



Indian Beach/Sapphire Shores LID Retrofit Pilot

Sarasota Bay Estuary Program

Contract 2011SBEP05



January 2012

WilsonMiller



Stantec

INDIAN BEACH / SAPPHIRE SHORES (IBSS)

STORMWATER LID RETROFIT PILOT

PREPARED FOR:

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**STORMWATER LID RETROFIT PILOT
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CONTRACT 2011SBEP05

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Indian Beach / Sapphire Shores (IBSS)
Stormwater LID Retrofit Pilot



SECTION 1

EXECUTIVE SUMMARY

1. EXECUTIVE SUMMARY

The Sarasota Bay Estuary Program (SBEP) received a grant from the Florida Department of Environmental Protection for the Indian Beach / Sapphire Shores (IBSS) Stormwater Low Impact Design (LID) Retrofit Pilot. The primary goal of the project is to demonstrate opportunities within the watershed (including New College, the Ringling Museum, Sapphire Drive, 47th Street, 40th Street and Virginia Drive) to retrofit existing stormwater infrastructure using LID concepts to improve the quality of the stormwater discharges into Sarasota Bay. WilsonMiller Stantec was tasked with developing low impact designs that could be reproduced in other urban, developed coastal basins. The designs need to be low cost and unobtrusive, reduce the volume of stormwater runoff discharging to Sarasota Bay, and reduce the transportation and discharge of sediments to Sarasota Bay, all with the intent to improve water quality and promote the health of seagrasses and other natural estuarine resources. WilsonMiller Stantec has identified over 200 locations and appropriate mechanisms for treating stormwater using traditional and LID technologies to retrofit selected stormwater conveyance systems in older neighborhoods built out before current stormwater regulations were adopted. Eight of those sites were chosen for more detailed study and conceptual plans for each were prepared. Potential stormwater volume reductions attributed to the bio-swales were calculated for each drainage basin. The conceptual designs can be used elsewhere in similar, coastal neighborhoods elsewhere in southwest Florida.

New College, the Ringling Museum, Sapphire Drive, 47th Street, 40th Street and Virginia Drive were included in the initial analysis of suitable sites for retrofitting with LID; however, New College and the Ringling Museum currently operate and maintain multiple stormwater management systems permitted by the Southwest Florida Water Management District so the potential for application of LID principles would require coordination with the property owners and potentially modification of the existing SWFWMD permits. Therefore, those sites were not evaluated further and the IBSS project focused on publicly owned right-of-ways and land in the residential areas including the 47th Street, 40th Street and Virginia Drive locations.

Stormwater discharges are currently untreated in most of the IBSS neighborhoods and carry sediment from roadways and unvegetated landscapes. This sediment can either smother existing seagrasses in adjacent receiving waters or it can raise the elevation of the bay bottom to a point where it cannot support seagrass colonization.

A bio-swale is a primary component of LID and is a depression that is typically planted with native vegetation and serves as a natural stormwater treatment facility. Bio-swales also constitute small urban wetlands by virtue of their vegetation and hydrology and often improve biodiversity and neighborhood aesthetics by replacing sod with aquatic and other native plants. Sediments that would have been carried and discharged into Sarasota Bay will be retained in the bio-swales and will reduce nutrient enrichment to some degree. Parts of the IBSS area contain wide right-of-ways with significant grassed areas between the curb and the front edge of the sidewalk which are ideal locations for bio-swales.

Once funding for the construction of the bio-swales is secured, public outreach meetings should be held to advise residents of the plans to improve their neighborhood and to solicit their input for the final design. The SBEP and the City of Sarasota staff should also solicit help from the neighbors to maintain the bio-swales. Neighborhood meetings may provide a springboard for the community to pursue other beautification or stormwater improvement programs outside of the scope of this project. The intent is to show the residents how fairly simple changes to the landscape can improve local aesthetics and maintain the ecological integrity of adjacent bay waters. As the LID / bio-swales designs are implemented, follow-up studies of their pollutant removal efficiency should be conducted. Previous studies in the scientific literature indicate that capturing stormwater within vegetated basins reduce potential inflow of contaminants in receiving bodies of water through biological uptake and percolation. Percent reductions are less understood and vary in response to a host of external factors.

A demonstration project has been constructed at the City of Sarasota's Lift Station No. 9 west of Bayshore Circle. As part of the public involvement, the Lift Station No. 9 project provided an opportunity to discuss the plant palette with adjacent neighbors and members of the neighborhood beautification committee. Originally, the sight included grassed swales to channel excess stormwater from Bayshore Circle to Sarasota Bay. For the demonstration project, the swales were widened and flattened and planted with native vegetation. The new bio-swales will not only channel stormwater as originally designed, but will also increase the contact time, allowing pollutants to percolate into the ground and to be assimilated by the plants which will ultimately improve the water quality in that section of Sarasota Bay.

The Lift Station No. 9 bio-swale should be studied to provide data for the greater stormwater industry for retrofits in urbanized, coastal basins. It is clear that introducing bio-swales will reduce the concentration of pollutants entering Sarasota Bay; however, the extent of that reduction is difficult to quantify and will not be known conclusively unless follow-up water quality studies are done.

In existing conditions in the IBSS neighborhood, stormwater runoff bypasses overwhelmed inlets during high stormwater flows. Extending the concept of the Lift Station No. 9 demonstration project to the IBSS coastal neighborhoods provides an opportunity to reduce the volume of stormwater runoff and pollution by retaining the first flush volume in bio-swales. The bio-swales will reduce the quantity of runoff; improve the water quality of Sarasota Bay; and will promote the reduction of contaminants and bacteria in stormwater in the neighborhood.



Indian Beach / Sapphire Shores (IBSS)
Stormwater LID Retrofit Pilot



SECTION 2

INTRODUCTION

2. INTRODUCTION

Low Impact Design Practices

The Sarasota Bay Estuary Program (SBEP) received a grant from the Florida Department of Environmental Protection to conduct a stormwater Low Impact Design (LID) retrofit pilot project in the Indian Beach/Sapphire Shores neighborhoods. The SBEP subsequently contracted with WilsonMiller Stantec to fulfill grant requirements.

Common stormwater management systems collect water from impervious surfaces, route it for treatment to a single detention or retention location such as a pond or grassed depression and then discharge it to a surface water body. Low Impact Design (or Development) creates what is commonly called a “treatment train” that incorporates one or more depressions that captures and pre-treats stormwater prior to its discharge to a final retention or detention system. These depressions hold stormwater for designed periods of time which allow nutrients and other potential contaminants to be assimilated by the vegetation, for sediment to settle out and for the water to percolate through the soils. All of these mechanisms reduce the volume and improve the quality of stormwater that is ultimately discharged to surface water offsite.

While LID can be incorporated into the design of new residential or commercial stormwater management systems, its real potential lies in using it to retrofit existing stormwater management systems that have no current form of stormwater treatment, such as those systems designed solely to collect runoff and to route it directly to a surface water. Part of the flow can rerouted through bio-swales, which are depressions containing sod or, preferably, native vegetation underlain with soils that facilitate percolation. Bio-swales can be as simple as small depressions in native soils or they can be more complex and contain underdrains or very specific materials designed to control the rate of percolation. Whether installed bio-swales are simple or complex, they will retain and treat stormwater runoff that would otherwise go untreated and contribute to surface water contamination.

The technical and scientific literature is replete with examples of the successful applications of LID throughout the United States (see for examples Stanley, 1999; Bedan and Clausen, 2009; Li and Davis, 2009; Passepport, *et al.*, 2009; Chapman and Horner, 2010; and Damodaram, *et al.*, 2010). Locally, two projects resulted in conceptual designs for stormwater improvements in the IBSS neighborhoods (PBS&J, 2007; Scheda Ecological Associates, Inc. and Brown and Caldwell, 2010), but both concentrated on making improvements at the outfalls rather than capturing and treating stormwater upstream. A third analysis done over ten years ago (New College, date unknown) included an inventory of stormwater discharge points throughout the neighborhoods, a public input component, and the production of educational materials. None of the conceptual designs prepared were ever constructed.

Sarasota County has embraced LID as a viable addition to traditional stormwater treatment methods and has developed a technical LID manual that is currently undergoing peer review. Sarasota County also commissioned a study to determine the efficiency of grassed swales in reducing pollutant loads in stormwater (PBS&J, 2010) and found that they removed particulate loading significantly. They were found to be less effective in reducing concentrations of dissolved constituents; however, since the grassed swales did reduce overall loading there would be a concomitant reduction in dissolved constituents in the final discharge.

Indian Beach and Sapphire Shores Project Areas

The Indian Beach / Sapphire Shores neighborhoods were platted and developed over 75 years ago, long before local and state governmental authorities adopted stormwater treatment requirements. The primary engineering concern at the time was to protect the new residents and structures from flooding when natural habitats were converted to impervious surfaces and higher volumes of stormwater runoff were generated. The neighborhoods were located on coastal

ridges immediately adjacent to Sarasota Bay which served as a convenient repository for the newly created runoff. That the runoff contained sediment, and contaminants primarily in the form of nitrogen and phosphorus, was not an issue because at that time and for many years thereafter the general assumption was that the Bay could assimilate whatever was contained in urban runoff.

Today, we know that is not the case and that untreated stormwater runoff is one of the primary causes of water pollution worldwide. Amendments to the Federal Clean Water Act in the early 1970s started a wave of adoptions of Federal, State and Local environmental regulations specifically aimed at improving water quality in the Nation's surface waters. While there should be no doubt that these regulations significantly improved the quality of stormwater (and other) surface water discharges for new developments, they did little to reduce the volume and improve the quality of existing discharges because the regulations were not retroactive and did not require "non-conforming" stormwater management systems to be retrofitted to meet current standards, except under very specific circumstances (such as redevelopment). That means that most communities developed prior to the 1970's continue to discharge untreated stormwater to surface waters. Because coastal areas were highly prized by early settlers, it is these areas that remain the primary sources of contamination and nutrient enrichment in adjacent bays and estuaries.

Indian Beach and Sapphire Shores are two such neighborhoods. While there is no legal requirement for residents to retrofit their stormwater management system, they and Sarasota Bay would benefit greatly from a program designed to improve the quality of stormwater originating in their neighborhoods and discharging to Sarasota Bay.

For a non-regulatory project to work, it must be cost effective to design and install, easy to maintain, unobtrusive to the neighbors and have the support of resident and local governments. It must also be permissible by the regulatory agencies because even though the retrofits are not required, they do constitute a modification to an existing stormwater management system which requires a permit. All of these factors were considered in the recommended designs and locations.

SECTION 3

LOW IMPACT DESIGN OPTIONS

3A. PUBLIC RIGHT-OF-WAY AND PROPERTY

3B. PRIVATE PROPERTY

3. LOW IMPACT DESIGN OPTIONS

3A. *PUBLIC RIGHT-OF-WAY AND PUBLIC PROPERTY*

When implementing low impact design in public rights-of-way and on public or private property, future maintenance costs and life cycle costs must be considered. For the IBSS project, the following low impact design options were considered to minimize the capital and future maintenance costs and infringement into the community.

Bio-swales

The construction of bio-swales in existing roadway rights-of-way in the IBSS project area has the potential to provide significant stormwater runoff treatment as an off-line treatment system. An off-line treatment system is for water quality and the runoff collected in the system has no direct discharge other than percolation and evaporation. Currently, the Southwest Florida Water Management District stormwater treatment regulations for off-line treatment systems in new developments require treatment of the first 0.50 inches of stormwater runoff if the project site is less than 100 acres and treatment is required for the first 1.0 inch of stormwater runoff for project sites greater than 100 acres. These regulations do not apply to the existing stormwater management system in IBSS. Since the early 1920's, the stormwater runoff from the roadways in the IBSS project area has been collected in a series of inlets and pipes that discharge directly to Sarasota Bay without the benefit of a treatment system.

While some drainage basins in the IBSS project area have limited road right-of-way and create challenges for construction of bio-swales, there are rights-of-way that are 100 feet wide. The roads are local roads, which normally are constructed in 60 feet of right-of-way. The roads in the Sapphire Shores area are comprised of 30-foot wide pavement and gutter with 5-foot wide sidewalks on both sides of the street in most locations. With the additional right-of-way, there is ample room to install bio-swales. Over 200 prospective suitable bio-swale sites have been identified in the IBSS project area (Figure 1). Combined, these sites potentially can retain a volume equivalent to 1.15 inches of stormwater runoff from the impervious roadway area. The bio-swales would be planted with drought tolerant, native vegetation suitable for coastal basins. In addition to the water quality benefits, the vegetation will require minimal maintenance while enhancing the aesthetics of the roadway.

Currently, runoff from the contributing basins drains to the roadway, collects in the roadway and the roadway is an impervious channel directing the runoff to the existing catch basins and ultimately to Sarasota Bay without the benefit of a treatment system. Construction of bio-swales in the road rights-of-way will provide collection areas for the initial roadway runoff, the "first flush", which is considered the most polluted runoff during a storm event. By collecting the first flush in the bio-swales, the runoff will be held for treatment by means of natural percolation and plant uptake while providing an opportunity for suspended solids to settle out.

Baffle Boxes

The use of baffle boxes or nutrient separation boxes provides treatment for areas with limited rights-of-way. Nutrient separation boxes have a mechanical system which includes a basket to capture trash and organic matter such as leaves in low flows and provides a bypass for high flows so as to minimize head loss in the structure. The structure also has a chamber or sump area providing an opportunity for suspended solids to settle out. Cost of maintenance of the structures will be dependent on the amount of material collected in the basket and the sump.

Baffle boxes are structures with a chamber or sump area providing an opportunity for suspended solids to settle out (Figure 2). Head losses in the structure are more constant because the variable of volume of debris in the basket is not a factor; however the debris has a greater chance of being conveyed into the receiving water. Use of baffle boxes or nutrient separation boxes would be limited to those drainage basins where the right-of-way is restricted and the use of bio-swales is limited.

Catch Basin Baskets

Catch basin baskets can be installed in the existing inlets. The intent of the basket is to capture trash and organic material preventing the transport to the bay. The stormwater runoff will bypass the basket once the basket is filled with trash and organic debris and can re-suspend debris from the basket making the efficiency of removal unreliable. Baskets can have significant maintenance costs associated with the routine removal of the debris. Maintenance costs tend to increase in areas with mature trees. If neighborhood programs where residents volunteer to clean out the debris can be established, maintenance costs can be reduced.

Pervious Pavement

Pervious pavement allows rain to percolate into the ground Instead of running off its surface, thereby reducing runoff volume. For the IBSS project area, there are opportunities for installing pervious pavement to meet multiple-use expectations for the roadway right-of-way. The Bayhaven Elementary School is congested during student drop off and pick up times. Parking areas are limited and often cars park in the right-of-way on grass areas. While these areas could be considered potential bio-swale sites, the construction of bio-swales may contribute to the congestion around the school because they would eliminate overflow parking areas. The addition of pervious pavement would provide a dual use for peak hour parking and water quality treatment.

3B. PRIVATE PROPERTY

Low Impact Design and rainwater harvesting options for private property require the property owner to participate financially by being responsible for capital and maintenance costs. However, there are options available to homeowners to help subsidize these costs, for example, Bay Partner Grants from the Sarasota Bay Estuary Program and other possible subsidies from the City of Sarasota, Sarasota County, the Florida Department of Environmental Protection and the Southwest Florida Water Management District. Any of these agencies may be able to secure grants to help defray costs to private land owners. Evidence suggests that homeowners are often willing to participate in stormwater improvement projects in their neighborhoods when they understand their value to the surrounding environment (see for examples, Dietz, *et al.*, 2004; Ferguson, 2004; and Shuster, *et al.*, 2008).

Rain Gardens / Bio-swales

Rain gardens and bio-swales serve the same functions which are to retain runoff, promote natural infiltration and plant uptake reducing the amount of pollution reaching the receiving water. Bio-swales tend to be deeper, not vegetated on the bottom and can include a soil and/or rock filter along the sloped bottom. Rain gardens are shallow and completely vegetated. Rain gardens can be easily incorporated into the landscape of private property capturing overland flow and retaining the runoff from the roof top or driveway thereby reducing the pollutant load to receiving waters.

Rain Barrels / Cisterns

Above ground large barrels (typically 55-gallon capacity) collect runoff from the roof downspout. The stored rainwater can then be used to water landscape features on the property thereby reducing the use of potable water for irrigation.

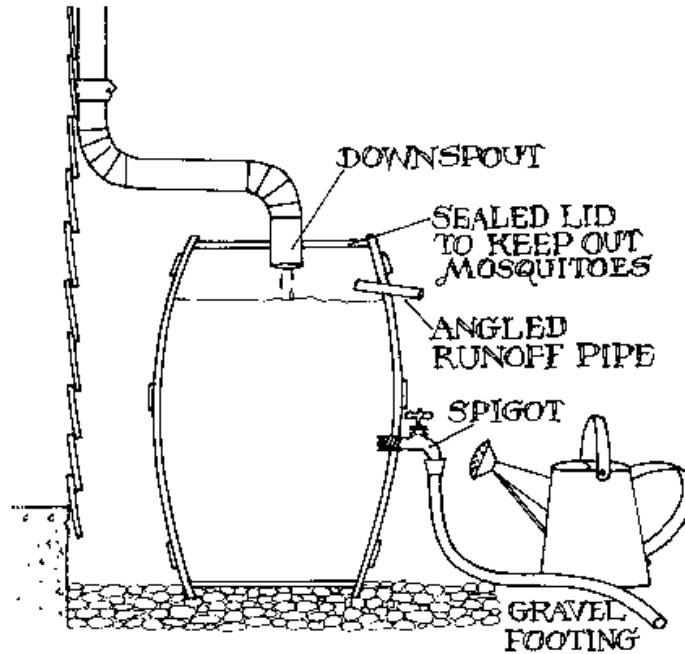


Figure 3. Rain barrel schematic

(Source: "A Country Garden for Your Backyard" by M. Smith)

Cisterns can be above or below ground and are designed with a filtration system and can typically hold more water than rain barrels. Cisterns are installed to harvest rainwater for use in the home as well as landscape irrigation.

Pervious Pavement

Driveways and walkways can be replaced with pervious pavement. The rainfall is retained on the property and filters through the material under the pervious pavement and recharges the groundwater. Capital cost and long term maintenance costs may be prohibitive for private property owners and vary depending on selected materials. Pervious pavement requires vacuuming biannually with a commercial cleaning unit to remove grit and gravel that can block infiltration.

Planting Trees

Trees contribute to the beauty of neighborhoods and provide shade that reduces the reflection of heat off of pavement. During rainfall, trees capture and retain some volume of water based on the tree canopy and species. Private property owners should seek advice regarding tree selection and placement so that trees have room to grow without impacting overhead and underground utilities.

Green Roof

Private property owners have the option of constructing a green roof which essentially consists of vegetation that captures and treats rainfall by assimilating the nutrients within. Care must be taken in the design to insure that the foundation and structure can handle the additional weight and that the roof top provides an effective treatment system. Often green roofs are combined with rain barrels or cisterns for irrigation of the vegetation.

SECTION 4

DRAINAGE BASINS

4A. IDENTIFICATION OF FLOOD PRONE AREAS

4B. SITE IDENTIFICATION

4C. TREATMENT CALCULATIONS

4. DRAINAGE BASINS

In this study, we divided the project areas into discrete drainage basins based on local topography and the Sarasota County GIS Asset Management Data Base which we used to locate the curb inlets and the stormwater pipes currently transporting runoff to Sarasota Bay. Twenty-three drainage basins were identified and are represented in Figures 6 through 28.

4A. IDENTIFICATION OF FLOOD PRONE AREAS

By examining the 2007 LiDAR one-foot contour maps provided by Sarasota County, we identified flood prone areas in the IBSS neighborhood (Figure 4). Identification of a flood prone area does not include depth of flooding. The capacity of the roadway inlets are often overburdened with runoff which limits the volume of water entering the pipes. In heavy rainfall events, the runoff from the drainage basin collects at the low lying areas (floodprone areas) and the standing water may become deep enough to find a secondary conveyance between homes to Sarasota Bay. The addition of bio-swales upstream of the flood prone areas could help to alleviate some flooding by retaining additional runoff volume. While the bio-swales would provide relief in high frequency, low volume rainfall events, flood prone areas would see minimal relief during a low frequency, high volume event.

4B. SITE IDENTIFICATION

Rights-of-way with the widest grassed areas were deemed most suitable for LID retrofits and were identified in each of the drainage basins. Sites providing multiple functions such as overflow parking or extensively landscaped were generally not explored farther. The final bio-swale locations will need to be balanced with the expectations of the residents for multi-use rights-of-way.

The entire IBSS project area was evaluated and over 200 potential bio-swale sites were identified (Figure 1) that could capture roadway runoff at multiple upstream locations to reduce runoff and the pollutant loading. In addition to bio-swales, baffle boxes may be beneficial to remove suspended solids in drainage basins where potential bio-swale sites are limited by the available right-of-way.

Drainage Basin Analysis

An analysis was performed in each basin by calculating the total basin area; the areas of road right-of-way; the total centerline length of roads; and the area of buildings. The impervious road area and the impervious building area were used to determine the percentage of impervious area in each basin (Table 1). The percentage of impervious area in the basins ranged from 18.1% to 36.5%. The basin with 18.1% of impervious area was the Woodland Drive basin which is comprised mainly of sodded yards. The basin with 36.5% of impervious area was the Windsor Drive basin which includes commercial development. Data developed in the drainage basin analysis was used in the treatment calculations.

4C. TREATMENT CALCULATIONS

Bio-swale sites were divided by drainage basin (Figures 6 through 28) and the total area of the identified bio-swales for each basin was calculated (Table 2). The potential treatment volume for each drainage basin was based on an assumed bio-swale depth of six inches and the total area of the bio-swale sites. The total bio-swale area for each basin was reduced to account for the side slopes of the bio-swales to calculate the potential treatment volume per drainage basin. Using the SWFWMD regulatory requirement to treat 0.5 inches of runoff in an off-line treatment system, the desired

treatment volume was calculated for the impervious roadway area determined in the drainage basin analysis.

The percentage of potential treatment volume was calculated by dividing the desired treatment volume for the impervious roadway by the potential treatment volume in the bio-swales. Of the 21 basins that contain potential bio-swale sites, 14 basins can meet the current regulatory requirements for treatment. In addition, three basins can meet at least 75% of the current regulatory requirements for treatment. Also, ten of the 21 basins can provide treatment for 1 inch of runoff from the impervious roadway area.

While roof tops, driveways and sidewalks are impervious surfaces in all of the drainage basins, these impervious areas contribute more to the volume of runoff than to the pollutant loading of runoff. The pollutant loading is considered minimal when compared to the pollutants from the impervious roadways.

SECTION 5

OUTFALL IMPROVEMENTS

5. OUTFALL IMPROVEMENTS

Seven basins have limited rights-of-way making use of bio-swales impracticable. At those locations, a viable option is to install a baffle box / nutrient separation box designed to capture suspended solids and organic matter which will improve the water quality of the stormwater runoff discharging to Sarasota Bay over the existing conditions. In the design of the structure, it is imperative that the headloss across the structure is minimized so the structure does not adversely impact flood stages. The following locations should be considered for baffle boxes / nutrient separation boxes (Figure 5). Baffle boxes / nutrient separation boxes cost a minimum of \$20,000 with the final cost dependent on the configuration and size of the structure.

Location 1 - 45th Street and Bayshore Road

Location 2 - 40th Street and Bayshore Road

Location 3 - Indian Beach Lane and Indian Beach Drive

Location 4 - Virginia Drive and Bayshore Circle

Location 5 - 22nd Street and Alameda Ave

Location 6 - Alameda Way and Alameda Ave

Location 7 - Sylvan Drive and Chippawa Place

SECTION 6

GEOTECHNICAL REPORT

6. GEOTECHNICAL REPORT

WilsonMiller Stantec identified eight sites within the Indian Beach / Sapphire Shores areas for geotechnical investigations to determine whether the proposed LID designs are feasible at the sites selected (Appendix 1). The geotechnical report includes the following:

Classification Borings

The report includes analysis of soil borings at the proposed locations of shallow depth bio-swales in rights-of-way along existing road alignments for treatment and infiltration of stormwater. The borings provide information regarding subsurface soil and groundwater conditions for use in design and permitting. The borings were to a nominal depth of eight feet to identify the soil profile, measure ground water levels and allow for an estimate of the normal seasonal high groundwater levels.

Infiltration Testing

Double Ring Infiltration (DRI) tests were conducted at seven locations at swale bottom elevations at or near the locations of the hand auger borings. The DRI tests provide vertical infiltration values for use in design.

Laboratory Classification Testing

A limited laboratory testing program provided additional information for soil classification and characterizing the engineering properties of the subsurface soils. Tests included grain size analysis and Atterberg limits determinations together with organic content tests when applicable.

Report

The report includes logs of the hand auger classification borings, a sketch showing the approximate test locations, an estimate of the normal seasonal high groundwater at the test locations, a graphical plot of the DRI test results and geotechnical recommendations relative to the design of the bio-swales.

SECTION 7

CONCEPTUAL BIO-SWALE DESIGN

7A. SITE DESCRIPTIONS AND COSTS

7. CONCEPTUAL BIO-SWALE DESIGN

Over 200 sites were identified as potentially suitable for LID improvements in the 23 drainage basins (Figures 6 through 28); conceptual bio-swale locations are illustrated on Figure 29. The eight selected sites were evaluated further for development of conceptual plans. The conceptual plans are included in this section (Figures 30 through 37). In addition, Figure 38 illustrates typical cross sections for grading bio-swales and a detail for curb cuts.

Survey data were collected at each location to support the conceptual design for each site. Elevations were collected as relative to a local point which means the elevations while comparable to one another were not tied to a benchmark elevation. After review of the survey data, it was determined that Site 5 was not suitable for a bio-swale due to restricted right-of-way.

Geotechnical data at the remaining seven locations was collected to determine seasonal high water elevation (SHWL) and the natural percolation rate for the soils at the proposed bio-swales. Based on elevation and geotechnical data collected at the sites, the remaining sites were found to be suitable for bio-swales.

Treatment Volume for Impervious Roadway vs. Potential Bio-swale Volume

For the conceptual sites, the objective was to design a bio-swale that would at minimum retain the first half inch of runoff from the contributing impervious roadway area. The impervious area contributing to each of the seven sites was determined and used to calculate the volume of runoff from the first half inch of runoff.

Design of the bio-swales was based on survey data using relative elevations. Depth of the bio-swale was determined based on the geotechnical report. Each of the bio-swales can be constructed to accommodate the first half inch of runoff from their respective contributing impervious roadway area and six of the seven sites can retain additional volume.

Of the seven viable sites, the percolation rates for six of them should be able to support natural percolation. For Site 8, the system may require addition of an exfiltration system or underdrain.

Table 3. Potential Bio-swale Volume

BIO-SWALE	Roadway Impervious Area (ac)	Volume of ½" of Runoff (ac-ft)	Bio-swale Area at Toe of Slope (ac)	Bio-swale Area at Top of Bank (ac)	Depth of Bio-swale (ft)	Volume in Bio-swale (ac-ft)
SITE 1	0.210	0.009	0.036	0.109	0.5	0.036
SITE 2	0.320	0.013	0.030	0.074	0.5	0.029
SITE 3	0.610	0.025	0.052	0.091	0.5	0.036
SITE 4	1.050	0.044	0.056	0.125	0.5	0.045
SITE 6	0.460	0.019	0.017	0.033	0.75	0.019
SITE 7	0.420	0.018	0.017	0.080	0.75	0.036
SITE 8	0.120	0.005	0.002	0.022	0.75	0.009

Plant Palette

The plant palette for the bio-swales was developed by the WilsonMiller Stantec Landscape Architecture group. The unique characteristics of the coastal basin area were accounted for in the selection of the grasses, plants, and trees. Plants used are Florida native, drought tolerant plants so that the future maintenance of the bio-swales is minimized. The Landscape Plant Palette (Figure 39) provides illustrations of the selected plants.

7A. Site Descriptions and Costs**SITE 1** (Figure 30)

Site 1 is located at the northwest corner of N. Shore Drive and Bay Shore Road. The site was selected for the available space in the roadway right-of-way and because of the high visibility due to the proximity to the Bay Shore Road. As they are installed and mature the bio-swales will not only improve stormwater quality but will also enhance the aesthetic quality of the main roadway.



Photograph 1. Site 1 existing conditions looking east.

The contributing roadway area for the Site 1 is approximately 0.21 acres requiring 0.009 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the Site 1 is 0.036 ac-ft. (Table 3). Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

Preliminary Opinion of Probable Cost

SITE 1				
ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 800	1	\$ 800
Clearing and Grubbing	AC	\$ 5,000	0.12	\$ 600
Staked Silt Fence	LF	\$ 3	600	\$ 1,800
Floating Barrier	LF	\$ 8	0	\$ -
Excavation	CY	\$ 15	90	\$ 1,350
Embankment	CY	\$ 15	10	\$ 150
Curb Cuts	EA	\$ 120	7	\$ 840
6"PVC pipe	LF	\$ 17	0	\$ -
Scarification	SY	\$ 2.50	350	\$ 875
Plantings	SY	\$ 3	350	\$ 1,050
Sod	SY	\$ 2.50	135	\$ 338
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 4,301	1	\$ 4,301
<i>Subtotal</i>				\$ 12,904
20% Contingency				\$ 2,581
Total Cost				\$ 15,485

SITE 2 (Figure 31)

Site 2 is located at the intersection of Sapphire Drive and Bay Shore Road where bio-swales could be located on the northwest and the southwest corners. The site was selected for the available space in the roadway right-of-way and because of the high visibility due to its proximity to Bay Shore Road.



Photograph 2. Site 2 existing conditions northwest corner looking east.

SITE 2 (Figure 31)

Photograph 3. Site 2 existing conditions southwest corner looking west.

SITE 2 (Figure 31)

Photograph 4. Site 2 rendering of the bio-swale for the northwest corner.

The contributing roadway area for the northwest bio-swale at Site 2 is approximately 0.22 acres requiring 0.009 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the northwest bio-swale at Site 2 is 0.009 ac-ft. Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

The contributing roadway area for the southwest bio-swales at Site 2 is approximately 0.10 acres requiring 0.004 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the southwest bio-swales at Site 2 is 0.020 ac-ft. (Table 3). Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

Preliminary Opinion of Probable Cost**SITE 2 (Northwest and Southwest Combined)**

ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 800	1	\$ 800
Clearing and Grubbing	AC	\$ 5,000	0.08	\$ 400
Staked Silt Fence	LF	\$ 3	600	\$ 1,800
Floating Barrier	LF	\$ 8	0	\$ -
Excavation	CY	\$ 15	65	\$ 975
Embankment	CY	\$ 15	0	\$ -
Curb Cuts	EA	\$ 120	9	\$ 1,080
6"PVC pipe	LF	\$ 17	0	\$ -
Scarification	SY	\$ 2.50	250	\$ 625
Plantings	SY	\$ 3	250	\$ 750
Sod	SY	\$ 2.50	115	\$ 288
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 3,759	1	\$ 3,759
<i>Subtotal</i>				\$ 11,276
20% Contingency				\$ 2,255
Total Cost				\$ 13,532

SITE 3 (Figure 32)

Site 3 directly discharges into a basin connected to Sarasota Bay and is located at the western end of Ringling Point Drive. The existing configuration of the cul-de-sac island at Ringling Point Drive provides the geometry to create the bio-swale with minimal capital cost while providing treatment for roadway runoff.



Photograph 5. Site 3 existing conditions looking southeast.

The contributing roadway and impervious driveway area for the Site 3 is approximately 0.61 acres requiring 0.025 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the Site 3 is 0.036 ac-ft. (Table 3). Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

SITE 3 (Figure 32)

Photograph 6. Site 3 rendering of proposed bio-swale.

Preliminary Opinion of Probable Cost

SITE 3				
ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 800	1	\$ 800
Clearing and Grubbing	AC	\$ 5,000	0.1	\$ 500
Staked Silt Fence	LF	\$ 3	390	\$ 1,170
Floating Barrier	LF	\$ 8	120	\$ 960
Excavation	CY	\$ 15	90	\$ 1,350
Embankment	CY	\$ 15	0	\$ -
Curb Cuts	EA	\$ 120	8	\$ 960
6" PVC pipe	LF	\$ 17	0	\$ -
Scarification	SY	\$ 2.50	0	\$ -
Plantings	SY	\$ 3	350	\$ 1,050
Sod	SY	\$ 2.50	90	\$ 225
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 3,908	1	\$ 3,908
<i>Subtotal</i>				\$ 11,723
20% Contingency				\$ 2,345
Total Cost				\$ 14,067

SITE 4 (Figure 33)

Site 4 directly discharges into a basin connected to Sarasota Bay and is located at the northwest corner of S. Shore Drive and Sun Circle. The site was selected for the available space in the roadway right-of-way and because of the high visibility due to the proximity to the neighborhood park along Sarasota Bay. Neighborhood residents will be able to view the bio-swale while enjoying the amenities at the park.



Photograph 7. Site 4 existing conditions looking south.

The contributing roadway area for the Site 4 is approximately 1.05 acres requiring 0.044 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the Site 4 is 0.045 ac-ft. (Table 3). Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

SITE 4 (Figure 33)

Photograph 8. Site 4 rendering of proposed bio-swale.

Preliminary Opinion of Probable Cost

SITE 4				
ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 800	1	\$ 800
Clearing and Grubbing	AC	\$ 5,000	0.15	\$ 750
Staked Silt Fence	LF	\$ 3	520	\$ 1,560
Floating Barrier	LF	\$ 8	120	\$ 960
Excavation	CY	\$ 15	110	\$ 1,650
Embankment	CY	\$ 15	10	\$ 150
Curb Cuts	EA	\$ 120	9	\$ 1,080
6"PVC pipe	LF	\$ 17	60	\$ 1,020
Scarification	SY	\$ 2.50	440	\$ 1,100
Plantings	SY	\$ 3	440	\$ 1,320
Sod	SY	\$ 2.50	120	\$ 300
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 5,745	1	\$ 5,745
<i>Subtotal</i>				\$ 17,235
20% Contingency				\$ 3,447
Total Cost				\$ 20,682

SITE 5 (Figure 34)

Survey data was collected at each location to support the conceptual design for each site. After review of the survey data, it was determined that Site 5 was not suitable for a bio-swale due to restricted right-of-way.



Photograph 9. Site 5 (existing conditions).

SITE 6 (Figure 35)

Site 6 is located on Windsor Drive in the center of a roundabout. Part of the contributing area is the back parking lot / loading dock of a retail building. The site was selected for the available space in the roadway right-of-way. The visibility of the site may be limited, but the nature of the contributing area provides an opportunity to address runoff from a residential roadway and a commercial impervious area.



Photograph 10. Site 6 existing conditions looking west.

SITE 6 (Figure 35)

Photograph 11. Site 6 existing conditions looking east.

SITE 6 (Figure 35)

Photograph 12. Site 6 rendering of proposed bio-swale.

The contributing roadway area for the Site 6 is approximately 0.46 acres requiring 0.019 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the Site 6 is 0.019 ac-ft. (Table 3). Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

Preliminary Opinion of Probable Cost

SITE 6				
ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 1,200	1	\$ 1,200
Clearing and Grubbing	AC	\$ 5,000	0.05	\$ 250
Staked Silt Fence	LF	\$ 3	160	\$ 480
Floating Barrier	LF	\$ 8	0	\$ -
Excavation	CY	\$ 15	30	\$ 450
Embankment	CY	\$ 15	0	\$ -
Curb Cuts	EA	\$ 120	4	\$ 480
Asphalt, Mill 2"	SY	\$ 2.50	484	\$ 1,210
Asphalt, S1	TN	\$ 600	1.6	\$ 960
Asphalt, S3	TN	\$ 400	1.6	\$ 640
6" PVC pipe	LF	\$ 17	0	\$ -
Scarification	SY	\$ 2.50	120	\$ 300
Plantings	SY	\$ 3	120	\$ 360
Sod	SY	\$ 2.50	35	\$ 88
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 5,000	1	\$ 5,000
<i>Subtotal</i>				\$ 12,218
20% Contingency				\$ 2,444
Total Cost				\$ 14,661

SITE 7 (Figure 36)

Site 7 is located along the north and south sides of Patterson Drive adjacent to the Bay Haven Elementary School. The site was selected for the available space in the roadway right-of-way and because of the potential educational value for the students, teachers, staff and parents. Bay Haven Elementary school is also a magnet school, so not only would neighborhood families be exposed to the concept of bio-swales, but families throughout Sarasota County would have the opportunity to be educated about the benefits of bio-swales. As the student population changes over the years, the audience would change.



Photograph 13. Site 7 existing conditions looking west on Patterson Drive.

SITE 7 (Figure 36)

Photograph 14. Site 7 rendering of proposed bio-swale.

The contributing roadway and impervious driveway area for the Site 7 is approximately 0.42 acres requiring 0.018 ac-ft of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the Site 7 is 0.036 ac-ft. (Table 3). Data from the geotechnical report suggests that the natural percolation at this location can support the retained volume.

Preliminary Opinion of Probable Cost

SITE 7				
ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 800	1	\$ 800
Clearing and Grubbing	AC	\$ 5,000	0.1	\$ 500
Staked Silt Fence	LF	\$ 3	975	\$ 2,925
Floating Barrier	LF	\$ 8	0	\$ -
Excavation	CY	\$ 15	60	\$ 900
Embankment	CY	\$ 15	0	\$ -
Curb Cuts	EA	\$ 120	15	\$ 1,800
6"PVC pipe	LF	\$ 17	0	\$ -
Scarification	SY	\$ 2.50	250	\$ 625
Plantings	SY	\$ 3	250	\$ 750
Sod	SY	\$ 2.50	220	\$ 550
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 4,825	1	\$ 4,825
<i>Subtotal</i>				\$ 14,475
20% Contingency				\$ 2,895
Total Cost				\$ 17,370

SITE 8 (Figure 37)

Site 8 is located along the north and south side of 23rd Street at N. Tamiami Trail. The site was selected for the available space in the roadway right-of-way and because of the high visibility due to the proximity to N. Tamiami Trail.

The contributing roadway area for the Site 8 is approximately 0.12 acres requiring 0.005 ac-ft. of storage volume to retain the first half-inch of stormwater runoff. The potential treatment volume for the Site 8 is 0.009 ac-ft. (Table 3). Data from the geotechnical report suggest that the natural percolation at this location may not be able to support the retained volume. Additional investigation should be conducted. The site may be able to support an underdrain system that could be connected to the adjacent catch basin along N. Tamiami Trail. The connection would require a Drainage Connection Permit from FDOT.



Photograph 15. Site 8.

Preliminary Opinion of Probable Cost

SITE 8				
ITEM	UNITS	UNIT COST (\$)	QTY	COST (\$)
Mobilization	EA	\$ 800	1	\$ 800
Clearing and Grubbing	AC	\$ 5,000	0.05	\$ 250
Staked Silt Fence	LF	\$ 3	350	\$ 1,050
Floating Barrier	LF	\$ 8	0	\$ -
Excavation	CY	\$ 15	20	\$ 300
Embankment	CY	\$ 15	0	\$ -
Curb Cuts	EA	\$ 120	7	\$ 840
6"PVC pipe	LF	\$ 17	0	\$ -
Scarification	SY	\$ 2.50	60	\$ 150
Plantings	SY	\$ 3	60	\$ 180
Sod	SY	\$ 2.50	80	\$ 200
Temp Irrigation	LS	\$ 800	1	\$ 800
Final Design and Permitting	LS	\$ 5,000	1	\$ 5,000
<i>Subtotal</i>				\$ 9,570
20% Contingency				\$ 1,914
Total Cost				\$ 11,484



Indian Beach / Sapphire Shores (IBSS)
Stormwater LID Retrofit Pilot



SECTION 8

PUBLIC OUTREACH

8. PUBLIC OUTREACH

Involving residents who would be most affected by a project is critical to the success of that project. When residents understand how local projects can have a significant positive impact on a regional resource (such as Sarasota Bay), the residents are more likely to embrace those projects and even to participate in their long term maintenance (see for example Dietz, *et al.*, 2004 and Ferguson, 2004).

IBSS has a very active neighborhood association that has participated in outreach meetings held to measure their interest in incorporating stormwater improvements in their neighborhoods associated with a grant that New College staff obtained almost 10 years ago. Neighborhood support was positive for many of the stormwater improvement projects but due to lack of further funding, no structural changes were made to the stormwater management system. Staff did however produce an informational brochure for the residents and install signage adjacent to a major water basin that receives untreated stormwater to show the residents what they can do to reduce pollution entering the basin and ultimately Sarasota Bay. Because this current project will result in conceptual designs only and because there are no funds earmarked currently to implement the designs, WilsonMiller Stantec with the Sarasota Bay Estuary Program's concurrence decided that it would be premature to hold additional neighborhood meetings. We strongly recommend that such meetings be held before more detailed designs or construction plans are created.

Although we have not approached the neighbors for input, we have presented study objectives and preliminary results to and sought input from the North Trail Redevelopment Committee, New College Coastal Ecology Class, the Sarasota Bay Estuary Program's Management and Policy Committees which include representatives from the Southwest Florida Water Management District and the Florida Department of Environmental Protection, and the Science and Environment Council of Sarasota County.

SBEP and WilsonMiller Stantec staffs discussed the conceptual plans for the IBSS bio-swales and baffle boxes with local SWFWMD management staff in late November 2011. SWFWMD staff was open to the potential projects and suggested that the permitting requirements should be minimal. Submittals to SWFWMD would need to include phasing of the projects due to the multiple site locations spread over a significant area.



Indian Beach / Sapphire Shores (IBSS)
Stormwater LID Retrofit Pilot



SECTION 9

DEMONSTRATION PROJECT LIFT STATION NO. 9

9. DEMONSTRATION PROJECT – LIFT STATION No. 9

The City of Sarasota was constructing Lift Station No. 9 west of Bayshore Circle when a group of neighbors approached the City and asked whether minor flooding along that section of Bayshore Circle could be alleviated as part of the design on the lift station's property. The City agreed to construct grassed swales that would capture stormwater that typically ponded on the road and would route it into a nearby retention pond (that ultimately discharges to Sarasota Bay). Sarasota Bay Estuary Program and WilsonMiller Stantec staff heard about this project after the swales were constructed and approached the City about converting the grassed swales into bio-swales to serve as a demonstration LID project. The City agreed and following discussions with neighbors, representatives from the IBSS Beautification Committee and Sarasota Bay Estuary Program staff, WilsonMiller Stantec prepared a final plan that included a landscape design (Figure 40). The redesigned bio-swale was constructed and planted in October 2011 and responses from the neighbors have been positive.

The plant palette for the demonstration project at Lift Station No. 9 includes the plants shown on the Landscape Plant Palette (Figure 41). These plants are appropriate for use within the bio-swales conceptually designed in IBSS neighborhoods. A temporary irrigation system was installed to help establish the plants.

The following photographs show the progression of the Demonstration Project from the initial grassed swales that were installed, through the completion of the redesigned bio-swales.

The following series of photographs (16-19) were taken from the southeast corner of the property looking north at the two intersecting swales constructed based on the original design of the Lift Station No. 9.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 16. Original design looking north on the east side of the property where two swales intersected.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 17. Area re-graded to remove earthen berm between two swales and increase bio-swale area.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 18. Planting of the bio-swale including temporary irrigation system for establishing plants.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 19. Completed bio-swale two months after construction.

The following series of photographs (20-23) were taken from the southeast corner of the property looking northwest at the main swale constructed adjacent to the Lift Station No. 9 structure based on the original design. The City of Sarasota Utility Department took the opportunity to redesign the access to the lift station at the west and south sides of the building.

DEMONSTRATION PROJECT – LIFT STATION No. 9



Photograph 20. Original design looking northwest at main swale adjacent to structure.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 21. Area re-graded to stabilize side slopes; maximize bio-swale area; and improve access to lift station.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 22. Planting of the bio-swale including the temporary irrigation system to establish plants.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 23. Completed bio-swale three months after construction.

The following series of photographs (24-27) were taken from the northwest corner of the property looking southeast at the main swale constructed adjacent to the Lift Station No. 9 structure. Access to the lift station at the west and south sides of the building was improved.

DEMONSTRATION PROJECT – LIFT STATION No. 9



Photograph 24. Original design looking southeast with swale adjacent to structure.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 25. Area re-graded to stabilize side slopes; maximize bio-swale area; and improve access to lift station.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 26. Planting of the bio-swale including the temporary irrigation system to establish plants.

DEMONSTRATION PROJECT – LIFT STATION No. 9

Photograph 27. Completed bio-swale three months after construction.

SECTION 10

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10. LITERATURE CITED

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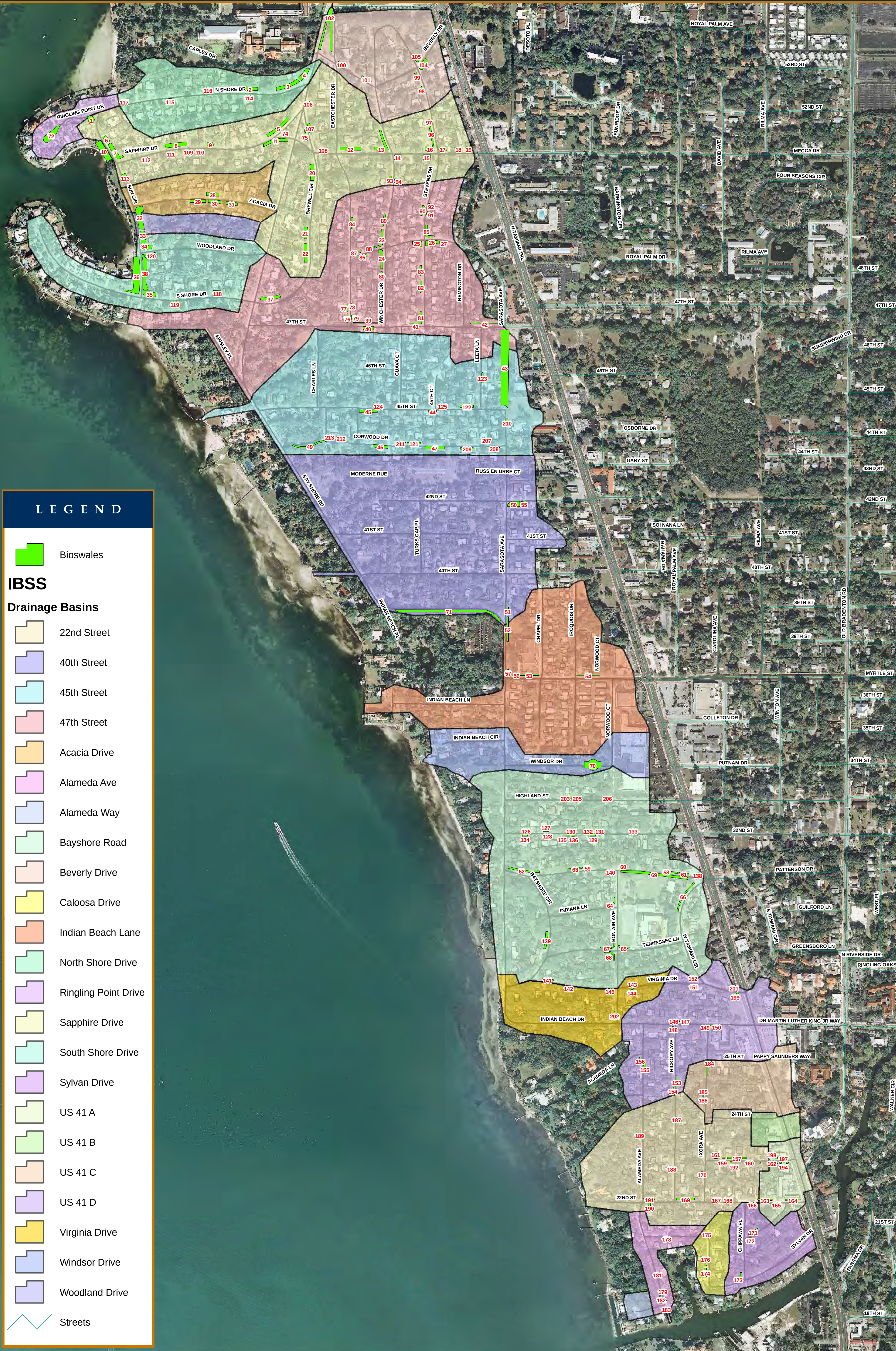
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SECTION 11

FIGURES*

*FIGURE 3 IS WITHIN THE TEXT, ON PAGE 3-3



LEGEND

Bioswales

IBSS

Drainage Basins

22nd Street

40th Street

45th Street

47th Street

Acacia Drive

Alameda Ave

Alameda Way

Bayshore Road

Beverly Drive

Caloosa Drive

Indian Beach Lane

North Shore Drive

Ringling Point Drive

Sapphire Drive

South Shore Drive

Sylvan Drive

US 41 A

US 41 B

US 41 C

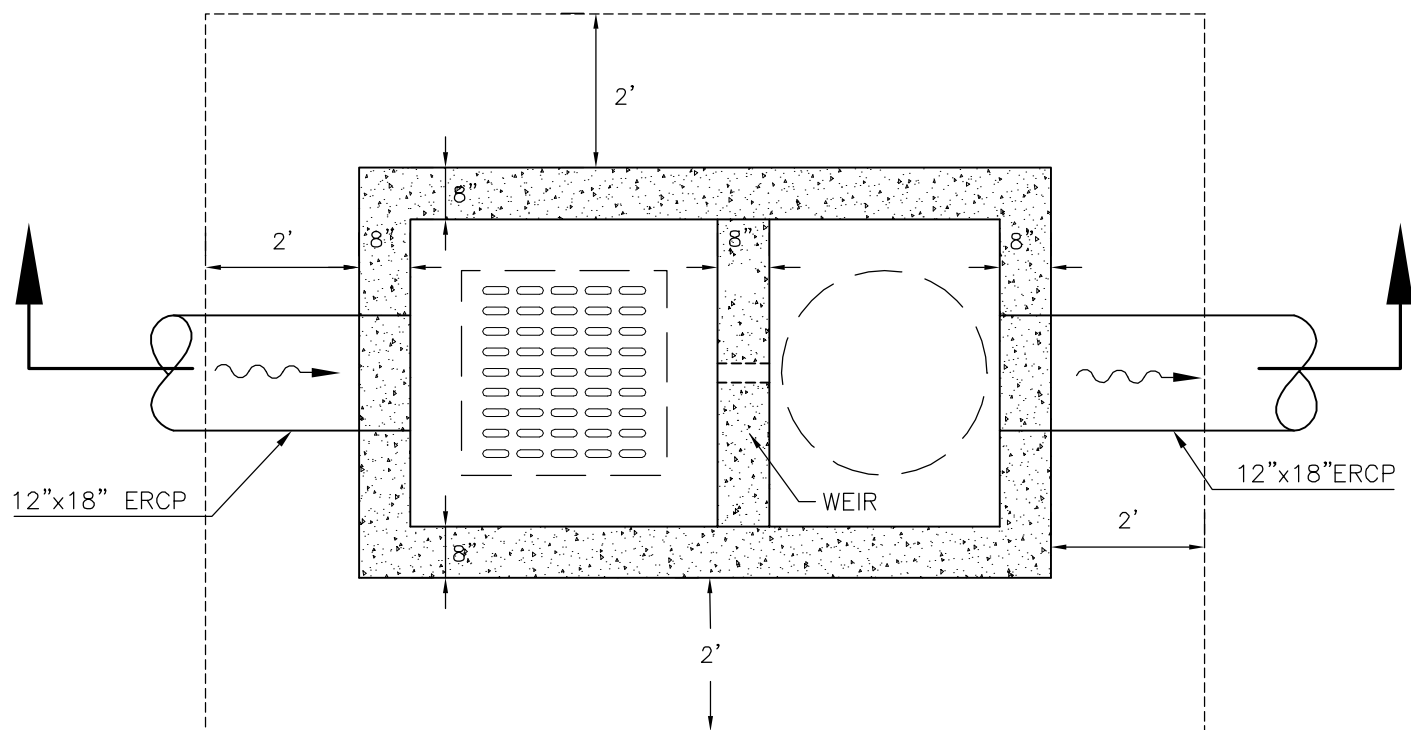
US 41 D

Virginia Drive

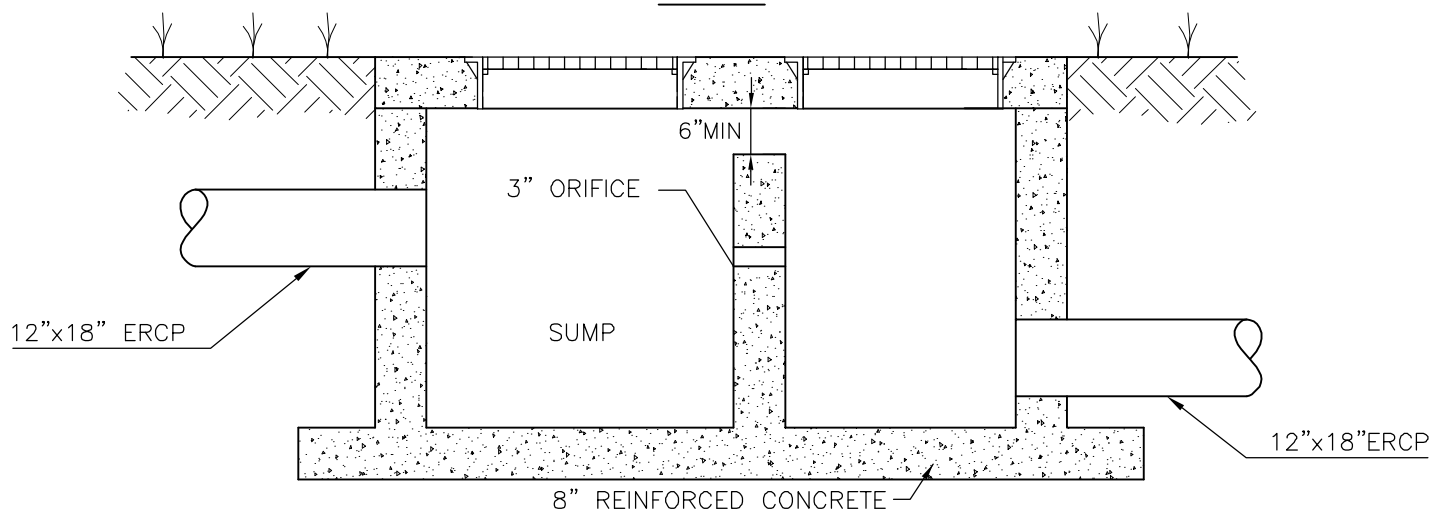
Windsor Drive

Woodland Drive

Streets



PLAN



NOTE:

SECTION

REFER TO F.D.O.T. STANDARD INDEX NO. 200 FOR CONCRETE REINFORCEMENT.

1. WALL THICKNESS SHALL NOT BE DECREASED.
2. PIPE LENGTH CALLOUT FROM CENTER OF INLET CHAMBER.
3. CAST-IN-PLACE STRUCTURAL DESIGN TO BE SUBMITTED TO ENGINEER OF RECORD PRIOR TO CONSTRUCTION.

BAFFLE BOX DETAIL

Figure 2

PROJECT: INDIAN BEACH / SAPPHIRE SHORES

CLIENT: SARASOTA BAY ESTUARY PROGRAM

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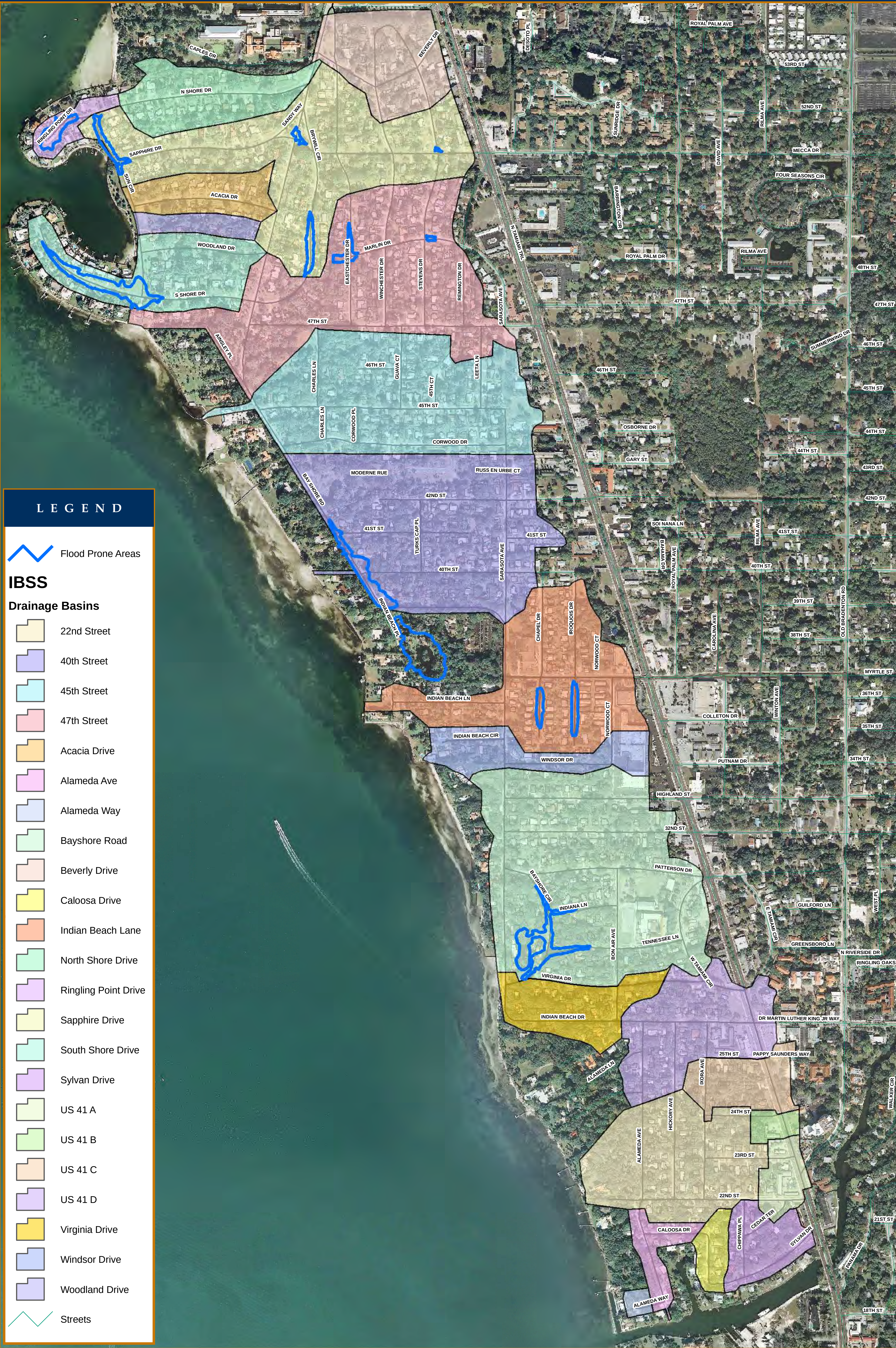
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FLORIDA LICENSE NO. 54281

SCALE:	N.T.S.	DATE:	JAN 2012
SEC:	TWP:	RGE:	REV NO:
PROJECT NO.	215510014	INDEX NO:	
DRWN BY/EMP NO.	SRJ	SHEET NO:	1 of 1



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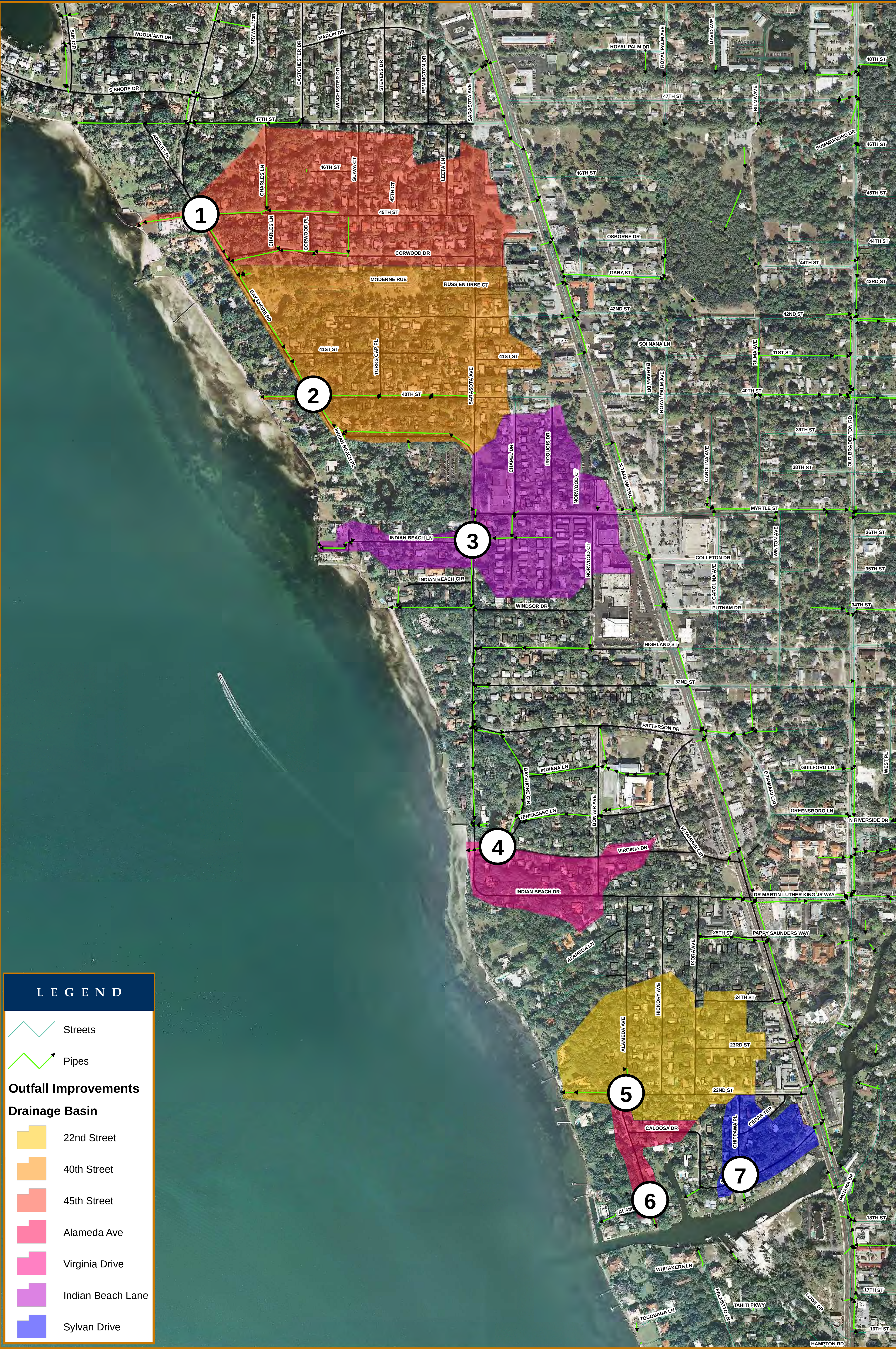
INDIAN BEACH / SAPPHIRE SHORES

Figure 4 - Flood Prone Areas
JANUARY 2012



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LEGEND

Streets

Pipes

Outfall Improvements

Drainage Basin

22nd Street

40th Street

45th Street

Alameda Ave

Virginia Drive

Indian Beach Lane

Sylvan Drive

INDIAN BEACH / SAPPHIRE SHORES

Figure 5 - Outfall Improvements
JANUARY 2012

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LEGEND

- Streets
- Bio-Retention
- Buildings
- Catchment
- Right-Of-Way

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BEVERLY DRIVE
 FIGURE 6 - POTENTIAL BIOSWALE SITES
 JANUARY 2012

N
 0 50 100 Feet
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LEGEND

Streets

Catchment

Buildings

Bio-Retention

Right-Of-Way

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NORTH SHORE DRIVE

FIGURE 7 - POTENTIAL BIOSWALE SITES

JANUARY 2012

N

0 50 100

Feet

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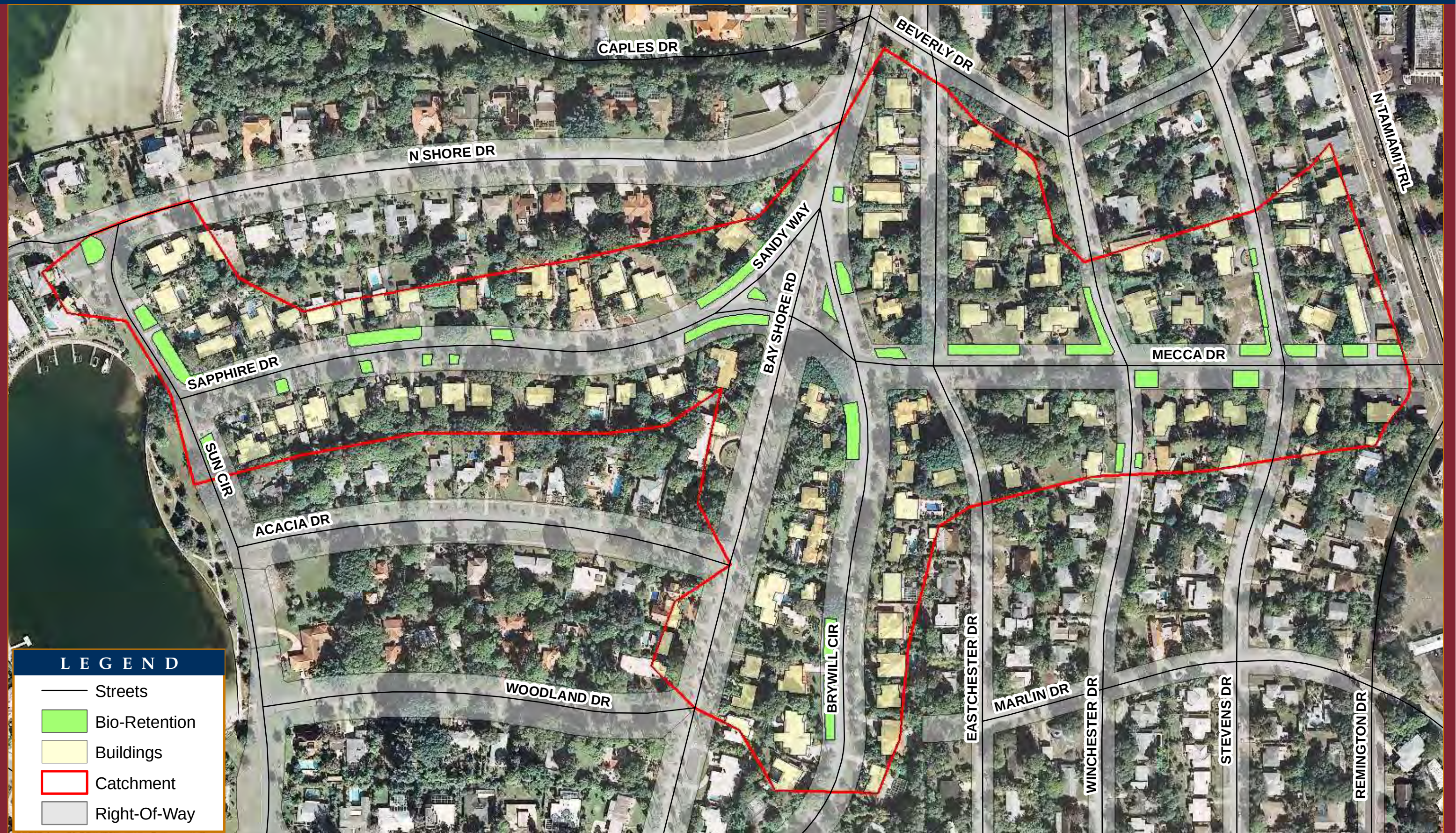
RINGLING POINT DRIVE

FIGURE 8 - POTENTIAL BIOSWALE SITES

JANUARY 2012

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N
0 30 60 Feet
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LEGEND

Streets

Bio-Retention

Buildings

Catchment

Right-Of-Way

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SAPPHIRE DRIVE

FIGURE 9 - POTENTIAL BIOSWALE SITES

JANUARY 2012

N

0 100 200

Feet

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LEGEND

- Streets
- Bio-Retention
- Buildings
- Catchment
- Right-Of-Way


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ACACIA DRIVE
 FIGURE 10 - POTENTIAL BIOSWALE SITES
 JANUARY 2012

N
 0 40 80 Feet

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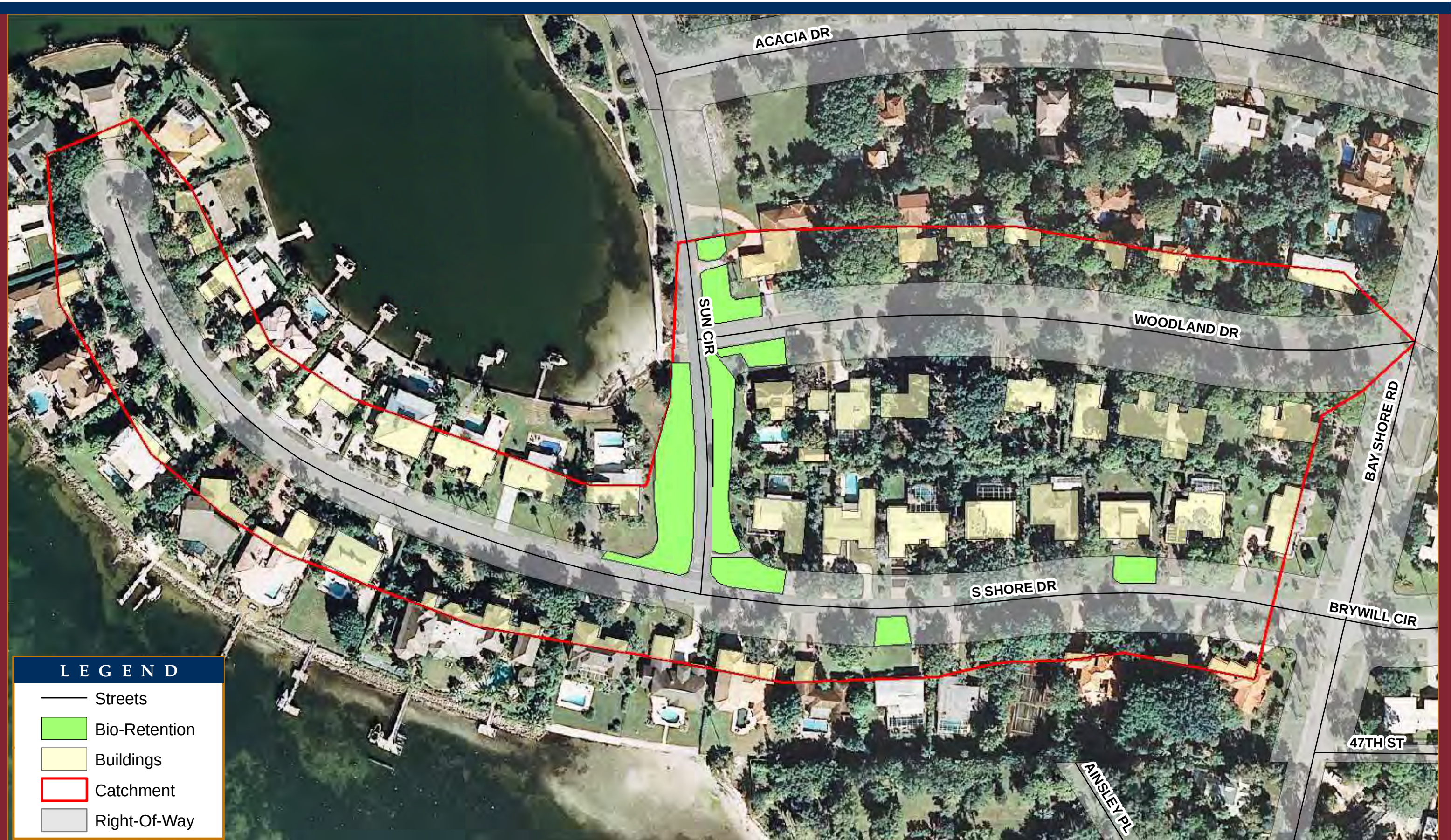
LEGEND

- Streets
- Bio-Retention
- Buildings
- Catchment
- Right-Of-Way

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WOODLAND DRIVE
FIGURE 11 - POTENTIAL BIOSWALE SITES
JANUARY 2012

  Feet
0 40 80
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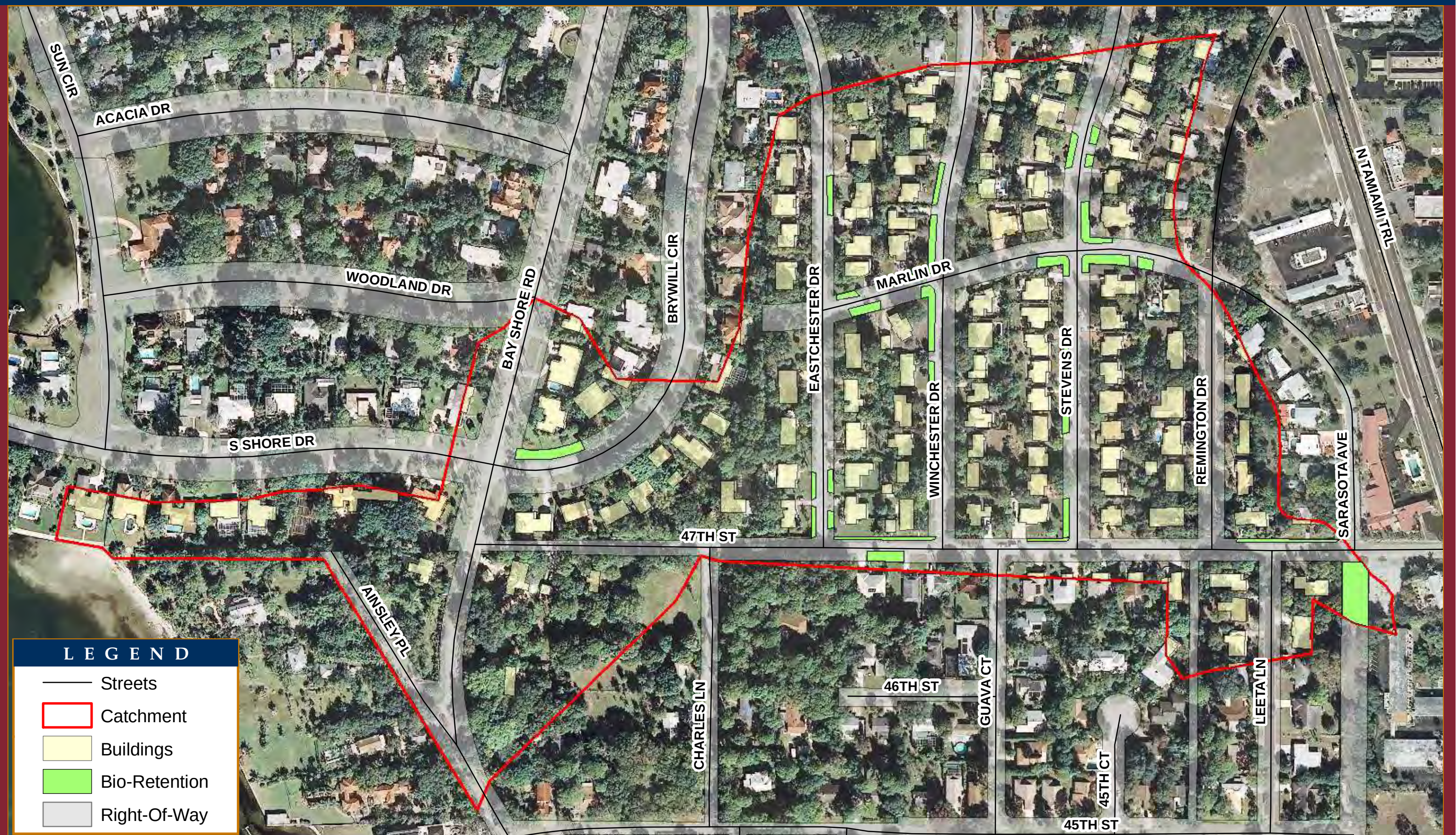
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SOUTH SHORE DRIVE
 FIGURE 12 - POTENTIAL BIOSWALE SITES
 JANUARY 2012

N

0 50 100 Feet

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LEGEND

Streets

Catchment

Buildings

Bio-Retention

Right-Of-Way



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47th STREET

FIGURE 13 - POTENTIAL BIOSWALE SITES

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N

0 100 200

Feet

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Catchment

Right-Of-Way

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45th STREET

FIGURE 14 - POTENTIAL BIOSWALE SITES

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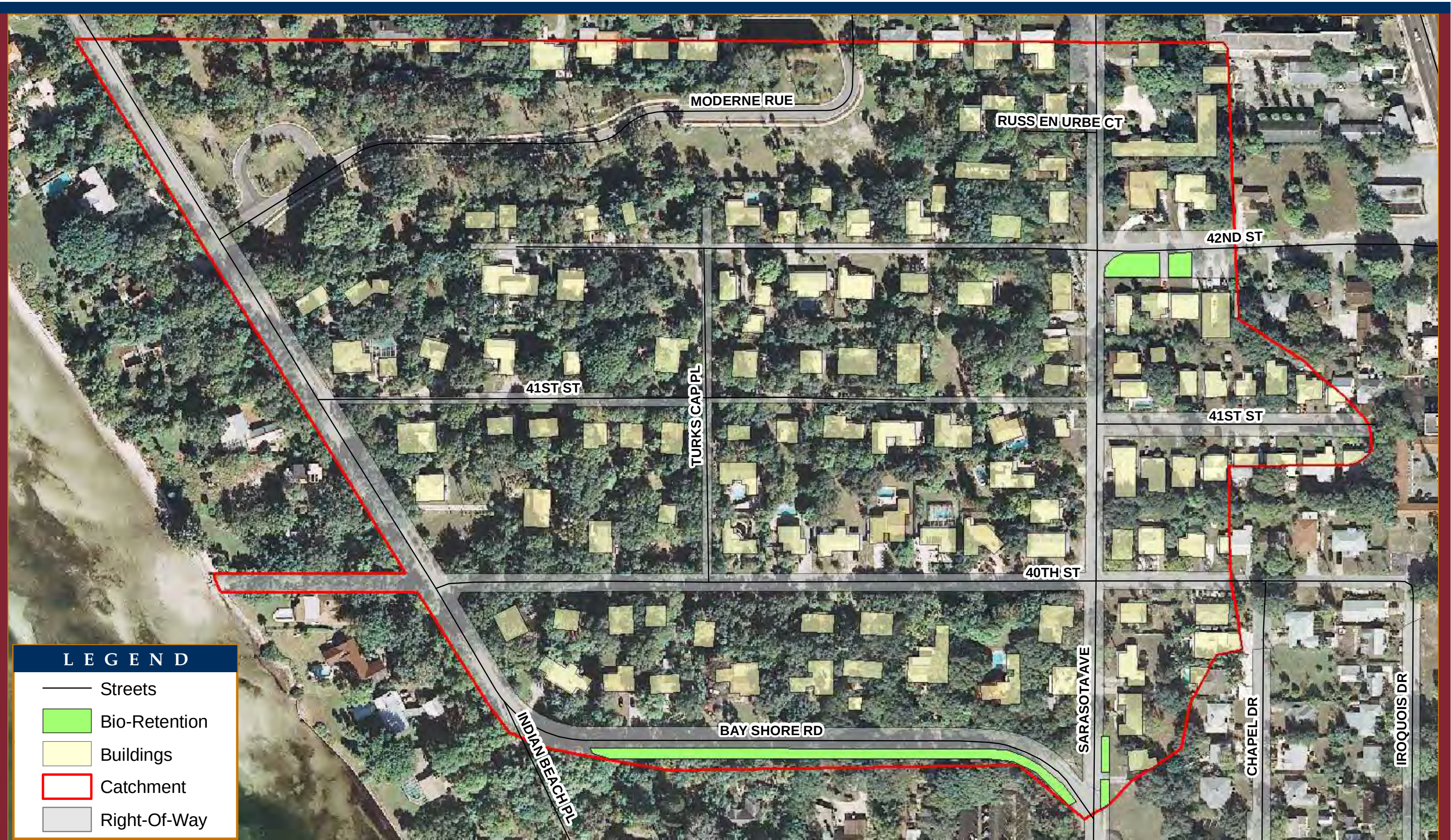
N

0 80 160

Feet

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LEGEND

- Streets
- Bio-Retention
- Buildings
- Catchment
- Right-Of-Way



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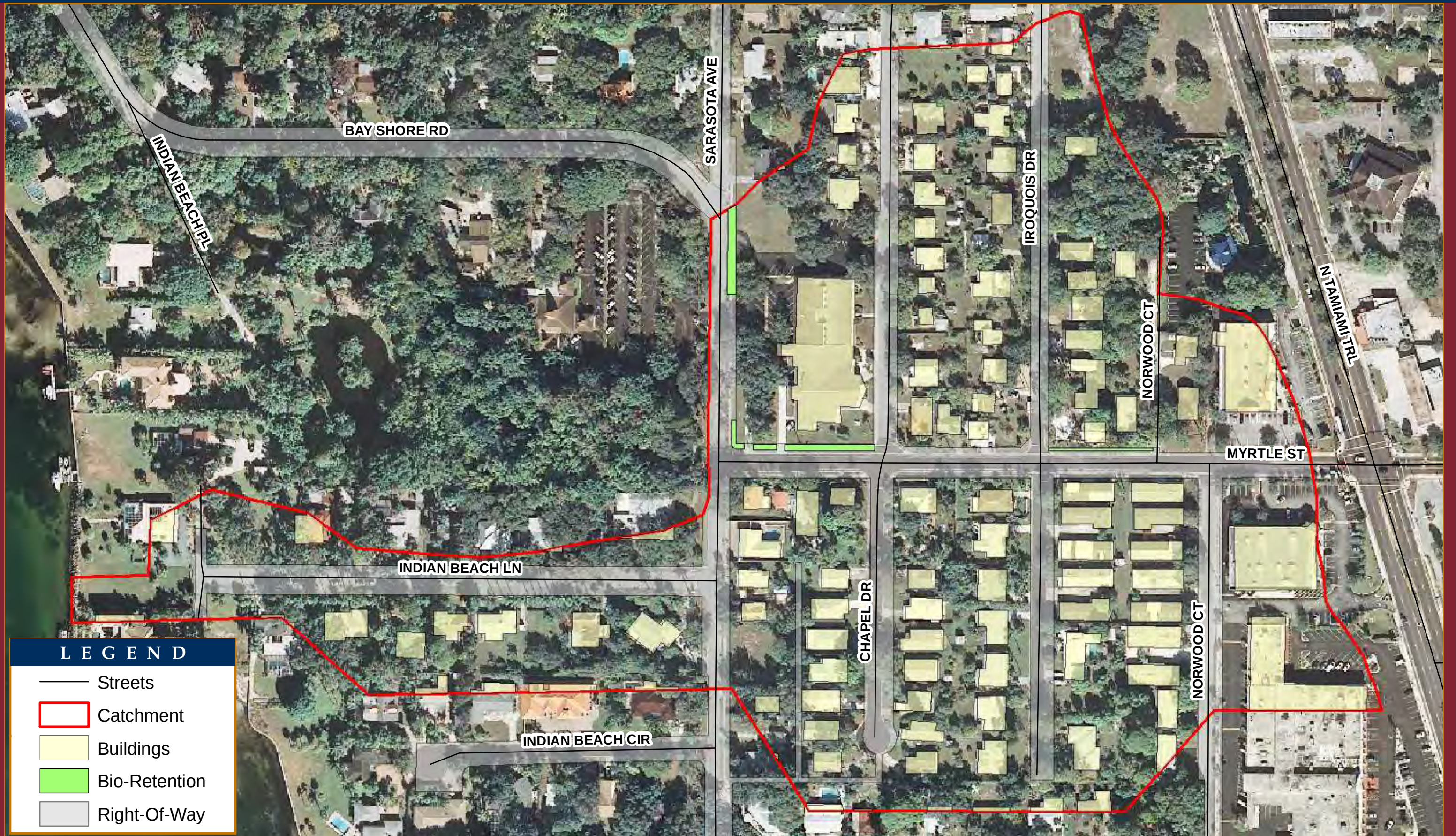
40th STREET

FIGURE 15 - POTENTIAL BIOSWALE SITES

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N
0 75 150 Feet
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INDIAN BEACH LANE

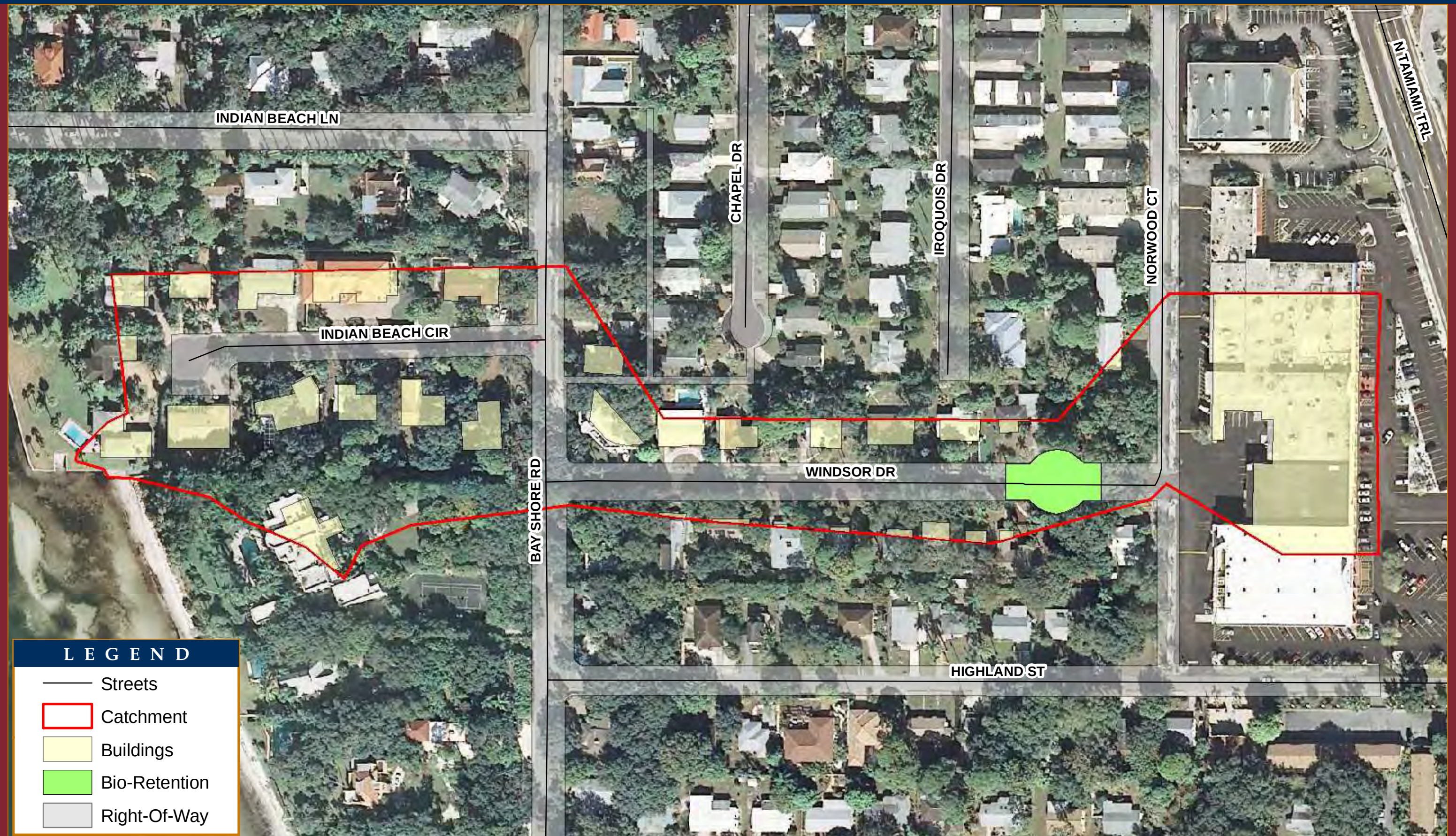
FIGURE 16 - POTENTIAL BIOSWALE SITES

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0 100 200
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LEGEND

- Streets
- Catchment
- Buildings
- Bio-Retention
- Right-Of-Way



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WINDSOR DRIVE

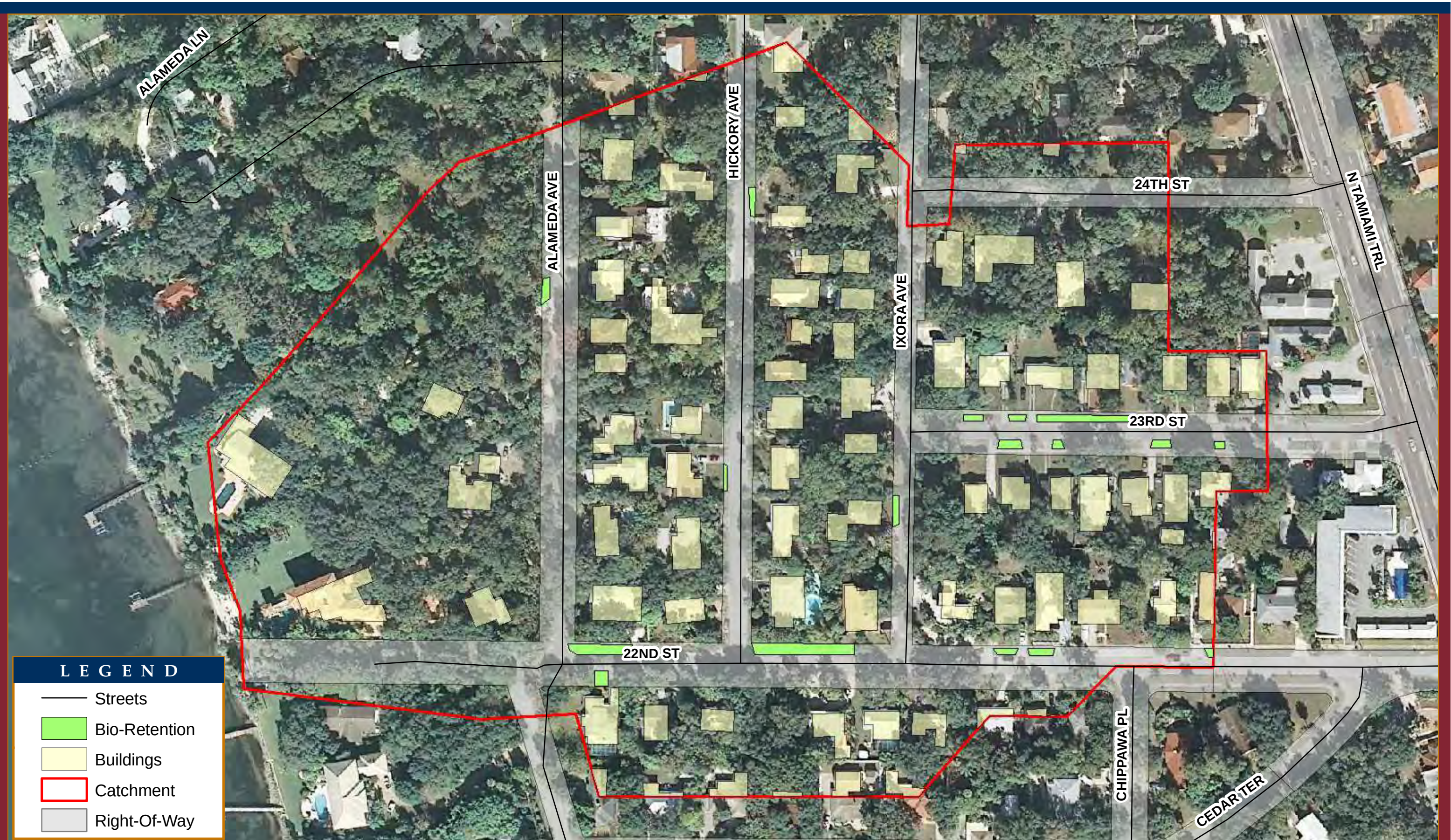
FIGURE 17 - POTENTIAL BIOSWALE SITES

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0 60 120 Feet
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Bio-Retention

Buildings

Catchment

Right-Of-Way

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22nd STREET

FIGURE 18 - POTENTIAL BIOSWALE SITES

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N

0 60 120

Feet

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BAYSHORE ROAD

FIGURE 19 - POTENTIAL BIOSWALE SITES

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N
0 100 200 Feet
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Bio-Retention

Buildings

Catchment

Right-Of-Way

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VIRGINIA DRIVE

FIGURE 20 - POTENTIAL BIOSWALE SITES

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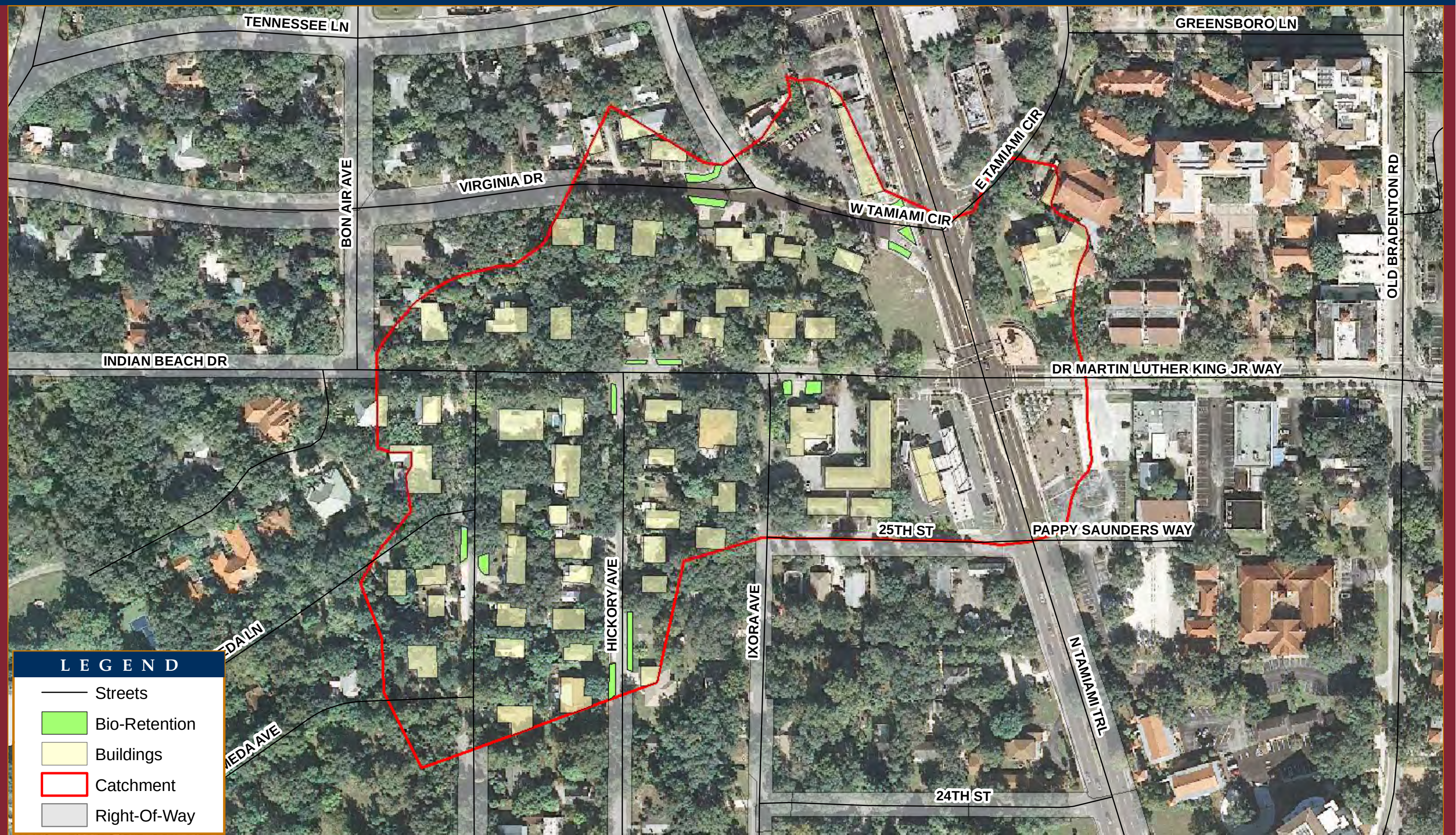
N

0 50 100

Feet

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LEGEND

- Streets
- Bio-Retention
- Buildings
- Catchment
- Right-Of-Way

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US 41 - AREA D
FIGURE 21 - POTENTIAL BIOSWALE SITES
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N
 0 75 150 Feet
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LEGEND

Streets

Bio-Retention

Buildings

Catchment

Right-Of-Way



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US 41 - AREA C

FIGURE 22 - POTENTIAL BIOSWALE SITES

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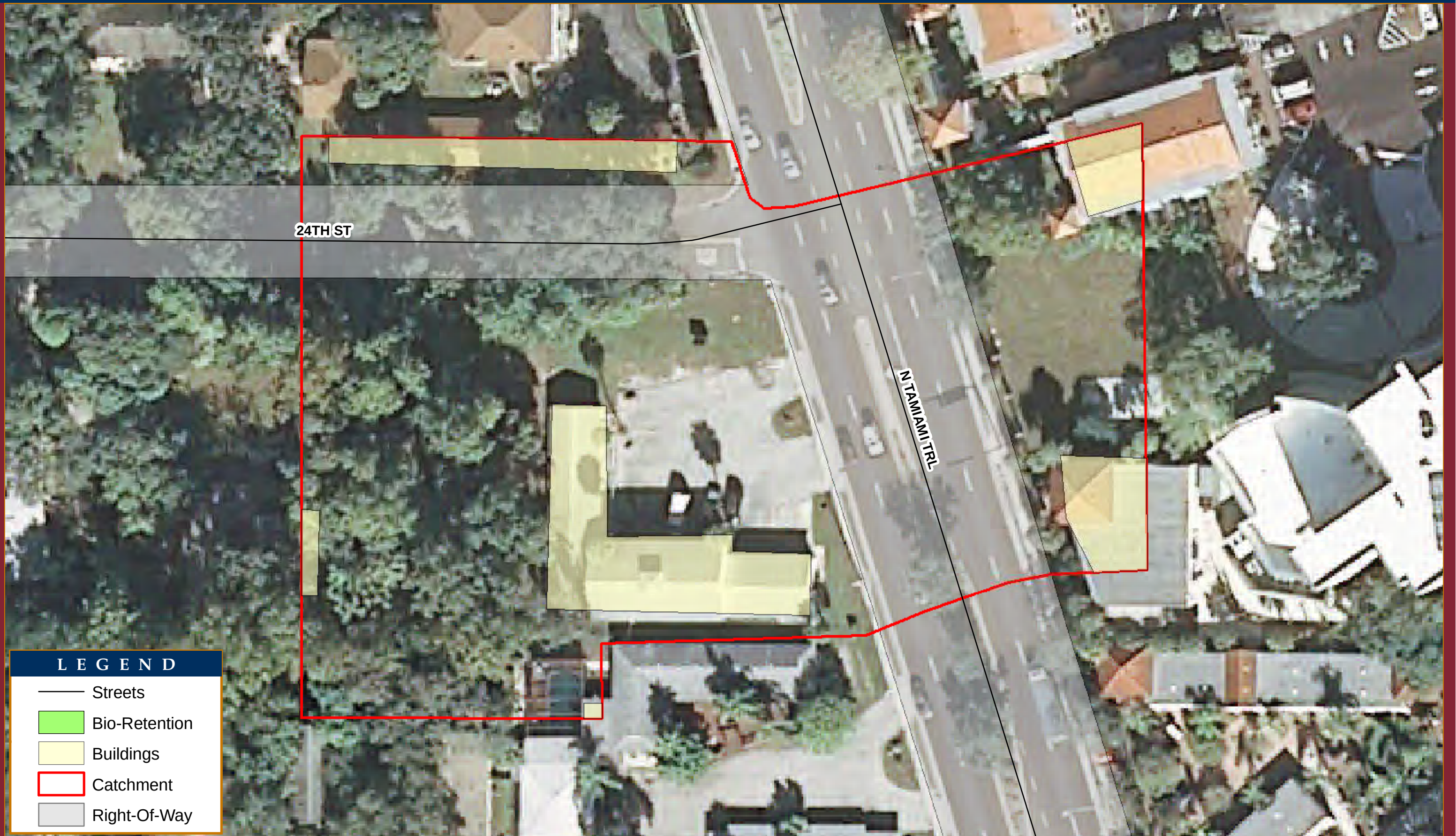
N

0 40 80

Feet

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US 41 - AREA B

FIGURE 23 - POTENTIAL BIOSWALE SITES

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0 20 40 Feet
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LEGEND

Streets

Bio-Retention

Buildings

Catchment

Right-Of-Way

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US 41 - AREA A
FIGURE 24 - POTENTIAL BIOSWALE SITES
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N

0 40 80 Feet

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LEGEND

- Streets
- Bio-Retention
- Buildings
- Catchment
- Right-Of-Way



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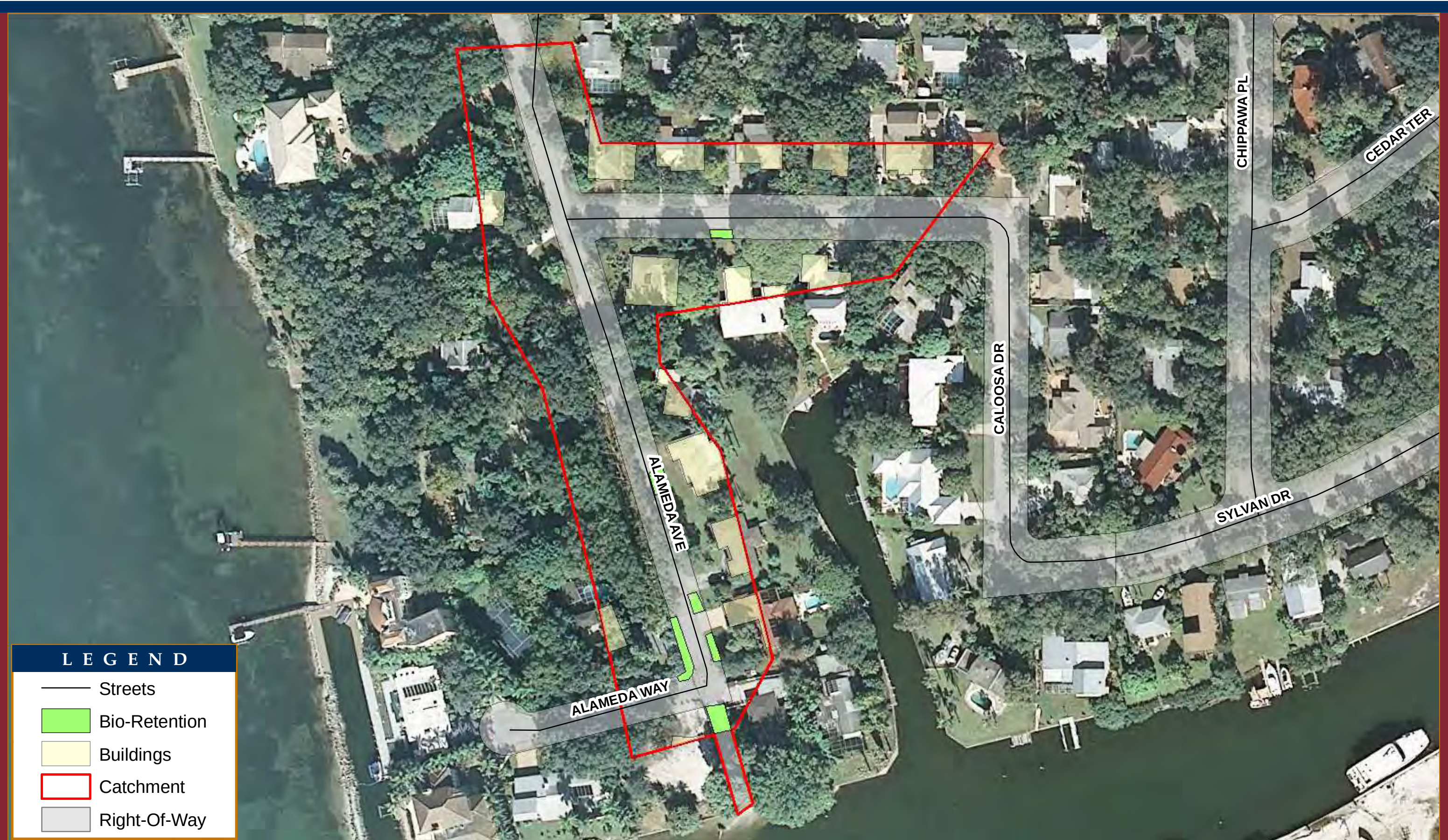
ALAMEDA WAY

FIGURE 25 - POTENTIAL BIOSWALE SITES
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0 20 40 Feet
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LEGEND

Streets

Bio-Retention

Buildings

Catchment

Right-Of-Way

Stantec

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ALAMEDA AVENUE

FIGURE 26 - POTENTIAL BIOSWALE SITES

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N

050100

Feet

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LEGEND

Streets

Bio-Retention

Buildings

Catchment

Right-Of-Way

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CALOOSA DRIVE

FIGURE 27 - POTENTIAL BIOSWALE SITES

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N

0 40 80

Feet

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LEGEND

Streets

Bio-Retention

Buildings

Catchment

Right-Of-Way

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SYLVAN DRIVE

FIGURE 28 - POTENTIAL BIOSWALE SITES

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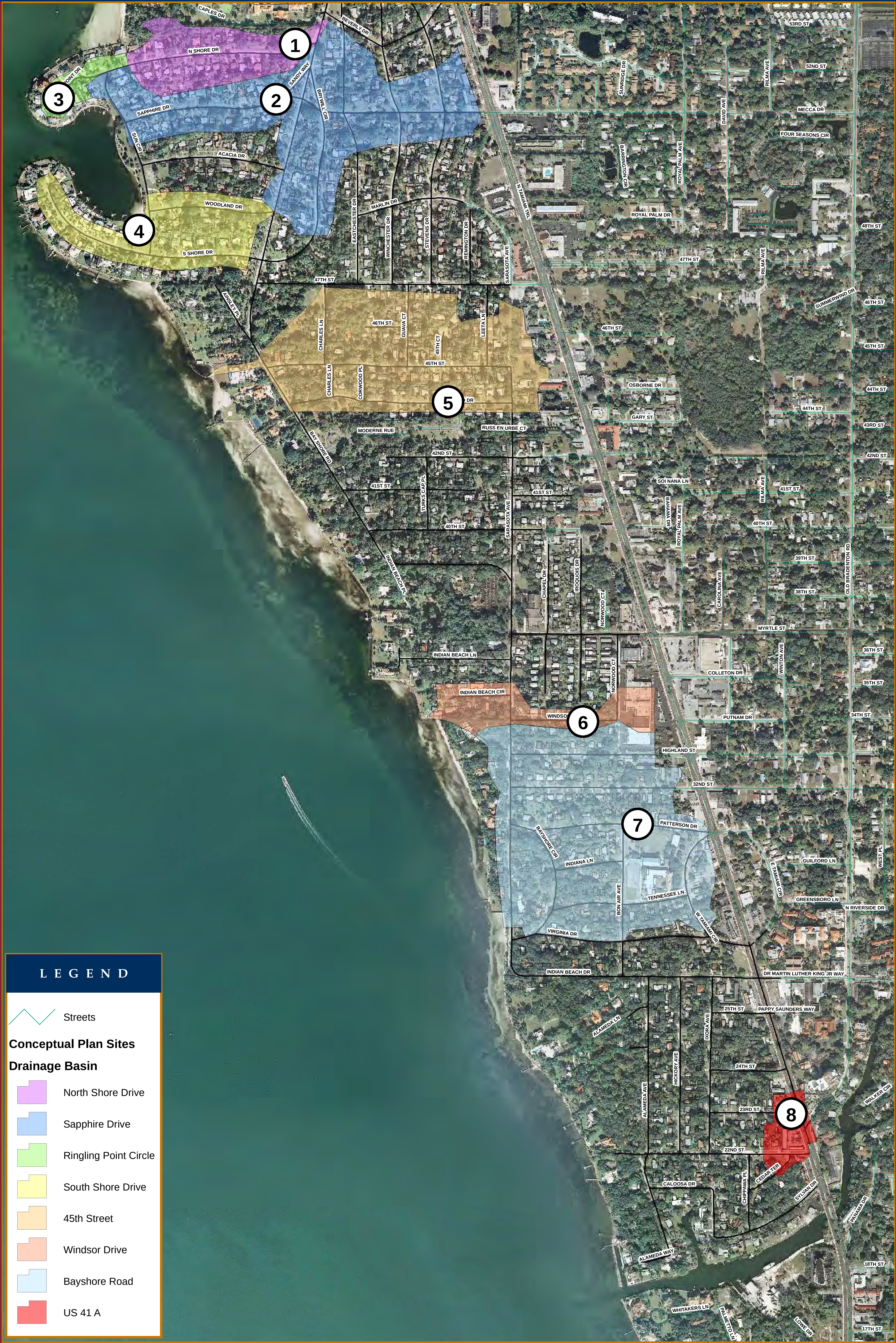
N

0 50 100

Feet

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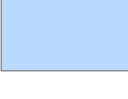
LEGEND

 Streets

Conceptual Plan Sites

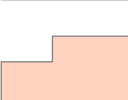
Drainage Basin

 North Shore Drive

 Sapphire Drive

 Ringling Point Circle

 South Shore Drive

 45th Street

 Windsor Drive

 Bayshore Road

 US 41 A

INDIAN BEACH / SAPPHIRE SHORES

Figure 29 - Conceptual Plan Sites
JANUARY 2012

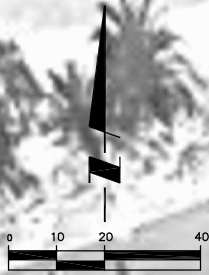
© WilsonMiller Stantec 2010. Saved: 1/18/2012 5:09:38 PM. MKIRKLAND | Plotted: 1/18/2012 5:11:29 PM. MKIRKLAND | V:\2155\active\215510014\transportation\drawing\concept\bio-swale-design\concept\bio-swale-10014TR-002.dwg\Layout



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						ISSUE DESCRIPTION:		PROJ:	INDIAN BEACH / SAPPHIRE SHORES	HORIZ. SCALE:	1"=40'			INDEX NO.:	215510014TR-002
								LEAD DESIGNER:		VERT. SCALE:	N/A			CROSS REF. NUMBER:	
														PROJECT NUMBER:	215510014
															SHEET NO.:
	ΔREV NO.	REVISION DESCRIPTION		REV. DATE	DRN BY/EMP. #	SEC-TWP-RGE	LEAD TECHNICIAN:								

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					ISSUE DESCRIPTION:		PROJ:	INDIAN BEACH / SAPPHIRE SHORES		HORIZ. SCALE: 1"=40'		INDEX NO.: 215510014TR-003
					LEAD DESIGNER:				VERT. SCALE: N/A	CROSS REF. NUMBER:		SHEET NO.: 3
					LEAD TECHNICIAN:					PROJECT NUMBER: 215510014		
ΔREV NO.	REVISION DESCRIPTION	REV. DATE	DRN BY/EMP. #	SEC-TWP-RGE								



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					ISSUE DESCRIPTION:		SARASOTA BAY ESTUARY PROGRAM	08/10			
					LEAD DESIGNER:		INDIAN BEACH / SAPPHIRE SHORES	1"=40'			
REV. NO.	REVISION DESCRIPTION	REV. DATE	DRN BY/EMP. #	SEC-TWP-RGE	LEAD TECHNICIAN:			VERT. SCALE:	CROSS REF. NUMBER:	PROJECT NUMBER:	SHEET NO.:
								N/A		215510014	4

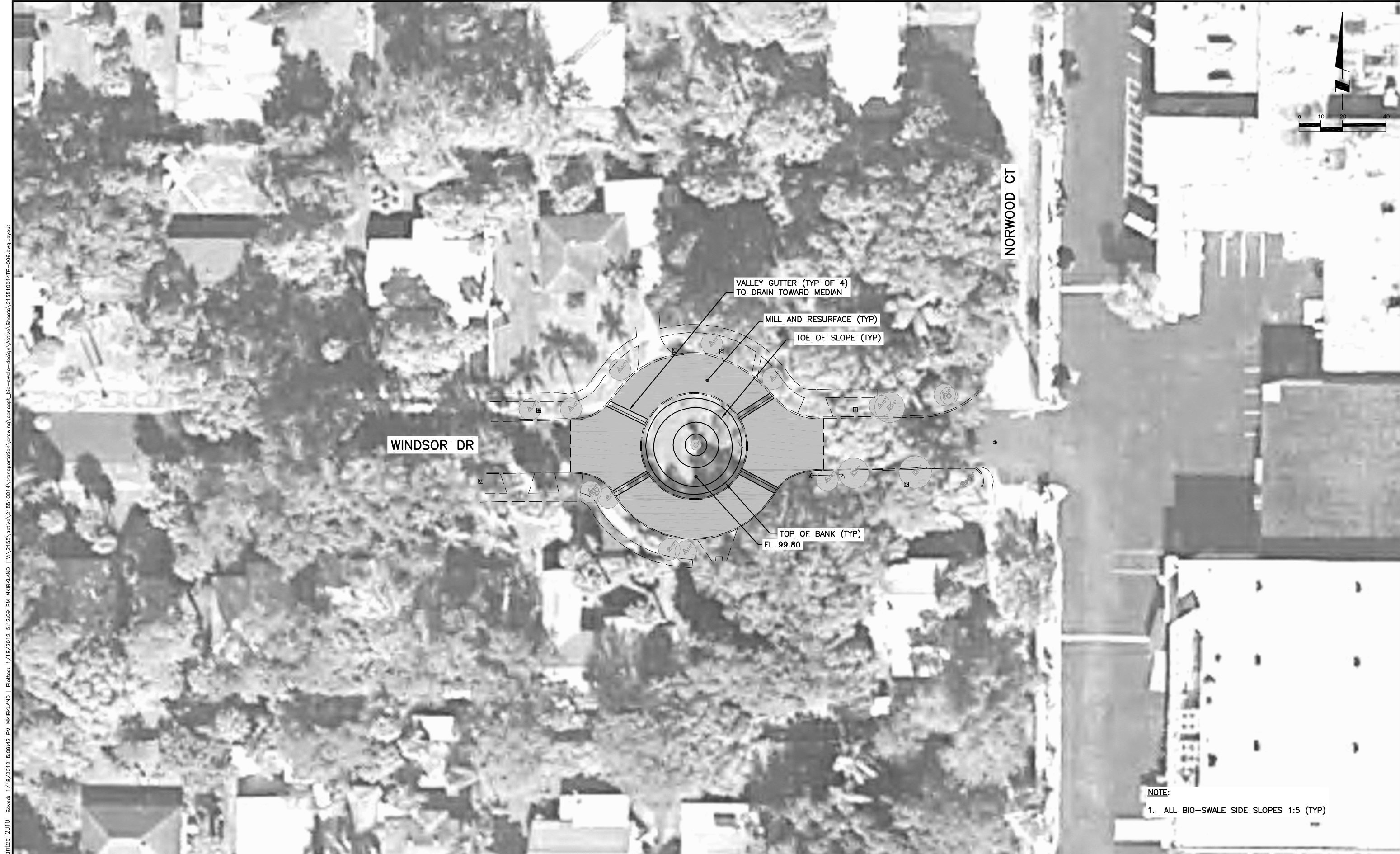
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					ISSUE DESCRIPTION:				HORIZ. SCALE: 1"=40'	INDEX NO.: 215510014TR-005					
					LEAD DESIGNER:				VERT. SCALE: N/A				CROSS REF. NUMBER:	PROJECT NUMBER: 215510014	SHEET NO.: 5
					LEAD TECHNICIAN:				INDIAN BEACH / SAPPHIRE SHORES						
ΔREV NO.	REVISION DESCRIPTION	REV. DATE	DRN BY/EMP. #	SEC-TWP-RGE											



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						ISSUE DESCRIPTION:		PROJ:	INDIAN BEACH / SAPPHIRE SHORES		HORIZ. SCALE: 1" = 40'			INDEX NO.: 215510014TR-006
						LEAD DESIGNER:				VERT. SCALE: N/A				
						LEAD TECHNICIAN:								
		ΔREV NO.	REVISION DESCRIPTION		REV. DATE	DRN BY/EMP. #		SEC-TWP-RGE				CROSS REF. NUMBER:	PROJECT NUMBER: 215510014	SHEET NO.: 6

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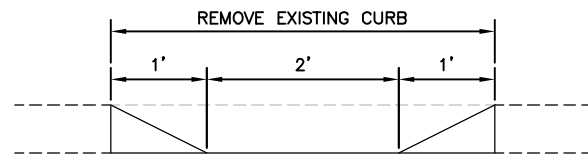
				CO.	ISSUE DATE: DECEMBER 2011	WilsonMiller Stantec New Directions In Planning, Design & Engineering. Since 1956. 6900 Professional Parkway East, Suite 100 Sarasota, FL 34240-8414 800.643.4336 • 941.907.8900 • F 941.907.8910 • www.WilsonMiller.com WilsonMiller, Inc. • Certificate of Authorization #43 • FL Lic. # LC-C000170	CLIENT:	SARASOTA BAY ESTUARY PROGRAM	START DATE:	CONCEPTUAL BIO-SWALE DESIGN		MOLLY CHARLENE WILLIAMS, P.E. FLORIDA LICENSE NO. 54281
					ISSUE DESCRIPTION:		PROJ:	INDIAN BEACH / SAPPHIRE SHORES	HORIZ. SCALE:	SITE #7		
					LEAD DESIGNER:				1"=40'	FIGURE 36		
					LEAD TECHNICIAN:				VERT. SCALE:	INDEX NO.: 215510014TR-007		
ΔREV NO.	REVISION DESCRIPTION	REV. DATE	DRN BY/EMP. #	SEC-TWP-RGE				N/A	CROSS REF. NUMBER:	PROJECT NUMBER:	SHEET NO.:	
										215510014	7	

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						ISSUE DESCRIPTION:		PROJ:	INDIAN BEACH / SAPPHIRE SHORES	HORIZ. SCALE:	1"=40'		
						LEAD DESIGNER:				VERT. SCALE:	N/A		
						LEAD TECHNICIAN:				CROSS REF. NUMBER:	PROJECT NUMBER:		
	ΔREV NO.	REVISION DESCRIPTION	REV. DATE	DRN BY/EMP. #	SEC-TWP-RGE						215510014		

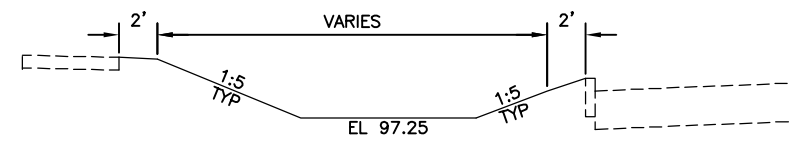


CURB CUT DETAIL

N.T.S.

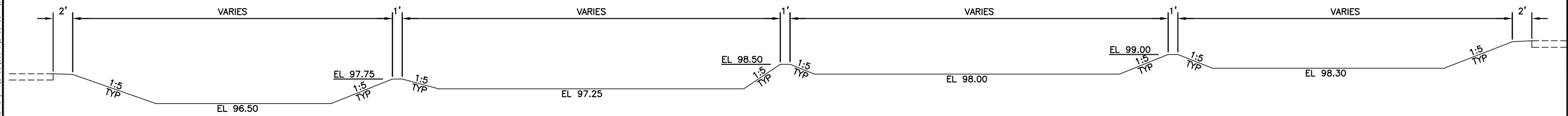
GENERAL NOTES:

1. MAINTAIN 2 FT GRASS STRIP BETWEEN HARD EDGE (SIDEWALK, DRIVEWAY, EDGE OF PAVEMENT, OR BACK OF CURB) BEFORE STARTING 5:1 SLOPE (TYP)
2. NEED DEPTH OF APPROXIMATELY 9 INCHES OF SLOPE, 3.50 FT TO 3.75 FT ACCEPTABLE.
3. SLOPE AT BOTTOM OF BIO--RETENTION CAN BE EQUAL TO SLOPE AT FACE OF CURB, OR EDGE OF PAVEMENT.



TYPICAL SECTION A-A

N.T.S.



TYPICAL SECTION B-B

N.T.S.

[illegible]

Bioswale Trees



'Swamp Fern'
4'-5' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Soft Rush'
1'-2' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Redroot'
1'-2' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Saw Palmetto'
6' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Cordgrass'
4'-6' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Fakahatchee Grass'
5'-6' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Red Maple'
40'-50' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Wax Myrtle'
20' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Bald Cypress'
60'-70' Ht. Approx.

Hydrophytic Needs/Tolerance Level

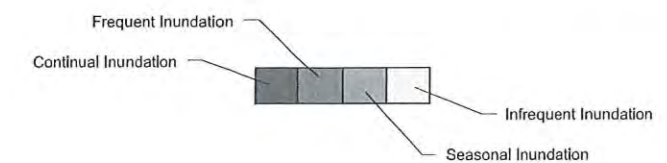


Up to 60' Ht. Approx.
'Cabbage Palm'

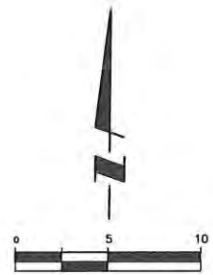
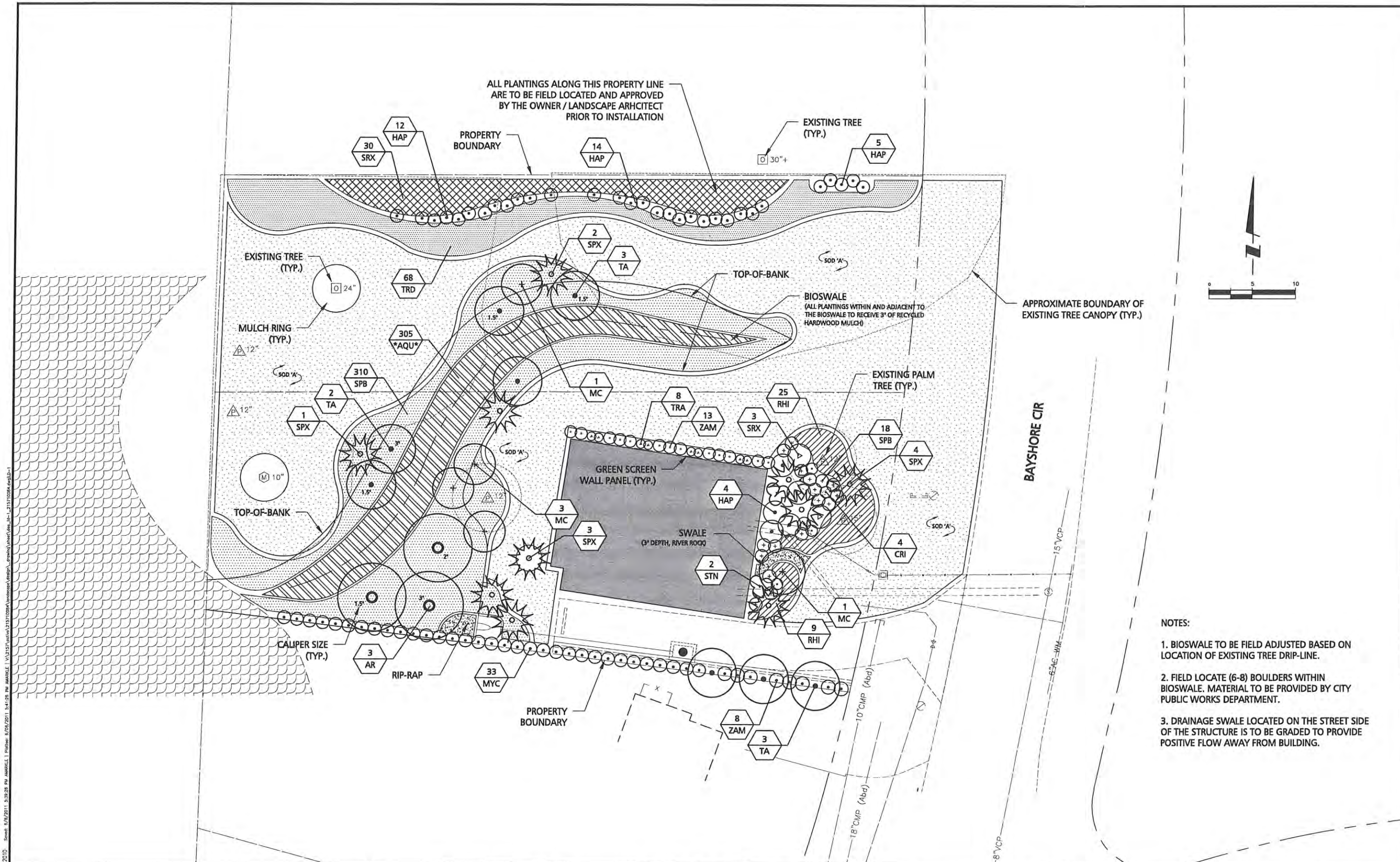
Hydrophytic Needs/Tolerance Level



Hydrophytic Needs / Tolerance Level Key



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- NOTES:
1. BIOSWALE TO BE FIELD ADJUSTED BASED ON LOCATION OF EXISTING TREE DRIP-LINE.
 2. FIELD LOCATE (6-8) BOULDERS WITHIN BIOSWALE. MATERIAL TO BE PROVIDED BY CITY PUBLIC WORKS DEPARTMENT.
 3. DRAINAGE SWALE LOCATED ON THE STREET SIDE OF THE STRUCTURE IS TO BE GRADED TO PROVIDE POSITIVE FLOW AWAY FROM BUILDING.

REV. NO. REVISION DESCRIPTION	REV. DATE DRAWN BY / EMP. NO. SEC.-TRIP-RGE	DATE: 06.08.2011 FOR REVIEW AND APPROVAL NOT ISSUED FOR CONSTRUCTION LEAD DESIGNER: LEAD TECHNICIAN:	WilsonMiller Stantec New Directions in Planning, Design & Engineering. Since 1956. 6900 Professional Parkway East, Suite 100 Sarasota, FL 34240-8414 800.643.4336 • 941.907.6900 • F&E 1.907.6910 • www.WilsonMiller.com WilsonMiller, Inc. • Certificate of Authorization #43 • FL Lic. # LC-C000170	CLIENT: CITY OF SARASOTA PROJECT: LIFT STATION #9 LANDSCAPE	PROJ. START DATE: 4/11 HORIZONTAL SCALE: AS SHOWN VERTICAL SCALE: N/A Copyright WilsonMiller Stantec	TITLE: LANDSCAPE PLANTING PLAN FIGURE 40	SCOTT A. BUTTARI, L.A. FLORIDA LICENSE NO. 1756 PROJECT NUMBER: 215710084-001 SHEET NUMBER: LD-1
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'Golden Canna'
4' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Soft Rush'
1'-2' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Redroot'
1'-2' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Cordgrass'
4'-6' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Wax Myrtle'
20' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Bald Cypress'
60'-70' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Red Maple'
40'-50' Ht. Approx.

Hydrophytic Needs/Tolerance Level



'Queen Emma Crinum Lily'
3'-4' Ht. Approx.



'Dwarf Firebush'
4'-5' Ht. Approx.



'Indian Princess' Indian Hawthorn'
3'-4' Ht. Approx.



'Saw Palmetto'
6' Ht. Approx.



'White Bird of Paradise'
12" Ht. Approx.



'Confederate Jasmine'
2'-3' Ht. Approx. (Green Screen Wall Panel)



'Fakahatchee Grass'
5'-6' Ht. Approx.

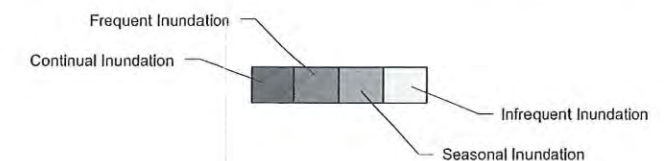


'Coontie'
4' Ht. Approx.



Up to 60' Ht. Approx.
'Cabbage Palm'

Hydrophytic Needs / Tolerance Level Key



WILSONMILLER STARTER 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 	
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SECTION 12

TABLES

Indian Beach / Sapphire Shores
Drainage Basin Analysis

Drainage Basin	Drainage Basin ACRES	Right-Of-Way ACRES	Centerline Length, FT	Roadway Impervious ACRES	Building Impervious ACRES	Percent of Drainage Basin that is Impervious
22nd Street	24.10	4.68	4088	2.25	3.56	24.1%
40th Street	44.47	6.44	8211	4.52	6.02	23.7%
45th Street	40.01	8.28	7157	3.94	6.66	26.5%
47th Street	44.91	12.14	9144	5.04	6.76	26.3%
Acacia Drive	7.85	2.80	1317	0.73	1.18	24.3%
Alameda Ave	4.29	1.28	1256	0.69	0.53	28.6%
Alameda Way	0.91	0.16	127	0.07	0.12	21.0%
Bayshore Road	55.15	12.09	10102	5.57	9.02	26.5%
Beverly Drive	14.71	4.26	3539	1.95	1.71	24.9%
Caloosa Drive	3.13	0.71	560	0.31	0.58	28.4%
Indian Beach Lane	29.38	5.38	5618	3.10	5.97	30.9%
North Shore Drive	13.16	3.58	1638	0.90	1.98	21.9%
Ringling Point Drive	3.18	0.86	639	0.35	0.48	26.1%
Sapphire Drive	42.30	15.54	8603	4.74	6.35	26.2%
South Shore Drive	16.77	6.21	3219	1.77	2.47	25.3%
Sylvan Drive	7.02	2.09	1747	0.96	0.86	26.0%
US 41 A	4.28	1.76	1251	0.69	0.66	31.5%
US 41 B	1.90	0.54	429	0.24	0.24	24.8%
US 41 C	7.64	1.46	1356	0.75	0.97	22.4%
US 41 D	19.17	4.79	4427	2.44	2.95	28.1%
Virginia Drive	10.59	2.65	2290	1.26	1.47	25.8%
Windsor Drive	9.80	2.00	1860	1.02	2.55	36.5%
Woodland Drive	3.40	0.26	180	0.10	0.51	18.1%

Indian Beach / Sapphire Shores
Potential Treatment Calculations

Drainage Basin	Centerline Length, FT	Roadway Impervious ACRES	Bio-Retention area, ACRES	Potential Treatment Volume, AC-FT	Desired Treatment Volume for Roadway Impervious, AC-FT			Potential Percentage of Treatment Volume for Roadway Impervious		
					1.5 inches of runoff	1.0 inches of runoff	0.5 inches of runoff	1.5 inches of runoff	1.0 inches of runoff	0.5 inches of runoff
22nd Street	4088	2.25	0.19	0.07	0.28	0.19	0.09	26.4%	39.6%	79.2%
40th Street	8211	4.52	0.47	0.21	0.57	0.38	0.19	36.3%	54.4%	108.9%
45th Street	7157	3.94	1.13	0.51	0.49	0.33	0.16	103.2%	154.8%	309.6%
47th Street	9144	5.04	0.98	0.42	0.63	0.42	0.21	66.7%	100.1%	200.2%
Acacia Drive	1317	0.73	0.26	0.12	0.09	0.06	0.03	131.0%	196.5%	392.9%
Alameda Ave	1256	0.69	0.06	0.02	0.09	0.06	0.03	26.5%	39.7%	79.5%
Alameda Way	127	0.07			0.01	0.01	0.00			
Bayshore Road	10102	5.57	0.81	0.33	0.70	0.46	0.23	47.8%	71.7%	143.5%
Virginia Drive	2290	1.26	0.06	0.02	0.16	0.11	0.05	15.6%	23.4%	46.8%
Beverly Drive	3539	1.95	0.39	0.17	0.24	0.16	0.08	69.6%	104.4%	208.9%
Caloosa Drive	560	0.31	0.04	0.02	0.04	0.03	0.01	43.0%	64.5%	129.1%
Indian Beach Lane	5618	3.10	0.13	0.05	0.39	0.26	0.13	12.9%	19.4%	38.8%
Windsor Drive	1860	1.02	0.18	0.09	0.13	0.09	0.04	68.3%	102.4%	204.9%
North Shore Drive	1638	0.90	0.36	0.16	0.11	0.08	0.04	142.3%	213.4%	426.8%
Ringling Point Drive	639	0.35	0.16	0.07	0.04	0.03	0.01	165.6%	248.3%	496.7%
Sapphire Drive	8603	4.74	1.52	0.68	0.59	0.40	0.20	114.6%	171.9%	343.8%
South Shore Drive	3219	1.77	0.82	0.38	0.22	0.15	0.07	170.5%	255.7%	511.5%
Sylvan Drive	1747	0.96	0.09	0.03	0.12	0.08	0.04	28.7%	43.0%	86.0%
US 41 A	1251	0.69	0.11	0.04	0.09	0.06	0.03	47.2%	70.8%	141.6%
US 41 B	429	0.24			0.03	0.02	0.01			
US 41 C	1356	0.75	0.03	0.01	0.09	0.06	0.03	9.8%	14.7%	29.5%
US 41 D	4427	2.44	0.17	0.07	0.30	0.20	0.10	21.5%	32.2%	64.5%
Woodland Drive	180	0.10	0.14	0.06	0.01	0.01	0.00	521.3%	782.0%	1564.0%



Indian Beach / Sapphire Shores (IBSS)
Stormwater LID Retrofit Pilot



APPENDIX 1

GEOTECHNICAL REPORT

GEOTECHNICAL SERVICES

***GEOTECHNICAL SERVICES
INDIAN BEACH/SAPPHIRE SHORES
STORMWATER LID RETROFIT PILOT
SARASOTA COUNTY, FLORIDA***

Date: January 10, 2012

Prepared For:

Stantec
6900 Professional Parkway East, Suite 100
Sarasota, Florida 34240

Prepared By:

Dunkelberger Engineering and Testing, Inc.
8260 Vico Court, Unit B
Sarasota, Florida 34240

Dunkelberger Project No.: SAR-11-1399

Stantec
6900 Professional Parkway East, Suite 100
Sarasota, Florida 34240

January 10, 2012
Project No.: SAR-11-1399

Attention: Mr. Gary S. Comp

Subject: **Geotechnical Services**
Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot
Sarasota County, Florida

Dear Mr. Comp:

INTRODUCTION

In accordance with Dunkelberger Engineering & Testing, Inc. (Dunkelberger) Proposal No. SAR-11-1399, Revision No.1, dated November 29, 2011, which was authorized by issuance of a subconsultant agreement on November 29, 2011, we have completed our geotechnical services in connection with the above referenced project.

PROJECT CONSIDERATIONS

The project consists of several shallow depth bio-swales in right-of-ways along existing roadway alignments within Sarasota County, Florida. The bio-swales are to be designed for the treatment and infiltration of stormwater runoff. The locations explored for this study are:

- Location 1 – The north side of North Shore Drive at the intersection of Bay Shore Road.
- Location 2 – The south side of Sapphire Drive at the intersection of Bay Shore Road.
- Location 3 – The median of the cul-de-sac at the west end of Ringling Point Drive.
- Location 4 – The west side of Sun Circle at the intersection of South Shore Drive.
- Location 5 – The triangular median on the north side of Sapphire Drive at the intersection of Bay Shore Road.
- Location 6 – The median of the round-a-bout on Windsor Drive just west of the intersection of Norwood Court.
- Location 7 – The south side of Patterson Drive just east of the intersection of Bon Air Avenue.
- Location 8 – The south side of 23rd Street at the intersection of North Tamiami Trail (U.S. 41).

The project areas are shown on the attached *Vicinity Map* as Sheet 1 and *Boring Location Plans*, as Sheets 2A through 2C in Appendix A.

If actual conditions vary from our present understandings, then we should be advised to allow re-evaluation of the opinions, recommendations and conclusions presented in this report.

SCS SOIL SURVEY

The Soil Survey of Sarasota County, Florida, issued September 1991 and published by the Soil Conservation Service (U.S. Department of Agriculture), indicates the sites are mapped with Soil Units 2, 10, and 33. Unit 2, Beaches, is comprised of nearly level to sloping, narrow strips of tide- and surf-washed sandy material and shell fragments along the Gulf of Mexico shoreline. Under natural (pre-development) conditions, the water table is reported to vary greatly ranging from 0 to 6 feet, depending on the distance from the shore, elevation, and tidal condition.

Unit 10, EauGallie and Myakka fine sand, is comprised of nearly-level, poorly drained soil in broad flatwoods. The typical soil profile consists of 48 inches of fine sand, underlain by loamy fine sand to a depth of 80 inches. Under natural (pre-development) conditions, the Seasonal High Groundwater Table (SHGWT) is reported to lie between 6 and 18 inches below land surface (bls) for 2 to 6 months of the year.

Unit 33, Pomello fine sand, is comprised of nearly level, moderately well drained soil on low ridges and knolls on flatwoods. The typical soil profile consists of fine sand to a depth of 80 inches. Under natural (pre-development) conditions, the Seasonal High Groundwater Table (SHGWT) is reported to lie at a depth of 24 to 40 inches for 1 to 4 months of the year.

Key characteristics of the soil types (map units) within the sites are summarized below:

Location No.	Map Unit No.	Soil Type	Loamy Soil	SHWL (Natural Conditions)
3	2	Beaches	N/A	At a depth of 0 to 6 feet depending on distance from shore, elevation, and tidal condition.
1, 2, 4, 5, 6, 8	10	EauGallie and Myakka fine sands	At 44" to 80" bls	At a depth of 6 to 18 inches bls for 1 to 3 months of the year
7	33	Pomello fine sand	N/A	At a depth of 24 to 40 inches bls for 1 to 4 months of the year

Note: 1) Loamy refers to fine-grained soils (i.e. silty/clayey sand)
2) SHWL – Seasonal High Water Level, per Soil Survey 1991 (pre-development)
3) bls – below existing land surface

SUBSURFACE CONDITIONS

Field Exploration

The subsurface conditions at each site were explored with one Double-Ring Infiltrometer Test (DRIT) and one auger boring hand drilled to a maximum depth of 8 feet bls. Grab samples of each soil stratum were collected from the auger bucket, placed in labeled glass jars, and transported to our laboratory for visual-manual classification by a geotechnical engineer.

A DRIT was performed in the proposed bio-swale area adjacent to each hand auger boring. The DRIT results were used to calculate the infiltration rate (inches per hour).

The groundwater level was measured in each borehole prior to the borings being backfilled with soil cuttings.

The locations of the borings are indicated on the attached *Boring Location Plans* as Sheets 2A through 2C in Appendix A.

Auger Boring Findings

In general, the borings found fine sand with trace silt to slightly silty fine sand (SP, SP-SM) to the maximum borehole termination depth of 8 feet bls.

Boring AB-8 found fine sand with trace silt to slightly silty fine sand (SP, SP-SM) to a depth of about 4 ½ feet bls underlain by clay (CL) to the borehole termination depth of 8 feet bls.

The boring results, including soil stratigraphy and classifications, groundwater levels, and results of laboratory testing are presented on the *Subsurface Profiles* included as Sheet 3 in Appendix A. This attachment should be reviewed for details at each boring location.

LABORATORY ANALYSIS

Soil samples collected from the borings were reviewed in our laboratory by a geotechnical engineer and assigned a visual-manual classification per the Unified Soil Classification System (U.S.C.S.). Also, three samples were selected for testing to aid in the U.S.C.S classification. Three moisture content tests and three minus No. 200 sieve washes were performed. The results of the laboratory testing are shown on the *Subsurface Profiles* on the attached Sheet 3.

CONCLUSIONS AND RECOMMENDATIONS

Seasonal High Groundwater Level

The best and most accurate method of determining the SHGWL is to obtain real-time site specific groundwater data through an entire hydroperiod (dry and wet seasons) during a year with normal rainfall. However, due to the expedited project schedule, this was not feasible. The groundwater measurements that we have collected during drilling are from a typical dry season, late December, 2011 to early January, 2012. Therefore, our SHGWL estimations are primarily based on the SCS Soil Survey and the groundwater measurements. Our recommendations, by location, can be seen in the following table.

Location	Date	Measured Groundwater Depth (feet)	SCS Estimated SHGWL	Recommended SHGWL Depth (inches-bls)
1	1/6/2012	4.5	6 to 18 inches	18
2	1/9/2012	4	6 to 18 inches	12
3	1/4/2012	3	0 to 6 feet	6
4	1/4/2012	3	6 to 18 inches	6
5	1/9/2012	4.7	6 to 18 inches	18
6*	1/4/2012	7.5	6 to 18 inches	18
7	1/5/2012	5	24 to 40 inches	30
8	12/30/2011	-	6 to 18 inches	12

*Location 6 is surrounded by impervious surface which may have created an artificially low groundwater level.

If more accurate groundwater data is desired, we recommend the installation of piezometers that could be monitored over a period of time.

Double Ring Infiltrometer Tests (DRITs)

The DRITs performed at each location were performed Between December 29, 2011 and January 9, 2012. The double-ring apparatus was seated in the sand with trace silt to slightly silty fine sand (SP, SP-SM) at a depth of approximately 9 inches below the existing land surface. Next the volume of water that infiltrated into the subgrade was recorded at 15 minute increments for a period of 4 hours. The field data was then used to calculate the infiltration rate (inches per hour), as shown on the attached Sheets 1 through 8 in Appendix B. The following table summarizes the results at each location.

DRIT No.	Stabilized Infiltration Rate (in/hr)
DRIT-1	21.6
DRIT-2	13.3
DRIT-3	8.2
DRIT-4	6.5
DRIT-5	8.6
DRIT-6	13.0
DRIT-7	8.0
DRIT-8	0.9

The very low infiltration rate of 0.9 inches/hour recorded during DRIT-8 is indicative of the clay (CL) encountered in the auger boring at a depth of 4.5 feet, which restricted the infiltration rate of the DRIT.

LIMITATIONS OF STUDY

Dunkelberger warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring profiles regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of the client. Additionally our scope of services did not include any investigation into the potential for ground subsidence due to the presence of sinkhole activity.

The analysis and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated. If any subsoil variations become evident during the course of the project, a re-evaluation of the recommendations contained in this report will be necessary after we have had an opportunity to observe the characteristics of the conditions encountered. The applicability of the report should also be reviewed in the event significant changes occur in the design, nature or location of the assumed structures.

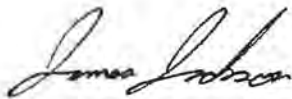
This report has been prepared for the exclusive use of Stantec for the specific application to the planned shallow depth bio-swales in Sarasota County, Florida

__oOo__

We appreciate the opportunity to be of service during this phase of the project. If you have any questions, please contact the undersigned at 941-379-0621.

Sincerely,

DUNKELBERGER ENGINEERING & TESTING, INC.



James M. Jackson, E.I.
Engineering Intern 1/10/12



Scott N. Parrish, P.E.
Branch Manager 1/10/12
FL License No.: 69091

Attachments: Appendix A

Vicinity Map
Boring Location Plans
Subsurface Profiles

Appendix B

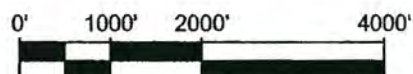
Double Ring Infiltrometer Test Results

APPENDIX A

VICINITY MAP, BORING LOCATION PLANS, & SUBSURFACE PROFILES



SOURCE: GOOGLE EARTH



LEGEND

● DRIT-1 AB-1
DOUBLE RING INFILTRMETER
TEST AND AUGER BORING
LOCATION AND NUMBER

Locations are approximate.

DRAWN	JJ
CHECKED	JJ
APPROVED	SNP
SCALE	SEE SCALE BAR
REVISED	

VICINITY MAP
INDIAN BEACH/SAPPHIRE SHORES
STORMWATER LID RETROFIT PILOT
SARASOTA COUNTY, FLORIDA

DUNKELBERGER
engineering & testing, inc.

DATE	1-4-12	PROJ. NO.	SAR-11-1399	SHEET	1
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SOURCE: GOOGLE EARTH



LEGEND

●
DRIT-1
AB-1

DOUBLE RING INFILTROMETER
TEST AND AUGER BORING
LOCATION AND NUMBER

Locations are approximate.

DRAWN	JJ
CHECKED	JJ
APPROVED	SNP
SCALE	SEE SCALE BAR
REVISED	

BORING LOCATION PLAN
INDIAN BEACH/SAPPHIRE SHORES
STORMWATER LID RETROFIT PILOT
SARASOTA COUNTY, FLORIDA

DUNKELBERGER
engineering & testing, inc.

DATE	1-4-12	PROJ. NO.	SAR-11-1399	SHEET	2A
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SOURCE: GOOGLE EARTH



LEGEND	
	DOUBLE RING INFILTROMETER TEST AND AUGER BORING LOCATION AND NUMBER
DRIT-6	
AB-6	

Locations are approximate.

DRAWN	JJ
CHECKED	JJ
APPROVED	SNP
SCALE	SEE SCALE BAR
REVISED	

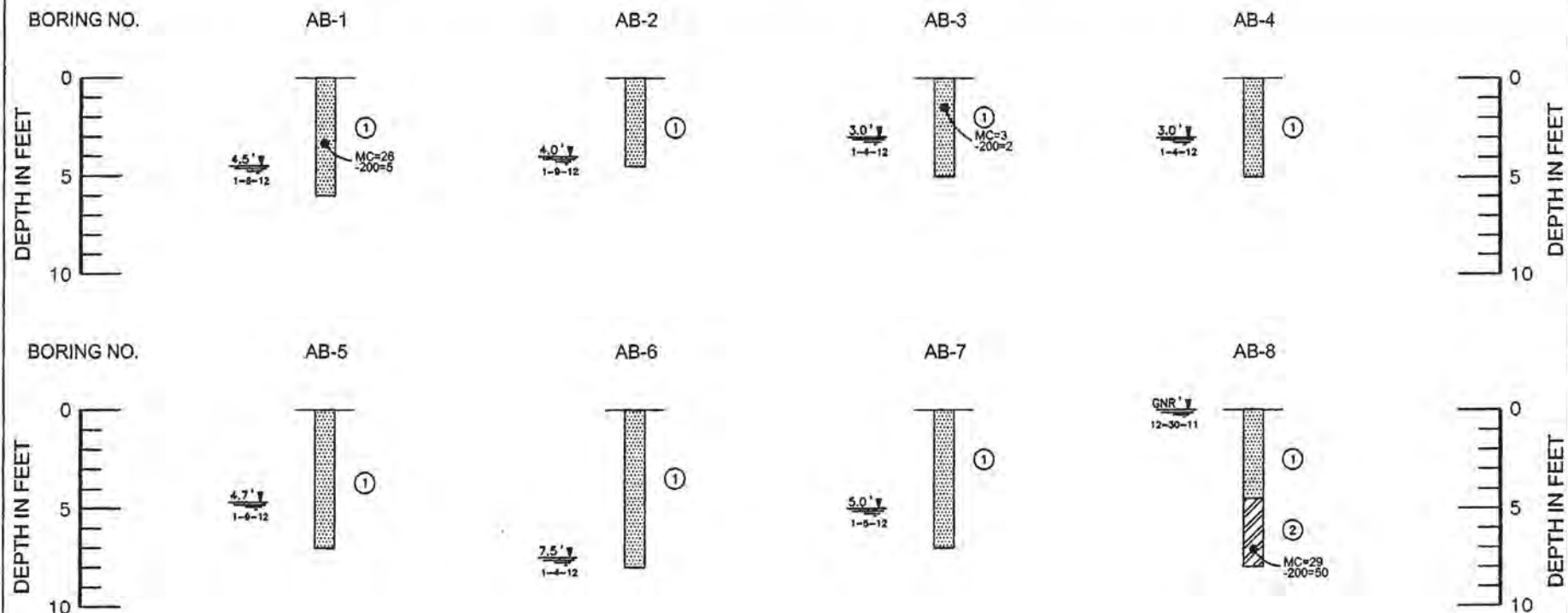
BORING LOCATION PLAN		
INDIAN BEACH/SAPPHIRE SHORES		
STORMWATER LID RETROFIT PILOT		
SARASOTA COUNTY, FLORIDA		
DUNKELBERGER engineering & testing, inc.		
DATE	1-4-12	PROJ. NO. SAR-11-1399
SHEET		2B



SOURCE: GOOGLE EARTH



● DRIT-8 AB-8 DOUBLE RING INFILTROMETER TEST AND AUGER BORING LOCATION AND NUMBER		DRAWNJJ CHECKEDJJ APPROVEDSNP SCALESEE SCALE BAR REVISED		BORING LOCATION PLAN INDIAN BEACH/SAPPHIRE SHORES STORMWATER LID RETROFIT PILOT SARASOTA COUNTY, FLORIDA DUNKELBERGER engineering & testing, inc.			
Locations are approximate.		DATE	1-4-12	PROJ. NO.	SAR-11-1399	SHEET	2C



LEGEND

① Light gray to dark brown fine SAND with trace silt to slightly silty (SP, SP-SM)

② Brown CLAY (CL)

SP - Unified Soil Classification System Group Symbol (ASTM D 2487)

AB-1 - Auger boring and number

3.0' 1-4-12 - Depth of groundwater (feet) & date measured

GNR' 12-30-11 - Groundwater not encountered

NOTES

- (1) Borings were drilled between December 30, 2011 through January 9, 2012 using hand turned auguring equipment.
- (2) Strata boundaries are approximate and represent soil strata at each test hole location only. Soil transitions may be more gradual than implied.
- (3) Groundwater depths shown on the subsurface profiles represent groundwater surfaces on the dates shown. Groundwater level fluctuations should be anticipated throughout the year.

DRAWN	JJ
CHECKED	JJ
APPROVED	SP
SCALE	1" = 5'
REVISED	
DATE	1-9-12
PROJ. NO.	SAR-11-1399
SHEET	3

SUBSURFACE PROFILES
INDIAN BEACH/SAPPHIRE SHORES
STORMWATER LID RETROFIT PILOT
SARASOTA COUNTY, FLORIDA

DUNKELBERGER
engineering & testing, inc.

APPENDIX B

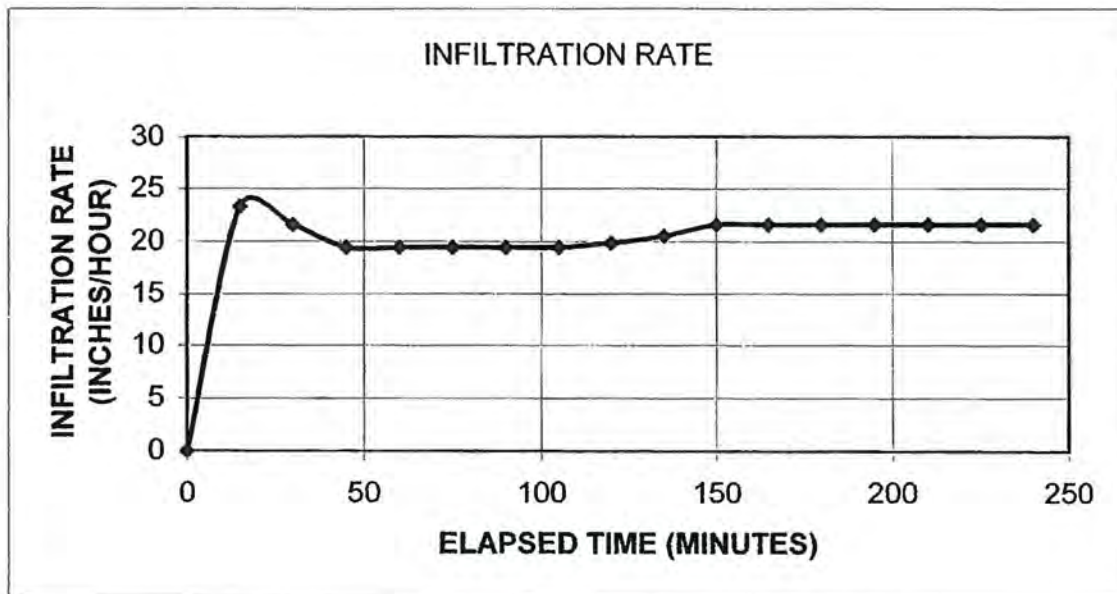
DOUBLE RING INFILTROMETER TEST RESULTS

DRIT-1

DOUBLE RING INFILTROMETER TEST RESULTS
 PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot
 PROJECT No.: SAR-11-1399
 TEST LOCATION: North Shore Drive

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
9:30	15	0	0	0
9:45	15	15	10800	23.31
10:00	15	30	10000	21.59
10:15	15	45	9000	19.43
10:30	15	60	9000	19.43
10:45	15	75	9000	19.43
11:00	15	90	9000	19.43
11:15	15	105	9000	19.43
11:30	15	120	9200	19.86
11:45	15	135	9500	20.51
12:00	15	150	10000	21.59
12:15	15	165	10000	21.59
12:30	15	180	10000	21.59
12:45	15	195	10000	21.59
1:00	15	210	10000	21.59
1:15	15	225	10000	21.59
1:30	15	240	10000	21.59

DIAMETER OF INNER RING = 12 INCHES
 DIAMETER OF OUTER RING = 36 INCHES

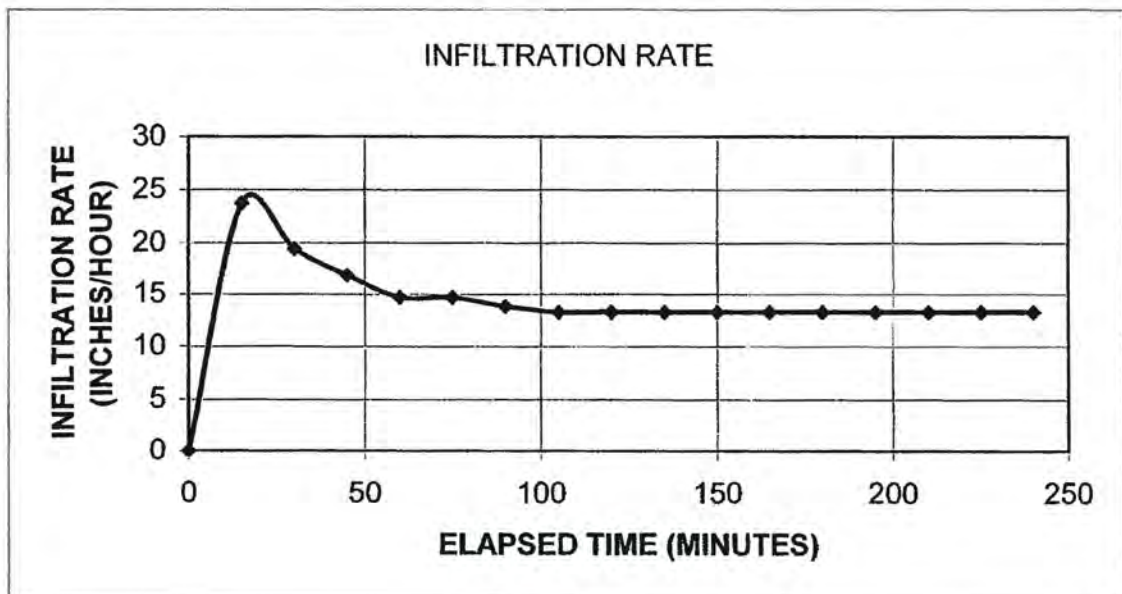


DRIT-2

DOUBLE RING INFILTROMETER TEST RESULTS
 PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot
 PROJECT No.: SAR-11-1399
 TEST LOCATION: Sapphire Drive

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
1:30	15	0	0	0
1:45	15	15	11000	23.75
2:00	15	30	9000	19.43
2:15	15	45	7800	16.84
2:30	15	60	6800	14.68
2:45	15	75	6800	14.68
3:00	15	90	6400	13.82
3:15	15	105	6150	13.28
3:30	15	120	6150	13.28
3:45	15	135	6150	13.28
4:00	15	150	6150	13.28
4:15	15	165	6150	13.28
4:30	15	180	6150	13.28
4:45	15	195	6150	13.28
5:00	15	210	6150	13.28
5:15	15	225	6150	13.28
5:30	15	240	6150	13.28

DIAMETER OF INNER RING = 12 INCHES
 DIAMETER OF OUTER RING = 36 INCHES

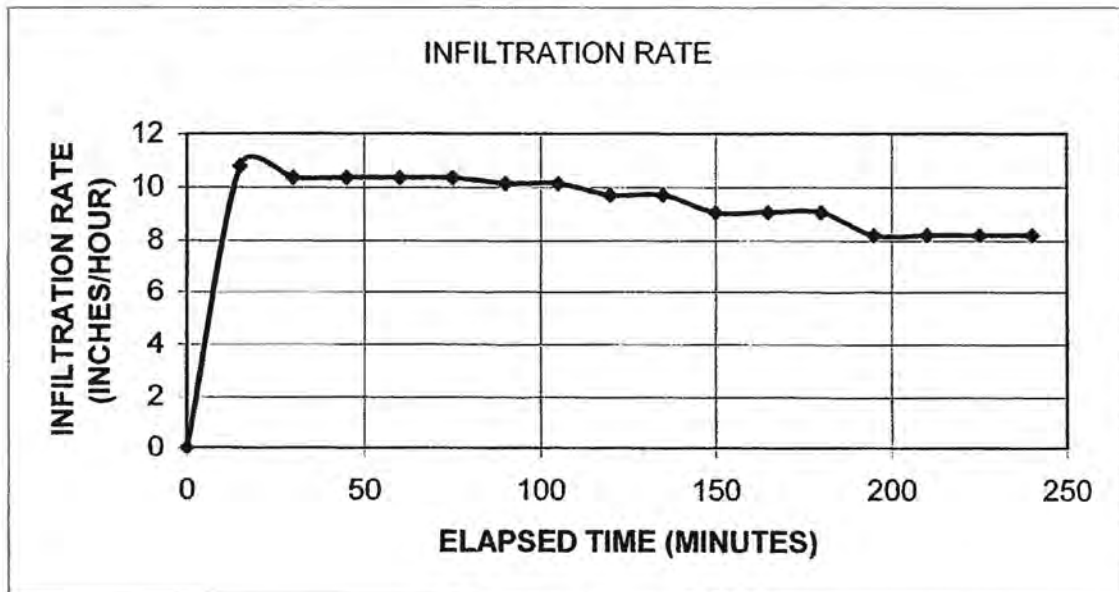


DRIT-3

DOUBLE RING INFILTROMETER TEST RESULTS
 PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot
 PROJECT No.: SAR-11-1399
 TEST LOCATION: Ringling Point Drive

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
9:30	15	0	0	0
9:45	15	15	5000	10.79
10:00	15	30	4800	10.36
10:15	15	45	4800	10.36
10:30	15	60	4800	10.36
10:45	15	75	4800	10.36
11:00	15	90	4700	10.15
11:15	15	105	4700	10.15
11:30	15	120	4500	9.71
11:45	15	135	4500	9.71
12:00	15	150	4200	9.07
12:15	15	165	4200	9.07
12:30	15	180	4200	9.07
12:45	15	195	3800	8.20
1:00	15	210	3800	8.20
1:15	15	225	3800	8.20
1:30	15	240	3800	8.20

DIAMETER OF INNER RING = 12 INCHES
 DIAMETER OF OUTER RING = 36 INCHES



DRIT-4

DOUBLE RING INFILTROMETER TEST RESULTS

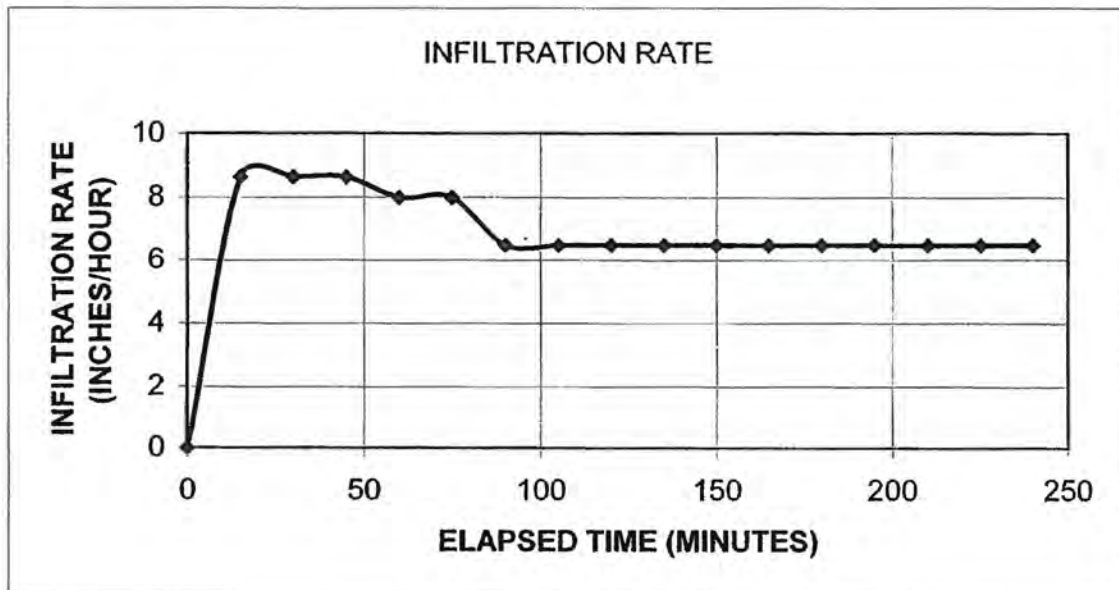
PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot

PROJECT No.: SAR-11-1399

TEST LOCATION: Sun Circle

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
9:15	15	0	0	0
9:30	15	15	4000	8.63
9:45	15	30	4000	8.63
10:00	15	45	4000	8.63
10:15	15	60	3700	7.99
10:30	15	75	3700	7.99
10:45	15	90	3000	6.48
11:00	15	105	3000	6.48
11:15	15	120	3000	6.48
11:30	15	135	3000	6.48
11:45	15	150	3000	6.48
12:00	15	165	3000	6.48
12:15	15	180	3000	6.48
12:30	15	195	3000	6.48
12:45	15	210	3000	6.48
1:00	15	225	3000	6.48
1:15	15	240	3000	6.48

DIAMETER OF INNER RING = 12 INCHES
DIAMETER OF OUTER RING = 36 INCHES

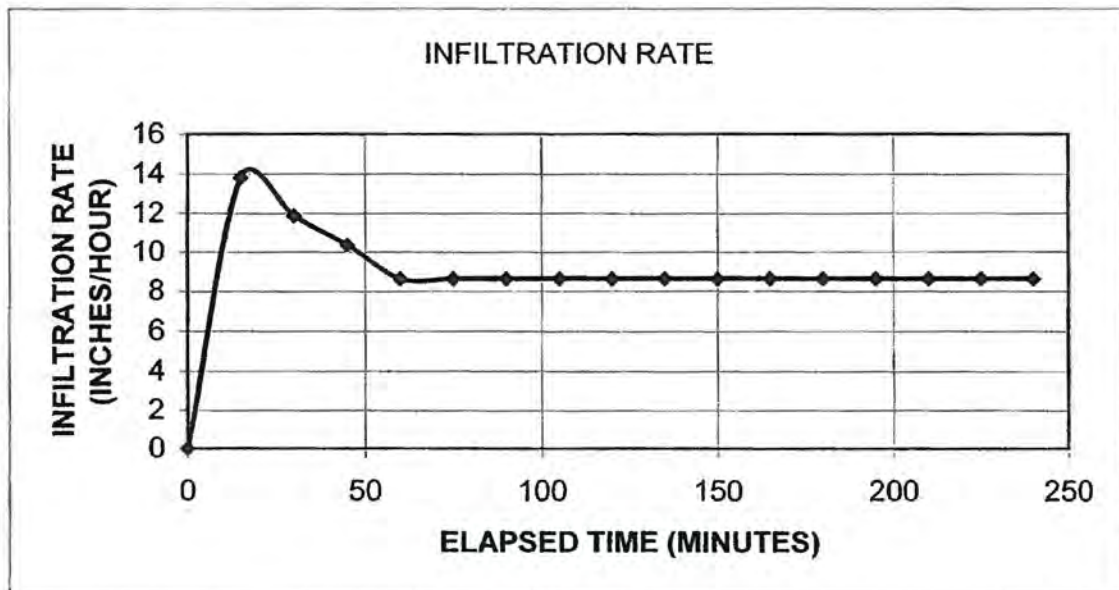


DRIT-5

DOUBLE RING INFILTROMETER TEST RESULTS
 PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot
 PROJECT No.: SAR-11-1399
 TEST LOCATION: Sun Circle

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
9:30	15	0	0	0
9:45	15	15	6400	13.82
10:00	15	30	5500	11.87
10:15	15	45	4800	10.36
10:30	15	60	4000	8.63
10:45	15	75	4000	8.63
11:00	15	90	4000	8.63
11:15	15	105	4000	8.63
11:30	15	120	4000	8.63
11:45	15	135	4000	8.63
12:00	15	150	4000	8.63
12:15	15	165	4000	8.63
12:30	15	180	4000	8.63
12:45	15	195	4000	8.63
1:00	15	210	4000	8.63
1:15	15	225	4000	8.63
1:30	15	240	4000	8.63

DIAMETER OF INNER RING = 12 INCHES
 DIAMETER OF OUTER RING = 36 INCHES

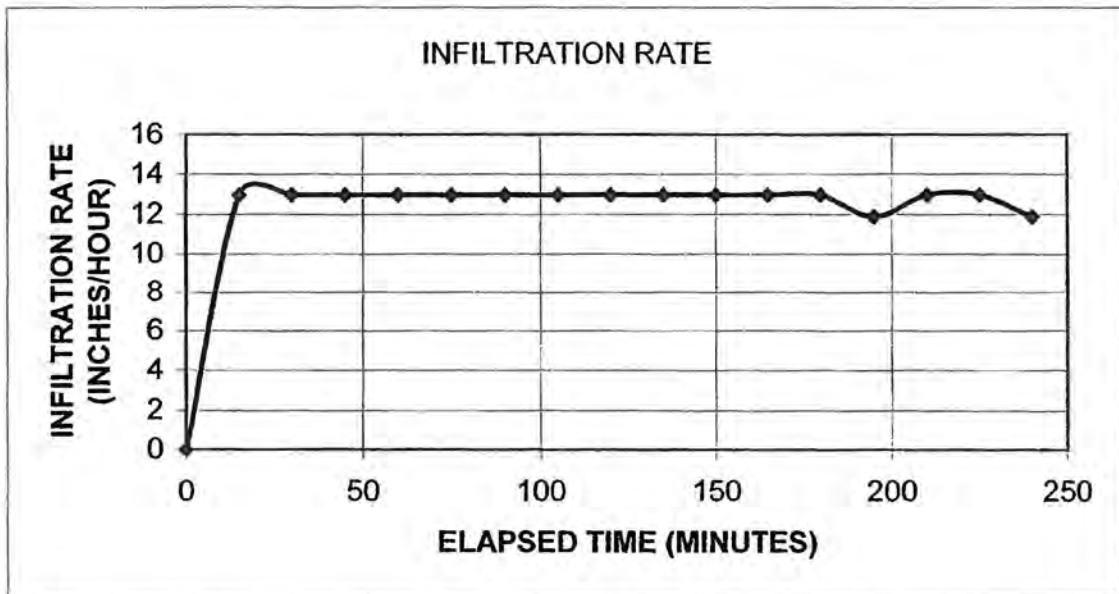


DRIT-6

DOUBLE RING INFILTROMETER TEST RESULTS
 PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot
 PROJECT No.: SAR-11-1399
 TEST LOCATION: Windsor Drive

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
9:45	15	0	0	0
10:00	15	15	6000	12.95
10:15	15	30	6000	12.95
10:30	15	45	6000	12.95
10:45	15	60	6000	12.95
11:00	15	75	6000	12.95
11:15	15	90	6000	12.95
11:30	15	105	6000	12.95
11:45	15	120	6000	12.95
12:00	15	135	6000	12.95
12:15	15	150	6000	12.95
12:30	15	165	6000	12.95
12:45	15	180	6000	12.95
1:00	15	195	5500	11.87
1:15	15	210	6000	12.95
1:30	15	225	6000	12.95
1:45	15	240	5500	11.87

DIAMETER OF INNER RING = 12 INCHES
 DIAMETER OF OUTER RING = 36 INCHES



DRIT-7

DOUBLE RING INFILTROMETER TEST RESULTS

PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot

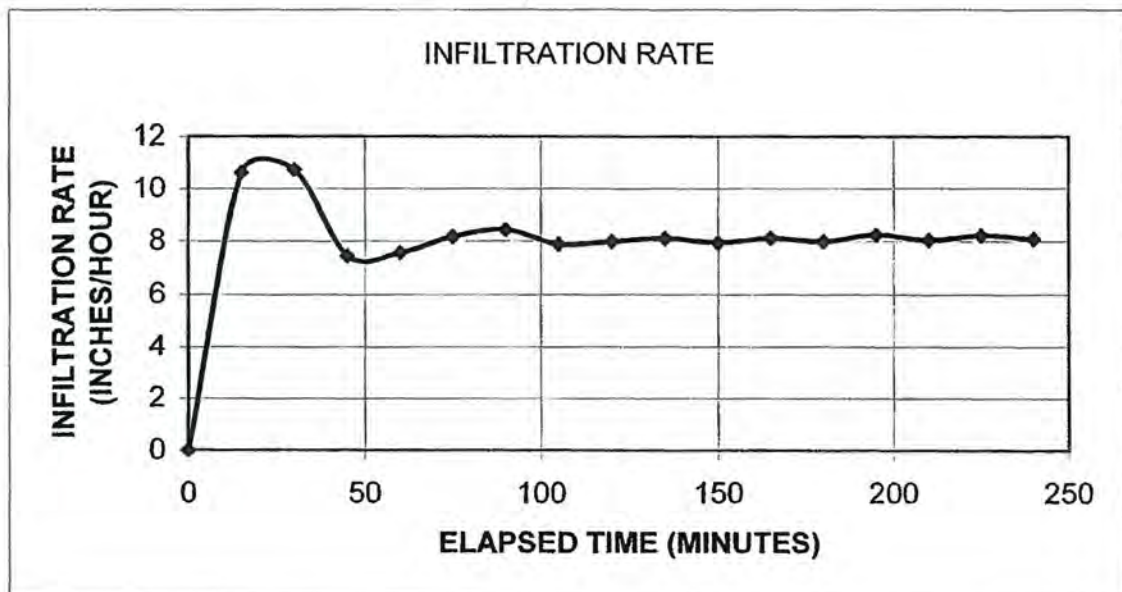
PROJECT No.: SAR-11-1399

TEST LOCATION: Patterson Drive

TIME	TIME INCREMENT (MINUTES)	ELAPSED TIME (MINUTES)	AMOUNT OF WATER ADDED TO INNER RING (ml)	INFILTRATION RATE (INCHES/HOUR)
9:45	15	0	0	0
10:00	15	15	4925	10.63
10:15	15	30	4975	10.74
10:30	15	45	3450	7.45
10:45	15	60	3500	7.56
11:00	15	75	3780	8.16
11:15	15	90	3900	8.42
11:30	15	105	3650	7.88
11:45	15	120	3700	7.99
12:00	15	135	3750	8.10
12:15	15	150	3680	7.94
12:30	15	165	3760	8.12
12:45	15	180	3700	7.99
1:00	15	195	3810	8.22
1:15	15	210	3720	8.03
1:30	15	225	3800	8.20
1:45	15	240	3740	8.07

DIAMETER OF INNER RING = 12 INCHES

DIAMETER OF OUTER RING = 36 INCHES



DRIT-8

DOUBLE RING INFILTROMETER TEST RESULTS

PROJECT NAME: Indian Beach/Sapphire Shores Stormwater LID Retrofit Pilot

PROJECT No.: SAR-11-1399

TEST LOCATION: 23rd Street

TIME	TIME INCREMENT	ELAPSED TIME	AMOUNT OF WATER ADDED	INFILTRATION RATE
	(MINUTES)	(MINUTES)	TO INNER RING (ml)	(INCHES/HOUR)
9:30	15	0	0	0
9:45	15	15	1000	2.16
10:00	15	30	1000	2.16
10:15	15	45	1000	2.16
10:30	15	60	900	1.94
10:45	15	75	600	1.30
11:00	15	90	600	1.30
11:15	15	105	500	1.08
11:30	15	120	500	1.08
11:45	15	135	500	1.08
12:00	15	150	500	1.08
12:15	15	165	475	1.03
12:30	15	180	400	0.86
12:45	15	195	400	0.86
1:00	15	210	400	0.86
1:15	15	225	400	0.86
1:30	15	240	400	0.86

DIAMETER OF INNER RING = 12 INCHES

DIAMETER OF OUTER RING = 36 INCHES

