CRADLE TO GRAVE CASE STUDY: FROM ASSESSMENT TO WATER QUALITY SUCCESS OF A BMP RETROFIT

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Outline

- Orange County Background
- Project Background
  - Lake Pineloch Study – Watershed Assessment
  - Project Recommendation
- Feasibility Study
  - Watershed Assessment
  - H&H Modeling
  - Water Quality Modeling
  - Recommendations
- Design and Construction
  - Design of NSBB and UFF
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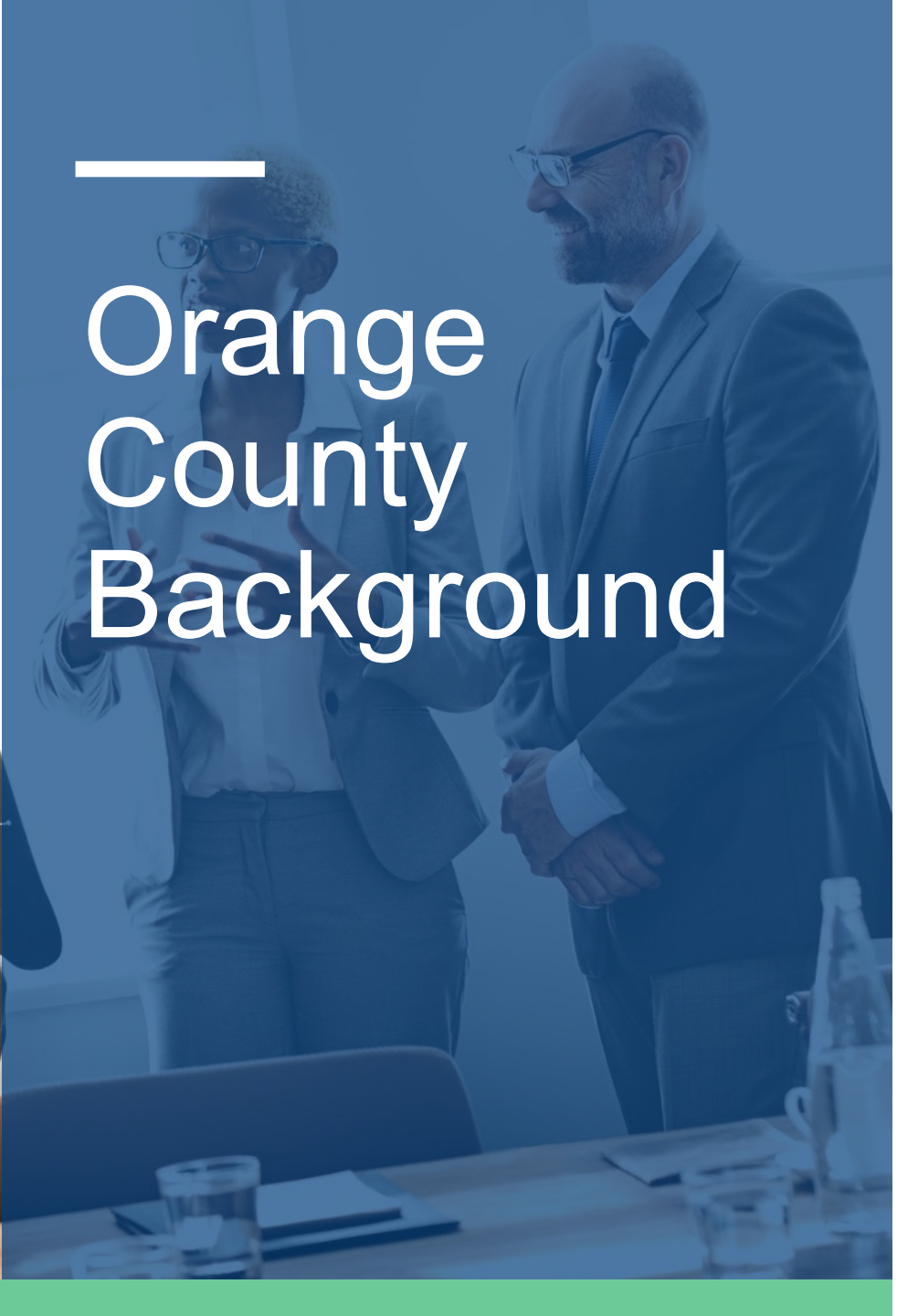
  - Construction Oversight
- Monitoring
  - Equipment layout and function
  - Sampling Summary
- Performance
  - Rainfall and Flow
  - Autosampler Results
  - Cleaning Results
  - Overall Performance
- Lessons Learned



Orange County Background

Cities within Orange County

Orange County Districts

Orange County Waters

Orange County Environmental Protection Division (EPD)

EPD Water Sciences Program

EPD Water Sciences Program: Field Services

EPD Water Sciences Program: Laboratory Analysis

State of Florida TMDL Assessment & Implementation

State of Florida TMDL/BMAP Program Overview

BMAP Areas in Orange County

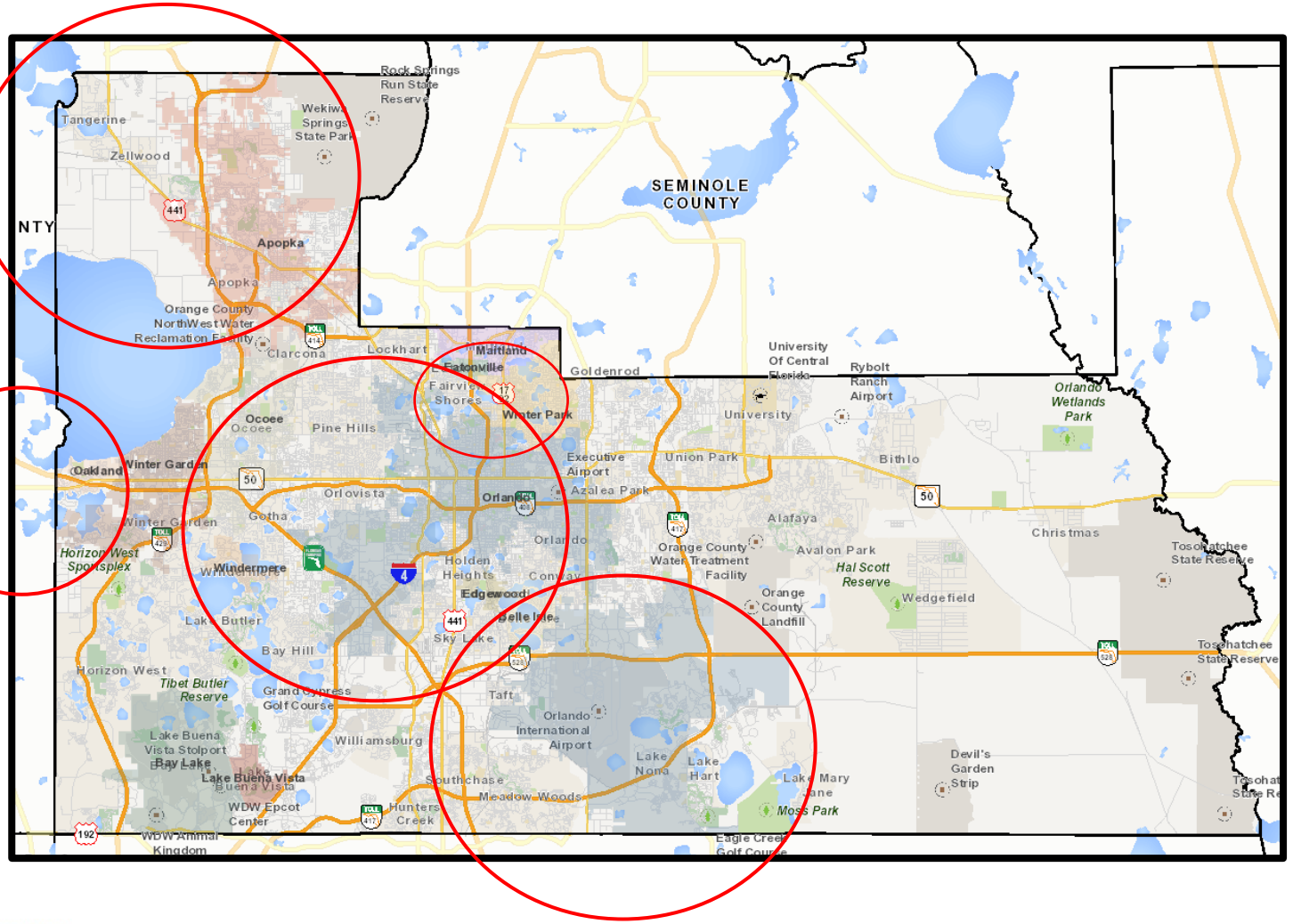
EPD Water Quality Projects

EPD Water Quality Project Examples

Cities within Orange County

Apopka

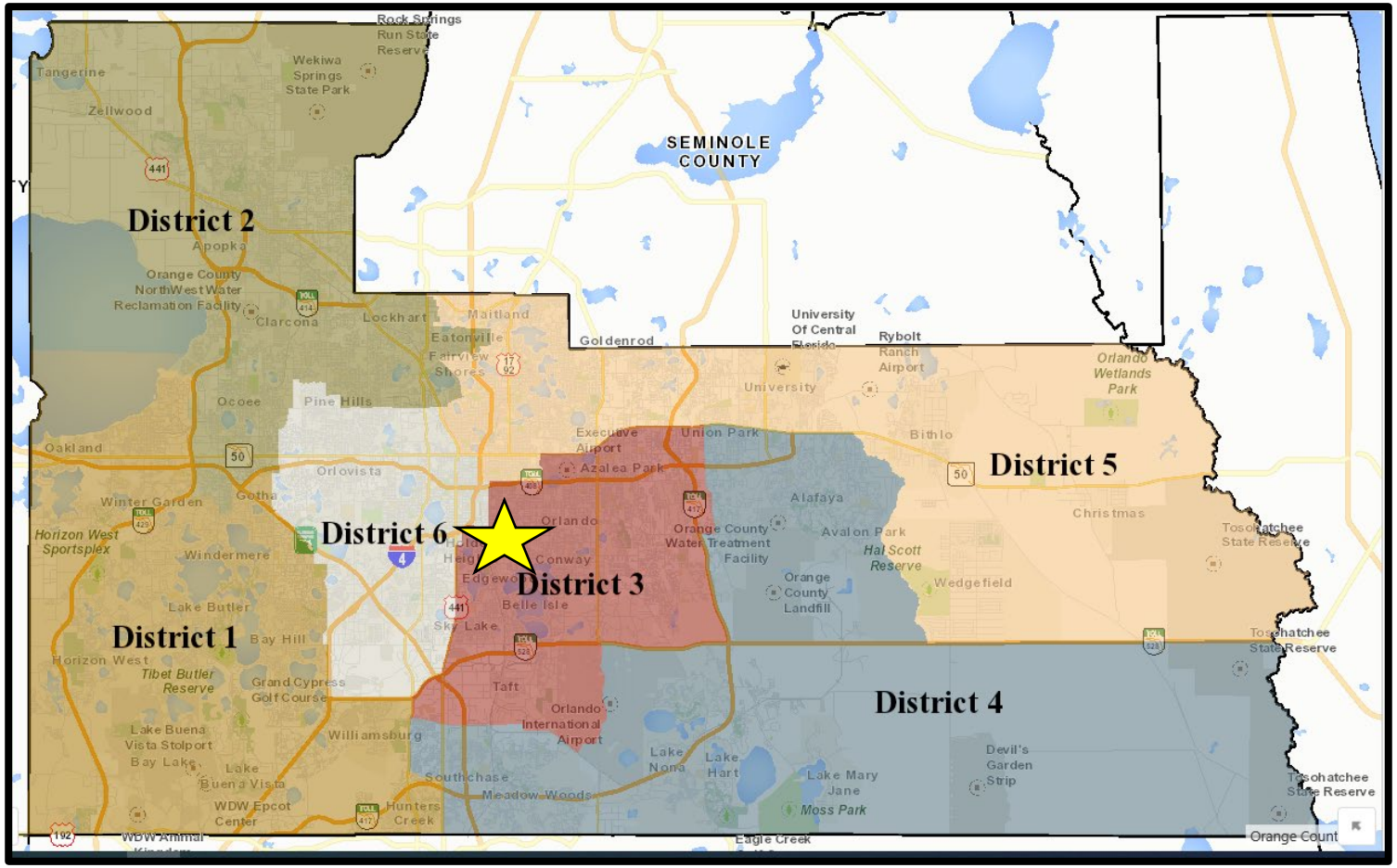
Winter Garden



Winter Park

Orlando

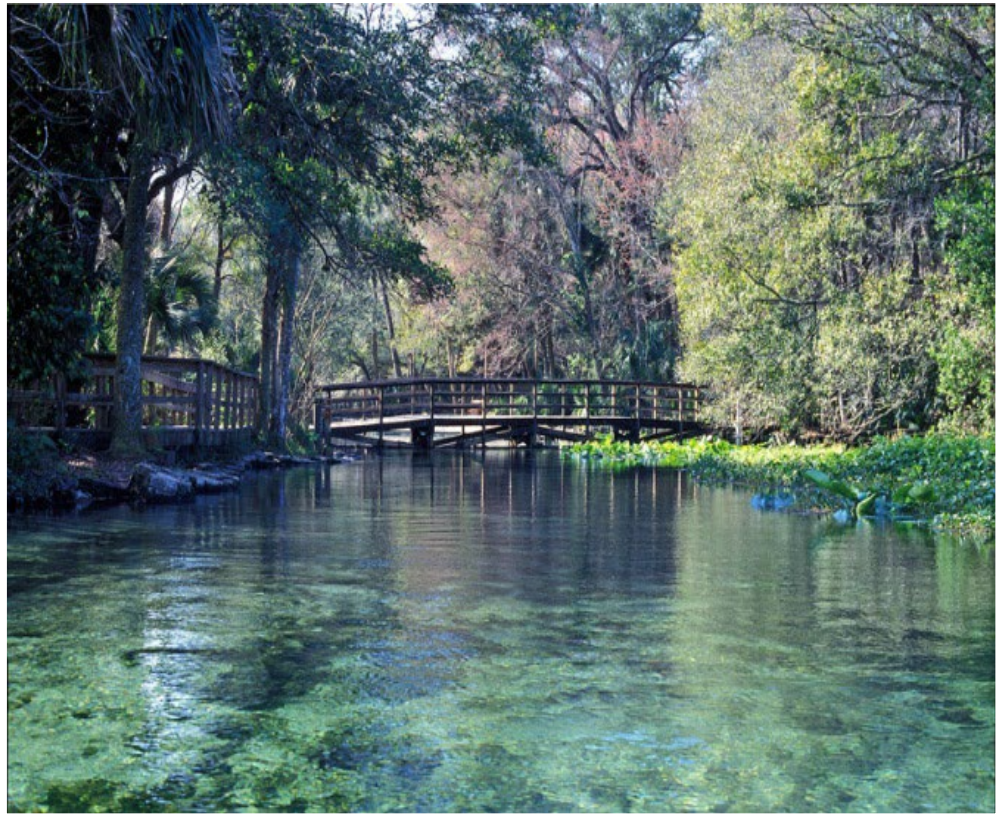
Orange County Districts



ORANGE COUNTY FLORIDA

Orange County Waters

- Orange County waters boast special designations:
  - State Aquatic Preserve
    - Wekiva River
  - National Wild and Scenic River (1 of 2 in Florida)
    - Wekiva River
  - Outstanding Florida Springs
    - Wekiwa and Rock Springs
  - Outstanding Florida Waters
    - Butler Chain of Lakes
    - Econlockhatchee River
    - Wekiva River



Orange County Environmental Protection Division (EPD)

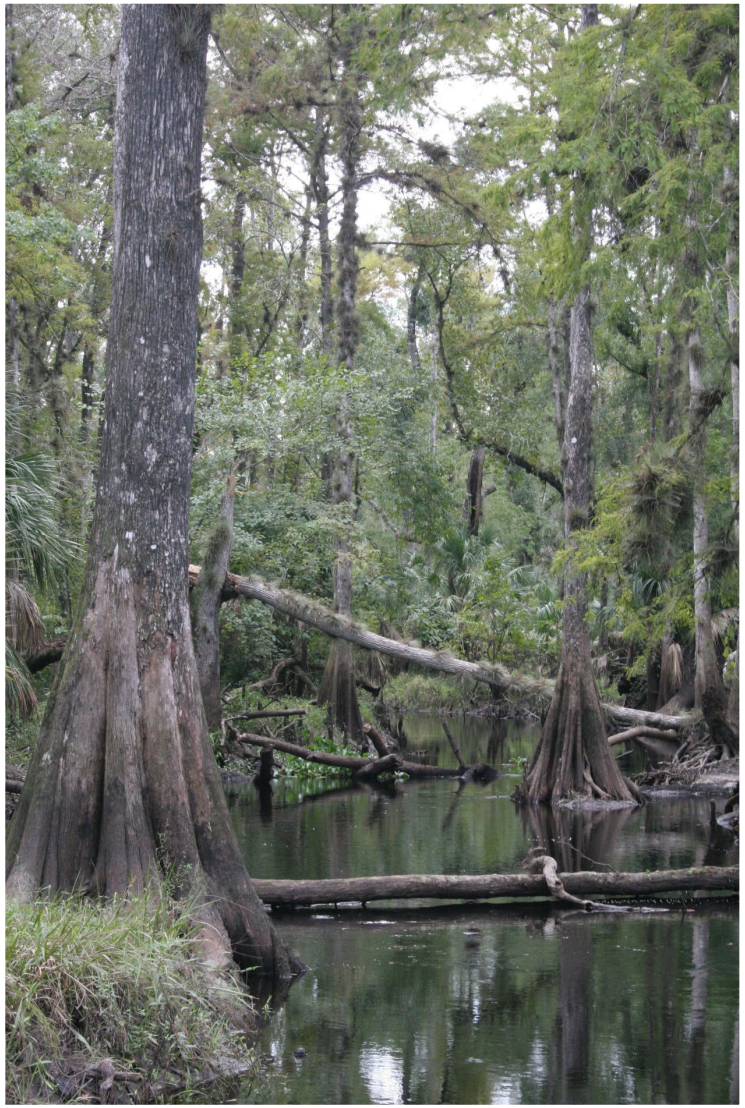
Mission Statement: Orange County's Environmental Protection Division (EPD) works to conserve, protect, and enhance the environment for current and future generations.

There are 13 programs within EPD focused on regulatory compliance, pollution prevention, and environmental stewardship, including:

- Compliance Support & Strategic Engagement
- National Pollutant Discharge Elimination System (NPDES)
- Pollution Prevention & Control
- Solid Waste Permitting & Compliance
- Air Quality Management
- Petroleum Restoration & Brownfields
- Petroleum Storage Tank Compliance
- Development Review
- Natural Resources Compliance & Enforcement
- Natural Resources Permitting
- Green PLACE
- Lake Management
- Water Sciences

EPD Water Sciences Program

- Water Sciences Program helps preserve and restore the quality of freshwater resources in Orange County through water sampling, laboratory analyses and data-driven solutions aimed at identifying, capturing and removing pollutants.
- 13 Full Time Staff
- 2 Interns



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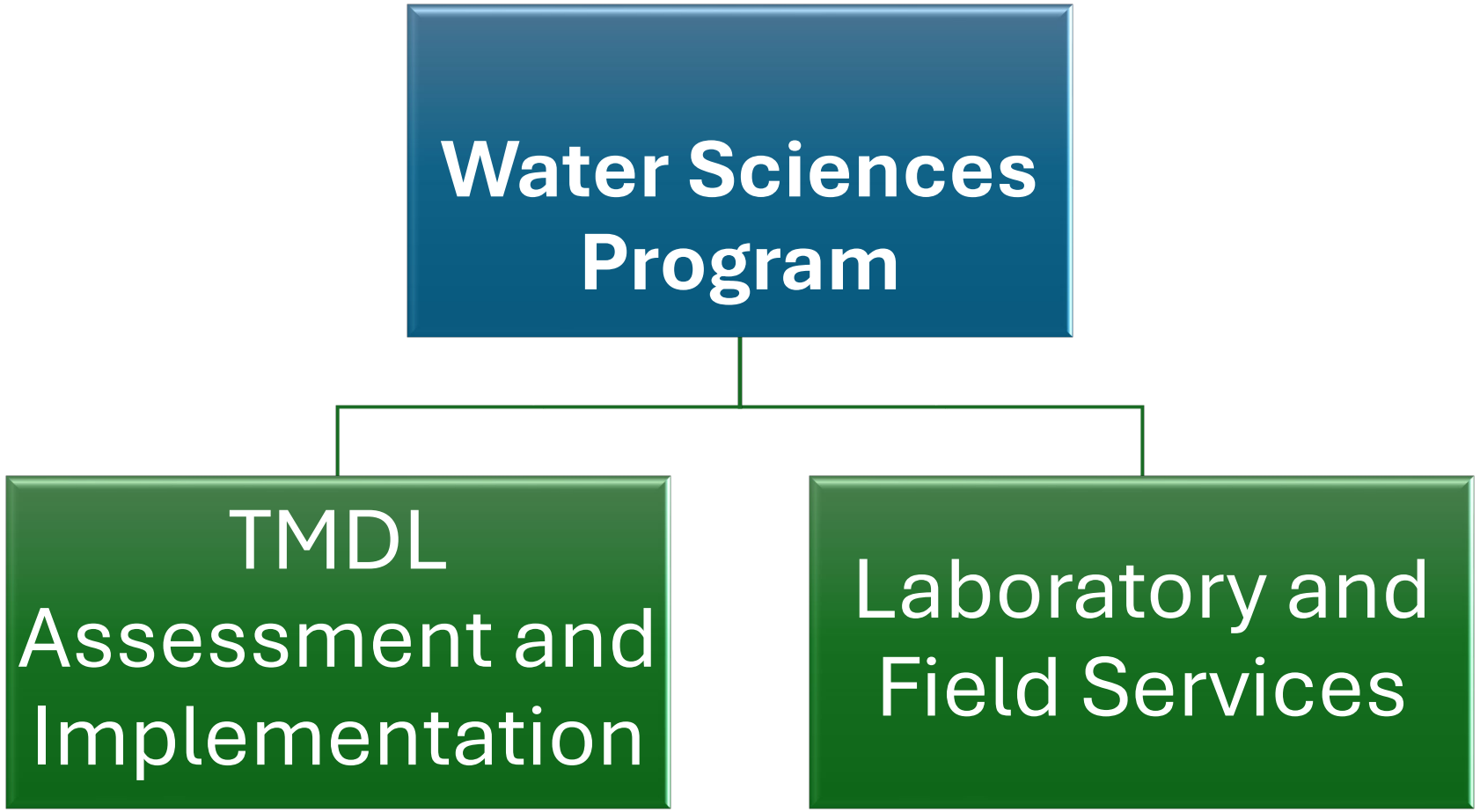
EPD Water Sciences Program



EPD Water Sciences Program: Field Services

Water Quality

Water Sampling

Flow Measurement

Real-Time Monitoring

Fire Rescue Sampling

Special Projects

Biology

- Lake Vegetation Index (LVI)
- Stream Condition Index (SCI)

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EPD Water Sciences Program: Laboratory Analysis

EPD Laboratory Analysis

- E. coli
- Color
- Chlorophyll-a
- Turbidity

Orange County Utilities (OCU) Laboratory Analysis

- All Other Analyses

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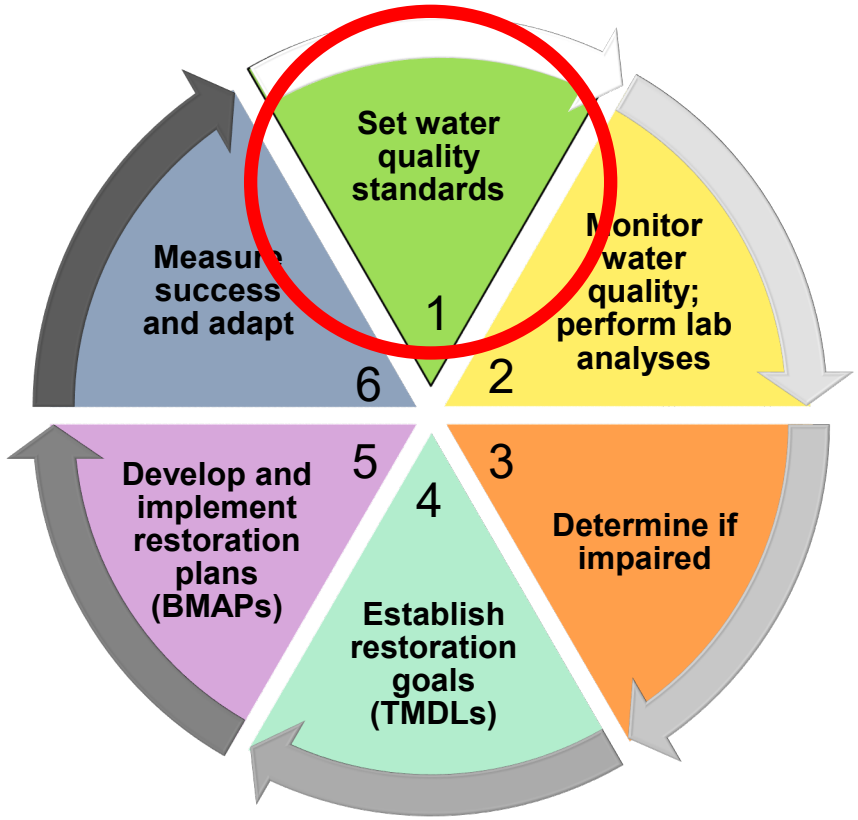
State of Florida TMDL Assessment & Implementation

- What is a TMDL?
  - Total Maximum Daily Load
  - A scientific determination of the maximum amount of a given pollutant that a surface water can absorb and still meet the water quality standards that protect human health and aquatic life.
- What is a BMAP?
  - Basin Management Action Plan
  - A framework for water quality restoration that contains a comprehensive set of solutions to achieve the pollutant reductions established by a TMDL.

State of Florida TMDL/BMAP Program Overview

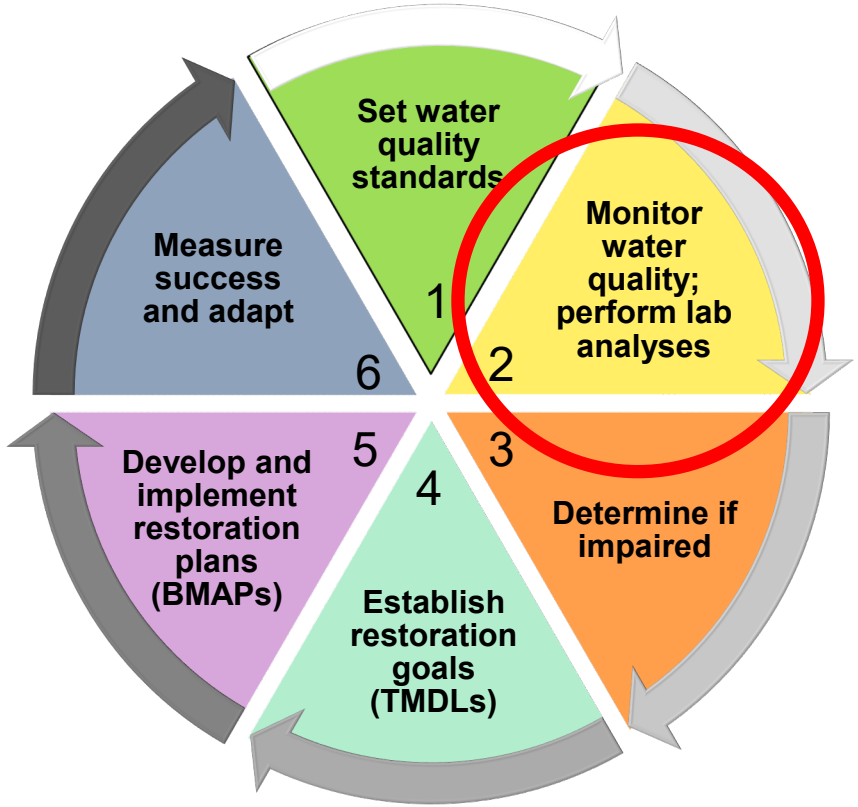
1. State water quality standards (62-302 FAC)
   - Waters of the County (Class III)
     - fishable
     - swimmable
   - Reviewed every 3 years
   - County provides comments



State of Florida TMDL/BMAP Program Overview

2. Water Quality monitoring

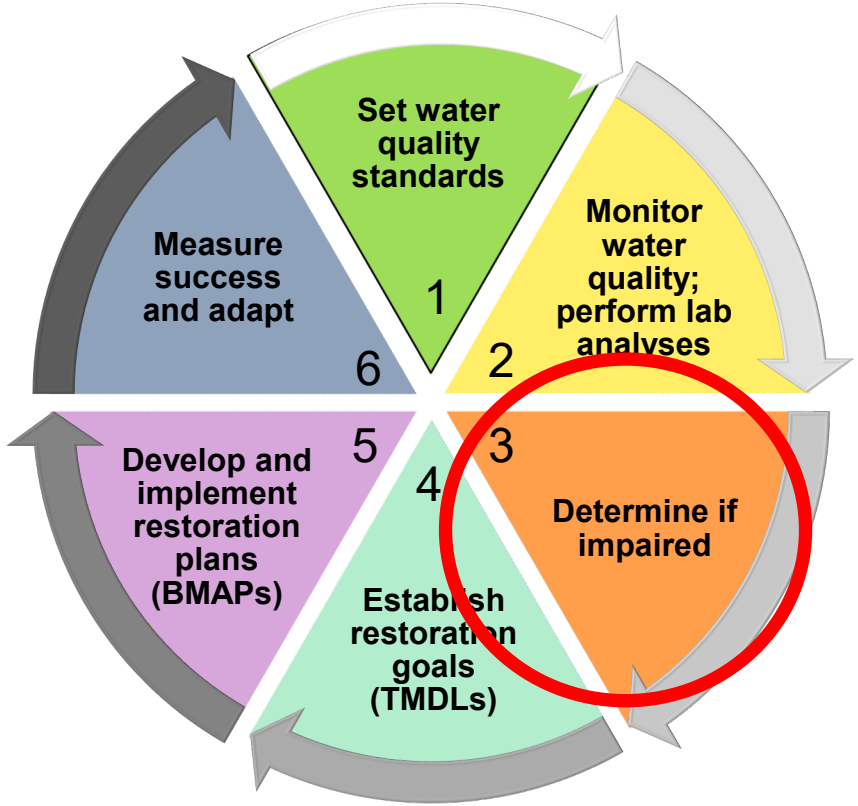
- Began in the 1960s to track pollution from wastewater discharges
- 150+ of ~600 waterbodies sampled quarterly to annually
- Analysis includes nutrients, bacteria, metals, biology, plants/physical properties
- EPD/OCU have Certified labs
- Data submitted to state database (Watershed Information Network; WIN)



State of Florida TMDL/BMAP Program Overview

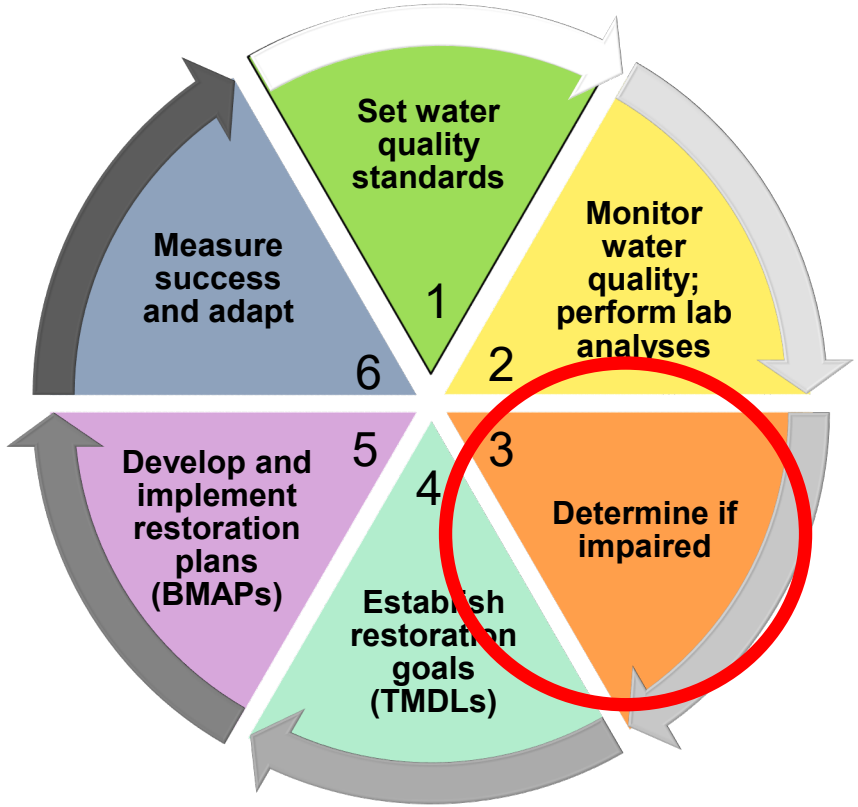
3. Impairment

- FDEP compares data to criteria (Ch 62-302 FAC)
- Stakeholders review draft results
- Impairment lists adopted
- Stakeholders can challenge
- County has 231 impairments on 104 waterbodies
  - Note: includes all parameters assessed using the Impaired Surface Waters Rule (IWR)
- EPD prioritizes impaired waters for assessment



State of Florida TMDL/BMAP Program Overview

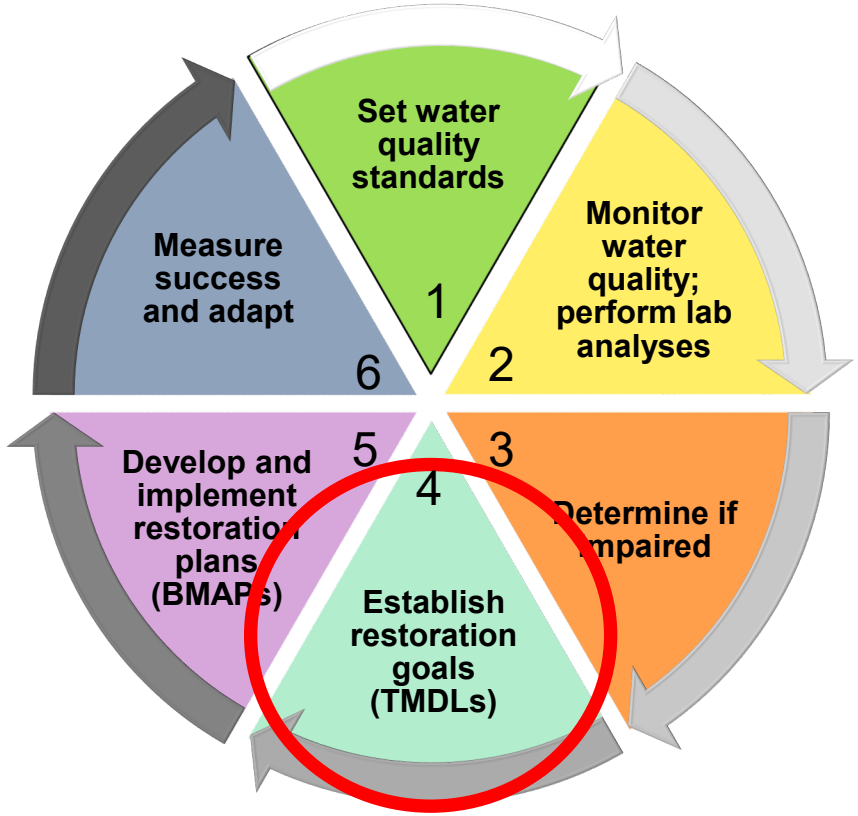
- Assessments:
  - Provide empirical data: site-specific samples and measurements!
  - Hydrologic & Nutrient Budgets
    - Inputs
    - Losses
  - Calculate pollutant loads & residence time
  - Goals
    - Identify/quantify contaminant sources
    - Efficient projects to reduce contaminant load



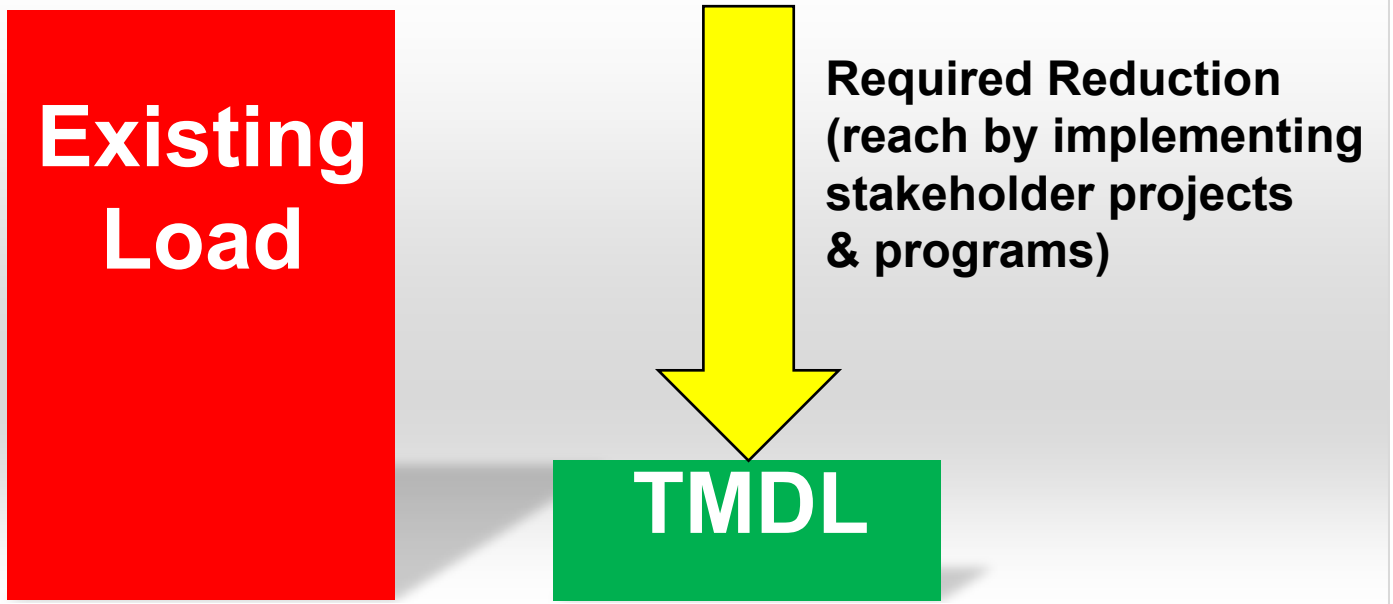
State of Florida TMDL/BMAP Program Overview

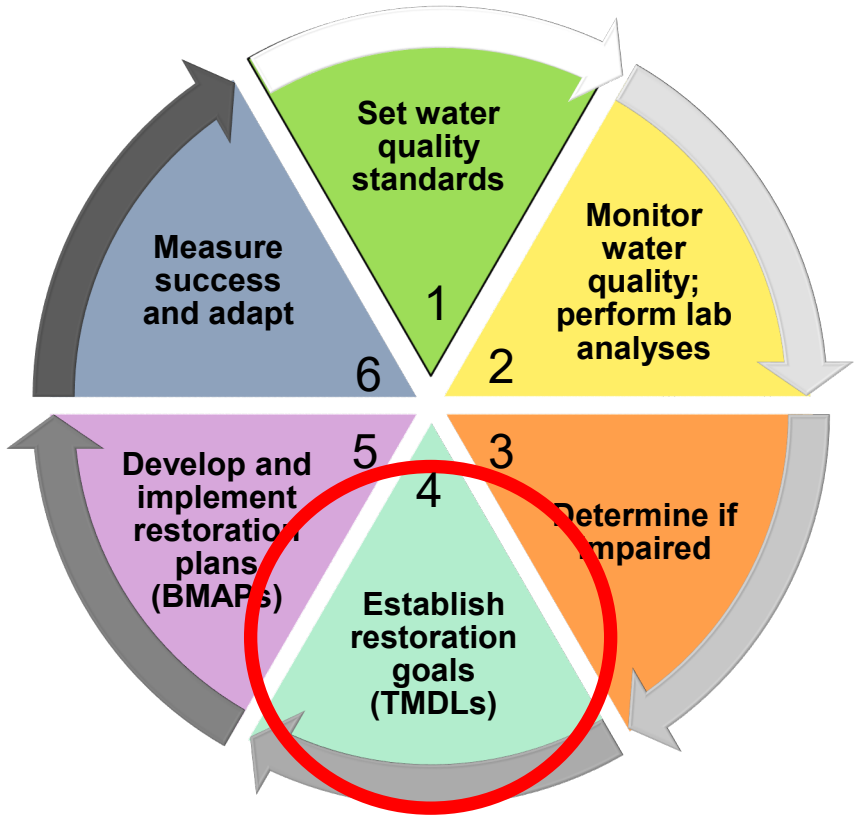
4. Total Maximum Daily Load (TMDL)

- Addresses impairments: usually specific to waterbody/pollutant
- Stakeholder engagement
- Pollutant sources identified
- Models run
  - Existing Load
  - TMDL
  - Difference is Target Reduction



State of Florida TMDL/BMAP Program Overview





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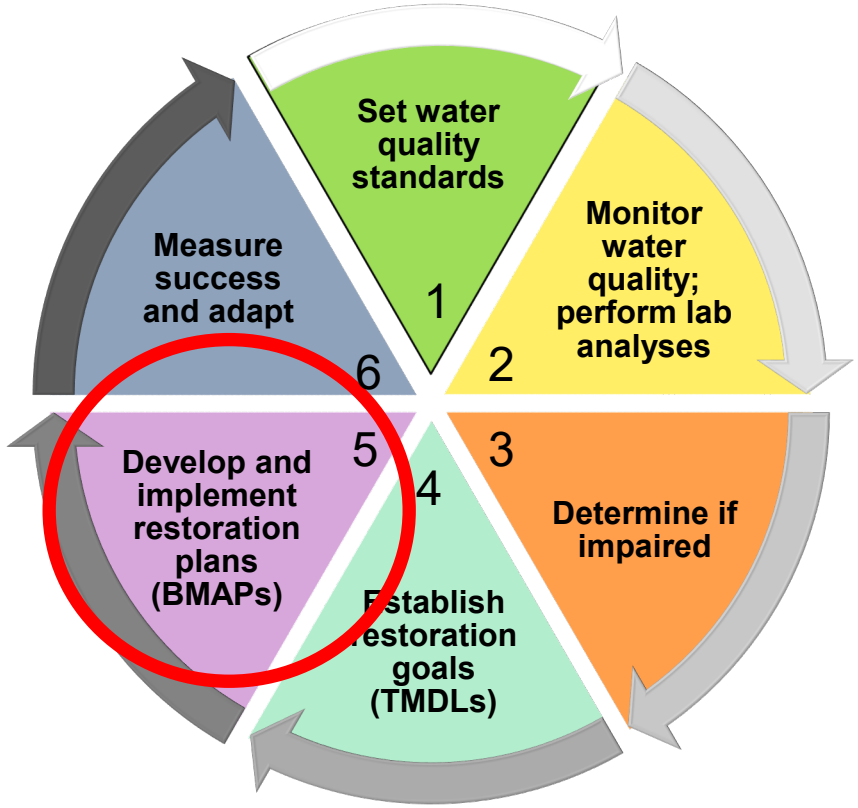
State of Florida TMDL/BMAP Program Overview

5. Basin Management Action Plans (BMAP)

- Cover larger geographic area, long term
- Stakeholders assemble to discuss priorities
- Develop list of projects to meet TMDL(s)
  - CIP ranking includes cost $/lb pollutant removed
  - Partners/grants
- Agree to plan and adopt
- Budget/begin project work
- County has 6 adopted BMAPs



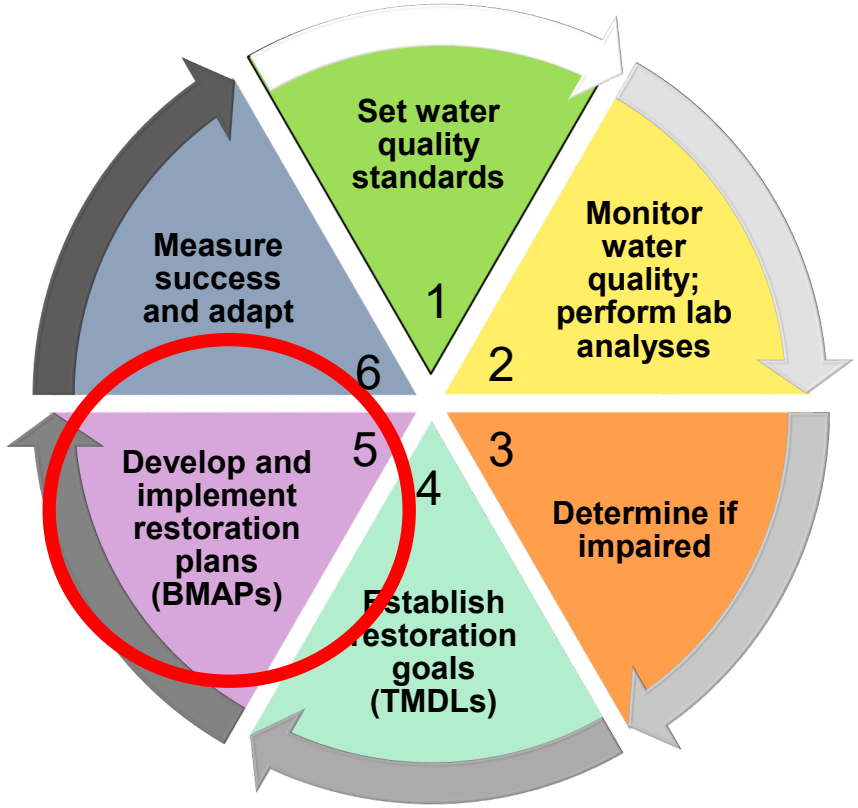
State of Florida TMDL/BMAP Program Overview

- Stakeholders select projects (from assessment):

Structural

Option	Description	TP Removed (kg/yr)	TN Removed (kg/yr)	Cost
1	Harvest Aquatics from Channel Near Stoneybrook Box Culverts (S5)	242	1,129	$142,500
2A	Baffle Boxes w/out Bold and Gold	76	855	$475,000
2B	Baffle Boxes with Bold and Gold	328	2,423	$495,500
3	Artificial Aeration	*NA	*NA	$100,000
4	Improvements to Stakeholder Detention Ponds	8	358	$1,300,000
5	Sediment Inactivation	10.7	*NA	$141,500
6	Sanitary Sewer Installation	*NA	*NA	NA
7	Rear Yard Swales and Berms	10	94	$48,000
8	Remove Floating Vegetation from Lake Shoreline and Install Submersed Vegetation	324	1,505	$112,500
9	Florida Yards and Neighborhoods	*NA	*NA	$93,000
10	Street Sweeping	3	11	$5,400
11	Public Education	*NA	*NA	NA
12	Boating Impacts	*NA	*NA	NA

Non-Structural



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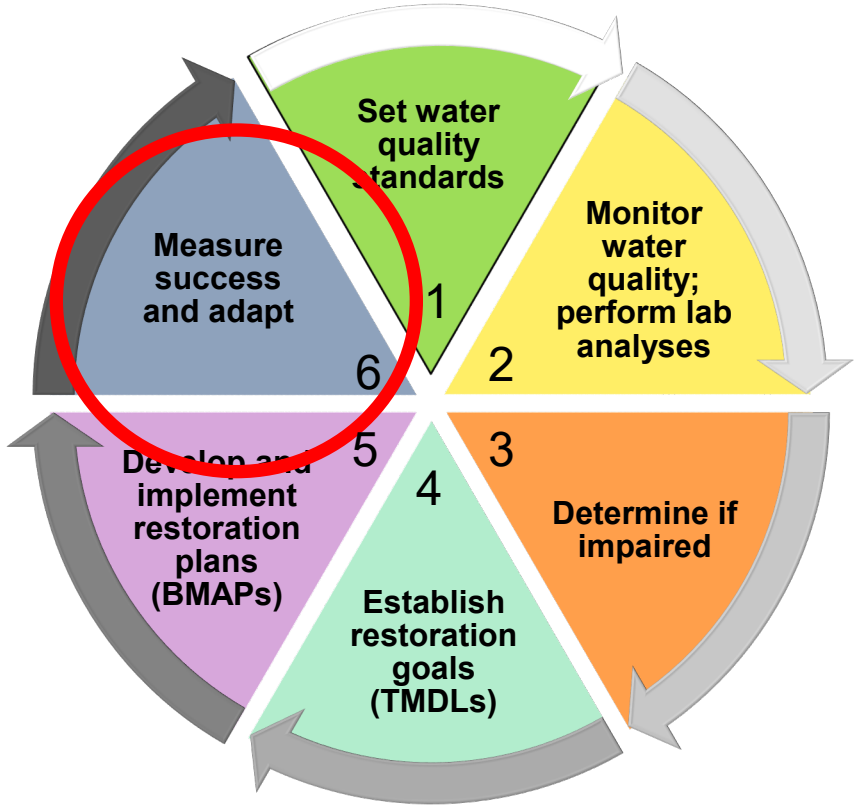
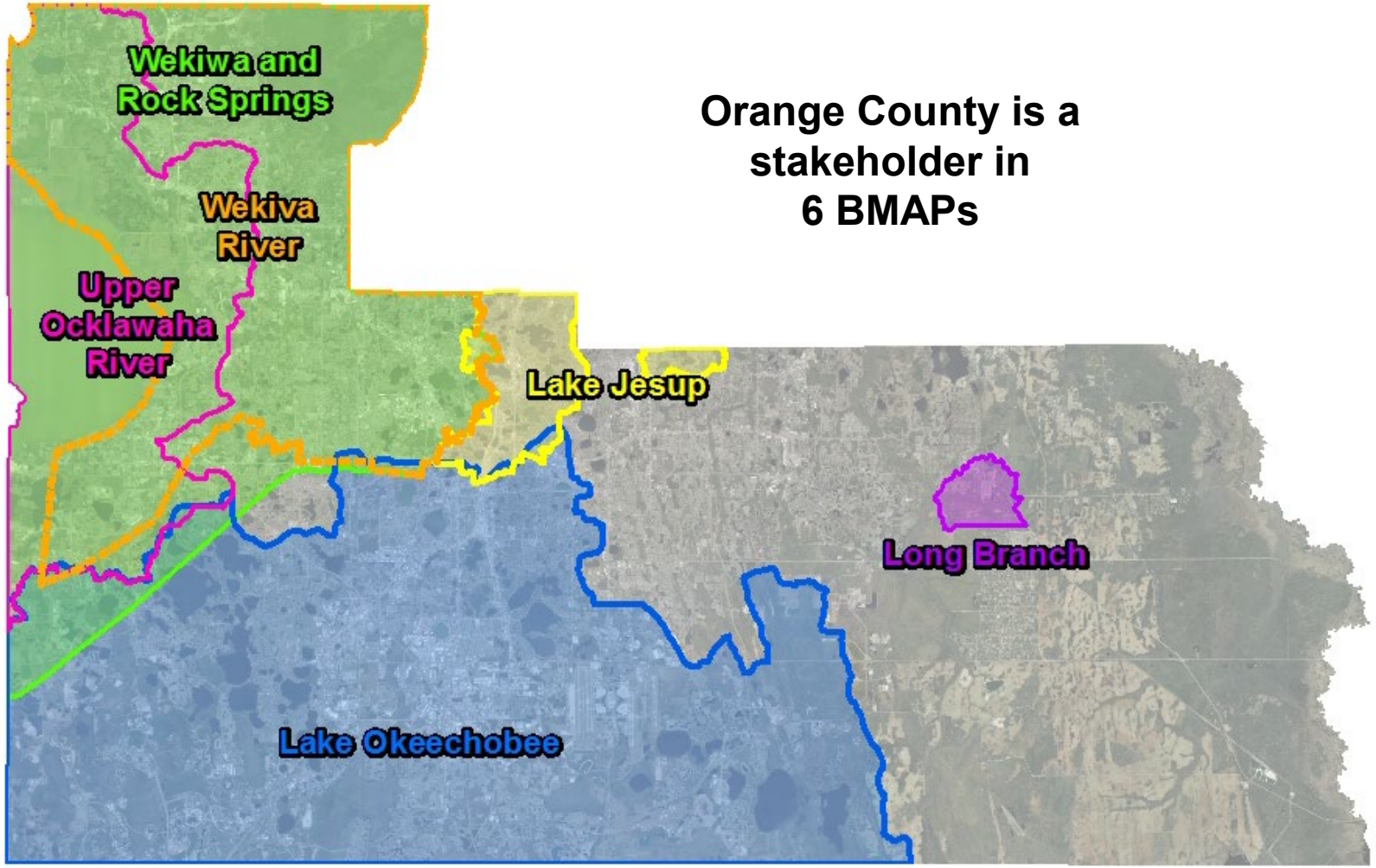
State of Florida TMDL/BMAP Program Overview

6. Measure success

- Evaluate Best management practices (BMP)
- Performance monitoring of BMPs and receiving water quality
- Evaluate and determine list of projects for CIP
- Report to FDEP annually on progress and efficiency of pollutant removals
  - BMAPs
  - NPDES



BMAP Areas in Orange County



Orange County is a stakeholder in 6 BMAPs

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EPD Water Quality Projects

- Groundwater Vulnerability Assessment (GVA)
- Stormwater Treatment
- Nutrient Reduction Projects
- Septic Upgrade Incentive Program
- Sediment Inactivation

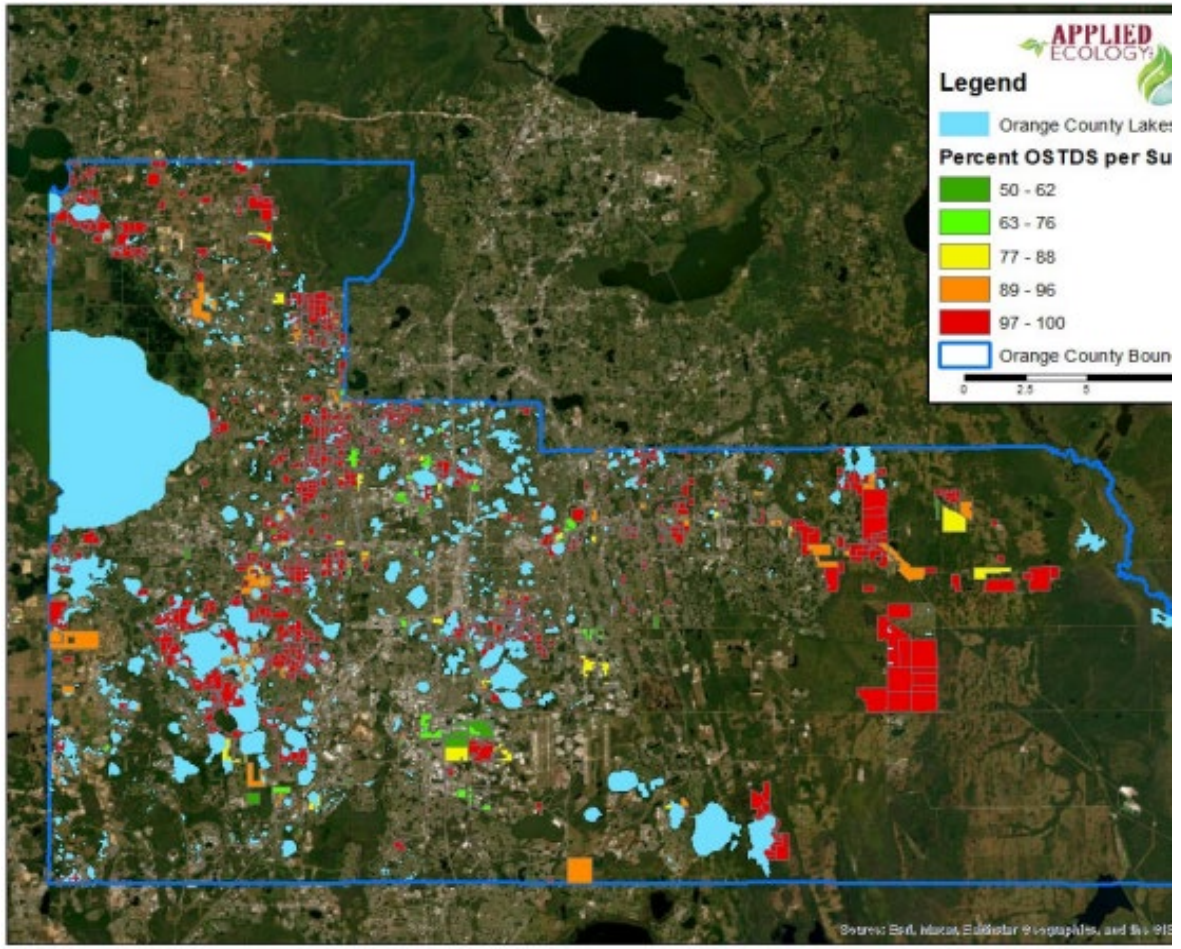

Figure 1. The geographic location of subdivisions with greater than 50% OSTDS with Orange County, Florida.

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EPD Water Quality Project Examples

Modular Wetlands

Alum Treatment

EPD Water Quality Project Examples

Septic Tank Upgrade

Modular Wetland System

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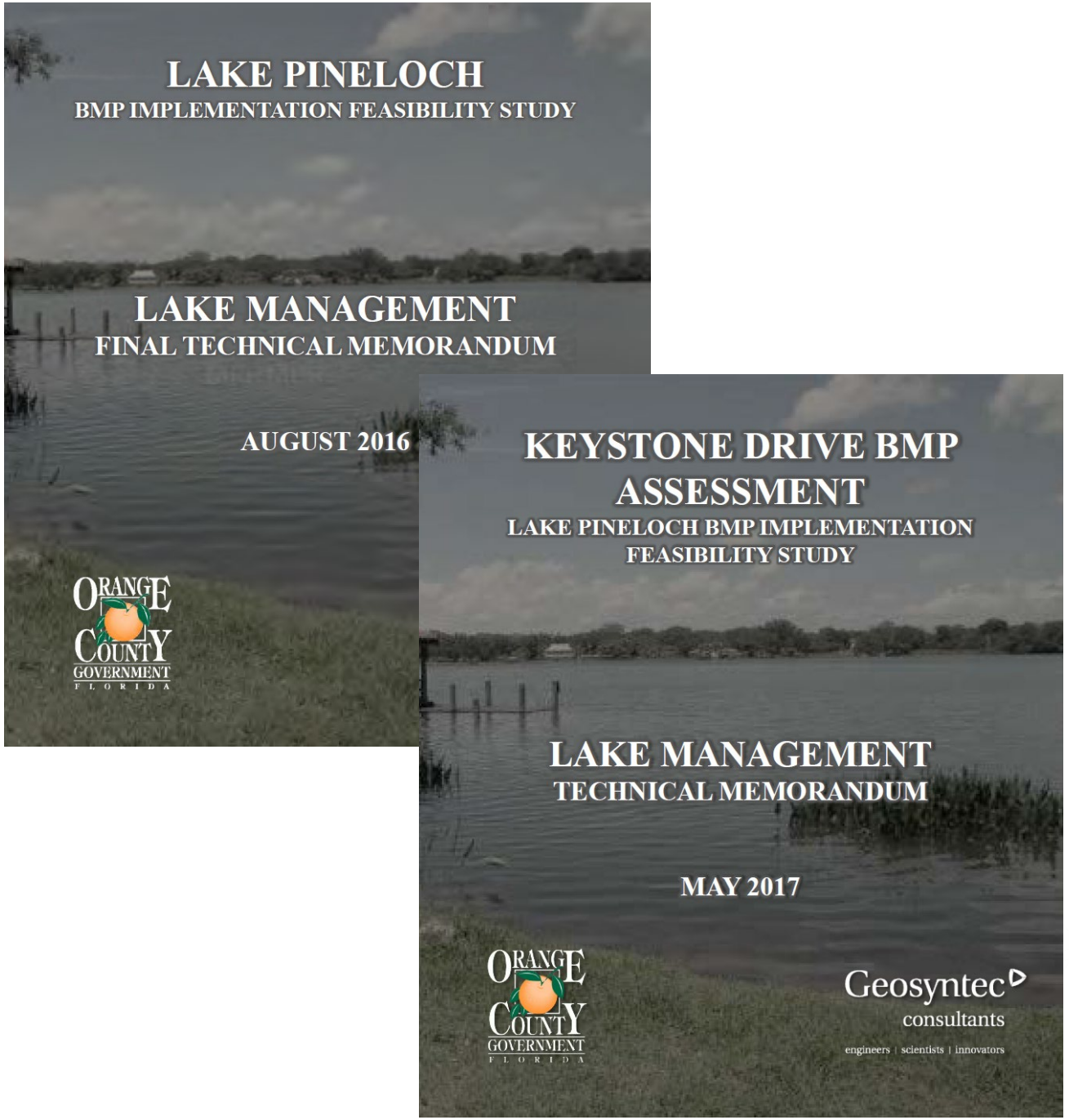
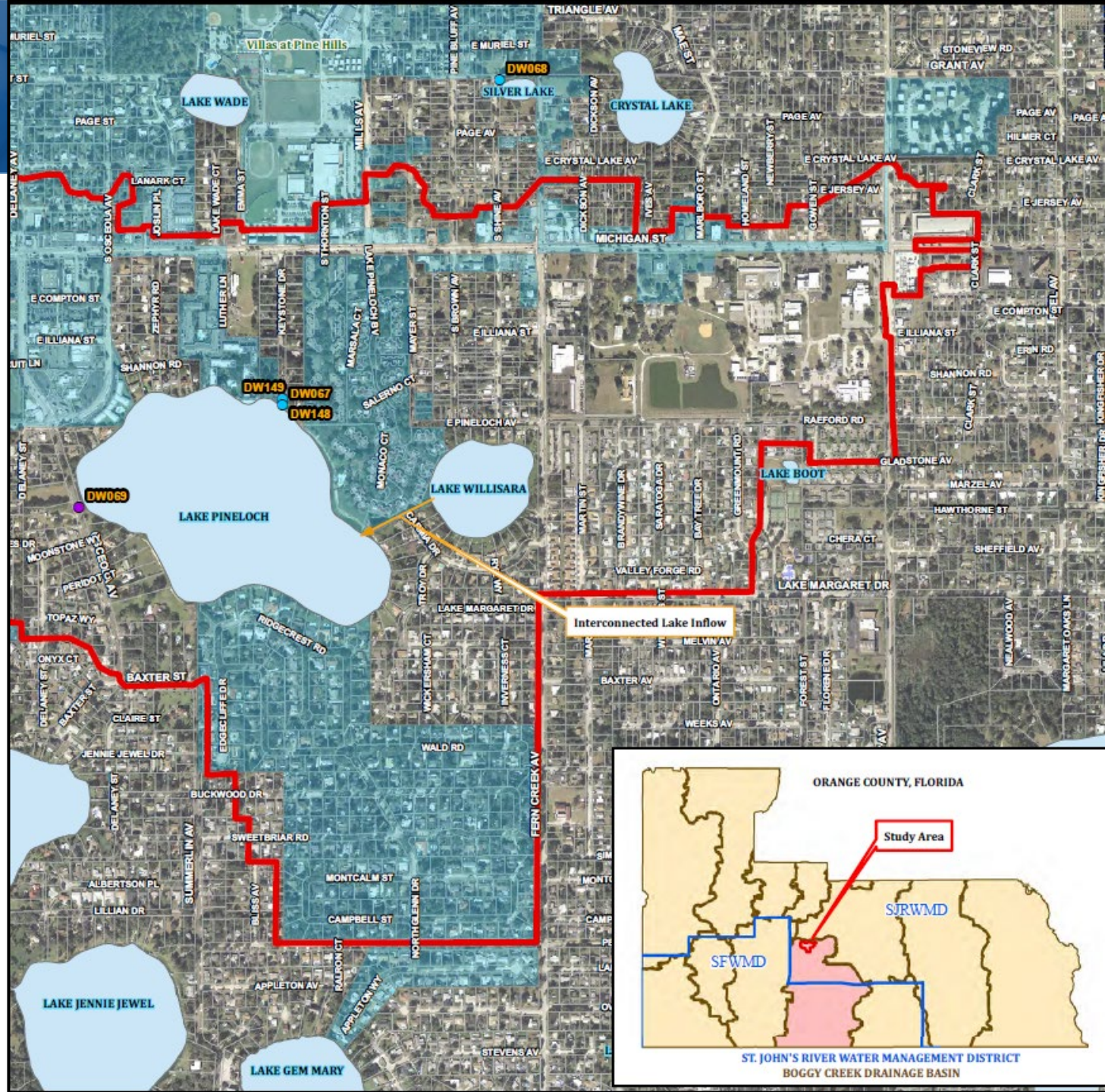
Geosyntec consultants

Background and Feasibility



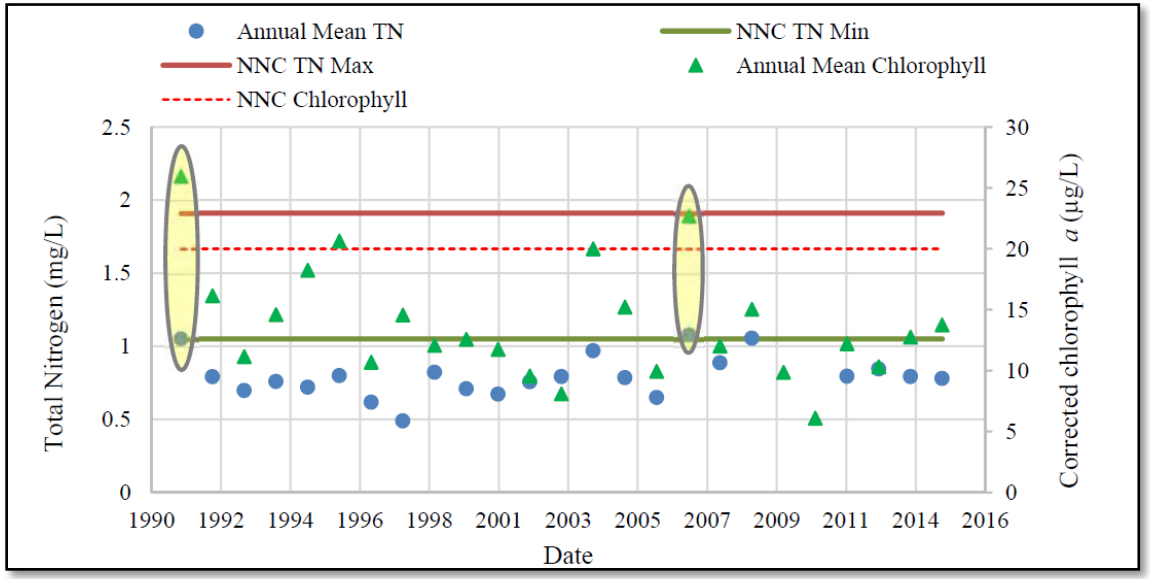
Watershed Assessment – Project Background

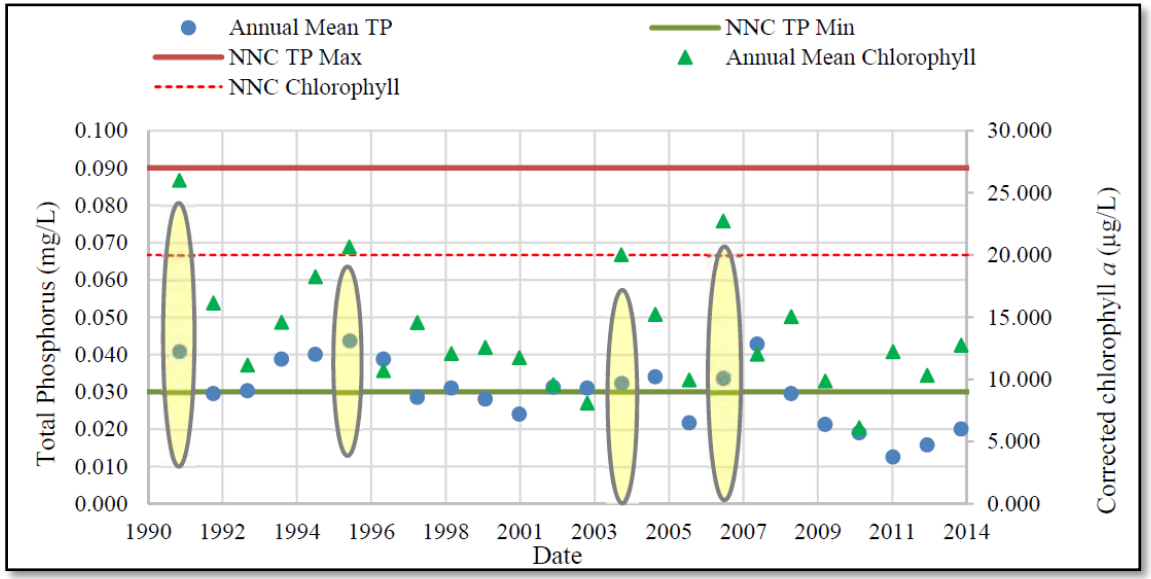
- Lake Pineloch listed by FDEP as nutrient-impaired (TN & TP)
- Located in urban, land-locked watershed within Boggy Creek Basin
- Within the Lake Okeechobee BMAP
- County aims for targeted, high-return nutrient reduction projects



Watershed Assessment – Regulatory Background

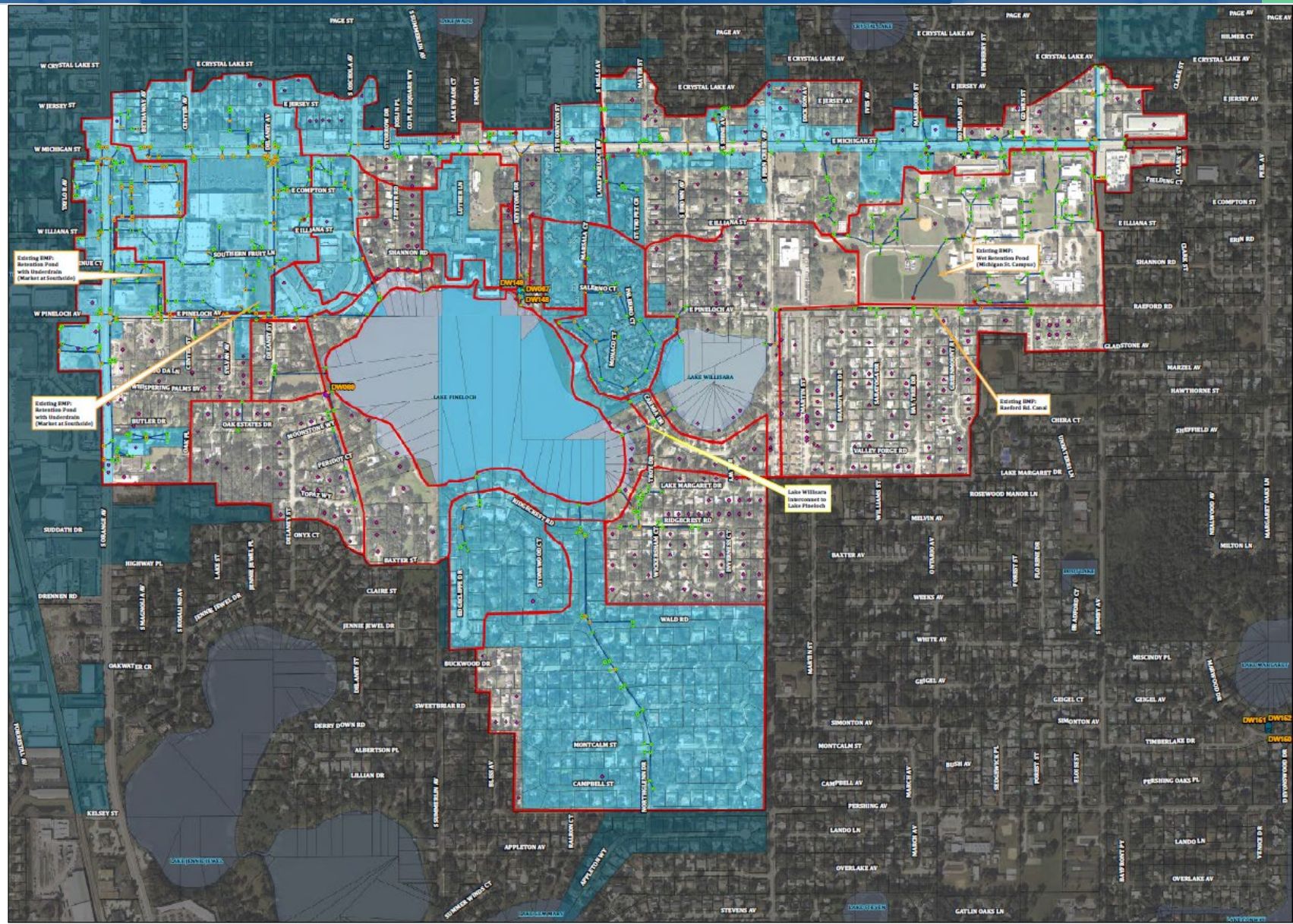
- Numeric Nutrient Criteria high color, high alkalinity
  - Multiple exceedances
- Lake Okeechobee BMAP emphasis on structural nutrient reductions
- County looking for measurable, trackable load reductions





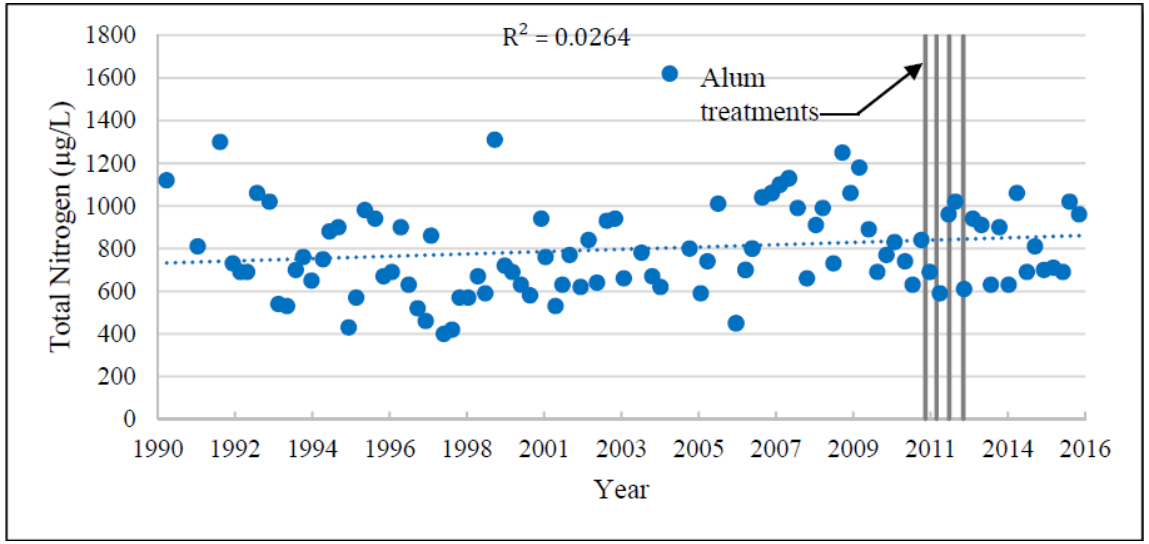
Watershed Assessment – Watershed Characteristics

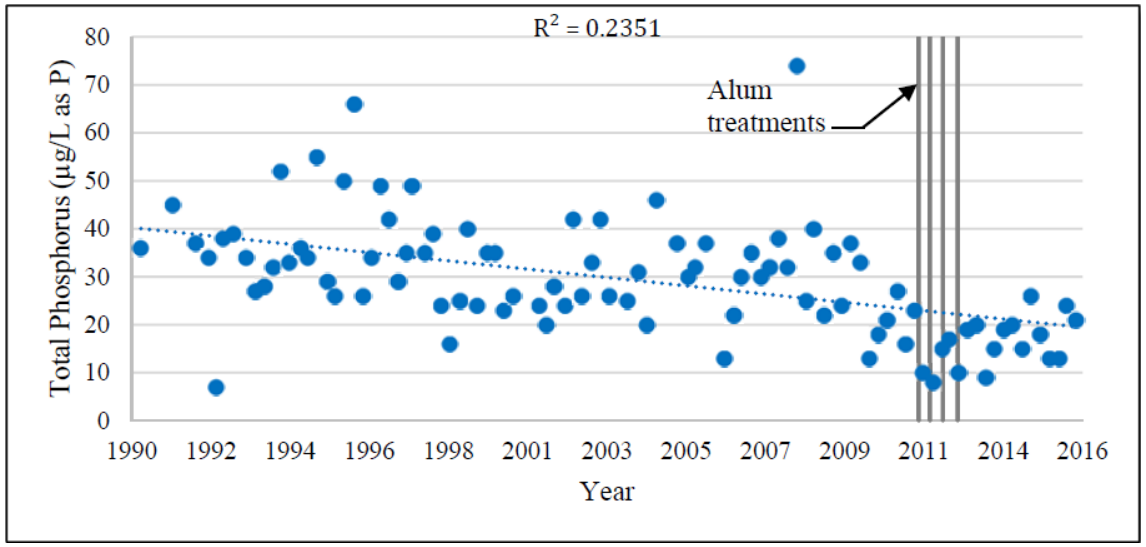
- ~724-acre, fully developed watershed
- 21 drainage subbasins
- Predominantly curb-and-gutter drainage
- Minimal existing water quality treatment
- Multiple direct discharges to Lake Pineloch
- Retrofit solutions required



Watershed Assessment – Water Quality Driver

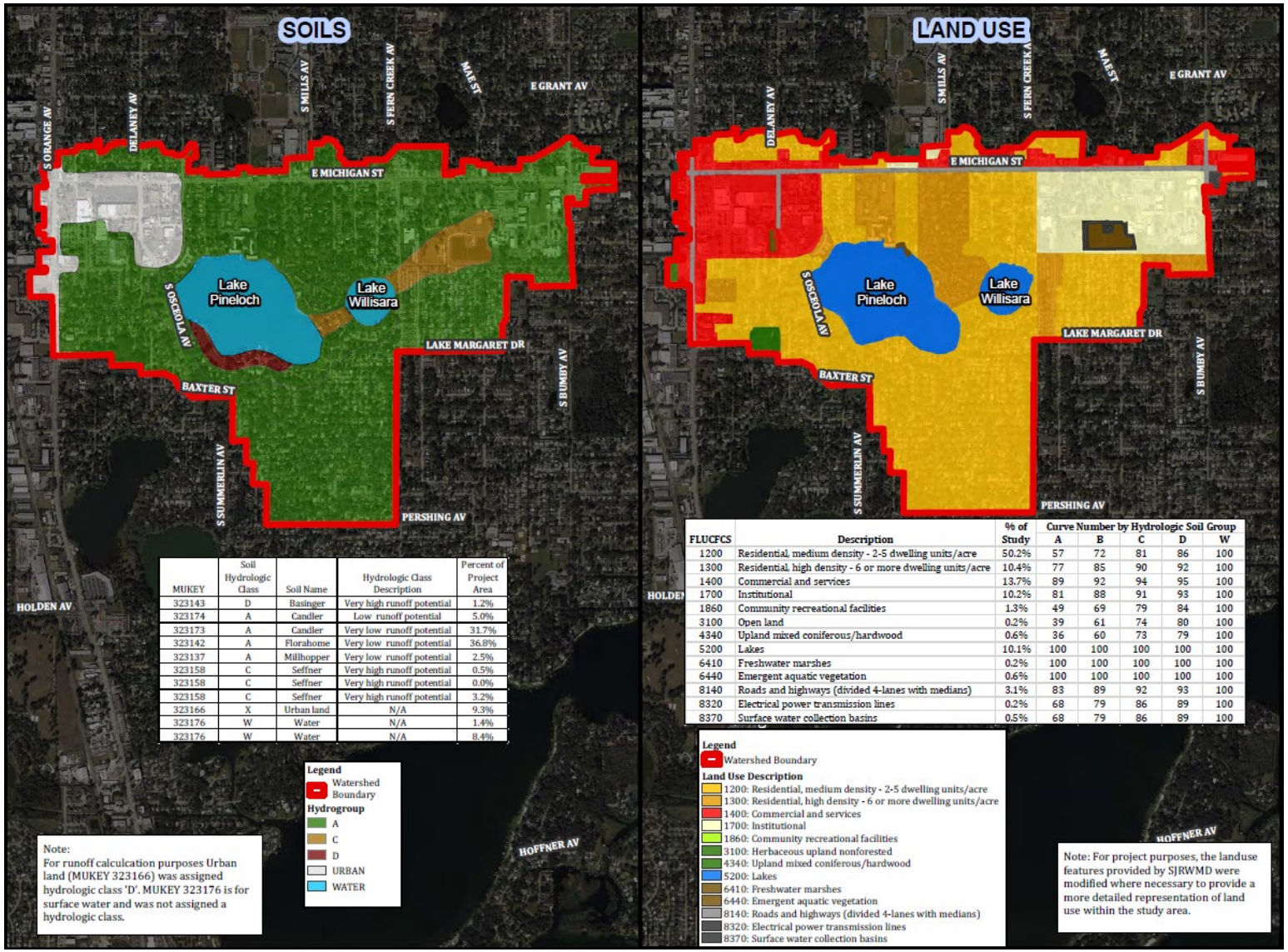
- Historic exceedances of nutrient criteria
- Alum treatment addressed TP but not TN
- TN identified as dominant long-term driver





Watershed Assessment – Assessment Approach

- Review of prior studies and monitoring data
- GIS analysis of land use, soils, imperviousness
- Field reconnaissance of drainage infrastructure

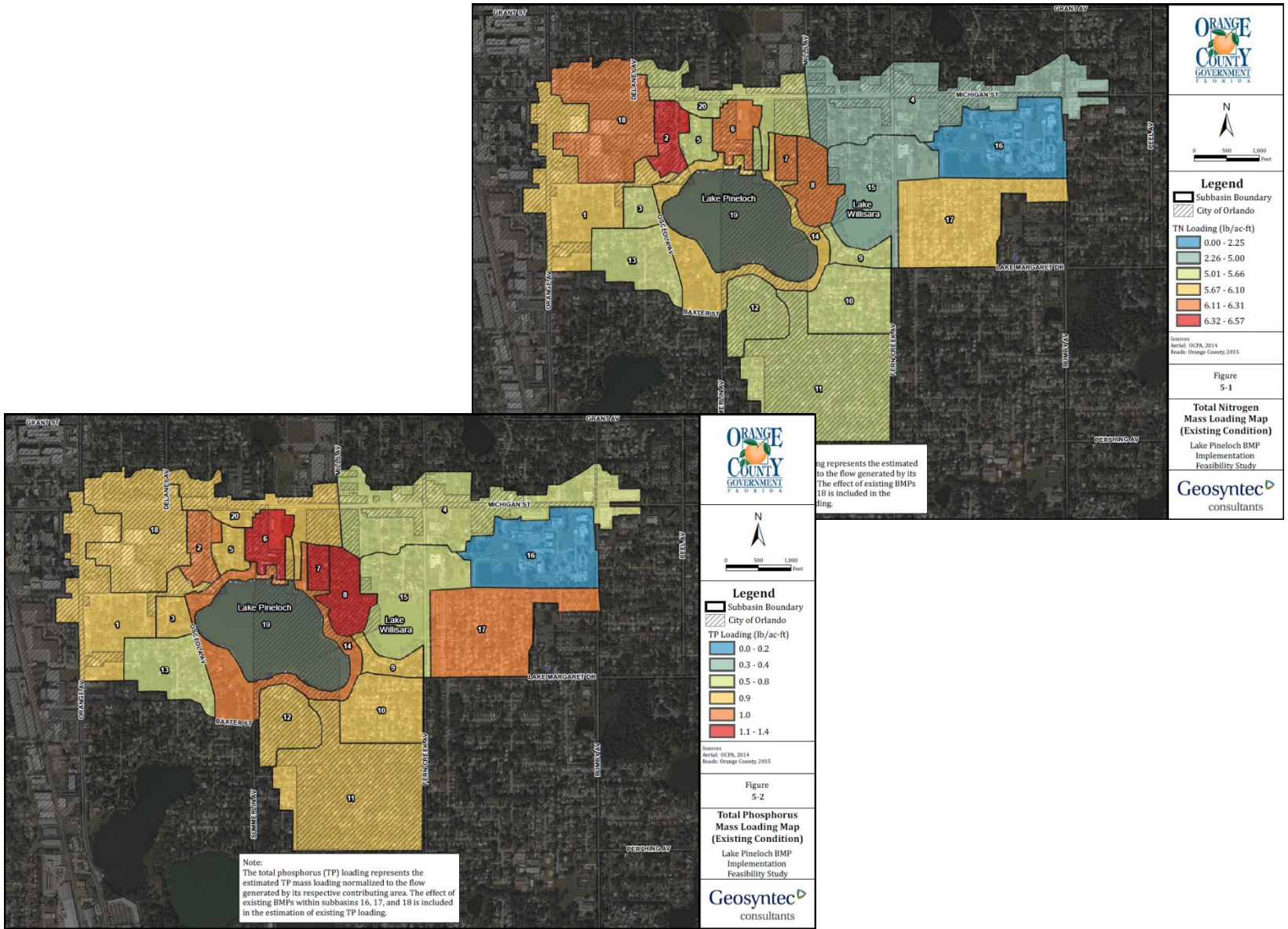


MUKEY	Soil Hydrologic Class	Soil Name	Hydrologic Class Description	Percent of Project Area
323143	D	Basinger	Very high runoff potential	1.2%
323174	A	Candler	Low runoff potential	5.0%
323173	A	Candler	Very low runoff potential	31.7%
323142	A	Florahome	Very low runoff potential	36.8%
323137	A	Millhopper	Very low runoff potential	2.5%
323158	C	Seffner	Very high runoff potential	0.5%
323158	C	Seffner	Very high runoff potential	0.0%
323158	C	Seffner	Very high runoff potential	3.2%
323166	X	Urban land	N/A	9.3%
323176	W	Water	N/A	1.4%
323176	W	Water	N/A	8.4%

FLUCFCS	Description	% of Study	Curve Number by Hydrologic Soil Group A	B	C	D	W
1200	Residential, medium density - 2-5 dwelling units/acre	50.2%	57	72	81	86	100
1300	Residential, high density - 6 or more dwelling units/acre	10.4%	77	85	90	92	100
1400	Commercial and services	13.7%	89	92	94	95	100
1700	Institutional	10.2%	81	88	91	93	100
1860	Community recreational facilities	1.3%	49	69	79	84	100
3100	Open land	0.2%	39	61	74	80	100
4340	Upland mixed coniferous/hardwood	0.6%	36	60	73	79	100
5200	Lakes	10.1%	100	100	100	100	100
6410	Freshwater marshes	0.2%	100	100	100	100	100
6440	Emergent aquatic vegetation	0.6%	100	100	100	100	100
8140	Roads and highways (divided 4-lanes with medians)	3.1%	83	89	92	93	100
8320	Electrical power transmission lines	0.2%	68	79	86	89	100
8370	Surface water collection basins	0.5%	68	79	86	89	100

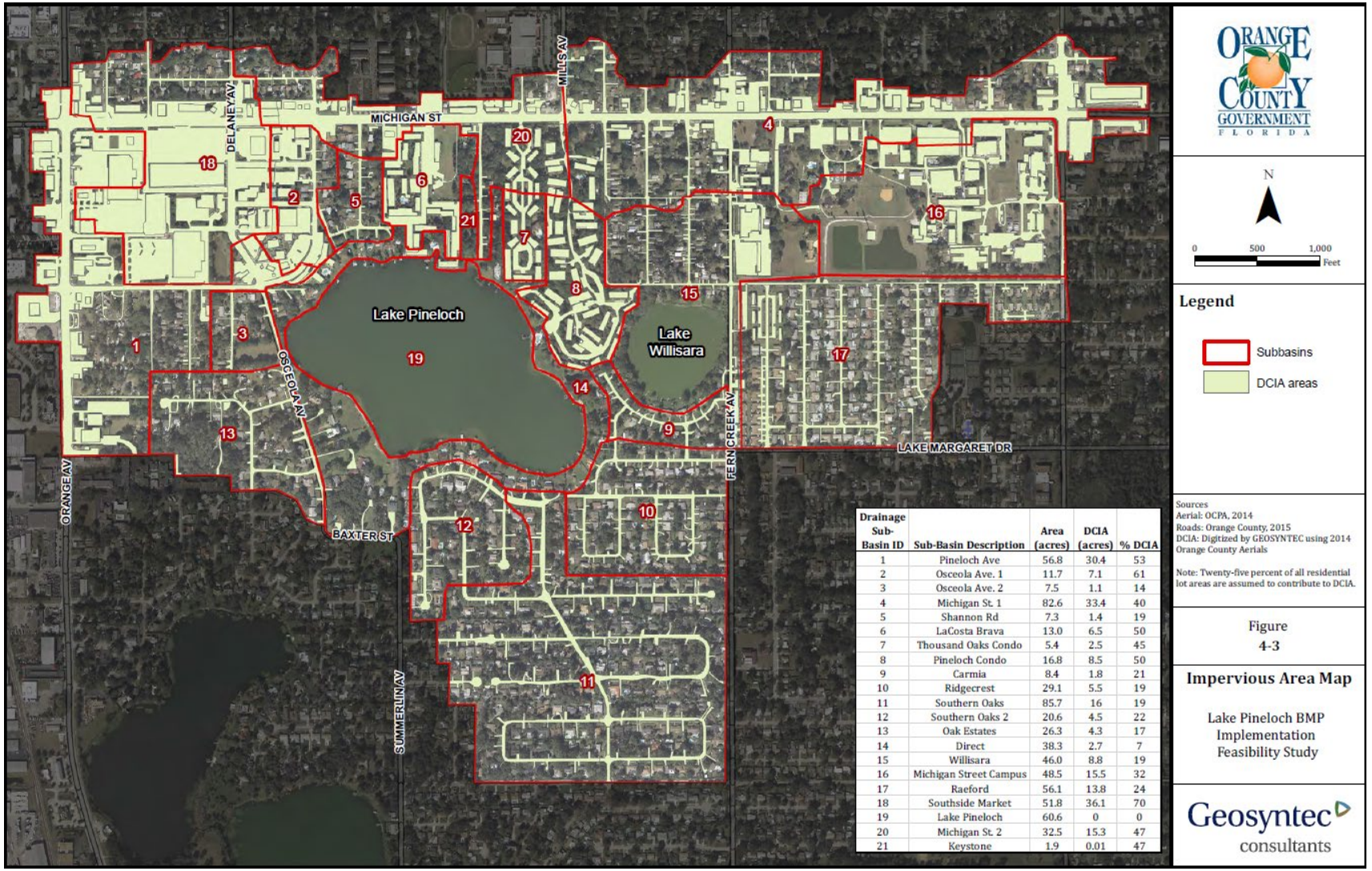
Watershed Assessment – Nutrient Loading Analysis

- Modeled using the BMPTRAINS Model
- Existing condition TN and TP loading quantified
- High-load subbasins identified



Watershed Assessment – Key Existing Conditions Findings

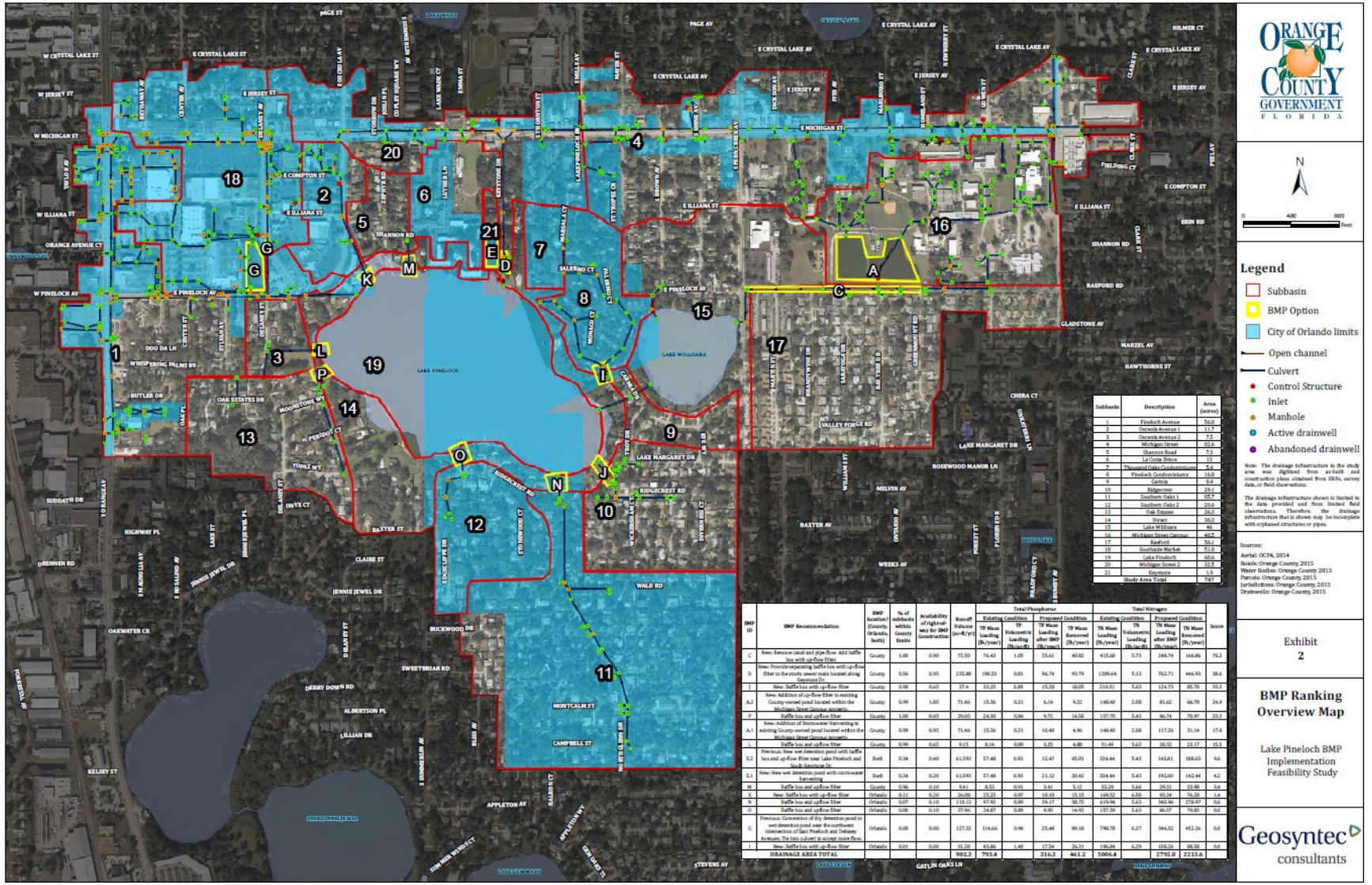
- Urban DCIA is dominant controllable source
- Michigan Street / Keystone drainage among highest contributors



Drainage Sub-Basin ID	Sub-Basin Description	Area (acres)	DCIA (acres)	% DCIA
1	Pineloch Ave	56.8	30.4	53
2	Osceola Ave. 1	11.7	7.1	61
3	Osceola Ave. 2	7.5	1.1	14
4	Michigan St. 1	82.6	33.4	40
5	Shannon Rd	7.3	1.4	19
6	LaCosta Brava	13.0	6.5	50
7	Thousand Oaks Condo	5.4	2.5	45
8	Pineloch Condo	16.8	8.5	50
9	Carmia	8.4	1.8	21
10	Ridgecrest	29.1	5.5	19
11	Southern Oaks	85.7	16	19
12	Southern Oaks 2	20.6	4.5	22
13	Oak Estates	26.3	4.3	17
14	Direct	38.3	2.7	7
15	Willisara	46.0	8.8	19
16	Michigan Street Campus	48.5	15.5	32
17	Raeford	56.1	13.8	24
18	Southside Market	51.8	36.1	70
19	Lake Pineloch	60.6	0	0
20	Michigan St. 2	32.5	15.3	47
21	Keystone	1.9	0.01	47

Watershed Assessment – BMP Identification

- Identified and evaluated 15 structural BMP concepts
- Focus on retrofit BMPs
- Baffle boxes, up-flow filters, wet detention



Watershed Assessment – Screening Criteria and Ranking

- Nutrient reduction effectiveness
- Cost and benefit-cost
- Right-of-way and constructability
- Top candidates identified

BMP ID	BMP Recommendation	BMP location? (County, Orlando, both)	% of subbasin within County limits	Availability of right-of-way for BMP Construction	Runoff Volume (ac-ft/yr)	Total Phosphorus				Total Nitrogen				Score
						Existing Condition		Proposed Condition		Existing Condition		Proposed Condition		
						TP Mass Loading (lb/year)	TP Volumetric Loading (lb/ac-ft)	TP Mass Loading after BMP	TP Mass Removed (lb/year)	TN Mass Loading (lb/year)	TN Volumetric Loading (lb/ac-ft)	TN Mass Loading after BMP	TN Mass Removed (lb/year)	
C	New: Remove canal and pipe flow. Add baffle box with an up-flow filter.	County	1.00	0.90	72.50	76.43	1.05	35.61	40.82	415.60	5.73	248.74	166.86	70.2
D	New: Provide nutrient separating baffle box with an up-flow filter to the storm sewer main located along Keystone Dr.	County	0.56	0.95	235.88	190.53	0.81	96.74	93.79	1209.64	5.13	762.71	446.93	38.6
J	New: Baffle box with an up-flow filter	County	0.98	0.65	37.4	33.25	0.89	15.20	18.05	210.51	5.63	124.73	85.78	33.3
A.2	New: Addition of an up-flow filter to existing County-owned pond located within the Michigan Street Campus property.	County	0.99	1.00	71.46	15.36	0.21	6.14	9.22	148.40	2.08	81.62	66.78	24.9
P	Baffle box and upflow filter	County	1.00	0.65	29.05	24.30	0.84	9.72	14.58	157.70	5.43	86.74	70.97	23.3
A.1	New: Addition of Stormwater Harvesting to existing County-owned pond located within the Michigan Street Campus property.	County	0.99	0.95	71.46	15.36	0.21	10.40	4.96	148.40	2.08	117.26	31.14	17.0
L	Baffle box and upflow filter	County	0.99	0.65	9.15	8.14	0.89	3.25	4.88	51.49	5.63	28.32	23.17	15.5
E.2	Previous: New wet detention pond with baffle box and an up-flow filter near Lake Pineloch and South Keystone Dr.	Both	0.34	0.40	61.593	57.48	0.93	12.47	45.01	334.44	5.43	145.81	188.63	9.6
E.1	New: New wet detention pond with stormwater harvesting	Both	0.34	0.20	61.593	57.48	0.93	21.12	20.42	334.44	5.43	192.00	142.44	4.2
M	Baffle box and upflow filter	County	0.96	0.10	9.41	8.53	0.91	3.41	5.12	53.29	5.66	29.31	23.98	3.4
K	New: Baffle box with an up-flow filter	Orlando	0.11	0.20	26.08	25.25	0.97	10.10	15.15	169.52	6.50	93.24	76.28	1.4
N	Baffle box and upflow filter	Orlando	0.07	0.10	110.13	97.92	0.89	39.17	58.75	619.94	5.63	340.96	278.97	0.6
O	Baffle box and upflow filter	Orlando	0.00	0.10	27.96	24.87	0.89	9.95	14.92	157.39	5.63	86.57	70.83	0.0
G	Previous: Conversion of dry detention pond to wet detention pond near the northwest intersection of East Pineloch and Delaney Avenues. Tie into culvert to accept more flow.	Orlando	0.00	0.00	127.32	114.66	0.90	25.48	89.18	798.78	6.27	346.52	452.26	0.0
I	New: Baffle box with an up-flow filter	Orlando	0.01	0.00	31.28	43.86	1.40	17.54	26.31	196.84	6.29	108.26	88.58	0.0
DRAINAGE AREA TOTAL					**982.3**	**793.4**		**316.3**	**461.2**	**5006.4**		**2792.8**	**2213.6**	

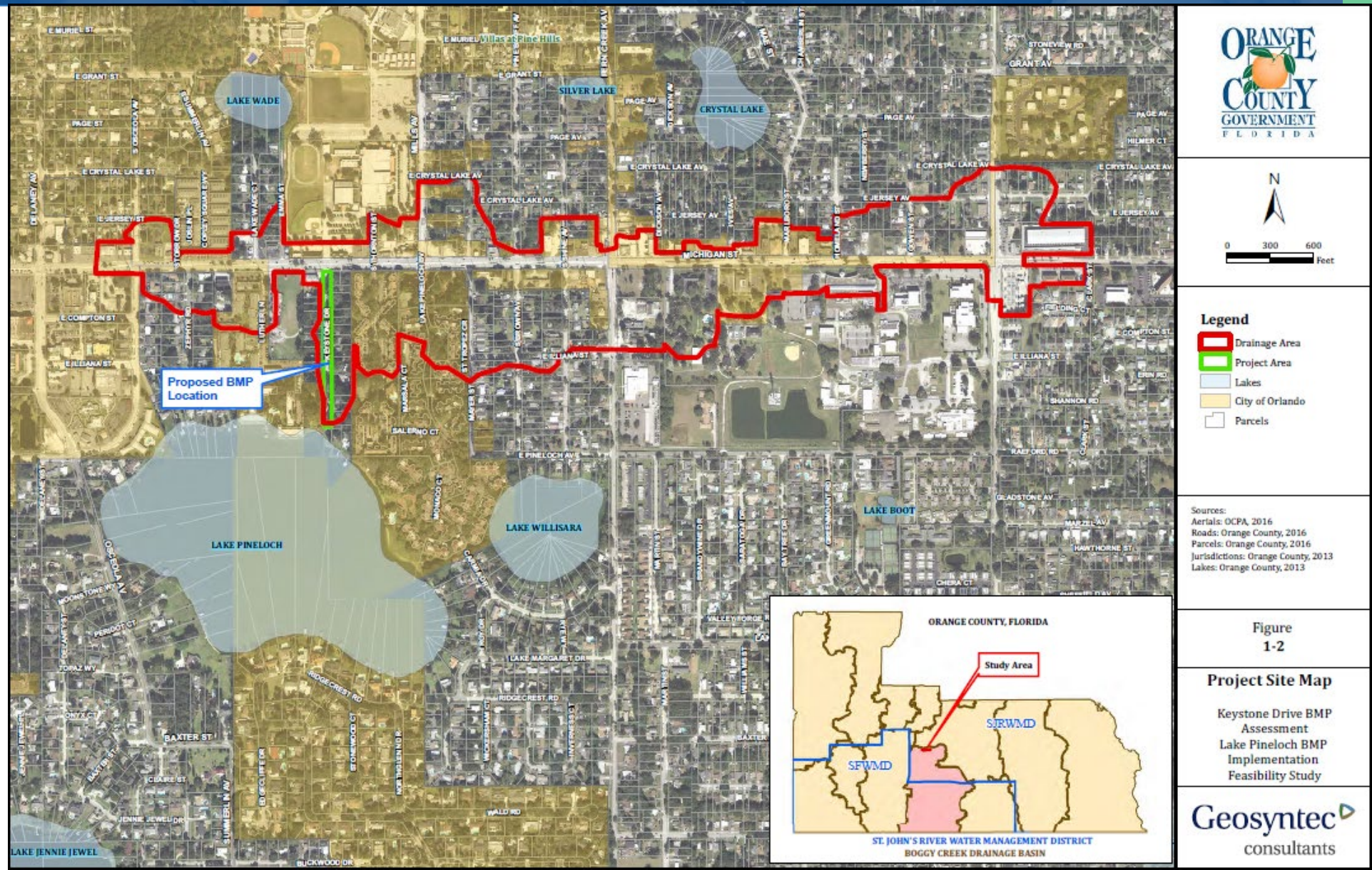
Watershed Assessment – Project Selection

- Narrowed down to 2 projects
- Final project NSBB with offline upflow filter along Keystone Drive
- Direct untreated discharge to Lake Pineloch
- ~109 acres of highly impervious drainage area
- Strong benefit-cost performance

Parameter	Proposed BMP Option #1 (BMP C – Raeford Rd)	Proposed BMP Option #2 (BMP D – Keystone Dr)
Water Quality Improvement	TP Mass Removed = 40.8 lb/yr TN Mass Removed = 166.4 lb/yr	TP Mass Removed = 93.8 lb/yr TN Mass Removed = 446.9 lb/yr
Objective	Improve water quality, aesthetics, and safety	Improve water quality
Utility Conflict Issues	Existing 75' easement consisting of canal and Raeford Road; dewatering and erosion control needed	Existing 25' easement on Keystone Drive; dewatering and erosion control needed
SJRWMD Permitting	Standard General Stormwater ERP (40C-42) likely needed; pre-application meeting with SJRWMD encouraged	Standard General Stormwater ERP (40C-42) likely needed; pre-application meeting with SJRWMD encouraged
Maintenance	Normal routine maintenance for storm sewer piping and shallow swale. Mowing required; manufacturer recommends quarterly maintenance on baffle box to keep clear of solids and media replacement every two years	Manufacturer recommends quarterly maintenance on baffle box to keep clear of solids and media replacement every two years
Cost	$1,042,993	$383,364
Property Acquisition	The existing right-of-way is sufficient for pipe and baffle box installation	The existing right-of-way is sufficient for pipe and baffle box installation
Public Acceptance	Increased public acceptance because of enhanced safety and aesthetics; BMP structure will be installed below grade	BMP structure will be installed below grade so that it is not visible
Flood Abatement	The baffle box will be designed with a bypass for high flow events to prevent flooding	The baffle box will be designed with a bypass for high flow events to prevent flooding
Benefit Cost	TP: $455 per lb-ac subbasin treated TN: $111 per lb-ac subbasin treated	TP: $36 per lb-ac subbasin treated TN: $7 per lb-ac subbasin treated

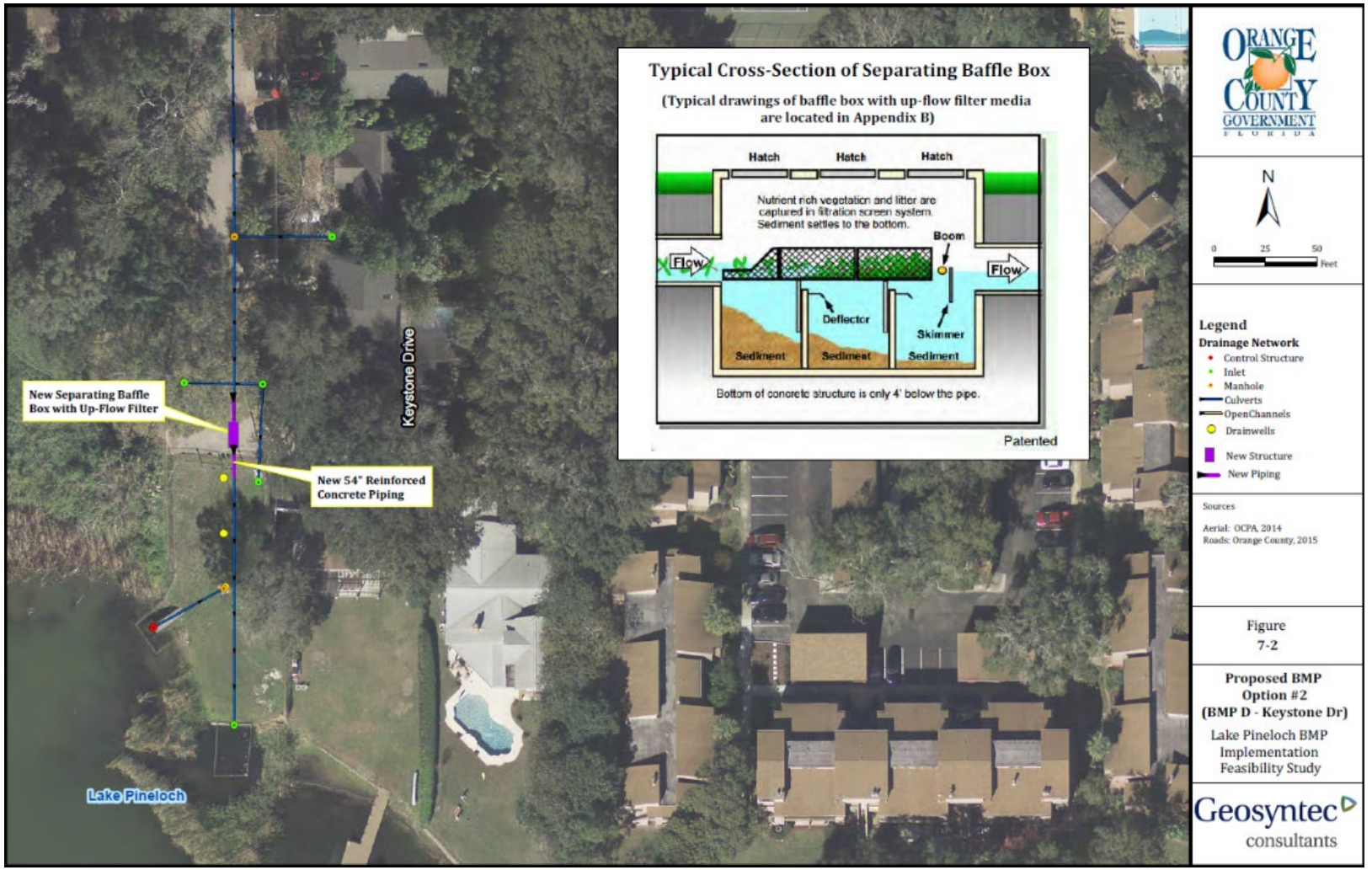
Keystone Feasibility - Existing Conditions

- 54-inch RCP outfall
- Continuous tailwater from Lake Pineloch
- No existing treatment



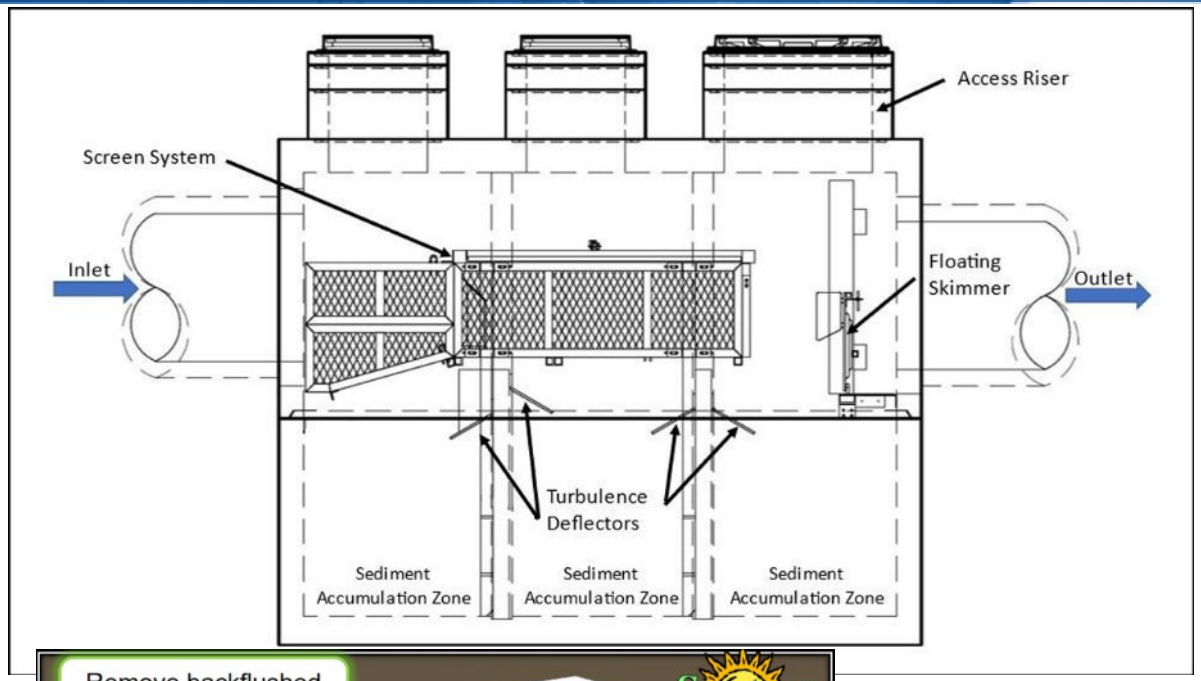
Keystone Feasibility - Proposed Conditions

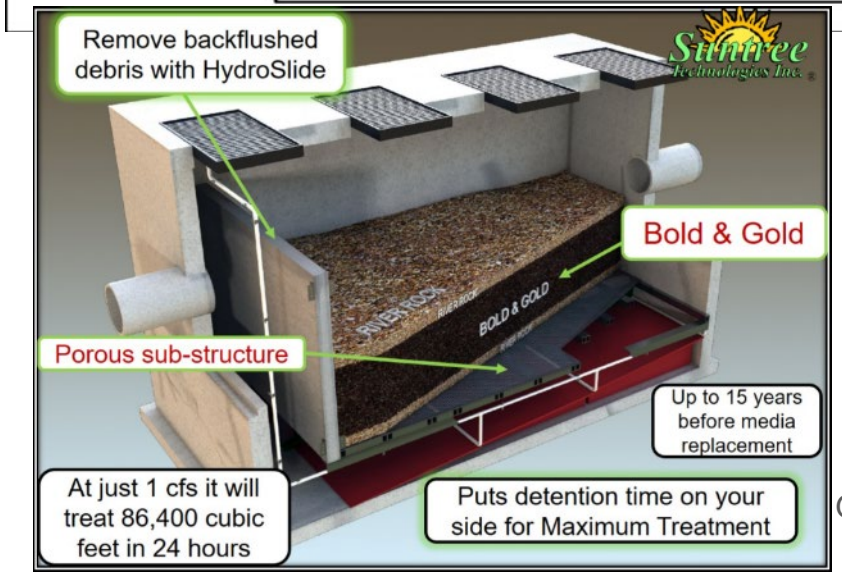
- In-line nutrient separating baffle box
- Off-line up-flow filter
- High-flow bypass maintained



Keystone Feasibility – Concept Development

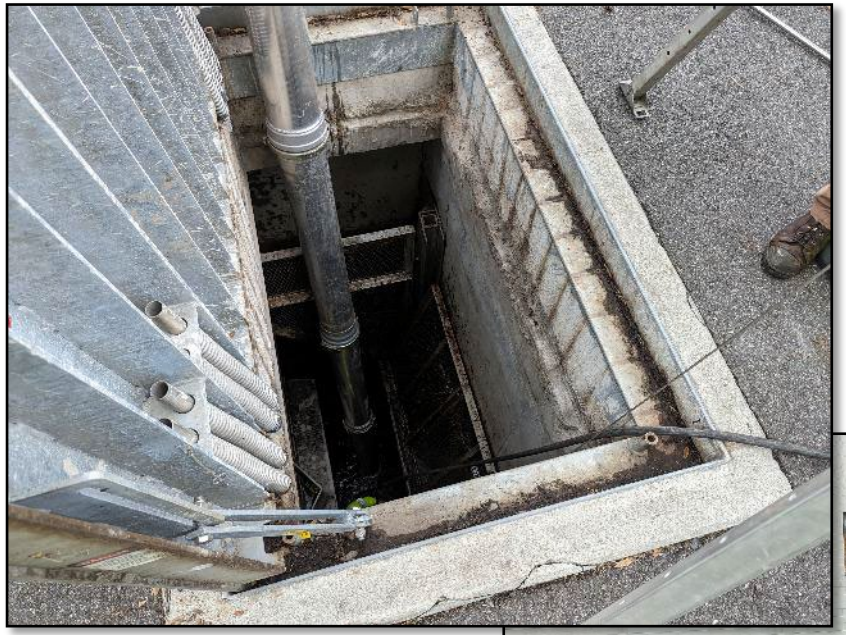
- Proposed project NSBB with an off-line upflow filter
  - NSBB has two removal mechanisms
    - Provides removal by straining out gross solids and organic matter
    - Provides removal by settling out particulate solids
  - Upflow filter off-line
    - Stormwater directed to upflow filter under normal flows and bypass for high flows
    - Provides removal via straining, adsorption, and biological processes

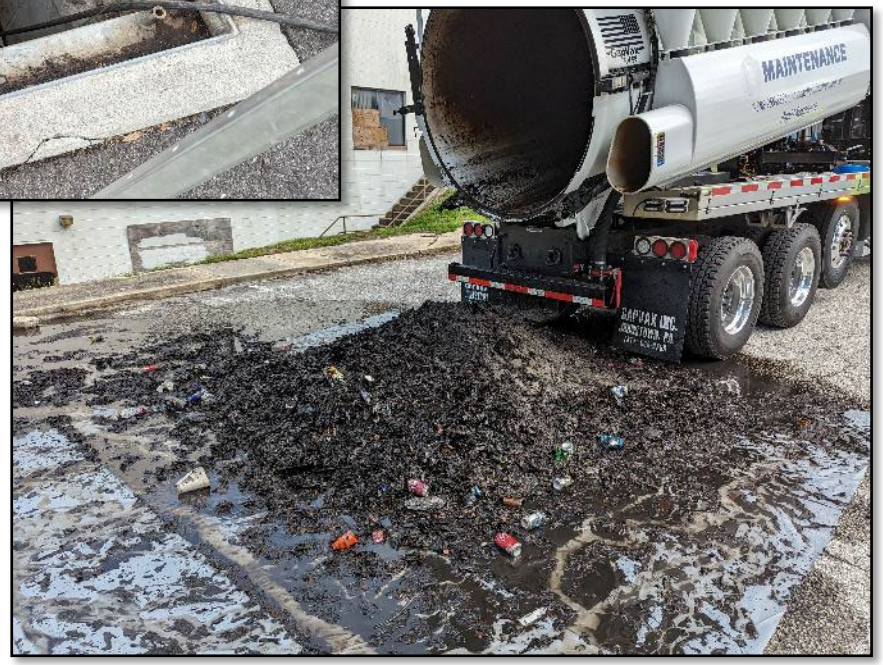




Keystone Feasibility – Anticipated Maintenance

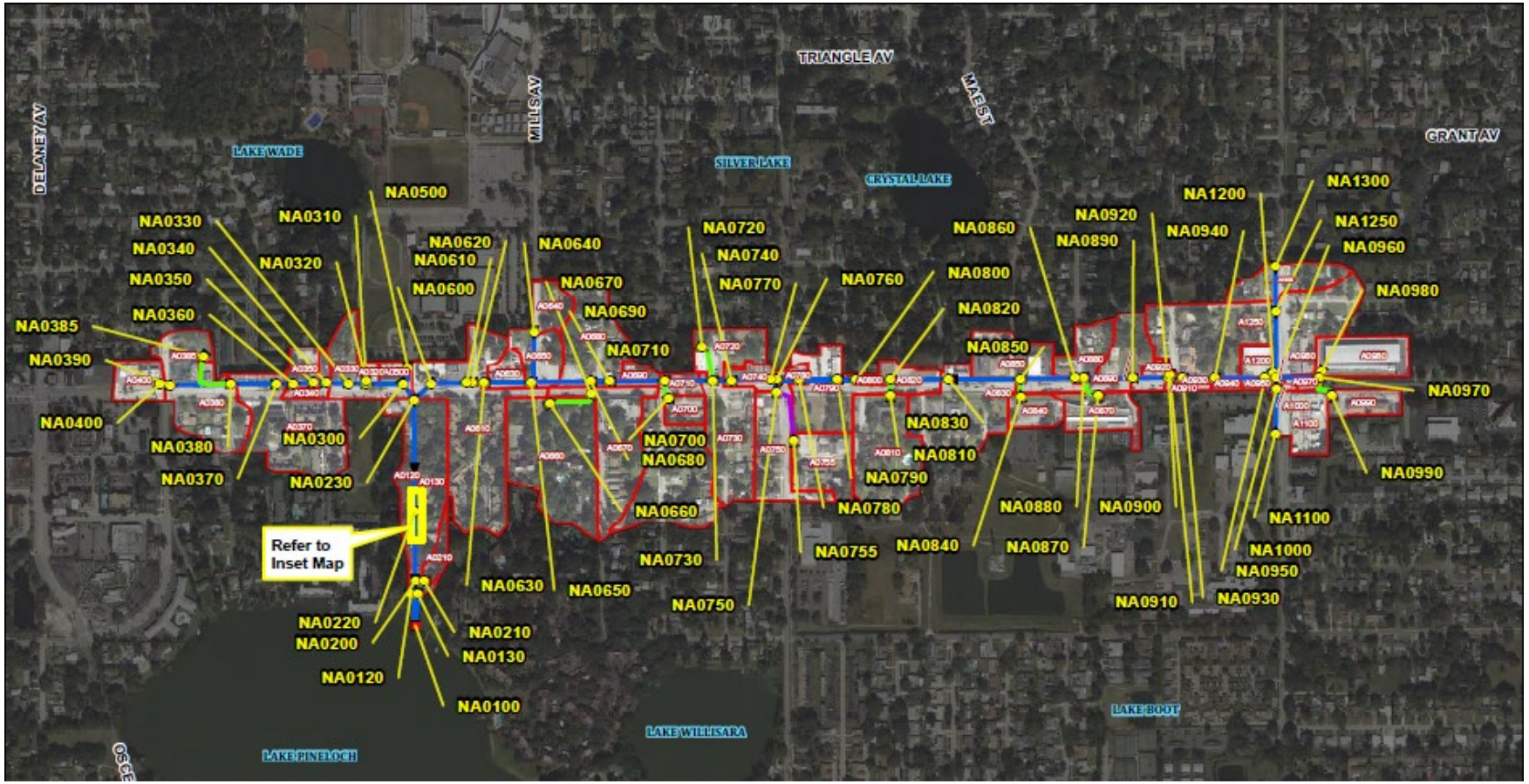
- System needs to be cleaned with vactor-truck
  - Frequency depends on watershed characteristics
  - Mass of material removed sampled and weight quantified to determine removals
- Performed field recon and drainage investigation of proposed project location





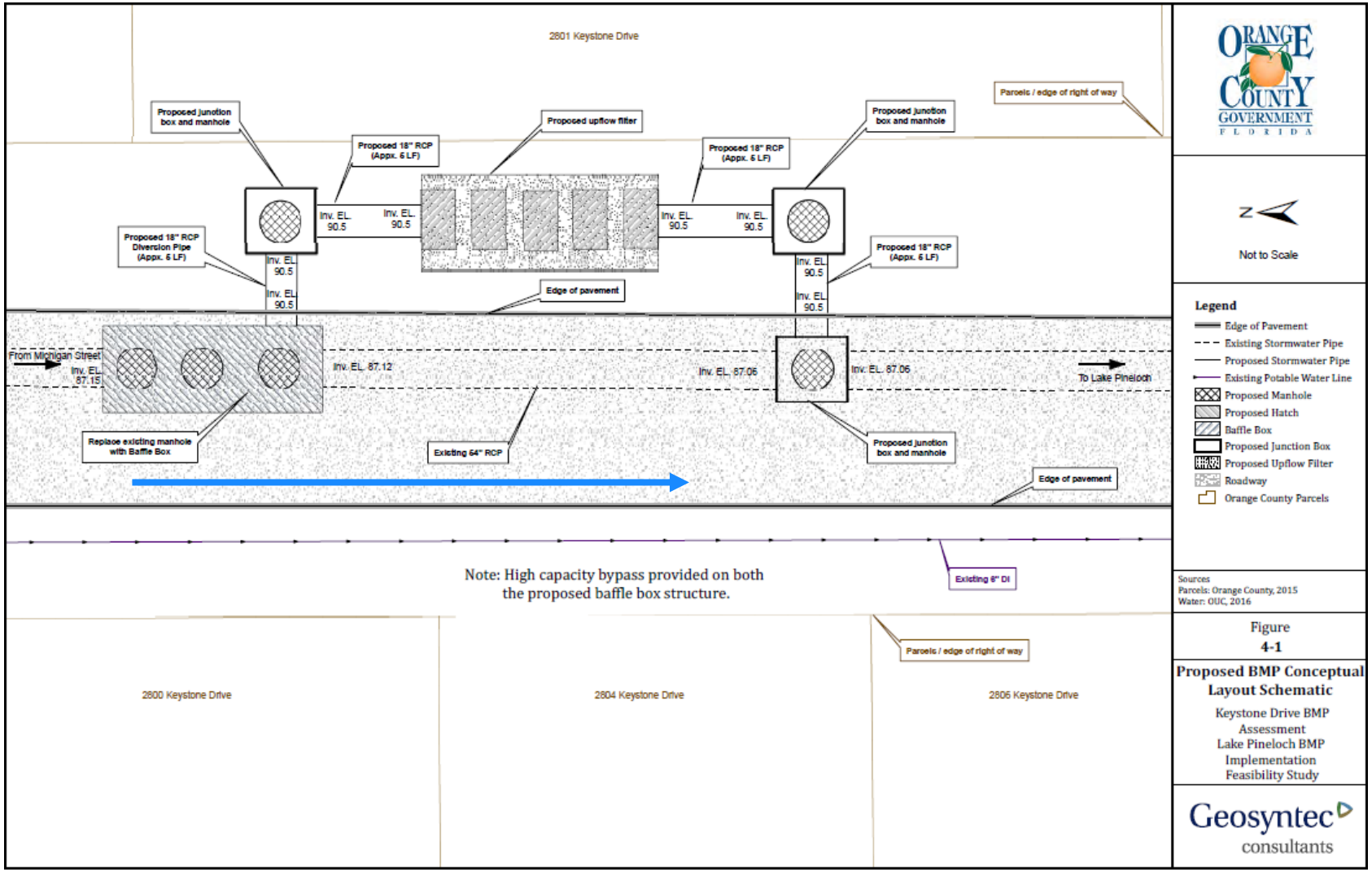
Keystone Feasibility – Hydraulic Feasibility

- Developed existing and proposed conditions H&H ICPR model for watershed and NSBB with offline UFF
  - No increase in upstream flood stages
  - Flood LOS maintained



Keystone Feasibility – Anticipated Water Quality Benefits

- Evaluated water quantity and quality impacts
  - Green Ampt runoff excess method for smaller storms to evaluate BMP performance
  - CN method for larger LOS storms
- Estimated removals
  - TN = 530.5 lb/yr
  - TP = 79.58 lb/yr
- Anticipated project cost and cost benefit
  - $494,905
  - TN: $933/lb
  - TP: $6,217/lb



Keystone Feasibility – Conclusions and Recommendations

- Watershed assessment leveraged to identify priority areas to target with stormwater treatment
  - Identified 15 potential water quality improvement projects
  - Narrowed down to 2
  - Keystone Drive basin received no treatment in the existing condition and has a highly urbanized land use
- Keystone Drive NSBB with off-line upflow filter
  - Provided most TN and TP removal
  - Most favorable cost benefit
- Recommended for implementation

Design & Construction

Field Data & Due Diligence

Design Development & Agency Coordination

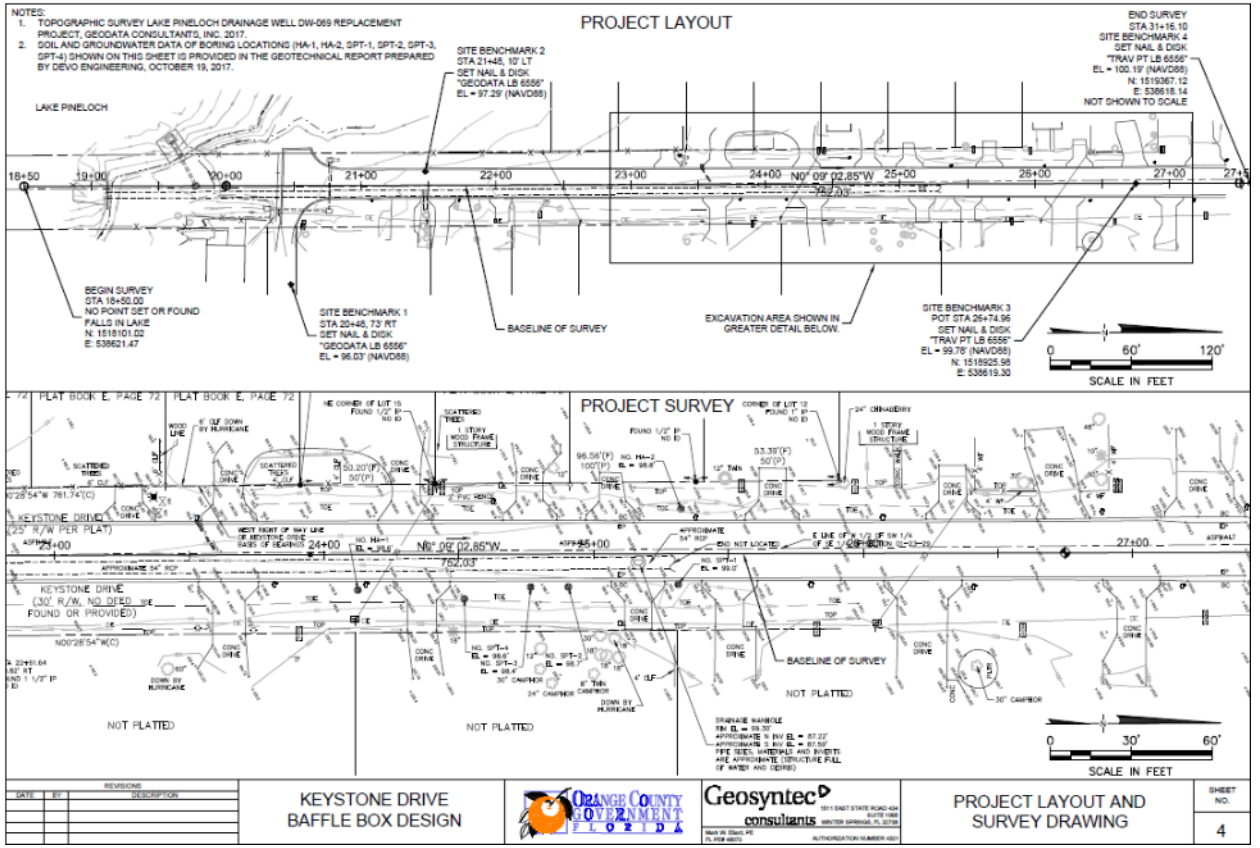
Engineering Design & Cost Analysis

Permitting and Regulatory Support

Final Deliverables and Construction Phase Support

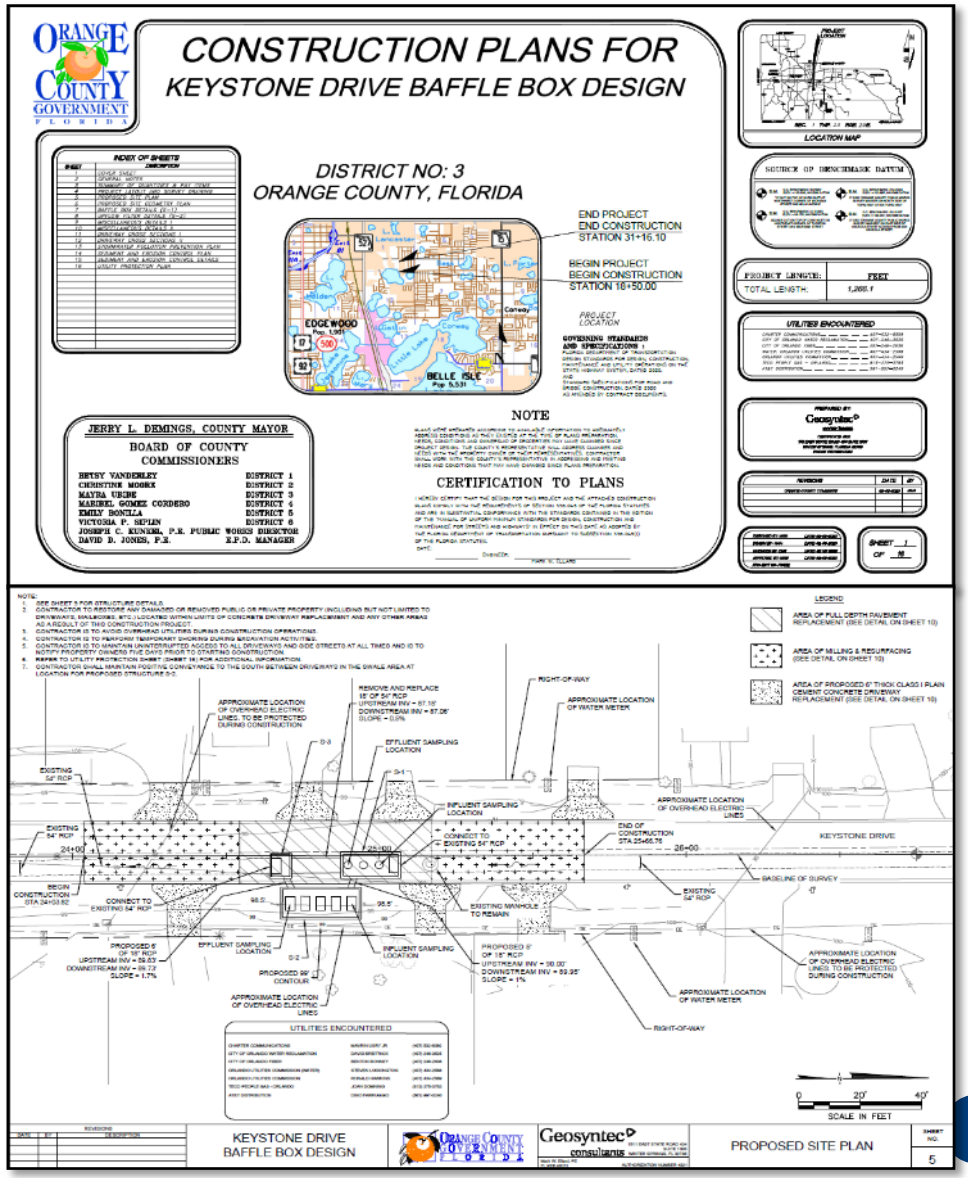
Design – Field Data & Due Diligence

- **Topographic Survey**
  - Collecting all existing information such as mailboxes for restoration.
- **Subsurface Utility Investigation (Sunshine 811)**
  - OCU, OUC, AT&T
  - Did not receive responses from all utility providers.
- **Geotechnical Investigation**
  - Getting SHGW for structure buoyancy calcs.



Design – Design Development & Agency Coordination; Engineering Design & Cost Analysis

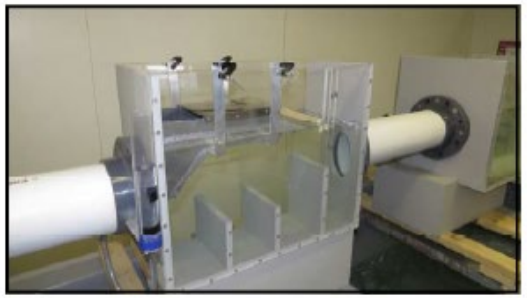
- Extensive coordination with Manufacturer
- Standard design procedure
  - SJRWMD pre-application meeting
  - Preparation of 30, 60, 90, and 100% construction plans and specifications
  - Develop engineers estimate of probable costs
  - Cost benefit



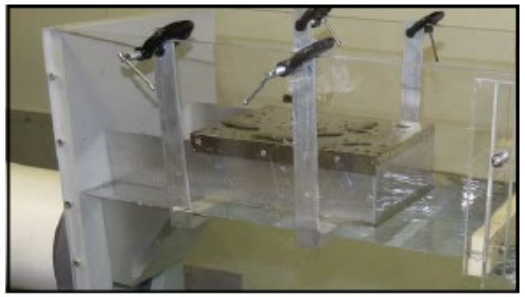
Design – Permitting & Regulatory Support; Final Deliverables

- Prepare, submit, and obtain SJRWMD ERP
- Signed, sealed, bid-ready plans and technical specifications
- Operations and maintenance manual

Manufacturer Coordination

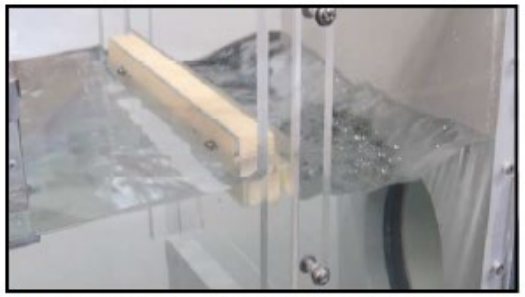


Model NSBB with water flowing.



Model screen system is made from solid sheet metal.

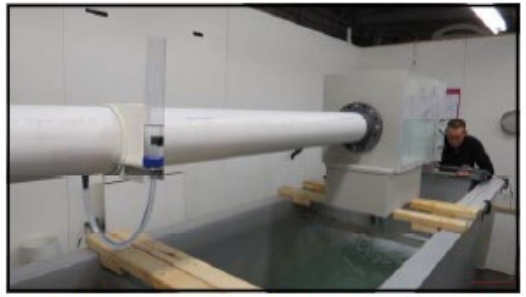
Step 13: Repeat step 4 through 11.



HGL begins to equalize as diversion SkimBoss raises.

Tailwater vault simulates an adjacent elevated lake level.

Hydraulic portal during straight pipe measurements.



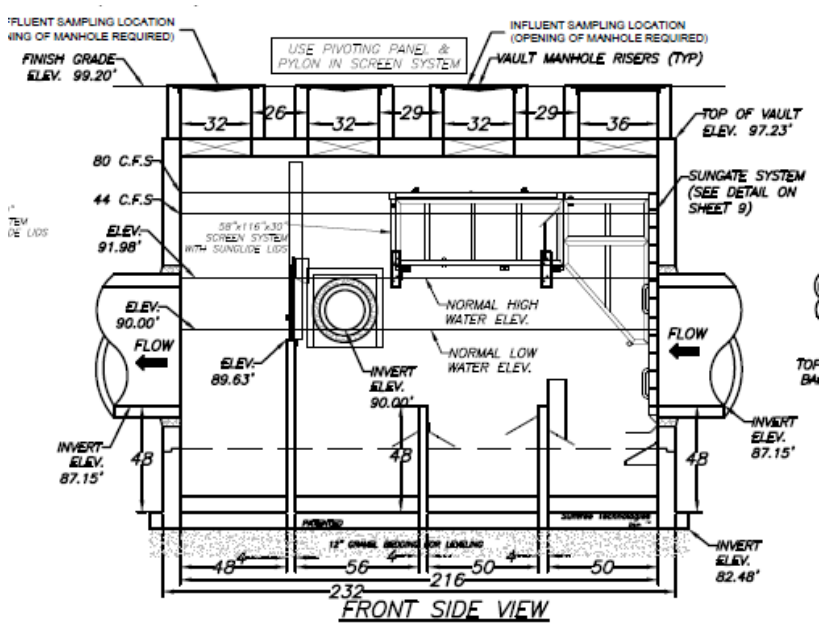
Straight pipe flows are measured flowing into tailwater vault.

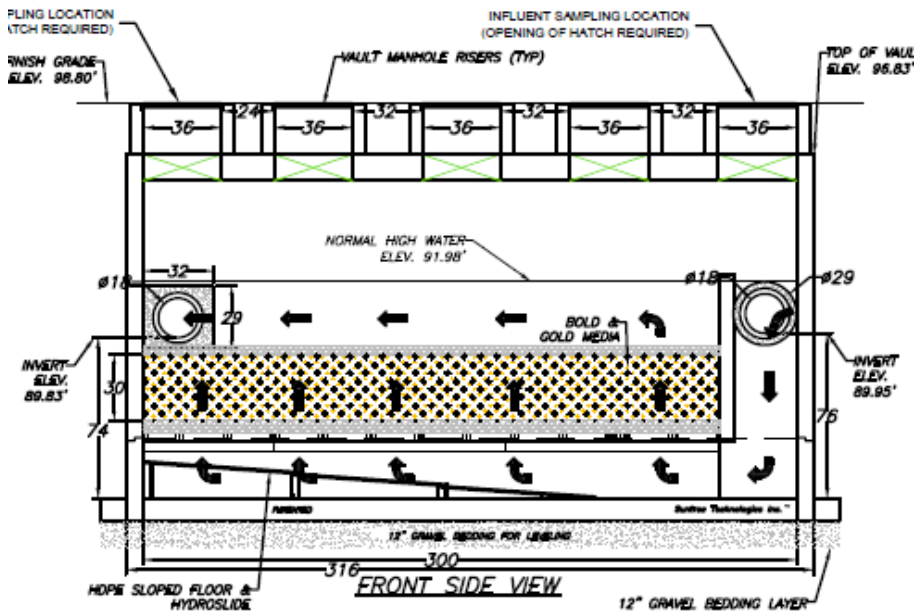
Page 7

- Extensive coordination was performed with the manufacturer of the baffle box at the time – Suntree Technologies, Inc.
- A pilot scale study was performed by the manufacturer specifically for this project to better understand the system hydraulics.

Design – Offline System Benefits

- Combined baffle box and media BMPs are typically undersized, resulting in significant bypass of the media filter.
- An offline up-flow filter was appropriate for this application to achieve the contact time needed for TN and TP reduction.





Permitting

- A drainage report was prepared outlining the water quality benefits of the project and demonstrating that there are no adverse impacts to upstream / downstream levels of flood protection.
  - Headloss through proposed structures
  - Peak stage / peak discharge was evaluated for existing vs. proposed.

- Permit obtained in March 2018 from SJRWMD for a General ERP pursuant to section 62-330.451, F.A.C.

Cost Estimate

- A detailed cost estimate was prepared as part of the design.
- Total estimated at $860,000.
- Contractor bid project at $745,000.

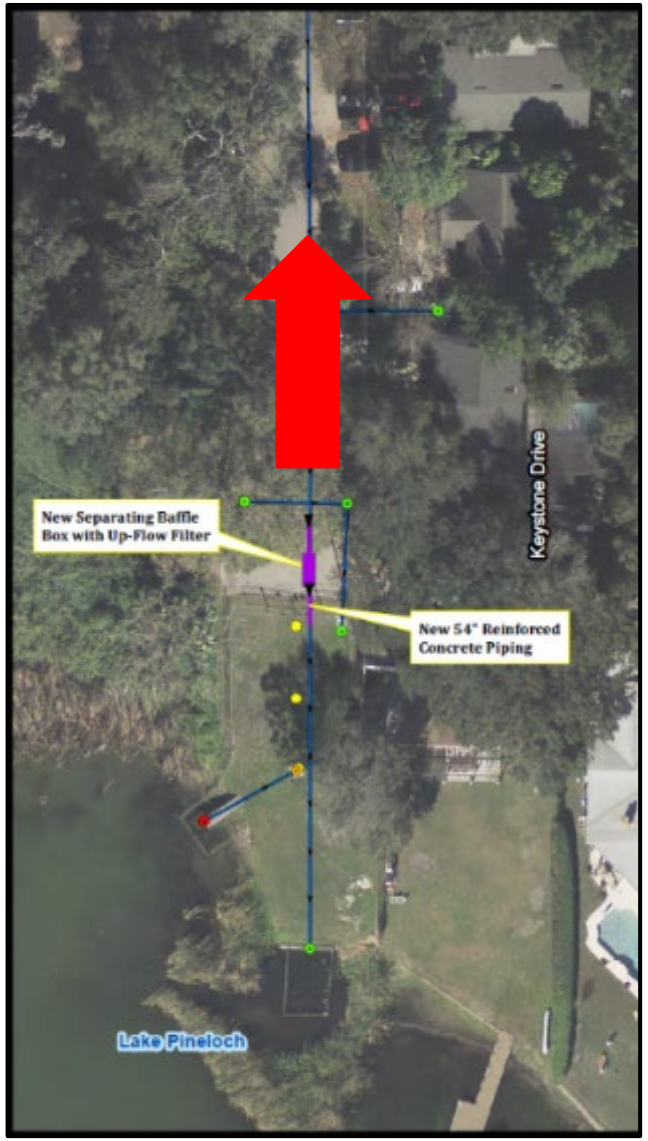
ENGINEER'S ESTIMATE OF PROJECT CONSTRUCTION COST

Item	FDOT Pay Item No.	Description	Unit	Unit Cost	Qty	Total
1	101-1	Mobilization	LS	$ 105,077.00	1	$ 105,077.00
2	102-1	Maintenance of Traffic	LS	$ 21,016.00	1	$ 21,016.00
3	104-14	Prevention, Control and Abatement of Erosion and Water Pollution	LS	$25,500.00	1	$ 25,500.00
4	110-1	Clearing and Grubbing	LS	$ 35,026.00	1	$ 35,026.00
5	120-1	Excavation, Embankment, and Grading	LS	$150,000.00	1	$ 150,000.00
6	285-706	Asphalt Base Course (8.0" Type B-12.5)	SY	$41.00	157	$ 6,437.00
7	327-70-5	Milling Exist Asph Pavt, 2" Avg Depth (Primed)	SY	$4.00	252	$ 1,008.00
8	334-1-13	Superpave Asphaltic Conc., Traffic C, (2.0", SP-12.5)	SY	$11.50	409	$ 4,703.50
9	425-2-122	Manhole Special Alternate B, 6'x8', J-8 >10' with Sungate or Approved Equal	EA	$34,200.00	1	$ 34,200.00
10	430-94-4	Desilting Pipe, 54"	LF	$35.00	620	$ 21,700.00
11	430-175-118	Class III Pipe Culvert, Steel Reinforced Concrete Pipe, Round, 18"	LF	$75.00	16	$ 1,200.00
12	430-175-154	Class III Pipe Culvert, Steel Reinforced Concrete Pipe, Round, 54"	LF	$275.00	24	$ 6,600.00
13	522-2	Concrete Driveway, 6" Thick	SY	$55.00	170	$ 9,350.00
14	570-1-2	Performance Turf Sod (Bahia or Match Existing)	SY	$3.00	500	$ 1,500.00
15	900-1	As-Built Plans	LS	$1,000.00	1	$ 1,000.00
16	900-2	Idemnification	LS	$100.00	1	$ 100.00
17	900-3	Suntree Baffle Box with Sungate or Approved Equal	EA	$263,210.00	1	$ 263,210.00
18	900-4	Suntree NRFS-10-25 Upflow Filter with Media or Approved Equal	EA	$174,000.00	1	$ 174,000.00
		ESTIMATED CONSTRUCTION COST:				**$ 861,627.50**

NOTES:
1) Above estimate does not include cost for utility protection, relecations, or right-of-way acquisition.
2) Cost for Pay Items 900-3 and 900-4 includes materials, delivery to the site, and installation of internal components (including Sungates) as well as assistance with placement of filter media within the vault.

Design – Siting of the Improvements

- Improvements were originally proposed at the south end of Keystone Drive.
- There were concerns associated with a surcharged system → system would be inundated due to tailwater conditions at Lake Pineloch.
- Improvements were shifted north to be further from the Lake.
- Implications associated with maintenance → system needs to be vacuumed which requires isolating the system and pumping out water to establish dry conditions.

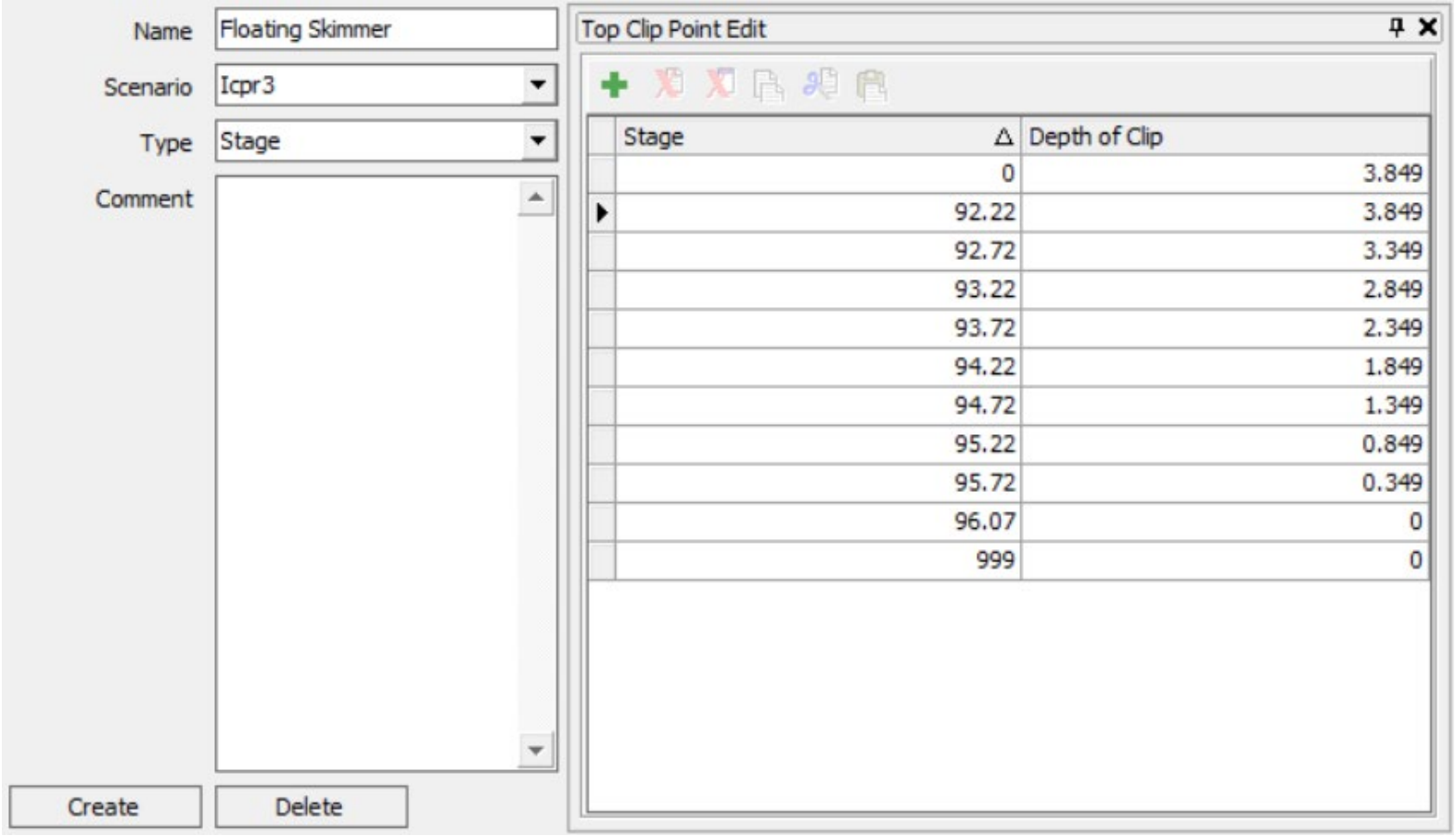


Design – Siting of the Improvements

- Other siting constraints
  - Residential roadway
    - Maintaining traffic
    - Maintaining access to driveways
  - Avoiding overhead power and underground utilities

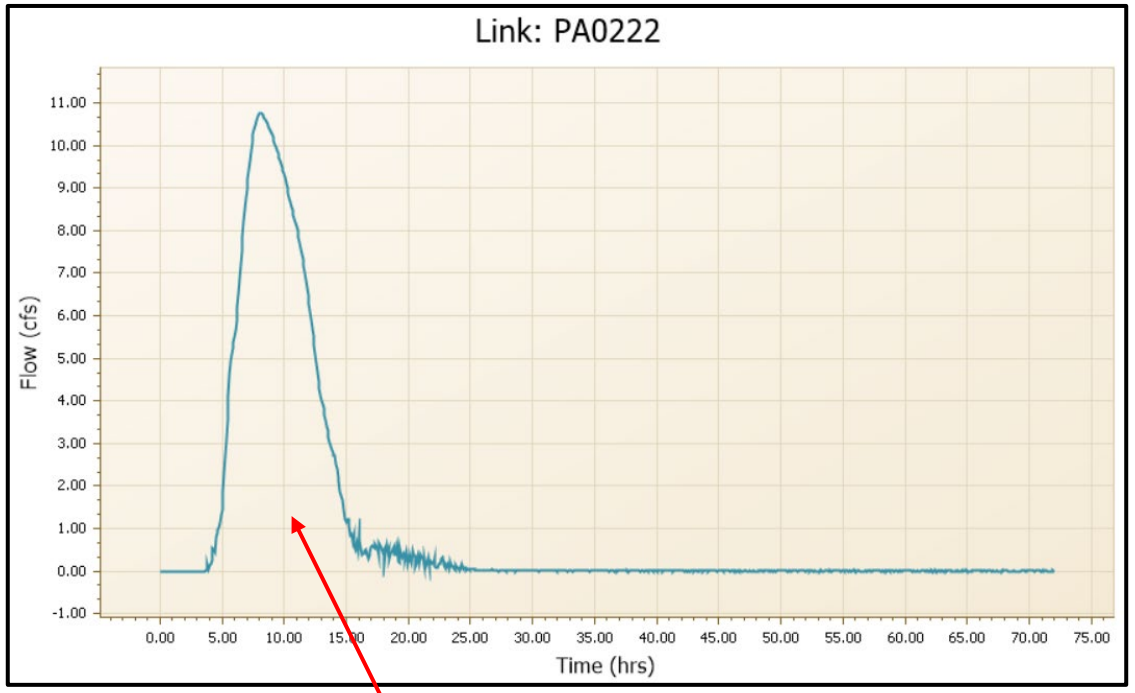
Design Model Updates – Modeling the Floating Skimmer

- A top clip with variable operating table was utilized to represent the NSBB floating skimmer.
- In the NSBB, as the water level rises in the structure, so does the floating skimmer.
- This ensures that flows bypass the system during large storm events and not cause upstream stage impacts.

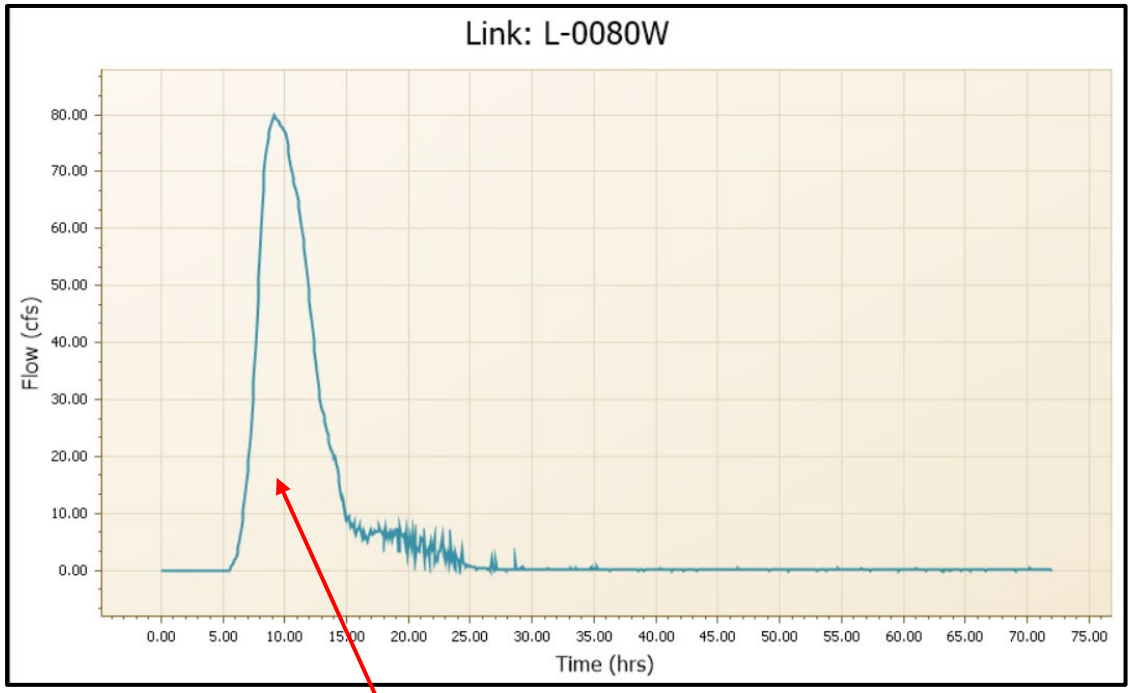


Stage	Depth of Clip
0	3.849
92.22	3.849
92.72	3.349
93.22	2.849
93.72	2.349
94.22	1.849
94.72	1.349
95.22	0.849
95.72	0.349
96.07	0
999	0

Design Model Updates – Modeling the Floating Skimmer



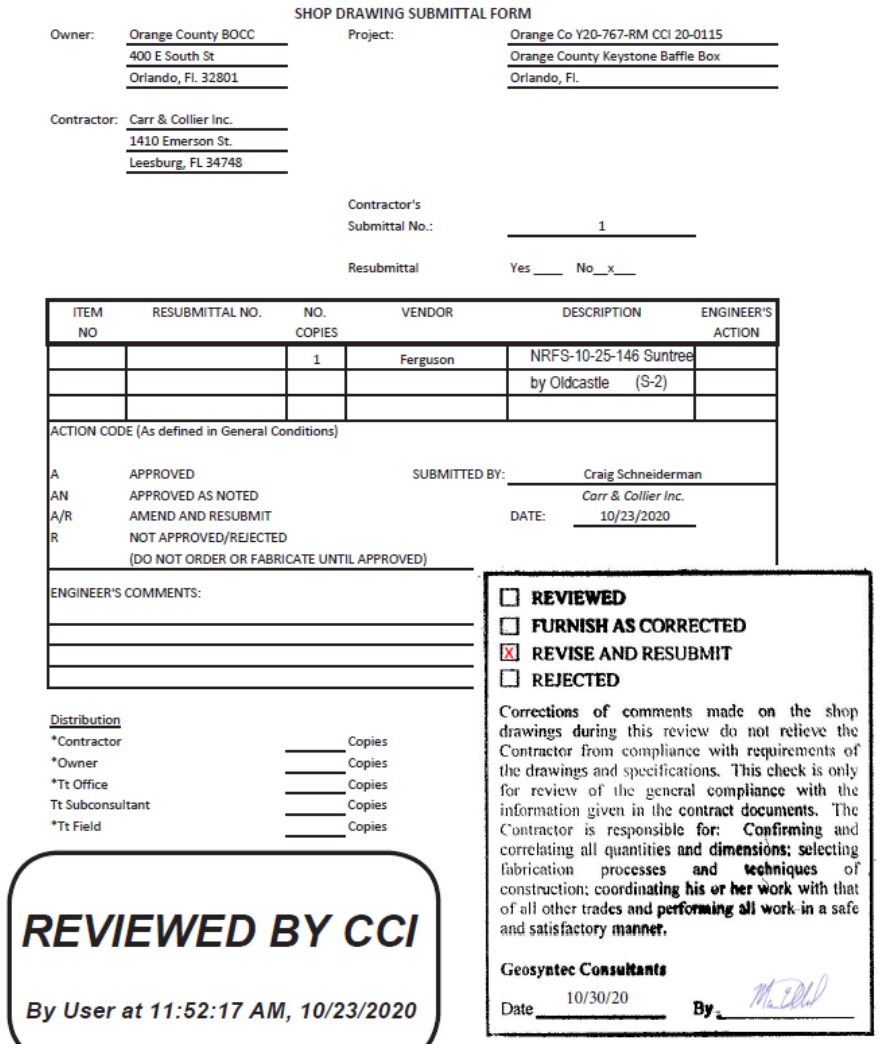
Flow to the up-flow filter during 10-year / 24-hour design storm



Bypass flow to downstream during 10-year / 24-hour design storm

Construction Phase Support Services

- Standard construction phase services.
  - Attend pre-bid meeting
  - Attend pre-construction meeting
  - Respond to Contractor RFIs
  - Review shop drawings
  - Plan revisions / clarification
  - Preparation of punch list
  - Review and certification of as-builts
  - On-site meetings with County, Contractor, and residents



SHOP DRAWING SUBMITTAL FORM

Owner: Orange County BOCC, 400 E South St, Orlando, Fl. 32801

Project: Orange Co Y20-767-RM CCI 20-0115, Orange County Keystone Baffle Box, Orlando, Fl.

Contractor: Carr & Collier Inc., 1410 Emerson St., Leesburg, FL 34748

Contractor's Submittal No.: 1

Resubmittal Yes ___ No__x__

ITEM NO	RESUBMITTAL NO.	NO. COPIES	VENDOR	DESCRIPTION	ENGINEER'S ACTION
		1	Ferguson	NRFS-10-25-146 Suntree by Oldcastle (S-2)	

ACTION CODE (As defined in General Conditions)

A APPROVED
AN APPROVED AS NOTED
A/R AMEND AND RESUBMIT
R NOT APPROVED/REJECTED
(DO NOT ORDER OR FABRICATE UNTIL APPROVED)

SUBMITTED BY: Craig Schneiderman, Carr & Collier Inc.
DATE: 10/23/2020

ENGINEER'S COMMENTS:

Distribution
*Contractor ____ Copies
*Owner ____ Copies
*Tt Office ____ Copies
Tt Subconsultant ____ Copies
*Tt Field ____ Copies

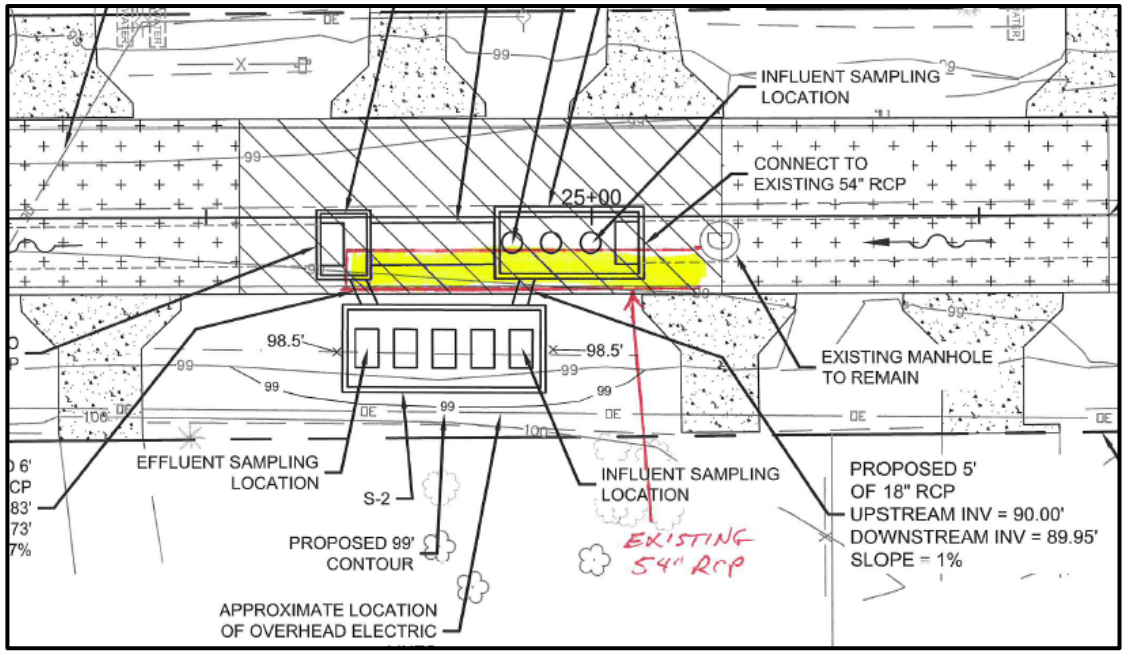
REVIEWED BY CCI
By User at 11:52:17 AM, 10/23/2020

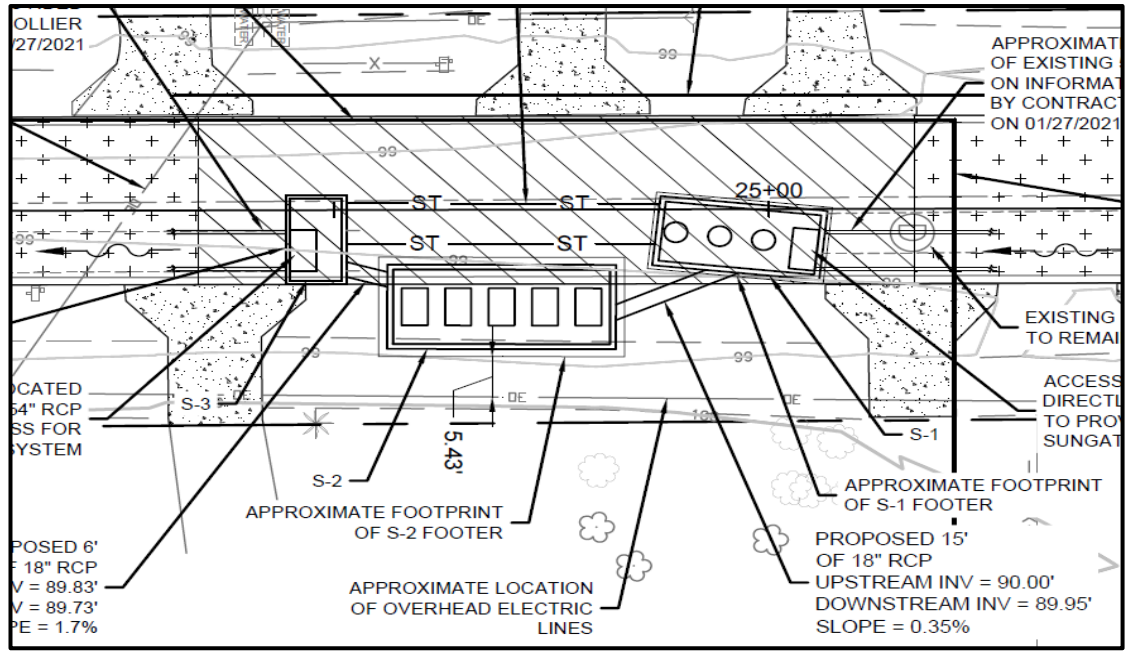
☐ REVIEWED
☐ FURNISH AS CORRECTED
☒ REVISE AND RESUBMIT
☐ REJECTED

Corrections of comments made on the shop drawings during this review do not relieve the Contractor from compliance with requirements of the drawings and specifications. This check is only for review of the general compliance with the information given in the contract documents. The Contractor is responsible for: Confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his or her work with that of all other trades and performing all work in a safe and satisfactory manner.

Geosyntec Consultants
Date 10/30/20 By

Construction Phase Support – Design Updates

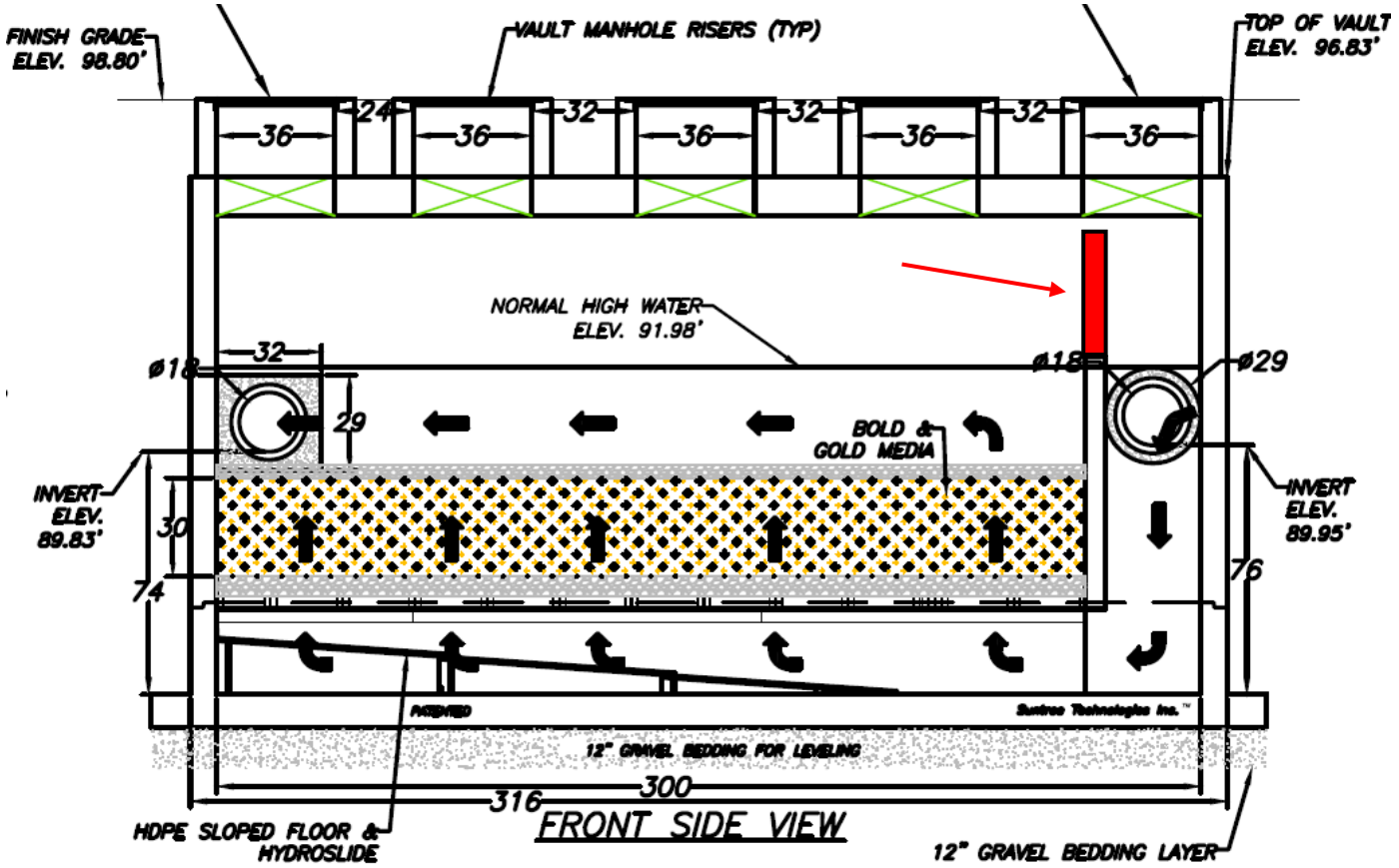




- 54-inch RCP was determined to be offset from manhole.
- Proposed location of the baffle box was not feasible due to offset pipe.
- RFI submitted by Contractor to develop a solution.

- Geosyntec developed a design revision that included adjusting the location of the baffle box, upflow filter, and downstream manhole.
- Baffle box was rotated to facilitate the 54-inch RCP connection.

Construction Phase Support – Design Updates



- During operation of the up-flow filter it was determined that significant bypass was occurring.
- The invert of the weir that allowed bypass around the treatment media was set too low.
- During construction, the top of the weir was extended with a metal plate to be 6-inches below the top of the structure.
- This resulted in a higher capture efficiency.

Construction Photographs


Bold & Gold media


Connection point for baffle box


Up-flow filter

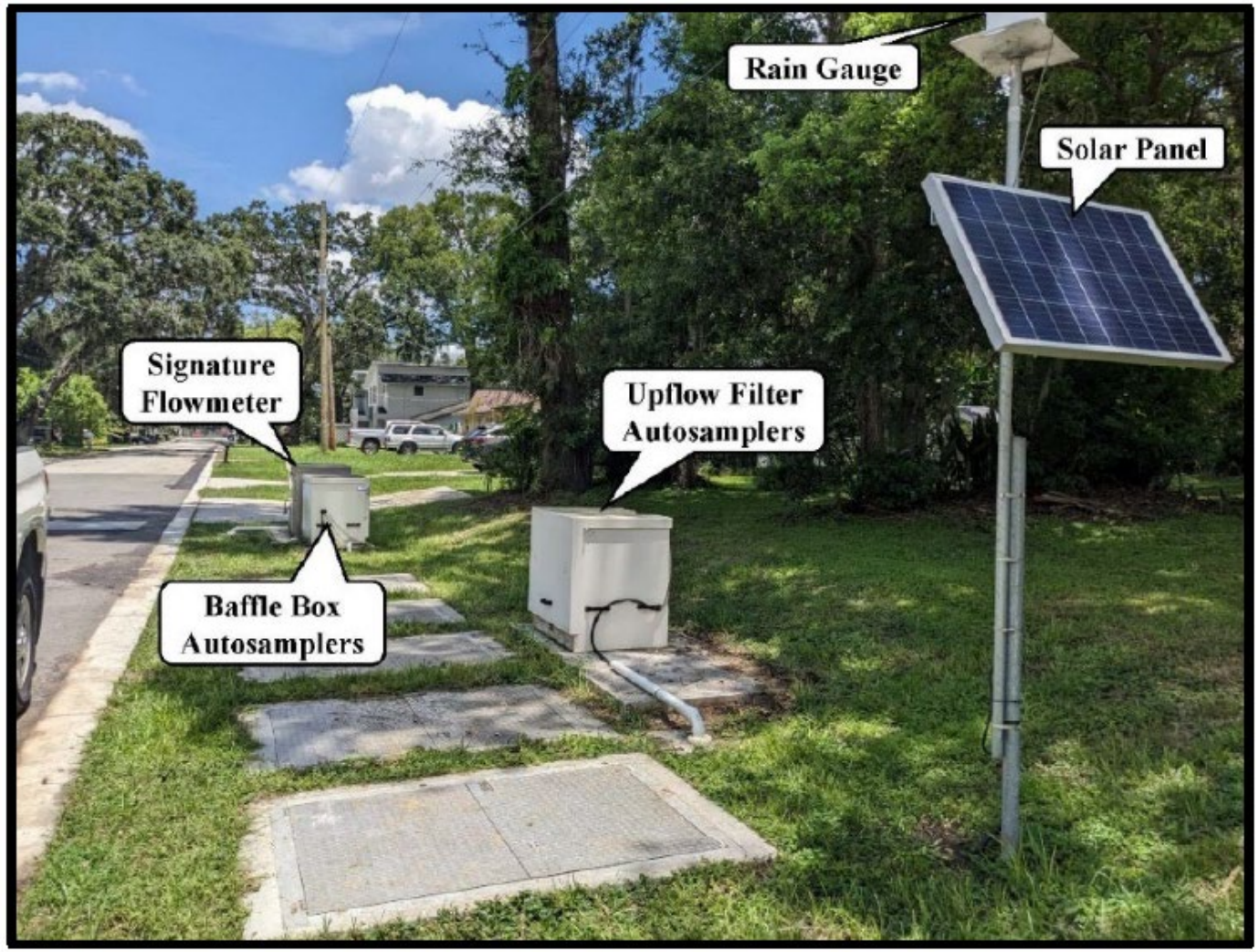

Utility protection during construction


Completed project

ANTS

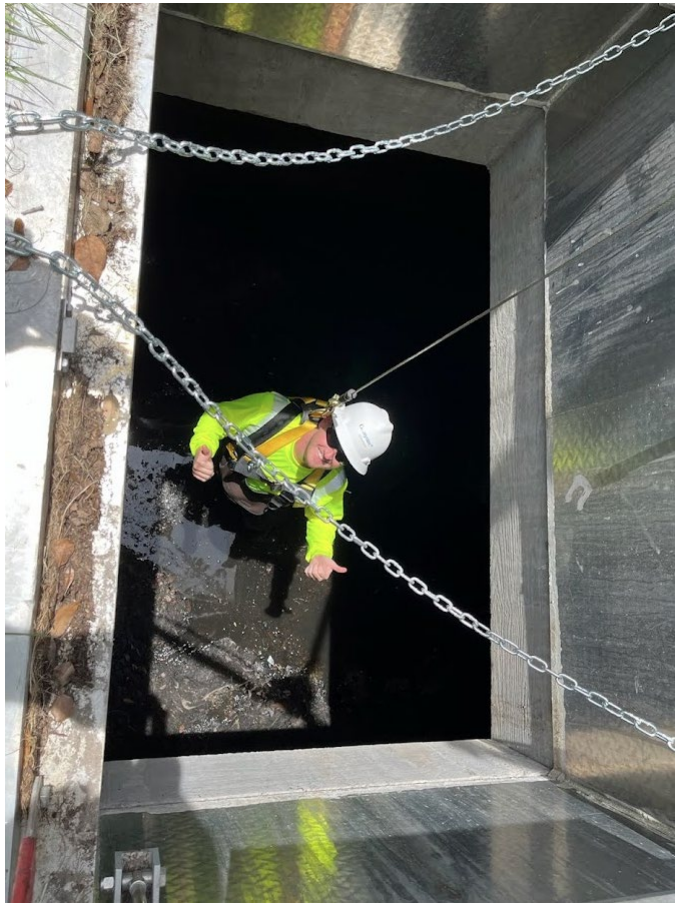
Monitoring


Geosyntec
consultants

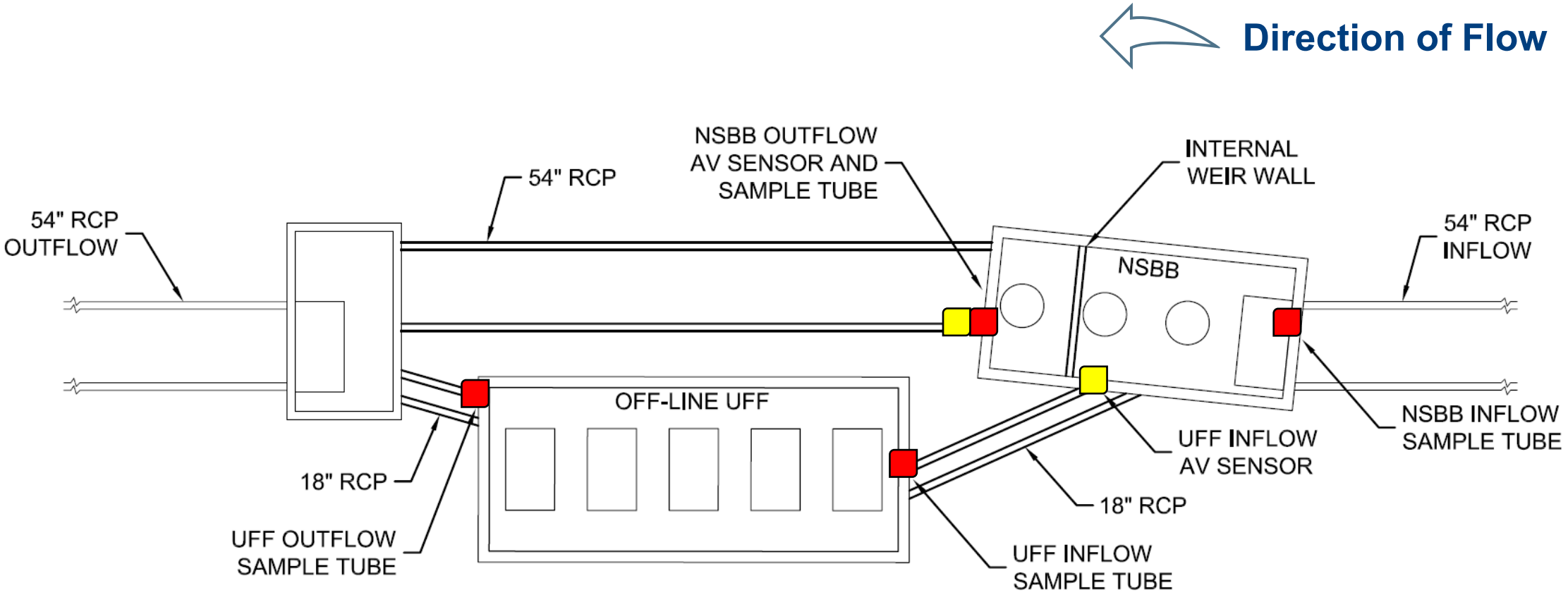

Rain Gauge
Solar Panel
Signature Flowmeter
Upflow Filter Autosamplers
Baffle Box Autosamplers

Monitoring

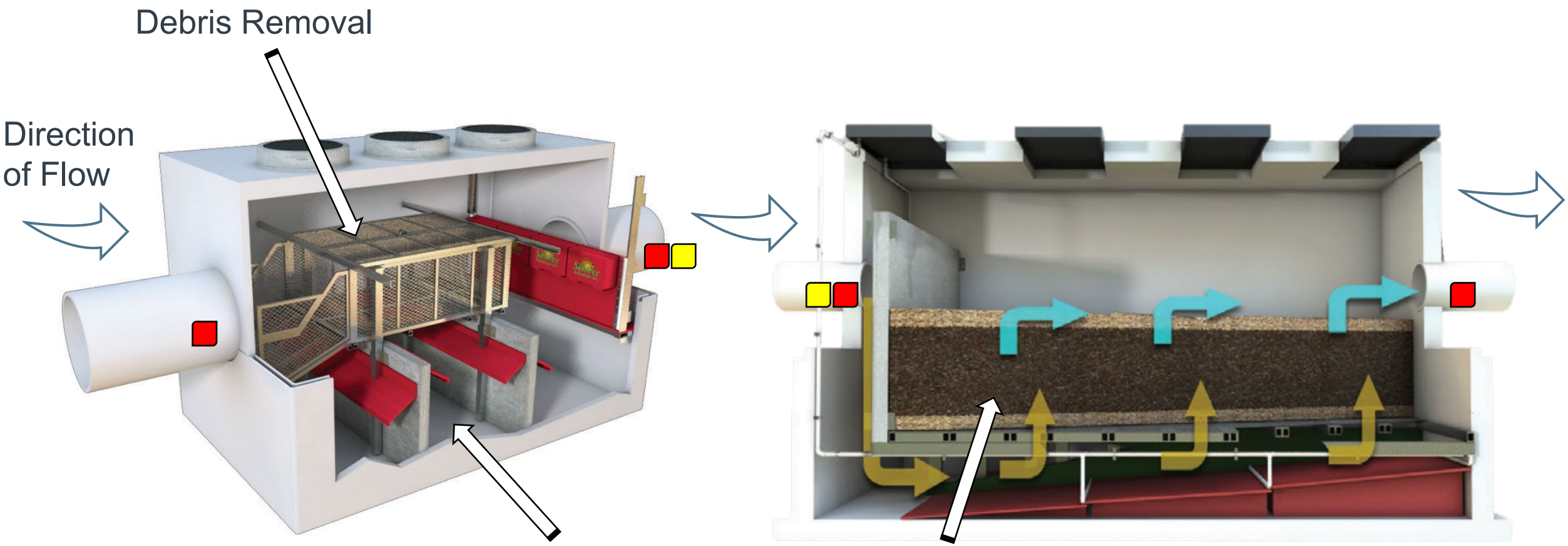
- Monitoring Period Aug 2022 to Jun 2025
  - Originally planned as a 2-year study
  - Extended due to unforeseen damage to equipment
    - Hurricane damage
    - Lawn maintenance damage
    - Vactor truck damage
- Flow Monitoring
  - Rainfall
  - Flow Rate
- Sample Collection
  - Stormwater
  - Sediment
- Laboratory Analytes
  - Nitrogen, Phosphorus, TSS



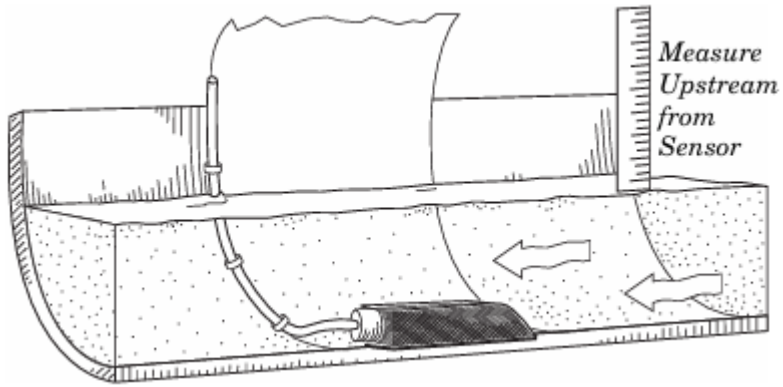
Monitoring


Direction of Flow
54" RCP OUTFLOW
54" RCP
NSBB OUTFLOW AV SENSOR AND SAMPLE TUBE
INTERNAL WEIR WALL
54" RCP INFLOW
NSBB
OFF-LINE UFF
18" RCP
UFF OUTFLOW SAMPLE TUBE
UFF INFLOW AV SENSOR
NSBB INFLOW SAMPLE TUBE
18" RCP
UFF INFLOW SAMPLE TUBE
Sample Tube
Flow Sensor

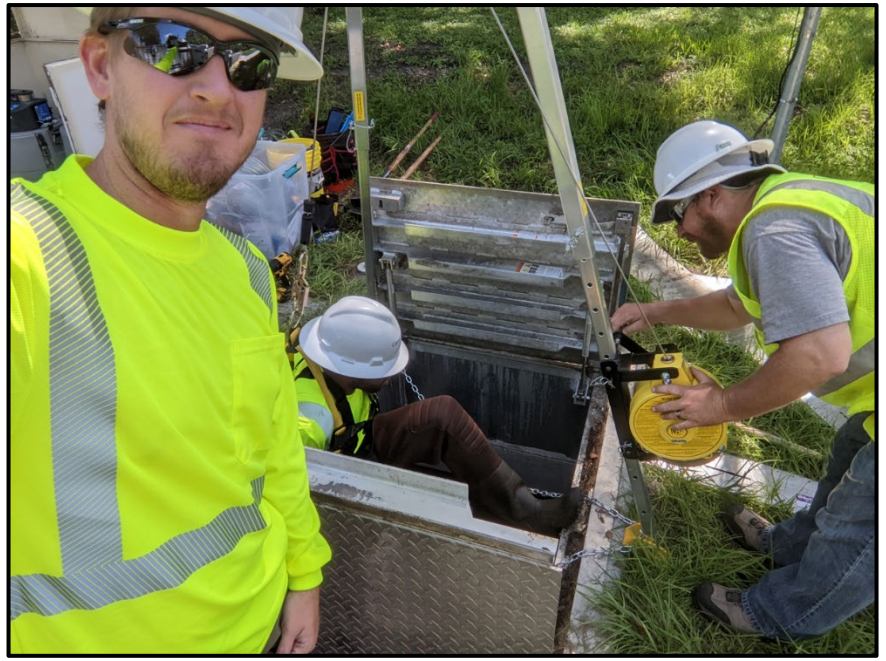
Monitoring


Debris Removal
Direction of Flow
Sedimentation
P adsorption & denitrification
Sample Tube
Flow Sensor

Monitoring

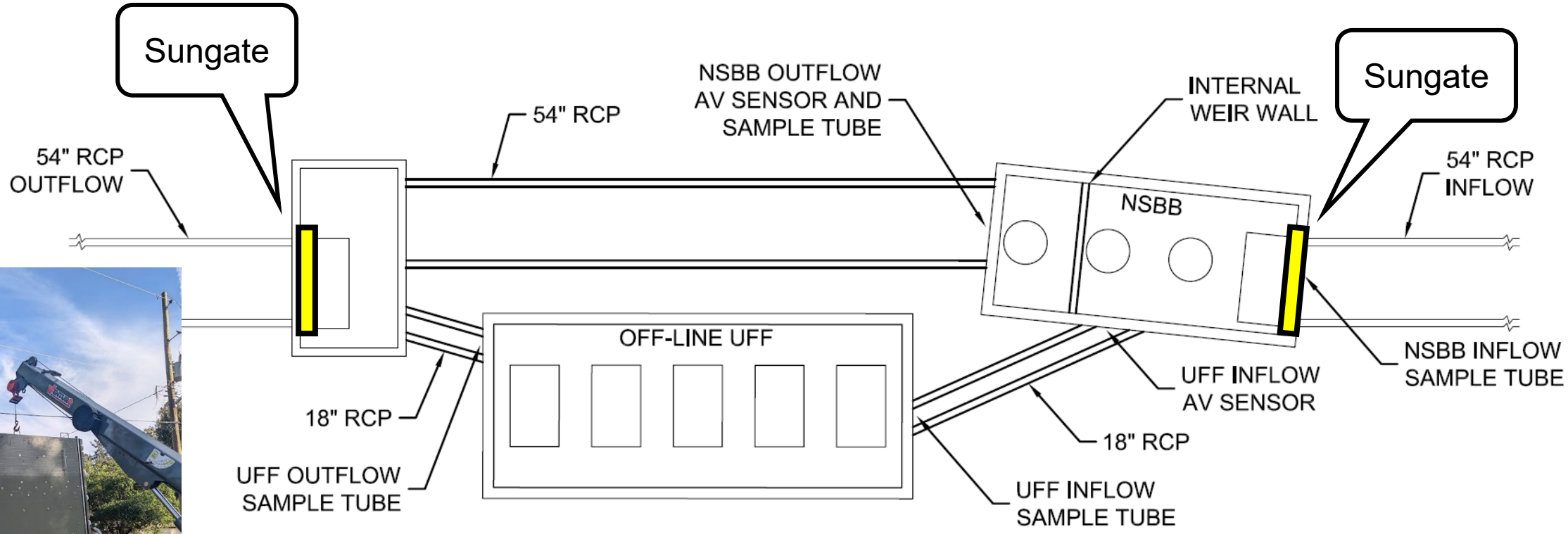


Monitoring

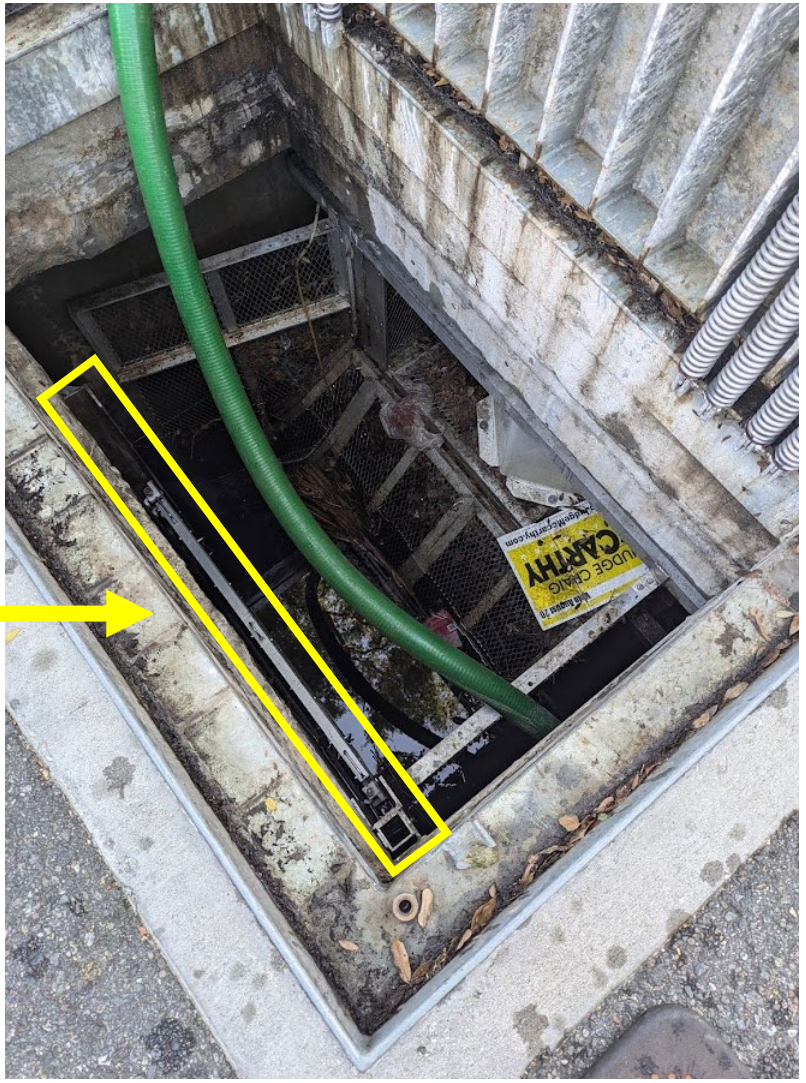


Monitoring

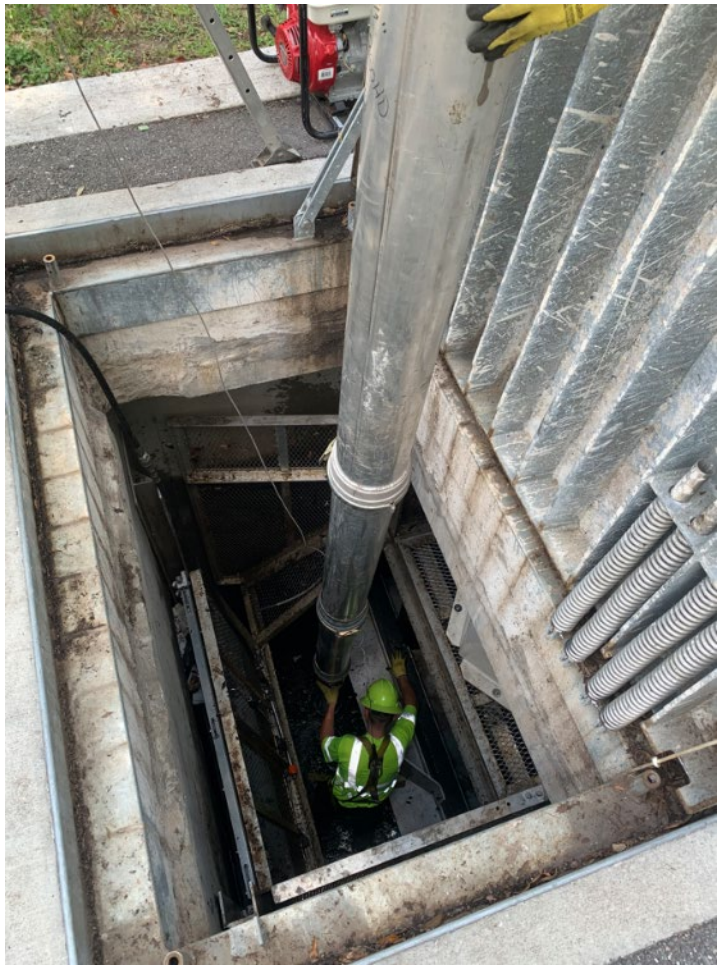
Baffle Box Cleaning and Sediment Sampling



Baffle Box Cleaning and Sediment Sampling



Baffle Box Cleaning and Sediment Sampling



Geosyntec consultants

Performance

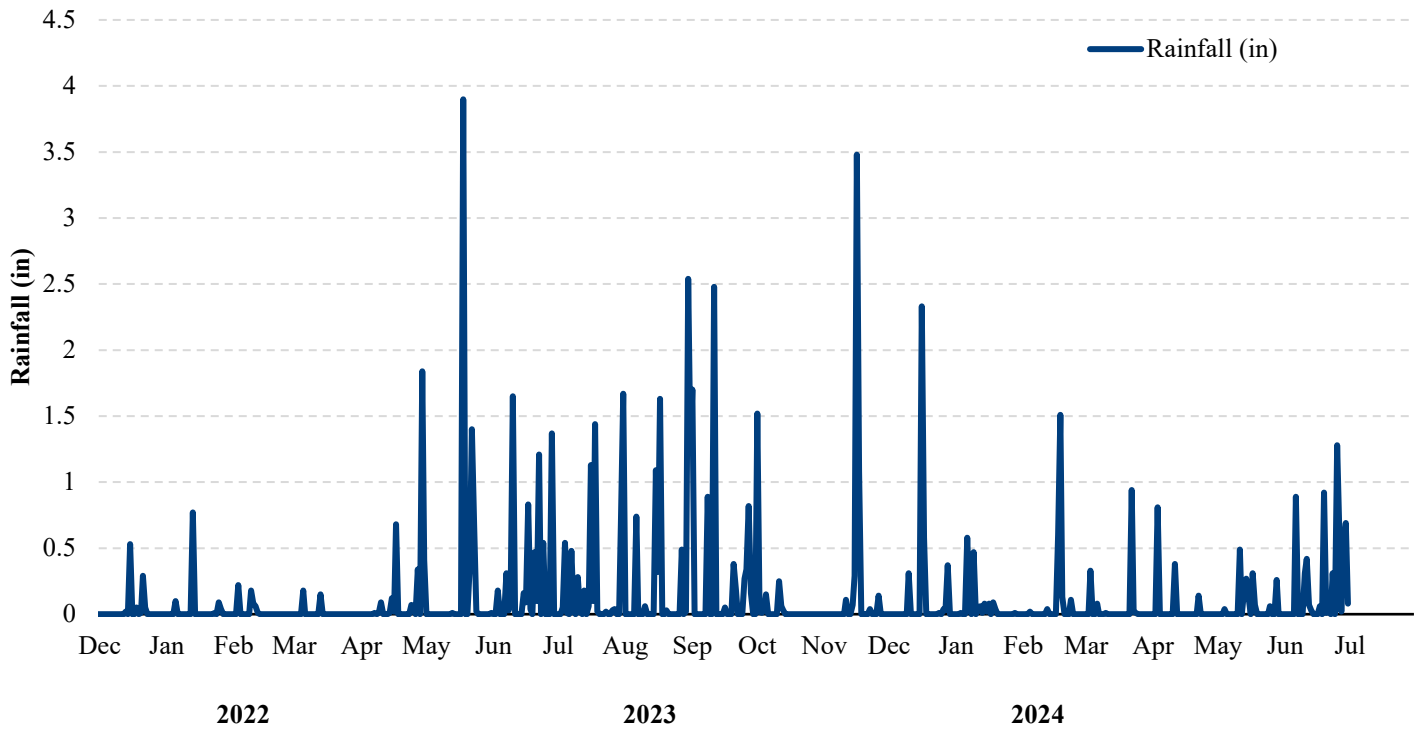
Performance

Rainfall was recorded by the on-site rain gauge and supplemented with data form NOAA Station ID GHCND:USW00012841 during periods of equipment malfunction.

ISCO 674 Rain Gauge
Source: https://store.teledyneisco.com

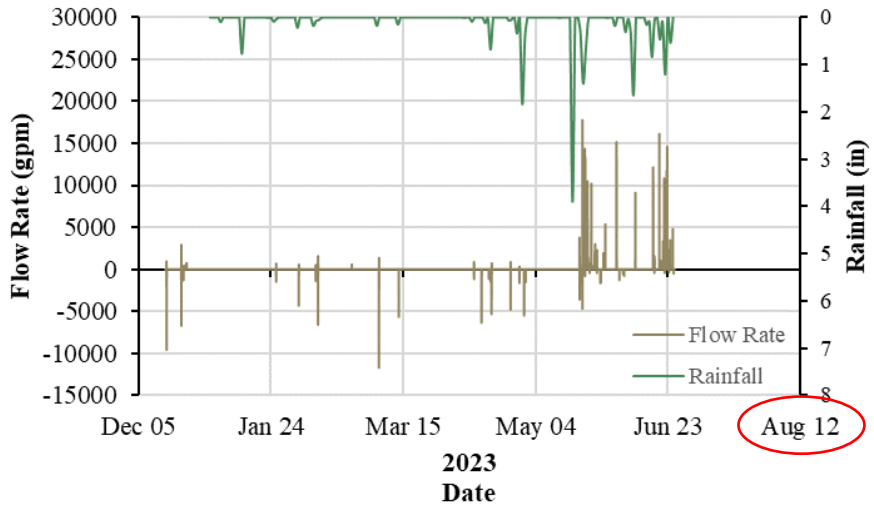
Performance

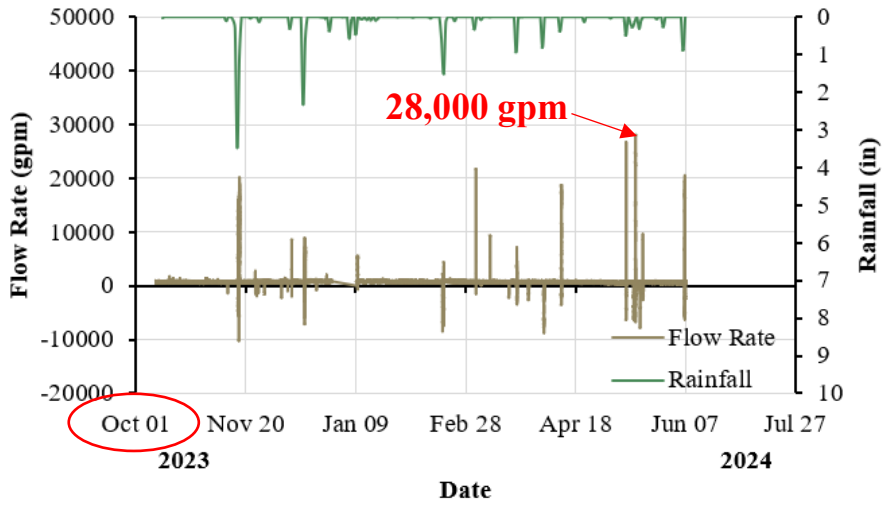
During the first study, the total rainfall was 68.25 inches with the peak rainfall event totaling 3.90 inches



- Flow monitoring equipment damaged from end of May until end of September 2023.
- Monitoring period extended as a result.
- Missed a lot of the wet season

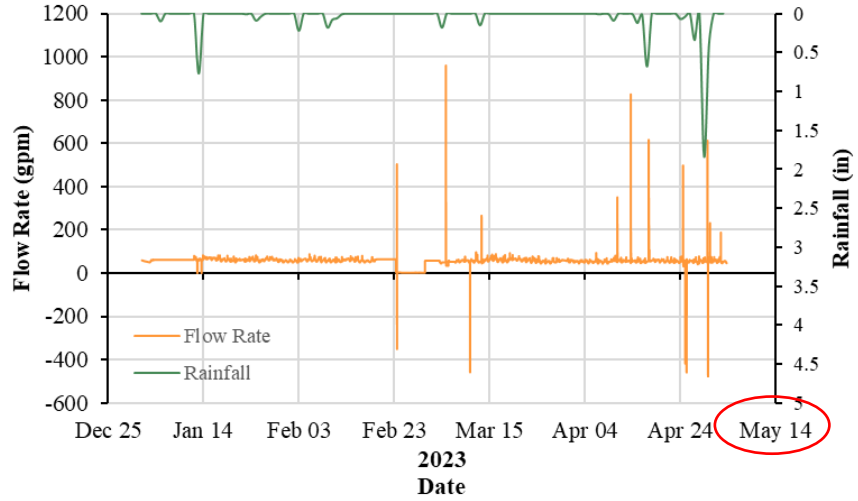
Performance

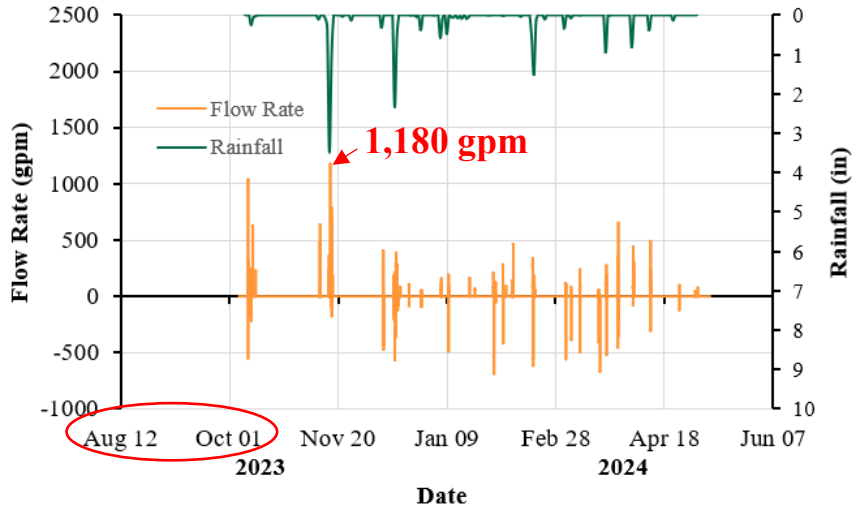




Study 1 Rainfall and Flow Rates

NSBB → UFF

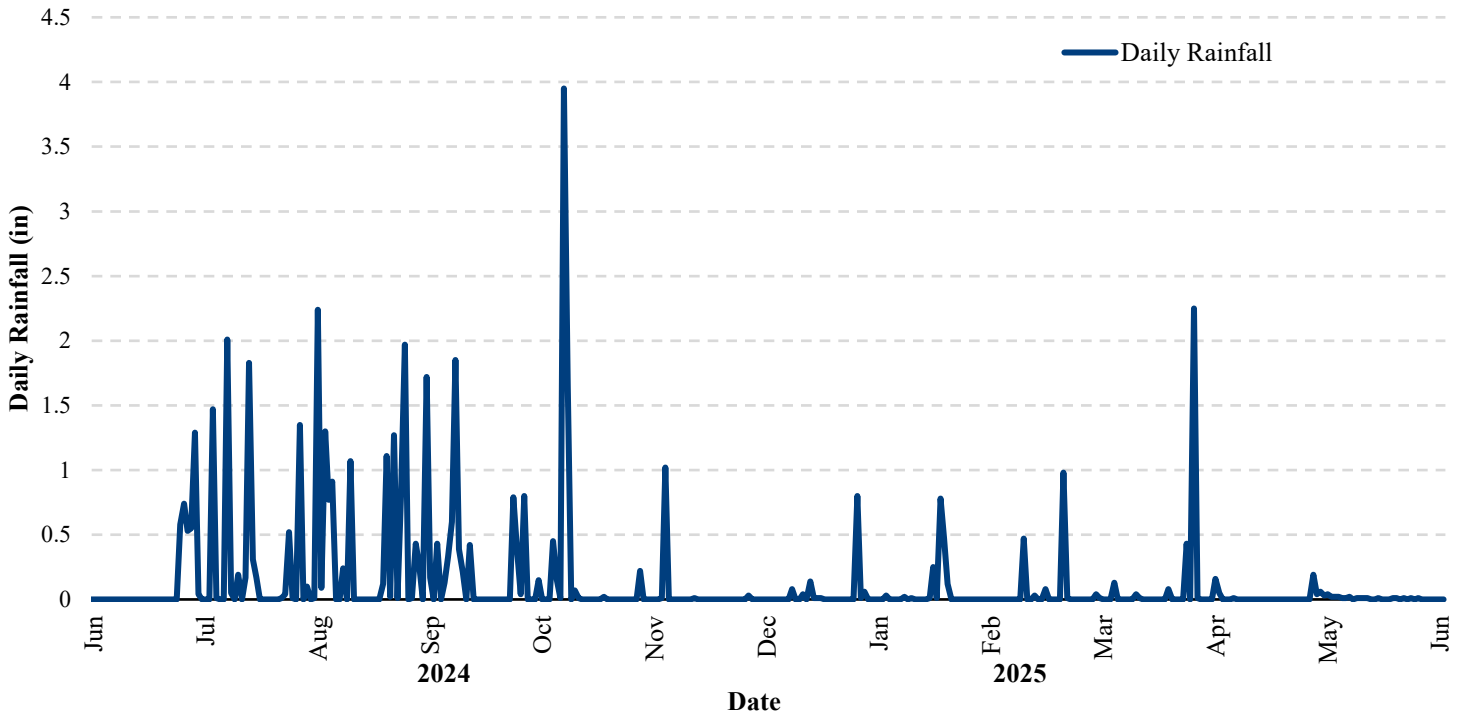




GEOSYNTEC CONSULTANTS

Performance

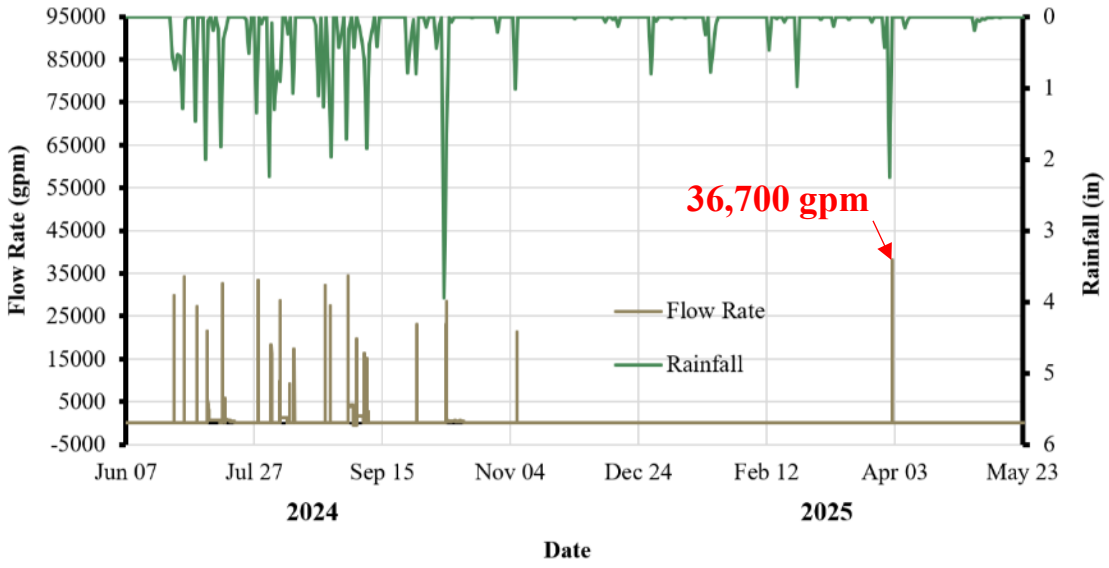
During the second study, the total rainfall was 48.85 inches with the peak rainfall event totaling 3.95 inches



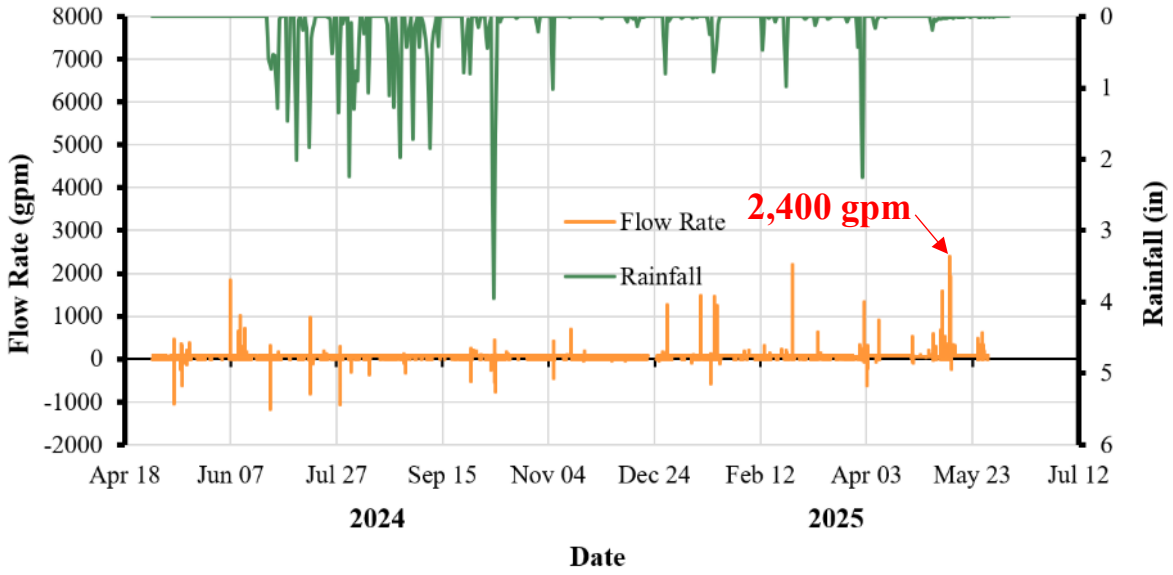
Performance

Study 2 Rainfall and Flow Rates

NSBB



UFF

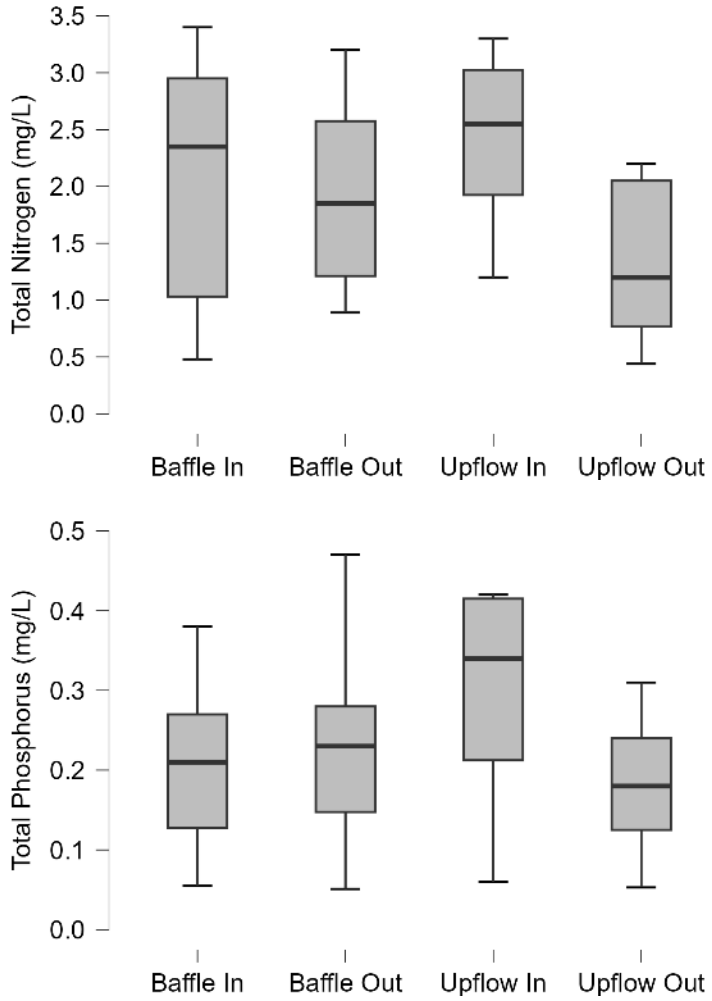


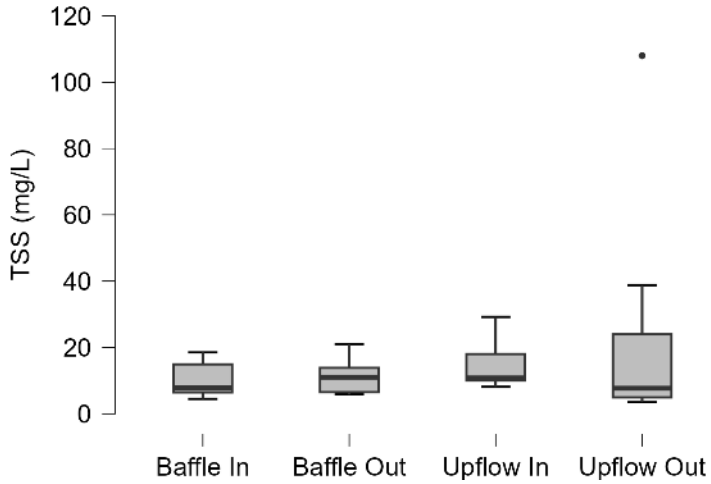
Performance – Total Flow Volumes

Study	NSBB Outflow Volume (gal)	UFF Inflow Volume (gal)	Total Flow Volume (gal)	UFF Bypass Volume (%)
1	5,443,643	10,054,786	15,498,430	35%
2	54,719,634	33,686,916	88,406,549	62%
Total	60,163,277	43,741,702	103,904,979	58%

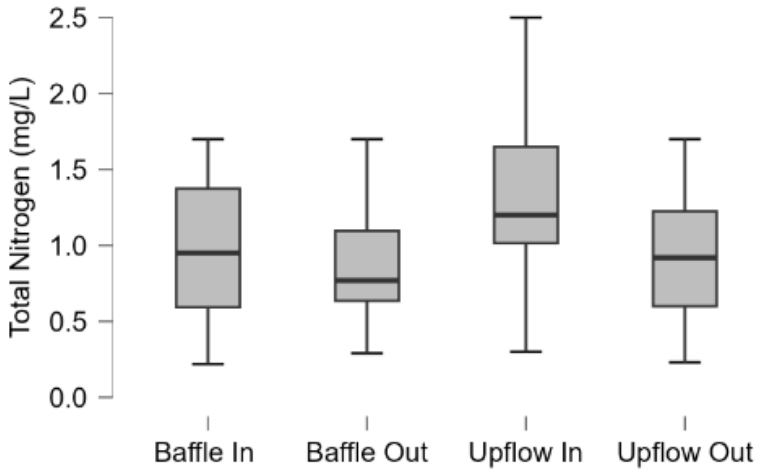
Performance – Study 1 Autosampling Results

UFF-IN 3-6-2024

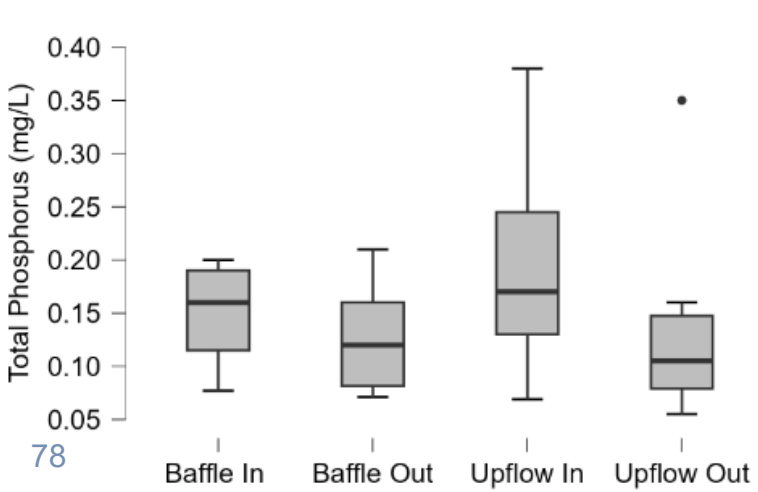


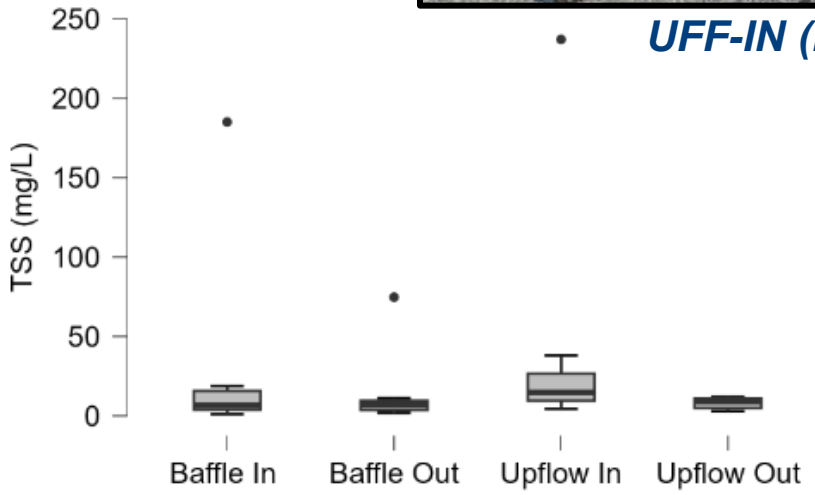


Performance – Study 2 Autosampling Results



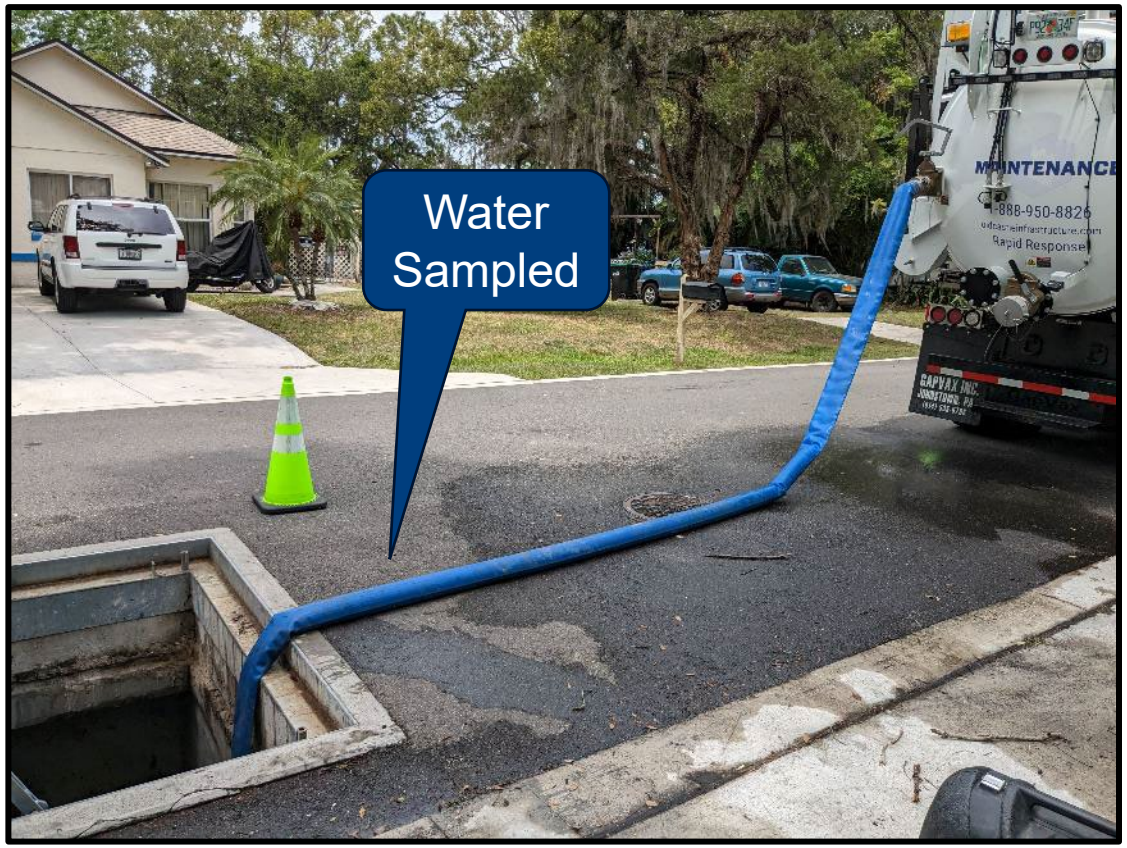
- ***UFF-IN (left) UFF-OUT (right) 4-7-2025***





Performance

Cleaning Event Sampling



Decanting Excess Water Prior to Site Departure

Dumped Debris Pile for Sediment Sampling

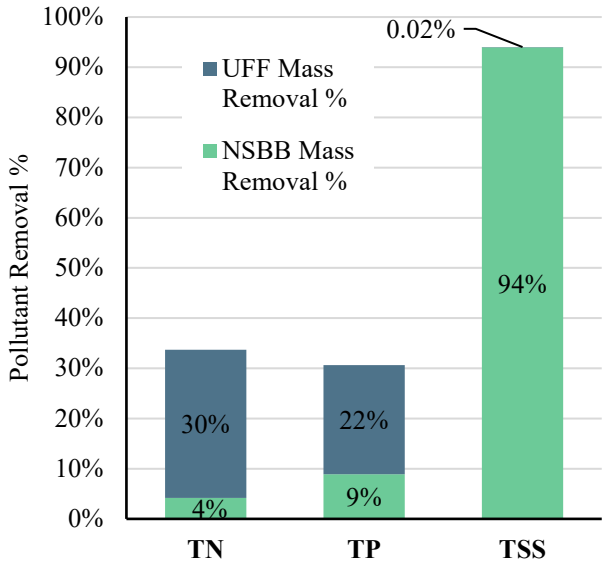
Performance – Cleaning Event Results

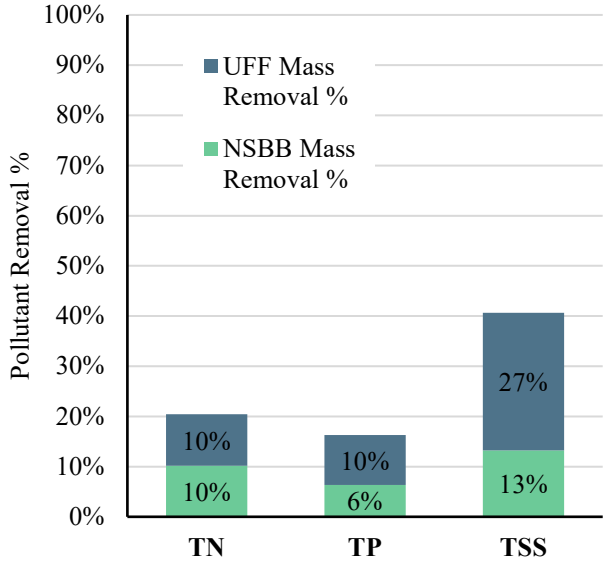
Study	Cleaning Date	Sediment			Purge Water		TOTAL	
		Total Dry Mass of Solids Collected (lb)	TP Removed (lb)	TN Removed (lb)	TP Removed (lb)	TN Removed (lb)	TP Removed (lb)	TN Removed (lb)
1	3/28/2024	4,749	0.39	0.65	0.03	0.23	0.42	0.88
	10/9/2023	4,932	0.25	3.30	0.23	2.81	0.49	6.11
	5/9/2023	3,574	0.07	0.29	0.25	1.56	0.32	1.85
	2/23/2023	10,153	1.81	2.37	0.35	2.01	2.16	4.38
	11/15/2022	6,456	0.56	0.83	0.03	0.64	0.58	1.47
	TOTAL	**29,865**	**3.08**	**7.44**	**0.90**	**7.25**	**3.97**	**14.69**
2	6/25/2024	4,240	0.65	2.04	0.34	2.17	0.99	4.21
	9/3/2024	5,720	1.07	0.67	0.05	0.62	1.12	1.29
	12/12/2024	5,326*	0.28	0.55	0.05	0.66	0.32	1.21
	4/8/2025	18,160	3.87	9.28	0.38	1.41	4.24	10.70
	TOTAL	**28,120**	**5.86**	**12.55**	**0.81**	**4.87**	**6.68**	**17.41**
COMBINED TOTAL		**57,985**	**8.94**	**19.99**	**1.71**	**12.12**	**10.65**	**32.10**
ANNUAL ESTIMATE**		**21,556**	**3.32**	**7.43**	**0.64**	**4.51**	**3.96**	**11.93**

Performance – Inflow Concentrations

Study	Total Flow Volume (gal)	Outflow TN (mg/L)	Outflow TP (mg/L)	Outflow TSS (mg/L)	TN Outflow Mass (lb)	TP Outflow Mass (lb)	TSS Outflow Mass (lb)
1	15,498,430	2.34	0.27	11.62	302.02	34.85	1,500
				Cleaning Removal (lb)	13.22	3.39	23,409
				Total Inflow mass (lb)	315.25	38.24	24,909
				Total Inflow mass (mg)	142,993,728	17,345,958	11,298,326,960
				Total Inflow Volume (L)	58,667,939	58,667,939	58,667,939
				Theoretical Influent Concentration (mg/L)	**2.44**	**0.30**	**192.58**
Study	**Total Flow Volume (gal)**	**Outflow TN (mg/L)**	**Outflow TP (mg/L)**	**Outflow TSS (mg/L)**	**TN Outflow Mass (lb)**	**TP Outflow Mass (lb)**	**TSS Outflow Mass (lb)**
2	88,406,549	1.46	0.20	15.84	1,074.91	147.1	11,661
				Cleaning Removal (lb)	17.41	6.68	28,120
				Total Inflow mass (lb)	1,092.33	153.8	39,781
				Total Inflow mass (mg)	495,471,404	69,752,423	18,044,172,846
				Total Inflow Volume (L)	334,655,192	334,655,192	334,655,192
				Theoretical Influent Concentration (mg/L)	**1.48**	**0.21**	**53.92**
				OVERALL AVERAGE THEORETICAL INFLUENT CONCENTRATION (mg/L)	**1.96**	**0.25**	**123.25**

Performance





Overall Pollutant Removal

Study			TN	TP	TSS	units
1	1	NSBB In Mass	315.25	38.24	24,908.55	lb
	2	NSBB Out Mass	106.08	12.24	526.78	lb
	3	UFF In Mass	195.94	22.61	973.00	lb
	4	UFF Out Mass	102.85	14.28	964.35	lb
	5	NSBB Mass Removal [1-(2+3)]	13.22	3.39	23,408.76	lb
	6	UFF Mass Removal [3-4]	93.09	8.33	8.65	lb
	7	Overall Mass Removal [5+6]	106.31	11.72	23,417.41	lb
2	1	NSBB In Mass	1,092.33	153.78	39,780.59	lb
	2	NSBB Out Mass	607.38	89.12	21,365.17	lb
	3	UFF In Mass	373.92	54.87	13,152.99	lb
	4	UFF Out Mass	261.37	39.60	2,241.06	lb
	5	NSBB Mass Removal [1-(2+3)]	111.02	9.79	5,262.44	lb
	6	UFF Mass Removal [3-4]	112.55	15.26	10,911.93	lb
	7	Overall Mass Removal [5+6]	223.57	25.05	16,174.37	lb

Reasons for decreased performance in Year 2

- Increased flow bypassing the upflow filter
- Upflow Filter needs cleaning

Summary and Conclusions

- Overall Average Nutrient Removals
  - 27% for TN (284 lb/yr) - ACTUAL
  - 50% for TN (530 lb/yr) - EXPECTED

  - 16% for TP (39 lb/yr) - ACTUAL
  - 49% for TP (80 lb/yr) - EXPECTED

- Cost Benefit
  - $387 per lb of TN removed
  - $2,187 per lb of TP removed

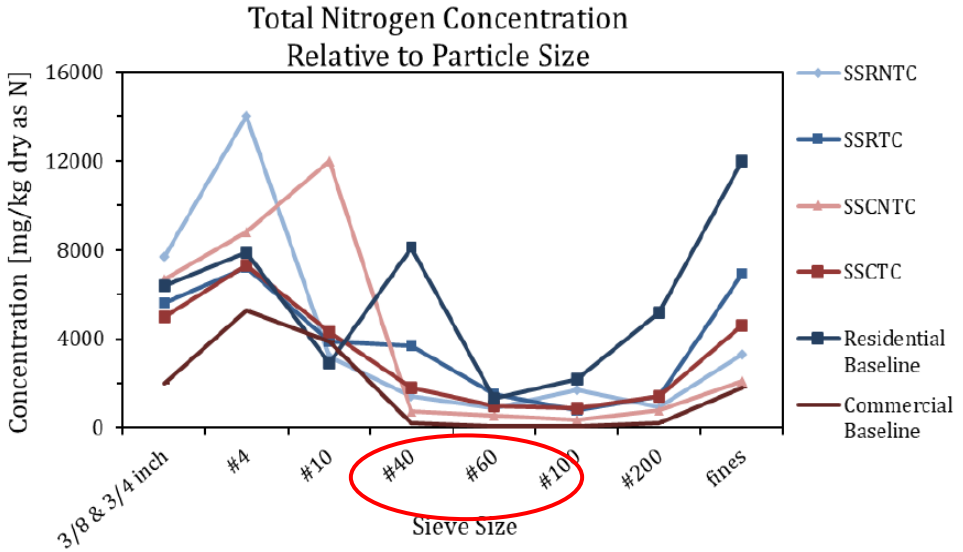
Geosyntec consultants

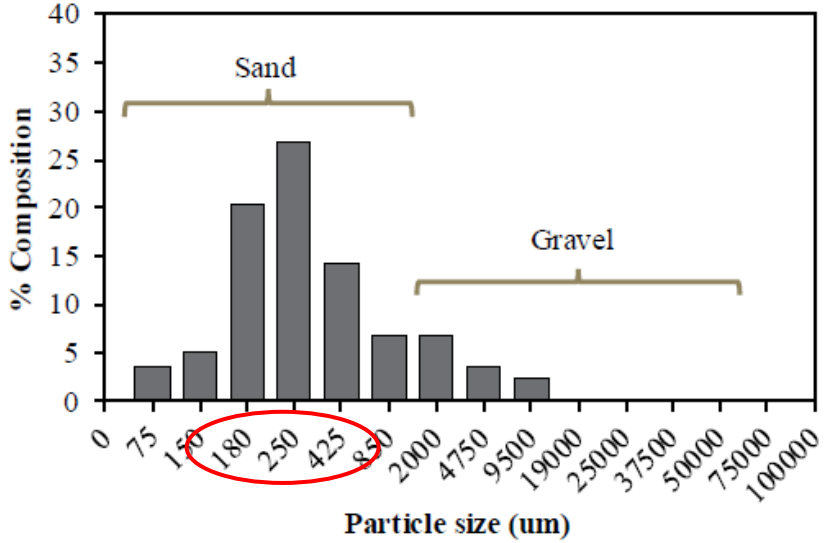
Lessons Learned

Lessons Learned

Baffle Box Performance

- Land use matters
- Performance dependent on organic load
- Organic load highly correlated with particle size





Fines

#100

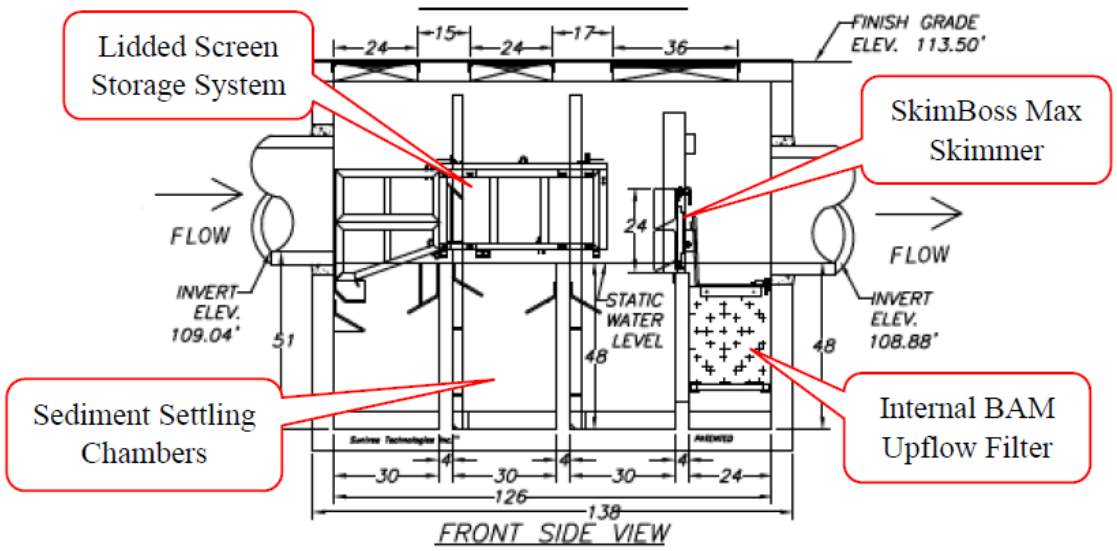
#40

Lessons Learned

Upflow Filter Performance

- Works much better when installed off-line
  - Other studies have shown poor nutrient removal performance when the upflow filter is installed in-line with the baffle box.
  - Off-line upflow filters can be sized appropriately for the expected flow rate.
  - In-line upflow filters are constrained by the size of the Baffle Box footprint.
- Need to inspect and clean regularly
  - Organic sediment accumulation observed in the upflow filter.

baffle box with in-line upflow filter



Lessons Learned

Surcharged System Challenges

- More difficult to clean and maintain
- Sungates are imperfect – and Oldcastle doesn't make them anymore
- Flows frequently bypass the Upflow Filter during the wet season peak
  - About 58% of the total stormwater inflow bypassed the upflow filter
  - Compared to about 12% bypass (Seminole County, non-surcharged baffle box with upflow filter)

Design and Post-Design Considerations

- Utility locates are never perfect
- Design updates are frequently needed during construction due to unknown site variables and constraints.

Thank you!

Questions?

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