DRAINAGE TECHNICAL MEMORANDUM

PEARCE DRAIN / GAP CREEK FLOOD MITIGATION SITE

PROJECT NO. 6115800 | Manatee County, FL

November 2023

PREPARED FOR:

Manatee County FLORIDA

PREPARED BY:

PATEL, GREENE & ASSOCIATES, LLC
12570 Telecom Drive
Temple Terrace, Florida 33637
Phone: 813-978-3100
Contact: Austin Goff, PE

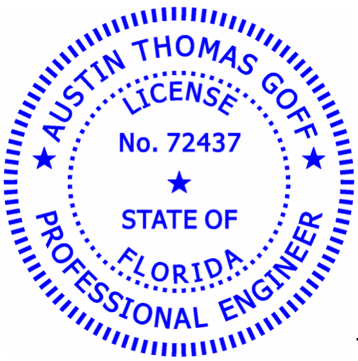
SIGNATURE PAGE

PROJECT: **Pearce Drain /Gap Creek Watershed Flood Mitigation Site**

PROJECT NUMBER: **6115800**

SCOPE OF RESPONSIBILITY: **Drainage Design Calculations**

SECTION(S) / PAGE RANGE(S): Drainage Report (pg1-pg164)



This item has been digitally signed and sealed by:

On the date adjacent to the seal.

Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Patel, Greene & Associates, LLC
12570 Telecom Drive
Temple Terrace, FL 33637
Austin T. Goff, P.E. No. 72437

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1.0 PROJECT DESCRIPTION

1.1 PROJECT OVERVIEW

Manatee County proposes to excavate a recently acquired 10.17 acre parcel of land to increase flood plain volume for the Pearce Drain watershed. This flood plain site will have a direct hydraulic connection to the existing drainage ditch. The project further proposes to extend the cross drain adjacent to the site along 33rd Avenue to remove the guardrails along the roadway. Please refer to **Appendix A** for the project location. The project includes side slope stabilization improvements where the site connects into the existing ditch. The purpose of this drainage technical memorandum is to provide a summary of the existing drainage conditions and proposed improvements related to this project. A feasibility analysis has also been performed to evaluate the cost/benefit associated with the potential inclusion of a Nutrient Separating Baffle Box (NSBB), and the results are presented in **Appendix C** for consideration by the County.

All elevations presented are in the North American Vertical Datum of 1988 (NAVD 88).

1.2 RESOURCES FOR ANALYSIS

The following resources were used in the analyses performed for this report.

- Manatee County Public Works Standards, Part 2. Stormwater Management Design Manual, June 2015
- FDOT Drainage Manual, 2023
- FDOT Drainage Design Guide, 2023
- Environmental Resource Permit Applicants' Handbook, Volume I, December 2020
- SWFWMD ERP Applicants' Handbook, Volume II June 2018
- Topographic Survey
- LiDAR Contours
- USGS Quad Map

2.0 SCOPE OF WORK

The drainage related scope of services for this project includes the following tasks:

- Provide a quantifiable increase in flood plain volume added to the Pearce Drain sub-basin.
- The final design will ensure existing drainage features are not adversely impacted by the project.
- Provide feasibility studies and measurable benefits for a Nutrient Separating Baffle Box.
- Provide permitting services and Final Construction Plans and Documents

3.0 EXISTING DRAINAGE CONDITIONS

In the existing conditions, the majority of the runoff sheet flows from the crown of 33rd Avenue east to the Pearce Drain Canal east of the project site. Approximately 472 acres from the basin west of 33rd Street flows towards Pearce Drain via a cross drain under 33rd Street East just north of the project site. There is one cross drain within the project limits, see table 1 below. There are no existing stormwater management facilities on the project site.

Table 1: Existing Cross Drains

Cross Drain	Station	Barrels / Size	Material
1	9+61	(1) – 58”x91”	ERCP

3.1 EXISTING DRAINAGE BASINS

The project is located within the Gap Creek, Manatee River WBID. Stormwater outfalls from the project flow to Gap Creek which is east of the project. The two creeks Gap Creek and Pearce Drain discharge to the Manatee River as Gap Creek, however just south of 53rd Avenue East and west of 37th Street East they separate with Gap Creek extending west and Pearce Drain extending further south. The general flow direction of Pearce Drain is from south to north and ultimately discharges to the Manatee River before flowing west to the Gulf of Mexico. Please refer to **Appendix A** for the WBID and USGS maps. The basin area contributing to the cross drain under 33rd Street East comprises of varying uses including of Industrial, commercial, extractive, open lands, transportation / utilities, reservoirs, streams and lakes, freshwater marshes, pine flat woods, mixed forest cropland and pastureland comprising 472 acres. Please refer to **Appendix A** for basin area.

3.2 FLOODPLAIN INFORMATION

The project limits are within Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panel number 12081C0317E for Manatee County, Florida, dated March 17, 2014. The project lies within Zone A per above referenced map. The purpose of this project is to provide flood plain storage volume for the Pearce Drain / Gap Creek basin.

Minor filling of the ditch located north of the site, for the removal of the existing guardrails, will be offset by the significant storage volume created by the proposed project. Please refer to **Appendix A** for the FEMA Maps.

Per the Manatee County watershed model the floodplain elevation for our site at 15.9 (NAVD 88). Refer to **Appendix A** for image.

3.3 SOIL CHARACTERISTICS

Soil data was obtained using the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey for Manatee County, Florida. The soil type within the project limits is predominantly comprised of fine silty sand with a seasonal water depth of approximately 5 feet below ground. Please refer to the excerpts from Limited Phase II Environmental Site Assessment by Professional Services Industries, Inc. dated November 28, 2022 and USDA NRCS Soils Report, provided in **Appendix D**.

3.4 OPERATIONAL CONDITION OF DRAINAGE INFRASTRUCTURE

A “plans in hand” field review is currently scheduled to evaluate the existing drainage infrastructure and validate the proposed layout. After reviewing the video inspection on the existing cross drain on 33rd Street the pipe appears to be in good condition. At this time, we do not recommend a replacement.

4.0 PROPOSED DRAINAGE DESIGN

4.1 PROPOSED IMPROVEMENTS

The project will excavate the existing site to provide flood mitigation volume within the Pearce Drain /Gap Creek Watershed. The NSBB feasibility analysis will be reviewed by the County for a final decision on inclusion of these improvements.

4.2 PERMIT REQUIREMENTS

The project will apply for an ERP application with SWFWMD. A pre-application meeting is scheduled for December 21st, 2023, and the design team will discuss the potential for permitting the provided floodplain volume as “credits” for future improvements within the basin.

4.3 APPROXIMATE FILL VOLUME

PRODUCED FILL QUANTITIES		
STAGE (NAVD 88)	CLEAN FILL	NOT CLEAN FILL
FEET	CY	CY
14.5 - 10	27,277*	7,793*
10 – 6	41,810*	11,946*
6 – 3	29,802*	8,515*

Estimated volume of available clean fill **98,889 CY***

*This estimate is based on the Limited Phase II Environmental Site Assessment where Arsenic was encountered at or exceeding the limit in boring SB-1 (0-6”), SB-7 (0-6”) & (6”-2’), approximate assumption is 2 out of 9 sample borings or 22% of the soil may contain contaminants. Arsenic levels were encountered, but they were below the detection limit. The above table is subject to change based on additional soil exploration and analysis currently scheduled for this project. The bottom is set at elevation 3.00 relative to NAVD 88.

4.4 APPROXIMATE FLOOD PLAIN VOLUME CREATED WITHIN SITE

Stage (NAVD)	Stage Area (Acres)	Stage Volume (AF)	Accumulated Volume Acre Feet (AF)
14.5	0.58	0.47	55.06
14	1.31	7.1	54.59
12	5.79	14.17	47.49
10	8.38	33.32	33.32
6	8.28	0	0

The above volume is based on follow up geotechnical exploration confirming an estimated seasonal high ground water table elevation of 6.0 (NAVD 88).

5.0 NUTRIENT SEPARATING BAFFLE BOX FEASIBILITY STUDY & MEASURABLE BENEFITS

ESTIMATED POLLUTANT LOAD REDUCTION CALCULATIONS
NUTRIENT SEPARATING BAFFLE BOX
FOR PEARCE DRAIN CROSS DRAIN ON 33RD STREET

BMP's Installed Baffle Box	TSS* kg / yr.	TP kg / yr.	TN kg / yr.
Pre-Project	85,992	300.05	1,605.05
Load Reduction	28,204	46.51	305.76
Post-Project	57,786	253.54	1,299.29
% Reduction**	67.2	15.5	19.05

*Based on 450 Kg / (Ha*Yr.) * # Acres * (1 Ha/2.47 Ac) Ref: Martin P. Wanielista & Yousef A. Yousef, 1993
% Reduction per Suntree Technologies Inc. now Oldcastle, Inc. See **Appendix C for documentation. Final Report Baffle Box Effectiveness Monitoring Project DEP Contract No. S0236 dated 1/7/2010.

The total project amount of Nitrogen removed from BMP is 305.76 kg/yr. or 13,481.7 lb. / 20 Yr.
The total project amount of Phosphorus removed from BMP is 46.51 kg./yr. or 2,050.74 lb. / 20 Yr.
The total project amount of TSS removed from BMP is 28,204 kg/yr. or 1,243,584 lb. / 20 Yr.

The cost of the BMP's with project is $528,000.00. ($264,000 cost of baffle box, based on feedback from several contractors who have installed these structures, the installed cost is approximately 2 times the cost of the structure. Baffle Box = $528,000 associated pipe, structure, and flared end section = $ 109,737. Total = $637,737. Opinion of Probable Cost, provided in **Appendix C**.

The cost to remove 1.0 lb of Nitrogen over 20 years is $637,737 / 13,481.7 lb.= $47.31 / lb.

The cost to remove 1.0 lb of Phosphorous over 20 years is $637,737 / 2,050.74 lb = $310.98 / lb.

The cost to remove 1.0 lb of TSS over 20 years is $637,737 / 1,243,584 lb = $ 0.51 / lb.

6.0 ASSUMPTIONS

- The county owns and has control over the ditch to the north to permit the improvements shown.
- Follow-up geotechnical exploration currently scheduled (by others), does not change the quantity of unfit soils found on site.
- The estimated season high ground water table elevation of 6.0' is verified by the soil investigative study by others.
- No protected species (flora and fauna) are present.
- Additional contaminants, etc. are not present on the subject parcel.

7.0 SUMMARY

Based on the information provided in this report, the system will provide measurable benefits for TSS removal if properly maintained to consistently achieve that benefit for 20 years. The operation and maintenance plans will be filed at the County Office and a report generated every two (2) years describing the operation and maintenance activities that have taken place and certifying the measurable benefit has been achieved.

The reduction of 13,481.7 pounds of nitrogen, 2,050.7 pounds of phosphorous, and 1,243,584 pounds of TSS would be a benefit to the residents of Manatee County. The Nutrient Separating Baffle Box would provide measurable benefits to the watershed by removing organic matter and litter from stormwater, thus preventing bacterial discharge and significantly reducing nutrient loads. The above stated removal quantities can be confirmed with in field measurements during maintenance activities to demonstrate the weight of removed TSS, TN, TP over the life of the NSBB device. This location also benefits from a cost saving since the flood mitigation excavation improvements for additional flood plain volume were scheduled to be undertaken regardless of the NSBB construction and are not required by the inclusion of the NSBB device.

8.0 RECOMMENDATION

Final recommendation to be completed with final submittal. One method for evaluating the effectiveness of this project is to consider the cost benefit. The information below provides two sets of data for comparison.

First this project would result in a lower cost per pound of removal than the County's recent Rubonia Subdivision Drainage Improvement project.

Nutrient Removal	Cost per lb. of removal Pearce Drain	Cost per lb. of removal Rubonia
TSS	$0.51	$6.67*
TN	$47.31	$615.70*
TP	$310.98	$2,313.24*

*Rubonia Subdivision Drainage Improvements, Revised 2/14/19, see **Appendix C** Life Cycle Cost Range

Second this project would qualify for the maximum points allotted in the SWFWMD Cooperative Funding scoring matrix for cost effectiveness. However, due to other factors this project would not qualify for funding.

$60.05 / lb** < $150 = 25 Points This would fall in the maximum 25-point range per Metrics for Scoring Cost Effectiveness ($637,737 opinion probable cost +$171,750 design fees = $809,487 / 13,481.7 lb over 20 years)

Cooperative Funding Initiative Guidelines, Southwest Florida Water Management District for Fiscal Year 2025, CFI Process Overview. Refer to **Appendix C.

APPENDICES

Appendix A Design Documents

- Project Location Map
- USGS Quadrangle Map
- WBID Map
- Lidar Map
- FEMA FIRM Panel

Appendix B Project Correspondence

- County Correspondence
- Conceptual Phase Comments

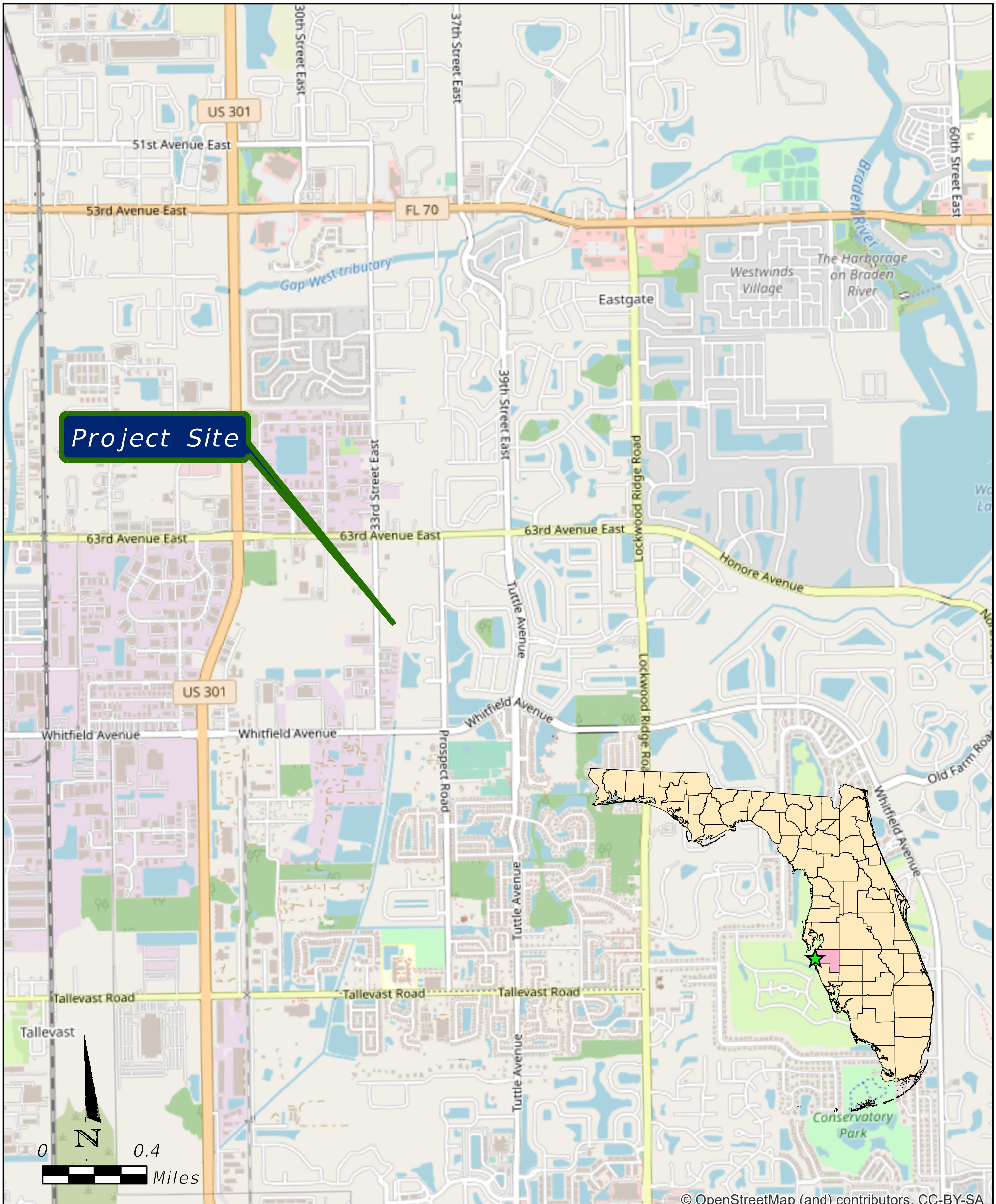
Appendix C Drainage Calculations

- BMP Load Reduction Calculations
- Life Cycle Cost for NSBB
- BMP Cost Range Comparison
- Diversion Manhole Calculations
- Excavation Calculations Exhibits
- Flood Plain Volume Creation Exhibits

Appendix D Geotechnical Information

- Excerpts from Limited Phase II Environmental Site Assessment
- NRCS Soil Survey

Appendix A
Design Documents



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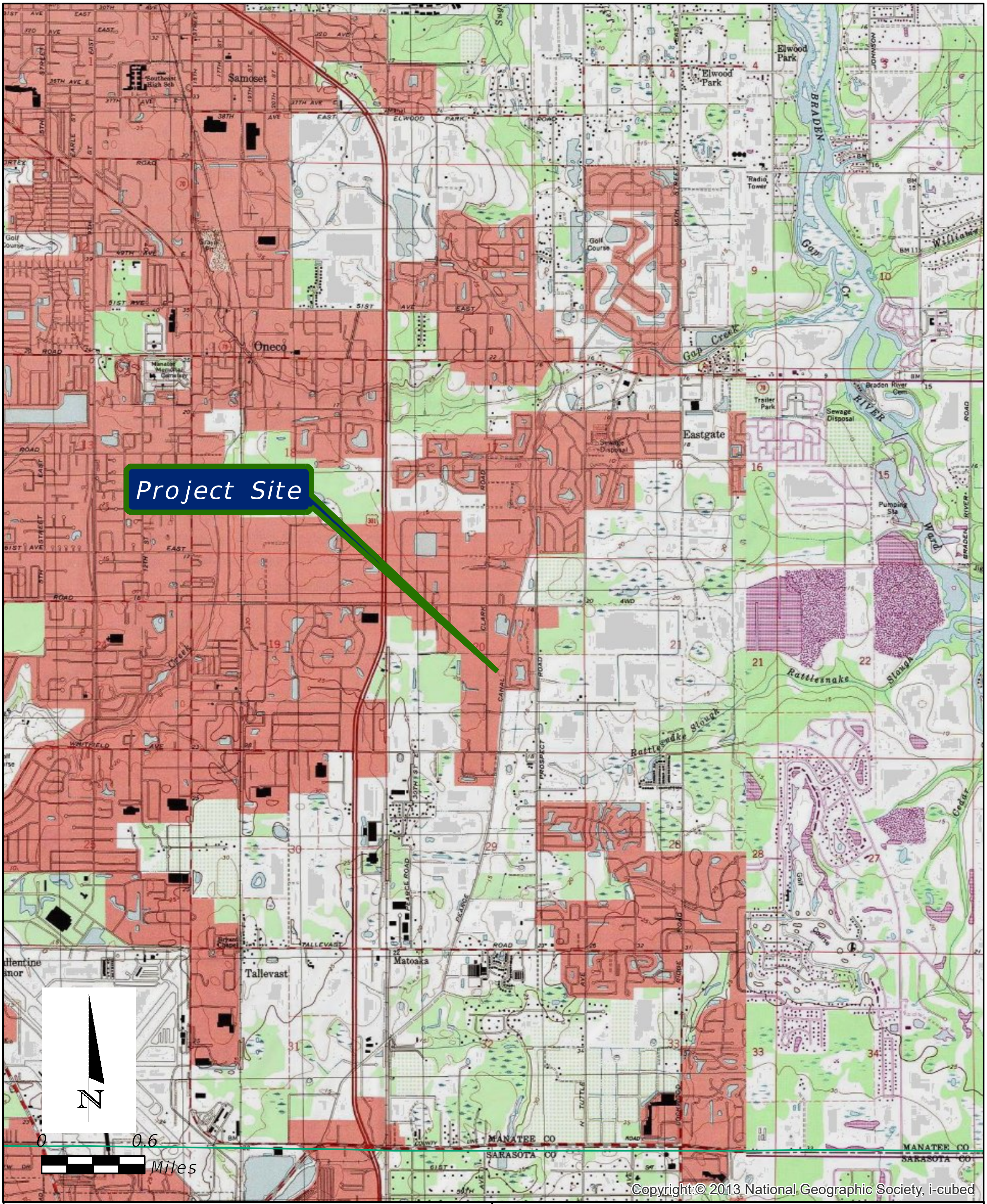
Project Location Map

Pearce Drain/Gap Creek Watershed Flood Mitigation Site

County Porject No.: 6115800

Date: 11/1/2023



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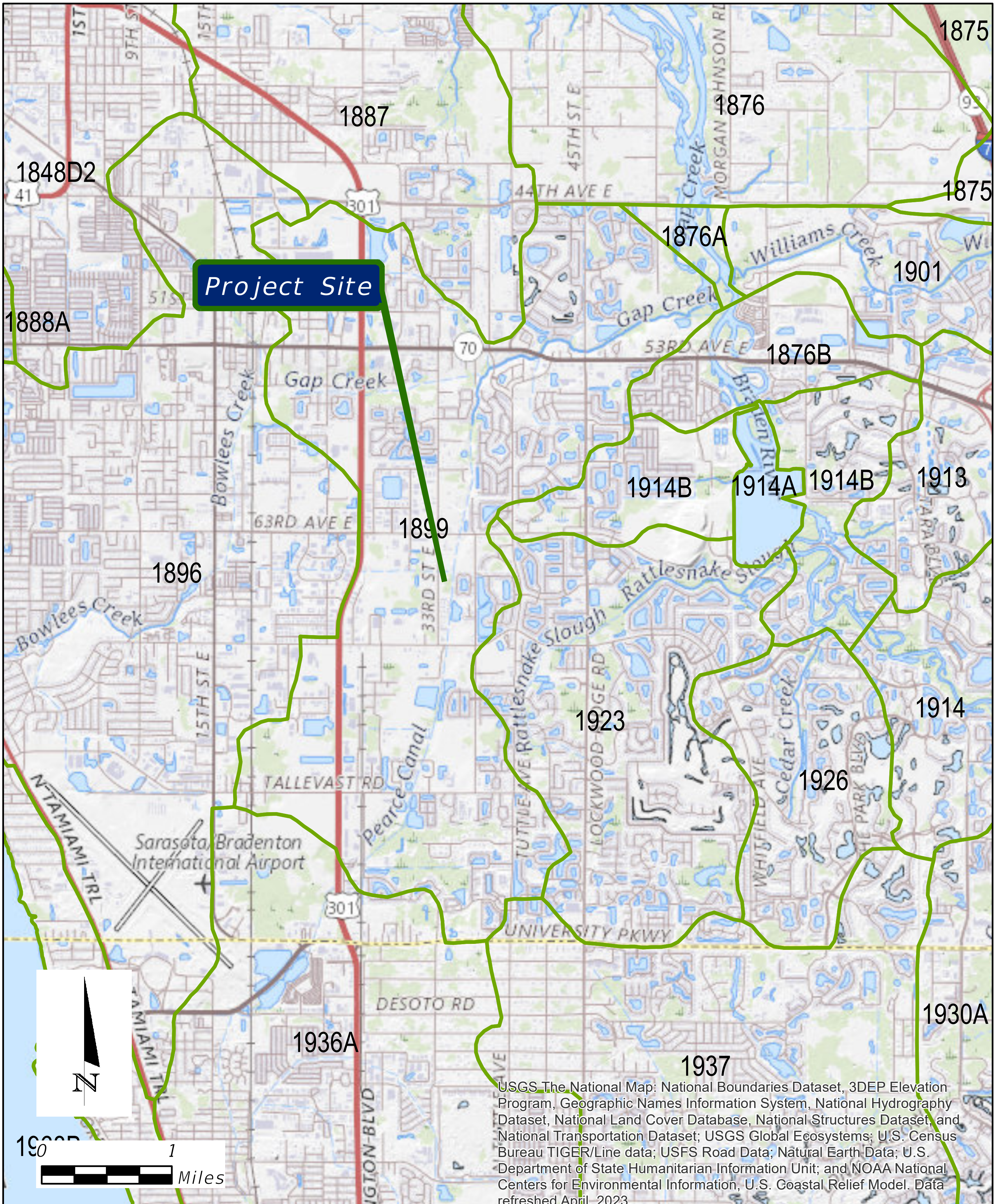
USGS Quad Map

Pearce Drain/Gap Creek Watershed Flood Mitigation Site

County Project No.: 6115800

Date: 11/10/2023



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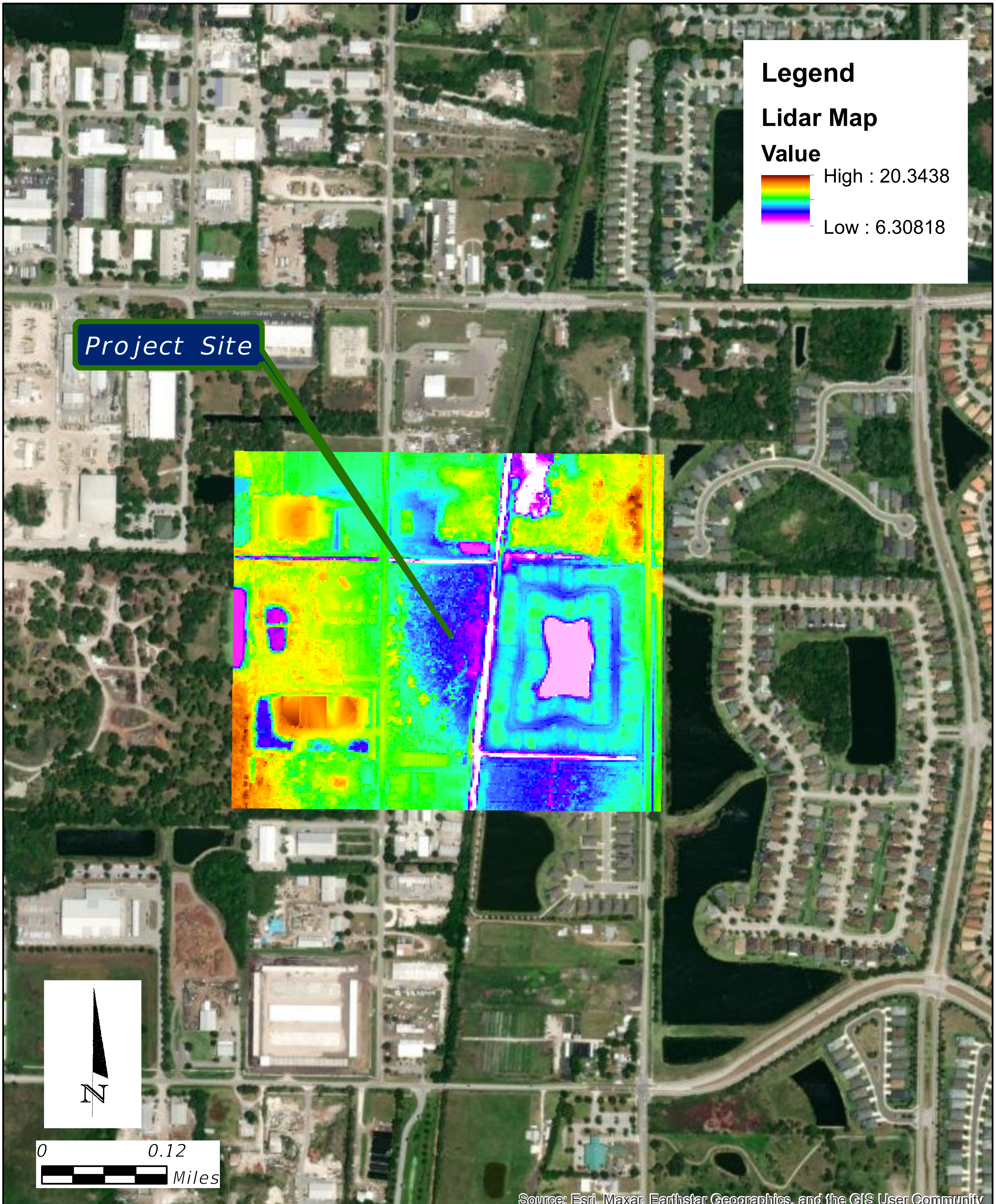
WBID Map

Pearce Drain/Gap Creek Watershed Flood Mitigation Site

County Project No.: 6115800 — *Date: 11/10/2023*



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Lidar Map

Pearce Drain/Gap Creek Watershed Flood Mitigation Site

County Project No.: 6115800

Date: 11/1/2023

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures.** Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Florida State Plane west zone (FIPSZONE 0902). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum.** For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242,** or visit its website at http://www.ngs.noaa.gov/.

Base map orthophotography was obtained from Southwest Florida Water Management District (SWFWMD) from one-foot resolution digital orthoimagery flown in 2008 and 2009. Vector base map data was provided by Manatee County and SWFWMD. Vector information was compiled in 2003 - 2009 by Manatee County GIS department.

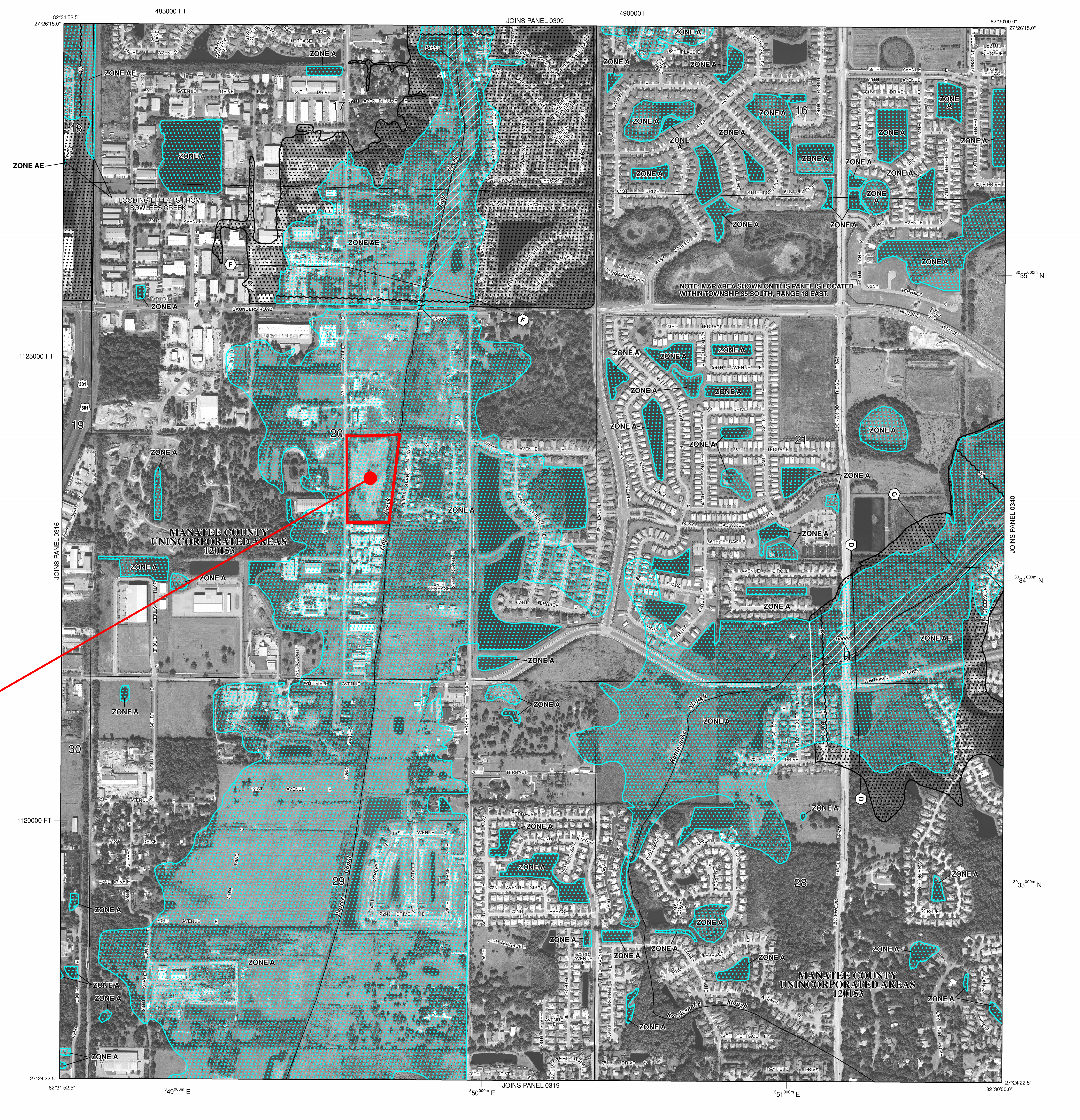
This map may reflect more detailed or up to date stream channel configurations than those shown on the previous FIRM. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations and improved topographic data. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the **FEMA Map Service Center** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the **FEMA Map Service Center** website or by calling the FEMA Map Information eXchange.

PROJECT LOCATION



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 17
6000000 FT	5000-foot grid ticks: Florida State Plane coordinate system, west zone (FIPSZONE 0902), Transverse Mercator
DX5510	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
March 17, 2014
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0317E

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
MANATEE COUNTY, FLORIDA
AND INCORPORATED AREAS

PANEL 317 OF 575
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MANATEE COUNTY	120153	0317	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
12081C0317E

EFFECTIVE DATE
MARCH 17, 2014

Federal Emergency Management Agency

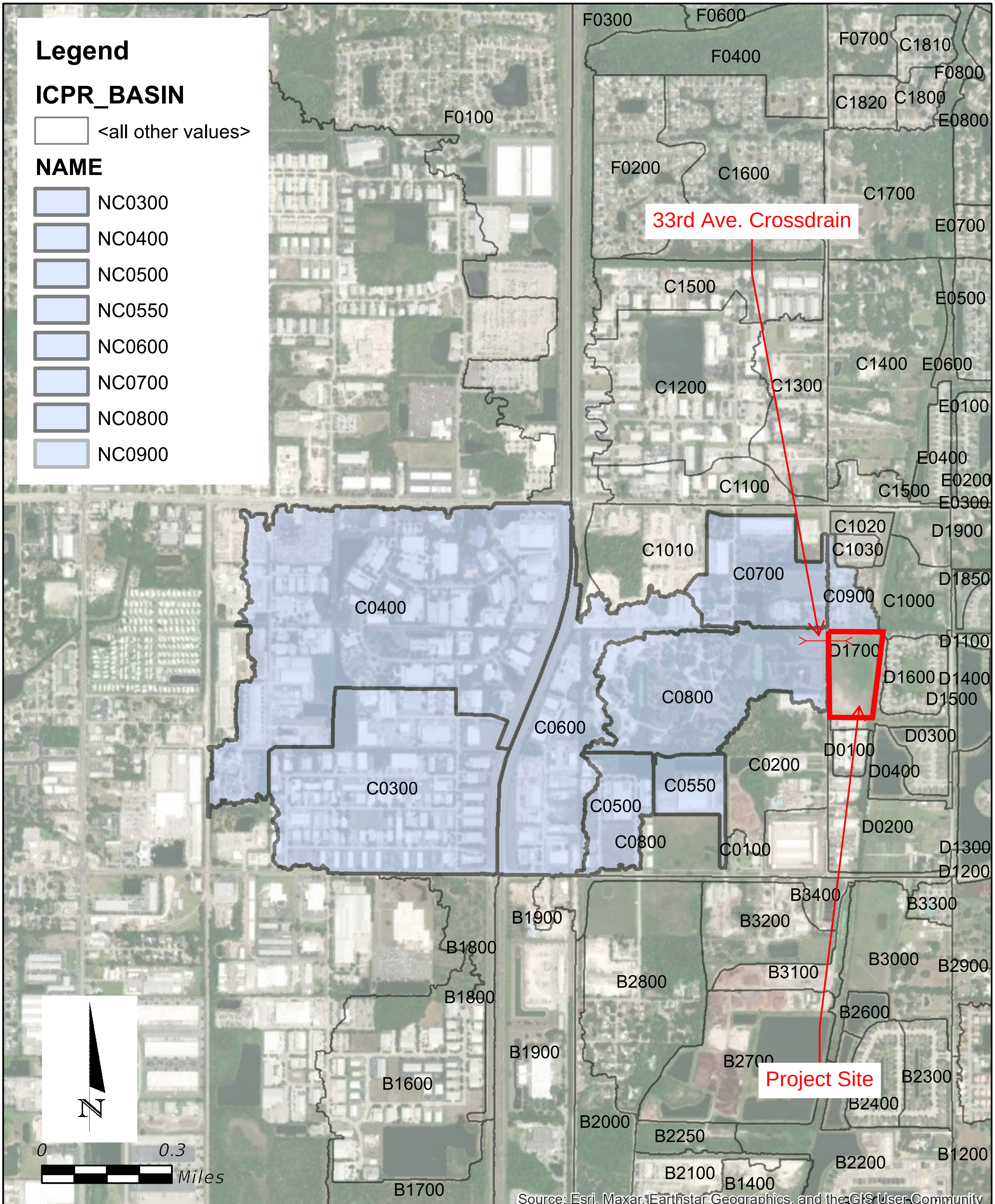
Manatee County FLORIDA

Patel, Greene & Associates, LLC
12570 Telecom Drive
Temple Terrace, FL 33637
Austin Goff, P.E. #72437

Manatee County Base Flood Elevations

Pearce Drain Flood Mitigation Site

County Project No. 6115800 | Date: 11/10/2023



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33rd Avenue Crossdrain

Basin Map

County Project No.: 6115800 | *Date: 11/10/2023*

Appendix B

Project Correspondence

Patel, Greene & Associates, LLC | 12570 Telecom Drive, Temple Terrace, FL 33637
813.978.3100 | patelgreene.com

MEETING MINUTES

Teams Call

DATE/TIME: June 20, 2023; 2:00pm – 3:00 pm

PROJECT: **Manatee County Pearce Drain Watershed – Flood Mitigation Site**

LOCATION: Teams Call

ATTENDEES: Jerry Varghese (Manatee County M.C.); Anthony Russo (M.C.); Tom Gerstenberger (M.C.); Kenneth Kohn, (M.C.); Richard Uptegraff (PGA); Michael Holt (PGA); Austin Goff (PGA).

The following notes reflect PGA's understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments regarding elements contained in these minutes, please contact PGA. The minutes will be considered accurate unless written notice is received within five working days of the date issued.

1. The focus of this project is to construct a floodplain compensation site on the acquired parcel adjacent to Center Lake. This project will require an environmental resource permit.
2. Manatee County (the County) requests a quick turnaround, with plans and permit available for bid sometime around March 2024 as a goes-with project to the 63rd Ave construction. The proposed site is to have a direct connection with Pearce Drain.
3. The scope shall include design and permitting of the pond. A contract has been awarded to WSP for a Phase II ESA to determine the suitability of on-site soils as fill. Park Coastal has been awarded the survey work. WSP has been awarded the wetland jurisdiction delineation and/ or surface water determination and 404 related permitting.
4. The County will provide Richard with contact information for all awarded services so he can oversee and coordinate services on this project.
5. The scope shall include at a minimum excavating the proposed site to the same depth as the adjacent Pearce Drain, but sufficient to impede the growth of cattails, etc. The County has no desire to extend the pond depth to (-)7.00' NAVD to obtain additional fill dirt as shown on the exhibit by Geosyntec.
6. There has been talk about a passive park and/or shell trail at the perimeter of the parcel, but that is not to be included in the scope at this time.
7. No improvements to 33rd Street are to be included in the scope at this time.
8. The scope is to include an investigation to determine if the north ditch can be included or diverted into the proposed site.
9. Floodplain compensation credit volume will be quantified and provided to the county. This project will not be pursuing wetland mitigation credits for a wetland bank or ledger. The county shall confirm that a feasibility study including cost, size, and permitting requirements will be added to the project scope for a Nutrient Separating Baffle Box (NSBB) by Sun Tree Technology successor company.

10. The County shall confirm that a 15’ maintenance berm is required if 4H:1V side slopes are proposed. If the pond utilizes 2H:1V side slopes a 20-foot maintenance buffer is required with chain link perimeter fence.
11. The project is to include a typical paved access driveway near the south property line for maintenance access.
12. No modeling is required. Geosyntec has already quantified that this pond will not have a significant impact on the 100-year flood stage.
13. PGA is to provide a proposal with staff hours and scope. The project is expected to be awarded as a task work order under the current Transportation/Stormwater continuing services contract.

ACTION ITEMS:

1. PGA to prepare scope, staff-hours, and fee.
2. County to provide contact information for point of contact for ancillary services already delegated for this project. - Done
3. County to confirm addition of investigation of suitability/feasibility of the NSBB at the northern edge of the property to the current scope of services.

Appendix C

Drainage Calculations

BMP Load Reduction Calculations

Complete Report (not including cost) Ver 4.3.5

Project: Pearce Drain
Date: 11/14/2023 12:44:26 PM

Site and Catchment Information

Analysis: BMP Analysis

Catchment Name	Pearce Drain Reservoir Industrial
Rainfall Zone	Florida Zone 4
Annual Mean Rainfall	52.00

Pre-Condition Landuse Information

Landuse	User Defined Values
Area (acres)	472.79
Rational Coefficient (0-1)	0.52
Non DCIA Curve Number	72.00
DCIA Percent (0-100)	59.00
Nitrogen EMC (mg/l)	1.225
Phosphorus EMC (mg/l)	0.229
Runoff Volume (ac-ft/yr)	1,062.649
Groundwater N (kg/yr)	0.000
Groundwater P (kg/yr)	0.000
Nitrogen Loading (kg/yr)	1,605.052
Phosphorus Loading (kg/yr)	300.046

Post-Condition Landuse Information

Landuse	User Defined Values
Area (acres)	472.79
Rational Coefficient (0-1)	0.52
Non DCIA Curve Number	72.00
DCIA Percent (0-100)	59.00
Wet Pond Area (ac)	0.00
Nitrogen EMC (mg/l)	1.225
Phosphorus EMC (mg/l)	0.229
Runoff Volume (ac-ft/yr)	1,062.649

Groundwater N (kg/yr)	0.000
Groundwater P (kg/yr)	0.000
Nitrogen Loading (kg/yr)	1,605.052
Phosphorus Loading (kg/yr)	300.046

Catchment Number: 1 Name: Pearce Drain Reservoir Industrial

Project: Pearce Drain
Date: 11/14/2023

User Defined BMP Design

Contributing Catchment Area (acres)	472.790
Provided Nitrogen Treatment Efficiency (%)	19
Provided Phosphorus Treatment Efficiency (%)	16

Watershed Characteristics

Catchment Area (acres)	472.79
Contributing Area (acres)	472.790
Non-DCIA Curve Number	72.00
DCIA Percent	59.00
Rainfall Zone	Florida Zone 4
Rainfall (in)	52.00

Surface Water Discharge

Required TN Treatment Efficiency (%)	
Provided TN Treatment Efficiency (%)	19
Required TP Treatment Efficiency (%)	
Provided TP Treatment Efficiency (%)	16

Groundwater Discharge (Stand-Alone)

Treatment Rate (MG/yr)	0.000
TN Mass Load (kg/yr)	0.000
TN Concentration (mg/L)	0.000
TP Mass Load (kg/yr)	0.000
TP Concentration (mg/L)	0.000

Load Diagram for User Defined BMP (stand-alone)

Load		Treatment		Surface Discharge
N: 1,605.05 kg/yr	→	N: 19 %	→	N: 1,299.29 kg/yr
P: 300.05 kg/yr		P: 16 %		P: 253.54 kg/yr

↓

Mass Reduction
N: 305.76 kg/yr
P: 46.51 kg/yr

Load Diagram for User Defined BMP (As Used In Routing)

Upstream Nodes	Load		Treatment		Mass Discharged
None	N: 1,605.05 kg/yr	→	N: 19.05 %	→	N: 1,299.29 kg/yr
	P: 300.05 kg/yr		P: 15.5 %		P: 253.54 kg/yr
	Q: 1,062.65 ac-ft				Q: 1,062.65 ac-ft

↓

Mass Removed
N: 305.76 kg/yr
P: 46.51 kg/yr

Summary Treatment Report Version: 4.3.5

Project: Pearce Drain

Analysis Type: BMP Analysis
BMP Types:
Catchment 1 - (Pearce Drain Reservoir Industrial) User Defined BMP
Based on % removal values to the nearest percent

Date:11/14/2023

Routing Summary
Catchment 1 Routed to Outlet

Summary Report
Nitrogen
Surface Water Discharge

Total N post load	1605.05 kg/yr	
Percent N load reduction	19 %	
Provided N discharge load	1299.29 kg/yr	2864.93 lb/yr
Provided N load removed	305.76 kg/yr	674.21 lb/yr

Phosphorus

Surface Water Discharge

Total P post load	300.046 kg/yr	
Percent P load reduction	16 %	
Provided P discharge load	253.539 kg/yr	559.05 lb/yr
Provided P load removed	46.507 kg/yr	102.548 lb/yr

Life Cycle Cost for NSBB

Unit Cost Summary

Pearce Drain Flood Reservoir Estimated Present Worth Nutrient Removal Unit Costs For Life Cycle Of: 20 Years				
	TOTAL N	TOTAL P	TSS	PARAMETER-USER CHOICE
	FOR	20	YEAR	DURATION
ESTIMATED POLLUTANT REMOVAL (LBS/YR)	674.0854	102.537	62,179.20	20
ESTIMATED POLLUTANT REMOVAL (LBS FOR LIFE CYCLE DURATION)	13481.71	2050.74	1243584	
ESTIMATED COST PER POUND OF POLLUTANT REMOVED (LOW END OF RANGE) ($/LB)	$97	$639	$1.05	
ESTIMATED COST PER POUND OF POLLUTANT REMOVED (HIGH END OF RANGE)($/LB)	$111	$727	$1.20	

Water Quality Project Life Cycle Cost Analysis

Alternative	
	Pearce Drain / Gap Creek Watershed Flood Mitigation Site

Duration			
	Economic Evaluation Duration	20	years

Construction Cost		Estimated Cost Low[1]	Estimated Cost High[2]
	Initial Capital Cost		
	Capital Cost, Range	$ 637,737	$ 956,606
	Capital Cost Annualized over the Project Evaluation Duration	$ 44,064	$ 66,096

Replacement Costs

	Replacement Costs	Expected Service Life (Years)	# Replacements Over Project Life	1 time Replacement Cost	Replacement Cost (Present Worth Assumed)	Upper End of Estimated Replacement Costs for Selected Elements (Optional): 1 time Replacement Cost	Replacement Cost (Present Worth Assumed)
11	Baffle Box/ Gross Pollutant Separators	60	0.3	$ 637,737	$ 212,579	$ 1,116,000	$ 372,000
0	0	0	#DIV/0!	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	#N/A	#N/A	#N/A	$ 1,000	$ -		$ -
	TOTAL PRESENT WORTH OF REPLACEMENT COST				$ 212,579		$ 372,000
	Replacement Costs Annualized over the Project Life				$ 8,181		$ 14,317

Annual Costs

	Annual Costs	Unit	% of Initial Cost	Present Worth Factor	Present Worth	Annual cost	Upper End of Estimated Annual Costs for Selected Elements (Optional): % of Initial Cost	Present Worth	Annual Cost
	Maintenance Cost of Items Listed in Replacement Cost Section. NOTE!: Must be in same order as Replacement Costs above as Annual Costs link to Replacement Cost Entries			14.4731					
11	Baffle Box/ Gross Pollutant Separators	1	5.00%		$ 461,501	$ 31,887	1.00%	$ 161,520	$ 11,160
0	0	1	0.00%		$ -	$ -	1.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A	0	0.00%		$ -	$ -	0.00%	$ -	$ -
	#N/A		0.00%		$ -	$ -	0.00%	$ -	$ -

	Other Maintenance Costs, $/unit	Unit	$/ unit	Present Worth Factor	Present Worth	Annual cost	$/ unit	Present Worth	Annual Cost
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	0	0	$ -		$ -	$ -	$ -	$ -	$ -
	Electrical Energy		0	kwh	$ -	$ -		$ -	$ -
	TOTAL PRESENT WORTH OF ANNUAL COST				$ 461,501			$ 161,520	
	TOTAL OF ANNUAL COSTS					$ 31,887			$ 11,160

	ESTIMATED REPLACEMENT + O&M ANNUALIZED COST RANGE	$ 40,070	TO	$ 25,480
LCC	TOTAL ANNUALIZED COST RANGE	$ 80,000	TO	$ 90,000
LCC	**TOTAL PRESENT WORTH COST RANGE[3]**	**$ 1,310,000**	**TO**	**$ 1,490,000**

1 - Opinion of Probable Construction Cost on Base Bid Item List Projected Out to Time of Construction
2 - Opinion of Probable Construction Cost plus Contingency plus Add-Alternate Bid Items as Applicable
3 - These are the values used on the Unit Cost Summary Sheet for computing benefit/cost information

FSA Educational Foundation BMP Life-Cycle Tool

Background Information

Project Title:	Pearce Drain Flood Reservoir	Location:	Manatee County	Date:	
Project ID:	6115800				
Prepared by:	ATG	e-mail:	austing.goff@patelgreene.com		
Organization:	PGA	Telephone:	(813) 978-3100		
Address:	12570 Telcom Drive				
City, State Zip:	Temple Terrace, FL 33637				

ASSUMPTIONS:

Economic Evaluation Duration:	20	years
Discount Rate:	3.30%	based on the long-term average CPI from 1915-2015

Cells C10 & C11 are populating from Cell J 5 of the "Life Cycle Cost Analysis" sheet and Cell C2 of the "Discount Rate Factors" sheet, respectively

BMP Cost Range Comparison

RUBONIA SUBDIVISION DRAINAGE IMPROVEMENTS

INDIVIDUAL RESOURCE PERMIT APPLICATION

REVISED: 2/14/19

Manatee County
FLORIDA

John K. Pari, P.E. 56368

Date: 2/14/2019

John K. Pari, PE State of Florida
Professional Engineer, License No. 56368

This item has been electronically signed & sealed by John K. Pari, PE on the date indicated here using a SHA authentication code.

Printed copies of this document are not considered signed & sealed and the SHA authentication code must be verified on any electronic copies.

Rubonia Drainage Improvements
Individual Resource Permit Application
Manatee County Public Works
Revised 2/14/19

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Exhibits (additional)

Pollutant Loading Calculations (Submitted to District under the Cooperative Funding Initiative)

ESTIMATED POLLUTANT LOAD REDUCTION CALCULATIONS

BMP's Installed **Wet Pond # 1** **17.2 Acres**	**TSS*** **Kg/Yr.**	**TP** **Kg/Yr.**	**TN** **Kg/Yr.**
Pre-Project	3,133	10.27	56.51
Post-Project	313.0	2.67	32.81
Load Reduction	2,820	7.6	23.7
% Reduction***	90	74	41.9
Baffle Box # 1 **w/ Upflow Filter** **9.37 Acres**	**TSS*** **Kg/Yr.**	**TP** **Kg/Yr.**	**TN** **Kg/Yr.**
Pre-Project	1,707	5.65	31.09
Post-Project	324	1.19	10.26
Load Reduction	1,383	4.46	20.83
% Reduction**	81	79	67
Baffle Box # 2 **w/ Upflow Filter** **6.67 Acres**	**TSS*** **Kg/Yr.**	**TP** **Kg/Yr.**	**TN** **Kg/Yr.**
Pre-Project	1,215	3.94	21.65
Post-Project	231	0.83	7.15
Load Reduction	984	3.11	14.50
% Reduction***	81	79	67

*Based on 450 Kg /(Ha*Yr.) * # Acre * (1 Ha/2.47 Ac) Ref: Martin P. Wanielista & Yousef A. Yousef, 1993.
**% Reduction per Suntree Technologies, Inc.
*** % Reduction based on FDOT/UCF BMPTRAINS® Version 8.6
EMC (Residential ¼ Acre) = 2.2 mg/L (N) and 0.40 mg/L (P)

ESTIMATED POLLUTANT LOAD REDUCTION CALCULATIONS

Wet Pond # 2 7.12 Acres	TSS* Kg/Yr.	TP Kg/Yr.	TN Kg/Yr.
Pre-Project	1,297	4.24	23.30
Post-Project	130	1.1	13.54
Load Reduction	1,167	3.14	9.76
% Reduction***	90	74	41.9

Total Load Removed	6,354.0 Kg/Yr.	18.31 Kg/Yr.	68.79 Kg/Yr.

The total project amt. of Nitrogen removed from combined BMP's is 68.79 Kg/Yr. or 3,026.8 lb. /20 Yr.
The total project amt. of Phosphorus removed from combined BMP's is 18.31 Kg/Yr. or 805.6 lb. /20 Yr.
The total project amount of TSS removed from combined BMP's is 6,354 Kg/Yr. or 279,576 lb. /20 Yr.
The total treatment area is 40.36 Acres.

The total cost of combined treatment BMP's with stormwater management system is $1,863,545.00.
The cost of 1.0 lb. of Nitrogen removal over 20 years is $1,863,545.00/3,026.8 Lbs. = $615.70/lb.
The cost per Acre is $1,863,545.00/40.36 Acres = $46,173.10.

The cost to remove 1.0 lb. of Phosphorus over 20 years is $1,863,545.00/805.6 Lbs. = $2,313.24/lb.

The cost to remove 1.0 lb. of TSS over 20 years is $1,863,545.00/279,576 Lbs. = $6.67/lb.

*Based on 450 Kg /(Ha*Yr.) * # Acre * (1 Ha/2.47 Ac) Ref: Martin P. Wanielista & Yousef A. Yousef, 1993.
**% Reduction per Suntree Technologies, Inc.
*** % Reduction based on FDOT/UCF BMPTRAINS® Version 8.6
EMC (Residential ¼ Acre) = 2.2 mg/L (N) and 0.40 mg/L (P)

CFI Process Overview

EVALUATION SHEET

District staff review CFI applications and develop concise one-page evaluations of potential projects. The staff evaluation is divided into six sections: project identification, description, evaluation, strategic goals, funding, overall scoring and recommendation.

Project Identification: Project Number, Title, Cooperating Entity (Cooperator), Risk Level and whether it is a Multi-Year Project.

Description: Concise description of the project including benefits and costs.

Evaluation: Includes six sections (Initial Application Quality, Project Benefit, Cost Effectiveness, Past Performance, Complementary Efforts, and Project Readiness) with scoring criteria associated with each section.

Strategic Goals: Separate section tied to the SWFWMD Strategic Plan.If project does not meet a Regional Priority or Strategic Initiative the project will not be recommended for funding.

Overall Scoring and Recommendation: Based on staff evaluation and scoring in both the evaluation and strategic goals sections. A project with a 1A Priority means it is an ongoing project approved for multiple years. With multi-year projects applicants are required to request funds through the CFI cycle each year.

Funding: Identifies the funding sources for the project including the District's share, Cooperator's share, as well as any other outside funding. Funding from prior, proposed and future fiscal years is provided.

CFI SCHEDULE

August:
CFI Workshop and Application Period Open

October:
Application Period Closes

October–February:
Applications Review and Preliminary Scorings Assigned

February:
Preliminary Scorings Presented

April:
Final Scorings presented and Project Presentations

August–September:
Final Budget Approved

RISK LEVELS

Type 1	Type 2	Type 3	Type 4
Requires the least amount of involvement of District staff time to track the progress, ensure the project is consistent with the contract scope of work and sign off on reimbursements to the Cooperator.	Requires more staff involvement to review the Cooperator's contracts with consultants and contractors to ensure the scope and budgets are consistent with the District's cooperative funding contract.	District staff involved in the design phase of the project and may provide meaningful guidance based on the District's experience, expertise and regional understanding that would lead to opportunities to enhance the water resource benefits and efficient use of limited funding.	District is the lead in managing the project activities.

CFI Process Overview

All Project Type Criteria

Criteria	Highest Points Possible	Scoring Criteria
Initial Application Quality	5	All Project Types
Project Benefits	25	Project Type Specific
Cost Effectiveness	25	Project Type Specific
Past Performance	5	All Project Types
Complementary Efforts	10	Project Type Specific
Project Readiness	10	All Project Types
Strategic Goals	25	All Project Types
Total Score	**105**	

Initial Application Quality – 0 or 5 points based on the assessment of the application submitted the first Friday of October. Scores are either 0 points for not enough information to properly evaluate the project for funding consideration or 5 points for all information was provided at the time of application.

Past Performance – 0, 2 or 5 points are assigned to Cooperators based on whether projects are on plan, the timely return of cooperative funding agreements, and expending budgeted funds per funding requests.

Project Readiness – 0-10 points are a sum of two sub criteria: start date (5) and program/construction ready (5). Start date (0-5 points) – start date refers to the date in which expenditure will begin (not encumbering funds or procuring services) 5 points if project starts on or before December 1, 2 points if project starts on or before March 1, 0 points if starts after March 1, Program or Construction is Shovel Ready (0-5 Points) – Conservation Program is already established and implementation of conservation elements will begin on or before December 1 = 5 points. Study supports and aligns schedule with Governing Board prioritized initiatives = 5 points. WMP with available LIDAR as of December 1, 2024. Design and permitting will be completed and project is out for construction bids on or before December 1 = 5 points. 0 points for projects that are not shovel ready by December 1.

Strategic Goals - Scored 25 points if project aligns with both a Strategic Initiative and a Regional Priority or for water quality projects consistent with the Executive Order 19-12. Scored 20 points if project aligns with multiple Strategic Initiatives. Scored 15 points if project aligns with a Strategic Initiative but not a Regional Priority. If project does not meet a Regional Priority or Strategic Initiative the project will not be recommended for funding.

Project Type Specific Criteria

Project Benefits (0-25 Points), Cost Effectiveness (0-25 Points) and Complementary Efforts (0-10 Points) are scored based on metrics developed through analysis of previous projects and efforts that support continued success of the project type being evaluated. Example – For Water Quality Project Type criteria: The pounds of Total Nitrogen (TN) removed, and the receiving water body determine the project benefit score. The cost per pound of TN removed is used to score cost effectiveness. The complementary efforts are scored based on the number of initiatives the Cooperator has implemented to improve water quality such as having a dedicated stormwater fee, street sweeping program, pet waste ordinance, fertilizer ordinance, and/or active education campaign.

METRICS FOR SCORING COST EFFECTIVENESS

Water Supply Projects					
Project Type	**5 Points**	**10 Points**	**15 Points**	**20 Points**	**25 Points**
Reuse (cost/gpd)	$13 - $10	$10 - $8	$8 - $5	$5 - $2.5	< $2.5
Brackish (cost/gpd)	$25 - $20	$20 - $15	$15 - $12.5	$12.5 - $10	< $10
Surface Water (cost/gpd)	$25 - $20	$20 - $15	$15 - $12.5	$12.5 - $10	< $10
Seawater (cost/gpd)	$35 - $30	$30-$25	$25-$22	$22-$20	< $20
Other AWS (cost/gpd)	$25 - $20	$20-$15	$15-$12.5	$12.50-$10	< $10
Conservation (cost/1000 gallons saved)	$6.00 - $5.50	$5.50 - $4.50	$4.50 - $3.00	$3.00 - $2.50	< $2.50
Water Quality Projects (cost/lb. of pollutant removed)					
Project Type	**5 Points**	**10 Points**	**15 Points**	**20 Points**	**25 Points**
Total Nitrogen (cost/lb.)	$475-$400	$400-$300	$300-$225	$225-$150	< $150
Natural Systems Restoration Projects (cost/acre restored; cost/linear foot restored)					
Project Type	**5 Points**	**10 Points**	**15 Points**	**20 Points**	**25 Points**
Shoreline Restoration ($/lf.)	$1250-$900	$900-$750	$750-$650	$650-$500	≤$500
Hydrologic Restoration	$21k-$18k	$18k-$9k	$9k-$4k	$4k-$1500	≤$1500
Combined Elements	$100k-$75k	$75k-$54k	$54k-$28k	$28k-$15k	≤$15k
Flood Protection Projects					
Project Type	**5 Points**	**10 Points**	**15 Points**	**20 Points**	**25 Points**
BMPs (benefit/cost ratio) Required Projects Over $500k	0.50 < 0.70	N/A	> 0.70 < 0.90	> 0.90 < 1.10	≥ 1.10
BMPs (when benefit/cost ratio is not available for projects under $500k)	Higher than Other Projects	N/A	Similar to Other Projects	N/A	N/A
WMP Urban (cost/sq. mile):	$109k-$95k	$95k-$83k	$83k-$72k	$72k-$66k	<$66k
WMP Rural (cost/sq. mile):	$27k-$22k	$22k-$17k	$17k-$13k	$13k-$11k	<$11k
WMP Mixed (cost/sq. mile):	$55k-$45k	$45k-$34k	$34k-$22k	$22k-$17k	<$17k
WMP Update Urban (cost/sq. mile):	$55k-$44k	$44k-$35k	$35k-$27k	$27k-$25k	<$25k
WMP Update Rural (cost/sq. mile):	$14k-$11k	$11k-$9k	$9k-$7k	$7k-$5k	<$5k
WMP Update Mixed (cost/sq. mile):	$28k-$24k	$24k-$21k	$21k-$16k	$16k-$14k	<$14k

METRICS FOR SCORING PROJECT BENEFIT

Water Supply Projects

Project Type	5 Points	10 Points	15 Points	20 Points	+5 Points
Reuse (MGD)	< 0.2 MGD	0.2-0.66 MGD	0.66-1.5 MGD	> 1.5 MGD	Identified as a regional priority in the Strategic
Brackish (MGD)	< 0.1 MGD	0.1-0.5 MGD	0.5-1.0 MGD	> 1.0 MGD	Identified as a regional priority in the Strategic
Surface Water (MGD)	< 0.1 MGD	0.1-0.5 MGD	0.5-1.0 MGD	> 1.0 MGD	Identified as a regional priority in the Strategic
Seawater (MGD)	< 0.1 MGD	0.1-0.5 MGD	0.5-1.0 MGD	> 1.0 MGD	Identified as a regional priority in the Strategic
Other AWS (MGD)	< 0.1 MGD	0.1-0.5 MGD	0.5-1.0 MGD	> 1.0 MGD	Identified as a regional priority in the Strategic
Conservation (total gallons saved)	1,000-5,000	5,000-10,000	10,000-25,000	25,000-50,000	> 50,000

Water Quality Projects (lb. of pollutant removed and waterbody)

Project Type	5 Points	10 Points	15 Points	+10 Points
Total Nitrogen (lbs.)	50-100 lbs.	100-1000 lbs.	>1000 lbs.	Impaired, SWIM or Ridge Lakes Waterbody

Restoration Projects (acre restored; linear foot restored)

Project Type	5 Points	10 Points	15 Points	20 Points	25 Points
Shoreline Restoration (lf.)	400-700	700-1000	1000-1250	1250-1500	> 1500
Hydrologic Restoration	12 - 30 acres	30 - 90 acres	90 - 200 acres	200 - 400 acres	> 400 acres
Comprehensive Ecosystem Restoration	1 - 2 acres	2 - 4 acres	4 - 6 acres	6 - 25 acres	> 25 acres
Recharge Restoration (benefits)	The total score for Recharge Restoration Projects is based on the sum of the following individual benefits: Project in priority area for recharge (8 points) + Project directly benefitting an MFL and/or aiding in mitigation of saltwater intrusion (8 points) + Project with quantifiable potable water benefits (4 points; regional suppliers only) + Project with quantifiable water quality benefits (5 points).				

Flood Protection Projects

Project Type	10 Points	15 Points	20 Points	25 Points
BMPs (benefits)	Benefits are from benefits cost ratio spreadsheet provided by Cooperator. Points assigned = street flooding (0-5 points) + number of vehicles (0-5 points) + structure flooding (0-5 points) + number of structures (0-5 points) + and intermediate (3 points) or regional system (5 points).			
Watershed Management Plan (sq. mile)	Watershed model 5-10 years old	Partial Planning Unit, No model or +10 years old	Partial or Entire Planning Unit, No model or +10 years old, update DFIRMs	Entire Planning Unit, No model or +10 years old, update DFIRMs
Watershed Management Plan Updates (sq. mile)	Watershed model 5-10 years old, update is justifiable or Partial Planning Unit, model +10 years old	Entire Planning Unit, model +10 years old	Partial Planning Unit, model +10 years old, update DFIRMs or Entire Planning Unit and in top 20	Entire Planning Unit, No model or +10 years old, update DFIRMs, and top 20 update list

Baffle Box Effectiveness provided by Old Castle Infrastructure

Final Report
Baffle Box Effectiveness Monitoring Project
DEP Contract No. S0236

For

Florida Department of Environmental Protection

And

Sarasota County Board of County Commissioners
1001 Sarasota Center Boulevard
Sarasota, Florida 34240

Prepared by:

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Tampa, Florida 33637
813-632-7676

January 7, 2010

GPI Southeast, Inc.

Stormwater Solutions, Inc.

SUTRON

PBSJ

This project was funded by an Urban BMP Research Grant from the Bureau of Watershed Restoration, Department of Environmental Protection. Total project cost was $347,272, of which DEP provided $347,272, or 100%

ACKNOWLEDGEMENTS

The authors thank Eric Livingston of Florida Department of Environmental Protection for his support of this project. Sarasota County, the City of Rockledge, and the City of Stuart are gratefully acknowledged for providing use of their sites for testing and for their support of the field activities. Sutron Inc. and PBS&J performed monitoring, including field installation, sample collection and processing. The contents of this report imply no endorsement by FDEP.

Project Team

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Executive Summary

GPI Southeast, Inc. (GPI-SE) was engaged by Sarasota County using funding from the Florida Department of Environmental Protection (FDEP) to determine the pollutant removal effectiveness of Type 1 and Type 2 baffle box BMPs. Type 2 baffle boxes have horizontal sieve screens above the pipe inverts so that floating organic matter and suspended sediments can be trapped above the water filled vaults. The design hypothesis for the screen is that organic matter trapped above the water will not leach nutrients into the water filled vault below. Type 1 baffle boxes do not have horizontal sieve screens, rather, they have swinging vertical screens that are ineffective for capturing debris.

A mass loading methodology was developed for long term monitoring and evaluation of the mass removal of stormwater pollutants by baffle boxes and applied to four full scale field installations in Florida. Two Type 1 baffle boxes in Stuart and two Type 2 baffle boxes were monitored, one in Rockledge and one in Sarasota. A primary objective of the monitoring was to determine if Type 2 baffle boxes were more effective than Type 1 baffle boxes at removing nutrient mass loadings associated with organic debris trapped in the screens. All four baffle boxes were monitored for over two years for seven or more storm events using a combination of influent and effluent autosamplers to measure water column pollutants as Event Mean Concentrations (EMCs), and manual cleaning of sediment and debris from screens and vaults to measure masses of settleable and floating pollutants. Fourteen pollutants were monitored under this program, but the principal pollutants of concern were Total Nitrogen and Total Phosphorus.

A quantitative evaluative methodology was devised to estimate and compare the total pollutant mass removal in the water column, bottom chamber material, and strainer screen material trapped in a baffle box. Results from monitoring the four baffle boxes are shown in Table 1.

The results of this study clearly demonstrated that Type 2 baffle boxes are more effective than Type 1 baffle boxes for removing TN and TP from stormwater runoff. The improved effectiveness is attributed to the horizontal screens used in Type 2 baffle boxes. The mass of nutrient material collected in the screens exceeded the mass of nutrients in the water column. At both Type 2 baffle box locations there were significant masses of leaves collected from the vault boxes, indicating that the screens were only partially effective in removing leaves from stormwater flows.

Site	Baffle Box Type	TN Mass Removal Efficiency (%)	TP Mass Removal Efficiency (%)	TN EMC Removal Efficiency (%)	TP EMC Removal Efficiency (%)	Fecal Coliform EMC Removal Efficiency (%)
Parkway Blvd, Stuart	1	0.03	0.06	5.60	-15.30	-4.2
Lincoln Lane, Stuart	1	1.00	4.50	-8.30	1.50	-89
Average Type 1		**0.50**	**2.30**	**-1.35**	**-6.90**	**-47**
Little John Lane, Rockledge	2	28.10	19.40	-11.30	-8.20	-249
Oriole Drive, Sarasota	2	10.00	11.60	30.60	21.60	13.1
Average Type 2		**19.05**	**15.50**	**9.65**	**6.70**	**-118**

Table 1 – Baffle box pollutant removal efficiencies

Note: TN and TP mass removal efficiencies for Type 2 baffle boxes are from watersheds with at least 44% tree canopy coverage. Since the majority of the gross solids collected in Type 2 baffle boxes was leaf material, watersheds with less than 44% tree canopy coverage will have lower mass removal efficiencies than shown in Table 1.

Both Type 1 and Type 2 baffle boxes showed net exports of fecal coliforms. Interevent sampling of Type 2 vault box water showed anaerobic conditions indicative of biological decomposition of organic material (predominantly leaves) leading to bacterial growth.

Monitoring results definitively showed that when performing an assessment of pollutant removals by baffle boxes, one must be cognizant of the materials not captured by typical autosamplers, including larger size sediment particles, large floating and suspended organic matter, and the pollutants associated with these materials. Using water column EMCs as the sole measure of performance can significantly underestimate loading reduction of stormwater constituents.

Upstream watershed characteristics greatly influence the mass removal efficiency of baffle boxes. The use of Type 2 baffle box BMPs are recommended when:

1. The pollutants targeted for reduction are nutrient based, and
2. There are no upstream BMPs such as ponds, exfiltration trenches, swales, inlet traps, or other filtration unit processes, and
3. The streets in the watershed have curb and gutters, and
4. The tree canopy coverage in the watershed exceeds 25%.

Background

Urban stormwater is an aqueous matrix containing a highly heterogeneous ensemble of solid components that span a size range from dissolved and colloidal to tens of centimeters (Roesner et al., 2007; Rushton et al., 2009). Stormwater solids include suspended sediment, bedload material transported by ablation, and large floating and suspended materials including grass, leaves, twigs and human derived trash. The size, density, and organic and inorganic composition of stormwater solids are highly variable. These factors greatly affect solids transport in conveyance systems and the amenability of stormwater solids to treatment through physical processes of skimming, straining, sedimentation, and filtration.

Although significant effort has been expended in characterizing solids removal by stormwater treatment devices, an approach is lacking that can unify the disparate components of stormwater solids in an integrated monitoring and evaluation framework. A number of factors hamper this effort. Urban stormwater runoff has extremely variable flowrates. The mass and composition of stormwater solids can change significantly over the course of single runoff events, and are influenced by factors including soil type, topography, land use, and magnitude of runoff (Kim and Sansalone, 2008). No single sampling technique is adequate for all types of stormwater solids. Stormwater treatment systems vary significantly in their design and configuration, and differential retention of solids components occurs at various applied flowrates. High flowrates can scour and remove previously deposited solids. These factors make it difficult to develop standardized monitoring protocols that represent solids content across the entire range of solids size and density (Clark et al., 2009; Strecker et al., 2001). Stormwater solids are also significant in affecting the fate and transport of urban stormwater constituents that sorb to stormwater solids or that are elemental components of the solid material itself. Stormwater constituents associated with solids include nitrogen (Taylor et al., 2005), phosphorus (Settle et al., 2007), heavy metals (Davis and Birch, 2009; Sansalone and Ying, 2008; Herngren et al., 2005), pathogenic indicator organisms (Characklis et al., 2005), and polycyclic aromatic hydrocarbons (Lau et al., 2009; Jartun et al., 2008; Hwang and Foster, 2006; Brown and Peake, 2006). Stormwater loadings of these constituents are a significant driver of impaired water quality and are inseparably linked to the retention of stormwater solids by treatment devices.

A standardized system for classifying stormwater solids was recently proposed based on particle sizes (Roesner et al., 2007). The size categories of stormwater solids were defined as *dissolved* (<2μm), *fine* (2-75μm), *coarse* (75μm–5 mm) and *gross* (> 5mm). The 2μm filter is similar to nominal filter pore sizes used in standard total suspended solids analyses, and delineates dissolved and colloidal materials that are typically not removed in sedimentation-based treatment devices. The No. 200 Sieve (75 μm) is the dividing boundary of *fine* and *coarse* stormwater solids and is the Unified Soil Classification System (USCS) divide defining the division between silt and sand (ASTM, 2006). *Fine* stormwater solids include clay, silt, and organic detritus from decomposition of larger organic materials. The No. 4

Sieve (5 mm) divides *coarse* from *gross* stormwater solids, and distinguishes between sand and gravel in USCS. *Coarse* solids include sand sized sediment and larger inorganic solids, organic detritus, larger organic solids such as leaf components, and human derived solids. *Gross* solids larger than 5mm include coarse sediment, organic matter such as twigs, leaves, grass, and pine needles, and human derived solids such as plastics, paper containers, styrofoam, and glass.

The ability of treatment devices to remove constituents of urban stormwater has traditionally focused on reduction of concentrations in flow weighted water column samples. For example, the International BMP Database provides an extensive compilation of performance evaluations of stormwater treatment devices for numerous water quality parameters (ASCE, 2009) and monitoring guidance for producing appropriate data sets (EPA, 2002). The primary performance metric employed by the database is flow weighted composite samples of influent and effluent water column, defined as EMCs. Autosampler-based EMC data are commonly used in many evaluations of stormwater treatment performance (Lee at al., 2007; Kim et al., 2005).

The traditional EMC approach is based on the use of autosamplers to collect flow composited samples of influent and effluent. A weakness in using EMCs is that autosamplers cannot sample the entire range of stormwater solids. This report uses an approach based upon the recommendations of the ASCE Guidelines for Monitoring Stormwater Gross Solids (Rushton, et.al. 2009) to estimate baffle box pollutant removal on a mass removal basis, including a description of a specifically designed monitoring program and a quantitative evaluative methodology. The goal of this approach is to measure masses of pollutants 1) in the water column using traditional EMC values and conversion factors, 2) in the sediment and herbaceous material accumulated in the bottom chamber, and 3) in the sediment and herbaceous material collected in the screens above the water. Summing of the masses removed continuously over a two year period will enable calculation of annual mass removal efficiency. Using a mass based efficiency calculation will give a more accurate evaluation of baffle box performance than just an EMC based calculation.

Experimental Evaluation

Baffle Box Technology

The baffle box is a structural stormwater treatment device that contains a series of settling chambers separated by baffles (Fig. 1). The unit processes utilized are sedimentation and filtration. In Florida, baffle boxes are used in retrofit scenarios where typical new development BMPs cannot be employed. A baffle box can be used with single or multiple inflow pipes and in offline or online designs. The “Type 2” baffle box is distinguished from the “Type 1” baffle box in that the Type 2 contains a sieve screen located above the water filled bottom chambers and collects larger floating and suspended materials.

Figure 1- Schematic of Type 2 baffle box showing sieve screen

Capture of stormwater sediment particles through the sedimentation unit process in a baffle box is a function of the particle size and density. Larger stormwater particles that move by ablation along the bottom of the influent pipe immediately settle into the chambers upon entry into the baffle box. Organic matter has a lower density than inorganic particles, making the capture of an equivalent size organic particle less likely than an inorganic particle with intrinsic density of 2.5 g/cc (Kayhanian, et al., 2008). Organic material consisting of ground up organic debris cannot be distinguished or separated from inorganic sediment. Standard methods used for TSS analysis do not differentiate between organic and inorganic sediments, leading to inherent inaccuracies in calculations of organic loadings in stormwater based solely on TSS measurements. In this study, the Percent Organic Matter test was used to determine the fraction of the dry mass of solids collected in the baffle boxes that was organic.

The Type 2 baffle boxes contain a basket-shaped strainer screen with 1.3 to 2 cm openings that is mounted above the bottom chamber baffles (Fig. 2). The strainer screen provides a second mechanism for removal of stormwater solids. Larger floating and suspended materials, including leaves, pine needles, and natural and human derived trash and debris, are retained on the screen by physical straining. Material captured in the baffle box screen during runoff events is held above the surface of the water column in interevent periods, thus reducing the potential for leaching of constituents into the water column and

Figure 1 - Sieve strainer screen of Type 2 baffle box

enhancing the opportunity to dry. Material that is captured and retained by the screens can form a mat on the screen surface, reducing the effective size of openings through which runoff passes. The result is the retention of stormwater particles that are smaller than the screen openings.

Project Sites

In order to monitor a baffle box or any BMP in the field, it is critical to choose a location that allows the researcher to control the flow and water quality variables to a degree that provides accurate results. Taking the laboratory to the field is difficult. Site selection criteria that were used for this baffle box monitoring program included:

- The baffle box had one influent pipe and one effluent pipe.
- There were no base flows through the pipes.
- There were no bypass flows during large storms.
- There were no backflows into the baffle box from adjacent streams, bays, or ocean.
- The baffle box was not located in a roadway. Access dictated a location outside of the pavement for safety reasons.
- For the rain gauge and solar panels to operate there was no tree coverage over the site.
- The autosamplers are expensive equipment. A site was chosen in neighborhoods where the vandalism potential was low. There was room for a theft proof enclosure to be placed in a yard or next to a road. Adjacent property owners were canvassed to ensure their cooperation with technicians accessing equipment at any hour.
- Technicians were able to park vehicles adjacent to the site to perform collection activities. Lane closures of roadways were avoided.

- In this study leaf collection was a major objective for the Type 2 baffle boxes. Therefore drainage basins were chosen for the Type 2 boxes that had significant tree canopy coverage.
- All four drainage basins were chosen with primarily residential land use in order to have similar pollutant loadings.
- The interior of the BMPs had sufficient clearance and access to enable a technician to install equipment and take samples.
- The sites were within reasonable driving distance of technicians making weekly visits to inspect and calibrate equipment.
- At the Type 2 locations there were no upstream BMPs in the drainage basin, including roadside swales that would filter pollutants, especially gross solids, before they entered the baffle box. The roadways had curb and gutters.

The monitoring study was conducted on four full-scale baffle boxes in Florida. Characteristics of the baffle boxes that were monitored in this study are summarized in Table 2. The Rockledge and two Stuart sites were located on the eastern central coast of Florida. Sutron Corporation was used to collect data at the three east coast sites. The Sarasota site was located on Florida's southwest coast. Due to the long distances between Sarasota and the east coast sites, a Sarasota based PBSJ office was chosen for data collection at the Oriole Drive site. The laboratories used for analyses of samples from the east coast sites were Harbor Branch Environmental, Inc., Genapure Analytical Services, Inc., and Mactec Engineering and Consulting, Inc. The laboratories used for the Oriole Drive sample analysis of the Sarasota site were Sanders Laboratories, Inc., U.S. Biosystems, and Mactec Engineering and Consulting, Inc.

All four baffle boxes evaluated in the study had a single entrance pipe and a single discharge pipe. Land uses of the contributing drainage basins were single family residential and light commercial as summarized in Table 3. Delineations of the contributing watersheds were shown in Figs. 3 through 6.

Little John Lane Baffle Box (Rockledge) – Type 2
The Little John Lane Baffle Box site receives runoff from a 16.18 acre drainage basin. The land use is single family residential with Type A soils and 0.4 acre lots. The streets have curb and gutter. There is a 44% tree canopy coverage, principally oak trees, in the basin that contribute to high levels of leaves trapped in the baffle box. All of the runoff is transported by sheet flow along the gutters until it reaches the intersection of Little John Lane and Rockledge Drive where 2 grated inlets intercept the water and small pipes convey the water to the baffle box. The grade of the land is steep, falling 15 feet from Brevard Ave. eastward to the Indian River.

Oriole Drive Baffle Box (Sarasota) – Type 2
There are 21 acres in the Oriole Drive drainage basin consisting of single family land use. The lots are ¾ to 1.0 acre in size. The roads have curb and gutters and storm drains throughout the basin. Oak and pine tree coverage in the basin is 86.8%. The grade of the land is moderate from east to west. Soil types in the area are B/D.

Lincoln Lane Baffle Box (Stuart) – Type 1

The drainage basin for this baffle box consists of 102.91 acres of mixed used residential, light industrial, and park land uses. Almost all of the basin has curb and gutters. A well developed stormdrain pipe system conveys water throughout the basin. The basin topography is flat with long times of concentration. In the northern end of the basin there are both a regional and two private wet detention ponds providing treatment for 27.85 acres. This treated area has curb and gutters. Downstream of those wet ponds there is no other stormwater treatment for the remaining 75.06 acres. Ground water west of the railroad tracks is low due to the low elevation of the adjacent Poppleton Creek. The soils in the basin are classified as Type A soils with high infiltration rates. Tree canopy coverage in the basin area downstream of the ponds is 9%. The trees are mostly isolated and scattered throughout the basin. Few of the trees are adjacent to streets where leaves could easily enter the storm drains. During the first seven months of monitoring, which corresponded to a drought period, the baffle box had no base flows from the upstream ponds. During the remainder of the monitoring period after the drought broke there were base flows measured through the baffle box.

Parkway Lane Baffle Box (Stuart) – Type 1

This baffle box receives runoff from 23.28 acres of single family residential property. There are no curb and gutters and no roadside swales. Most of the runoff in the basin is conveyed by sheet flow along the streets. There is one 900 foot long run of pipe leading to the baffle box. North of 7th Street, between SE Madison and SE Fini Drive, there is a vegetated swale in the alley receiving water from the northern parts of the drainage basin. The swale has a number of berms to create a series of cascading retention swales that lead to SE 7th. The ground water in much of the basin should be low due to the low elevation of the adjacent Krueger Creek. Soils in the drainage basin are predominantly B soils with moderate infiltration. There is only 7.5% tree coverage in the drainage basin. Topography in the basin is flat with low flow velocities and little erosion.

Site	Baffle Box Type[1]	Inner Length, ft.	Inner Width, ft.	Plan Area, ft^2	Number of Chambers
Little John Drive, Rockledge City	2	9.83	5.00	49.2	3
Oriole Drive, Sarasota	2	9.00	5.00	45.0	3
Lincoln Avenue, Stuart City	1	9.00	4.17	37.5	3
SE Parkway Drive, Stuart City	1	9.00	4.17	37.5	3

[1]Type 1 does not include strainer screen; Type 2 includes strainer screen.

Table 2 - Four baffle boxes monitored in study

Site	Baffle Box Type	Drainage Basin (ac)	Curb and Gutter	Tree Coverage (%)	Upstream BMP
Parkway Blvd	1	23.28	No	9	Swales
Lincoln Lane	1	102.91	No	7.5	Ponds
Little John Lane	2	16.18	Yes	44	N/A
Oriole Drive	2	21	Yes	86.8	N/A

Table 3 - Watershed characteristics

Figure 2 - Rockledge baffle box project location and watershed

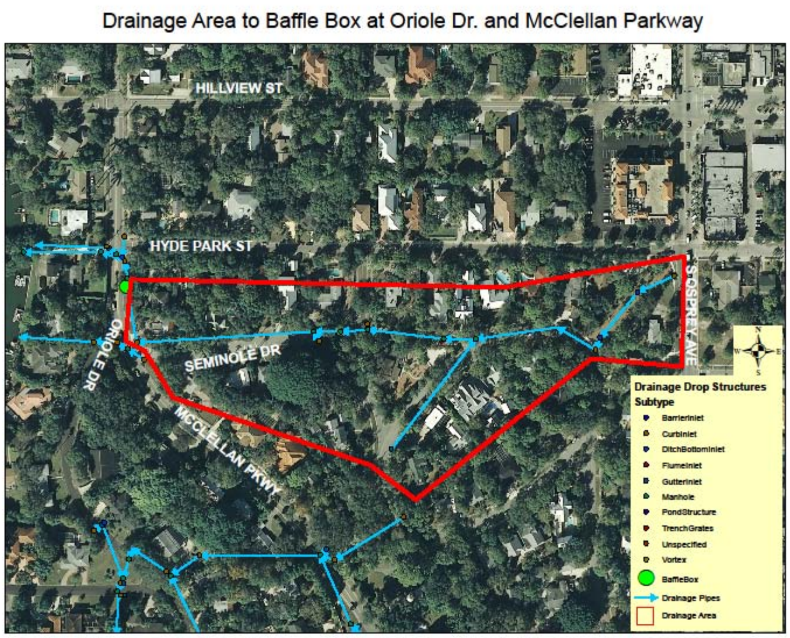

Figure 3 - Sarasota baffle box project location and watershed

Figure 4 - Lincoln baffle box project location and watershed

Figure 5 - Parkway baffle box project location and watershed

Monitoring Approach

The primary objectives of this project were to 1) provide a comprehensive representation of all pollutant masses removed by the baffle boxes, 2) compare the performance of Type 1 vs. Type 2 baffle boxes, and 3) provide recommendations for site selection criteria for use of baffle box BMPs. The monitoring program was developed to include three separate components:

- *Water column*: autosamplers to collect flow composited samples of baffle box influent and effluent in runoff events to develop EMCs;
- *Bottom chamber material*: discreet monitoring to determine total accumulated mass and to perform physical and chemical analyses; and
- *Strainer screen materials*: quantifying total volume and captured mass of captured materials including gross solids components and to perform physical and chemical analyses of representative samples.

To relate and integrate monitoring results for all three solids components, continuous flow monitoring over the whole test period allowed matching the three sampling components to their appropriate time frames and volumetric data. For instance, water column samples were matched to storm event flows that were high enough to trip autosampling. Gross solids samples were matched to total volumes of flow between sampling events, including the storms too small to trip the autosampler. Based upon the completeness of flow data at each baffle box site, a common time period was chosen at each site to combine the water column and gross solids data, enabling total mass calculations over the common time period.

Multiple influent and effluent EMC pairs were used to represent overall water column removals over the common time period. The materials that accumulated in the bottom chamber and strainer screen were not amenable to event-based autosampler monitoring, requiring a different sampling approach. For solids collected in the bottom chamber and strainer screen, the total mass of solids that accumulated during the study period was determined by completely cleaning the baffle box at the start and end of the common study period, and by accounting for all mass removed through during the study period ($t_{start} < t < t_{end}$). The common period of operation was defined by the initial baffle box cleanout (t_{start}) and the final cleanout (t_{end}). Physical and chemical analyses of accumulated solids in the bottom chamber and strainer screen materials was performed on materials collected at the end of the study period and was not able to account for decomposition of collected material that may have occurred during storage.

Water Column Sampling and Analysis

Water column sampling and analyses methods were described in the Baffle Box Testing Program Final Quality Assurance Project Plan (QAPP) (Sutron Corporation, 2006) (QAPP), approved by FDEP. Baffle boxes were equipped with a rain gauge (ISCO 674), two refrigerated Portable Sequential Samplers (ISCO 6712), and an Area-Velocity Flow Module (ISCO 750). Flowlink software was used to program the flow meter, collect precipitation data, and instruct autosamplers to initiate sample collection when cumulative event precipitation reached 0.508 cm. Autosampler initiation was also constrained by analyte holding times and laboratory availability. Flow composited samples were poured into prepared HDPE containers, placed on ice and shipped to the analytical laboratory within allocated holding times, except where noted. Seven or more individual runoff events were monitored at each baffle box and a flow record was maintained through the study. Analyses performed on water column samples are listed in Table 4. Composite samples were analyzed using EPA methods for Total Suspended Solids (160.2), Total Kjeldahl Nitrogen (351.2), Ammonia (350.1), Nitrate+Nitrite (353.2), Total Phosphorus (365.1), Orthophosphate (365.1), and heavy metals (EPA 200.7). Grab samples were utilized to test for Fecal Coliforms (SM 18-9222D).

Per the QAPP, sampling events were initially set to occur after 0.2 inches of rain in a 30 minute time period. Sampling of several storms of this small magnitude resulted in sampling volumes too small to send to the lab. In order to meet the temporal nature of rainfall at the Rockledge and Stuart sites, several adjustments to the tripping criteria were tried, with the final criteria being a 0.4-inch storm in 15 minutes.

Holding times were the maximum time between sample collection and lab analysis. Holding times defined the time windows that could be used for autosampler collection, technician travel to site, sample preparation, shipping, lab receipt, and lab analysis. The QAPP defined holding times for the various parameters analyzed. The minimum holding times for water column samples were 4 hours for fecal coliform and 48 hours for Orthophosphate. Laboratories generally do not work overtime, meaning only storms occurring before 12:00 P.M. could be sampled to meet the fecal coliform holding time. Many storms in Florida occur in the afternoon and evenings. For the first few months numerous afternoon storms were missed due to this holding time limitation. After consultation with FDEP the QAPP was amended to allow testing for fecal coliforms with grab samples independently from the autosampler samples and fecal tests became optional if the technician could reach the site during the morning hours. This QAPP revision allowed collection of storm samples any time of the day or night.

At the Rockledge site a problem was encountered with the flow meter incorrectly recording data. The meter was recalibrated, then replaced, but still was showing erratic flows during storms. An inspection of the downstream pipe showed numerous spider webs hanging from the pipe soffit that were full of leaves. During storms these dangling spider webs over the flow meter caused interference with the readings. After removing the spider webs no further problems were encountered with the flow meter.

At the Sarasota site there were several set up problems and equipment failures in the first year. As a result, only one of the first five sampling events met QAQC protocols and was fully usable.

Parameter	Matrix	Units	Method	Precision (% RSD)	Accuracy (% Recovery)
Sieve Analysis (5 screens: #20, #40, #80, #100, <#200)	Sediment/Solid	N/A	ASTM D422	N/A	N/A
Percent Organic Matter	Sediment/Solid	%	ASTM D2974	N/A	N/A
Density	Sediment/Solid	g/cc	ASTM D2937	N/A	N/A
Total Nitrogen	Sediment/Solid	mg/kg	EPA/CE81	12	64 - 136
Chemical Oxygen Demand	Sediment/Solid	mg/kg	EPA 410.4	12	71 - 136
Total Phosphorus	Sediment/Solid	mg/kg	EPA 365.4	14	70 - 132
Mercury	Sediment/Solid	mg/kg	EPA 7470	12	67-141
Aluminum	Sediment/Solid	mg/kg	EPA 6010	15	80 - 116
Barium	Sediment/Solid	mg/kg	EPA 6010	9	88 - 111
Chromium	Sediment/Solid	mg/kg	EPA 6010	7	88 - 112
Cadmium	Sediment/Solid	mg/kg	EPA 6010	8	89 - 113
Iron	Sediment/Solid	mg/kg	EPA 6010	18	79 - 138
Nickel	Sediment/Solid	mg/kg	EPA 6010	7	85 - 111
Zinc	Sediment/Solid	mg/kg	EPA 6010	18	80 - 125
Copper	Sediment/Solid	mg/kg	EPA 6010	17	84 - 120
Acenaphthylene	Sediment/Solid	µg/kg	EPA 8270	22	36 - 122
Benzo(a)pyrene	Sediment/Solid	µg/kg	EPA 8270	9	55 - 117
Benzo(g,h,i)perylene	Sediment/Solid	µg/kg	EPA 8270	13	56 - 123
Fluoranthene	Sediment/Solid	µg/kg	EPA 8270	20	50 - 126
Fluorene	Sediment/Solid	µg/kg	EPA 8270	14	40 - 131
1-Methylnaphthalene	Sediment/Solid	µg/kg	EPA 8270	18	25 - 113
Naphthalene	Sediment/Solid	µg/kg	EPA 8270	21	27 - 112
Pyrene	Sediment/Solid	µg/kg	EPA 8270	13	51 - 121

Table 4 – Parameters measured

Bottom Chamber Sampling and Analysis

Samples collected from Type 1 baffle box bottom chambers were almost entirely sediment or decomposed organic material. At the Lincoln Lane site 3,014 pounds of material were collected over the sampling period. At the Parkway Lane site only 87 pounds of material was collected over the sampling period.

Bottom chamber sampling and analyses methods were described in the QAPP. The bottom chambers were sampled and cleaned at the end of each sampling period on the dates shown below. There was so little sediment accumulation in the Parkway baffle box that only one cleaning operation was performed at the end of the project. Cleanout masses are shown in Tables 15 – 18.

At the Sarasota site only one bottom chamber sediment sample was correctly performed, on 11/15/2007. On 1/27/2009 County crews inadvertently cleaned the bottom chamber and sieve screens without the knowledge of PBSJ. Two other baffle boxes not associated with the project were also cleaned on the same day and the materials from all three baffle boxes were mixed and deposited at a County facility. Samples were taken of the mixed material from all three baffle boxes; however, sediment sampling results for this event were considered to be inaccurate.

Site	Cleanout #	Date
Little John Drive, Rockledge City	1	11/6/2007
	2	3/9/2009
Oriole Drive, Sarasota	1	11/15/2007
	2	1/27/2009
Lincoln Avenue, Stuart City	1	12/6/2007
	2	2/26/2009
SE Parkway Drive, Stuart City	1	2/26/2009

Table 5 – Dates of box cleanouts

Before sampling, the depth of sediment was measured at multiple points in each chamber and total bulk volume was calculated using the average depth and chamber cross sectional areas. Sediment sampling and analyses were conducted following recommended procedures (EPA, 2001) designated in the QAPP. For each chamber, numerous sediment samples were collected with a Stainless Steel Petite Ponar, mixed, placed into Ziploc bags for geotechnical analyses, into glass bottles for inorganics and metals analyses, and into glass bottles with Teflon lids for organics analyses. Ziploc bag samples for each separate chamber were shipped to the geotechnical laboratory. In the laboratory, a single composite sample was assembled for geotechnical analyses by combining samples from each bottom chamber in proportion to the volume accumulated in that chamber. Geotechnical analyses were conducted according to American Society for Testing and Materials methods (ASTM, 2009) and included wet and dry density (D2937), percent organic matter (D2974), and sieve analysis for Particle Size Distribution (D422). Glass bottle samples for each separate chamber were placed on ice for shipment. In the analytical laboratory, single composite samples for chemical analyses was assembled by combining material from each of the three chambers in proportion to the volume accumulated in each chamber. Analyses were conducted by the following EPA methods: Chemical Oxygen Demand (410.4), Total Nitrogen (351.2/353.2), Total Phosphorus (365.4), metals (6010), mercury (7470), and Polycyclic Aromatic Hydrocarbons (8270). The geotechnical and chemical analyses results for the composite samples were used to represent the entire mass of solids removed from the bottom chambers at the end of the common study period (t_{final}). A list of analyses performed for material collected from the bottom chambers of the baffle boxes is listed in Table 4.

Field sampling showed that materials in the bottom chambers of the Rockledge and Sarasota baffle boxes were a mixture of sediment and leaves that had not been trapped in the screen. See photographs in Appendix A. Laboratory analyses of composite bottom chamber samples indicated the percentage of the bottom chamber materials that were organic were 12.6% to 16.7% for Rockledge and 55.8% for Sarasota baffle boxes. Percent Organic Material collected in the Stuart baffle boxes were 5.8% for Lincoln, and 7.5% for Parkway. The higher levels of bottom chamber organic content at the Rockledge and Sarasota baffle boxes were ostensibly due to leaf and organic materials that had bypassed the sieve screen or to finer organic breakdown products that had passed through the screen.

Results of the bottom chamber sampling were used to represent the entire mass of solids removed from the bottom chambers from all four baffle boxes over the common study periods.

Sieve Screen Sampling and Analysis

Type 2 baffle boxes screens are designed to trap gross solids, primarily organic debris, and keep the material above the water in the vault, thus preventing nutrients from leaching into the vault water and out to receiving waters. At the two sites monitored, the organic debris was almost entirely leaves. There was no significant accumulation of grass clippings in the debris. Observations of collected mass in both Type 2 baffle boxes showed that after leaf mass collected just a few centimeters on the screens, the screen openings became blocked and the leaves became fine filters that trapped sediment as well as fine organic debris. The resulting mass of trapped material and sediment had very low porosity causing water to become trapped in the matted material and ponding above the vault water level in a micro pond in the basket. Interevent observations showed that the organic material stayed moist and sometimes submerged for days after a rain event. Ponded water in the screen was turbid even though water in the vault was clear, indicating that nutrients were leaching out of the organic debris. In addition, material collected from the vault chambers had a high number of leaves, demonstrating that the screens were only partially successful in keeping organic debris out of the water filled vaults.

Sieve screen sampling and analyses methods were described in the QAPP. The material captured on the strainer screen was removed nine and five times over the course of the study for Rockledge and Sarasota, respectively. Total masses cleaned are shown in Tables 15 – 18.

Site	Cleanout #	Date
Little John Drive, Rockledge City	1	3/13/2007
	2	3/28/2007
	3	4/20/2007
	4	8/1/2007
	5	11/6/2007
	6	2/14/2008
	7	6/18/2008
	8	9/9/2008
	9	3/9/2009
Oriole Drive, Sarasota	1	2/13/2007
	2	7/26/2007
	3	11/15/2007
	4	7/17/2008
	5	1/27/2009

Table 6 – Sieve screen cleanout dates

This material was a combination of leaves, organic debris, and sediment. For each removal event, the bulk volume of accumulated material was first estimated from the average depth and plan area of the strainer screen. The material was placed in plastic bags and weighed in an as-collected state. Strainer screen materials were processed for geotechnical and chemical analyses at the conclusion of the common study periods (t_{end}). After bulk volume determination, the accumulated material was removed from the screens, weighed and transported to an indoor processing facility. All of the material was spread out at approximately two-inch thickness on a polyethylene sheet to air-dry for 48 hours. The material was then mixed and spread to a thickness of ½ inch and air-dried for an additional 72 hours. The material was mixed again, and human-derived trash was removed and quantified.

The material was then divided into a grid with 20 regions. A large polypropylene scoop was used to collect 20 individual samples that were placed in empty polypropylene beakers (empty weights were recorded before material was collected). The beakers containing the sampled material were dried for several days until the material was sufficiently dry to enable the fine sediment particles to be separated from the larger materials (predominantly leaves) using a 1mm mesh non metallic screen. The separation process was accomplished by moving the large material gently back and forth over the 1 mm grid screen, such that smaller particles were able to dissociate from the larger material while the leaves did not break apart. The separation screen was placed over a tared polypropylene beaker. The weight of the tared collecting beaker plus the material passing through the 1 mm screen was recorded before sending samples to geotechnical and analytical laboratories. The remaining mass of the large sized material, from which the smaller sediment was derived, was removed and recorded before preparing samples for shipment to geotechnical and analytical laboratories.

Samples of material > 1mm and < 1 mm were placed in Ziploc bags and shipped in a cooler to the geotechnical laboratory. Geotechnical analyses were conducted according to ASTM methods and included wet and dry density (D2937), percent organic matter (D2974), and sieve analysis for Particle Size Distribution (D422). Samples of > 1mm and < 1 mm materials were placed in glass bottles for inorganics and metals analyses, and glass bottles with Teflon lids for organics analyses, and shipped on ice to the analytical laboratory. Analyses were conducted by the following EPA methods: Chemical Oxygen Demand (410.4), Total Nitrogen (351.2/353.2), Total Phosphorus (365.4), metals (6010), mercury (7470), and Polycyclic Aromatic Hydrocarbons (8270). The analyses used for sieve screen samples are listed in Table 4. The results of geotechnical and chemical analyses of composite samples were used to represent the entire mass of solids removed from the strainer screen of the Rockledge and Sarasota baffle boxes over the common study periods.

Performance Assessment Methodology

Storm Event Scale-Up

Mass removals for the common periods were calculated individually for three components: 1) water column runoff, 2) material accumulated in bottom chambers, and 3) material accumulated on the strainer screen. Due to sampling thresholds, equipment failures, holding time limitations, and not sampling during Tropical Storm Fay for safety reasons, water column monitoring was not conducted for all runoff events that occurred in the common study period. However total flow volumes passing through the baffle boxes were recorded during the common study period. Therefore total water column mass removals were scaled up based on the ratio of total runoff volume during the common study period to the total monitored runoff volume:

$$R = \frac{Volume_{tot}}{Volume_n} = \frac{\sum_{i=1,tot} Volume_i}{\sum_{i=1,n} Volume_i} \qquad (1)$$

where: R = ratio of total runoff volume to monitored event runoff volume (-)
tot = total runoff events in common period
n = monitored runoff events in common period
$Volume_i$ = volume of runoff event i (liter)

Estimation of Mass Removals

Total water column mass removal over the common periods were estimated as the sum of mass removals for the monitored events, scaled up to the total runoff volume treated by the baffle boxes during the study period.

$$Mass_{WCM} = \sum_{i=1,n} Volume_i * \left(EMC_{inf_i} - EMC_{eff_i}\right) * R \qquad (2)$$

where: $Mass_{WCM}$ = water column mass removal in common period, (mg)
EMC_{effi} = influent EMC of runoff event i, (mg/L)
EMC_{effi} = effluent EMC of runoff event i, (mg/L)

Mass removals of stormwater pollutants in bottom chamber materials were calculated as the product of the accumulated bulk volume, its dry bulk density, and the solids pollutant concentration.

$$Mass_{BCM} = Volume_{bcm} * \rho_{bulk,bcm} * q_{bcm} \qquad (3)$$

where: $Mass_{BCM}$ = mass removed in bottom chamber in common period, (mg)
$Volume_{bcm}$ = bulk volume of bottom chamber material removed, (liter)

$\rho_{bulk,bcm}$ = bulk density of bottom chamber material, (kg/L)
q_{bcm} = solid phase constituent concentration, (mg/)

Mass removals of stormwater constituents in strainer screen materials were calculated as the product of the accumulated bulk volume, its dry bulk density, and the solid phase concentration.

$$Mass_{SSM} = Volume_{ssm} * \rho_{bulk,ssm} * q_{ssm} \tag{4}$$

where: $Mass_{SSM}$= mass removed in strainer screen in common period, (mg)
$Volume_{ssm}$ = bulk volume of strainer screen material removed (liter)
$\rho_{bulk,ssm}$ = bulk density of strainer screen material, (kg/L)
q_{ssm} = solid phase constituent concentration, (mg/kg)

Equivalent Concentration

Traditional testing methods for the water column use an EMC measurement at the inflow and outflow points of a BMP. The difference in concentrations gives the percent removal efficiency of the device for one storm or group of storms based on the water column measurements. This method cannot be used for measuring gross solids because there is no method for measuring gross solids entering and leaving the BMP. The only measurement is mass of gross solids trapped in the BMP. Taking mass samples of gross solids upstream of the BMP would invalidate the measurement of masses trapped in the BMP.

Therefore an alternative method was used to determine the mass removal efficiency of the Rockledge baffle box. Whole mass measurements (not samples) of effluent and gross solids leaving the baffle box were taken with a specially designed screening device, see Appendix A. While this device accurately captured large floating gross solids, its ability to capture bypass sediment particles was limited to visual rather then measured quantification. Results from the bypass test showed a 99% capture efficiency for the Rockledge baffle box, i.e. the mass of leaves and sediment captured in the bypass device were only a few grams, whereas the masses captured in the baffle box were hundreds of pounds. By summing the total mass of gross solids trapped in the baffle box with the total mass leaving the baffle box, the total influent gross solids mass was calculated.

The equivalent concentration of captured solids and associated constituents is that which would occur if the captured material were homogenized and distributed uniformly into the entire volume of runoff treated during the common study period., (mg/L)

$$EC_{BCM} = \frac{Mass_{BCM}}{Volume_{tot}} \tag{5}$$

$$EC_{SSM} = \frac{Mass_{SSM}}{Volume_{tot}} \tag{6}$$

where: EC_{BCM} = equivalent concentration of bottom chamber material (mg/L)
EC_{SSM} = equivalent concentration of strainer screen material (mg/L)
(7)

Derived Efficiency

The baffle box monitoring configuration was not able to fully measure all components of stormwater solids entering and leaving the baffle boxes, precluding conventional approaches to estimating mass removal efficiency. A new approach was developed to estimate mass removal efficieny for the baffle boxes in this study, based on the assumption that the influent water column samples plus the accumulation of solids in the baffle box account for all influent discharge mass, while effluent water column samples account for all discharge mass. The calculated mass removal efficiency is here termed the Derived Efficiency, and is calculated for individual constituents over the common period:

$$DE = \frac{Mass_{BCM} + Mass_{SSM}}{Mass_{BCM} + Mass_{SSM} + Mass_{WC,Eff}} \text{ x } 100 \qquad (8)$$

where: DE = derived efficiency in common period. The DE is an upper limit of removal efficiency because any passage of larger solids into the discharge would reduce the calculated efficiency.

Results and Discussion

Monitored Periods and Storm Events

Baffle box monitoring periods are shown in Table 7, along with days of operation, total treated volume, and water column scale-up factor for constituent mass. Monitored storm events are listed in Table 8, including precipitation associated with the monitored storm event and the total treated volume. A runoff volume time series for the Rockledge baffle box is shown in Figure 7, which illustrates the dates at which the individual storm event monitoring was conducted. The cumulative distribution of runoff events for Rockledge is shown in Figure 8, along with the position of the monitored storm events on the runoff volume distribution. Similar plots are shown for the Sarasota, Lincoln, and Parkway baffle boxes in Figures 9 through 14. Visual inspection of runoff distribution plots indicated that treated volumes of the monitored storm events were reasonably distributed over the runoff volumes

Site	Start Date	End Date	Number of Days	Total Volume, million gallon	Treated Runoff Volume, inch/year	Monitored Storm Volume, million gallon	Water Column Scale Up Factor
Little John Drive, Rockledge City	10/11/06	3/9/09	880	2.94	2.8	0.290	10.1
Oriole Drive, Sarasota	11/1/06	1/27/09	818	13.0	10.2	1.16	11.2
Lincoln Avenue, Stuart City	10/2/06	2/26/09	878	17.9	2.7	0.232	77.2
SE Parkway Drive, Stuart City	10/2/06	2/26/09	878	5.79	3.8	0.560	10.3

Table 7 - Baffle box monitoring periods

Storm Event Number	Little John Drive, Rockledge City			Oriole Drive, Sarasota			Lincoln Avenue, Stuart City			SE Parkway Drive, Stuart City		
	Date	Precip., in	Runoff Volume, gal.	Date	Precip., in	Runoff Volume, gal.	Date	Precip., in	Runoff Volume, gal.	Date	Precip., in	Runoff Volume, gal.
1	3/16/07	0.52	12,765	11/16/06	0.86	33,791	4/10/07	1.11	30,693	5/14/07	1.19	29,020
2	4/10/07	0.81	17,932	12/21/07	0.48	75,241	5/13/07	0.72	11,362	7/25/07	0.46	2,306
3	7/24/07	0.41	17,249	6/21/08	0.61	46,855	5/14/07	0.72	25,639	8/14/07	2.34	165,267
4	7/31/07	0.79	36,207	7/6/08	1.24	122,926	5/24/07	0.27	10,503	12/14/07	0.74	20,311
5	8/2/07	1.47	77,943	8/4/08	0.67	91,645	7/23/07	0.42	35,146	3/6/08	2.32	377,526
6	8/23/07	0.92	43,817	8/8/08	1.16	197,450	7/25/07	0.68	40,321	3/30/08	2.61	291,140
7	10/18/07	1.24	53,900	8/9/08	0.79	108,026	7/30/07	0.49	43,728	10/18/08	1.30	46,646
8	2/12/08	0.89	30,392	9/9/08	2.72	395,393	2/12/08	1.16	34,748	-	-	-
9	-	-	-	9/30/08	0.50	24,639	-	-	-	-	-	-
10	-	-	-	10/6/08	0.91	32,968	-	-	-	-	-	-
11	-	-	-	1/13/09	0.71	30,745	-	-	-	-	-	-

Table 8 – Monitored storm events

treated by the baffle boxes over the time period of the study. The flow rate data collected by flow monitors was used directly to calculate treated volume for three of the four baffle boxes; a different procedure was applied to the Lincoln Ave. baffle box volume data due to a baseflow component providing significant flow volumes on single or multiple days with zero precipitation.

Due to the sampling and monitoring failures at the Sarasota site, autosampling data was compromised on several occasions. Gross solids mass cleanout data at that location was also compromised. The mass cleaned on 1/27/2009 from the screens and bottom chamber were estimated from County records rather from PBSJ measurements. Laboratory sampling of bottom sediments were qualified as being from a combination of three baffle boxes rather than just the Oriole baffle box. The overall usefulness of data from the Sarasota site was limited and did not meet program goals. Result summaries of pollutant removals from the Sarasota site are adjusted to reflect the time periods of accurate data collection.

Data collection at the other three sites had minor problems typically encountered in field sampling, but nothing significant like the Sarasota site. Therefore, the Rockledge site data collection over the entire time period was accurate and will be referenced more heavily than the Sarasota site for summaries and conclusions.

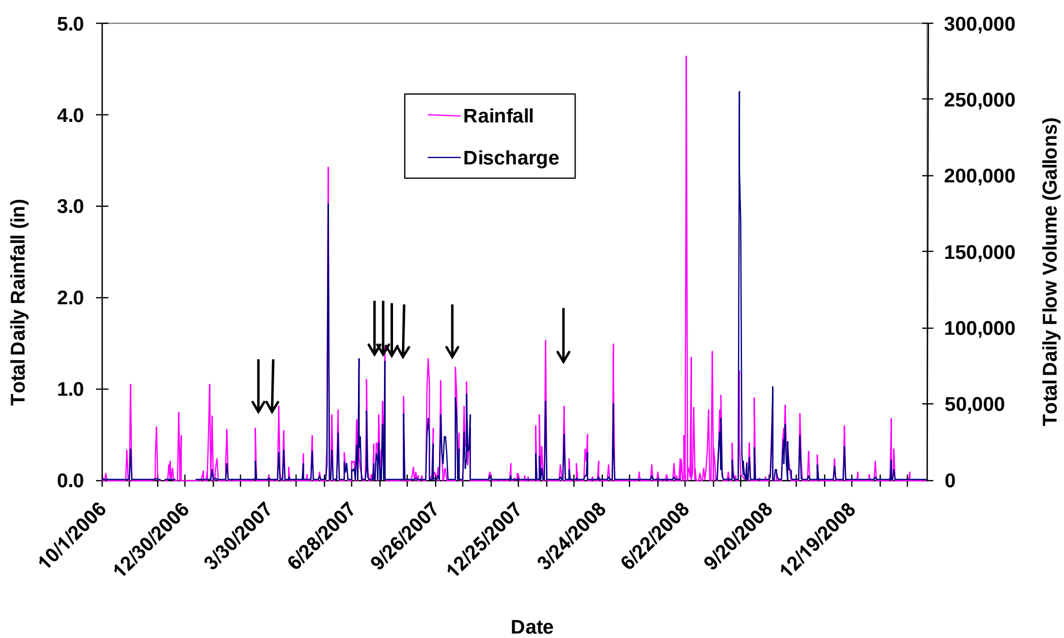

Figure 6 - Rockledge flow record showing monitored storm events

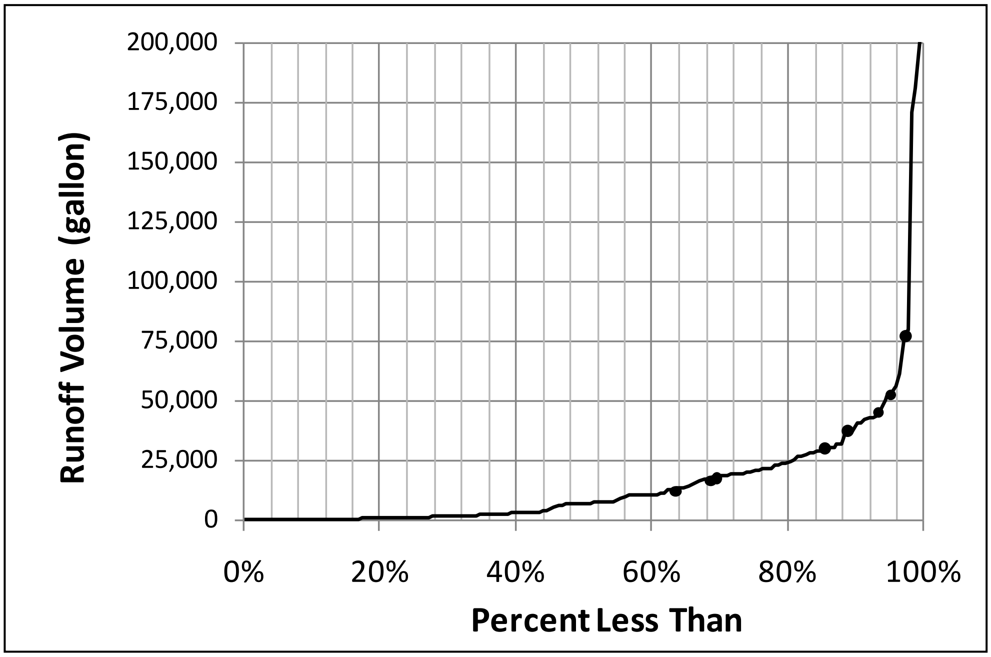

Figure 7 - Rockledge cumulative runoff distribution showing monitored storm events

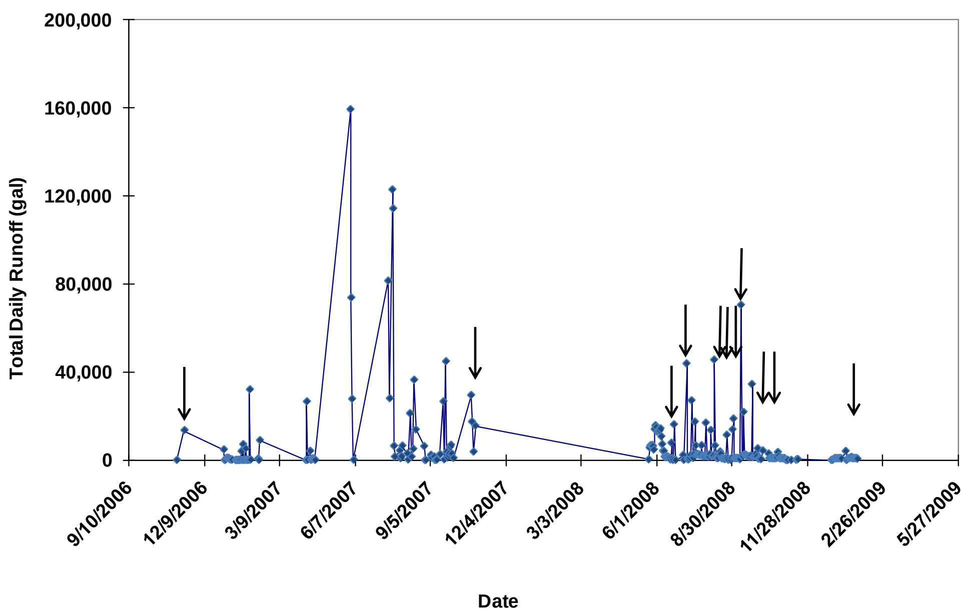

Figure 8 - Sarasota flow record showing monitored storm events

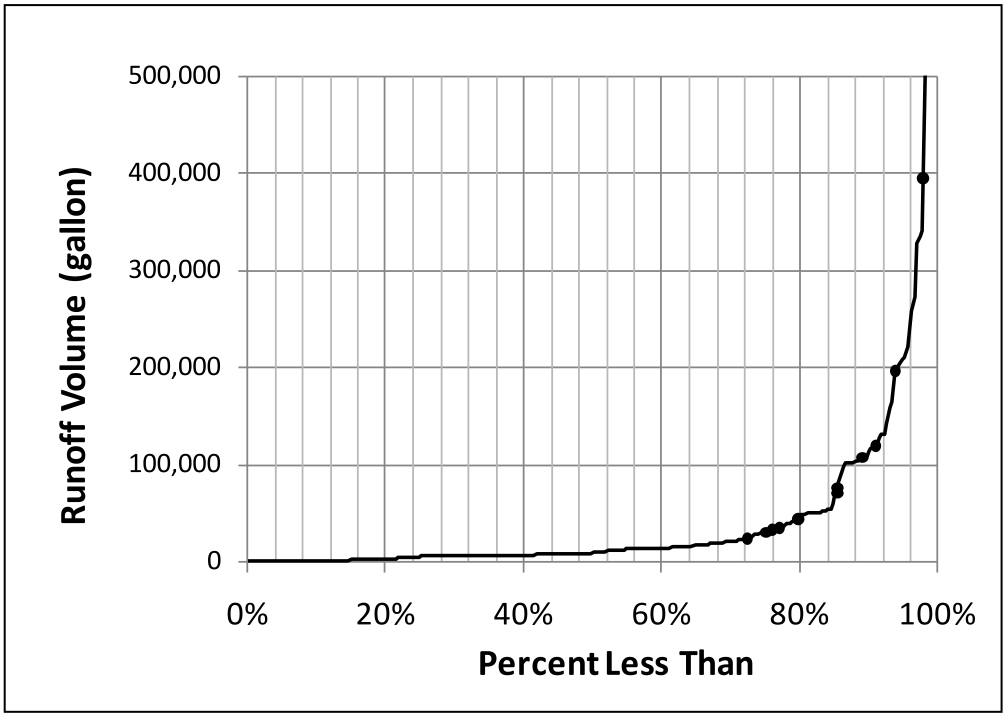

Figure 9 - Sarasota cumulative runoff distribution showing monitored storm events

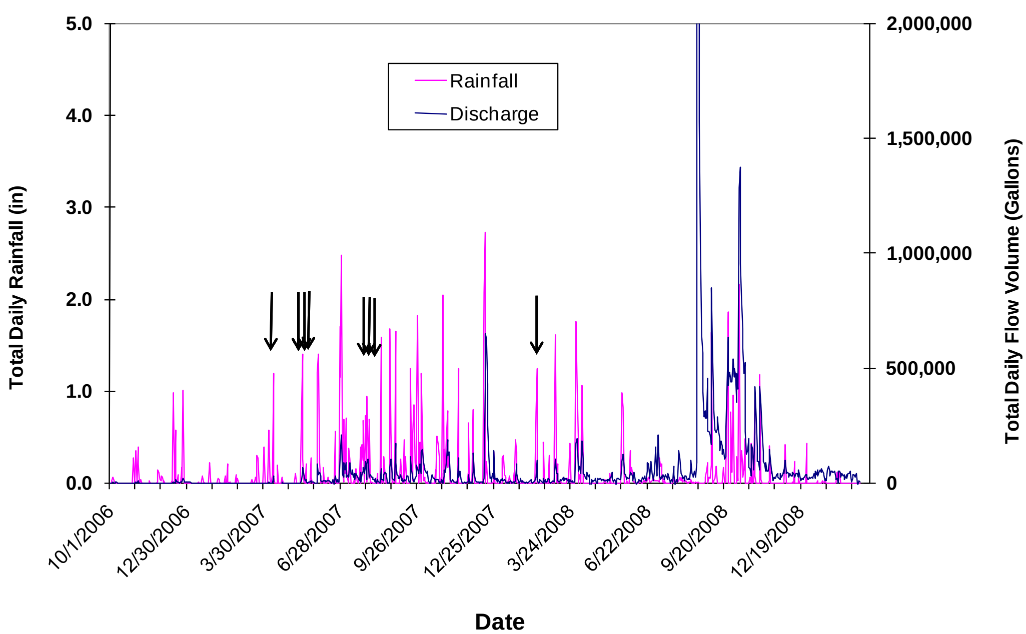

Figure 10 - Lincoln flow record showing monitored storm events

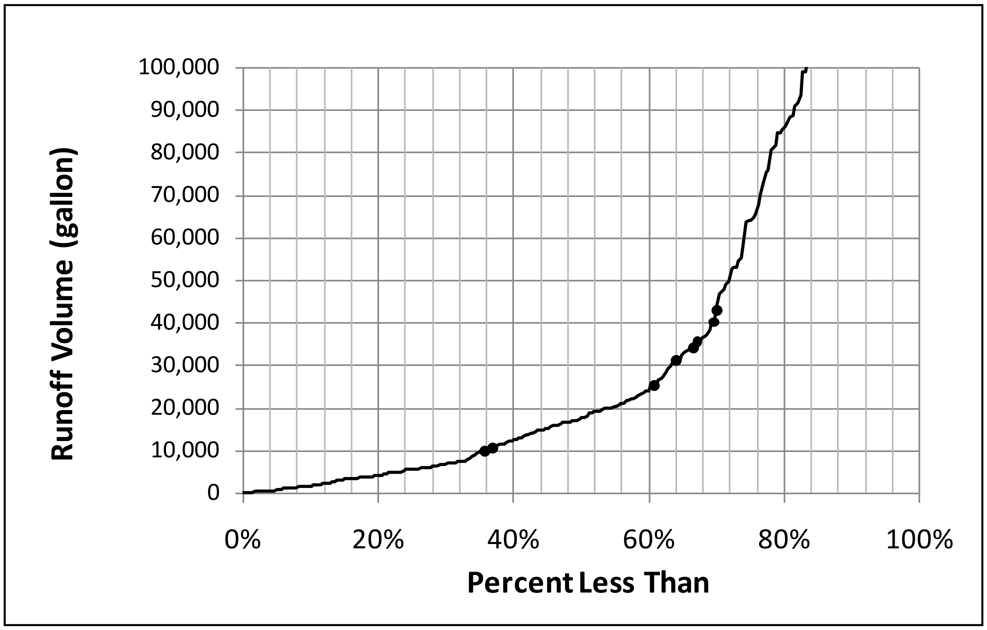

Figure 11 - Lincoln cumulative runoff distribution showing monitored storm events

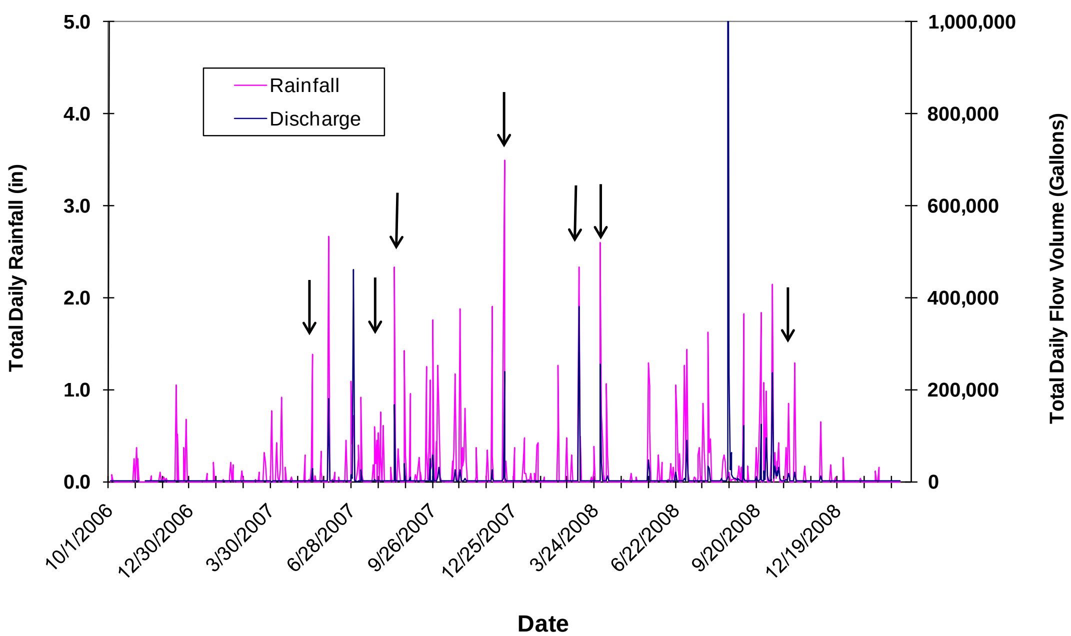

Figure 12 - Parkway flow record showing monitored storm events

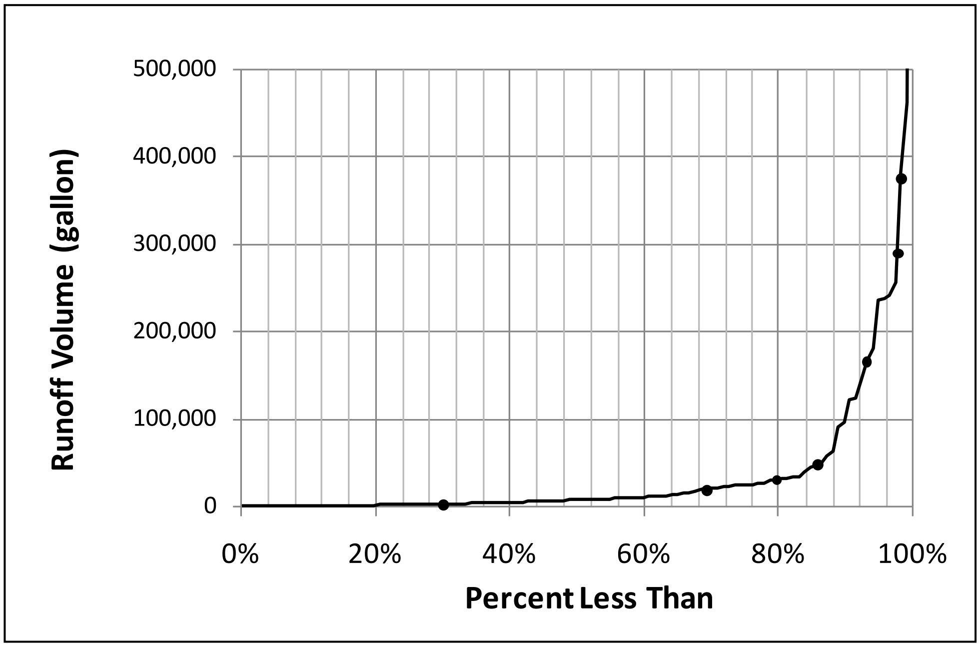

Figure 13 - Parkway cumulative runoff distribution showing monitored storm events

Pollutant Removal Summary

Event Mean Concentrations (Water Column)

Discussion in the section is limited to water column concentrations. Water column mass removals are discussed in the next section. Average EMC reduction performance of the four baffle boxes are summarized in Tables 9 through 12. An example regression of TSS discharge EMC to influent EMC is shown in Fig. 15 for the Rockledge baffle box (n=7). The correlation had an R^2 of 0.72. Average EMC reductions represent the average percent reduction in EMC based on the monitored storm events. The overall flow weighted mass removal efficiency (last column on Tables 9-12) accounts for the masses removed during the storm events. EMC performance of the four baffle boxes are compared in Table 14. Overall EMC reduction efficiency was moderate or negative for suspended solids, total nitrogen, and total phosphorus. EMCs were used for the water column mass calculations in the next section.

There was not a strong correlation between TN, TP, and fecal coliform effluent concentrations. Type 1 baffle boxes averaged a 46.9% increase between influent and effluent fecal coliform concentrations. Type 2 baffle boxes had mixed results with a 13.1% reduction at the Sarasota site and -249% increase in fecal coliform concentrations at the Rockledge site. See Table 13. Probable causes for fecal coliform growth in baffle boxes are the interevent anaerobic conditions discussed further in the Interevent Monitoring section.

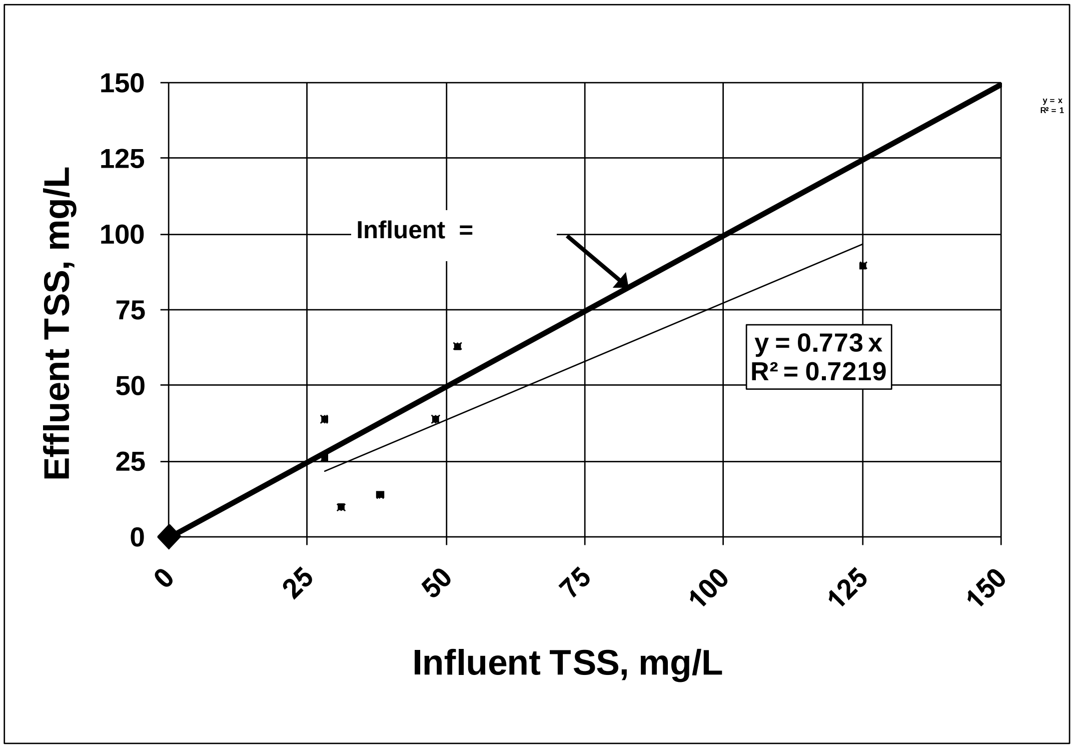

Figure 14 - Regression of Total Suspended Solids EMCs at Rockledge

Constituent	Average EMC_{inf}	Average EMC_{eff}	Average % EMC Reduction	EMC % Reduction Range		Average EMC Reduction, (EMC_{inf}-EMC_{eff})	Flow Weighted Mass Removal Efficiency, %
				Minimum	Maximum		
Total Suspended Solids, mg/L	49.0	43.2	8.5	-57	68	5.7	8.5
Total Nitrogen, mg/L	2.19	2.14	-11.3	-67	36	0.05	-4.3
Total Kjeldahl Nitrogen, mg/L	1.75	1.85	-17.3	-77	19	-0.10	-14.8
Organic Nitrogen, mg/L	1.56	1.62	-15.2	-71	24	-0.06	-14.4
NH_4^+-N, mg/L	0.19	0.22	-31.6	-157	72	-0.04	-18.5
NO_x-N, mg/L	0.45	0.30	10.2	-18	68	0.15	37.2
Total Phosphorus, mg/L	0.56	0.57	-8.2	-27	18	-0.01	-2.9
Organic Phosphorus, mg/L	0.23	0.23	-4.7	-27	17	-0.003	-1.6
PO_4-P, mg/L	0.33	0.34	-13.3	-57	18	-0.01	-4.0
Fecal Coliform, counts/100 ml	34,517	78,014	-249	-841	75	0.10000	-28.3
Cadmium, ug/L	0.00085	0.00059	9.4	0	47	-0.08200	36.3
Chromium, ug/L	0.00321	0.00293	9.5	-28	34	-0.02000	-0.7
Copper, ug/L	0.00773	0.00768	0.014	-34	56	0.00000	-7.1
Zinc, ug/L	0.07523	0.06315	5.1	-136	35	0.00000	14.6

Table 9 - Rockledge baffle box EMC performance

Constituent	Average EMC_{inf}	Average EMC_{eff}	Average % EMC Reduction	EMC % Reduction Range		Average EMC Reduction, (EMC_{inf}- EMC_{eff})	Flow Weighted Mass Removal Efficiency, %
				Minimum	Maximum		
Total Suspended Solids, mg/L	108.4	66.5	35.1	-65	89	41.9	49.7
Total Nitrogen, mg/L	3.62	2.42	30.6	14	52	1.20	41.2
Total Kjeldahl Nitrogen, mg/L	3.48	2.27	32.5	15	52	1.22	42.5
Organic Nitrogen, mg/L	3.26	2.12	31.8	15	52	1.14	42.8
NH_4^+-N, mg/L	0.22	0.15	20.7	-84	78	0.07	33.4
NO_x-N, mg/L	0.13	0.15	-95.3	-500	12	-0.02	-35.5
Total Phosphorus, mg/L	0.59	0.44	21.6	-3	59	0.15	39.5
Organic Phosphorus, mg/L	0.34	0.22	37.7	-18	98	0.123	43.8
PO_4-P, mg/L	0.25	0.22	7.6	-17	67	0.02	32.1
Fecal Coliform, counts/100 ml	74,250	40,250	13	-19	25	0.20900	57.3
Chromium, ug/L	0.00000	0.00000	0.0	-396	66	-0.04300	Cr
Copper, ug/L	0.00000	0.00000	0.000	-480	96	0.00500	Cu
Zinc, ug/L	0.00000	0.00000	0.0	-93	109	0.00000	Zn

Table 10 - Sarasota baffle box EMC performance

Constituent	Average EMC_{inf}	Average EMC_{eff}	Average % EMC Reduction	EMC % Reduction Range		Average EMC Reduction, (EMC_{inf}-EMC_{eff})	Flow Weighted Mass Removal Efficiency, %
				Minimum	Maximum		
Total Suspended Solids, mg/L	55.8	35.5	12.3	-61	78	20.3	41.3
Total Nitrogen, mg/L	1.00	0.97	-8.3	-45	65	0.03	11.1
Total Kjeldahl Nitrogen, mg/L	0.81	0.73	-5.5	-49	67	0.08	17.6
Organic Nitrogen, mg/L	0.72	0.65	-7.6	-49	65	0.07	16.0
NH_4^+-N, mg/L	0.10	0.08	8.3	-51	87	0.02	29.0
NO_x-N, mg/L	0.19	0.24	-50.7	-373	17	-0.05	-16.8
Total Phosphorus, mg/L	0.17	0.15	1.5	-20	58	0.02	12.8
Organic Phosphorus, mg/L	0.13	0.12	-1.1	-26	62	0.011	12.5
PO_4-P, mg/L	0.04	0.03	5.4	-44	36	0.00	14.0
Fecal Coliform, counts/100 ml	5,088	10,505	-89	-600	75	0.01690	-32.4
Cadmium, ug/L	0.00066	0.00063	9.4	0	49	-0.01100	6.9
Chromium, ug/L	0.00311	0.00308	-13.4	-75	73	0.00200	12.2
Copper, ug/L	0.01309	0.01168	7.612	-50	75	0.00000	24.0
Zinc, ug/L	0.13700	0.08084	18.7	-28	129	0.00000	38.9

Table 11 - Lincoln baffle box EMC performance

Constituent	Average EMC_{inf}	Average EMC_{eff}	Average % EMC Reduction	EMC % Reduction Range		Average EMC Reduction, (EMC_{inf}- EMC_{eff})	Flow Weighted Mass Removal Efficiency, %
				Minimum	Maximum		
Total Suspended Solids, mg/L	39.5	45.7	-38.5	-122	4	-6.2	-5.6
Total Nitrogen, mg/L	2.48	2.14	5.6	-53	52	0.35	14.1
Total Kjeldahl Nitrogen, mg/L	1.94	1.69	4.1	-48	55	0.25	11.6
Organic Nitrogen, mg/L	1.80	1.57	3.1	-61	56	0.24	11.9
NH_4^+-N, mg/L	0.14	0.12	-112.8	-882	65	0.02	5.7
NO_x-N, mg/L	0.54	0.45	2.7	-59	43	0.09	23.2
Total Phosphorus, mg/L	0.51	0.56	-15.3	-90	18	-0.05	-8.0
Organic Phosphorus, mg/L	0.12	0.15	-20.1	-65	51	-0.028	-49.5
PO_4-P, mg/L	0.39	0.41	-21.1	-181	9	-0.02	5.6
Fecal Coliform, counts/100 ml	37,736	61,419	-4	42	40	0.06000	-5.9
Cadmium, ug/L	0.00044	0.00041	-3.8	-100	28	-0.29000	24.4
Chromium, ug/L	0.00259	0.00246	5.5	-7	8	0.01200	5.5
Copper, ug/L	0.00793	0.00809	-19.538	-125	53	0.00000	5.3
Zinc, ug/L	0.04267	0.04583	-19.0	-233	3	0.00000	3.3

Table 12 - Parkway baffle box EMC Performance

Site	Baffle Box Type	Average TN Effluent Conc. (mg/L)	Average TP Effluent Conc. (mg/L)	Average Fecal Coliform Effluent Concentration (counts/100mL)
Parkway Blvd, Stuart	1	2.14	0.56	61,419
Lincoln Lane, Stuart	1	0.97	0.15	10,505
Average Type 1		**1.56**	**0.36**	**35,962**
Little John Lane, Rockledge	2	2.14	0.57	78,014
Oriole Drive, Sarasota	2	2.42	0.44	40,250
Average Type 2		**2.18**	**0.51**	**59,132**

Table 13 - Summary pollutant concentrations for all four baffle boxes

Site	Average EMC Removal Efficiency, %			
	Total suspended solids	Total nitrogen	Total phosphorus	Fecal coliforms
Little John Drive, Rockledge City	8.5	-11.3	-8.2	-249
Oriole Drive, Sarasota	35.1	30.6	21.6	13.1
Lincoln Avenue, Stuart City	12.3	-8.3	1.5	-89.5
SE Parkway Drive, Stuart City	-38.5	5.6	-15.3	-4.2
Average	4.4	4.2	-0.1	-82.4

Table 14 - Comparison of average baffle box EMC performance

Mass in Water Column, Bottom Chamber and Sieve Screen

The masses of constituents contained in the solids that accumulated in the bottom chambers and sieve screens are summarized in Tables 15 through 18 respectively for the Rockledge, Sarasota, Lincoln, and Parkway baffle boxes. Also shown is the calculated mass removed in the water column based on EMC monitoring discussed in the previous section. The ratio of the total accumulated solids mass to calculated water column mass scales the mass calculations.

In the material collected from the Rockledge sieve screen, the mass of non-dissolved solids, TN, and TP in the < 1 mm fraction were greater than or similar to the > 1 mm fraction. The solids in the < 1 mm fraction were a combination of sediment, and fine organic debris. The % organic matter in the Rockledge > 1 mm fraction were 73.3 and 11% for Cleanouts 1 and 2, and for the < 1 mm fraction were 30 and 51.6%.

For the Sarasota baffle box, the % organic matter in the > 1 mm fraction was 83% and for the < 1 mm fraction was 54.6%. For the Rockledge baffle box, accumulated solids are 26.8 times the water column EMC calculation, indicating that the autosampler is not representing all stormwater solids in the stormwater entering the baffle box. Negative values for nitrogen and phosphorus indicate that these parameters were actually being exported during storm events. Variable results for other baffles boxes reflect the flow and quality characteristics of runoff, limited solids mass that accumulate within the baffle box, and uncertainties in sampling, analysis and quantification of solid materials that accumulate within the baffle box.

Constituent	Bottom Chambers	Strainer Screen		Total Chamber + Screen	Water Column	Water Column Mass/ Accumated Solids Mass
		> 1 mm	< 1 mm			
Non-dissolved Solids	3,479	1,012	1,378	5,869	110	0.019
Total Nitrogen	16.1	0.79	1.14	17.99	-1.91	-0.106
Total Phosphorus	1.1	0.64	1.05	2.80	-0.32	-0.116

Table 15 - Rockledge baffle box constituent mass (lb)

Constituent	Bottom Chambers	Strainer Screen		Total Chamber + Screen	Water Column	Water Column Mass/ Accumated Solids Mass
		> 1 mm	< 1 mm			
Non-dissolved Solids	1627	2491	3586	7704	7232	0.94
Total Nitrogen	9.0	1.64	21	32	200	6.3
Total Phosphorus	1.4	0.26	4.20	5.81	29	5.0

Table 16 - Sarasota baffle box constituent mass (lb)

Constituent	Bottom Chambers	Water Column	Water Column Mass/ Accumated Solids Mass
Non-dissolved Solids	3,014	3,521	1.17
Total Nitrogen	1.28	16.0	12.5
Total Phosphorus	1.05	3.28	3.13

Table 17 - Lincoln baffle box constituent mass (lb)

Constituent	Bottom Chambers	Water Column	Water Column Mass/ Accumated Solids Mass
Non-dissolved Solids	87	-195	-2.2
Total Nitrogen	0.030	19.1	628
Total Phosphorus	0.017	-1.95	-116

Table 18 - Parkway baffle box constituent mass (lb)

Average Parameter Mass Removals Over Monitoring Period	Type 1 Baffle Box	Type 2 Baffle Box
TN Removed From Water Column (lb)	35.1	198.1
TN Removed From Vault (lb)	1.31	25.1
TN Removed From Screens (lb)	NA	24.57
TP Removed From Water Column (lb)	1.33	28.68
TP Removed From Vault (lb)	1.07	2.5
TP Removed From Screens (lb)	NA	6.15

Table 19 - Summary mass removals by baffle box type

Equivalent Concentrations

Equivalent concentrations based on treatment volume and mass removals from the whole study period are shown in Table 20 for solids, nitrogen and phosphorus. ECs were higher for the Type 2 baffle box that included the sieve screen, but the higher EC in Type 2 baffle boxes also reflected the characteristics of the contributing watershed. The contributing watersheds to the Type 2 baffle boxes (Rockledge and Sarasota) had large macroscopic vegetation inputs and limited upstream opportunity for attenuation of pollutant mass. The Stuart sites had relatively limited organic matter input and possible upstream attenuation.

Site	Equivalent Concentration of Accumulated Solids (mg/L)		
	Total non-dissolved solids	Total nitrogen	Total phosphorus
Little John Drive, Rockledge City	183	0.69	0.071
Oriole Drive, Sarasota	37.9	0.098	0.015
Lincoln Avenue, Stuart City	20.2	0.009	0.007
SE Parkway Drive, Stuart City	1.8	0.00063	0.00035
Average	60.7	0.20	0.023

Table 20 - Equivalent concentrations of accumulated solids

Derived Efficiencies

Derived Efficiencies based on total mass removals are summarized in Table 1. DE for Type 1 baffle boxes averaged 0.5% for nitrogen and 2.3% for phosphorus. Type 2 baffle boxes averaged 19.1% DE for TN and 15.5% DE for TP. The higher removal efficiencies of Type 2 baffle boxes was attributed to the sieve screen capture of large floating and suspended materials in Type 2 boxes. Note that mass loadings from leaves were in drainage basins having 44% to 87% tree canopy coverage.

Site	Baffle Box Type	TN Mass Removal Efficiency (%)	TP Mass Removal Efficiency (%)	TN EMC Removal Efficiency (%)	TP EMC Removal Efficiency (%)
Parkway Blvd, Stuart	1	0.03	0.06	5.60	-15.30
Lincoln Lane, Stuart	1	1.00	4.50	-8.30	1.50
Average Type 1		**0.50**	**2.30**	**-1.35**	**-6.90**
Little John Lane, Rockledge	2	28.10	19.40	-11.30	-8.20
Oriole Drive, Sarasota	2	10.00	11.60	30.60	21.60
Average Type 2		**19.05**	**15.50**	**9.65**	**6.70**

Table 21 - Mass removal efficiencies of monitored baffle boxes

Polycylycic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbon (PAH) concentrations in accumulated solids are shown in Figures 16 through 19. PAH levels in bottom chamber and sieve screen solids are summarized in Tables 22 and 23 based respectively on total dry solids and solid organic matter. For the Rockledge baffle box, PAH levels were highest in the sieve screen captured material that was smaller than 1 mm, and both size fractions of the sieve screen material had higher PAH levels than the chamber sediment (Fig. 16). The PAH levels were below the exposure limits found in Chapter 62-777, Table II, F.A.C., with the exception of Benzo (A) pyrene, which was slightly higher than residential and industrial exposure limits.

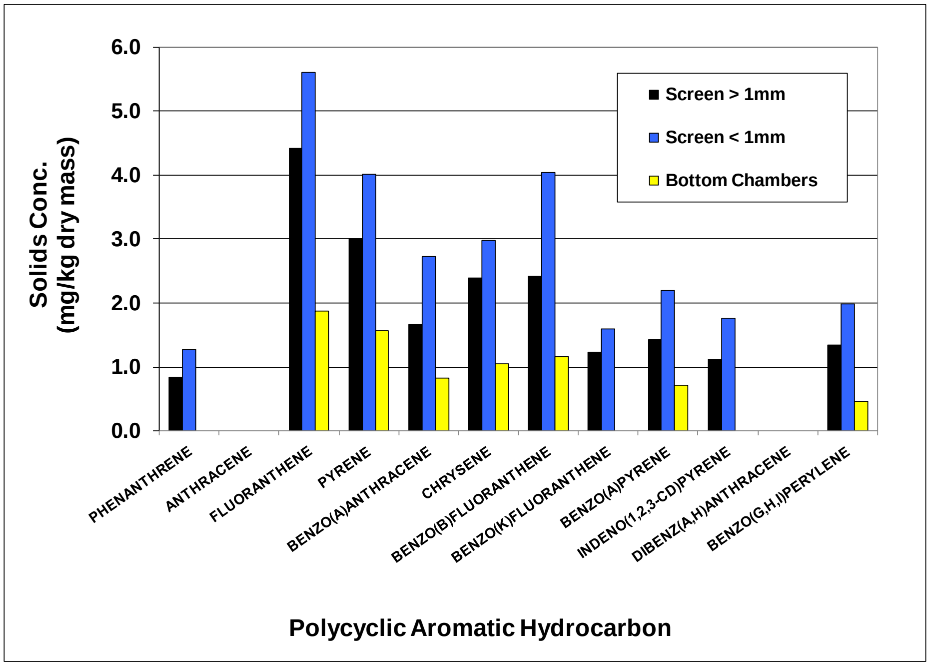

Figure 15 – Polycyclic aromatic hydrocarbons in Rockledge solids

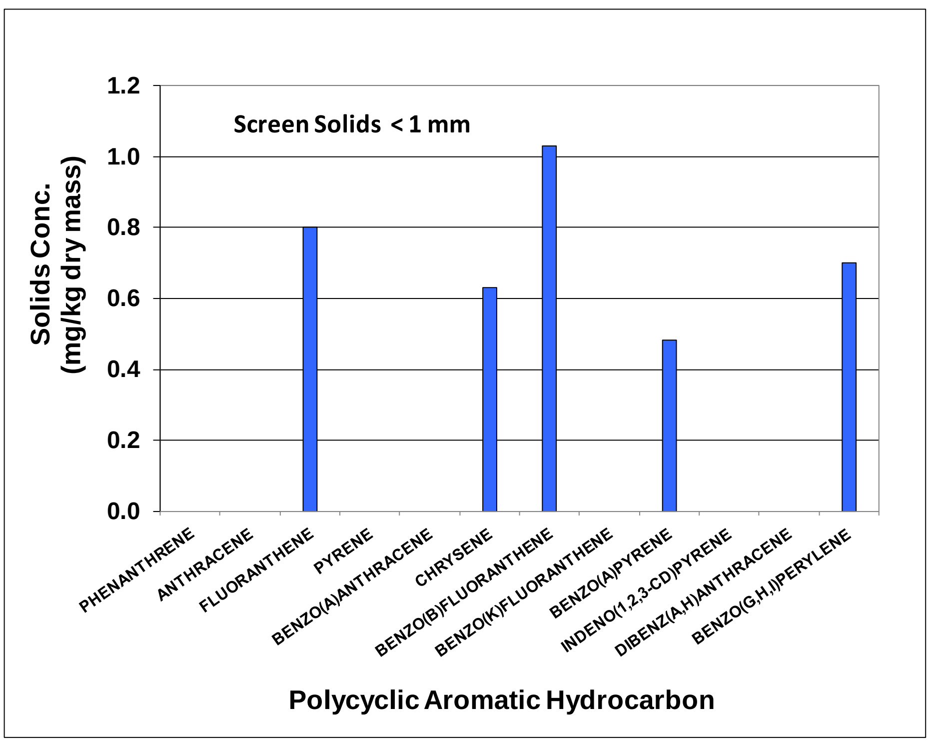

Figure 16 - Polycyclic aromatic hydrocarbons in Sarasota solids (bottom chamber PAH reported as less than detection limit)

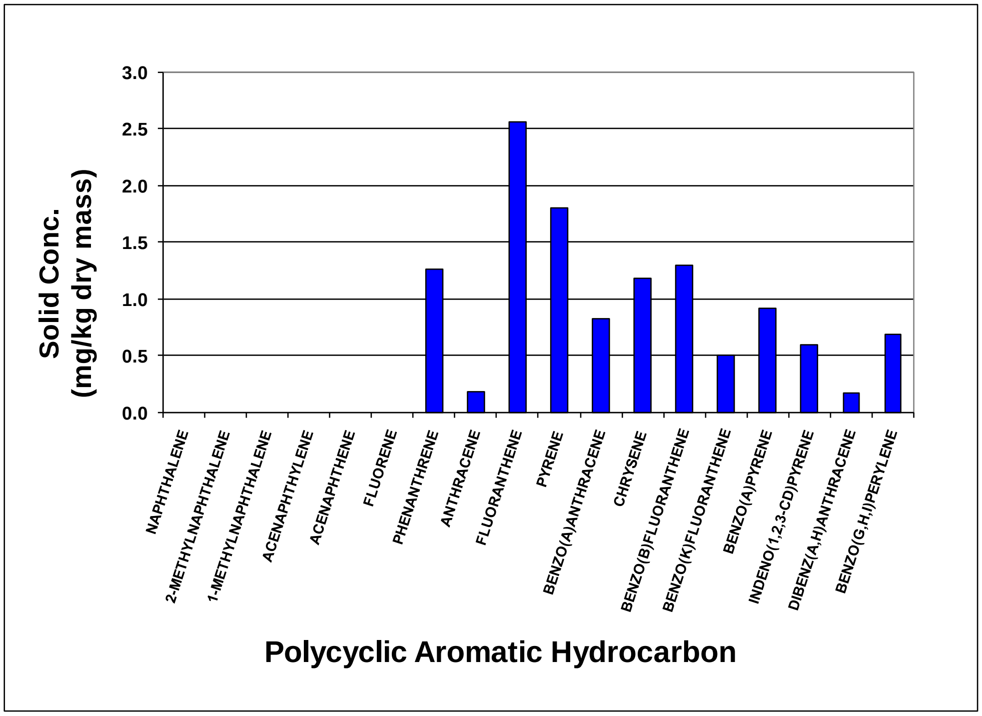

Figure 17 - Polycyclic aromatic hydrocarbons in Lincoln solids.

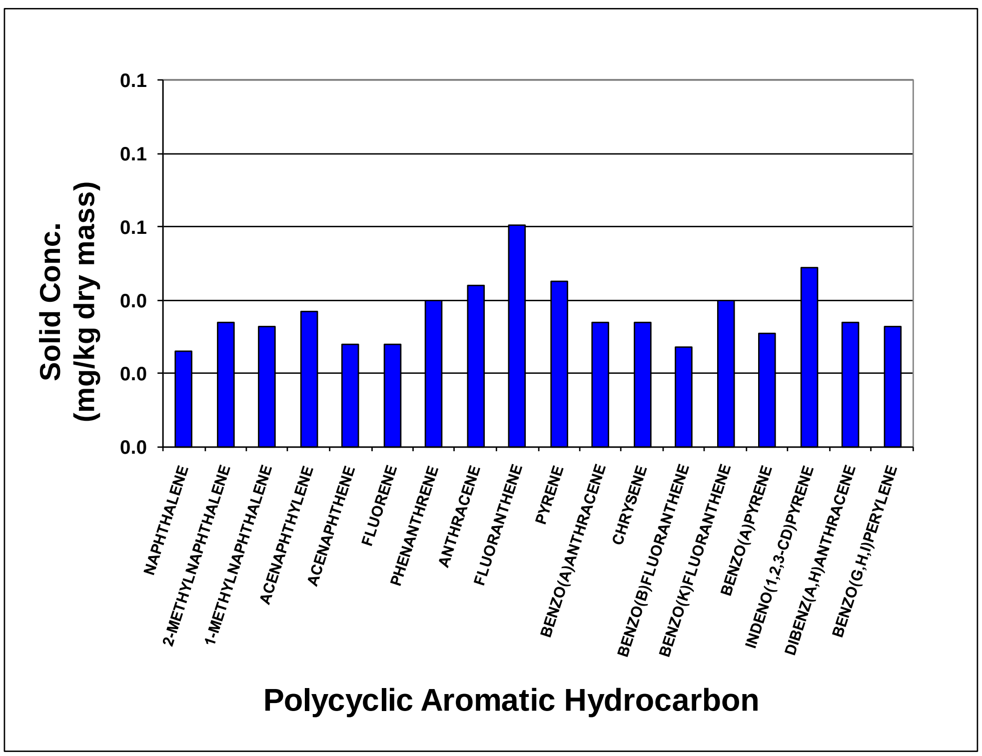

Figure 18 - Polycyclic aromatic hydrocarbons in Parkway solids.

Site	Total PAH, mg/kg solids		
	Bottom chamber	Sieve screen > 1 mm	Sieve screen < 1 mm
Little John Drive, Rockledge City First Cleanout	7.6	19.8	28.2
Little John Drive, Rockledge City Second Cleanout	1.7	52.9	70.0
Oriole Drive, Sarasota	ND	ND	3.02
Lincoln Avenue, Stuart City First Cleanout	12.0	-	-
Lincoln Avenue, Stuart City Second Cleanout	15.5	-	-
SE Parkway Drive, Stuart City	0.66	-	-

Table 22 - Total polycyclic aromatic hydrocarbons in accumulated solids

Site	Total PAH, mg/kg solid organic matter		
	Bottom chamber	Sieve screen > 1 mm	Sieve screen < 1 mm
Little John Drive, Rockledge City First Cleanout	60.7	27.1	94.0
Little John Drive, Rockledge City Second Cleanout	10.0	480.9	135.6
Oriole Drive, Sarasota	5.52	ND	ND
Lincoln Avenue, Stuart City First Cleanout	29.1	-	-
Lincoln Avenue, Stuart City Second Cleanout	266	-	-
SE Parkway Drive, Stuart City	6.3	-	-

Table 23 - Organic carbon normalized total polycyclic aromatic hydrocarbons levels

Heavy Metals

The reported levels of heavy metals in solids materials from sieve screen and bottom chamber are listed below.

Metal	Bottom Chamber Material, mg/kg dry weight		Sieve Screen Material, mg/kg dry weight			
	Cleanout 1	Cleanout 2	Cleanout 1		Cleanout 2	
			> 1 mm	< 1 mm	> 1 mm	< 1 mm
Cadmium	0.0404	2.10	0.643	0.471	0.73	0.70
Chromium	4.6	29	449	18.1	10	9.6
Copper	8.17	15.6	41.9	36	12	9.02
Nickel	1.59	14	5.9	4.59	4.8	6.57
Zinc	58.5	49.8	213	184	59.8	48.9
Mercury	0.0162	0.009	0.0783	0.0909	0.042	0.030

Table 24 - Metals concentration in Rockledge water column and solids

Metal	Bottom Chamber Material, mg/kg dry weight	Sieve Screen Material, mg/kg dry weight	
		> 1 mm	< 1 mm
Cadmium	0.55	0.14	0.68
Chromium	6.3	3.2	21.2
Copper	22.6	33.4	145
Nickel	2.9	1.6	8.5
Zinc	116	158	329
Mercury	-	0.028	0.142

Table 25 - Metals concentration in Sarasota water column and solids

Metal	Bottom Chamber Material, mg/kg dry weight	
	Cleanout 1	Cleanout 2
Cadmium	0.144	0.95
Chromium	5.5	13
Copper	19.4	8.4
Nickel	2.03	6.2
Zinc	290	108
Mercury	0.0158	0.0051

Table 26 - Metals concentration in Lincoln water column and solids

Metal	Bottom Chamber Material, mg/kg dry weight
	Cleanout 1
Cadmium	0.87
Chromium	12.0
Copper	2.8
Nickel	5.70
Zinc	44
Mercury	0.0060

Table 27 - Metals concentration in Parkway water column and solids

Interevent Monitoring

A primary mechanism by which baffle boxes remove stormwater pollutants is by sedimentation of stormwater solids that enter during storm events, sieving in Type 2 baffle boxes, and by retention of large macroscopic solids that may bypass the sieve screen and become trapped beneath it and ultimately sink to the bottom. In interevent periods, the organic materials in the solids that collect in bottom chambers can biologically degrade. Organic matter degradation could be expected to result in oxygen utilization with possible anoxic or anaerobic conditions and release of inorganic nutrients from the decomposing solids. Inorganic nutrients in the baffle box water column could be flushing into the receiving water during the initial period of the next storm event, or continuously flushed out if there was a baseflow during interevent periods. A limited scope sampling program was implemented as a first step in assessing interevent water quality within baffle boxes. Another scope task was to evaluate methods of collection and laboratory analyses for the materials that accumulate in the sieve screens of Type 2 baffle boxes. This material is a mixture of large size vegetation (leaves, plant parts), smaller organic materials, and inorganic particles. The estimate of the mass of pollutant removed in solids that accumulated within sieve screens depends on the sampling, sample preparation, and analytical methods used to characterize these materials. Interevent monitoring and sampling of the four baffle boxes was conducted on 3/25/2009. Monitoring included measurements of dissolved oxygen profiles, point measurements of temperature, pH, alkalinity and oxidation reduction potential, and collection of water column samples from a single point in the downstream baffle box chamber for laboratory analyses of suspended solids, BOD, COD, and nitrogen and phosphorus species. Water column samples were stored on ice and delivered to Pace Analytical Services, Inc. Tampa, FL on 3/26/2009.

Dissolved oxygen profiles are shown in Figure 20. Dissolved oxygen in the Rockledge and Sarasota baffle boxes was zero from 6 in. below the surface to the bottom. The Lincoln and Parkway baffle boxes had DO greater than 4 throughout their depth. For all baffle boxes, DO levels were constant through the vertical profile of the baffle boxes, with very limited depth stratification. Water column field parameter results for the interevent monitoring are summarized in Table 28. The water quality of the Type 2 baffle boxes (Rockledge and Sarasota) was distinct from the Type 1 baffle boxes (Lincoln and Parkway). Rockledge and Sarasota exhibited zero dissolved oxygen, highly negative oxidation reduction potentials, and higher chemical and biochemical oxygen demand, total nitrogen, and total phosphorus. Highly negative oxidation reduction potentials indicate that oxygen has been consumed and reducing conditions have been established by biochemical degradation of organic matter.

These observations are consistent with the hypothesis that organic matter captured in the Rockledge and Sarasota baffle boxes undergoes biological decomposition within the baffle box, leading to depletion of molecular oxygen, anaerobic redox conditions, and release of inorganic and soluble nutrient species into the overlying water column within the baffle box. The data in Figure 20 provide the first known documentation of patterns of DO depletion in Florida baffle boxes, due ostensibly to interevent biochemical processes. Organic matter decomposition was apparently more significant in the Rockledge and Sarasota baffle boxes, while the Lincoln and Parkway baffle box DO and ORP indicated a lower predominance of organic matter decomposition. Several factors could contribute to the observed difference in the interevent water quality between the Type 2 and Type 1 baffle boxes. The most significant could be the characteristics of the contributing watershed, particularly in terms of the vegetative contributions from the watershed. Rockledge and Sarasota watersheds were generally highly vegetated while vegetation coverage in the Lincoln and Parkway watersheds was much lighter.

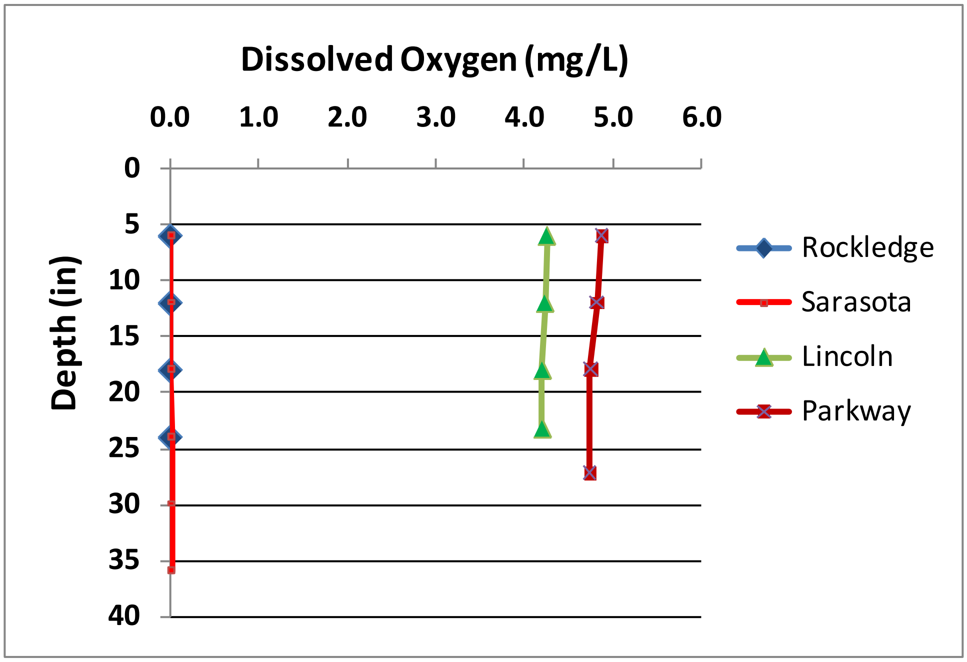

Figure 19 – Dissolved oxygen profiles in baffle boxes

The organic matter and vegetation that are subject to biological decomposition in a Type 2 baffle box can include materials that are retained in the sieve screen overlying the water column and materials that are not retained in the sieve screen that end up in the bottom chambers. Organic particulate material can enter the bottom chamber through bypass of the sieve screen or by transport of smaller organic matter through the sieve screen itself, particularly when the screen has been cleaned and a mat layer has not built up. Storm-transported vegetation that enters a Type 1 baffle box could pass directly through the baffle box into the receiving water, thus not contributing to water quality modifications in the baffle box itself. Another factor is the contribution of baseflow, which could act to continuously dilute soluble nutrients releases from decaying organic matter.

The second interevent monitoring task was to collect solid materials that accumulated in the sieve screens of the Type 2 baffle boxes (Rockledge and Sarasota) and to provide subsample splits to different laboratories for nitrogen and phosphorus analyses using wet chemistry and composting analytical methods. Three separate samples of solid material accumulated in the

Rockledge sieve screens were collected. Each sample was subdivided into three subsamples, which were shipped to three separate laboratories for analyses. The three laboratories that received solid material subsamples were A&L Great Lakes Laboratories, Inc. **(A&L)**, Ft. Wayne, IN (water and compost methods); Columbia Analytical Services, Inc. **(Columbia)**, Jacksonville, FL (water methods); and the Institute of Food and Agricultural Sciences Analytical Services Laboratories **(IFAS),** Environmental Water Quality Laboratory, University of Florida, Gainesville, FL (water methods).

A primary question investigated was the appropriateness of using water and wastewater test methods for the sediments and biosolids captured in the baffle box screens and chambers. An alternative to water based methods was to use analytical methods from the solid waste and agricultural industries. A&L used test procedures from Standard Methods for the Examination of Water and Wastewater and Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (Table 29). In addition, A&L used Test Methods for the Examination of Composting and Compost, as shown in Table 30. Columbia used Methods of Chemical Analysis of Water and Waste analytical procedures.

On the sample date the sieve screen in the Sarasota baffle box contained negligible quantities of solid material so sample collection was not possible. The Rockledge sieve screen materials contained highly visible macroscopic plant matter and also small organic and non-organic sediment material.

Parameter	Rockledge	Sarasota	Lincoln	Parkway
Time	1300	1700	0730	0930
Temperature, C	19.4	21.40	21.5	21.70
pH	6.8	7.0	7.1	7.5
Alkalinity, mg/L as $CaCO_3$	73	144	44	125
Dissolved Oxygen, mg/L	0	0	4.2	4.8
ORP, mV	-306	-357	117	138
Total suspended solids, mg/L	8.5	8.3	12	5.0
Carboneceous biochemical oxygen demand, five day, mg/L	10	28	2.0	2.0
Chemical oxygen demand, mg/L	91	120	31	22
Total nitrogen, mg/L	0.03	0.03	0.10	0.97
Total kjeldahl nitrogen, mg/L	2.2	3.9	0.95	0.65
Organic nitrogen, mg/L	-0.25	-1.20	-0.14	-0.02
Ammonia nitrogen, mg/L	.25	1.20	0.14	0.02
(Nitrate+nitrite) nitrogen, mg/L	0.03	0.03	0.10	0.97
Total phosphorus, mg/L	.89	1.40	0.13	0.57
Organic phosphorus, mg/L	0.29	0.30	0.10	0.07
Orthophosphorus, mg/L	0.60	1.1	0.029	0.50

Table 28 - Average water column values of field parameters

Results of analyses of the solid materials removed from the Rockledge sieve screen are presented in Tables 29 and 30. Analytical results were provided by two laboratories (A & D and Columbia). The third laboratory (IFAS) was in possession of the samples for over four months and finally reported that nutrient analyses could not be performed due to the unique characteristics of the sample matrix and technical issues associated with sample processing.

Note that A&L used a volatile solids method to estimate organic matter in the solids while Columbia used a total organic carbon analysis.

For the same reported analyte, the percent error between A&L and Columbia results was calculated as the absolute difference in the reported A&L and Columbia results divided by the absolute value of the A&L result, multiplied by 100 (Table 29). For wet chemistry analyses, the average percent error in the total solids analyses reported by the two laboratories was 0.73% (n=3) with a range of -13.2 to +7.4%. For total kjeldahl nitrogen, the average percent error was +14.5% (n=3) and with a range of -1.8 to +48.4%. TKN results in Columbia Subsample 1 was particularly lower than other TKN values and was likely due to difficulties in processing of the subsample prior to digestion. The average percent error for total phosphorus was +29.3% (n=3) and with a range of +26.3 to +33.8%. The variation in the two reported results was significant for both nitrogen and phosphorus. The different results could have a significant effect on calculations of nutrient removal in the material captured on sieve screens of Type 2 baffle boxes. Inspection of the water method results for TP (Table 29) indicates that results were relatively consistent among the three subsamples for both A&L (mean = 1500, range = 1481 to 1524) and Columbia (mean = 1060, range = 980 to 1100). Mean TP reported by A&L was 41% higher than Columbia, however, indicating that interlaboratory variability for these types of samples can be significant.

Sample	Parameter	A&L	Columbia	A&L Method	Columbia Method	Percent Error[1]
1	Total Solids, %	24.84	23	SM (20th) 2540G	160.3MOD	7.4
	Volatile Solids, %	89	-	SM (20th) 2540G	-	-
	Total Kjeldahl Nitrogen, mg/kg	16,659	8,600	SM-4500 N(org)B & NH	351.2	48.4
	Total Phosphorus, mg/kg	1,481	980	SW846-6010B	365.1	33.8
	Total organic carbon, mg/kg	-	10,000	-	9060M	-
2	Total Solids, %	19.42	22	SM (20th) 2540G	160.3MOD	-13.3
	Volatile Solids, %	90	-	SM (20th) 2540G	-	-
	Total Kjeldahl Nitrogen, mg/kg	17,482	18,000	SM-4500 N(org)B & NH	351.2	-3.0
	Total Phosphorus, mg/kg	1,524	1,100	SW846-6010B	365.1	27.8
	Total organic carbon, mg/kg	-	15,000	-	9060M	-
3	Total Solids, %	20.67	19	SM (20th) 2540G	160.3MOD	8.1
	Volatile Solids, %	89	-	SM (20th) 2540G	-	-
	Total Kjeldahl Nitrogen, mg/kg	18,670	19,000	SM-4500 N(org)B & NH	351.2	-1.8
	Total Phosphorus, mg/kg	1,495	1,100	SW846-6010B	365.1	26.4
	Total organic carbon, mg/kg	-	11,000	-	9060M	-

[1] (A&L Result - Columbia Result)/A&L Result x 100

Table 29 - Water analyses method results for Rockledge sieve screen subsamples

Table 30 shows analytical results that were obtained for the three subsamples using Test Methods for Evaluation of Compost and Composting (TMECC) analytical procedures performed by A& L Laboratories. TMECC results were compared to A&L water analyses results by making appropriate unit conversions to compare water analysis results with TMECC results. TMECC % Organic Matter was 72 to 95% (mean = 83%) of water analysis volatile solids. TMECC % Total Nitrogen was 93 to 118% (mean = 112%) of water analysis Total Kjeldahl Nitrogen. TMECC % Total Phosphorus was 97 to 109% (mean = 102%) of water analysis Total Phosphorus. These results suggest that TMECC composting analytical methods may be applicable to analyses of sieve screen material analyses. Further work is required to verify this result and gain confidence in the methods. The units for water column methods are expressed in solids concentrations of mg/kg, while solids methods units are given as “percent” of a parameter. The differences in units between the two methods explains why there are blank values in Table 29. The appropriateness of using calculations that combine water based analytical methods and units from the water column with solids based analytical methods and units for gross solids is uncertain.

Sample	Parameter	A&L	Method
1	Total Nitrogen, %	0.49	TMECC 04.02-D
	Total Phosphorus, %	0.04	TMECC 04.03-A
	Organic matter by LOI @ 550C, %	15.87	TMECC 05.07-A
2	Total Nitrogen, %	0.42	TMECC 04.02-D
	Total Phosphorus, %	0.03	TMECC 04.03-A
	Organic matter by LOI @ 550C, %	14.35	TMECC 05.07-A
3	Total Nitrogen, %	0.36	TMECC 04.02-D
	Total Phosphorus, %	0.03	TMECC 04.03-A
	Organic matter by LOI @ 550C, %	17.62	TMECC 05.07-A

Table 30 - Compost analyses method results for Rockledge sieve screen subsamples

Additional sampling was conducted on 10/5/2009. Three samples were collected of materials that had accumulated in the sieve screen of the Sarasota baffle box. Samples were shipped to the Columbia Analytical Laboratory for analyses of total solids, TKN, and TP. Results are shown in Table 31. Mean parameter values for TS, TKN, and TP were 26.7%, 11,767 mg/kg and 1006 mg/kg, respectively. The coefficient of variation for the three TS, TKN and TP samples were 0.13, 0.20 and 0.25, which indicates that the results were reasonable similar for the three samples. TKN from the Sarasota sieve screen material was generally about two thirds that of the material collected from the Rockledge sieve screen, while Sarasota TP was to 67 to 95 % of the Rockledge TP depending on which laboratory data for Rockledge TP are used for comparison.

Sample	Parameter	Columbia	Columbia Method
1	Total Solids, %	30	160.3MOD
	Total Kjeldahl Nitrogen, mg/kg	12,000	351.2
	Total Phosphorus, mg/kg	860	365.1
2	Total Solids, %	27	160.3MOD
	Total Kjeldahl Nitrogen, mg/kg	9,300	351.2
	Total Phosphorus, mg/kg	860	365.1
3	Total Solids, %	23	160.3MOD
	Total Kjeldahl Nitrogen, mg/kg	14,000	351.2
	Total Phosphorus, mg/kg	1,300	365.1

Table 31 - Water analyses method results for Sarasota sieve screen samples

The results of the sieve screen analyses were mixed overall, with some consistent results and some inconsistencies. Five of the six Rockledge TKN were in reasonable agreement with each other; one TKN was significantly different from the two other TKN from the same lab and also significantly different from the subsamples supplied to the second lab. Rockledge TP values were in reasonable agreement for three samples for each lab, but consistently different between labs. Sample processing methodology may have had some influence on the discrepancy. Unfortunately, the third laboratory had reservations about a methodology and elected not to pursue analyses. Significant differences between Rockledge and Sarasota TKN and TP could reflect differences in the materials captured within the sieve screens and transformations of materials that occur in the captured material. For both nitrogen and phosphorus, reported nutrient values of sieve screen materials were subject to large differences for the small number of split samples analyzed. This result was not unexpected; it reaffirms the complexity of stormwater solids matrices and the need to focus more effort on them. A result which is encouraging is the relative agreement of total solids values for the two laboratories and the agreement of the composting methods for solids, nitrogen and phosphorus. The later suggests that composting or whole sample combustion methodologies, which do not employ sample digestion procedures, might be used in a standardized methodology for characterization of stormwater gross solids.

The scope of the interevent monitoring for sieve screen materials was highly limited due to budget restrictions. For analyses of solids collected in baffle boxes, and more generally for solid materials that are removed from stormwater management systems in Florida, a more comprehensive effort is needed to fully address the integrated tasks of collection, preparation, and analyses of solid materials captured in sieve screens and bottom sediments. The objective of this effort should be to develop a standardized protocol for sample collection, preservation, sample handling, and preparation, with the goal of providing protocols that can be applied with confidence by many entities and laboratories. The limited scope of the work provided valuable insight that can be used to formulate the needed methods development effort, which should as a minimum include a much greater number of split samples and analyses.

Conclusions and Recommendations

Total Maximum Daily Load (TMDL) mandates are challenging communities to reduce pollutants from stormwater runoff above and beyond standard permitting requirements associated with new development. The primary method used to reduce pollutants is by retrofitting older development with BMPs to clean runoff from those areas that do not have treatment practices. Retrofitting older areas with traditional treatment practices such as ponds is difficult due to lack of undeveloped land. The limited amount of undeveloped land in older developments turns stormwater practitioners to other tools in the BMP toolbox.

A common BMP used in ultra urban locations has been the baffle box. Early model (Type 1) baffle boxes were underground vault boxes with weirs set at the pipe inverts that trapped pollutants through the sedimentation unit process. The primary pollutants targeted by Type 1 baffle boxes were sediments, heavy metals, and PAHs associated with sediments that fell by gravity into water filled chambers. Removal of nutrient pollutants was minimal in Type 1 boxes.

Nutrient TMDLs are generally expressed as reductions of TN and TP. Nutrients can be found dissolved in the water column, bound to sediments, or part of the structural matrix of organic debris. The primary source of anthropogenic TN is dissolved fertilizer in the water column. A small amount of TN is associated with organic sediments. Organic debris leaches significant levels of TN and TP into water within 72 hours of submersion, England et.al. (2000). Approximately 30-40% of stormwater based TP is bound to sediment particles with the remainder being dissolved in the water column.

Development of TMDLs over the last few years has shown that nutrients were the primary pollutants causing environmental degradation in Florida. In response to the need to provide BMPs with nutrient removal capability, Suntree Technologies has developed proprietary Type 2 baffle boxes that added a horizontal screen above the water line of the vaults. This filtration unit process traps gross solids such as leaves, grass clippings, sediment, and trash during high flows when the hydraulic grade line rises above the screen level. After the water surface recedes upon cessation of rain, gross solids trapped in the screens are kept above the water filled vaults with the design goal of letting the organic debris dry to prevent leaching of nutrients into the vaults. In addition, the screens enhance sedimentation of organic and inorganic sediments by physically blocking and filtering particles that are limited to velocity constraints of Stokes law for settling in Type 1 baffle box designs. The unit processes of sedimentation and filtration in a baffle box do not provide treatment of water column based TN and TP.

Sarasota County received funding from FDEP to monitor two Type 1 and two Type 2 baffle boxes to document pollutant removal effectiveness, primarily focused on the parameters TN and TP. The County contracted with GPI-SE to develop and manage the monitoring program. Field monitoring and data collection was subcontracted to Sutron Corporation for three baffle boxes in Rockledge and Stuart, and to PBSJ for one baffle box in Sarasota.

BMP site selection is critical and challenging for an effective field monitoring program. Pollutant loadings vary with every watershed and every rainfall event. A site must be chosen that allows the researcher to control as many of the pollutant loading variables as possible. A site must allow for proper setup and maintenance of equipment and collection of samples. Recommendations for site selection to give an affective baffle box monitoring program are:

- Minimize equipment requirements by using a baffle box with one influent pipe and one effluent pipe, each of which uses one autosampler. Additional pipes will require additional autosamplers and flow meters. More equipment leads to more malfunctions and lost storm sampling opportunities.
- There should be no base flows through the pipes or backwater or submersion from downstream waterbodies.
- There should be no bypass flows during large storms.
- BMPs in roadways should not be monitored. Technician vehicles will need to be parked next to the site for sampling and equipment maintenance. Access dictates a location outside of the pavement for safety reasons and to avoid lane closures.
- For rain gauges and solar panels to operate accurately there can be no tree coverage over the site.
- Theft proof enclosures should be used to house autosamplers, batteries, and solar panels. Adjacent property owners should be canvassed to ensure their cooperation with technicians accessing equipment at any hour.
- Testing for gross solids requires selecting a watershed with a high tree canopy coverage.
- When monitoring to compare multiple BMPs, each BMP watershed should be of similar land use in order to have similar pollutant loadings for each BMP.
- The interior of the BMPs should have sufficient clearance and access to enable a technician to install equipment and take samples.
- The sites should be within reasonable driving distance of technicians who will be making weekly visits to inspect and calibrate equipment. Automated sampling equipment that contacts technicians via modem or internet should be used to minimize

site visits for rainfalls that do not trip the autosampler. Many storms in Florida are below tripping criteria for rain intensity and duration.
- Roadways in the watershed should have curb and gutters. There should be no other upstream BMPs in the drainage basin, including roadside swales that will filter pollutants, especially gross solids, before they enter the BMP.

The monitoring approach that was developed and applied in this study measured water column pollutant removal performance based on flow composited water column autosamplers as well as masses that accumulated in the baffle box as gross solids. The monitoring approach demonstrated that the solids which accumulate in a baffle box must be included in an overall assessment of pollutant removal effectiveness of the baffle box. In some cases, mass removal in accumulated solids was significantly greater than water column mass removal. Use of a Derived Efficiency (DE) provided an index of pollutant reduction efficiency that incorporated accumulated solids and water column monitoring, resulting in a net positive retention of nitrogen and phosphorus. DE is a more useful indicator of baffle box treatment performance than water column EMC methods.

Field monitoring of four full scale baffle boxes resulted in the following findings:

- The average DE for non-dissolved stormwater solids removal was 43.6%, ranged from 2 to 83%, and was higher for Type 2 than Type 1 baffle boxes.
- The average DE for nitrogen removal was 9.8%, ranged from 0.03 to 28%, and was higher for Type 2 than Type 1 baffle boxes.
- The average DE for phosphorus removal was 8.9%, ranged from .06 to 19%, and was higher for Type 2 than Type 1 baffle boxes.
- Watershed characteristics and the presence of sieve screens significantly affected the differences in DE between the Type 2 and Type 1 baffle boxes.
- EMC removal efficiencies for total suspended solids averaged 8.5, 35.1, 12.3, and -38.5 %, respectively, for Rockledge, Sarasota, Lincoln, and Parkway baffle boxes.
- EMC removal efficiencies for total nitrogen averaged -11.3, 30.6, -8.3 and 5.6 %, respectively, for Rockledge, Sarasota, Lincoln, and Parkway baffle boxes.
- EMC removal efficiencies for total phosphorus averaged -8.2, 21.6, 1.5 and -15.3 %, respectively, for Rockledge, Sarasota, Lincoln, and Parkway baffle boxes.
- EMC removal efficiencies for fecal coliforms averaged -28, 13, -89 and -4.2 %, respectively, for Rockledge, Sarasota, Lincoln, and Parkway baffle boxes.
- Total polycyclic aromatic hydrocarbons ranged from non-detect to 15.5 mg/kg dry solids in materials collected from the baffle box bottom chambers.
- Total polycyclic aromatic hydrocarbons ranged from 20 to 53 mg/kg and 28 to 70 mg/kg in sieve screen materials greater and less than 1 mm, respectively.

When measured by the EMC method, Type 1 baffle boxes provided average reductions of 13.1%, -1.3%, -6.9%, and -46.8% for TSS, TN, TP, and fecal coliforms respectively. When using the DE methodology there were average mass removals of 19.9%, 0.5%, and 2.28% for Total non-dissolved solids, TN, and TP respectively.

Parameter	EMC	DE
TSS	13.1%	n/a
Total non-dissolved solids	n/a	19.9%
TN	-1.3%	0.5%
TP	-6.9%	2.28%
Fecal coliform	-46.8%	n/a

Table 32 – Type 1 baffle box removal efficiency using EMC and DE methodology

Type 2 baffle boxes showed higher pollutant removal effectiveness than Type 1 baffle boxes, with average EMC removals 21.8% for TSS, 9.6% for TN, 6.7% for TP, and -118% for fecal coliforms. Using DE calculations the Type 2 baffle boxes averaged 67.2% TSS removal, 19% TN removal, and 15.5% TP removal.

Parameter	EMC	DE
TSS	21.8%	67.2%
TN	9.6%	19%
TP	6.7%	15.5%
Fecal coliform	-118%	n/a

Table 33 - Type 2 baffle box removal efficiency using EMC and DE methodology

The screens in Type 2 baffle boxes trapped organic debris that would not be filtered in Type 1 baffle boxes. In watersheds that have a significant amount of tree canopy coverage, Type 2 baffle boxes give a greater nutrient removal than Type 1 baffle boxes due to the ability to filter leaves. Grass clippings were not a significant source of organic debris at the four sites monitored, indicating that public education programs to train residents not to place grass clippings in streets appear to be successful. During the monitoring program residents were observed several times blowing grass clippings into the yards. Oak leaf and pine needle accumulations were the significant source of organic debris in these watersheds.

At three of the four baffle box locations, fecal coliform concentrations were observed to be 44% - 61% higher in the effluent than the influent. Baffle boxes and other vault type BMPs that store interevent water act as septic tanks, promoting bacteria growth and low DO in the nutrient laden water. If fecal coliform is a parameter of concern for a waterbody, use of a baffle box or any water storing vault box can lead to increased fecal coliform counts to waterbodies.

Pollutant loadings vary widely among watersheds. Pollutants are present in the water column, street sediments, and in organic debris. In the Rockledge watershed, masses from leaves and sediment were 53.4 times greater than water column solids masses. In the Sarasota watershed sampling failures did not allow an accurate comparison of water column and gross solids masses. In watersheds with significant tree coverage, selection of BMPs that remove leaves from stormwater runoff can reduce nutrient discharges. Selection of BMPs that keep leaves in a dry state will provide greater nutrient removal than BMPs that store leaves in a wet condition.

While Type 2 baffle boxes kept leaves out of the water filled vault, the accumulation of leaves in the baskets filtered sediment creating a semi-pervious liner that stored water for several days, enabling leaves to leach nutrients slowly into the vault. In addition, the inherent design of screens that enabled high flow bypass for flood reduction allowed significant masses of leaves to fall from the screens into the vault boxes. It is worthwhile to mention that without the screens almost all leaves would wash through the box and end up in the receiving water where they would leach their entire nutrient mass.

The ability of leaves to leach nutrients even from a Type 2 baffle box demonstrated the importance of cleaning BMPs. The Sarasota baffle box screen was observed to completely fill with leaves after a small rain event. Even with the limited documentation of leaf accumulations from the Sarasota baffle box, 3586 pounds of leaves and sediment were collected. At the Rockledge baffle box 1,378 pounds of debris were collected from the screens. In watersheds with high leaf falls, it is recommended that baffle box screens be cleaned after every rain event in order to maximize nutrient reduction and prevent nutrient leaching from Type 2 baffle boxes.

Baffle box performance could be improved if there was a way to pump or bleed off chamber water between storms. The nutrient leaching and bacterial growth problem would be eliminated. The trade off for such an improvement would be moving from a passive design to an active mechanical design with maintenance and costs for pumps, electricity, and trained personnel. Passive low maintenance technology has been taken about as far as possible. Further advances in pollutant treatment will require mechanical and/or chemical technology similar to the wastewater industry.

Another recommendation related to the maintenance of the baffle box is to set up a clean-out schedule based on the observed needs of the individual baffle boxes, rather than a set quarterly or monthly clean out schedule. Some of the baskets in the study filled completely after a single rain event. Better tracking of the amount of organic material removed from the boxes can also aid in directing more maintenance efforts towards boxes that need frequent clean outs. This will aid in optimizing effectiveness.

Based upon the findings of this report, the following criteria are recommended for use of Type 2 baffle boxes:

1. When pollutants targeted for reduction in the watershed are nutrient based,
2. When fecal coliform reduction within the watershed is not a goal,
3. When the streets in the watershed have curb and gutters,
4. When there are no upstream BMPs such as ponds, exfiltration trenches, swales, inlet traps, and
5. When tree canopy coverage in the watershed exceeds 25%.

In watersheds with curb and gutter, an alternative to the use of Type 2 baffle boxes is installing inlet traps at all inlets. These BMPs act as a form of source control by reducing the leaching potential from trapped organic debris. Allowing organic debris to dry in an inlet trap can act as a unit process as nutrients are released to the atmosphere (England, 2008.) A limitation of inlet traps is that they trap little sediment and have much smaller debris trapping capacity than a Type 2 baffle box. However, they have much smaller drainage basins than a baffle box typically installed at the end of a watershed. Inlet traps will also require more frequent maintenance than a baffle box. Maintenance of a baffle box requires an expensive vacuum truck, while cleaning an inlet trap can be accomplished with by hand or a small truck mounted vacuum pump. Inlet traps cost about $1,000 while baffle boxes will cost approximately $50,000 for installation and road reconstruction. Inlet traps trade off lower upfront cost with higher maintenance frequency than a baffle box.

Another alternative BMP that could be used to collect gross solids is street sweeping. This form of source control removes 100% of the pollutants associated with the mass of material removed, does not require expensive engineering and construction, and is promoted by FDEP with special credits toward reducing TMDL load allocations. The City of Pensacola's Surface Water Quality Assessment (England, 2009) documents that the City's once a week street sweeping program collects an average of 5,734,865 pounds of sediment and gross solids. Based upon testing of street sweeping material by the City, the collected mass equates to

2,265 lb/yr of TN and 720 lb/yr of TP removed from the streets. Using an annual street sweeping program cost of $185,000, TN annual removal costs are $82/lb and TP removal costs are $257/lb.

To improve the quantification accuracy of stormwater pollutant reductions by BMPs that accumulate gross solids, a comparison of laboratory protocols and sampling procedures was made to improve the methodologies to quantify solids that accumulate in those BMPs and characterize their pollutant concentrations. Based on the limited number of samples and disparity of results, a recommendation to use solids based analytical methods for gross solids could not be made. This issue requires further investigation.

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Diversion Manhole Calculations

NSBB TREATMENT FLOW CALCULATIONS

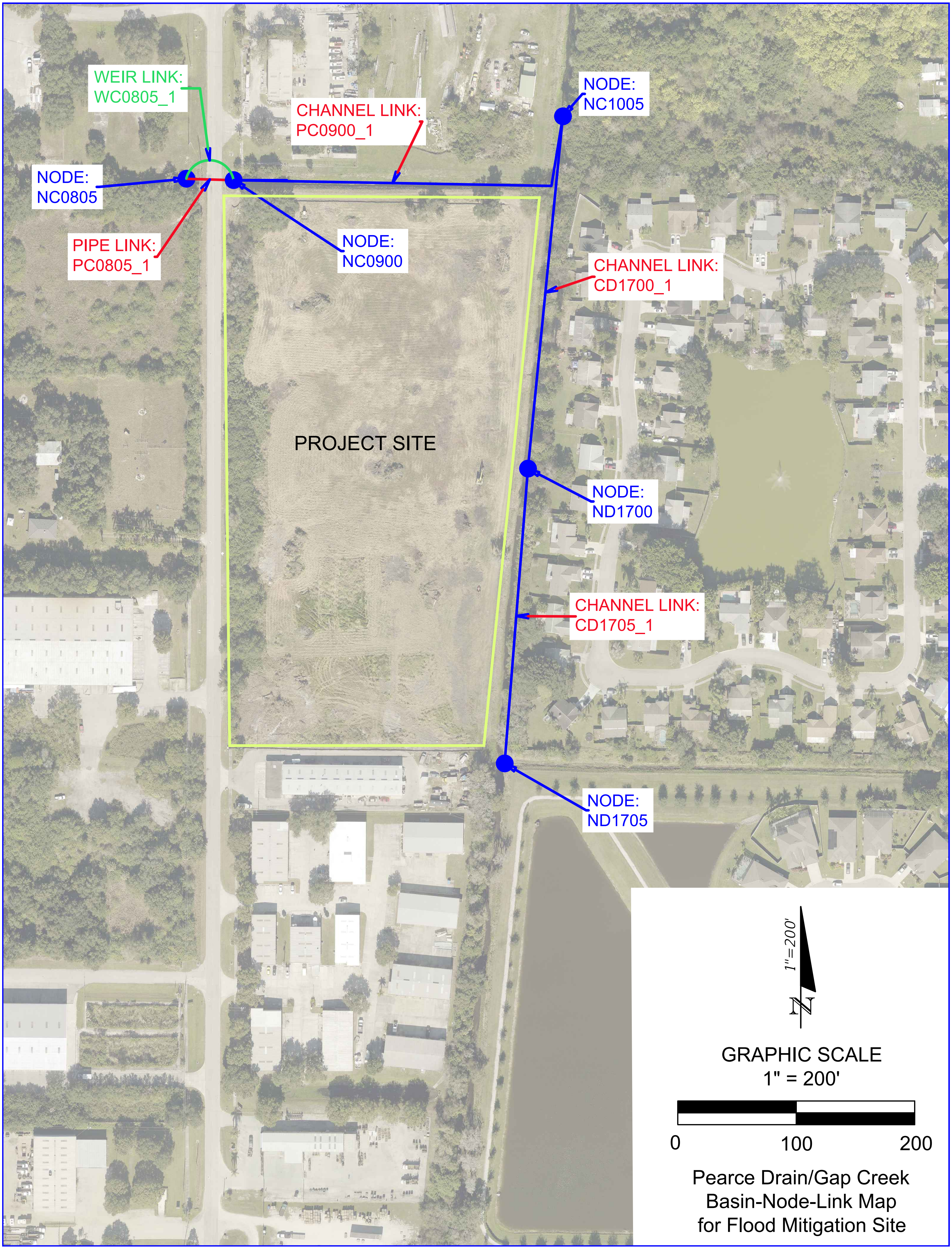
Per Ferguson Waterworks Sizing Guidance revised 07/20/23 Model NSBB 12 – 24 has a peak treatment flow rate of 109.5 CFS.

Per ICPR routing exhibits, the cross drain just west of our site is labeled PC0805_1 and the node on the east side of 33rd is labeled Node NC0900. From the exhibit in Appendix C the stage elevation when flowing a minimum of 109 cfs is 12.68 FT. Once the flow rate exceeds the maximum treatment flow rate of the NSBB device stormwater will divert into two separate stormwater pipes that outfall to the flood mitigation reservoir. We propose a diversion manhole with a weir at elevation top set to 12.70 to divert all flow less than 109.5 cfs towards the NSBB device for BMP collection and treatment.

The 100-year flow rate for the cross drain is 421.47 CFS. The maximum flow rate of the NSBB 12 – 24 is 287.7 CFS. Thus, a bypass was created to bypass the remaining 133.77 CFS. Please see weir sizing calculations below.

The weir in the diversion manhole was sized to discharge the above referenced remaining flow rate of 133.77 CFS. Length = 21.09 Ft, Height = 1.54 Ft, Weir Coefficient = 3.32
Q = C x L x H^(3/2) (Horizontal Broad Crested Weir Equation)
Q = 133.81 CFS. Thus, the proposed weir within the diversion manhole is sufficiently sized to flow the minimum rate of 133.77 CFS.

See the following figure for additional details on the NSBB and weir sizing and configuration.



Pearce Drain/Gap Creek
Basin-Node-Link Map
for Flood Mitigation Site

33rd Ave Crossdrain Treatment Flow

Link Name	Sim Name	Max Flow [cfs]	Min Flow [cfs]	Min/Max Delta Flow [cfs]	Max Us Velocity [fps]	Max Ds Velocity [fps]	Max Avg Velocity [fps]
PB2700_4	2YR24H	3.98	-28.27	0.12	-3.20	-5.63	-4.29
PB2700_5	2YR24H	3.88	-26.98	0.12	-3.14	-5.56	-4.24
PB2700_6	2YR24H	3.88	-28.54	0.12	-3.35	-5.62	-4.35
PB2800_1	2YR24H	86.46	0.00	2.24	6.79	2.72	4.75
PB2900_1	2YR24H	11.51	0.00	0.07	5.74	6.96	6.35
PB3200_1	2YR24H	50.42	0.00	0.50	7.13	7.13	7.13
PC0200_1	2YR24H	42.28	0.00	6.47	7.92	5.98	6.95
PC0305_1	2YR24H	35.07	0.00	-0.06	3.22	5.73	4.48
PC0405_1	2YR24H	46.75	0.00	0.01	4.86	4.86	4.86
PC0405_2	2YR24H	46.75	0.00	0.01	4.86	4.86	4.86
PC0555_1	2YR24H	1.74	0.00	0.01	2.97	2.98	2.63
PC0601_1	2YR24H	115.44	-0.11	0.05	4.59	4.59	4.59
PC0705_1	2YR24H	3.68	-0.99	-0.07	2.46	2.63	2.44
PC0805_1	2YR24H	190.49	0.00	21.66	9.16	14.53	11.85
PC1200_1	2YR24H	7.12	0.00	0.01	2.74	4.40	3.57

33rd Ave Crossdrain 100-Year Flow

Link Name	Sim Name	Max Flow [cfs]	Min Flow [cfs]	Min/Max Delta Flow [cfs]	Max Us Velocity [fps]	Max Ds Velocity [fps]	Max Avg Velocity [fps]
PB2700_4	100YR24H	5.84	-38.89	-0.02	-3.83	-4.53	-3.83
PB2700_5	100YR24H	5.84	-38.89	-0.02	-3.83	-4.45	-3.83
PB2700_6	100YR24H	5.84	-38.89	0.01	-3.83	-4.48	-3.83
PB2800_1	100YR24H	203.18	0.00	1.68	7.06	6.39	6.54
PB2900_1	100YR24H	28.58	0.00	4.36	9.10	9.47	9.28
PB3200_1	100YR24H	53.37	-16.92	0.61	7.55	7.55	7.55
PC0200_1	100YR24H	34.61	-0.12	1.92	5.43	4.94	4.90
PC0305_1	100YR24H	113.72	0.00	0.25	4.88	8.43	6.65
PC0405_1	100YR24H	56.09	0.00	0.02	5.83	5.83	5.83
PC0405_2	100YR24H	56.09	0.00	0.02	5.83	5.83	5.83
PC0555_1	100YR24H	7.47	0.00	-0.01	3.31	2.98	2.65
PC0601_1	100YR24H	173.68	-0.28	-0.05	6.91	6.91	6.91
PC0705_1	100YR24H	8.12	-5.26	-0.45	2.20	2.34	2.19
PC0805_1	100YR24H	421.47	0.00	134.93	14.26	17.35	14.55
PC1200_1	100YR24H	13.02	0.00	0.01	4.15	5.61	4.64

STORMWATER MANAGEMENT

OLDCASTLE NSBB® SIZING

SUMMARY

Municipalities across Florida utilize nutrient separating baffle box (NSBB) programs to treat outfalls that discharge to impaired waterbodies. This is because the NSBB has many features that maximize the pollutants captured, provides ideal access for maintenance, and allows for large flows to bypass internally without significant head loss.

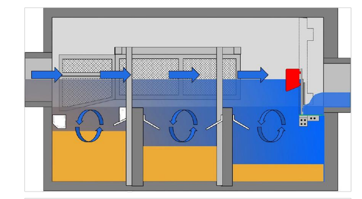


Figure 1: Normal Flow Path

GPI Southeast's 3rd party test report, Baffle Box Effectiveness Monitoring Project DEP Contract No. S02356, gives second generation baffle boxes 15.5% credit for TP and 19.05% for TN. While this report generically gives this credit to second generation baffle boxes, the specific products tested in this report were all Suntree (now Oldcastle) NSBB's.

SIZING

NSBB's are typically design based off pipe size and flowrate. In a typical application the width of the NSBB to be double the width of the pipe diameter. Additionally, the length of the vault (while in accordance with standard mold sizes) to be double the width. Thus a 48" pipe would be sized to have an 8ft wide by 16 ft long interior concrete structure. After a vault size is selected, it is necessary to cross check the flowrate of the location to the peak flow rates or design flow rates of the structure.

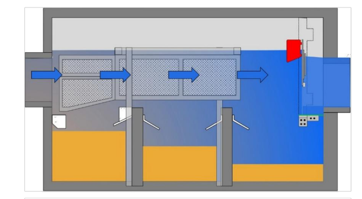


Figure 2: Bypass Flow Path

The table below shows the standard vault sizes, peak flowrates, and other applicable information, based on the Oldcastle NSBB Operations and Maintenance Manual at the time of publication:

Model	Structure Size (FT x FT)	Max Pipe Size (IN)	Sump Depth (FT)	Sediment Storage (CF)	Treatment Flow Rate (CFS)	Max Peak Flow (CFS)
NSBB 48	4 x 8	24	3.0	15.0	21.50	21.5
NSBB 612	6 x 12	36	4.8	34.3	42.80	66.2
NSBB 816	8 x 16	48	6.2	61.3	72.00	94.1
NSBB 10-20	10 x 20	60	7.6	95.0	88.2	175.3
NSBB 12-24	12 x 24	72	9.0	138.0	109.5	287.7

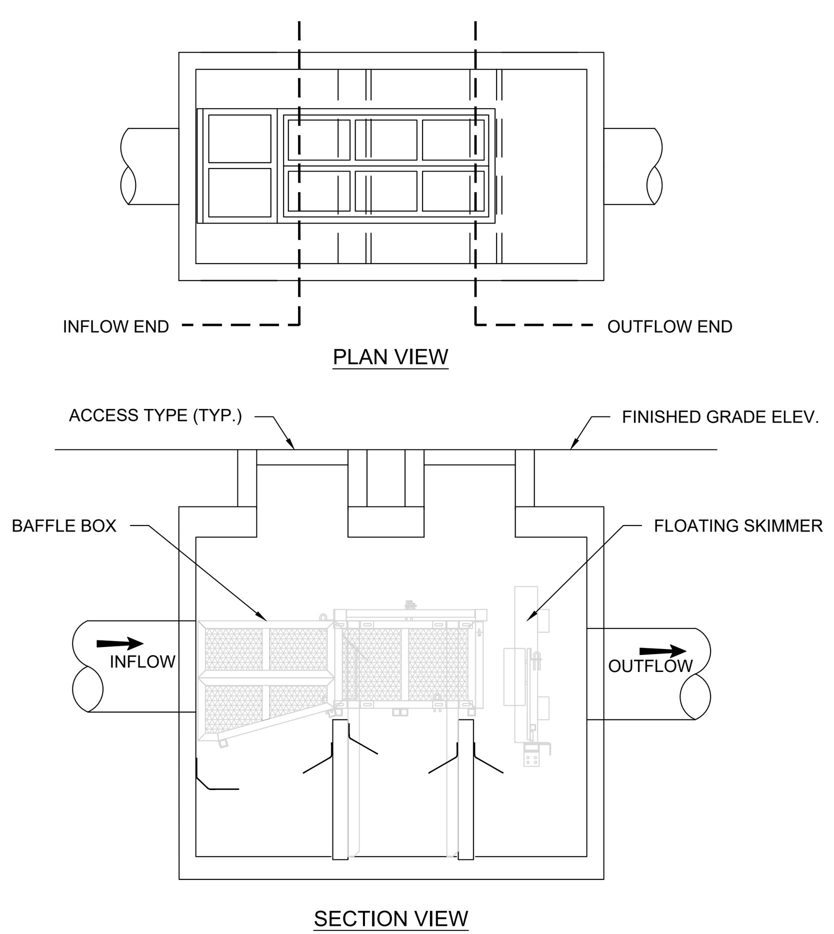
* For additional information, review the NSBB Operation and Maintenance Manual and "Stormwater Improvements with Nutrient Separating Baffle Boxes" by Ferguson Waterworks.

Rev: 07/20/23

FERGUSON WATERWORKS

DESIGN DATA						
UNIT DESCRIPTION	NSBB -					
FINISHED GROUND SURFACE		ROAD		PARKING LOT		GRASS
LOAD RATING		HS-20		PEDESTRIAN		OTHER
ACCESS COVER TYPE		GRATE		SOLID LID		HATCH
WQ FLOW RATE	109.5 CFS					
PEAK FLOW RATE	287 CFS					
FINISHED GRADE ELEV.	15.00'					
TOP OF VAULT	15.00'					
WATER TABLE ELEV.	6.00'					

PIPE INFORMATION			
	PIPE DIA.	MATERIAL	INVERT
INFLOW	58"x91"	ERCP	6.67
OUTFLOW	72"	RCP	6.17



NOT TO SCALE

01/09/2023

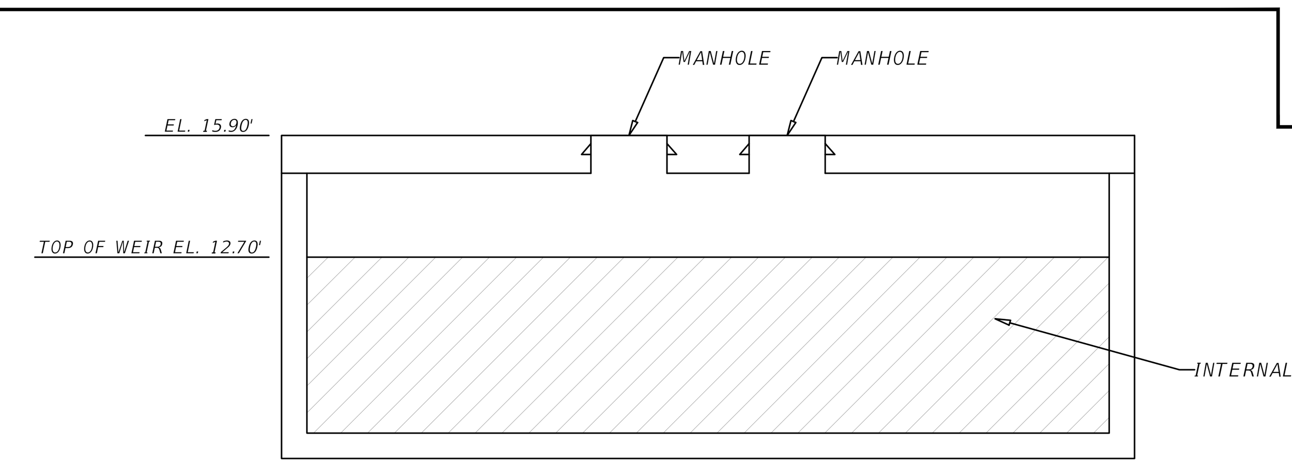
FERGUSON WATERWORKS

FOR ADDITIONAL INFORMATION PLEASE CONTACT:
FERGUSON WATERWORKS, 1-800-448-3636, www.ferguson.com

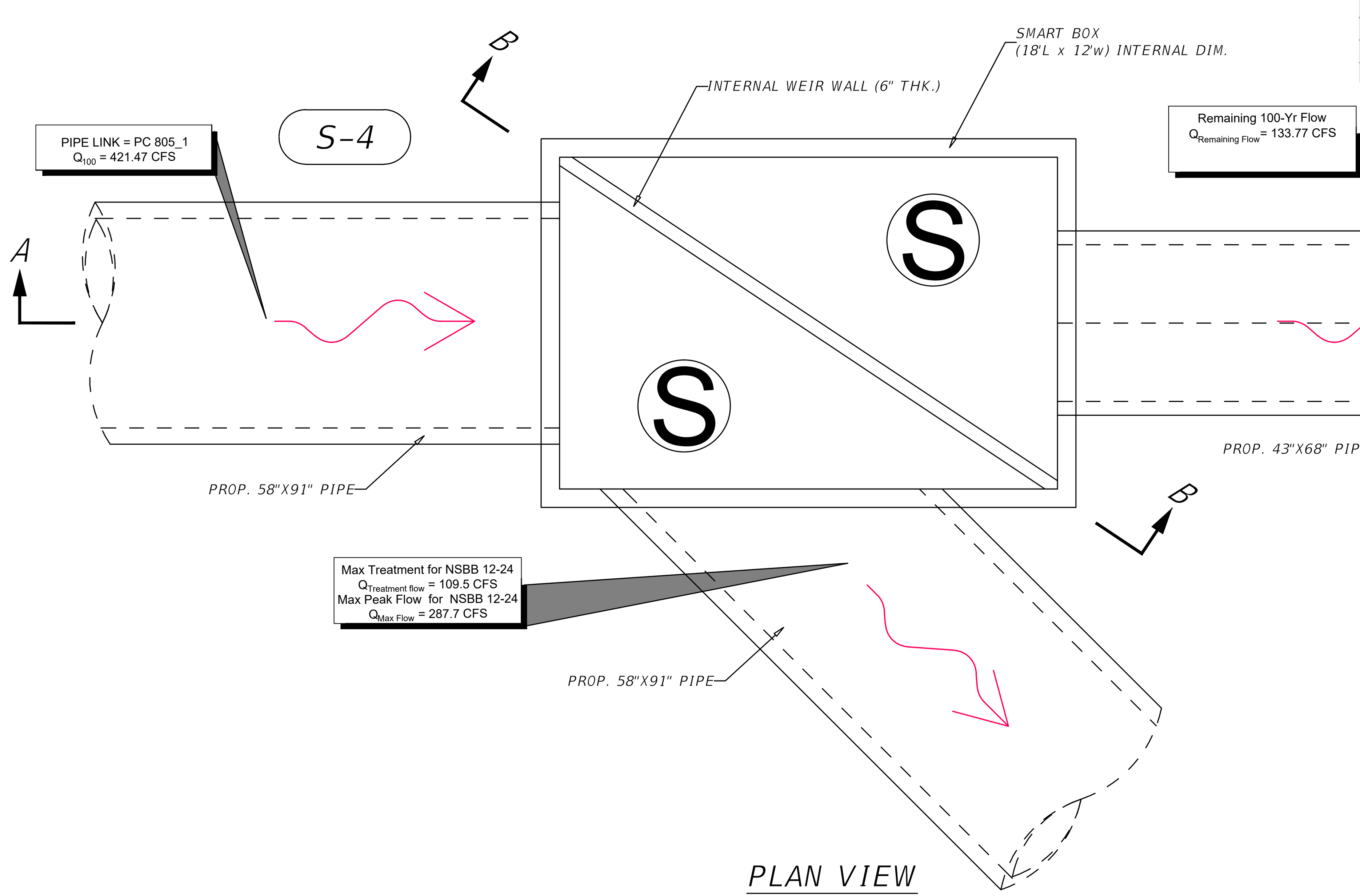
NUTRIENT SEPARATING BAFFLE BOX (NSBB)
BY OLDCASTLE INFRASTRUCTURE

33rd Ave Max Stage at Treatment Flow

Node Name	Sim Name	Warning Stage [ft]	Max Stage [ft]	Min/Max Delta Stage [ft]	Max Total Inflow [cfs]	Max Total Outflow [cfs]	Max Surface Area [ft2]
NB1500	2YR24H	26.50	23.95	0.0001	62.98	3.71	293288
NB1600	2YR24H	27.50	24.64	0.0001	104.11	14.86	596750
NB1700	2YR24H	24.17	19.38	0.0010	60.58	60.52	4526
NB1800	2YR24H	29.32	23.18	0.0003	16.86	15.37	880
NB1900	2YR24H	22.91	18.69	0.0010	208.66	165.78	179712
NB2000	2YR24H	20.40	14.95	0.0004	204.89	152.28	247275
NB2100	2YR24H	17.40	12.89	0.0003	154.84	152.20	39672
NB2105	2YR24H	18.53	13.23	0.0005	168.38	151.84	9006
NB2200	2YR24H	15.81	12.84	0.0003	397.00	331.03	796750
NB2205	2YR24H	15.47	12.88	0.0017	382.55	375.19	59878
NB2210	2YR24H	16.16	12.81	0.0021	332.13	331.03	24364
NB2250	2YR24H	19.00	12.84	0.0001	9.85	2.33	184972
NB2300	2YR24H	16.87	14.00	0.0002	27.37	13.03	36249
NB2400	2YR24H	16.52	12.86	0.0003	28.60	5.81	41634
NB2405	2YR24H	17.27	12.80	-0.0013	18.74	18.71	1131
NB2500	2YR24H	11.02	12.80	0.0003	158.67	136.53	185095
NB2600	2YR24H	11.02	12.78	0.0002	145.77	126.62	163097
NB2700	2YR24H	14.50	12.81	0.0001	177.21	23.53	915318
NB2800	2YR24H	21.29	13.19	-0.0004	86.78	86.46	5912
NB2900	2YR24H	24.26	15.73	0.0004	11.70	11.51	3936
NB3000	2YR24H	17.13	12.57	0.0003	236.15	239.09	398293
NB3005	2YR24H	16.45	12.80	0.0002	115.58	113.99	28402
NB3010	2YR24H	17.41	12.78	0.0019	232.19	232.41	52340
NB3100	2YR24H	16.52	13.77	0.0002	21.16	3.79	46484
NB3200	2YR24H	18.20	12.57	0.0010	54.00	50.42	5923
NB3300	2YR24H	25.46	15.73	0.0001	7.42	6.25	26166
NB3400	2YR24H	15.71	12.34	0.0028	244.43	244.70	29827
NC0100	2YR24H	15.71	12.32	0.0005	246.39	246.61	18610
NC0200	2YR24H	20.20	12.32	0.0003	35.26	42.28	17051
NC0300	2YR24H	30.10	22.63	0.0003	147.06	103.47	150703
NC0305	2YR24H	29.22	21.03	0.0002	35.41	35.07	8951
NC0400	2YR24H	23.28	17.35	0.0003	273.13	92.26	624895
NC0405	2YR24H	21.42	16.74	0.0004	92.26	93.50	19133
NC0500	2YR24H	23.50	22.49	0.0001	29.14	5.72	128477
NC0550	2YR24H	23.50	21.62	0.0001	28.52	1.73	156123
NC0555	2YR24H	26.12	16.65	-0.0001	1.73	1.74	1723
NC0600	2YR24H	20.77	15.72	0.0004	148.81	148.17	20147
NC0601	2YR24H	21.60	16.00	0.0004	115.04	115.44	8888
NC0605	2YR24H	21.22	16.27	0.0004	114.71	115.04	10235
NC0610	2YR24H	20.37	15.23	0.0003	148.17	147.87	16247
NC0700	2YR24H	17.50	15.22	0.0001	52.79	11.69	330385
NC0705	2YR24H	21.89	14.47	-0.0004	3.67	3.68	854
NC0800	2YR24H	19.74	14.46	0.0003	194.94	190.55	93295
NC0805	2YR24H	19.45	13.25	-0.0007	190.55	190.49	5518
NC0900	2YR24H	19.15	12.68	0.0003	194.24	193.79	17305
NC1000	2YR24H	14.69	11.78	0.0004	369.92	371.07	161487



SECTION B-B
N.T.S.



PLAN VIEW
N.T.S.

Weir Calculations

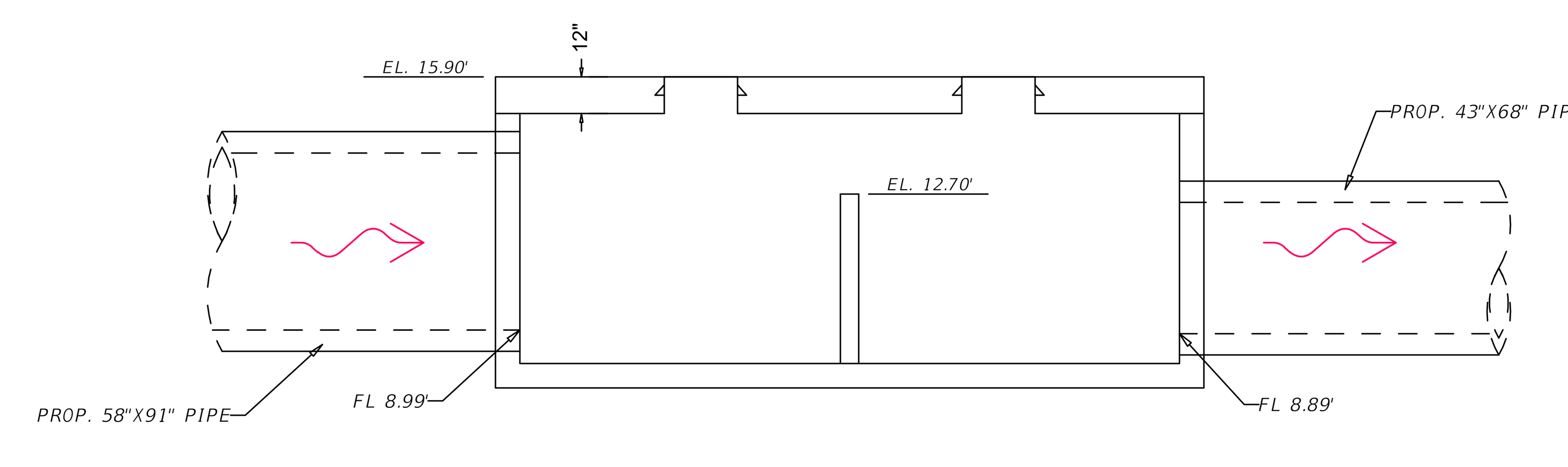
Rectangular Weir

Coefficient of discharge - C is caculated from table 5-3 on page 5-40 in the sixth edition of Brater and King's Handbook of Hydraulics and is based on a 6" weir crest width.

	Find the Length		Find the Q		Find the Height	
Weir Coefficient (C) =	3.32		3.32		3.32	
Discharge (Q) =	133.81	cfs	133.81	cfs	133.81	cfs
Height above Weir (H) =	1.54	feet	1.54	feet	1.54	feet
Weir Crest Length (L) =	21.09	feet	21.09	feet	21.09	feet

Horizontal Broad Crested Weir Equation

$Q = C\,L\,H^{3/2}$



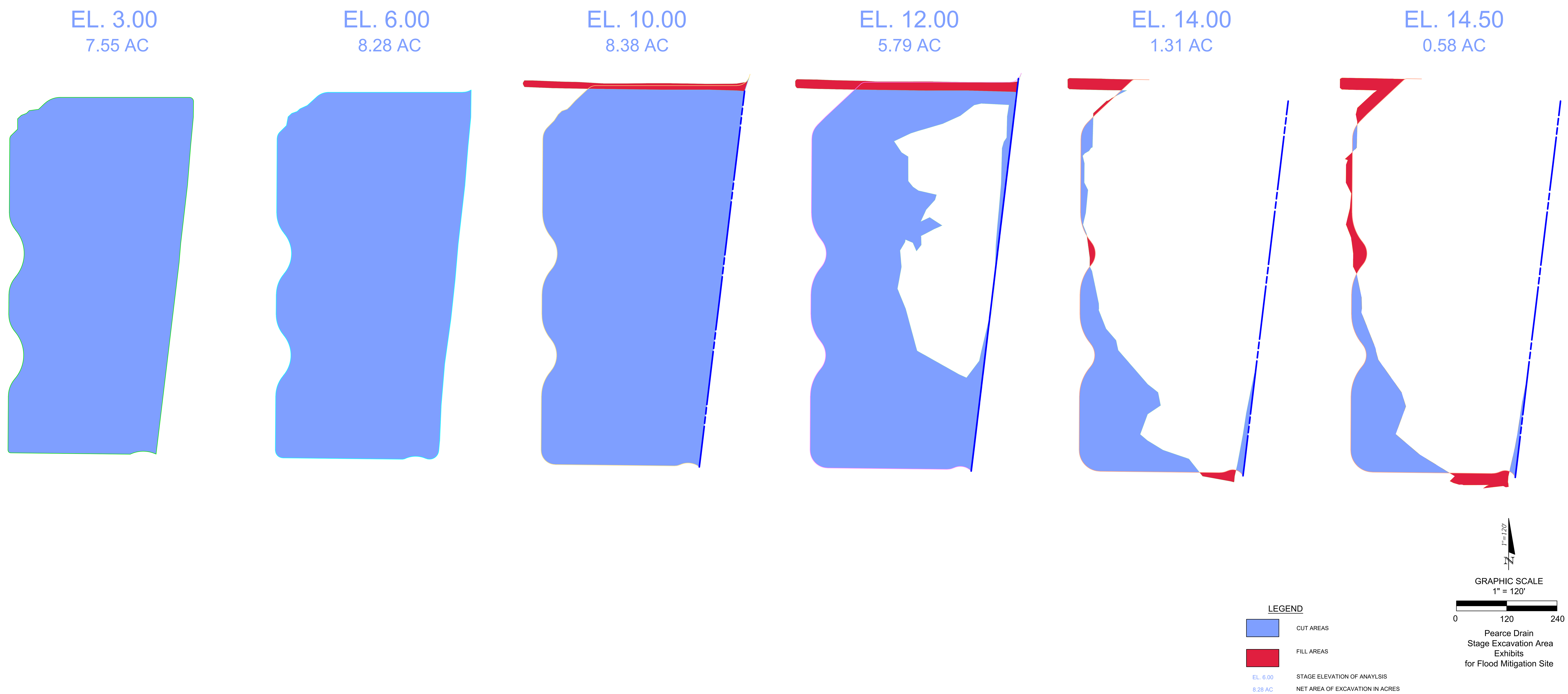
SECTION A-A
N.T.S.

	OPINION OF PROBABLE COST FOR NSBB				
0430175272	NSBB	EA	1	$528,000.00	$528,000.00
0430175254	PIPE CULV, OPT MATL, OTHER, 54"S/CD	LF	16	$845.00	$13,520.00
0430175154	PIPE CULV, OPT MATL, ROUND, 54"S/CD	LF	88	$633.64	$55,760.32
0430200 42	FLARED END SECTION, CONCRETE, 54"	EA	1	$11,000.00	$11,000.00
0425 2101	MANHOLES, SPECIAL, <10'	EA	1	$29,457.00	$29,457.00
				Total	$637,737.32

Excavation Calculations

EXCAVATION

Stage (ft)	*Area* (ac)	*Delta Cut* (ac-ft)	*Sum Cut* (ac-ft)
14.50	0.58	0.47	78.81
14.00	1.31	7.10	78.34
12.00	5.79	14.17	71.24
10.00	8.38	33.32	57.07
6.00	8.28	23.75	23.75
3.00	7.55	0.00	


EL. 3.00
7.55 AC
EL. 6.00
8.28 AC
EL. 10.00
8.38 AC
EL. 12.00
5.79 AC
EL. 14.00
1.31 AC
EL. 14.50
0.58 AC
1"=120'
N
GRAPHIC SCALE
1" = 120'
0
120
240
LEGEND
CUT AREAS
FILL AREAS
EL. 6.00
STAGE ELEVATION OF ANAYLSIS
8.28 AC
NET AREA OF EXCAVATION IN ACRES
Pearce Drain
Stage Excavation Area
Exhibits
for Flood Mitigation Site

Flood Plain Calculations

FLOOD PLAIN VOLUME

Stage (ft)	*Area* (ac)	*Delta Cut* (ac-ft)	*Sum Cut* (ac-ft)
14.50	0.58	0.47	55.06
14.00	1.31	7.10	54.59
12.00	5.79	14.17	47.49
10.00	8.38	33.32	33.32
6.00	8.28		0.00

Appendix D

Geotechnical Information

Excerpts from Limited Phase II Assessment

Limited Phase II Environmental Site Assessment

Vacant Industrial Property
6525 33rd Street E
Sarasota, FL 34243

Prepared for

Manatee County
1112 Manatee Avenue West, Suite 800
Bradenton, Florida 34205

Prepared by

Professional Service Industries, Inc.
5801 Benjamin Center Drive, Suite 112
Tampa, Florida 33634

November 28, 2022

PSI Project 05523636

Certificate of Authorization No. 3684

Ashley Douthirt
Project Scientist

Michael Rothenburg, PE
Senior Engineer

Courtland Alvies, PE
Project Engineer

TABLE OF CONTENTS

1 INTRODUCTION

Professional Service Industries, Inc. (PSI), an Intertek company, has conducted a Limited Phase II Environmental Site Assessment at the subject property located at 6525 33rd Street E in Sarasota, FL. This report documents the user's objectives for performing the work, the scope of work and sampling rationale, field and laboratory methodologies, an evaluation of data with respect to the recognized environmental conditions assessed, and conclusions. A United States Geological Survey (USGS) Topographic Map showing the site location is provided as **Figure 1**.

1.1 AUTHORIZATION

PSI has performed a Limited Phase II Environmental Site Assessment at the subject property in accordance with the scope of work outlined in PSI's Work Assignment No. 20PE and W2300014, under contract 21-R076506AJ, which was authorized by the client on June 27, 2022.

1.2 SITE DESCRIPTION

The subject property consists of one parcel of land totaling approximately 11.36 acres of land located in Sarasota, Florida. According to the Manatee County Property Appraiser website, the parcel included in this property is located at 6525 33rd Street East, with the Parcel ID listed as 1876210004. The property is currently a vacant field. No active onsite business activities were identified. The property is bordered on the east and north by drainage canals.

The subject property is located in an industrial area in Sarasota. A Site Vicinity Map is provided as **Figure 2**.

PSI prepared a Phase I ESA in accordance with the ASTM Standard E 1527-13 in July 2022 (PSI Project No.: 05523554). PSI identified the following recognized environmental conditions associated with the historic use of the property and adjoining properties, as listed below:

The Phase I did not identify any specific recognized environmental conditions within the definition of a REC pursuant to the ASTM criteria. However, the County has requested PSI perform a Phase II Environmental Site Assessment to evaluate the potential from offsite environmental concerns possibly impacting the subject property as well as potential agrochemical impacts from prior use as a farming operation. PSI was also requested to conduct several borings within the boundary of the property to determine if any potential filling of the site occurred as a result of waste disposal activities and to evaluate the geotechnical character of the soils for potential use as landfill cover and roadway construction.

1.3 PURPOSE AND SCOPE OF SERVICES

The Limited Phase II ESA field investigation and sampling activities were conducted by PSI personnel in October 2022. PSI understands that Manatee County requested this Limited Phase II ESA to verify that soil and groundwater concerns were not present at the property and to gather additional information regarding potential property use options.

The scope of the Limited Phase II Environmental Site Assessment included the advancement of nine soil borings and the installation of four shallow direct push temporary screenpoints to facilitate the collection and analysis of representative soil and groundwater samples (SB-1 through SB-9 and SB-1 through SB-4, respectively).

1.4 PHYSICAL CHARACTERISTICS OF THE ASSESSMENT AREA

Based on a review of the United States Geological Survey (USGS) *Bradenton, FL* Quadrangle topographic map, the subject property is situated at an elevation approximately 14 feet above mean sea level, and the local topography slopes gently to the east-northeast. Refer to **Figure 1** for a topographic map of the site vicinity.

Based on soil borings advanced during this investigation, the underlying subsurface consisted predominantly of fine silty sands to the depth of 5 feet below land surface (bls) in soil borings SB-1 through SB-9, with a grey silty clay layer observed in SB-5 between approximately 3-4 feet bls.

Groundwater was encountered at approximately 5 feet bls at all soil boring locations on the property.

2 SITE ASSESSMENT ACTIVITIES

Field investigation and sampling activities were conducted by PSI personnel on October 26 and 27, 2022 to address the identified RECs. Soil and groundwater samples were analyzed by AEL (Advanced Environmental Laboratories, Inc).

2.1 SOIL ASSESSMENT ACTIVITIES

During the assessment, soil borings SB-1 and SB-2 were installed along the northern boundary, while SB-3 and SB-4 were installed along the southern boundary. These borings were to assess for potential off-site impacts from north or south adjoining properties. Soil borings SB-5 through SB-9 were installed within the interior of the property to assess for potential agrochemical impacts from prior use as a farming operation. The five interior borings were installed to 25 feet bls to also evaluate the geotechnical character of the soils for potential use as landfill cover and roadway construction.

One soil sample was collected from each of the four borings installed along the northern and southern boundaries from 0 to 6 inches bls. The four soil samples were analyzed for VOAs/VOHs and ketones by EPA method 8260, polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270, total recoverable petroleum hydrocarbons (TRPH) by FL-PRO and the four Resource and Recovery Conservation Act (RCRA) metals (arsenic, cadmium, chromium and lead) by EPA method 6010/7471.

Soil samples from the interior areas of the property were collected at 0-6 inches bls, 6 inches to two feet and two feet to four feet. The upper sample interval (0-6 in) for each boring (SB-5 to SB-9) was analyzed initially and the remaining intervals held. Each of the 0-6 inch samples were analyzed for eight RCRA metals by EPA Method 6010 and organochlorine pesticides (OCPs) by EPA Method 8081. Based on initial lab results, the samples from SB-7 collected at the 6 inches to two feet and two feet to four feet intervals were analyzed for arsenic.

Soil boring locations are depicted on **Figure 3**. Soil boring logs are provided in **Appendix A**.

Summary of OVA/PID Field Screening Results

Soils above the water table were subjected to headspace analysis with a photoionization detector (PID). Organic vapor levels were non-detectable (<1 part per million (ppm)). PID testing results are presented on the soil boring logs in **Appendix A**.

2.2 GROUNDWATER ASSESSMENT ACTIVITIES

Groundwater samples were obtained using direct push subsurface drilling technology (i.e., the direct push screenpoint sampling system). Groundwater samples were obtained at each of the four boring locations installed at the north and south property boundaries (SB-1 through SB-4). Groundwater screenpoint locations are depicted on **Figure 3**.

The screenpoints were screened in a four-foot section and were set in the shallow groundwater at a depth of 5-9 feet bls. A peristaltic pump was used to purge the groundwater in order to collect a sample generally representative of ambient conditions. Field measurements including pH, dissolved oxygen (DO), temperature, conductivity and turbidity were taken during screen point purging to monitor for stabilization.

The groundwater samples were transferred to laboratory provided containers and submitted to the laboratory for VOAs/VOHs and ketones by EPA method 8260, PAHs by EPA Method 8270, TRPH by FL-PRO, and the four Resource and Recovery Conservation Act (RCRA) metals (arsenic, cadmium, chromium and lead) by EPA method 6010/7471. Metals can sorb to suspended particles and therefore require very low turbidity during sampling. As such, field filtered (dissolved) samples for groundwater were also collected. Based on initial results, the dissolved sample from SB-1 was analyzed for arsenic and the dissolved sample for SB-3 was analyzed for arsenic, chromium and lead. Chain of custody forms were documented in accordance with standard operating procedures.

Groundwater sampling and calibration logs are provided in **Appendix A**.

2.3 QUALITY ASSURANCE/QUALITY CONTROL MEASURES

All field decontamination and sampling procedures were performed in general accordance with the FDEP's Standard Operating Procedures (SOPs) for field activities. All downhole equipment utilized during the field activities was decontaminated prior to and between each soil boring. Decontamination was accomplished by washing the equipment with a non-phosphate detergent and final water rinse. Single-use disposable gloves were used for each sampling point in an attempt to eliminate cross-contamination between sampling locations.

3 DATA ANALYSIS AND INTERPRETATION

Analysis and interpretation of the data generated during the field investigation and laboratory analyses is presented in the following sections. Where appropriate, the results are compared with regulatory limits for the test parameters identified in the applicable media. A copy of the laboratory analytical reports and chain-of-custody documentation is provided in **Appendix C**.

3.1 REGULATORY GUIDANCE

The analytical results of soil and groundwater samples collected during this assessment were compared to the applicable Soil and Groundwater Cleanup Target Levels of Chapter 62-777, Florida Administrative Code (FAC).

3.2 SOIL ASSESSMENT RESULTS

A concentration slightly exceeding the arsenic residential Soil Cleanup Target Level (SCTL) of 2.1 milligrams per kilogram (mg/kg) was detected in SB-7 toward the northwest area of the property at 0-0.5 feet measured at 2.2mg/kg. Based on initial lab results, the samples on hold from SB-7 collected at the 0.5 to two feet and two feet to four feet intervals were analyzed for arsenic to determine the vertical extent of impacts. Arsenic was detected in exceedance of the residential SCTL at 4.0 mg/kg in the 0.5-2 feet interval sample. The sample collected from 2-4 feet bls in SB-7 had a detection of arsenic (1.3 mg/kg), but was below the SCTL.

The soil sample collected from 0-0.5 feet in SB-1 had a detection of arsenic equal to, but not exceeding the residential SCTL.

VOCs, TRPH, OCPs, and PAHs were not detected in the soil samples at levels exceeding regulatory criteria.

A summary of the soil analytical results is presented in **Table 1**. A Benzo(a)pyrene Conversion Table is included in **Table 3**. A copy of the laboratory analytical report is included in **Appendix C**.

3.3 GROUNDWATER ASSESSMENT RESULTS

In both the total and dissolved (filtered) samples from SB-1 and SB-3, arsenic was detected at levels exceeding the groundwater cleanup target level (GCTL). The detection of arsenic in the dissolved sample from SB-3 was at a lower level than the total sample and slightly exceeded the GCTL.

In the total groundwater sample collected at SB-3, chromium and lead were also detected in exceedance of the GCTLs. The dissolved (filtered) sample from SB-3 did not detect lead at the method detection limit (MDL). Chromium was detected in the dissolved sample, but at a level below the GCTL. This may indicate that elevated turbidity could have contributed to the detections of metals in exceedance of GCTLs from SB-3.

VOCs, TRPH, and PAHs were not present in the screenpoint groundwater samples at levels exceeding laboratory MDLs, with the exception of acetone detected in one sample at a level below the GCTL.

A summary of the groundwater analytical results is presented in **Table 2**. A copy of the laboratory analytical report is included in **Appendix C**.

4 GEOTECHNICAL DISCUSSION

4.1 SUBSURFACE CONDTIONS

Samples from borings SB-5, SB-6, SB-7, and SB-8 were reviewed for geotechnical material property considerations. Within the noted borings, a sequence of variable sands grading from relatively clean to slightly silty (SP/SP-SM) to slightly clayey (SP-SC), to clayey (SC) were observed from the existing ground surface to boring termination approximately 25 feet below existing grade. Generally, the uppermost 10 to 15 feet of the encountered soil column was revealed to comprise predominantly of relatively clean to slightly silty and/or clayey sands. Occasionally, pockets of clayey sand estimated to be 1-foot to 4-feet thick were observed in the upper soils. Beyond 10 to 15 feet, the borings were noticeably less consistent with clayey sands representing the most commonly encountered soil composition. For additional information please refer to the **Geotechnical Soil Profiles** included in **Appendix B.**

4.2 FILL SUITABILITY DISCUSSION

General Discussion

Typically, we recommend engineered fill material for building pads, roadways, and other critical development areas consist of clean sand that is free of organic matter, clay, rubble, debris, and other deleterious substances. Ideally, this fill material has a fines content that does not exceed 12 percent by dry weight passing the U.S. Standard Number 200 sieve, is placed near its optimal moisture content, and is placed in uniform lifts not exceeding 12 inches in loose thickness. These physical material property characteristics have been developed to optimize the workability and performance of fill materials with the ultimate goal of supporting pavement, slabs, foundations, etc. It should be noted specific fill placement criteria and/or specifications should be developed on a project specific basis which may impact what materials can be used and how those materials are to be placed.

The use of any material with fines content in excess of 12% may result in increased construction costs associated with moisture conditioning, workability concerns, and regionally atypical construction earthwork practices. If used, the entities responsible for working these materials should be adequately equipped and experienced with working with these types of fill materials. These materials are not recommended within 2 feet of the groundwater table and will become extremely difficult to compact and work when exposed to moisture. Soils with fines content in excess of 15% are generally not considered suitable for Engineered Fill for these reasons.

The materials encountered in our subsurface exploration for the proposed borrow pit can be categorized into two distinct categories. Those categories include (1) readily suitable materials for re-use as fill and (2) marginal materials which may be considered for use as fill provided they are handled and/or manipulated properly with tight moisture control during and following placement. A discussion regarding these fill material categories is provided below.

Readily Suitable Fill Material

Based on the results of our borings, it is our opinion that the on-site relatively clean to slightly silty and/or clayey sandy soils (Strata 1 & 3), with the exception of any topsoil or organic-laden soils, will be suitable for use as engineered fill material, provided the soil is free of organics, clay, debris, rubble, and other unsuitable materials.

Marginal Material Potentially Suitable for Use as Fill

Based on the results of the noted borings, the remaining soil stratum (Strata 2 – SC clayey sand) falls into the category of potentially suitable for limited use as a fill resource. This material may require significant drying and potentially following some mixing with clean imported sands to be rendered suitable. It should be noted these marginal materials may be difficult to work and ultimately compact during eventual construction activities, particularly as they are introduced to moisture. Marginal materials being considered for use as potential fill should be subjected to a rigorous testing program prior to and during placement. It is also recommended these materials be reviewed and approved by an experience civil and/or geotechnical engineer for use in a prospective application so that recommendations and/or specifications for handling and placement of these materials can be developed on a project specific basis.

5 ENVIRONMENTAL CONCLUSION AND RECOMMENDATIONS

PSI has performed a Limited Phase II Environmental Site Assessment at the subject property in accordance with the scope of work outlined in PSI's Work Assignment No. 20PE and W2300014, under contract 21-R076506AJ, which was authorized by the client on June 27, 2022. Based on the results of the investigation, the following conclusions and recommendations have been developed.

5.1 CONCLUSIONS

- From the soil samples collected, arsenic impacts were identified in one boring. A concentration slightly exceeding the arsenic residential SCTL was detected in the soil sample from SB-7 toward the northwest area of the property at 0-0.5 feet bls. Based on initial lab results, the lower interval soil samples from SB-7 were analyzed for arsenic. Arsenic was detected in exceedance of the Residential SCTL in the 0.5-2 feet interval sample. The sample collected from 2-4 feet bls in SB-7 did not exceed the SCTL.
- Two of the groundwater samples collected at the subject property had detections for metals in exceedance of GCTLs. In both the total and dissolved (filtered) groundwater samples from SB-1 and SB-3, arsenic was detected at levels exceeding the GCTL. The detection of arsenic in the dissolved sample from SB-3 was at a lower level than the total sample and only slightly exceeded the GCTL.
- In the total groundwater sample collected at SB-3, chromium and lead were also detected in exceedance of the GCTLs. However, the dissolved (filtered) sample from SB-3 did not detect lead at the MDL. Chromium was detected in the dissolved sample, but at a level below the GCTL. This may indicate that elevated turbidity could have contributed to the detections of metals in exceedance of GCTLs.

5.2 RECOMMENDATIONS

PSI performed a limited assessment to determine if off-site operations to the north or south of the subject property or former agricultural operations on the subject property have impacted the soil and groundwater at levels exceeding regulatory cleanup target levels. Based on the assessment results, impacts from metals were identified.

If Manatee County wishes to further explore the extent of soil arsenic impacts, further horizontal and vertical assessment could be conducted to determine how extensive the arsenic impacts are. Step-out soil samples could be conducted to the cardinal directions around the impacted boring.

PSI understands that Manatee County is interested in the possibility of using soil from the site for other uses, such as road fill material or landfill cover. FDEP would require that soil for these uses be held to the residential SCTL. Additional assessment of the extent of arsenic impact could determine what options may be available to allow soil reuse, such as removing or avoiding use of the impacted soils for reuse or if soil blending may be a viable method to reduce the level of arsenic below SCTLs.

If Manatee County wishes to further evaluate the metals detections in the groundwater, permanent monitor wells could be installed at the two locations of the detected metals exceedances. Groundwater samples could then be collected from the wells. Permanent monitor wells could allow for lower turbidity levels in groundwater samples so that the sample results can help to either confirm that metals are present in the groundwater at elevated levels or indicate if the prior results may have been "false positives".

6 REPRESENTATIONS

6.1 WARRANTY

The field observations, measurements, and research reported herein are considered sufficient in detail and scope to form a reasonable basis for a Limited Subsurface Investigation of this property. The investigation, and conclusions presented herein are based upon the subjective evaluation of limited data. They may not represent all conditions at the subject site as they reflect the information gathered from specific locations. PSI warrants that the findings and conclusions contained herein have been promulgated in accordance with generally accepted environmental investigation methodologies and only for the site described in this report.

The Limited Subsurface Investigation has been developed to provide the client with information regarding degree of impact (not delineation) relating to the subject property. It is necessarily limited to the conditions observed and to the information available at the time of the work.

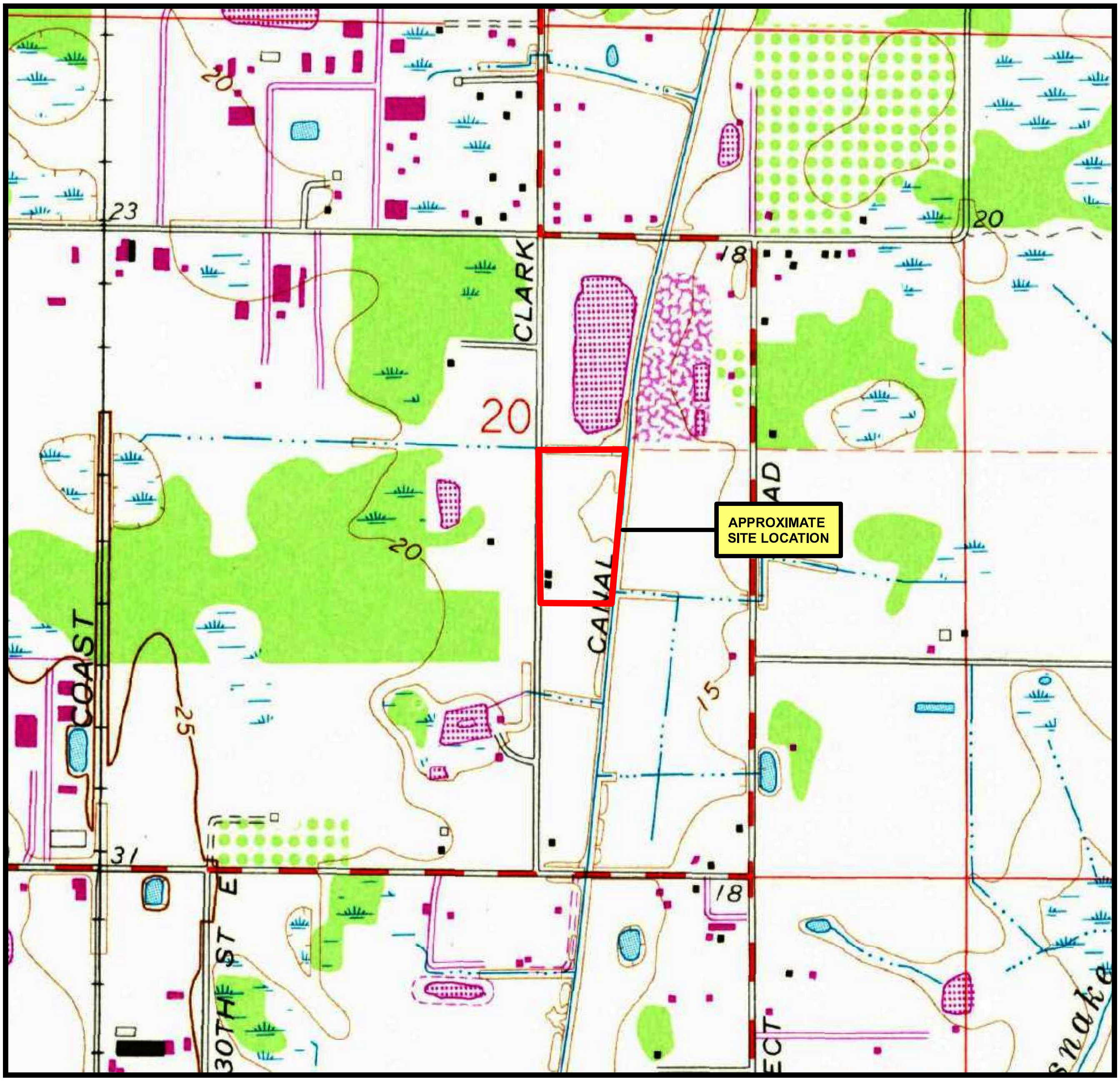
Due to the limited nature of the work, there is a possibility that there may exist conditions which could not be identified within the scope of the investigation or which were not apparent at the time of report preparation. It is also possible that the testing methods employed at the time of the report may later be superseded by other methods. The description, type, and composition of what are commonly referred to as "hazardous materials or conditions" can also change over time. PSI does not accept responsibility for changes in the state of the art, nor for changes in the scope of various lists of hazardous materials or conditions. PSI believes that the findings and conclusions provided in this report are reasonable. However, no other warranties are implied or expressed.

6.2 USE BY THIRD PARTIES

This report was prepared pursuant to the contract PSI has with Manatee County. Because of the importance of the communication between PSI and its client, reliance or any use of this report by anyone other than Manatee County is prohibited and therefore not foreseeable to PSI.

Reliance or use by any such third party without explicit authorization in the report does not make said third party a third-party beneficiary to PSI's contract with Manatee County. Any such unauthorized reliance on or use of this report, including any of its information or conclusions, will be at third party's risk. For the same reasons, no warranties or representations, expressed or implied in this report, are made to any such third party.

FIGURES



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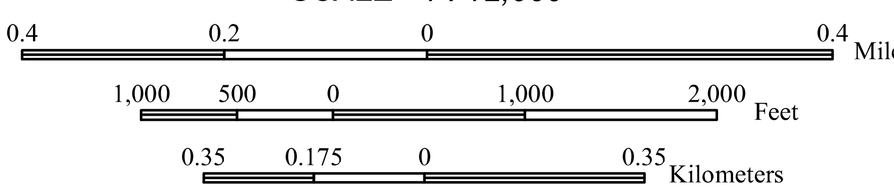

CONTOUR INTERVAL 5 FEET

SOURCE: USGS QUADRANGLE "BRADENTON, FLA"
NATIONAL GEODETIC VERTICAL DATUM 1929
DATE: 1964 DATE REVISED: 1981

SECTION 20, TOWNSHIP 35 SOUTH, RANGE 18 EAST

P:\552-Env\05523554 - Manatee Co - Vacant Industrial Property, Sarasota PHI\GIS\fig 1 - USGS Topographic Map.mxd

PROJECT NO.	intertek psi	USGS TOPOGRAPHIC MAP	FIGURE
05523636	5801 Benjamin Center Drive, Suite 112, Tampa, Florida 33634, (813) 886-1075, (813) 249-4916 fax	VACANT INDUSTRIAL PROPERTY	1
DRAWN BY: BTW		6525 33RD STREET EAST	
DATE CREATED: 7/13/2022		SARASOTA, MANATEE COUNTY, FLORIDA	

REFERENCE: 2020 AERIAL IMAGE PROVIDED BY FDOT.

LEGEND

APPROXIMATE SUBJECT PROPERTY BOUNDARY

0 200 400 800 Feet

1 inch = 400 feet

PROJECT NO. 05523636 DRAWN BY BTW DATE CREATED 7/18/2022	intertek psi 5801 Benjamin Center Drive, Suite 112 Tampa, Florida 33634 (813) 886-1075 (813) 249-4916 fax	SITE VICINITY MAP VACANT INDUSTRIAL PROPERTY 6525 33RD STREET EAST SARASOTA, MANATEE COUNTY, FLORIDA	FIGURE 2

P:\552-Env\05523554 - Manatee Co - Vacant Industrial Property, Sarasota PH\\GIS\fig 2 - Site Vicinity Map.mxd

Figure 3 - Sample Locations Map

Vacant Industrial Property
6525 33rd Street E
Sarasota, Florida 34243
Project Number: 05523636

intertek psi

TABLES

TABLE 1
SOIL ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

		RCRA 4 Metals - EPA 6010D (mg/kg)								FL-PRO (mg/kg)
Sample ID	Date Collected	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver	Mercury	TRPH
Direct Exposure-Commercial/Industrial (mg/kg)		12	130000	1700	470	1400	11000	8200	17	2700
Direct Exposure-Residential (mg/kg)		2.1	120	82	210	400	440	410	3	460
Leachability-Groundwater (mg/kg)		--	1600	7.5	38	--	5.2	17	2.1	340
SB-1 (0-6")	10/26/2022	**2.1**	--	0.085	3.8	3.8	--	--	--	27
SB-2 (0-6")	10/26/2022	1.6	--	0.32	13	13	--	--	--	25
SB- 3 (0-6")	10/26/2022	0.29	--	0.15	6.5	11	--	--	--	11 I
SB-4 (0-6")	10/26/2022	0.43	--	0.14	4.4	5.9	--	--	--	39
SB-5 (0-6")	10/26/2022	0.23 I	7.5	0.130	8.3	12	1.1 U	0.23 U	0.035	--
SB-6 (0-6")	10/26/2022	0.43	5.4	0.048 I	2.4	2.8	1.1 U	0.23 U	0.027	--
SB-7 (0-6")	10/26/2022	2.2	24	0.35	16	24	1.3 U	0.27 U	0.063	--
SB-7 (6"-2')	10/26/2022	4.0	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	1.3	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	1.1	28	0.36	19	18	1.3 U	0.26 U	0.074	--
SB-9 (0-6")	10/26/2022	0.44	16	0.3	15	16	1.2 U	0.24 U	0.052	--

	Polycyclic Aromatic Hydrocarbons (PAHs) - EPA 8270E (ug/L)																	
Sample ID	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
Direct Exposure-Commercial/Industrial (mg/kg)	1800	2100	20000	20000	300000	--	0.7	--	52000	--	--	--	59000	33000	--	300	36000	45000
Direct Exposure-Residential (mg/kg)	200	210	2400	1800	21000	--	0.1	--	2500	--	--	--	3200	2600	--	55	2200	2400
Leachability-Groundwater (mg/kg)	3.1	8.5	2.1	27	2500	0.8	8	2.4	32000	24	77	0.7	1200	160	6.6	1.2	250	880
SB-1 (0-6")	0.0016 U	0.0021 U	0.0016 U	0.0018 U	0.0026 U	0.0022 I	0.0033 I	0.0070 I	0.0046 I	0.0024 U	0.0030 U	0.0017 U	0.0032 I	0.0022 U	0.0043 I	0.0018 U	0.0022 U	0.0044 I
SB-2 (0-6")	0.0018 U	0.0023 U	0.0017 U	0.0020 U	0.0029 U	0.0044 I	0.0063 I	0.010	0.0073 I	0.0036 I	0.0065 I	0.0019 U	0.0073 I	0.0025 U	0.0062 I	0.0019 U	0.0025 U	0.0081 I
SB- 3 (0-6")	0.0017 U	0.0022 U	0.0016 U	0.0019 U	0.0027 U	0.0024 I	0.0032 I	0.0056 I	0.0041 I	0.0025 U	0.0035 I	0.0018 U	0.0039 I	0.0023 U	0.0032 I	0.0018 U	0.0023 U	0.0042 I
SB-4 (0-6")	0.0018 U	0.0023 U	0.0017 U	0.0021 U	0.0029 U	0.017	0.028	0.037	0.035	0.013	0.020	0.0054 I	0.029	0.0025 U	0.027	0.0020 U	0.0066 I	0.033
SB-5 (0-6")	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-6 (0-6")	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (0-6")	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (6"-2')	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-9 (0-6")	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

U = Less than the method detection limit

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= Values are calculated into benzo(a)pyrene equivalents

V = Analyte was detected in both the sample and the associated method blank

Bold indicates value exceeds the applicable FDEP SCTL

The color indicates which regulatory limit is exceeded.

*** = No Standard

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TABLE 1
SOIL ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

Organochlorine Pesticides (OCPs) - EPA 8081 (mg/kg)

Sample ID	Date Collected	ALDRIN	alpha-BHC	beta-BHC	CHLORDANE	delta-BHC	DIELDRIN	ENDOSULFAN I	ENDOSULFAN II	ENDOSULDAN SULDATE	ENDRIN	ENDRIN ALDEHYDE
Direct Exposure-Commercial/Industrial (mg/kg)		0.3	0.6	2.4	14	490	0.3	--	--	--	510	--
Direct Exposure-Residential (mg/kg)		0.06	0.1	0.5	2.8	24	0.06	--	--	--	25	--
Leachability-Groundwater (mg/kg)		0.2	0.0003	0.001	9.6	0.2	0.002	--	--	--	1	--
SB-1 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-2 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB- 3 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-4 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-5 (0-6")	10/26/2022	0.00057 U	0.001 U	0.00081 U	0.012 U	0.0006 U	0.00068 U	0.00049 U	0.00064 U	0.00091 U	0.00059 U	0.001 U
SB-6 (0-6")	10/26/2022	0.0006 U	0.0011 U	0.00085 U	0.013 U	0.00063 U	0.00071 U	0.00052 U	0.00067 U	0.00096 U	0.00062 U	0.001 U
SB-7 (0-6")	10/26/2022	0.00069 U	0.0012 U	0.00098 U	0.015 U	0.00072 U	0.00082 U	0.0006 U	0.00077 U	0.0011 U	0.00071 U	0.0012 U
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	0.00066 U	0.0012 U	0.00093 U	0.014 U	0.00069 U	0.00078 U	0.00057 U	0.00073 U	0.001 U	0.00068 U	0.0011 U
SB-9 (0-6")	10/26/2022	0.00062 U	0.0011 U	0.00088 U	0.013 U	0.00064 U	0.00074 U	0.00053 U	0.00069 U	0.00099 U	0.00064 U	0.0011 U

Sample ID	Date Collected	gamma-BHC (LINDANE)	HEPTACHLOR	HEPTACHLOR EPOXIDE	METHOXYCHLOR	4,4'-DDD	4,4'-DDE	4,4'-DDT	TOXAPHENE	Endosulfan (alpha+beta+sulfate)	Heptachlor (and its epoxide)
Direct Exposure-Commercial/Industrial (mg/kg)		2.5	1	0.5	8800	22	15	15	4.5	7600	0.5
Direct Exposure-Residential (mg/kg)		0.7	0.2	0.1	420	4.2	2.9	2.9	0.9	450	0.1
Leachability-Groundwater (mg/kg)		0.009	23	0.6	160	5.8	18	11	31	3.8	0.6
SB-1 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--
SB-2 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--
SB- 3 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--
SB-4 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--
SB-5 (0-6")	10/26/2022	0.00066 U	0.0015 U	0.00069 U	0.00078 U	0.00038 U	0.00061 U	0.00061 U	0.012 U	0.00049 U	0.00069 U
SB-6 (0-6")	10/26/2022	0.00069 U	0.0015 U	0.00072 U	0.00082 U	0.0004 U	0.00064 U	0.00064 U	0.013 U	0.00052 U	0.00072 U
SB-7 (0-6")	10/26/2022	0.00079 U	0.0018 U	0.00083 U	0.00094 U	0.00046 U	0.00074 U	0.00074 U	0.015 U	0.0006 U	0.00083 U
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	0.00075 U	0.0017 U	0.00079 U	0.0009 U	0.00044 U	0.0007 U	0.00071 U	0.014 U	0.00057 U	0.00079 U
SB-9 (0-6")	10/26/2022	0.00071 U	0.0016 U	0.00074 U	0.00085 U	0.00041 U	0.00066 U	0.00066 U	0.013 U	0.00053 U	0.00074 U

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TABLE 1
SOIL ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

Volatile Organic Compounds (VOCs) - EPA 8260D (mg/kg)

Sample ID	Date Collected	1,1,1,2-Tetrachloroethane	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,1-Dichloropropene	1,2,3-Trichlorobenzene	1,2,3-Trichloropropane	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,2-Dibromo-3-chloropropane
Direct Exposure-Commercial/Industrial (mg/kg)		4.3	3900	1.2	2	2100	510	--	8200	0.1	8500	95	3.8
Direct Exposure-Residential (mg/kg)		2.9	730	0.7	1.4	390	95	--	650	0.06	660	18	0.7
Leachability-Groundwater (mg/kg)		0.01	1.9	0.001	0.03	0.4	0.06	--	4.6	0.0001	5.3	0.3	0.001
SB-1 (0-6")	10/26/2022	0.00088 U	0.00064 U	0.00047 U	0.00044 U	0.00064 U	0.00067 U	0.00044 U	0.00073 U	0.0015 U	0.0006 U	0.0008 U	0.0012 U
SB-2 (0-6")	10/26/2022	0.00093 U	0.00067 U	0.00049 U	0.00047 U	0.00068 U	0.00071 U	0.00047 U	0.00077 U	0.0016 U	0.00063 U	0.00085 U	0.0012 U
SB- 3 (0-6")	10/26/2022	0.00073 U	0.00053 U	0.00038 U	0.00031 U	0.00053 U	0.00055 U	0.00037 U	0.0006 U	0.0013 U	0.00049 U	0.00066 U	0.00097 U
SB-4 (0-6")	10/26/2022	0.00072 U	0.00052 U	0.00038 U	0.00036 U	0.00053 U	0.00055 U	0.00036 U	0.0006 U	0.0013 U	0.00049 U	0.00066 U	0.00097 U
SB-5 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-6 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-9 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--

Sample ID	Date Collected	1,2-Dibromoethane	1,2-Dichlorobenzene	1,2-Dichloroethane	1,2-Dichloropropane	1,3,5-Trimethylbenzene	1,3-Dichlorobenzene	1,3-Dichloropropane	1,4-Dichlorobenzene	2,2-Dichloropropane	2,2-Dichloroethyl vinyl ether	2-Chlorotoluene	2-Butanone
Direct Exposure-Commercial/Industrial (mg/kg)		0.2	5000	0.7	0.9	80	2200	***	9.9	***	--	1200	110000
Direct Exposure-Residential (mg/kg)		0.1	880	0.5	0.6	15	380	***	6.4	***	--	200	16000
Leachability-Groundwater (mg/kg)		0.0001	17	0.01	0.03	0.3	7	***	2.2	***	--	2.8	17
SB-1 (0-6")	10/26/2022	0.00045 U	0.00043 U	0.00072 U	0.00049 U	0.00061 U	0.00051 U	0.00039 U	0.00061 U	0.0011 U	0.0024 U	0.00061 U	0.00092 U
SB-2 (0-6")	10/26/2022	0.00048 U	0.00046 U	0.00076 U	0.00052 U	0.00064 U	0.00053 U	0.00041 U	0.00064 U	0.0011 U	0.0024 U	0.00064 U	0.00097 U
SB- 3 (0-6")	10/26/2022	0.00037 U	0.00036 U	0.00059 U	0.00041 U	0.0005 U	0.00042 U	0.00032 U	0.0005 U	0.00088 U	0.002 U	0.0005 U	0.00076 U
SB-4 (0-6")	10/26/2022	0.00037 U	0.00036 U	0.00059 U	0.0004 U	0.0005 U	0.00041 U	0.00032 U	0.0005 U	0.00088 U	0.002 U	0.0005 U	0.00076 U
SB-5 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-6 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--
SB-9 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--

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TABLE 1
SOIL ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

Sample ID	Date Collected	Volatile Organic Compounds (VOCs) - EPA 8260D (mg/kg)								
		2-Hexanone	4-Chlorotoluene	Acetone	Acrolein	Acrylonitrile	Benzene	Bromobenzene	Bromochloromethane	Bromodichloromethane
Direct Exposure-Commercial/Industrial (mg/kg)		130	990	68000	0.3	0.6	1.7	--	530	2.2
Direct Exposure-Residential (mg/kg)		24	170	11000	0.05	0.3	1.2	--	95	1.5
Leachability-Groundwater (mg/kg)		1.4	2.5	25	0.01	0.0003	0.007	--	0.6	0.004
SB-1 (0-6")	10/26/2022	0.0014 U	0.00068 U	0.002 U	0.0057 U	0.00048 U	0.00045 U	0.00051 U	0.00059 U	0.00048 U
SB-2 (0-6")	10/26/2022	0.0015 U	0.00072 U	0.0021 U	0.006 U	0.0005 U	0.00048 U	0.00054 U	0.00062 U	0.00051 U
SB- 3 (0-6")	10/26/2022	0.0012 U	0.00056 U	0.0017 U	0.0047 U	0.00039 U	0.00038 U	0.00042 U	0.00049 U	0.0004 U
SB-4 (0-6")	10/26/2022	0.0012 U	0.00056 U	0.0016 U	0.0047 U	0.00039 U	0.00037 U	0.00042 U	0.00048 U	0.0004 U
SB-5 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--
SB-6 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--
SB-7 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--
SB-9 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--

Sample ID	Bromoform	Bromomethane	Carbon disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane	cis-1,2-Dichloroethene	cis-1,3-Dichloropropene	Dibromochloromethane
Direct Exposure-Commercial/Industrial (mg/kg)	93	16	1500	0.7	650	5.4	0.6	5.7	180	2.2	2.3
Direct Exposure-Residential (mg/kg)	48	3.1	270	0.5	120	3.9	0.4	4	33	1.4	1.5
Leachability-Groundwater (mg/kg)	0.03	0.05	5.6	0.04	1.3	0.06	0.4	0.01	0.4	0.002	0.003
SB-1 (0-6")	0.0018 U	0.0011 U	0.00078 U	0.00077 U	0.00041 U	0.0014 U	0.00056 U	0.00063 U	0.00054 U	0.0019 U	0.0016 U
SB-2 (0-6")	0.0019 U	0.0012 U	0.00083 U	0.00081 U	0.00043 U	0.0014 U	0.00059 U	0.00066 U	0.00057 U	0.0021 U	0.0017 U
SB- 3 (0-6")	0.0015 U	0.00094 U	0.00065 U	0.00064 U	0.00034 U	0.0011 U	0.00046 U	0.00052 U	0.00045 U	0.0016 U	0.0013 U
SB-4 (0-6")	0.0015 U	0.00093 U	0.00064 U	0.00063 U	0.00033 U	0.0011 U	0.00046 U	0.00051 U	0.00044 U	0.0016 U	0.0013 U
SB-5 (0-6")	--	--	--	--	--	--	--	--	--	--	--
SB-6 (0-6")	--	--	--	--	--	--	--	--	--	--	--
SB-7 (0-6")	--	--	--	--	--	--	--	--	--	--	--
SB-7 (6"-2')	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	--	--	--	--	--	--	--	--	--	--	--
SB-9 (0-6")	--	--	--	--	--	--	--	--	--	--	--

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TABLE 1
SOIL ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

		Volatile Organic Compounds (VOCs) - EPA 8260D (mg/kg)												
Sample ID	Date Collected	Dibromomethane	Dichlorodifluoromethane	Ethylbenzene	Hexachlorobutadiene	Iodomethane (methyl iodide)	Isopropylbenzene	Methylene Chloride	Methyl Isobutyl Ketone	Methyl-tert-Butyl Ether	Naphthalene	n-Butyl Benzene	n-Propyl Benzene	sec-Butylbenzene
Direct Exposure-Commercial/Industrial (mg/kg)		550	410	9200	13	--	1200	26	44000	24000	300	--	--	--
Direct Exposure-Residential (mg/kg)		96	77	1500	6.2	--	220	17	4300	4400	55	--	--	--
Leachability-Groundwater (mg/kg)		0.3	44	0.6	1	--	0.2	0.02	2.60	0.09	1.2	--	--	--
SB-1 (0-6")	10/26/2022	0.00055 U	0.00093 U	0.00033 U	0.0014 U	0.0019 U	0.00057 U	0.0037 U	0.00062 U	0.0009 U	0.0013 U	0.00074 U	0.00064 U	0.00061 U
SB-2 (0-6")	10/26/2022	0.00058 U	0.00099 U	0.00034 U	0.0015 U	0.002 U	0.0006 U	0.0039 U	0.00065 U	0.00095 U	0.0013 U	0.00079 U	0.00067 U	0.00065 U
SB- 3 (0-6")	10/26/2022	0.00046 U	0.00077 U	0.00027 U	0.0012 U	0.0016 U	0.00047 U	0.003 U	0.00051 U	0.00074 U	0.0011 U	0.00062 U	0.00053 U	0.0005 U
SB-4 (0-6")	10/26/2022	0.00045 U	0.00077 U	0.00027 U	0.0012 U	0.0016 U	0.00047 U	0.003 U	0.00051 U	0.00074 U	0.001 U	0.00061 U	0.00052 U	0.0005 U
SB-5 (0-6")	10/26/2022	--	--	--	--	--	--	--		--	--	--	--	--
SB-6 (0-6")	10/26/2022	--	--	--	--	--	--	--		--	--	--	--	--
SB-7 (0-6")	10/26/2022	--	--	--	--	--	--	--		--	--	--	--	--
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	--	--	--	--	--	--	--		--	--	--	--	--
SB-9 (0-6")	10/26/2022	--	--	--	--	--	--	--		--	--	--	--	--

		Volatile Organic Compounds (VOCs) - EPA 8260D (mg/kg)										
Sample ID	Date Collected	Styrene	tert-Butylbenzene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	trans-1,3-Dichloropropene	Trichloroethene	Trichlorofluoromethane	Vinyl acetate	Vinyl chloride	Xylenes (Total)
Direct Exposure-Commercial/Industrial (mg/kg)		23000	--	18	60000	290	2.2	9.3	1500	1700	0.8	700
Direct Exposure-Residential (mg/kg)		3600	--	8.8	7500	53	1.4	6.4	270	320	0.2	130
Leachability-Groundwater (mg/kg)		3.6	--	0.03	0.5	0.7	0.002	0.03	33	0	0.007	0.2
SB-1 (0-6")	10/26/2022	0.00036 U	0.00083 U	0.00052 U	0.00034 U	0.00055 U	0.0017 U	0.00067 U	0.00061 U	0.0013 U	0.00053 U	0.0012 U
SB-2 (0-6")	10/26/2022	0.00038 U	0.00087 U	0.00055 U	0.00036 U	0.00059 U	0.0018 U	0.00071 U	0.00064 U	0.0014 U	0.00056 U	0.0013 U
SB- 3 (0-6")	10/26/2022	0.0003 U	0.00068 U	0.00043 U	0.00028 U	0.00046 U	0.0014 U	0.00056 U	0.0005 U	0.0011 U	0.00044 U	0.00098 U
SB-4 (0-6")	10/26/2022	0.0003 U	0.00068 U	0.00043 U	0.00028 U	0.00045 U	0.0014 U	0.00055 U	0.0005 U	0.0011 U	0.00043 U	0.00098 U
SB-5 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-6 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-7 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-7 (6"-2')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-7 (2-4')	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-8 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--
SB-9 (0-6")	10/26/2022	--	--	--	--	--	--	--	--	--	--	--

TABLE 2
GROUNDWATER ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

		RCRA 4 Metals - EPA 6020B (ug/L)							FL-PRO (ug/L)
Sample ID	Date Collected	Arsenic (Total)	Arsenic (Dissolved)	Cadmium (Total)	Chromium (Total)	Chromium (Dissolved)	Lead (Total)	Lead (Dissolved)	TRPH
GCTL (ug/L)		10	10	5	100	100	15	15	5000
NADC (ug/L)		100	100	50	1000	1000	150	150	50000
SB-1	10/26/2022	44	46	1 U	29	--	7.2 I	--	570 U
SB-2	10/26/2022	8 U	--	1 U	17	--	8 I	--	540 U
SB-3	10/26/2022	20	12	2.4	110	5.6 I	45	3 U	570 U
SB-4	10/26/2022	9.1 I	--	1 U	16	--	6.9 I	--	570 U

	Polycyclic Aromatic Hydrocarbons (PAHs) - EPA 8270E (ug/L)																	
Sample ID	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
GCTL (ug/L)	28	28	20	210	2100	0.05	0.2	0.05	210	0.5	4.8	0.005	280	280	0.05	14	210	210
NADC (ug/L)	280	280	200	2100	21000	5	20	50	2100	5	480	0.5	2800	2800	5	140	2100	2100
SB-1	0.043 U	0.032 U	0.028 U	0.032 U	0.053 U	0.042 U	0.036 U	0.043 U	0.045 U	0.027 U	0.031 U	0.053 U	0.038 U	0.038 U	0.042 U	0.055 U	0.036 U	0.037 U
SB-2	0.043 U	0.032 U	0.028 U	0.032 U	0.053 U	0.042 U	0.036 U	0.043 U	0.045 U	0.027 U	0.031 U	0.053 U	0.038 U	0.038 U	0.042 U	0.055 U	0.036 U	0.037 U
SB-3	0.043 U	0.032 U	0.028 U	0.032 U	0.053 U	0.042 U	0.036 U	0.043 U	0.045 U	0.027 U	0.031 U	0.053 U	0.038 U	0.038 U	0.042 U	0.055 U	0.036 U	0.037 U
SB-4	0.043 U	0.032 U	0.028 U	0.032 U	0.053 U	0.042 U	0.036 U	0.043 U	0.045 U	0.027 U	0.031 U	0.053 U	0.038 U	0.038 U	0.042 U	0.055 U	0.036 U	0.037 U

Notes:

U = Less than the method detection limit
I = The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit
Color **Bold** indicates value exceeds the FDEP GCTL or NADC.
*** = No Standard
- = Analyte not analyzed for by lab.
GCTL = Groundwater Cleanup Target Level
NADC = Natural Attenuation Default Criteria

TABLE 2
GROUNDWATER ANALYTICAL DATA SUMMARY
PROJECT NAME: SARASOTA INDUSTRIAL PROPERTY
PSI PROJECT NO.: 05523636

		Volatile Organic Compounds (VOCs) - EPA 8260 (ug/L)																	
Sample ID	**Date Collected**	**1,1,1-Trichloroethane**	**1,1-Dichloroethane**	**1,1-Dichloroethene**	**1,2,4-Trimethylbenzene**	**2-Butanone**	**Methyl isobutyl ketone**	**Acetone**	**Benzene**	**cis-1,2-Dichloroethene**	**Ethylbenzene**	**Isopropylbenzene**	**Methylene chloride**	**Tetrachloroethene**	**Toluene**	**trans-1,2-Dichloroethene**	**Trichloroethene**	**Vinyl chloride**	**Xylenes (Total)**
GCTL (ug/L)		**200**	**70**	**7**	**10**	**4200**	**560**	**6300**	**1**	**70**	**30**	**0.8**	**5**	**3**	**40**	**100**	**3**	**1**	**20**
NADC (ug/L)		**2000**	**700**	**70**	**100**	**42000**	**5600**	**63000**	**100**	**700**	**300**	**8**	**500**	**300**	**400**	**1000**	**300**	**100**	**200**
SB-1	10/26/2022	0.39 U	0.38 U	0.41 U	0.41 U	0.33 U	0.4 U	0.9 U	0.28 U	0.39 U	0.56 U	0.42 U	0.56 U	0.45 U	0.66 U	0.39 U	0.32 U	0.44 U	1.3 U
SB-2	10/26/2022	0.39 U	0.38 U	0.41 U	0.41 U	0.33 U	0.4 U	0.9 U	0.28 U	0.39 U	0.56 U	0.42 U	0.56 U	0.45 U	0.66 U	0.39 U	0.32 U	0.44 U	1.3 U
SB-3	10/26/2022	0.39 U	0.38 U	0.41 U	0.41 U	0.33 U	0.4 U	19	0.28 U	0.39 U	0.56 U	0.42 U	0.56 U	0.45 U	0.66 U	0.39 U	0.32 U	0.44 U	1.3 U
SB-4	10/26/2022	0.39 U	0.38 U	0.41 U	0.41 U	0.33 U	0.4 U	0.9 U	0.28 U	0.39 U	0.56 U	0.42 U	0.56 U	0.45 U	0.66 U	0.39 U	0.32 U	0.44 U	1.3 U

Benzo(a)pyrene Conversion Table

For Direct Exposure Soil Cleanup Target Levels

Instructions can be found below the table

Facility/Site Name:	McLeod Industrial Property
Site Location:	Sarasota, Florida
Facility/Site ID No.:	

SCTL Type	Value	Units
Residential Direct Exposure SCTL	0.1	mg/kg
Industrial Direct Exposure SCTL	0.7	mg/kg
Alternative SCTL (Optional)		mg/kg
Site Specific Background (Optional)		mg/kg

TEF = Toxic Equivalency Factor

	Soil Sample #	SB-1 (0-6")	SB-2 (0-6")	SB-3 (0-6")	SB-4 (0-6")						
	Sample Date	10/26/2022	10/26/2022	10/26/2022	10/26/2022						
	Sample Location:										
	Depth (ft):										
Contaminant Concentrations											
Contaminant	**TEF**	SB-1 (0-6") (mg/kg)	SB-2 (0-6") (mg/kg)	SB-3 (0-6") (mg/kg)	SB-4 (0-6") (mg/kg)						
Benzo(a)pyrene	1.0	0.0033	0.0063	0.0032	0.028						
Benzo(a)anthracene	0.1	0.0022	0.0044	0.0024	0.017						
Benzo(b)fluoranthene	0.1	0.0070	0.010	0.0056	0.037						
Benzo(k)fluoranthene	0.01	0.0012	0.0036	0.00125	0.013						
Chrysene	0.001	0.0015	0.0065	0.0035	0.020						
Dibenzo(a,h)anthracene	1.0	0.00085	0.00095	0.0009	0.0054						
Indeno(1,2,3-cd)pyrene	0.1	0.0043	0.0062	0.0032	0.027						
Benzo(a)pyrene Equivalents											
Contaminant	**TEF**	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)						
Benzo(a)pyrene	1.0	0.0033	0.0063	0.0032	0.0280	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Benzo(a)anthracene	0.1	0.0002	0.0004	0.0002	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Benzo(b)fluoranthene	0.1	0.0007	0.0010	0.0006	0.0037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Benzo(k)fluoranthene	0.01	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Chrysene	0.001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Dibenz(a,h)anthracene	1.0	0.0009	0.0010	0.0009	0.0054	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Indeno(1,2,3-cd)pyrene	0.1	0.0004	0.0006	0.0003	0.0027	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total Equivalents											
Total Benzo(a)pyrene Equivalents		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Comparisons to SCTLs											
Does This Sample Exceed:		**SB-1 (0-6") (mg/kg)**	**SB-2 (0-6") (mg/kg)**	**SB-3 (0-6") (mg/kg)**	**SB-4 (0-6") (mg/kg)**						
The Residential Direct Exposure SCTL of 0.1 mg/kg?		**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**
The Industrial Direct Exposure SCTL of 0.7 mg/kg?		**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**
No Alternative SCTL Given		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
No Site Specific Background Given		**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

NRCS Soil Data

United States Department of Agriculture

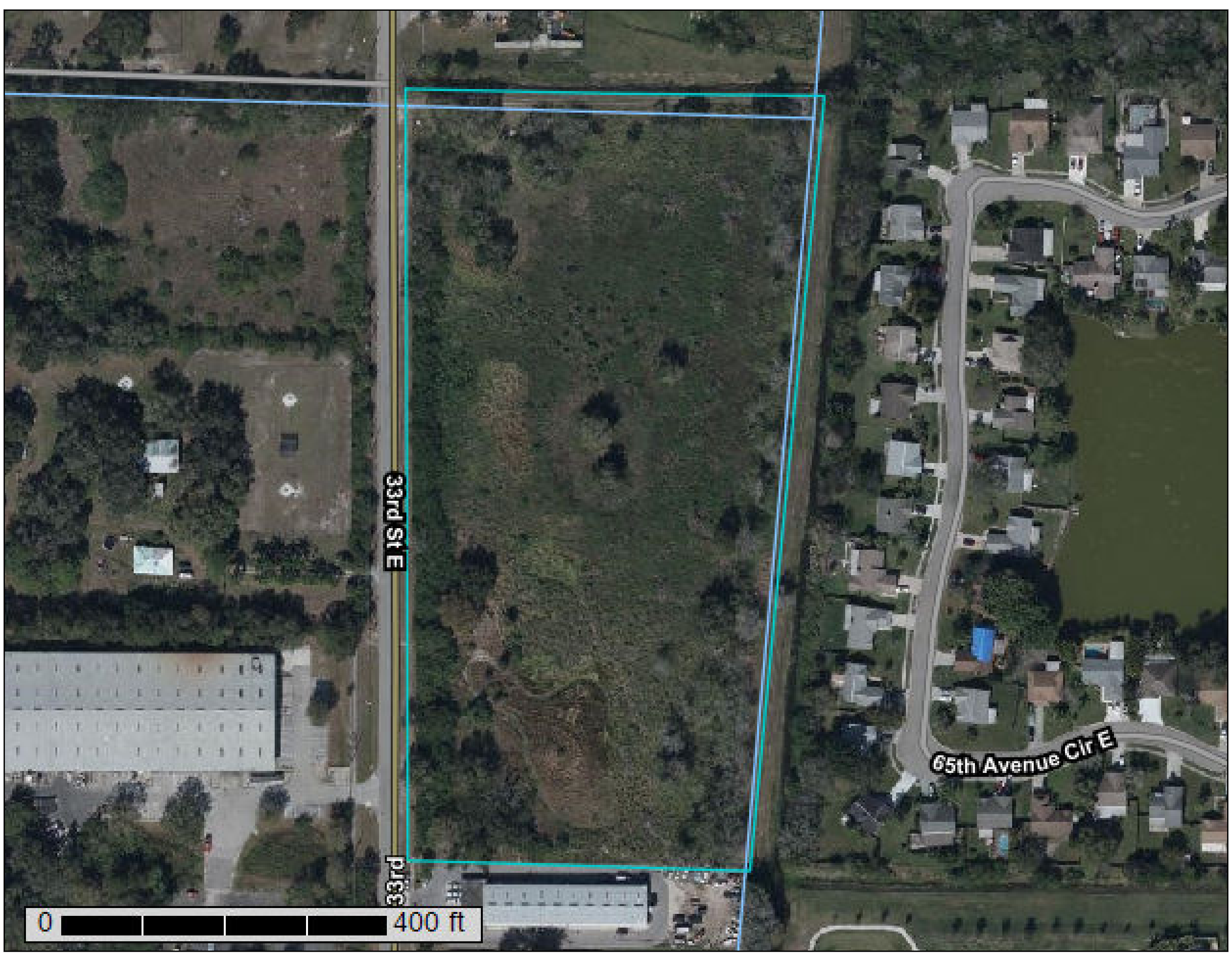
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Manatee County, Florida



October 4, 2023

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

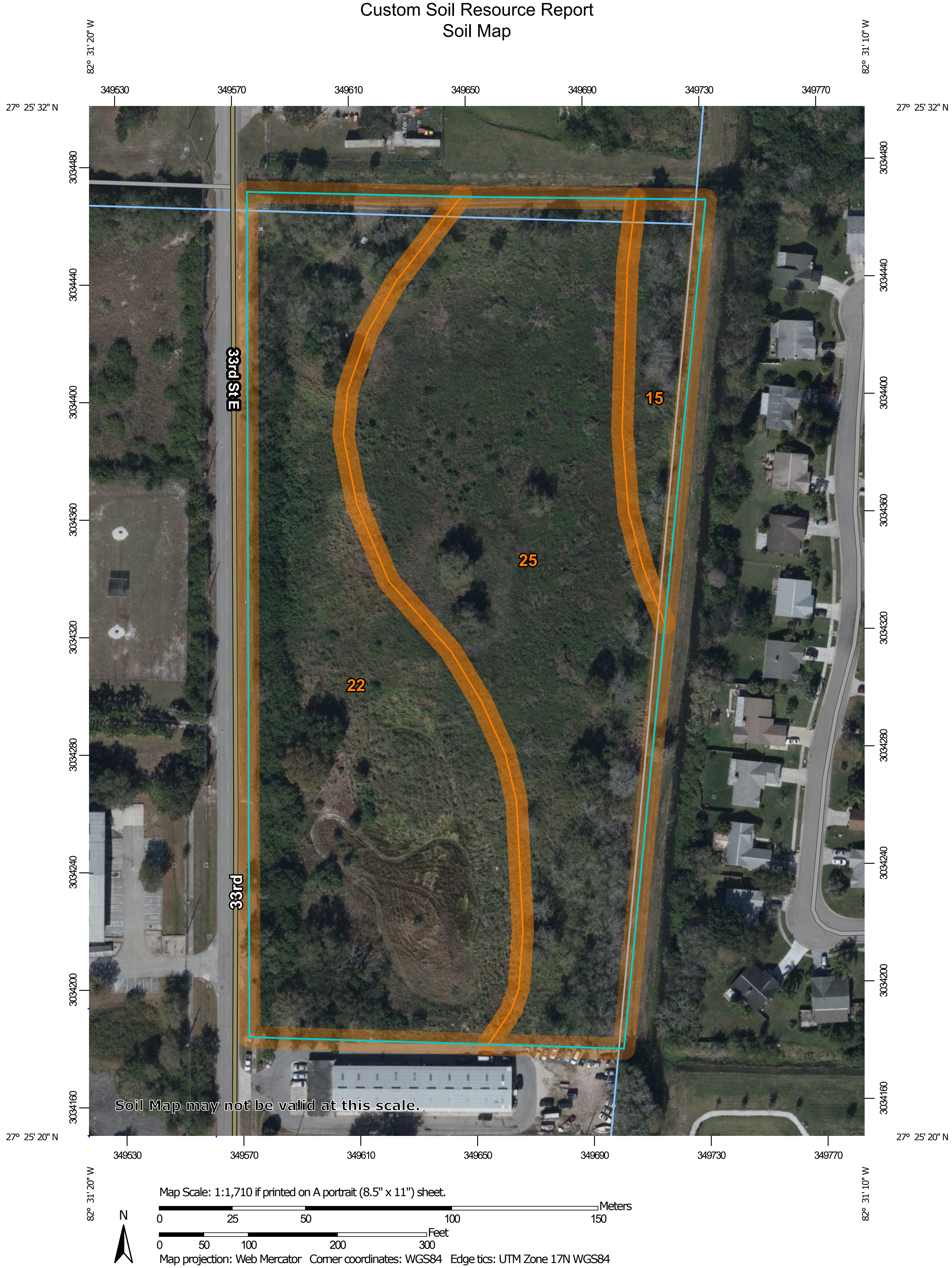
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


82° 31' 20" W
82° 31' 10" W
349530
349570
349610
349650
349690
349730
349770
27° 25' 32" N
27° 25' 20" N
3034480
3034440
3034400
3034360
3034320
3034280
3034240
3034200
3034160
33rd St E
33rd
15
25
22
Soil Map may not be valid at this scale.
Map Scale: 1:1,710 if printed on A portrait (8.5" x 11") sheet.
Meters
0
25
50
100
150
Feet
0
50
100
200
300
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Manatee County, Florida
Survey Area Data: Version 20, Sep 6, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 5, 2020—Mar 10, 2020

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
15	Delray mucky loamy fine sand	0.7	6.5%
22	Felda fine sand, 0 to 2 percent slopes	4.7	46.1%
25	Floridana fine sand, 0 to 2 percent slopes	4.8	47.4%
Totals for Area of Interest		**10.2**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Manatee County, Florida

15—Delray mucky loamy fine sand

Map Unit Setting

National map unit symbol: 1hg7t
Elevation: 10 to 80 feet
Mean annual precipitation: 48 to 56 inches
Mean annual air temperature: 68 to 75 degrees F
Frost-free period: 350 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Delray and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Delray

Setting

Landform: Depressions on marine terraces
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy and loamy marine deposits

Typical profile

A - 0 to 8 inches: mucky loamy fine sand
E - 8 to 51 inches: fine sand
Btg - 51 to 80 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: R155XY070FL - Sandy Freshwater Isolated Marshes and Swamps
Forage suitability group: Sandy soils on stream terraces, flood plains, or in depressions (G155XB145FL)

Other vegetative classification: Sandy soils on stream terraces, flood plains, or in depressions (G155XB145FL), Freshwater Marshes and Ponds (R155XY010FL)
Hydric soil rating: Yes

Minor Components

Felda, hydric

Percent of map unit: 4 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R155XY080FL - Sandy over Loamy Freshwater Isolated Marshes and Swamps
Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL), Slough (R155XY011FL)
Hydric soil rating: Yes

Floridana, depressional

Percent of map unit: 4 percent
Landform: Depressions on marine terraces
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R155XY080FL - Sandy over Loamy Freshwater Isolated Marshes and Swamps
Other vegetative classification: Sandy over loamy soils on stream terraces, flood plains, or in depressions (G155XB245FL), Freshwater Marshes and Ponds (R155XY010FL)
Hydric soil rating: Yes

Chobee

Percent of map unit: 4 percent
Landform: Depressions on marine terraces
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R155XY090FL - Loamy and Clayey Freshwater Isolated Marshes and Swamps
Other vegetative classification: Loamy and clayey soils on stream terraces, flood plains, or in depressions (G155XB345FL)
Hydric soil rating: Yes

Manatee

Percent of map unit: 3 percent
Landform: Depressions on marine terraces
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R155XY090FL - Loamy and Clayey Freshwater Isolated Marshes and Swamps
Other vegetative classification: Loamy and clayey soils on stream terraces, flood plains, or in depressions (G155XB345FL), Freshwater Marshes and Ponds (R155XY010FL)
Hydric soil rating: Yes

22—Felda fine sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2tzvy
Elevation: 0 to 180 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 70 to 77 degrees F
Frost-free period: 350 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Felda and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Felda

Setting

Landform: Flatwoods on marine terraces, drainageways on marine terraces
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Linear
Across-slope shape: Linear, concave
Parent material: Sandy and loamy marine deposits

Typical profile

A - 0 to 4 inches: fine sand
Eg - 4 to 35 inches: fine sand
Btg - 35 to 43 inches: fine sandy loam
Cg - 43 to 80 inches: extremely paragravelly fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: About 3 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 4 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: A/D
Ecological site: F155XY130FL - Sandy over Loamy Flatwoods and Hammocks

Forage suitability group: Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL)
Other vegetative classification: Slough (R155XY011FL), Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL)
Hydric soil rating: Yes

Minor Components

Wabasso

Percent of map unit: 6 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: F155XY120FL - Sandy Flatwoods and Hammocks
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: No

Oldsmar

Percent of map unit: 5 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: F155XY120FL - Sandy Flatwoods and Hammocks
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: No

Valkaria

Percent of map unit: 4 percent
Landform: Drainageways on flatwoods on marine terraces
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Linear
Across-slope shape: Linear, concave
Ecological site: F155XY120FL - Sandy Flatwoods and Hammocks
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), Slough (R155XY011FL)
Hydric soil rating: Yes

25—Floridana fine sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2sm50
Elevation: 0 to 100 feet
Mean annual precipitation: 44 to 60 inches
Mean annual air temperature: 70 to 77 degrees F
Frost-free period: 350 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Floridana and similar soils: 92 percent
Minor components: 8 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Floridana

Setting

Landform: Flats on marine terraces, drainageways on marine terraces, depressions on marine terraces
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Sandy and loamy marine deposits

Typical profile

A - 0 to 15 inches: fine sand
E - 15 to 32 inches: fine sand
Btg - 32 to 65 inches: fine sandy loam
Cg - 65 to 80 inches: fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: R155XY080FL - Sandy over Loamy Freshwater Isolated Marshes and Swamps
Forage suitability group: Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL)
Other vegetative classification: Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL), Freshwater Marshes and Ponds (R155XY010FL)
Hydric soil rating: Yes

Minor Components

Felda

Percent of map unit: 4 percent
Landform: Flatwoods on marine terraces, drainageways on marine terraces
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Linear
Across-slope shape: Linear, concave
Ecological site: F155XY130FL - Sandy over Loamy Flatwoods and Hammocks

Other vegetative classification: Slough (R155XY011FL), Sandy over loamy soils on flats of hydric or mesic lowlands (G155XB241FL)
Hydric soil rating: Yes

Samsula

Percent of map unit: 2 percent
Landform: Depressions on marine terraces
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R155XY100FL - Organic Freshwater Isolated Marshes and Swamps
Other vegetative classification: Organic soils in depressions and on flood plains (G155XB645FL), Freshwater Marshes and Ponds (R155XY010FL)
Hydric soil rating: Yes

Wabasso

Percent of map unit: 2 percent
Landform: Flatwoods on marine terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear, convex
Across-slope shape: Linear
Ecological site: F155XY120FL - Sandy Flatwoods and Hammocks
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G155XB141FL), South Florida Flatwoods (R155XY003FL)
Hydric soil rating: No

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