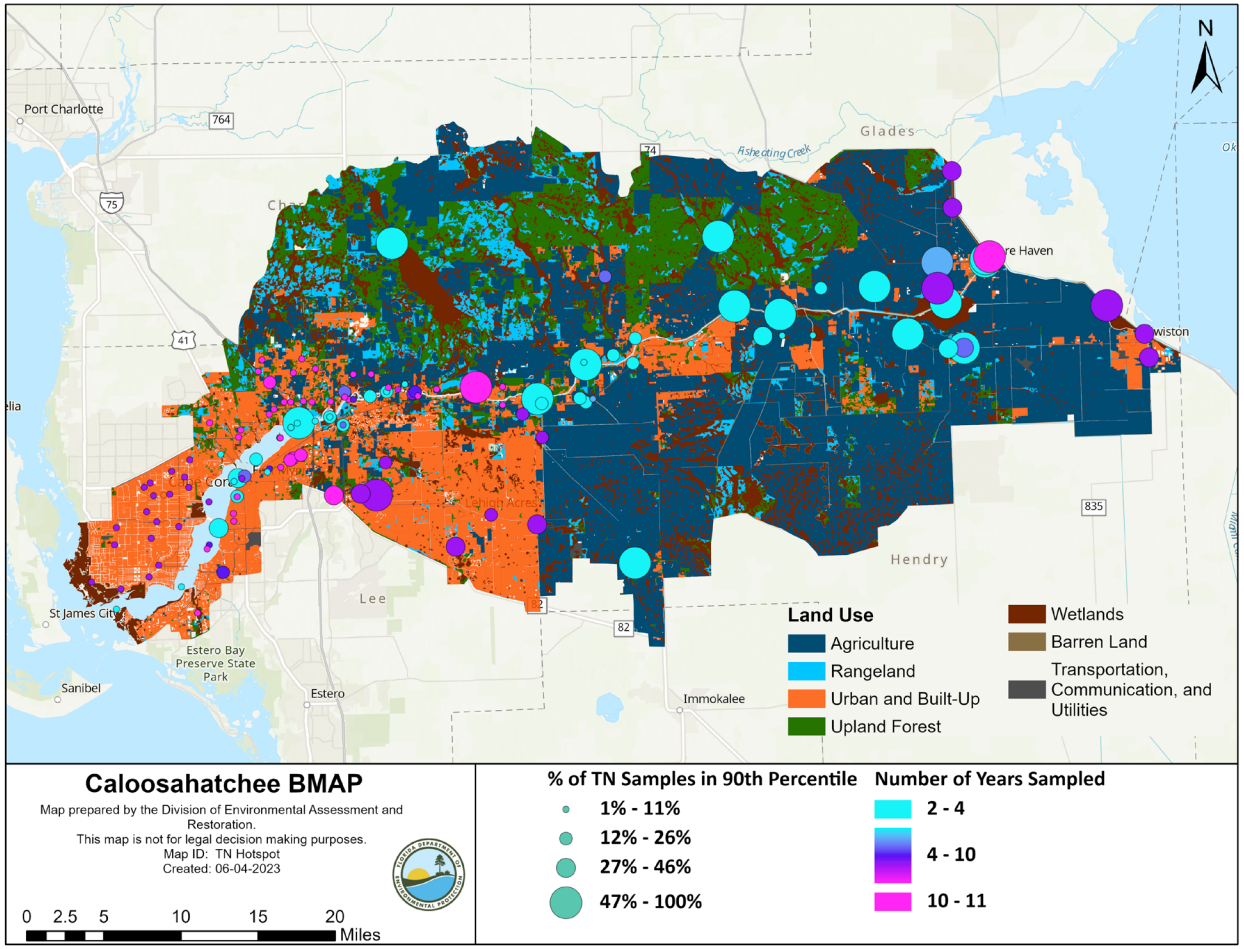
HOT SPOT ANALYSES

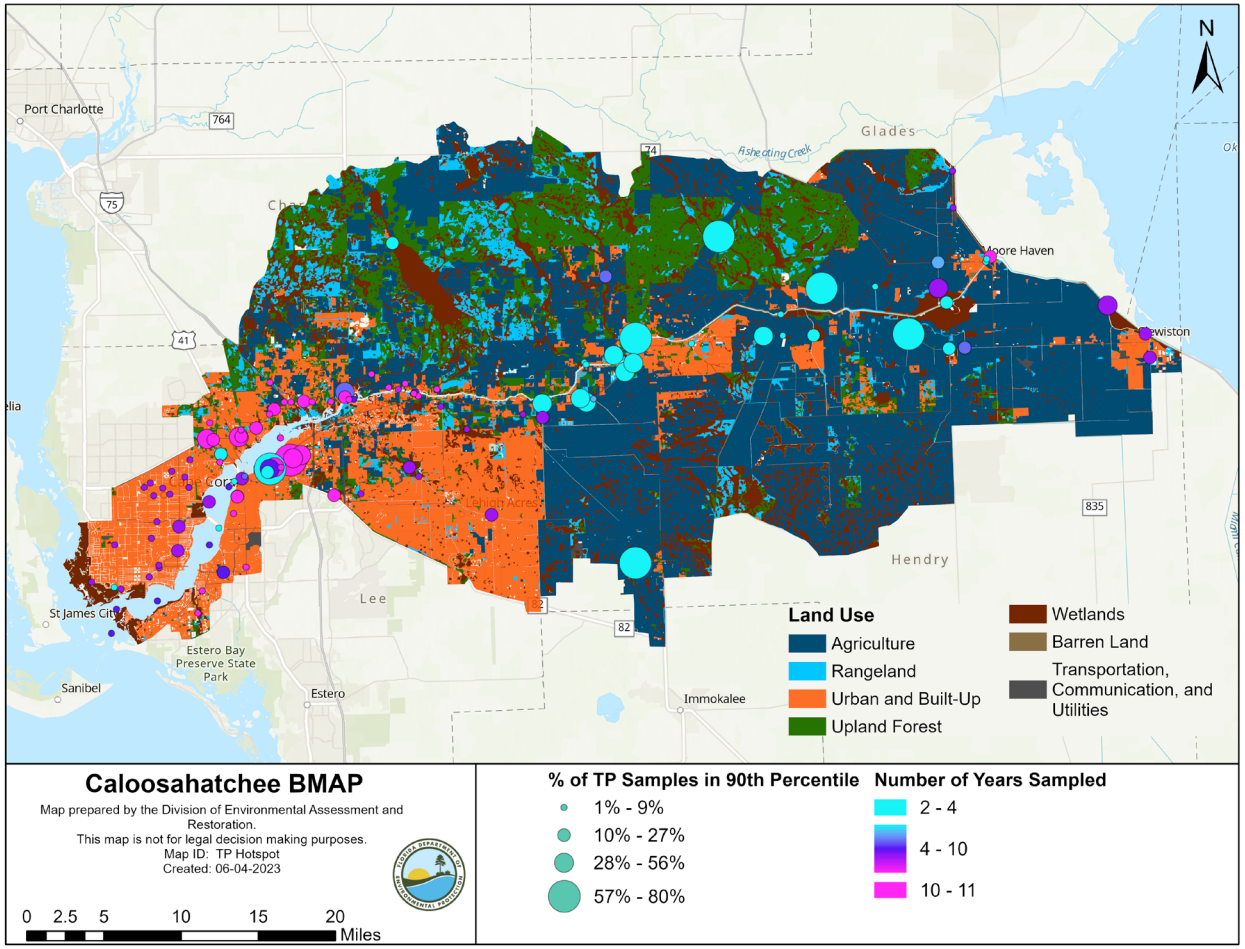




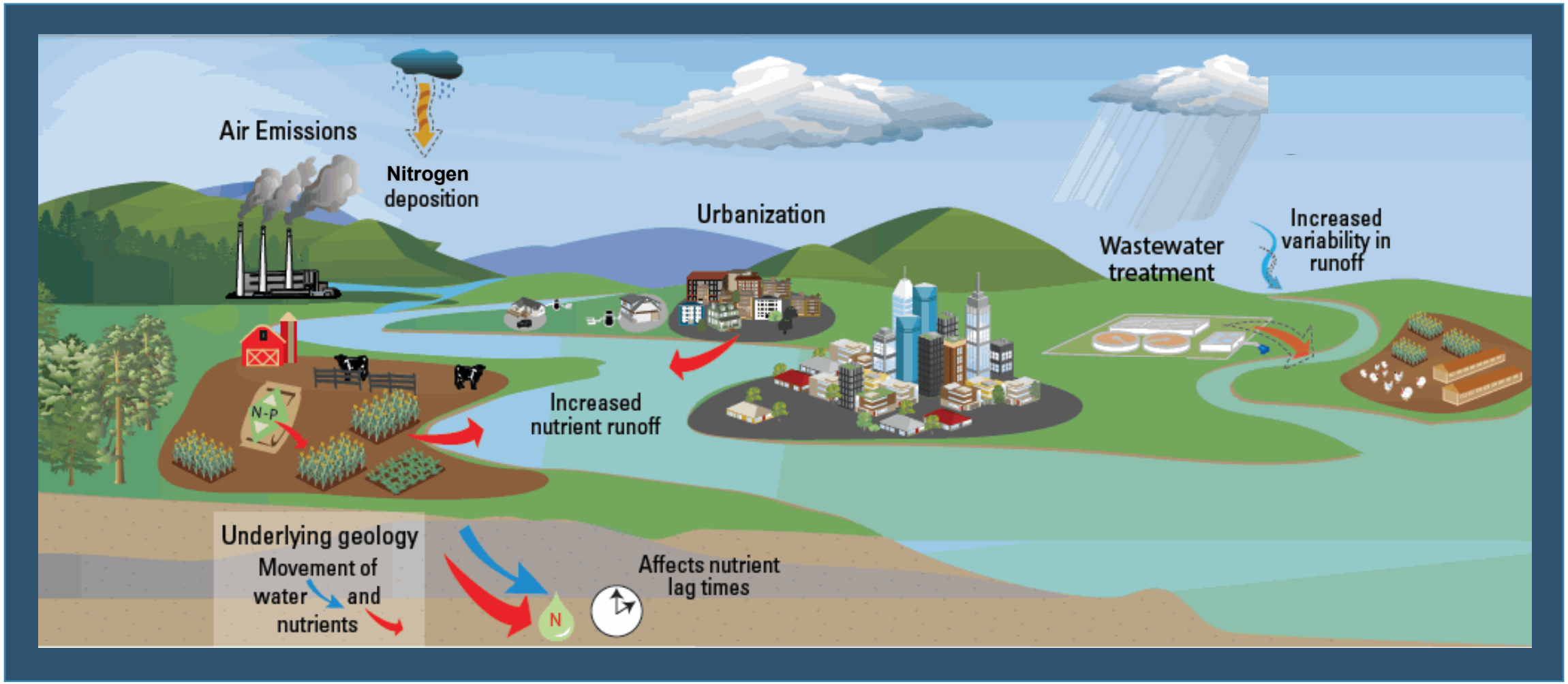
CALOOSAHATCHEE WATER QUALITY ANALYSES

HOT SPOT ANALYSES

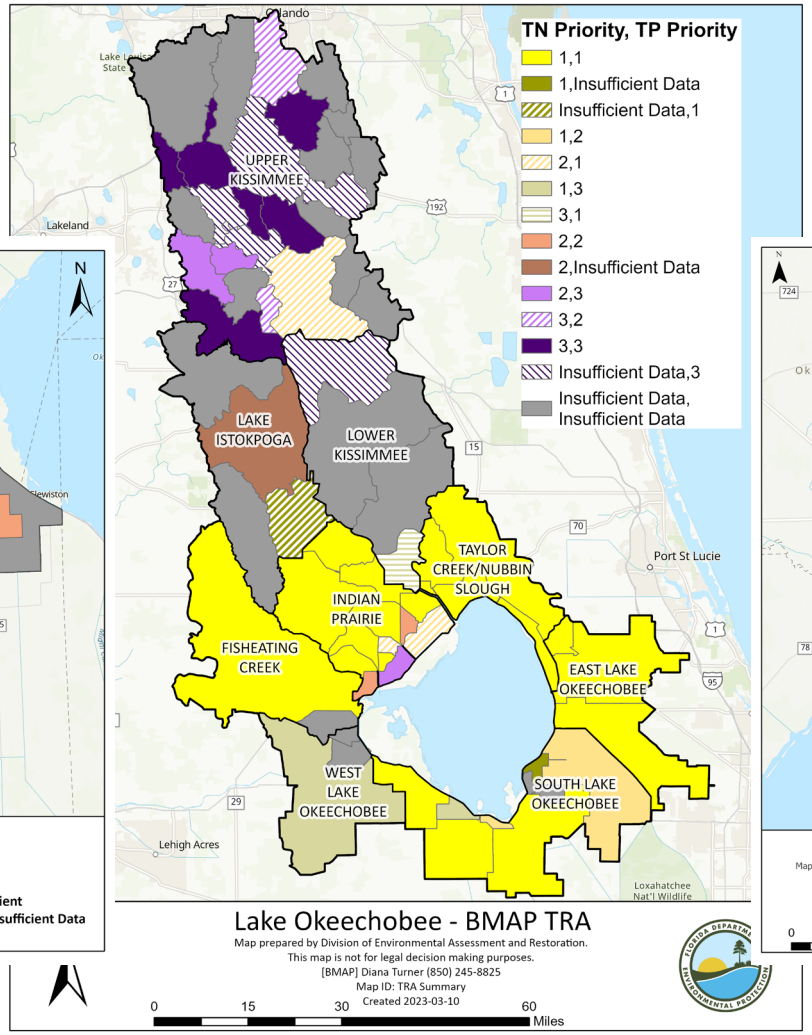


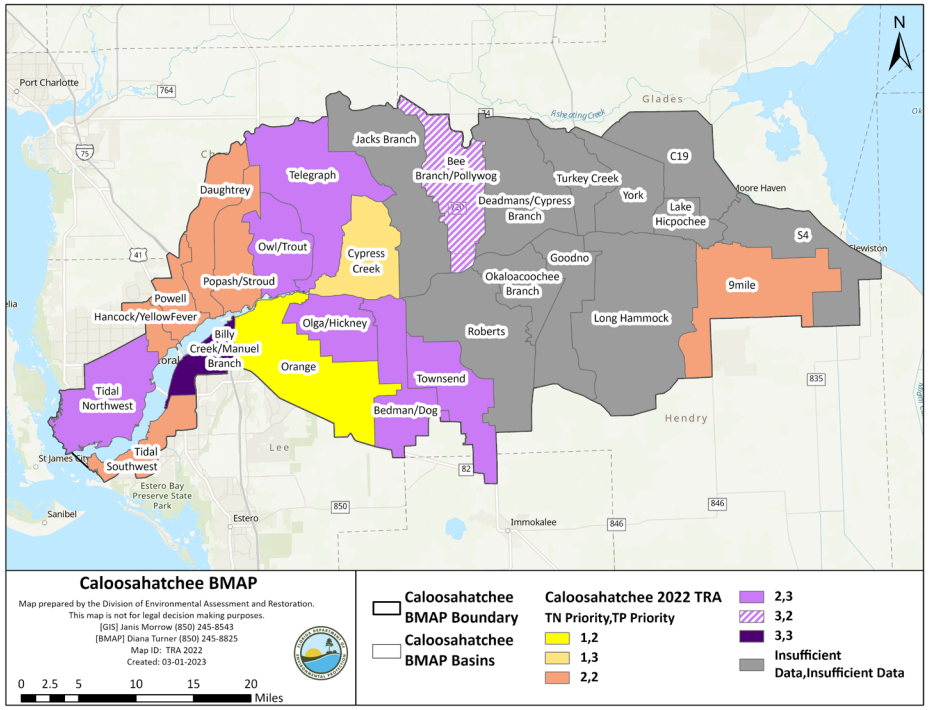


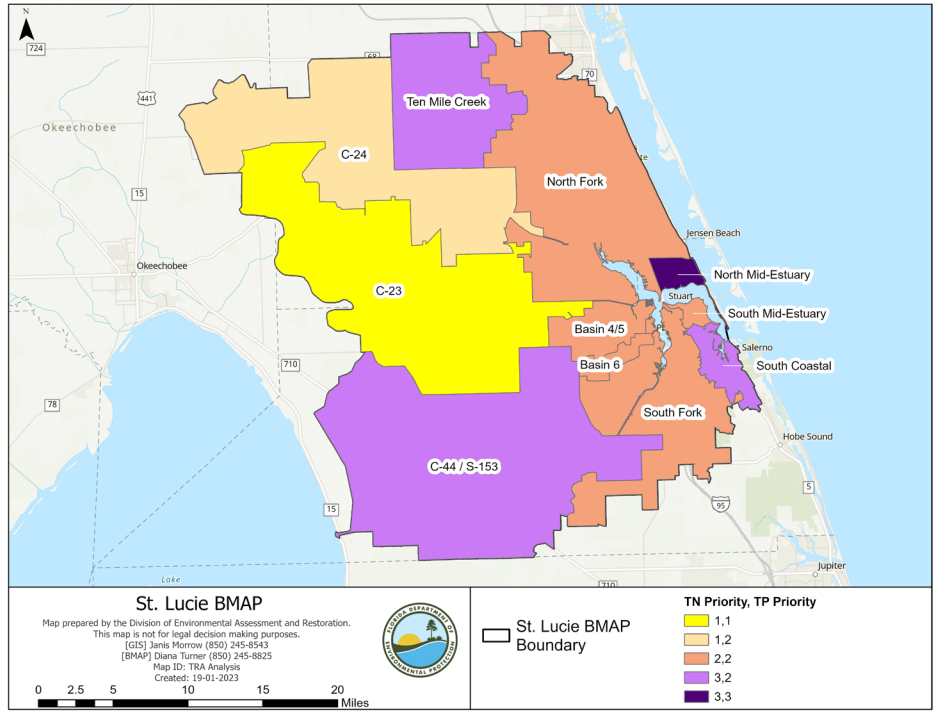
CONCLUSION


Air Emissions
Nitrogen deposition
Urbanization
Wastewater treatment
Increased variability in runoff
N-P
Increased nutrient runoff
Underlying geology
Movement of water and nutrients
N
Affects nutrient lag times

CONCLUSION


TN Priority, TP Priority
1,1
1,Insufficient Data
Insufficient Data,1
1,2
2,1
1,3
3,1
2,2
2,Insufficient Data
2,3
3,2
3,3
Insufficient Data,3
Insufficient Data, Insufficient Data
UPPER KISSIMMEE
LAKE ISTOKPOGA
LOWER KISSIMMEE
TAYLOR CREEK/NUBBIN SLOUGH
INDIAN PRAIRIE
FISHEATING CREEK
EAST LAKE OKEECHOBEE
WEST LAKE OKEECHOBEE
SOUTH LAKE OKEECHOBEE
Lake Okeechobee - BMAP TRA
Map prepared by Division of Environmental Assessment and Restoration.
This map is not for legal decision making purposes.
[BMAP] Diana Turner (850) 245-8825
Map ID: TRA Summary
Created 2023-03-10
0 15 30 60 Miles


Caloosahatchee BMAP
Map prepared by the Division of Environmental Assessment and Restoration.
This map is not for legal decision making purposes.
[GIS] Janis Morrow (850) 245-8543
[BMAP] Diana Turner (850) 245-8825
Map ID: TRA 2022
Created: 03-01-2023
0 2.5 5 10 15 20 Miles
Caloosahatchee BMAP Boundary
Caloosahatchee BMAP Basins
Caloosahatchee 2022 TRA
TN Priority,TP Priority
1,2
1,3
2,2
2,3
3,2
3,3
Insufficient Data,Insufficient Data
Jacks Branch
Bee Branch/Pollywog
Deadmans/Cypress Branch
Turkey Creek
York
Lake Hicpochee
C19
S4
9mile
Goodno
Okaloacoochee Branch
Long Hammock
Roberts
Olga/Hickney
Orange
Townsend
Bedman/Dog
Telegraph
Daughtrey
Owl/Trout
Cypress Creek
Popash/Stroud
Powell
Hancock/YellowFever
Billy Creek/Manuel Branch
Tidal Northwest
Tidal Southwest


St. Lucie BMAP
Map prepared by the Division of Environmental Assessment and Restoration.
This map is not for legal decision making purposes.
[GIS] Janis Morrow (850) 245-8543
[BMAP] Diana Turner (850) 245-8825
Map ID: TRA Analysis
Created: 19-01-2023
0 2.5 5 10 15 20 Miles
St. Lucie BMAP Boundary
TN Priority, TP Priority
1,1
1,2
2,2
3,2
3,3
Ten Mile Creek
C-24
North Fork
C-23
C-44 / S-153
North Mid-Estuary
South Mid-Estuary
Basin 4/5
Basin 6
South Coastal
South Fork

THANK YOU

Kimberly Shugar
850-245-7518
Kimberly.Shugar@FloridaDEP.gov

Diana Turner
850-245-8825
Diana.M.Turner@FloridaDEP.gov