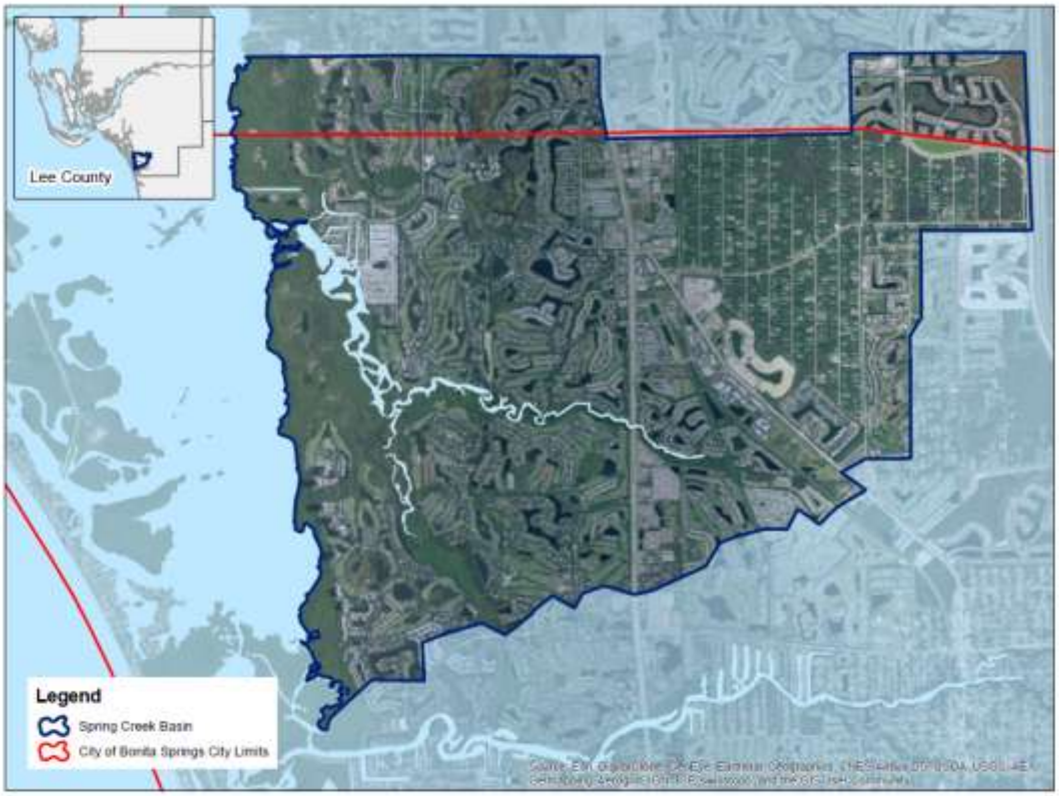

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Special thanks to all the citizens and community organizers who have participated and attended the public meeting throughout the watershed that have identified important issues and added significant value in understanding the human dimensions of the conditions, health and enjoyment of Spring Creek.

THIS REPORT WAS DEVELOPED UNDER FUNDING FROM THE CITY OF BONITA SPRINGS

Abstract:

The Southwest Florida Regional Planning Council (SWFRPC) is assisting the City of Bonita Springs in developing a Spring Creek Restoration Plan that will include plans for restoration of hydrology, water quality, habitat, and navigation.

The Spring Creek Watershed is located in the southern area of Lee County. It is approximately ten (10) square miles in size. The watershed mouth originates at Estero Bay approximately 6,000 feet south of Coconut Road. The watershed is approximately two miles wide and five miles long. This watershed is generally located south of the Halfway Creek Watershed and north and west of the Imperial River Watershed.

In the development of this Vulnerability Assessment we meet with the City of Bonita Springs staff to introduce project and began in discussions of previously identified and considered restoration needs, vulnerabilities and potential mitigations. We completed initial meetings with citizens at Cedar Creek, Imperial Harbor, Pelican Landing, and Spring Creek Village . We confirmed the scope of work and selected protocols, confirmed accepted population projections for the watershed. We undertook data acquisition, continued meetings and fact finding as needed, and coordinated data needs. We distributed and responded to all time-critical data requests. Set up and performed site visits for project assessments. WE then applied the Regional Restoration Coordination Team, Southwest Florida Comprehensive Watershed Plan , and Southwest Florida Vulnerabilities Assessment to the watershed to identify vulnerabilities.

Identified Vulnerabilities for the Spring Creek Waetrshed include:

1) Improved reconnection of the original headwaters of Spring Creek located east of Interstate 75 in the Flint Penn strand to the headwaters located in the San Carlos Estates and the north branch of Spring Creek
2) Improvement of undersized culverts to larger capacity
3) Removal of man-made damming of tributaries to the creek
4) Modifications of weirs and causeway barriers impeding flow in the upper and middle reaches of the creek
5) Placement ditch block/ structures in swales within San Carlos Estates to delay and control runoff.
6) Removing sand shoals that have formed in the estuarine portions of the creek providing reasonable navigational access.
7) Removing muck and debris in the freshwater portions of the creek that have accumulated over time.
8) Copper pollution associated with human activities
9) Bacterial pollution as indicated by fecal coliform in the freshwater and estuarine parts of Spring Creek
10) Increases in nitrogen in the freshwater and estuarine parts of Spring Creek
11) The low dissolved oxygen events can likely be improved by addressing the issues of hydrologic flow, nutrients, and anthropogenic oxygen demanding pollution sources
12) Completing the proposed Florida Forever Land Acquisitions
13) Removing exotic vegetation from existing conservation easements
14) Removing exotics along the main channels of Spring Creek.
15) Removing exotics with the storm water management systems of existing developments with outfalls to Spring Creek.
16) Creation of filter marshes in appropriate locations to offset the loss of freshwater headwater wetlands
17) Improving public access to Spring Creek viewing, canoeing and kayaking.
18) Development of a Climate Change Adaptation Plan for the Spring Creek Watershed

Following acceptance of this report we will proceed with the development of **The Spring Creek Restoration Plan** that will describe how to address these vulnerabilities.

Part 1: Hydrology:

Physiographic Areas

The Estero Bay estuary and watershed in southwestern Lee County, consists of Estero Bay and associated barrier islands, the Estero Bay basin, including the Imperial and Estero rivers, and the Six-Mile Cypress Slough Watershed.

Estero Bay is a shallow, subtropical estuarine lagoon, approximately 4,580 hectares (ha) , (~11,317 acres) in area. The major Gulf of Mexico passes on Estero Bay include Matanzas Pass, Big Carlos Pass, Big Hickory Pass, Little Hickory Pass, and Wiggins Pass. (Antonini, et. al. 2002). Five creeks and rivers drain into the bay including Hendry Creek, Mullock Creek, Estero River, Spring Creek, and Imperial River. The Six-Mile Cypress Slough subbasin (830 hectares or 2,051 acres) is in central Lee County. Estero Bay is separated from the Gulf of Mexico by several barrier islands: Estero Island, the Lovers Key complex (Long Key, Lovers Key, Black Island), Big Hickory Island, Little Hickory Island, and Bonita Beach Island (CHNEP 1996).

The Estero Bay Watershed

Spring Creek is located in the Estero Bay Watershed in Lee County, Florida. The Estero Bay Watershed is located on the lower west coast of Florida, on the Gulf of Mexico. The Estero Bay watershed encompasses 89,443.54 hectares (221,019.8 acres), or 345.3 square miles. The Estero Bay Watershed is listed as U. S. Geological Service (USGS) Cataloging Unit: Everglades – West Coast: 03090204. The Estero Bay Watershed is a sub-basin within the CHNEP study area

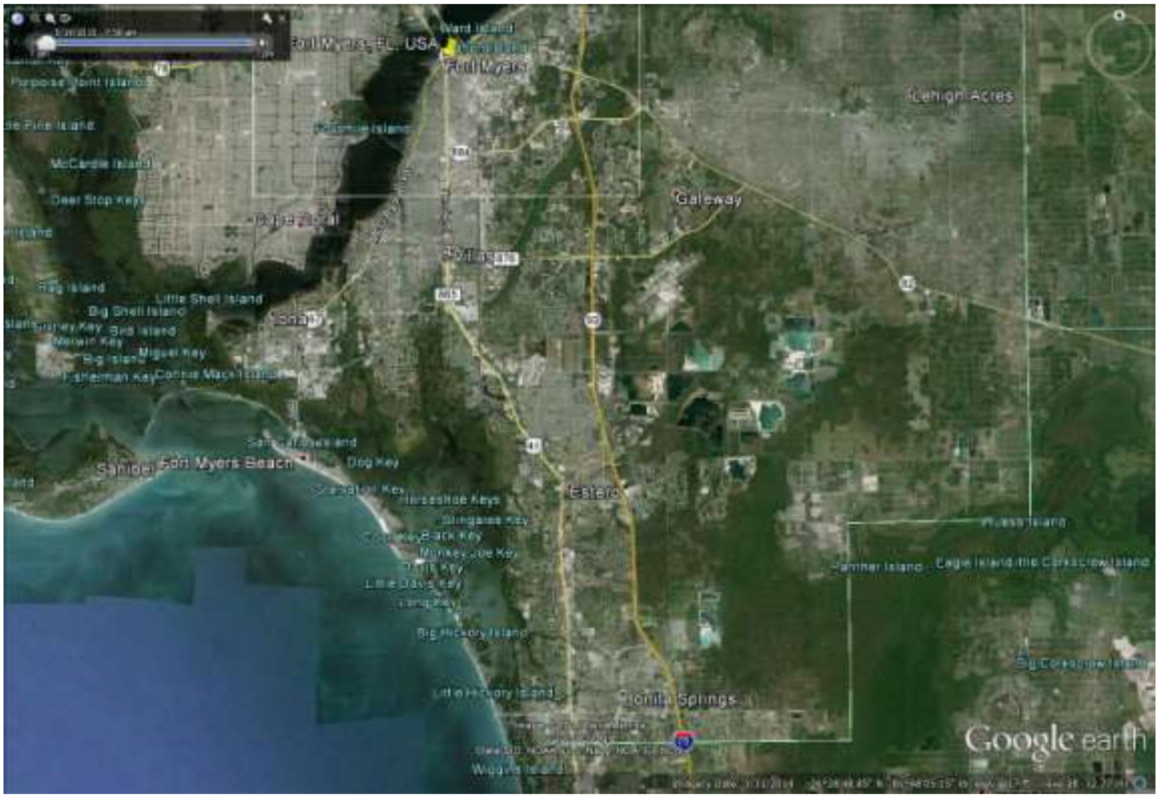


Figure 1: The Estero Bay Watershed

The Estero Bay Watershed is roughly bounded by Summerlin Road-McGregor Boulevard (CR 869) east to 6th Street north to 24th Street east to Lee Boulevard east to Immokalee Road (SR82) southeast to Wildcat Road, south on TPI Road, west to Six Ls Farm Road, south to Pioneer Road, south to the Bird Rookery Swamp, west to Interstate 75, north to Tuscany Reserve, west to new US 41, north to Bonita Beach Road, west to the Gulf of Mexico Beach of Bonita Beach, north and northwest along the beaches of Bonita Beach, Big Hickory Island, Black Island, Lovers Key, . Estero Island, Bunche Beach and on a north west bearing from Bodwitch Point to the landward end of the Sanibel Causeway at Summerlin Road.

Three different methodologies have produced estimates of the impervious surface of the watershed in 2000 (7% to 13%), 2025 (13% to 31%) and 2050 (15% to 32%). Population growth for the period between 1950 and 1980 was a nearly a 100% average increase per decade while 1980 to 2000 had almost 50% average increase per decade. By 2000, the area qualified as an urbanized area, as the population density had exceeded 1,000 people per square mile, with a population of 121,923. Historically, the watershed encompassed more than 30,351.42 hectares (75,000 acres) of wetlands. Over 28 percent or 7,746.9 hectares (19,143 acres) of wetlands have been lost in the Estero Bay Watershed. All of the Estero Bay tributaries have the Outstanding Florida Waters designation and Estero Bay itself was the first estuary in the Florida to receive the Aquatic Preserve designation. The Estero Bay Watershed is within the South Florida Water Management District's (SFWMD) Lower Charlotte Harbor Surface Water Improvement Management (SWIM) program.

In 1999, the South Florida Water Management District completed the Estero Bay and Watershed Management and Improvement Plan. The plan developed land and water management strategies to achieve water quality and quantity objectives for Estero Bay. More recently, in 2003 the SFWMD Governing Board designated Lower Charlotte Harbor a priority SWIM Program water body, which includes Estero Bay. The SFWMD also received delegated authority to issue Environmental Resource Permits (ERP) from the State of Florida Department of Environmental Protection (FDEP).

The Estero Bay Watershed area is composed of a variety of landscapes with urban development comprising approximately 26% of the total watershed area in 2003. The urban development is primarily concentrated in the western portion of the Estero Bay basin. Interspersed between these urbanized areas are sections of public conservation land, agricultural land, other native land habitats, uplands, floodplain and riverine wetlands, tidal marsh and open water. Estero Bay Watershed includes almost 32,000 acres of managed public conservation areas, or 17.4% of the SWFRPC land area, including the western part of the Corkscrew Regional Ecosystem Watershed (CREW). Agriculture and rangeland covers approximately 5%, native upland habitats 16.4%, open water 19.2%, native wetlands 28.5% and barren lands (principally in conversion to development) 4%.

The natural hydrology of the Estero Bay Watershed has been altered by man-made canals, water control structures, drainage ditches, berms, and roads. SFWMD has delineated basins in Estero Bay Watershed differently than FDEP. Compared to FDEP's Plan Units below, the northern headwaters of the Cocohatchee are in the Estero Bay Plan Unit. As a result of flooding in 1995, SFWMD determined that Trafford basin flows west to the Estero Bay or south depending on the amount of rainfall.
For the purposes of this study the Estero Bay Watershed comprises 89,443.54 hectares (221, 019.8 acres) (Table 1 and Figure 1). The basins are also represented by the FDEP Plan Units which are further defined by water body identification (WBID) areas (Table 1 and Figure 3).

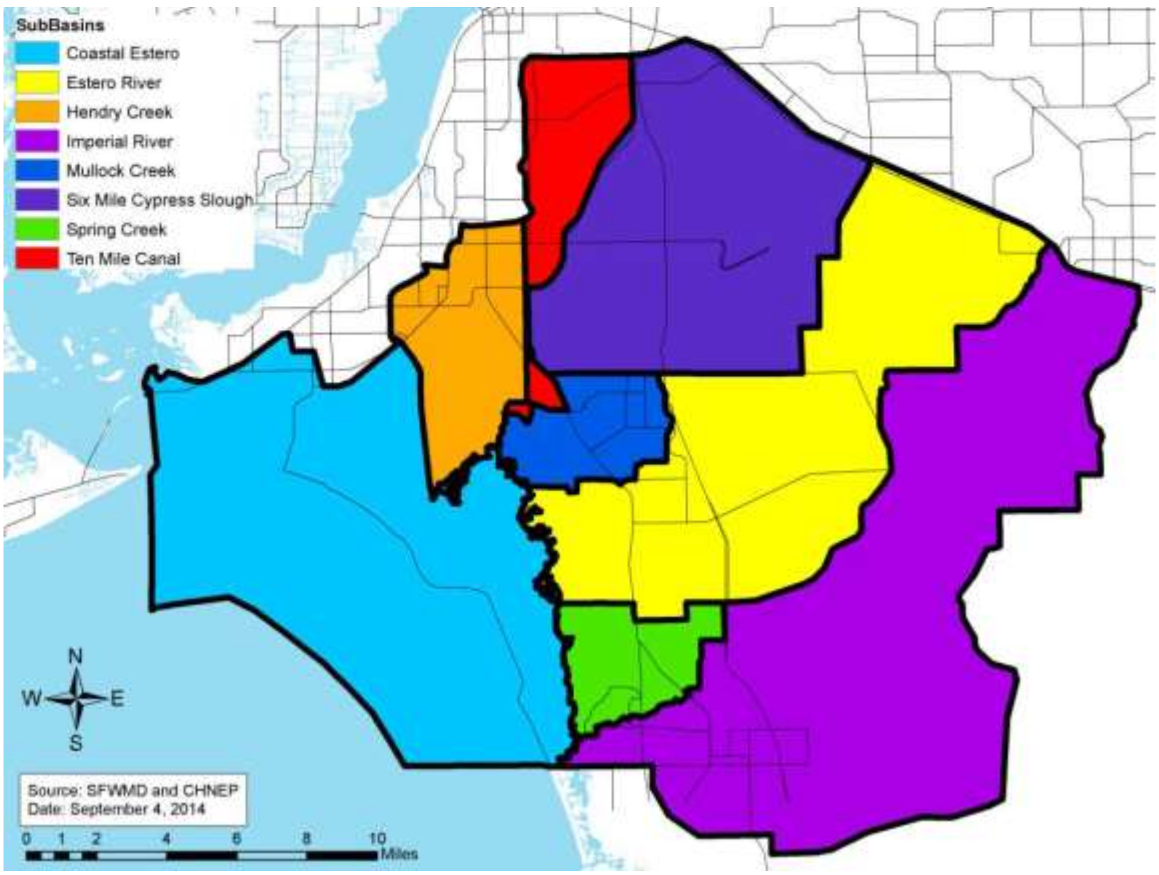


Figure 2: FDEP Basins

Table 1: Area of the Estero Bay Watershed under Different Definitions

Source	Area Hectares	Area (acres)	Area (square miles)
Estero Bay SFWMD	119,633.17	295,620.0	461.91
Estero Bay FDEP Plan Units	89,443.54	221,019.8	345.3

SFWMD has delineated basins in LCH differently than FDEP (Figure 2). Compared to FDEP's Plan Units below, a small area of Charlotte Harbor is attributed to the Estero Bay Watershed south of the Caloosahatchee Estuary, and the northern headwaters of the Cocohatchee are in the Estero Bay Plan Unit. In addition, as a result of flooding in 1995, SFWMD determined that Trafford basin flows west to the Estero Bay or south depending on the amount of rainfall**.**

Figure 3: SFWMD Basins

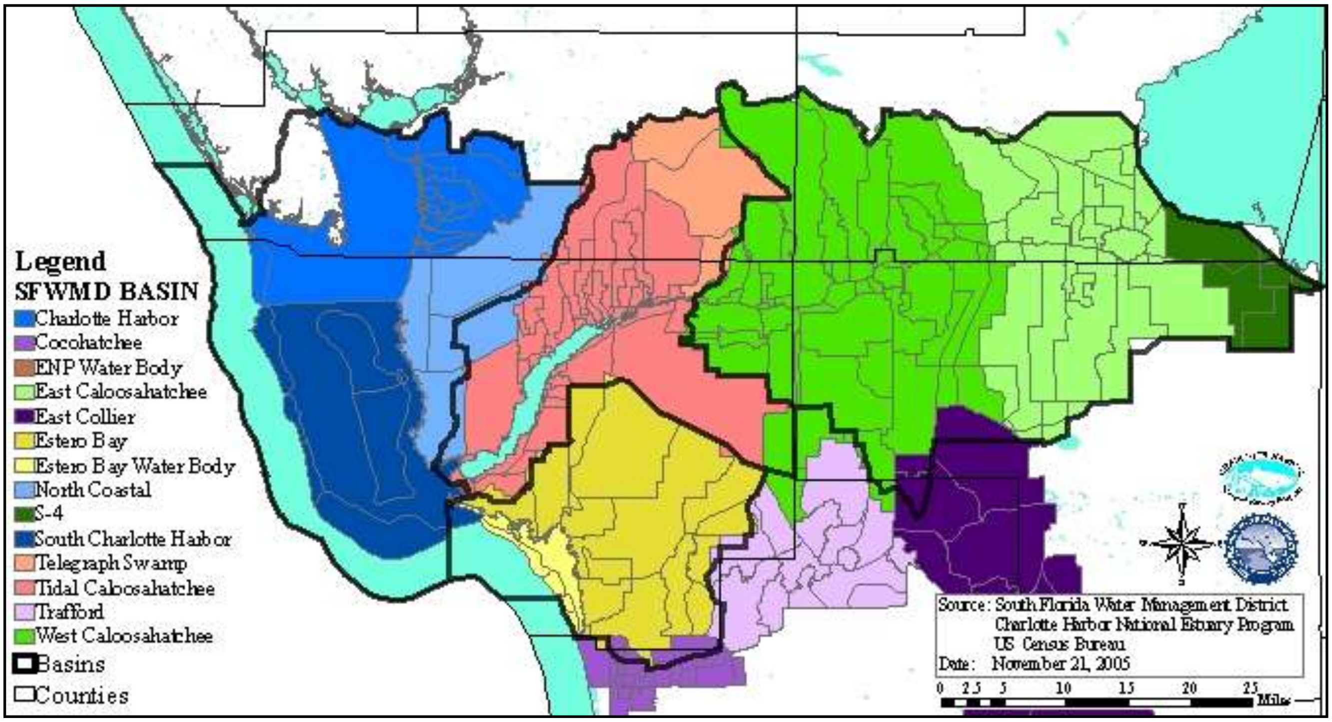
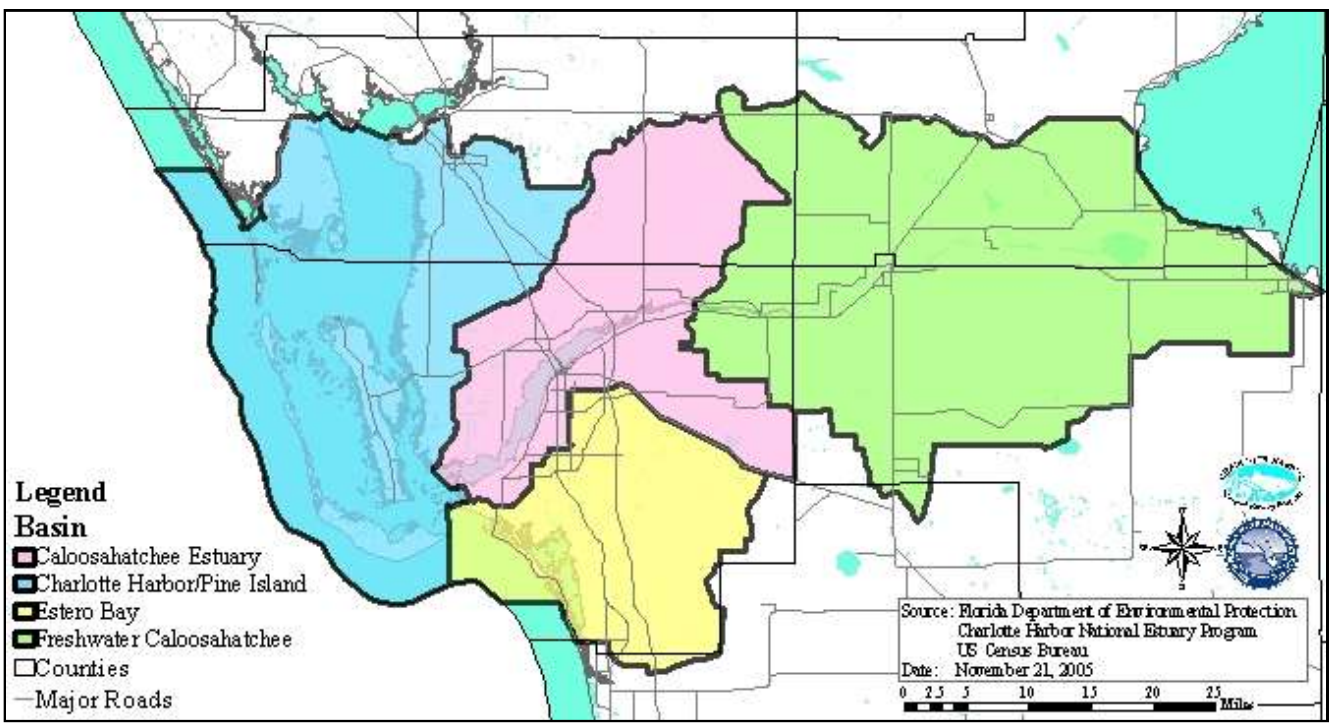


Figure 4: FDEP Plan Units



The Spring Creek Watershed

The Spring Creek Watershed is located in the southern area of Lee County. It is approximately ten (10) square miles in size comprising 2,974.44 hectares (7,350 acres) or 4% of the Estero Bay watershed.. The watershed mouth originates at Estero Bay approximately 6,000 feet south of Coconut Road. The watershed is approximately two miles wide and five miles long. This watershed is generally located south of the Halfway Creek Watershed and north and west of the Imperial River Watershed.

It is a highly modified watershed and probably was at least twice the size of what it is today before Interstate 75 was constructed. The watershed boundary has changed somewhat since the 1979 "Water Management in Lee County" report by Johnson Engineering and the "Lee County Interim Surface Water Management Plan." The watershed has decreased in size approximately two square miles from the 1979 report. The majority of this area was north of Coconut Road and its extension to the east. Johnson Engineering utilized a number of verification methods including SFWMD permit information and on-the-ground reconnaissance to generally confirm the watershed boundary. The only significant flow crossing along the watershed boundary is a tidal brackish water slough that runs north-south through Bonita Bay. This slough cuts across the south watershed boundary and connects Spring Creek with the Imperial River. The Spring Creek Watershed boundary within Bonita Bay has been determined from Bonita Bay permit data on file at South Florida Water Management District. The Spring Creek main trunk west of Old US 41remains a natural channel which has seen little modification.

A general description of the Spring Creek Watershed boundary is as follows: beginning at the intersection of Coconut Road and Spring Creek Road run east to U.S. 41; then south along U.S. 41 to the north line of Section 16, Township 47 South, Range 25 East; then run north along the north line of Section 16 to the northeast corner of Section 15; then north to the half section line of Section 11, Township 47 South, Range 25 East; then east to I-75; then south along I-75 to a point approximately 600 feet south of Strike Lane; then west to the east line of Bonita Springs Golf and Country Club; then south to the north line of Bonita Springs Golf Villas; then east, south, west, north and west around Bonita Springs Golf Villas to Corzine Road; then south along Corzine Road to Shangrila Road; then southwest along Shangrila Road to Old U.S. 41; then south along Old U.S. 41 for 1,000 feet; then generally west by contour to a point on U.S. 41 approximately 2,000 feet north of West Terry Street; then continuing west through Bonita Bay; then north by contour to the mouth of Spring Creek.

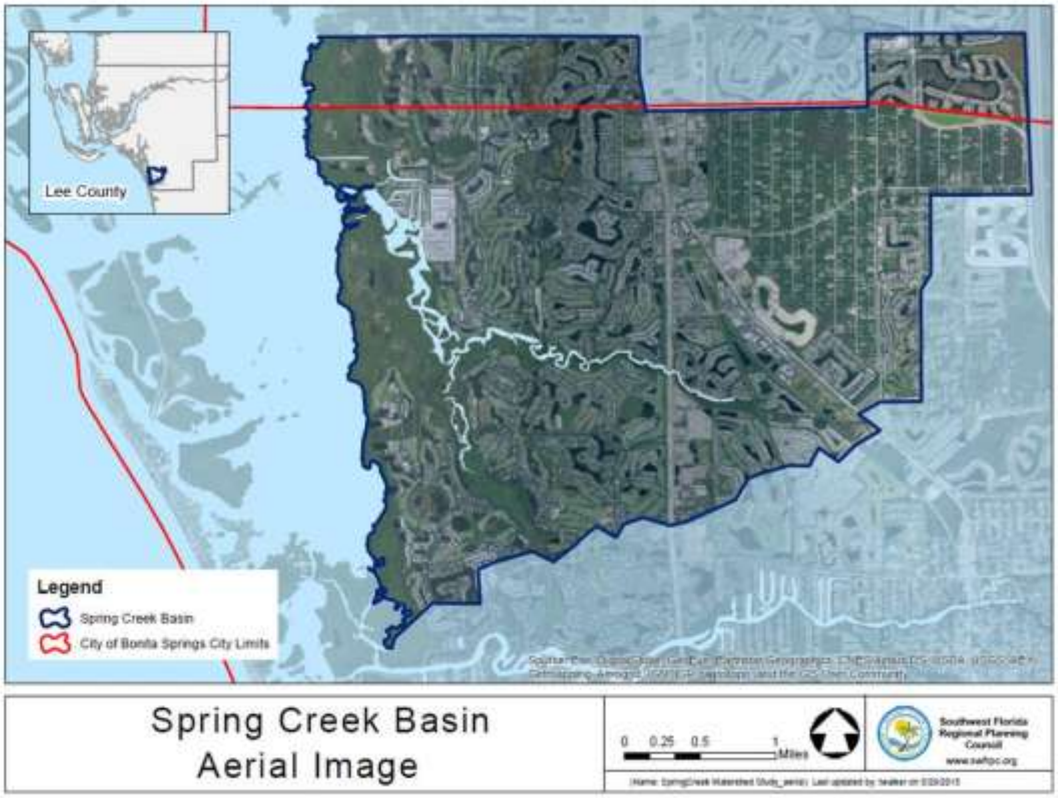


Figure 5: Aerial of the Spring Creek Watershed

Located in Southwest Lee County, the Spring Creek Watershed encompasses an area of approximately ten square miles. A watershed boundary and description is attached. It is located south of Halfway Creek Watershed and north and west of the Imperial River Watershed. The Lee County Surface Water Management Master Plan notes that the watershed had decreased in area by approximately two square miles from the original 1979 “Water Management in Lee County” report. The decrease in area occurred north and east of Coconut Road. The only flow crossing the watershed boundary occurs in Bonita Bay. This tidal salt water slough connects to the Imperial River at the southern boundary of the watershed. The main conveyance in the Spring Creek watershed is natural channel beginning at Estero Bay running approximately five miles to the railroad bridge. The creek is tidally controlled by Estero Bay to the FPL bridge crossing. The channel narrows at US-41 from approximately 100’ to a width of 30’ with an average bottom of -4.0’ NGVD. At the railroad bridge it becomes a dug channel to Old US-41 with an approximate bottom of 5.0’ NGVD. Attached are plan and profiles of Spring Creek taken from the Lee County Surface Water Management Master Plan showing five significant structures. These structures are the twin bridges at US-41, concrete bridge at the power line easement, corrugated metal pipes in Imperial Harbor, railroad bridge and a box culvert at Old US-41. The basin consists of residential, golf course, and commercial development as well as farm fields and vacant land areas. The creek contains no water control structures. Per SFWMD criteria the allowable discharge for new development in the watershed is limited to 81 csm for the 3 day – 25 year event.

The Headwaters of Spring Creek

The current Spring Creek Watershed Basin is defined as beginning west of I-75 and currently includes a small portion of the Brooks adjacent to I-75. There is however a small amount of flow of 160 cfs that enters this defined watershed from flows east of I-75 through a culvert under the Interstate located at an area between the

Edison Farms/ Flint Penn Strand/(western CREW acquisition area) and The Brooks at the area set aside for a former proposed interstate interchange.

Figure 6: Culvert between Flint Penn Strand (Edison Farms) and The Brooks crossing under Interstate 75.
Source Google Earth 2015

The South Florida Water Management District (SFWMD) permit (36-00288-S) for the Brooks allows discharge to the San Carlos Estates Drainage District for 89 hectares (220 acres) of the Brooks Development known as Basin 3 in the approved permit. Per the approved permit, Basin 3 has a design discharge of 12.0 cfs and a control elevation of 14.00' NGVD. A review of the I-75 SFWMD permit (36-03802-P: I-75 Collier/Lee Co. Line North To Corkscrew Road Segment B) shows that an additional discharge The permit states Lee County Department of Transportation included this capacity in the Three Oaks Parkway project (Permit No. 36-04007-P). This area separated from the other portions of San Carlos Estates by the construction of Three Oaks Parkway, is heavily vegetated and swale-like.

The construction of Three Oaks Parkway provided a box culvert to convey flows of Spring Creek from the area to the east into the San Carlos Estates Drainage District in the permit 36-04007-P. Only Basin D of the approved permit discharges into the Spring Creek Basin and it is limited to 6.9 cfs with a peak stage of 16.8' NGVD for the 25 year – 3 day storm event. The control elevation for Basin D is 14.50' NGVD. The drainage ditch in this area is well maintained. The flow continues through the box culvert into the San Carlos Estates Drainage District.

Figure 7: Box Culvert at Three Oaks Parkway Extension east side
Source: 2008, Exceptional Engineering, Inc

Developed in 1962, in an area that was historically cypress swamp, hydric pine flatwoods and mesic pine flatwoods, San Carlos Estates consists of approximately 950 residential lots varying in size from one acre to one and half acres. The total development is approximately 460.53 hectares (1,138 acres). The area is poorly drained with shallow rim canals enclosing the development. Spoils from the excavation of the canals were used to form a berm around the property boundary effectively closing off Spring Creek and damming it within the site. The canals flow to the south end of the development where they discharge into two locations that flow under Old US-41 into Spring Creek. At the time of the construction no SFWMD permits were required. However SFWMD did issue a permit on November 19, 2003 (36-04757-P) for sealing and paving of the existing unpaved roadways and recontouring of existing roadside swales. No information concerning the control elevation could be found within SFWMD files. However, the plan of reclamation for the San Carlos Estates Drainage District did notate a discharge of 182 cfs from the development to Spring Creek. The discharge to Spring Creek occurs at two points within the system. The location of these weirs is shown on the attached aerial exhibit. The field inspection conducted in 2008, by Exceptional Engineering, Inc showed that erosion around the southernmost weir has allowed flows to bypass the weir. This erosion could lead to failure of the weir if not repaired and could lead to significant downstream impacts to Spring Creek.

Figure 8: San Carlos Estates berm and canal system.
Source: 2008, Exceptional Engineering, Inc

Figure 9: San Carlos Estates Weir
Source: 2008, Exceptional Engineering, Inc

Figure 10: San Carlos Estates southern most weir. Note: flow from erosion.
Source: 2008, Exceptional Engineering, Inc

Figure 11: Erosion around the southernmost weir at San Carlos Estates.
Source 2008: Exceptional Engineering, Inc

The North Branch

Flows leaving San Carlos Estates in two areas form into the north branch tributary and south branch tributary. The north branch runs in a manmade canal adjacent to the Villages of Bonita subdivision which rerouted the original creek path to its perimeter. The canal in this area is heavily vegetated as shown in the picture below. Flows could be increased in this by removing the vegetation and general maintenance grading of the canal.

Pic 19. North Branch adjacent to Villages of Bonita

Figure 12:. Pic 19. North Branch adjacent to Villages of Bonita
Source: 2008, Exceptional Engineering, Inc

The flow then crosses under Old US-41 through 2 – 8’ x 4’ box culverts and into the Bernwood Business Park. Inside Bernwood Business Park the tributary is moderately vegetated and the flow passes through another box culvert to the railroad right-of-way.

Pic 20. Culvert in Bernwood Business Park – North Branch

Figure 13:. Culvert in Bernwood Business Park – North Branch
Source: 2008, Exceptional Engineering, Inc.

Pic 21. North Branch entering railroad right-of-way.

Figure 14: Pic 21. North Branch entering railroad right-of-way.
Source: 2008, Exceptional Engineering, Inc

Pic 22. 48" RCP at railroad crossing looking east

Figure 15: Pic. 22 48" RCP at railroad crossing looking east
Source: 2008, Exceptional Engineering, Inc

At the railroad right-of-way the vegetation in 2008, was very heavy as shown. There are several 48" RCP pipes along the railroad right of way which convey water from the east side ditch to the west side ditch that runs parallel to the tracks. Two of these pipes were located in the area of the north branch. In both instances the pipes were in poor condition and covered with vegetation and debris. Further analysis of the pipes and condition of the conveyance swales along the railroad right-of-way is recommended. Based on the size of the upstream box culverts at Old US-41 and inside Bernwood Business Park it is likely that the amount of vegetation and condition and spacing of the pipes at the railroad right of way is constricting the flow of the north branch. As flows pass the railroad right of way the north branch is almost completely covered by vegetation until it reaches the FPL right-of-way. The FPL right-of-way operates similar to the railroad with two adjacent ditches running parallel to the power poles with pipes spaced at intervals in the ditches. Again the pipes are in poor condition and covered with vegetation. Maintenance of the parallel ditches and inspections of the existing pipes is recommended in the area of the FPL easement.

Pic 23. 48" RCP at FPL easement

Figure 16: Pic. 23. 48" RCP at FPL easement
Source: 2008, Exceptional Engineering

As flow exits the FPL easement it flows into the Cedar Creek Subdivision preserve area. This area is heavily vegetated and in some areas the flow is almost completely blocked off or absorbed and evapotranspirated. As the north branch exists the Cedar Creek Subdivision it merges with the south branch of Spring Creek.

Pic 24. restricted flow inside the Cedar Creek Subdivision

Figure 17:. Pic 24.Restricted flow inside the Cedar Creek Subdivision
Source: 2008, Exceptional Engineering, Inc

The South Branch

As flows leave San Carlos Estates in the south branch of Spring Creek they are conveyed by a drainage canal to

Old US-41. The photo below shows the intersection of the San Carlos Estates drainage canals and the offsite conveyance. As shown in the photo, as flows leave San Carlos Estates the conveyance is heavily vegetated and flows become restricted at this point to the box culvert at Old US-41.

Figure 18: Intersection of San Carlos Estates canals and offsite conveyance
Source 2008: Exceptional Engineering, Inc

On July 14, 2006, the SFWMD approved permit 36-05877-P titled Old 41 Widening Project. This permit authorized the construction and operation of a surface water management system serving 14.17 hectares (35.01 acres) of roadway improvements with discharges to the Imperial River and Spring Creek. The permit was issued to the City of Bonita Springs. Prior to issuance of the permit, there were no water control structures permitted for this section of Old US-41. The existing roadway drained to roadside ditches with discharge to Spring Creek in the area of existing box culverts. The permit delineated 7 basins with basins 1-2 discharging to the Imperial River and basins 3-7 discharging to Spring Creek. Basin 3 extends from Hope Lutheran Church to the existing 10'X6' box culverts. Runoff is directed to Hope Lutheran Church (36-03118-P) and additional improvements are provided for attenuation and discharge within that system with a permitted control elevation of 9.3'. Basins 4 & 5 include Bernwood Business Park and extend from the existing box culvert to the rail road crossing. This area has a direct impact on the headwaters of Spring Creek. Runoff in this area is directed to the surface water management system for Bernwood Business Park (36-02904-S) which discharges to the headwaters directly downstream of the box culverts at Old US-41. In order to provide water quality and attenuation two existing control structures within Bernwood Business Park were modified and a new control structure proposed to maintain the original peak design discharge for the Business Park. The permitted control elevation for this is 10.00' for Basin 5 and 9.3' for Basin 4. Basin 6 conveys runoff to the existing railroad ditch and provides for offsite flows from two commercial developments. Basin 7 extends from the railroad crossing to the intersection with US41. The runoff from this basin enters dry detention areas and is discharged to the existing ditch along the FPL Powerline easement with a control elevation of 10.70' and an allowable discharge of 11.37 cfs. The Lee County Master Surface Water Management Plan lists an average elevation of the box culverts of 6.6'. A USGS monitoring station is located just upstream of the box culverts at Old US-41. Monitoring data shows monthly mean gage height in feet and monthly mean flow data in cubic feet per second from 2002-2007.

Figure 19: Old US41 Box Culvert Upstream of Bernwood Business Park
Source 2008: Exceptional Engineering, Inc

After exiting the box culverts at Old US-41, the headwaters continue into Bernwood Business Park. Bernwood Business Park was permitted on March 9, 1995 (36-02904-S) and subsequently modified on several occasions to permit individual lot development as well as modifications to the master storm water management system. The permit authorized construction and operation of a surface water management system to serve 44.68 hectares (110.41 acres) of industrial development. The development was divided into five basins. Basin 1 flowed into Basin 2 then into the Spring Creek tributary. Basins 3-5 discharged directly to the tributary. The control elevation for all basins discharging to the tributary is 9.3'. The four proposed control structures limited discharge to the tributary to a total of 12.1 cfs. The conveyance in the area of Bernwood Business Park is heavily vegetated causing flows to be restricted. Also, the field inspection revealed that a cattle crossing had been constructed inside Bernwood Business Park. A picture of the cattle crossing is shown below. The cattle crossing does not appear to restrict flow in this area.

Figure 20: Bernwood Business Park upstream to Old US-41
Source: 2008, Exceptional Engineering, Inc

Pic 10. Spring Creek Tributary inside Bernwood Business Park

Figure 21: Pic. 10 Spring Creek Tributary inside Bernwood Business Park
Source: 2008, Exceptional Engineering, Inc

Pic 11. Cattle Crossing inside Bernwood Business Park

Figure 22: Pic 11. Cattle Crossing inside Bernwood Business Park in 2008
Source: 2008, Exceptional Engineering, Inc

The flow continues past Bernwood Business Park to the Seminole Gulf Railroad crossing. The crossing is shown in the picture below. The creek is shallow at the crossing and appears to widen at the crossing during maximum flows. During the field inspection an additional pipe was discovered at the south end of the crossing. This pipe is at a higher elevation and is intended to pass flows during high water events.

Pic 12. Seminole Gulf Railroad Crossing

Figure 23: Pic. 12 Seminole Gulf Railroad Crossing
Source: 2008, Exceptional Engineering, Inc

Pic 13. Additional Pipe at Railroad Crossing

Figure 24: Pic 13. Additional Pipe at Railroad Crossing
Source 2008, Exceptional Engineering, Inc

In 2008 the pipe was clogged with debris and had eroded areas both upstream and downstream. The Lee County Master Surface Water Management Plan details the crossing as a 51' bridge with road elevation of 14.1' NGVD. There is no mention of the additional pipe. As the flow continues past the railroad bridge it again becomes constricted with vegetation until it reaches Imperial Harbor. Imperial Harbor is an existing mobile home development. The only permit issued by SFWMD is for unit 7 which discharges to the Imperial River and was issued on September 23, 1982. However, the Spring Creek tributary does run along the northern border of the development and is connected to the perimeter ditch of Imperial Harbor. There is a crossing inside Imperial Harbor consisting of four corrugated metal pipes. The Lee County Master Surface Water Management Plan shows 2-42" CMP's and 1-36" CMP with average inverts of 3.2'. The conveyance is very well maintained inside of the Imperial Harbor development. However, as flows continue past Imperial Harbor it again becomes densely vegetated to the point of causing a stagnate condition. This vegetation continues to the concrete bridge crossing for the FPL easement crossing. The Lee County Master Surface Water Management Plan shows the FPL crossing as a 40' concrete bridge crossing with a road elevation of 11.2'.

Pic 14. Imperial Harbor CMP pipe crossing.
Figure 25: Pic 14. Imperial Harbor CMP pipe crossing.
Source 2008, Exceptional Engineering, Inc

Pic 15. Canal inside Imperial Harbor
Figure 26: Pic 15. Canal inside Imperial Harbor
Source: 2008, Exceptional Engineering, Inc

Pic 16. Downstream of Imperial Harbor

Figure 27:Pic 16. Downstream of Imperial Harbor

Source 2008, Exceptional Engineering, Inc

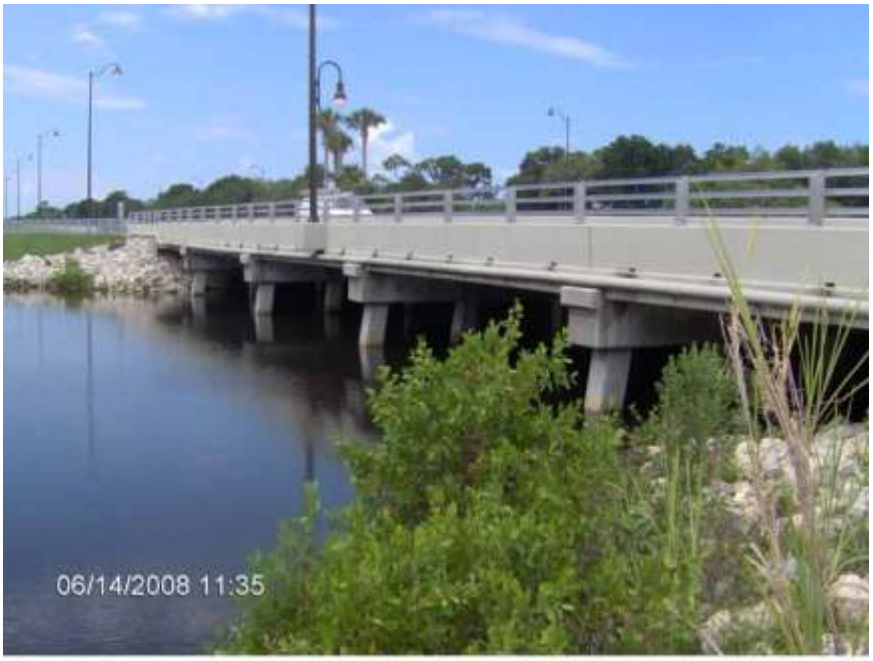
There is vegetation in the conveyance both upstream and downstream at the FPL bridge crossing. It is at this point that Spring Creek becomes a natural waterway.

Pic 17. FPL Easement Bridge Crossing

Figure 29: Pic 17. FPL Easement Bridge Crossing

Source: 2008, Exceptional Engineering, Inc

At the FPL easement crossing, Spring Creek becomes a natural waterway and is controlled by tidal conditions. From the FPL easement to the bridge at US-41 the banks of Spring Creek are vegetated and begin to widen. According to the Lee County Master Surface Water Management Plan, the bridge is 148' with a road elevation of 9.4'. As the creek continues to Estero Bay, it varies greatly in width in excess of 100'. The creek is generally free of vegetation in the areas downstream of US-41. Downstream of US-41 the creek is bordered on the north by Pelican Landing (SFWMD Permit #36-01620-S), Pelicans Nest (3600433-S) and Spring Creek West (36-02469-S).



Pic 18. Bridge crossing at US-41

Figure 30: Pic 18. Bridge crossing at US-41
Source: 2008, Exceptional Engineering, Inc

Permitted on February 9, 1984 by SFWMD the Pelican's Nest Development included construction and operation for 75.76 hectares (187.2 acres) of residential and recreational development. The project was divided into six drainage basins with basins 4-6 discharging directly into Spring Creek. The permit was modified several times to include a total development area of 160.86 hectares (397.5 acres) with an allowable discharge of 55 cfs. The project discharge points to Spring Creek remain unchanged from the original construction and operating permit.

The Pelican Landing permit authorized construction and operation for 34.14 hectares (84.37 acres) of residential development know as Pelican Landing Unit III and authorization for an additional 83.05 hectares (205.23 acres). Unit III consisted of 5 drainage basins labeled 8A, 8B, 8C, 8D, and 8E. Only Basins 8C and 8E discharge to Spring Creek via and existing drainage ditch. The design discharge for Basin 8C is 39.32 cfs with a control elevation of 11.0'. The design discharge for Basin 8E is listed as 11.36 cfs, however the allowable listed in the permit is 1.55 cfs with a control elevation of 11.00'. The Pelican Landing permit has been modified on several occasions to permit additional development and modify the surface water management system. On August 15, 1991 a modification was issued for construction and operation of Unit 4 consisting of 48.14 hectares (118.96 acres) and modifications to Unit III. An additional outfall to Spring Creek was added with a design discharge of 9.41 cfs at a control elevation of 11.5' within basin 8H. Basin 8C was modified to include two control structures with a design discharge of 86.91 cfs at control elevation 11.0". On July 15, 1993 the SFWMD approved another modification for conceptual approval for 356.07 hectares (879.87 acres) of residential and golf course development was approved. This permit split Pelican Landing into two major drainage basins B and C and several sub-basins. Drainage basin B would discharge through previously permitted facilities in Basin 8 which were designed to accommodate the additional flows and basin C would discharge directly to Estero Bay and not impact Spring Creek.

Spring Creek West was approved on May 13, 1993 for conceptual approval for 127.48 hectares (315 acres) of residential and golf course development and construction and operation approval of Phase 1 totaling 55.8 hectares (137.9 acres) of golf course development. It was subsequently modified and granted construction and operation for 89.68 hectares (221.6 acres) within Phase 1. The modification proposed 10 drainage basins with Basins 2, 3, 6, 7 and 9 discharging to a tributary to Spring Creek and Basin 8 directly to Spring Creek. The control elevations and design discharges are shown in the table below:

Table 2: Spring Creek West Control Structures

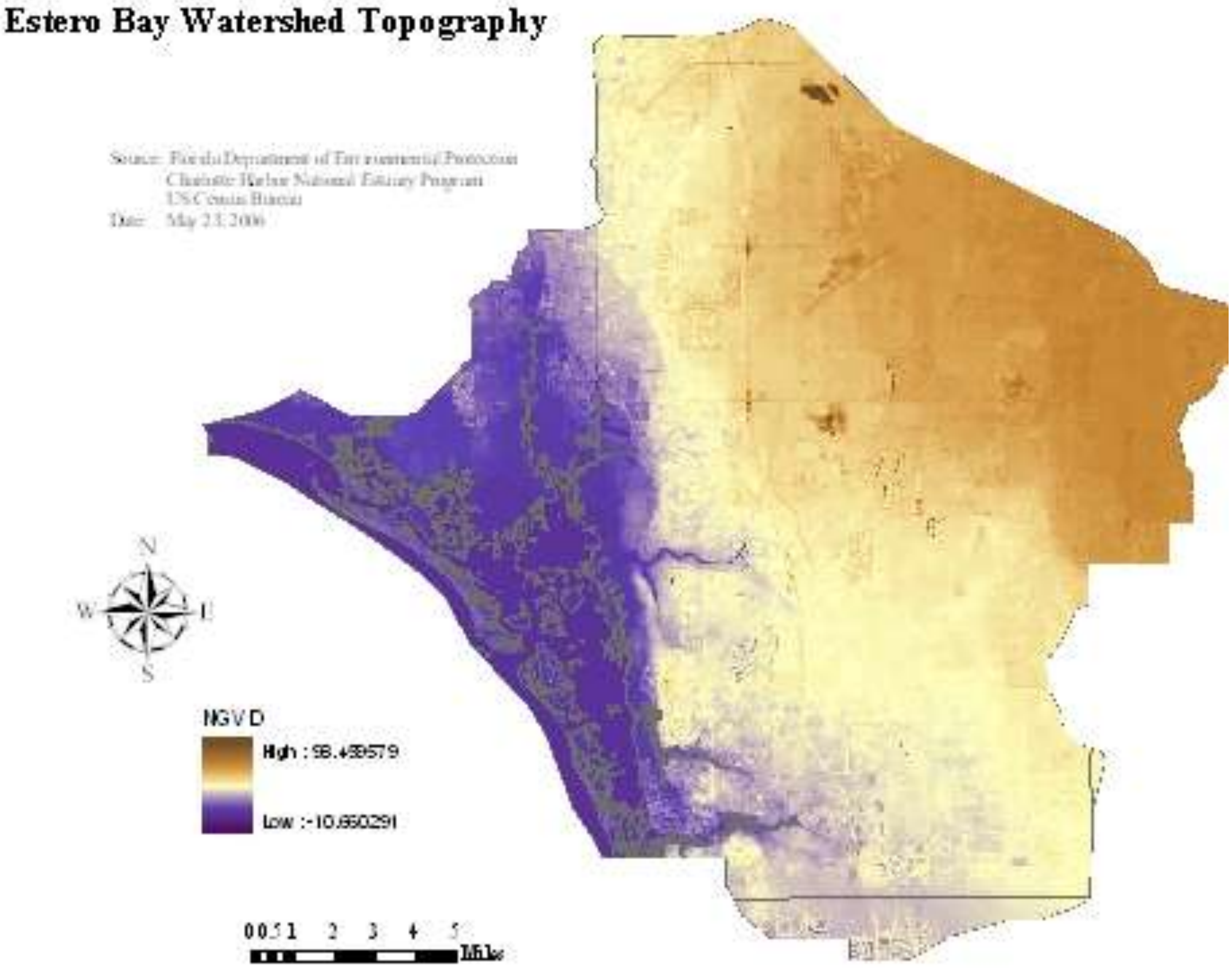
Basin	Control Elevation (ft)	Design Discharge (cfs)
2	9.0'	7.9
3	9.0'	8.2
6	6.0'	5.2
7	4.0'	5.7
8	5.0'	1.6
9	8.0'	5.0

On March 9, 1995 another modification was approved for construction and operation of 85.14 acres of residential development and added drainage basins 11 and 12 with modifications to drainage basin 6 from the original permit. Basin 12 was approved with one structure that discharged directly to Spring Creek with a control elevation of 3.5' and a design discharge of 3.63 cfs. The modification also increased the Basin 6 design discharge to 6.45 cfs. On May 11, 1995 a modification was approved to place three weirs into the existing Spring Creek tributary that served 544.3 of land comprised mostly of the three major developments of Pelican Landing, Pelican's Nest and Spring Creek West. The purpose of the modification was to stabilize water levels in the tributary and raise ground water elevations. The final weir discharged directly to Spring Creek with a design discharge rate of 185 cfs with a control elevation of 3.5'. Although this modification was issued under the Spring Creek West permit number it effectively limits all discharge to Spring Creek via the north/south tributary to 185 cfs.

On the south side Spring Creek is bordered by the Bonita Bay (36-00289S) development. Bonita Bay was granted conceptual approval by SFWMD in October 1981. The conceptual approval included 961.13 hectares (2,375 acres) of total development including 112.1 hectares (277 acres) of water management and 350.5 hectares (886.1 acres) of impervious area. The conceptual permit also references 9,240 dwelling units and 1,410,000 so of commercial area. The permit has been modified on several occasions to permit individual tract development. Most discharges within the development is directed to the north/south tidal slough that connects Spring Creek to the Imperial River. The establish discharge rate for the area east of the slough is 0.277 cfs/acre. The first construction and operation permit was issued on January 7, 1982 with discharging 129 cfs to the Imperial River and Spring Creek. The information contained within the SFWMD files did not specifically break the discharge into two separate watersheds. As show on the aerial exhibit the tidal slough becomes wide as it reaches Spring Creek where most of the discharges from Bonita Bay occur. Control elevations range from 6.0' to 2.5' within the Bonita Bay Development.

After this point Spring Creek discharges to Estero Bay and is well defined with mangrove wetland areas.

Figure 31: Topography of Estero Bay Watershed

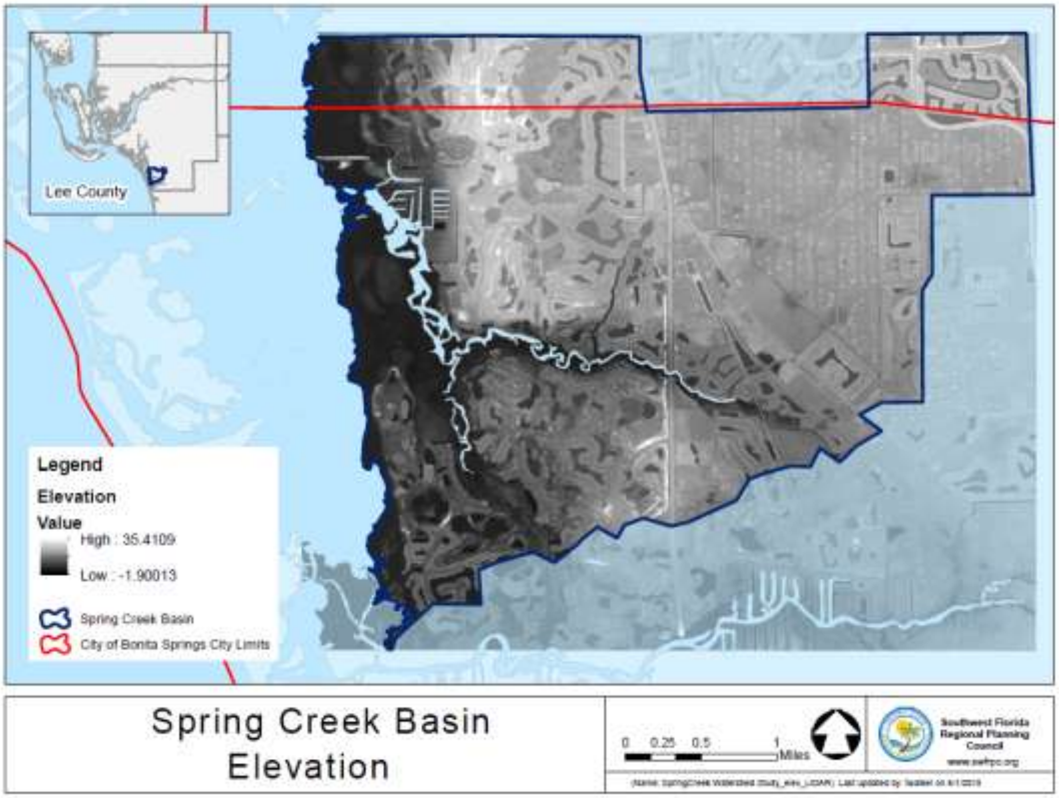


The Gulf Coast Lowlands, DeSoto Plain and the Immokalee Rise are apparent in the topographic map shown in Figure 5. The topographic assessment was developed as a component of the Southwest Florida Feasibility Study using LIDAR technology.

The Estero Bay Watershed is a series of relatively flat plateaus with intervening old shoreline ridges ranging in elevation from sea level to a natural maximum of 50 feet NGVD in the eastern portion of Lee County. The Hendry Creek basin is low and does not exceed 5 feet National Geodetic Vertical Datum (NGVD) throughout, while elevations in basins farther south such as Spring Creek, increase closer to the coast due to a xeric ridge of relic prehistoric beaches.

The higher elevations in the eastern part of the watershed are associated with the Immokalee Rise, and increase relatively steeply from 15 feet to over 40 feet in elevation. The Immokalee Rise separates the flowways of the Big Cypress and the Everglades from the Estero Bay Watershed.

Figure 32: Topography of the Spring Creek Watershed



Geologic History of Lower Charlotte Harbor and the Spring Creek Watershed

The basement rock of Florida is on a separate tectonic plate from most of the rest of North America. The plate underlying what is now Florida is technically called the Tallahassee-Suwanee Terrane and is a fragment from the Gondwana plate. This Gondwana plate fragment was adjacent to present-day West Africa and South America during the Devonian, 390 million years ago (mya). This was also the time of the first amphibians and first jawed fishes.

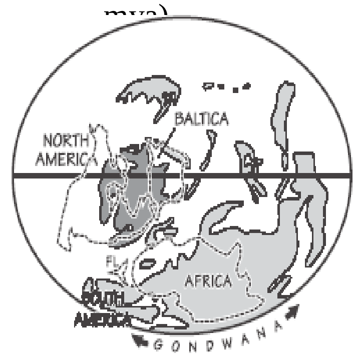
In the period including the Mississippian, Pennsylvanian, and Permian 354-250 million years ago, Gondwana collided with proto-North America, forming the super-continent, Pangea. The collision also formed the central south Appalachian Mountains. This period represents the late Paleozoic and the emergence of scale trees, seed ferns, and the first reptiles. The end of Permian had the greatest recorded major extinctions of any extinction event including many marine forms of life and most of the dominant mammal-like reptiles, that evolved into mammals.

During the Triassic and Jurassic periods, 250-142 million years ago, Pangea began to split and rifts are created in the crust. With the formation of the rift basins, the Atlantic Ocean and Gulf of Mexico began opening. During the Triassic, the first dinosaurs and mammals emerged. Dinosaurs and giant marine reptiles subsequently dominated the Jurassic and the first birds evolved.

It was during the period including the Cretaceous (the last period of the dinosaurs), Tertiary, and Quaternary that Florida drifted to its present location and emerged from the sea. During the Cretaceous the Tethys Sea was created with the rifts between the northern and southern continental plates and on this sea's shoreline the first red mangroves appear. Common fossils found in rocks of this period in the Spring Creek watershed include marine fossils such as mollusks, shark and ray teeth and manatee bones. Florida began to emerge from the shallow marine coral seas during the Tertiary and attained significantly large extents during the ice ages of the Quaternary. Interior deposits from the Age of Mammals include fossils of the giant land tortoise, land mammals including giant sloth, mastodon, camels, early horses, and saber cats.

The surface geology of the Estero Bay area is characterized by Quaternary (Holocene-10 mya and Pleistocene-1.8 mya) and Tertiary (Pliocene- 2 mya and Miocene- 2.4 mya) deposits. The original basement rock plate from Gondwana is now thousands of feet below the surface.

Devonian
(417-354 mya)



Mississippian-Permian
(354-250 mya)

Triassic-Jurassic
(250-142 mya)

Cretaceous-Quaternary
(142 mya-Present)

Figure 33: Continental Drift: Dark areas above the water. Figures by J. Houghton, after C. Scotese, Paleomap Project, 2000 (www.scorcese.com).

Aquifers

The resulting aquifer systems of significance in the Spring Creek Area (and in fact for all of Florida) are from the Quaternary and Tertiary periods. The deepest of the aquifer systems is the Floridan, followed by the Intermediate, with the Surficial Aquifer System at the surface.

Period	Series	Surface Geology	Stratigraphic and Hydrologic Units			Thickness (in Feet)	Lithology
Quaternary	Holocene	Qh/Qu	Undifferentiated alluvium and terrace deposits	**Surficial Aquifer System**		20-75	Sand with local shell beds
	Pleistocene	TQsu	Caloosahatchee Marl			20-75	Marl with minor shell and silt, Shelly sediments
Tertiary	Pliocene	Tt	Tamiami Formation	Confining Unit		20-75	Sand, limestone, and shell beds. Thick clay near top.
				Tamiami Unit		50-150	
	Miocene	No Surface Exposures	Hawthorn Unit	Upper Hawthorn Confining Unit	**Intermediate Aquifer System**	300-500	Mostly limestone, sandy limestone, and sand. Phosphatic in part. Dolomite beds common. Clayey in middle part.
				Sandstone Aquifer		Insufficient Data	
				Confining Unit			
				Mid-Hawthorn Unit			
				Lower Hawthorn Confining Unit			
	Ogliocene		Floridan Unit	Upper Floridan	**Floridan Aquifer System**	3000-3400	Thick sequence of carbonate rocks (limestone and dolomite).
				Confining Unit			
	Eocene			Lower Floridan			
	Paleocene			Confining Unit			

Figure 34: Stratigraphy *(assembled from Miller 1990 and SFWMD 2004)*

All three aquifer systems are characterized by calcareous sedimentary rock with clayey confining layers of lower permeability. Each aquifer system has different extents in the southeastern United States. The Floridan underlies all of Florida and the southern extents of Alabama, Georgia and South Carolina. The Lower Charlotte Harbor area is the area where the unit is at its thickest. The Intermediate aquifer is restricted to Southwest Florida. Finally, the Surficial Aquifer covers all of the Lower Charlotte Harbor Area, the Atlantic Coast north of Palm Beach, and Apalachicola.

Figure 35: Aquifers

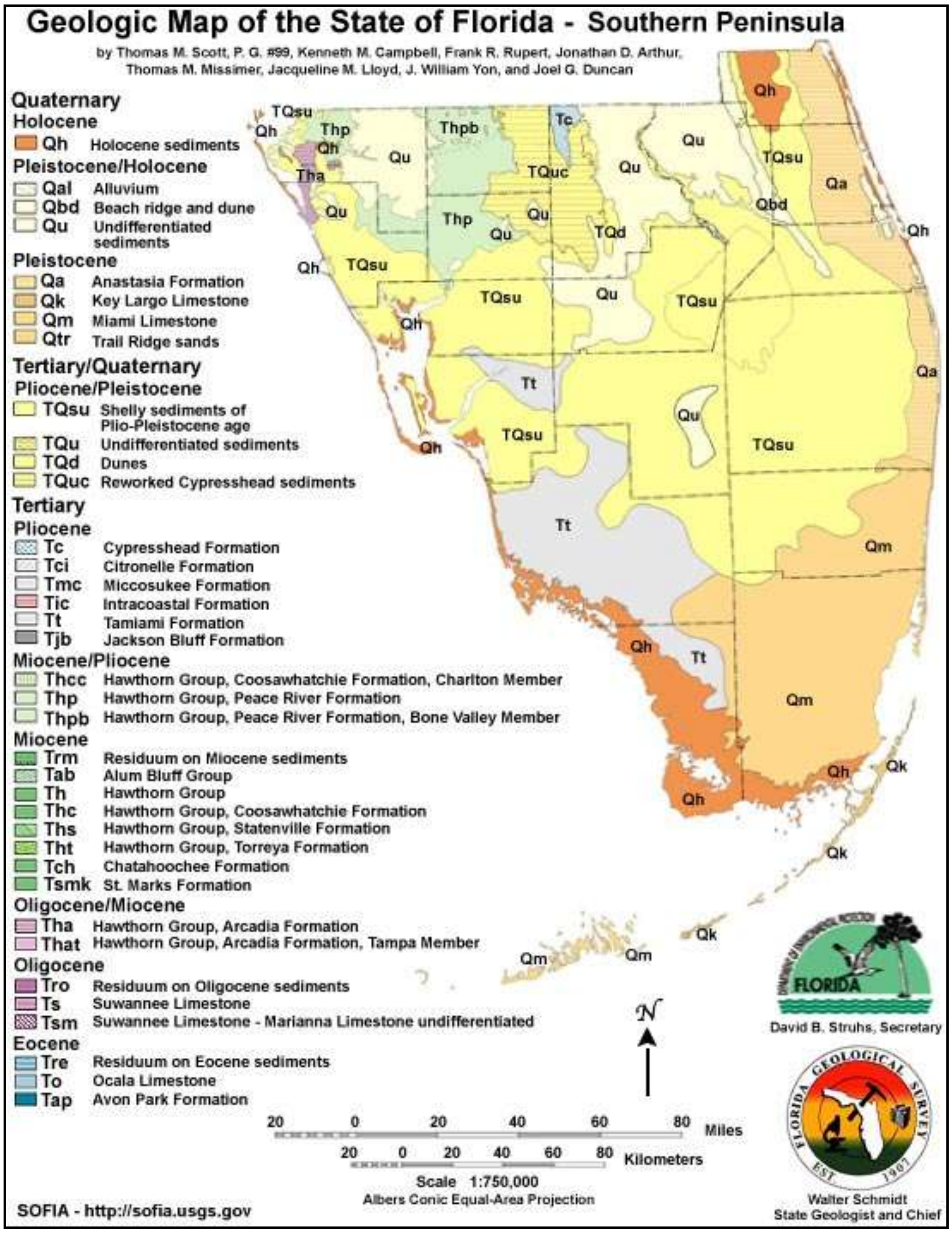
Floridan   Intermediate   Surficial

(Maps from Miller 1990)

The "Geologic Map of the State of Florida – Southern Peninsula," classifies the surface geology for Lower Charlotte Harbor is comprised of Holocene sediments (Qh), undifferentiated sediments (Qu), shelly sediments of Plio-Pleistocene age (TQsu), and the Tamiami Formation (Tt). These exposures represent the Surficial Aquifer.

The Holocene sediments (Qh and Qu) are probably from an interglacial period of rising sea levels and coastal marshes advancing inland. A period of erosion predated the deposition of these sediments during the low sea level stages in the late Pleistocene. The Caloosahatchee formation (TQsu) was deposited in the Pleistocene and late Pliocene ages. In this epoch, there were both glacial and interglacial periods (Gleason and Stone 1994).

Figure 36: Geologic Map of South Peninsula Florida



Soils

Soils in the Spring Creek Watershed are typically hydric or partially hydric (see Figure 37). Non-hydric areas are associated with the banks of natural drainage courses and the Chapel Ridge that parallels the east shore of Estero Bay. Soils in the area are most typically poorly drained (see Figure 38).

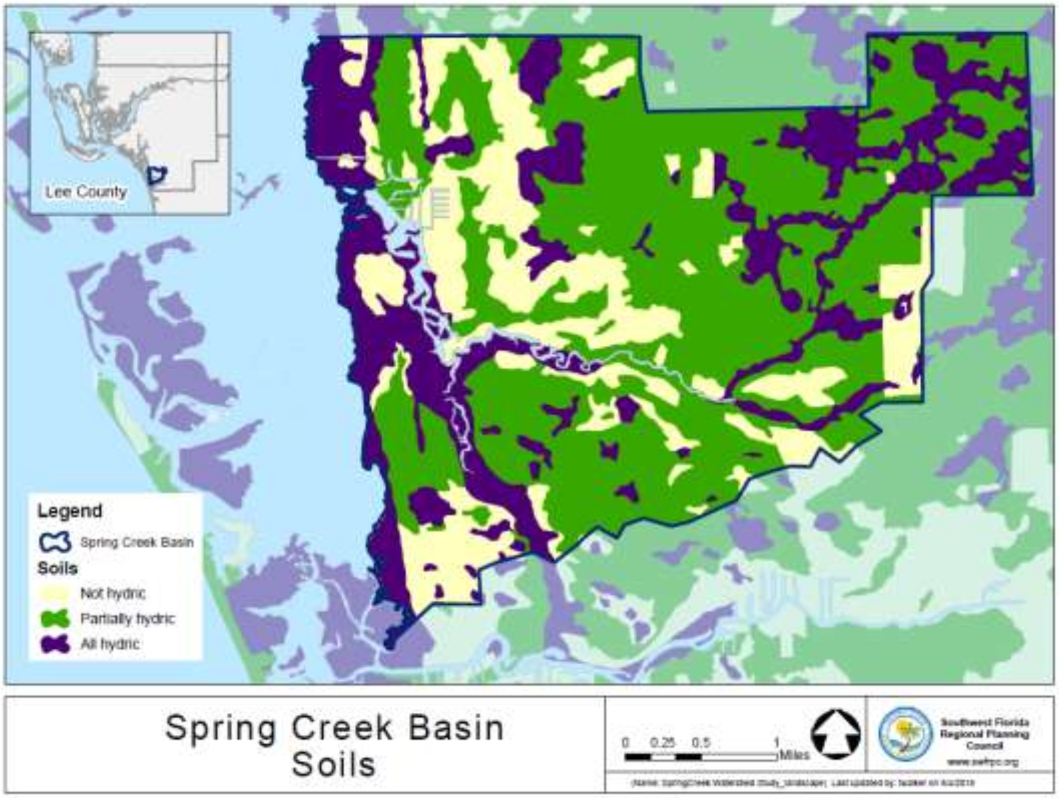


Figure 37: Hydric Characteristics of Soils

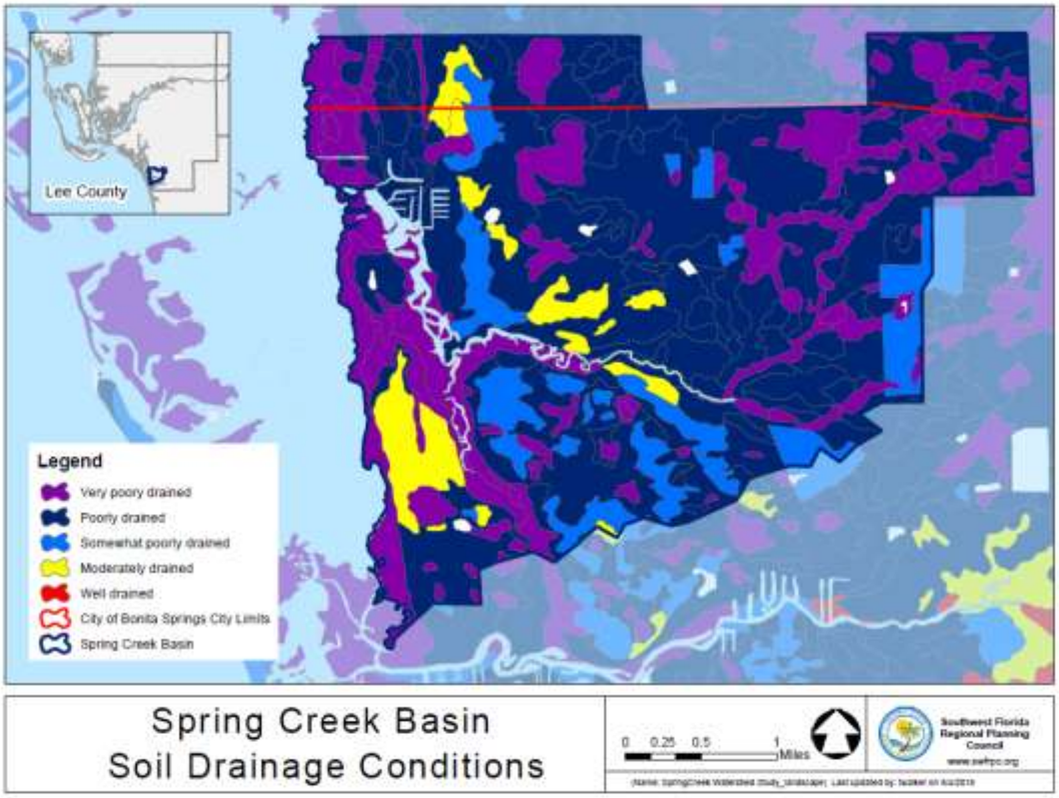


Figure 38: Drainage Characteristics of Soils

Existing Hydrology and Hydraulics Plans

Spring Creek tributary flows to Estero Bay have been altered by enhancements intended to drain land surfaces during the wet season and to retain water behind weirs and salinity barriers during the dry season. This continues to result in a spiked hydroperiod with reduced to little discharge of water during the dry season and sharp peaks of discharge during rain events, particularly when water control structures are opened or overtopped. The reduction of surface water retention through percolation into the landscape and the elimination of gradual sheetflow delivery to the estuary has shortened freshwater wetland hydroperiods. Surface water table elevations have been lowered, formerly flowing springs ceased and or capped and drought conditions are accentuated, encouraging the invasion of exotic vegetation into wetlands and increasing the severity of fire season. Fisheries and wildlife that are dependent on depressional wetlands and riparian habitats lose valuable breeding periods and nursery habitats as the hydrologic system acts as a flush plumbing mechanism. In some areas, wading bird breeding, particularly wood stork, is reduced and fails as wetlands drain too quickly and vital food concentration is lost. Amphibians, such as gopher frogs and tree frogs, are unable to complete reproductive life cycles. Under these conditions, exotic fish, amphibian and plant species fill in and flourish.

Data for analysis in this section is from the US Geological Survey.

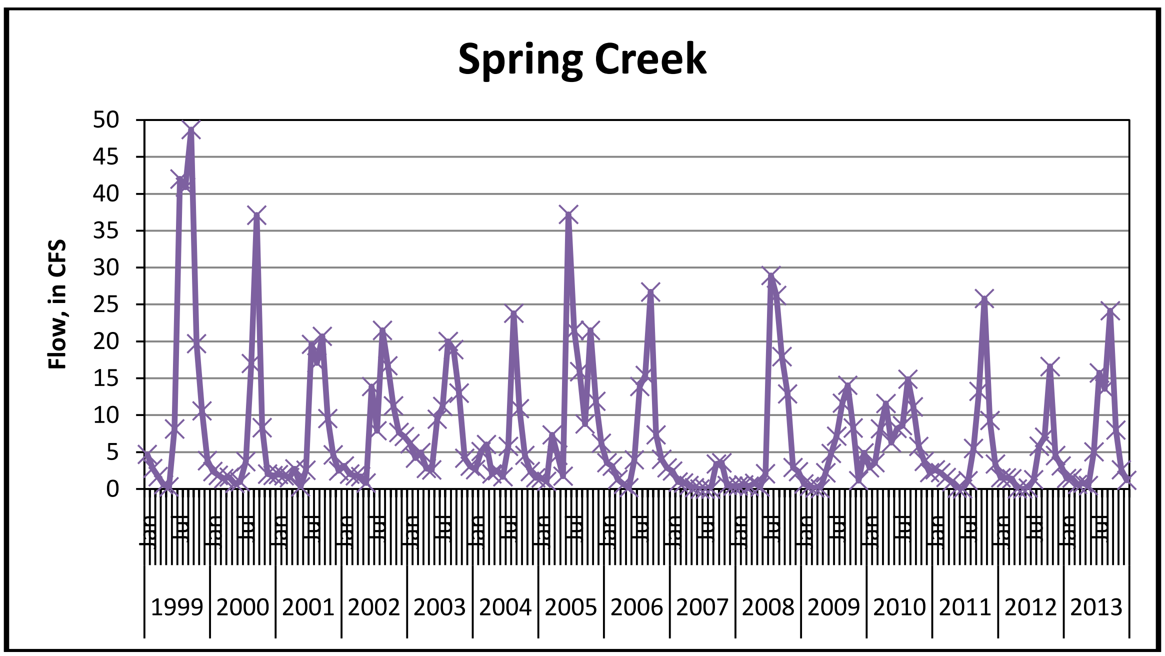


Figure 39: Recent Spring Creek Hydroperiod

The regional efforts in hydrology and hydraulics plans within the Estero Bay Watershed study area have been a component of the Comprehensive Everglades Restoration Plan (CERP) and the Southwest Florida Feasibility Study (SWFFS) which is now known as the Southwest Florida Comprehensive Waetrshed Plan (SWFCWP). The SWFCWP investigates water resources problems and opportunities in all or parts of Lee, Collier, Hendry, Glades, Charlotte, and mainland Monroe counties. The purpose of the study is to determine the feasibility of making structural, non-structural, and operational modifications and improvements in the region in the interest of environmental quality, water supply, and other purposes. The SWFCWP developed a comprehensive regional plan of action to address the health of aquatic and upland ecosystems; the quantity, quality, timing, and distribution of water flows; agricultural, environmental, and urban water supply; the sustainability of economic and natural resources; flood protection; fish and wildlife; biological diversity; and natural habitat. Modeling was used for detailed design and environmental output evaluation purposes. Hydrologic model development, environmental model development, water quality analyses, and water supply analyses refined alternative plan formulation. Cost-effectiveness and incremental cost analysis was used to compare different outputs resulting from the various levels of expenditures.

Four hydrologic and hydraulic models are used to support decision-making through the SWFCWP. They include the SWFCWP Regional Model, MIKE SHE, MIKE 11, and CH3D (Hydrodynamic Model). The 2003 Strategic Model Plan lists these models as a part of an overall model strategy for SFWMD. This plan can be viewed at: http://gwmftp.jacobs.com/Peer_Review/strategic_plan_final_2%200.pdf.

Hydrology and hydraulic studies and plans also includes stormwater and drainage planning efforts and a discussion of the identified problems that need to be addressed. The spatial relationship of these plans within the watershed, the time period that they were developed and the implementation extent are presented. Forty-five separate active Stormwater Master Plans (SMP) have been identified and collected.

Lee County

Lee County has pursued SMP development and implementation. The web page devoted to stormwater planning is http://www.lee-county.com/STORMWATER/MasterPlanpage.htm. According to the website: "One of the main purposes of the Plan was to identify the existing flowways, streams and runoff rates for each basin and provide recommendation for protection and improvement of each flow-way and stream. This is being done to protect upstream lands from additional flooding which might be caused from downstream developments. The first portion of the Surface Water Management Plan was an inventory of existing facilities on the major streams and a detailed study of Six Mile Cypress watershed. The Six Mile Cypress Watershed Plan was finished in February, 1990. This plan was adopted by the Board of County Commissioners on April 18, 1990." More watersheds were studied and the report was completed in June, 1991. In December 1992, additional watersheds were completed. In the most recent effort, Lee County is currently updating the Six Mile Cypress Plan.

Table 3: Lee County Water Management Plans

AUTHOR	DATE	PUBLICATION	GEOGRAPHIC AREA
MONTGOMERY	1988	LEE COUNTY WATER RESOURCES MANAGEMENT PROJECT	Lee County
BENDER	1990	MANAGING THE QUALITY, QUANTITY, AND TIMING OF SURFACE WATER DISCHARGE INTO THE ESTERO BAY STATE AQUATIC PRESERVE	Estero Bay
JOHNSON ENGINEERING	1992	VOL I & IIA, IIB, III MASTER PLAN DECEMBER 1992	Lee County
USDA	1992	FLOOD PRONE AREAS OF LEE COUNTY FLORIDA FLOOD PLAIN MANAGEMENT STUDY PHASE I ESTERO BAY AREA	Estero Bay
JOHNSON & HM	1998	SURFACE WATER MANAGEMENT PLAN VOL 1-3 CONVEYANCE INVENTORY REGIONAL MSTU/GIS MAPPING	Lee County

POST BUCKLEY	1998	SOUTH LEE COUNTY WATERSHED PLAN VOL I	Estero Bay
LEE COUNTY PUBLIC SAFETY	1999	LEE COUNTY FLOODPLAIN MANAGEMENT HAZARD MITIGATION PLAN 1999	Lee County
PSI	2001	LEE COUNTY ENVIRONMENTAL SERVICES NATURAL RESOURCES DIVISION FLOW MEASUREMENT PROJECT	Lee County
LEE COUNTY PARKS & REC	2002	SIX MILE CYPRESS SLOUGH PRESERVE LAND STEWARDSHIP PLAN 2002	Six Mile Cypress Slough

City of Bonita Springs

In 2002, the City of Bonita Springs completed a Stormwater Master Plan (SMP). The SMP presented the history of flooding in Bonita Springs, prepared 2 foot contour maps of the City, delineated drainage basins, and identified thirteen of the most seriously flood prone areas. General cost estimates were prepared for improvements in these areas, with detailed estimates for remedial measures within the three more serious problem areas. The improvements in the thirteen areas were estimated to cost approximately $4 million in 2002. The SMP also estimated annual Stormwater system maintenance costs and projected this to a cost per household. The total value of the annual O & M (operation & maintenance) costs was expected to total approximately $0.5 million per year. The City initiated a feasibility study for a Stormwater Utility. The report for the Feasibility Study of a Stormwater Utility was completed. Over the past two years the City has undertaken many "small" projects to improve both storm water quantity and quality. Several of these have implemented a portion of some of the thirteen areas addressed in the Stormwater Master Plan. The City has also been able to obtain two grants from SFWMD to assist in these improvements. Currently, the City is develops 5-year Financial Plans that show the City funding the recommended CIP improvements over a 10-year period, along with the necessary O & M.

Table 4: Bonita Springs Stormwater Management Plans

AUTHOR	DATE	PUBLICATION	GEOGRAPHIC AREA
HARTMAN & ASSOC	2002	STORMWATER MASTER PLAN VOLUME I FOR THE CITY OF BONITA SPRINGS	Bonita Springs

SFWMD

To assist local governments in the Estero Bay Watershed area, SFWMD has developed and implemented various stormwater plans.

Table 5: SFWMD Stormwater Management Plans

AUTHOR	DATE	PUBLICATION	GEOGRAPHIC AREA
JOHNSON ENG	1999	SOUTH LEE COUNTY WATERSHED PLAN	Estero Bay
POST BUCKLEY	2002	ESTERO BAY & WATERSHED ASSESSMENT	Estero Bay

Lee County and Bonita Springs have prepared GIS maps of outfall locations for their NPDES permits. The Town of Fort Myers Beach has begun mapping them but the work is not completed yet. The City of Fort Myers reports the mapping of outfalls to be a need. Infrastructure such as catch basins and piping has been mapped in only a few places. A comprehensive inventory and map of catch basins and piping are needed.

Summary of Hydrology Vulnerabilities and Issues of Concern for Spring Creek

Hydrology management issues of concern for the Spring Creek Watershed include:

1) the reconnection of the original headwaters of Spring Creek located east of Interstate 75 in the Flint Penn strand to the headwaters located in the San Carlos Estates and the north branch of Spring Creek

2) improvement of undersized culverts to larger capacity

3) removal of man-made damming of tributaries to the creek

4) modifications of weirs and causeway barriers impeding flow in the upper and middle reaches of the creek

5) placement ditch block/ structures in swales within San Carlos Estates to delay and control runoff.

6) removing sand shoals that have formed in the lower estuarine portions of the creek.

PART 2: Water Quality

Water Quality Monitoring

This section presents information on water quality monitoring performed and the water quality status and trends for the four basins. Terms defining the different water quality parameters can be found at: www.epa.gov/trs/.

In Southwest Florida and the Spring Creek Watershed, water quality data are collected by numerous agencies and volunteer organizations. All of these entities have water quality monitoring programs that sample at varying frequencies for various core analytes. Each is presented below. These data are normally placed into a central database that is maintained by the State of Florida. The database STOrage and RETrieval (STORET) is a structure used nation-wide and used for water quality analysis. Most large area analysis of water quality begins with the use of STORET.

The Charlotte Harbor Environmental Center (CHEC), Watershed Resources Center, with funding from the SWFWMD and CHNEP develops up-to-date maps of water quality for Charlotte Harbor estuarine waters and maintains a water quality monitoring website. CHEC works directly with the agencies that collect and analyze water quality samples on a routine basis. CHEC receives the data as soon as it is available, normally 1-2 months after collection. The tabular data are drawn into a GIS environment and values are interpolated spatially. The user of the Internet site may compare monthly water quality maps with medians from the 1993-2000 time frames. CHNEP is working with CHEC to develop methods to expand the mapping to include the Estero Bay area. The site is: http://www.checflorida.org/chec/waterquality.htm.

The Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN)

This program is managed by FDEP Charlotte Harbor Aquatic Preserve Office in Punta Gorda. There are over 100 volunteers that take monthly, synoptic water quality samples at approximately 44 fixed stations from Lemon Bay, Charlotte Harbor and southward to Estero Bay. Eight stations are located in Estero Bay. Water samples are tested for:

dissolved oxygen	water temperature	wind speed & direction
pH	air temperature	precipitation
salinity	water clarity	weather & water surface conditions
water color	water depth	tide stage

This program started in 1996 and the data are available at: http://www.dep.state.fl.us/coastal/sites/charlotte/volunteer/waterquality.htm.

FDEP monitoring programs

FDEP is responsible for identification of impaired waters pursuant to the Impaired Waters Rule (see the next section concerning Impaired Waters). FDEP completes compliance monitoring, algal bloom complaints, and studies as required including Total Maximum Daily Loads (TMDL) data gaps, lake (wet season) and stream (wet and dry season) condition indexes. Benthic, habitat condition, pesticides and periphyton studies can be included. Water samples are tested for:

dissolved oxygen	Total Phosphorus	Chlorophyll A (corrected)
pH	Ortho Phosphate	Heavy Metals
water temperature	Total Nitrogen	Alkalinity
conductivity	NO_2-NO_3	BOD
color	TKN	turbidity

Florida Fish and Wildlife Conservation Commission
The Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute (FWRI) collect and compile information related to red tide levels and shell fish closures. This information is available for Southwest Florida at: http://www.floridamarine.org/features/view_article.asp?id=12373.

South Florida Water Management District
Water quality data are taken on a monthly frequency and used to produce annual technical reports on the current status and trends of several nutrients and physical attributes of the system, provide supporting data for water supply modeling, and contribute to a growing body of regional data made available to all interested parties. Analytes collected under this program are below. Lee County Environmental Lab collects and analyzes the samples for the SFWMD and has added several additional analytes to the SFWMD effort. Water samples are tested for:

Chlorophyll A (corrected)	Ortho Phosphate	water temperature
Color	PAR (4 pi Licor)	TKN
Conductivity	pH	TN
dissolved oxygen	salinity	TOC
NH_3	Secchi disk depth	Total Phosphorus
NO_2-NO_3	silica	Turbidity

In addition, SFWMD maintains a central database, similar to STORET named DBHYDRO. DBHYDRO is the SFWMD's environmental database, storing hydrologic, meteorologic, hydrogeologic, and water quality data. It contains data collected by the SFWMD and other agencies and organizations. To assess water quality within 16 South Florida counties, the SFWMD monitors surface water in a variety of locations, including canals, pumping stations, agricultural discharges, and many other types of aquatic environments. The District also monitors sediments and fish for a variety of pollutants, including nutrients, trace metals and pesticides, which can be conveyed by water.

The Southwest Florida Feasibility Study (SWFFS) developed by the SFWMD jointly with the US Army Corps of Engineers includes a Water Quality analysis completed in June 2004, entitled "Compilation, Evaluation, and Archiving of Existing Water Quality Data for Southwest Florida." The work was completed by TetraTech with the assistance of Janicki Environmental, Inc. This report is an extensive listing of water quality data available as of early 2004 throughout the entire lower southwest Florida region. Each set of data is evaluated for quality and the times and parameters tested are detailed. The location of the data is also provided, with a large percentage in the DBHYDRO database. The data were used to identify areas for potential concern and gaps in important information. The analysis and database of water quality readings is available from the SFWMD on CD.

Lee County
Lee County's water quality monitoring program, managed by the County's Environmental Lab, samples 14 sites on a monthly basis at fixed stations in Pine Island Sound and Matlacha Pass, 14 fixed sites in Estero Bay, and approximately 90 stations throughout the County at freshwater sites such as 10-Mile and 6-Mile. The water samples are analyzed for core analytes including:

Aluminum	Enterococci	Secchi disk depth
Arsenic	Fecal coliform	Selenium
BOD	Flow and stage	silica
Cadmium	Lead	TKN
Chlorine	Mercury	TN

Chlorophyll A (corrected)	Nickel	TOC
Chromium	NH_3	Total alkalinity
COD	NO_2-NO_3	Total Phosphorus
Color	Ortho Phosphate	Turbidity
Conductivity	PAR (4 pi Licor)	water temperature
Copper	pH	Zinc
dissolved oxygen	salinity	

Data from this program are maintained at the Environmental Lab and uploaded into STORET and can be viewed at a new website maintained by the County at: http://lcems.edats.com/. The County also runs a new atmospheric deposition monitoring station on Lover's Key that collects both wet and dry nitrogen deposition rates.

Lee County Hyacinth Control District

The Lee County Hyacinth Control District (LCHCD) manages a program called Pondwatch. Pondwatch is a volunteer monitoring program created in 1993 by the LCHCD to help residents manage ponds and lakes and to answer their concerns about problems related to aquatic weeds in Lee County. Both seasonal and permanent residents participate in the program, averaging 10 – 15 participants per month. Water samples are collected monthly and brought to the LCHCD's water quality laboratory for chemical analysis of total phosphorus, orthophosphate, ammonia, nitrites-nitrates, and chlorophyll-a. Some of the benefits experienced by some participating groups have been a reduction of the chemical control required to maintain the ponds. Other communities have followed recommendations for aeration systems minimizing the potential for stratification and dissolved oxygen problems.

Charlotte Harbor National Estuary Program

The Charlotte Harbor National Estuary Program (CHNEP) coordinates the Coastal Charlotte Harbor Monitoring Network. In support of its long-term monitoring strategy, an inter-agency, collaborative program was initiated in April 2001 for the coastal Charlotte Harbor region, including the tidal Caloosahatchee, Peace and Myakka Rivers, and Estero and southern Lemon Bays. SWFWMD, SFWMD, Charlotte and Lee Counties, FWC-FWRI, the Cities of Sanibel and Cape Coral, and FDEP Charlotte Harbor Aquatic Preserve monitor the region using a stratified, random sampling design for the core analytes listed in the CHNEP CCMP, including biological, nutrient and field parameters. The Charlotte Harbor and Lemon and Estero Bay region is broken into 12 strata with five monitoring stations randomly chosen every month for each. The Lower Charlotte Harbor strata are listed below:

Lower Charlotte Harbor within Charlotte County	Matlacha Pass
Bokeelia region of Charlotte Harbor	San Carlos Bay
Tidal Caloosahatchee River	Pine Island Sound
Estero Bay	

This program comprehensively monitors the ambient water quality conditions of the coastal Charlotte Harbor region and will allow resource managers to determine if conditions for this large area are improving or degrading over time. The analytes collected by the Network are as follows, although some members may collect additional such as bacteria, BOD and silica, depending on resources and interests:

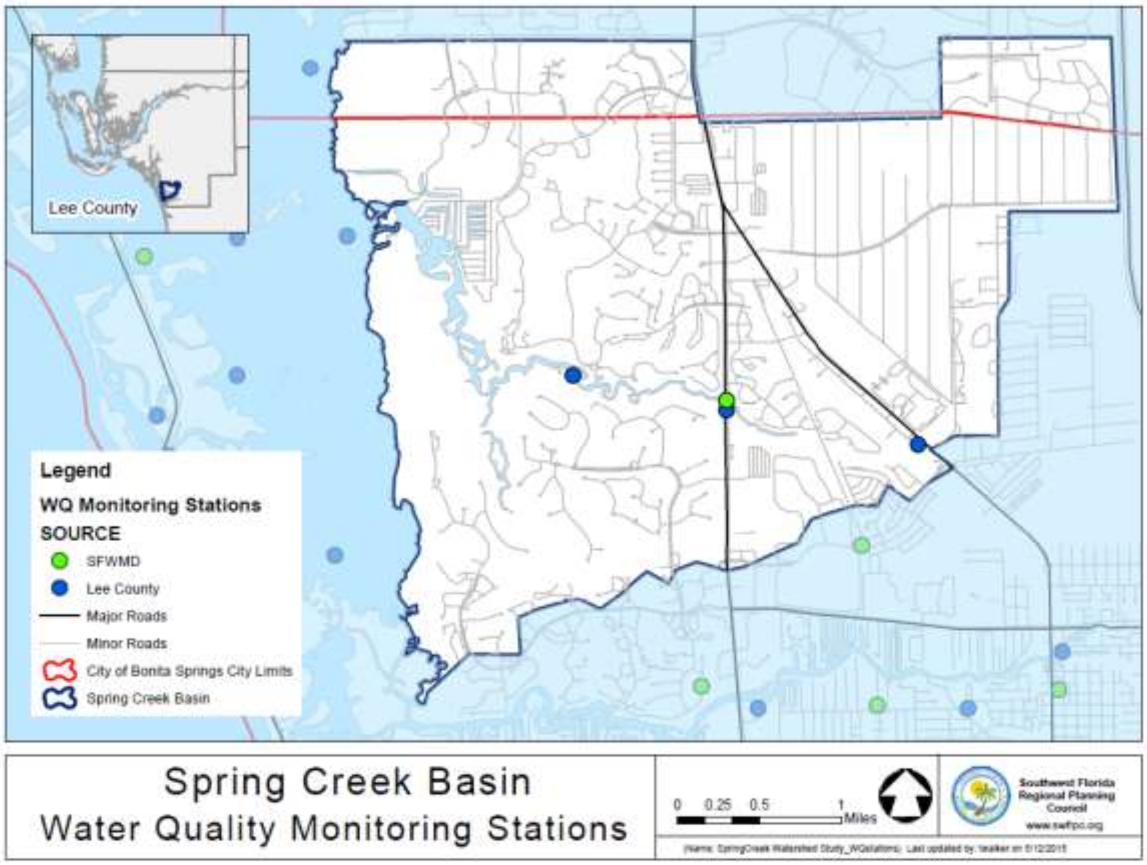
Chlorophyll A (corrected)	Ortho Phosphate	TKN
Color	PAR (4 pi Licor)	TN
Conductivity	pH	TOC
dissolved oxygen	salinity	Total Phosphorus

NH_3	Secchi disk depth	Turbidity
NO_2-NO_3	water temperature	TSS

In 2003, the CHNEP published its Water Quality Status and Trends Report. The report was completed by Janicki Environmental, Inc. and developed methods which were later used for the SWFFS study discussed above. Findings were consistent between the two studies where the geographic area coincided.

Water Quality Monitoring Locations
Spring Creek Watershed are shown as Figure 40.

Figure 40: Current Fixed Water Quality Monitoring Station Locations



Outstanding Florida Waters

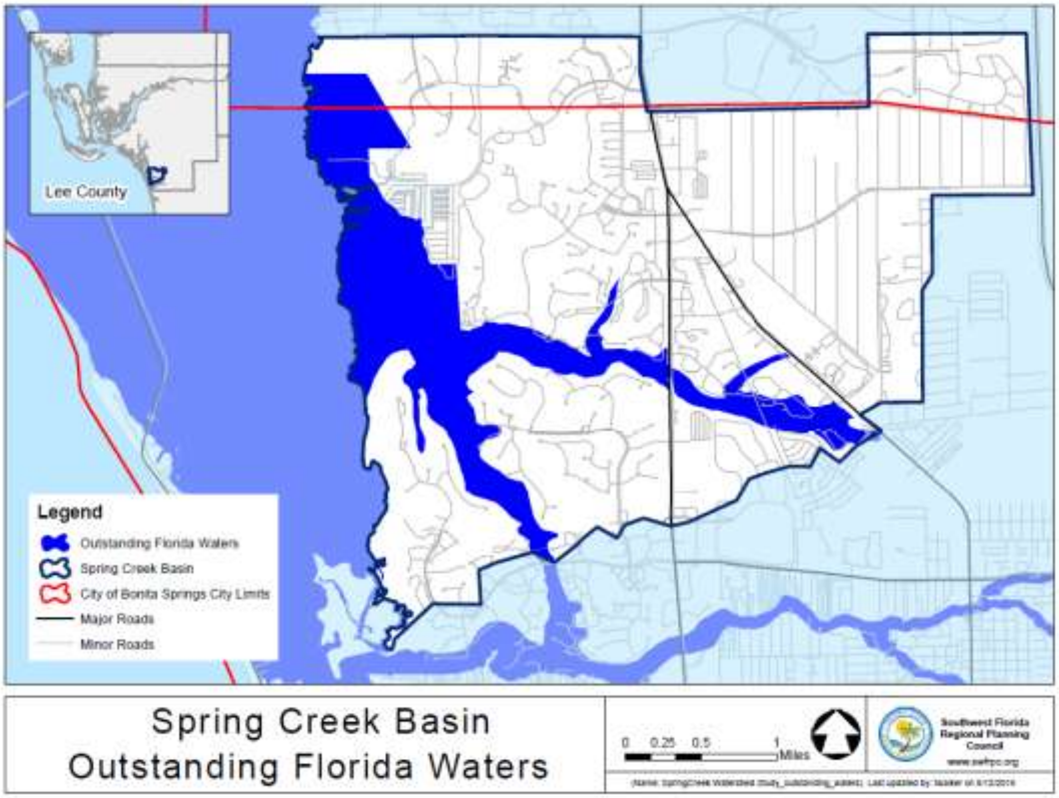


Figure 41: Outstanding Florida Waters in the Spring Creek Watershed.

Impaired Waters

In Florida, the Clean Water Act (CWA) is implemented through the Watershed Restoration Act of 1999 (FS 403.067). The state's Impaired Waters Rule (IWR) was adopted in 2001 as Chapter 62-303, Florida Administrative Code. The IWR establishes a methodology to identify surface waters of the state that will be included on the state's planning list of waterbodies. It also establishes a methodology to identify impaired waters that will be included on the state's verified list of impaired waters, for which the FDEP will calculate Total Maximum Daily Loads (TMDLs).

Section 303(d) of the Clean Water Act (CWA) requires states to list waters that do not meet applicable quality standards and establish Total Maximum Daily Loads (TMDLs) for those waters on a prioritized schedule. TMDLs establish the maximum amount of pollutants a water body can assimilate without exceeding water quality standards. In 1998, EPA approved Florida's 1998 303(d) Impaired Waters list, which was based either on existing, readily available data or best professional judgment. State waterbodies were on the 1998 303(d) list. However, in 1999, the Florida Watershed Restoration Act, Section 403.067, FS was enacted by the Florida Legislature. This law requires FDEP to adopt, by rule, a scientific methodology for analyzing environmental data and determining whether a waterbody is impaired or healthy. All waterbodies on the 1998 303(d) list are required to be either 1) verified as impaired, 2) de-listed as they are meeting water quality standards, or 3) placed on a planning list if insufficient data exist (Category 3). FDEP's 2002 update to Florida's 1998 303(d) Impaired Waters List for Group 1 Basins with sufficient data (Category 5) was amended August 2002 by

Secretarial order and submitted to EPA October 2002. The verified list was amended March 11, 2003 by Secretarial order. The 2002 update was developed in accordance with EPA guidelines for Integrated Water Quality monitoring and Assessment Reports. Group 1 included Everglades West, which includes Estero Bay. FDEP's 2004 update to Florida's 1998 303(d) Impaired Waters List for Group 2 Basins with sufficient data (Category 5) was adopted May 27, 2004 by Secretarial order, including Charlotte Harbor, a portion of which is Charlotte Harbor, Pine Island Sound, and Matlacha Pass. FDEP's 2005 update to Florida's 1998 303(d) Impaired Waters List for Group 3 Basins with sufficient data (Category 5) was adopted June 20, 2005 by Secretarial order, including the Caloosahatchee basin. The Florida Watershed Restoration Act addresses processes for refining the list for calculating and allocating TMDLs. According to EPA guidelines, waters expected to attain and maintain applicable water quality standards through other Federal, State, or Local requirements do not need to be included on the 303(d) list pursuant to approval of "Reasonable Assurance."

Water bodies were divided into five groups, and a five-year rotation of assessment, analysis, and implementation was established. In 2000, FDEP began addressing the first group of basins (Group 1) and continues to initiate activities in a new group (Groups 2 through 5) each year over a five-year cycle to cover the entire state.
The general sequence of the five-year cycle is:

Phase 1- Basin Assessment
Preliminary basin assessment focusing on existing data.

Phase 2 –Verified List
Strategic water quality monitoring to obtain additional detailed scientific evidence of water quality conditions and adoption of basin-specific verified lists of impaired waters.

Phase 3 – Total Maximum Daily Loads (TMDL)
Data analysis and TMDL development and adoption where impairment exists.

Phase 4 – Basin Management Action Plans (B-MAP) Development
Development of a Basin Management Action Plan, in conjunction with local stakeholders, to allocate, among the local sources of pollution, reductions necessary to meet the TMDL.

Phase 5 - B-MAP Implementation

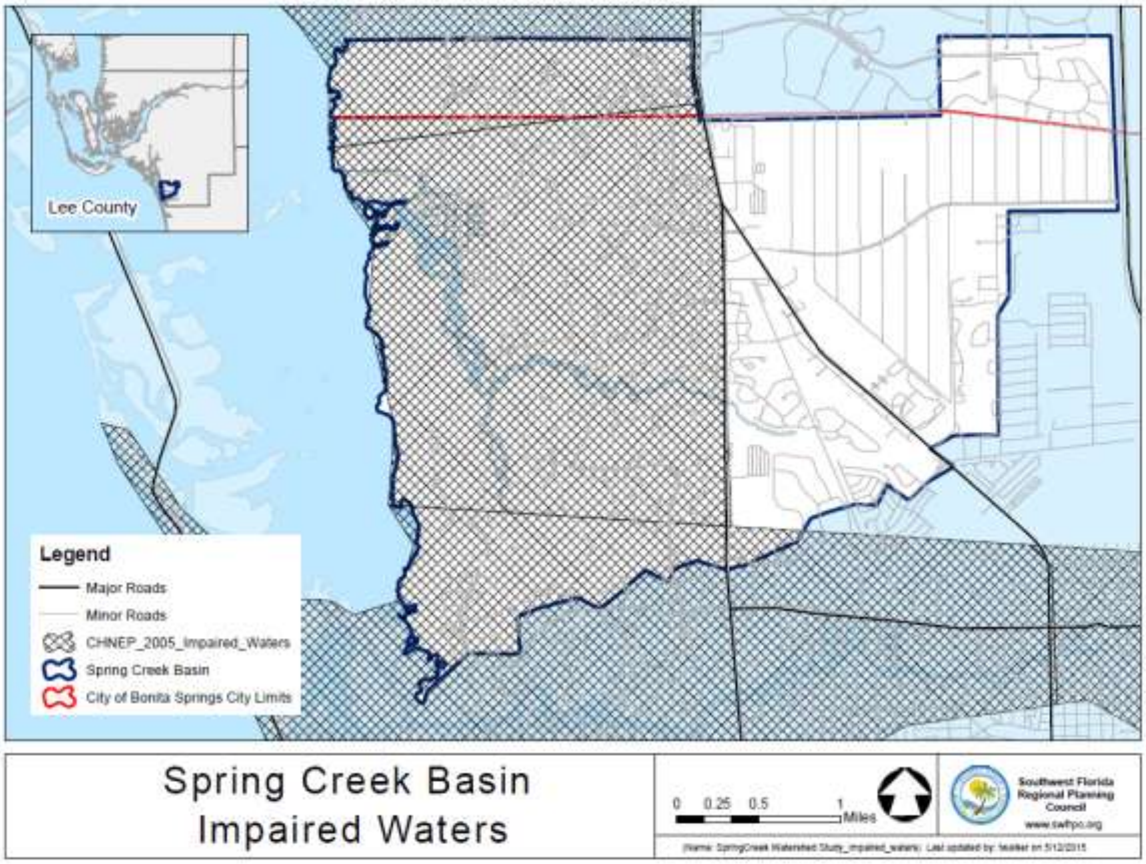
Implementation of the TMDL.

In Lower Charlotte Harbor, Everglades West (including Estero Bay) is in Group 1. Charlotte Harbor (including Pine Island Sound) is in Group 2. Caloosahatchee (both fresh and tidal portions) are in Group 3.

Integrated Assessment

FDEP's integrated assessment (Figure 42) areas attaining some designated uses (white), and areas were water quality is not attained (hatched).

Figure 42: Impaired Waters Designation for Spring Creek



Designated Uses

When FDEP considers water quality impairments, the impairment assessment is based on the use of the waterbody. For example, Class 1 waters are designated for drinking water and must be held to a higher standard than other class designations. Class 2 waters are for shell fishing and must have lower bacteria levels than other classes. Therefore, Pine Island Sound may have impairment for bacteria but may have lower bacteria levels than Class 3 waters designated for fishing and swimming that may not be shown to have impairment. More information about the Clean Water Act is available at: http://www.cleanwateract.org/.

Waters not belonging to Class 1 or Class 2 is designated Class 3. Class 3 designated uses include fishing and swimming.

The Estero Bay planning unit is in Group 1 as part of the Everglades West group. Estero Bay has seven waterbodies that are impaired. The impaired waterbodies by name, Water Body Identification (WBID) and impairment(s) are as follows.

In 2007 Spring Creek marine (WBID 3258H1) had verified nutrient impairments. Copper impairments affect the marine section of Spring Creek (WBID 3258H1).

Figure 43: Estero Verified Impairments

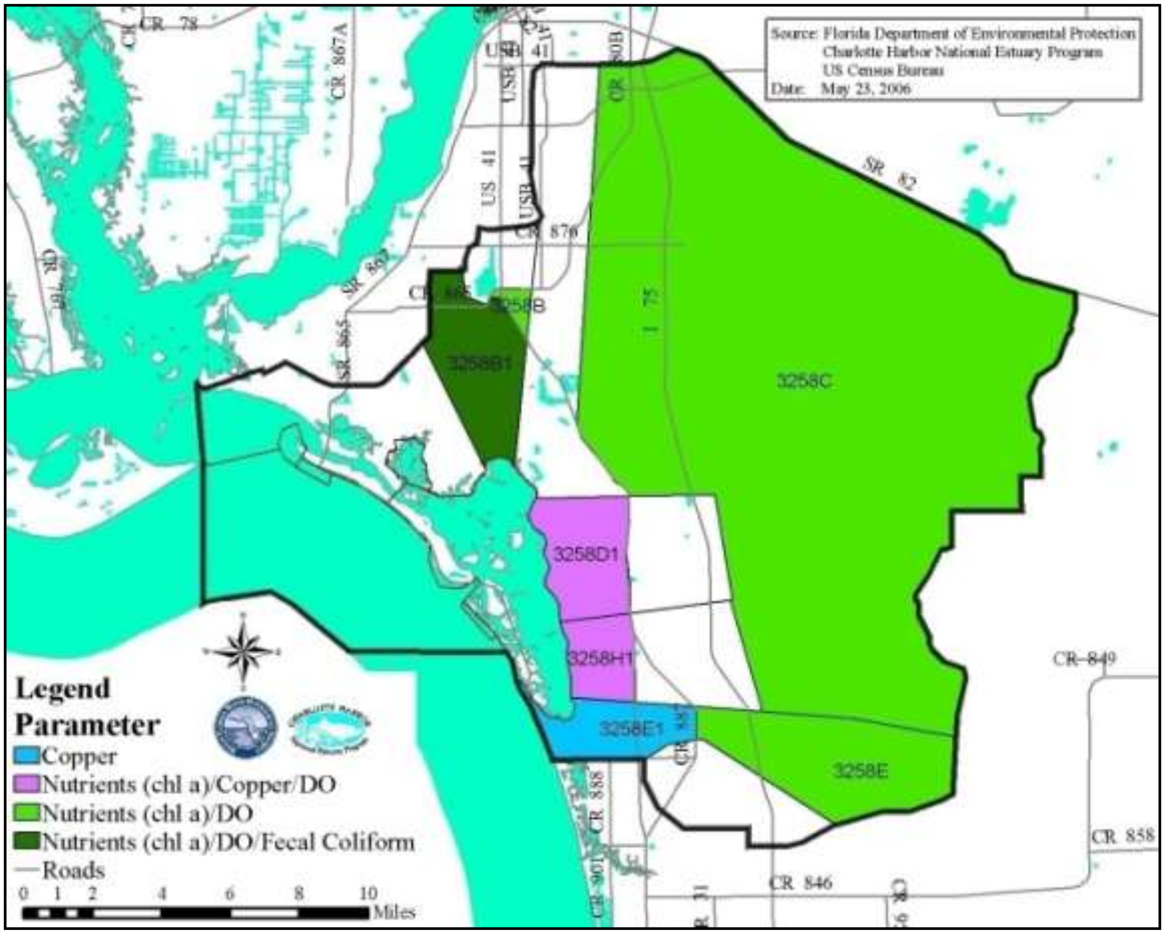

Source: Florida Department of Environmental Protection
Charlotte Harbor National Estuary Program
US Census Bureau
Date: May 23, 2006
3258B
3258B1
3258C
3258D1
3258H1
3258E1
3258E
Legend
Parameter
Copper
Nutrients (chl a)/Copper/DO
Nutrients (chl a)/DO
Nutrients (chl a)/DO/Fecal Coliform
Roads
0 1 2 4 6 8 10
Miles

Table 6: Estero Bay TMDL Schedule and Impairments

WBID	Water Segment Name	1998 303(d) Parameters of Concern	Parameters Assessed Using the 2001 Impaired Surface Waters Rule (IWR)	Comments (# of Exceedences/ # of Samples) PP=Planning Period VP=Verified Period[3]
3258H1	SPRING CREEK MARINE		Dissolved Oxygen	pp = 194 / 287; vp = 57 / 115. Causative pollutant linked to nutrients with TN/TP ratio median of 16.4 mg/L (84 obs). Listed as impaired on Cycle 1 Verified List.
3258H1	SPRING CREEK MARINE		Nutrients (chlorophyll-a)	Chlorophyll-a annual averages exceeded the 11 ug/L threshold for estuaries in 2001 -2004. Chlorophyll-a annual average in 2001 is 14.48 ug/L, 2002 is 13.29 ug/L, 2003 is 14.41 ug/L, 2004 is 12.80 ug/L, 2005 is 6.11 ug/L, and 2006 is 2.96 ug/L. Nutrient impairment due to co-limitation of nitrogen and phosphorus. Need one more year to have three consecutive years not exceeding threshold. Listed as Impaired on Cycle 1 Verified List.
8999	FLORIDA GULF COAST	Mercury (Fish Tissue)	Mercury (Fish Tissue)	Data verified to be within the last 7.5 years (2002, 2003/2004). Confirmed recent data for coastal and associated estuary fish advisories for king mackerel and bull shark. This includes the following WBIDs; 3258A, 3258B1, 3258C1, 3258D1, 3258E1, 3258F, 3258H1, 3258I, 3258J, 3259A, 3259M, 3259Z, 3278I, 3278Q, 3278R, 3278U, 8060, 8061, 8062, 8063, 8064, and 8065. Confirmed recent data for freshwater fish located in fish advisories for largemouth bass. This includes the following WBIDs: 3261B and 3261C in 2006, 3266A and 3278M from 2002 - 2004. Confirmed recent data in 2003 for freshwater fish advisories for warmouth. This includes the following WBIDs: 3259I and 3278I. Average HG levels were 0.67 mg/kg in king

				mackerel, 1.85 mg/kg in bull shark, 0.51 mg/kg in warmouth, and 0.89 mg/kg in largemouth bass which exceeded the threshold of 0.43 mg/kg of mercury.

Trends

The report entitled “Compilation, Evaluation, and Archiving of Existing Water Quality Data for Southwest Florida” is discussed in Section 5 of this report. The report included a discussion of water quality trends for the LCH area plus Big Cypress basin. The report evaluates data quality and details it, evaluates and identifies trends; identifies water quality parameters of concern; and identifies data gaps. For the purposes of the study, “shallow trends” were defined as statistically significant trends with a rate of change less than 5% per year of the median value for the period of record for the waterbody, and “steep trends” were defined as statistically significant trends with a rate of change greater than or equal to 5% of the median value per year. Thus, “shallow trends” represent water quality conditions that are changing (either decreasing or increasing) at a lesser rate of change than the rate of change for “steep trends”. These are relative terms, and the actual estimated rates of change are presented for each station in the statistical summary tables as described in the report. The terms “steep” and “shallow” do not imply ecological significance or lack of ecological significance.

The following figures show trends of dissolved oxygen, bio-chemical oxygen demand, turbidity, total suspended solids, Kjeldahl nitrogen, total phosphorous, and chlorophyll a trends

Figure 44: Dissolved Oxygen Trends

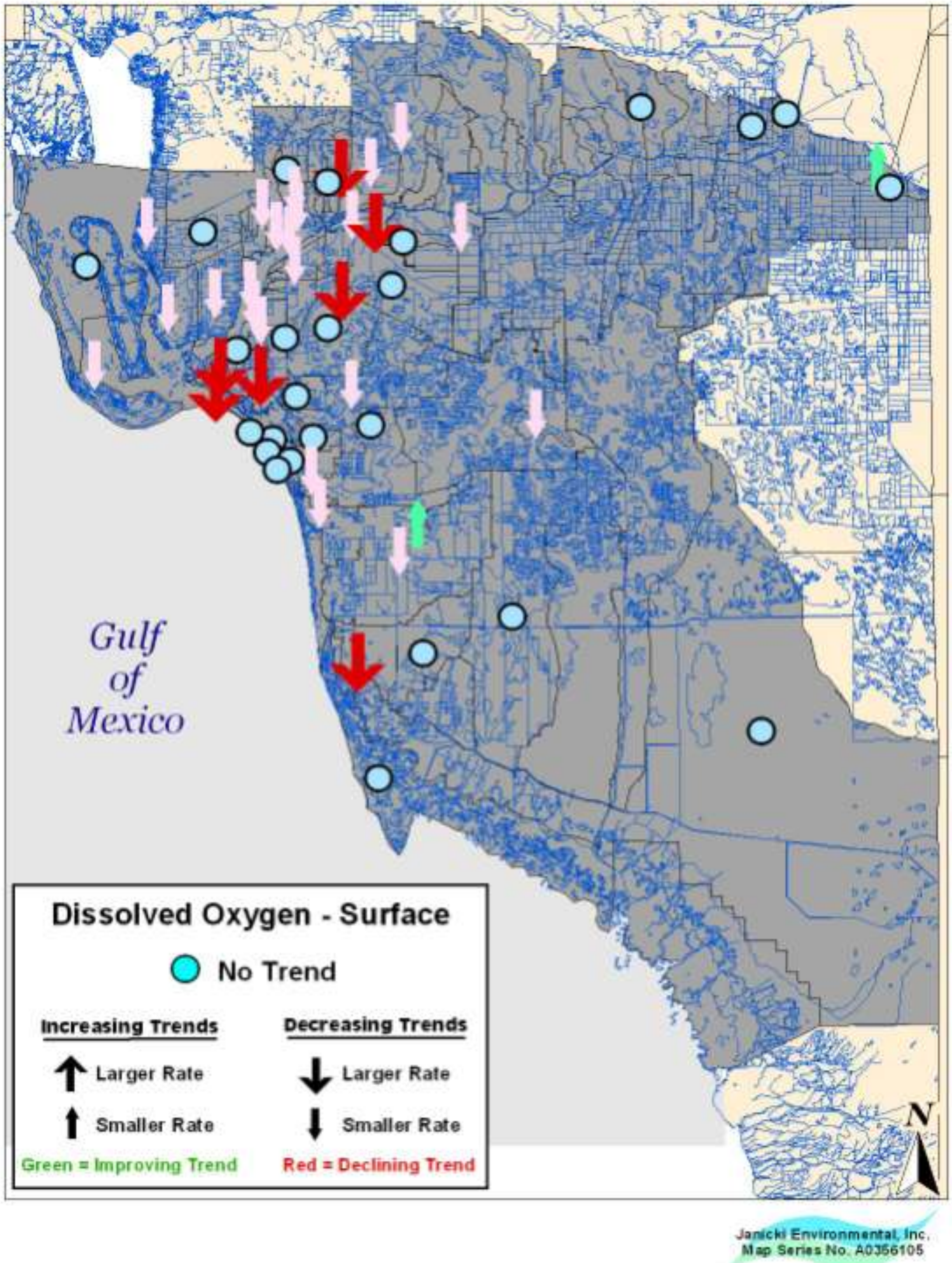


Figure 45: Bio-Chemical Oxygen Demand Trends

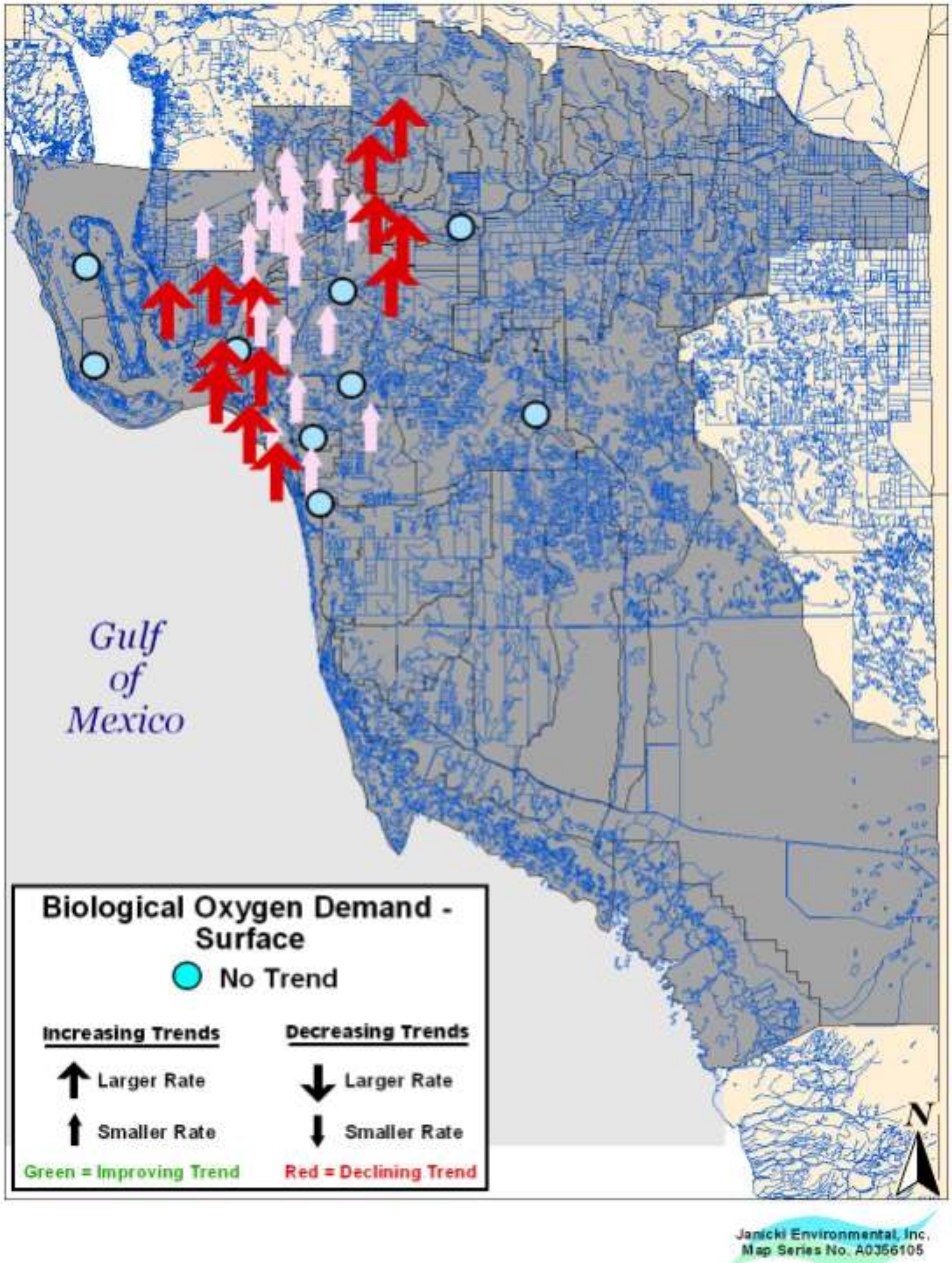


Figure 46: Turbidity Trends

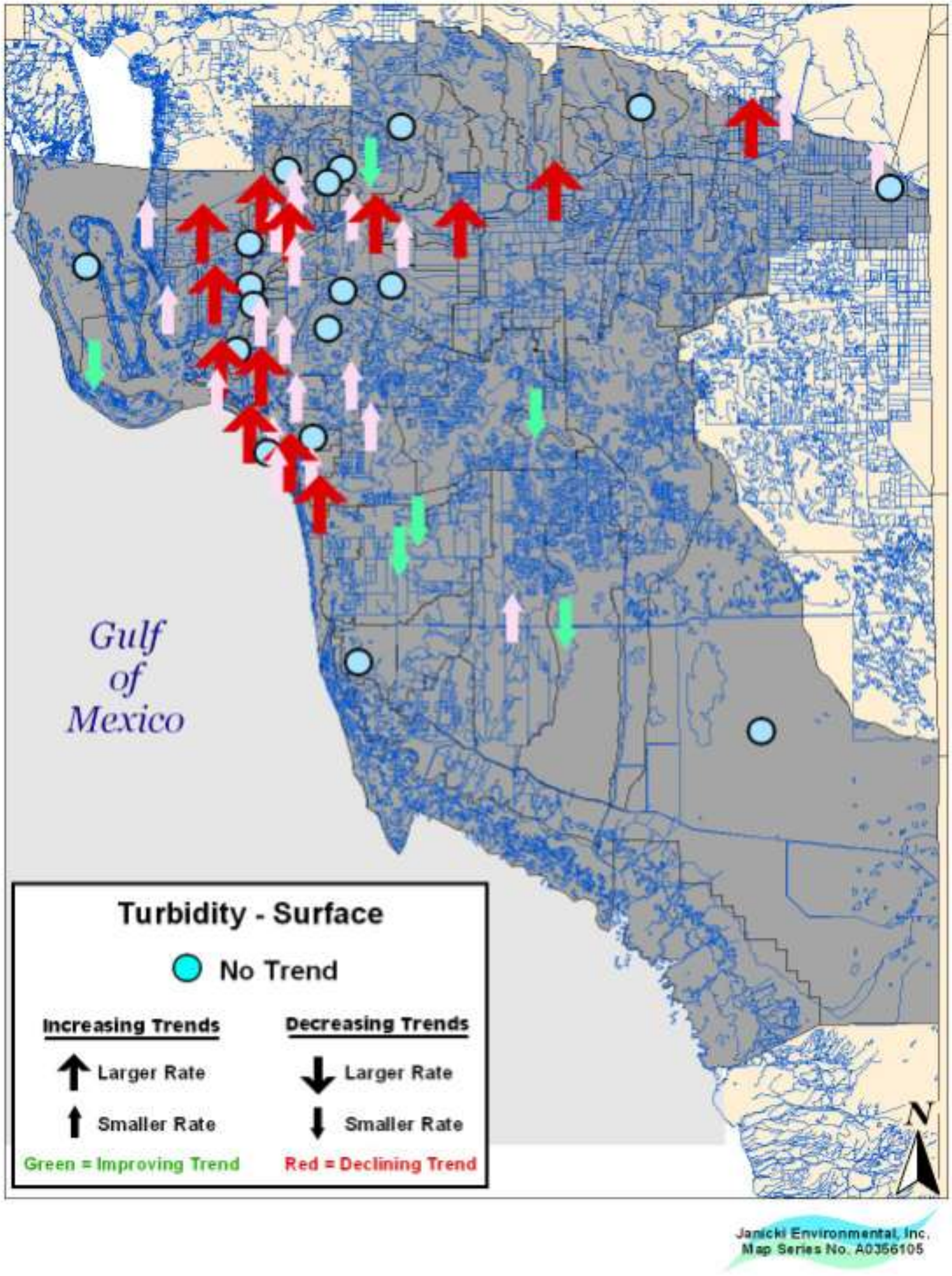


Figure 47: Total Suspended Solids Trends

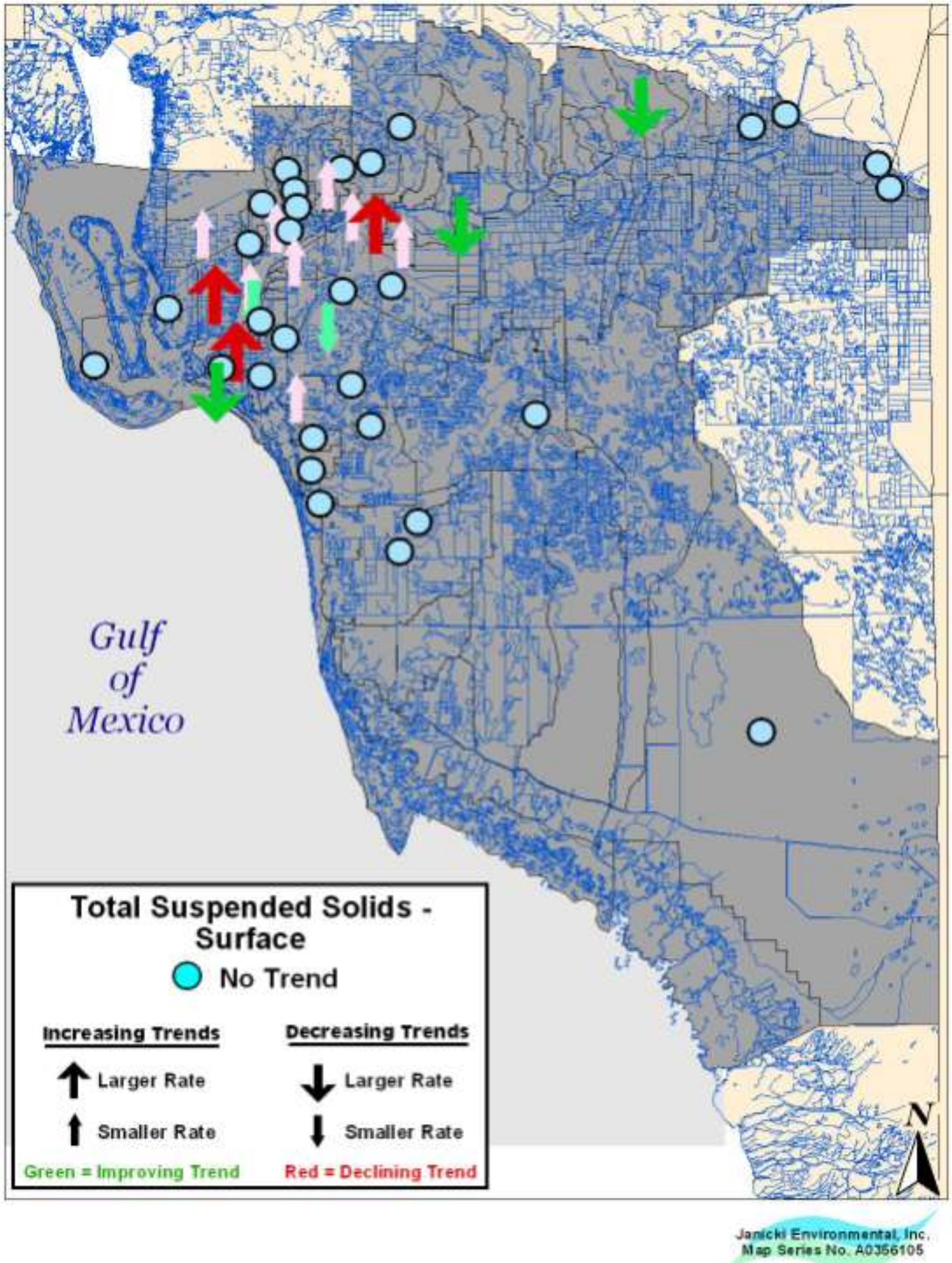
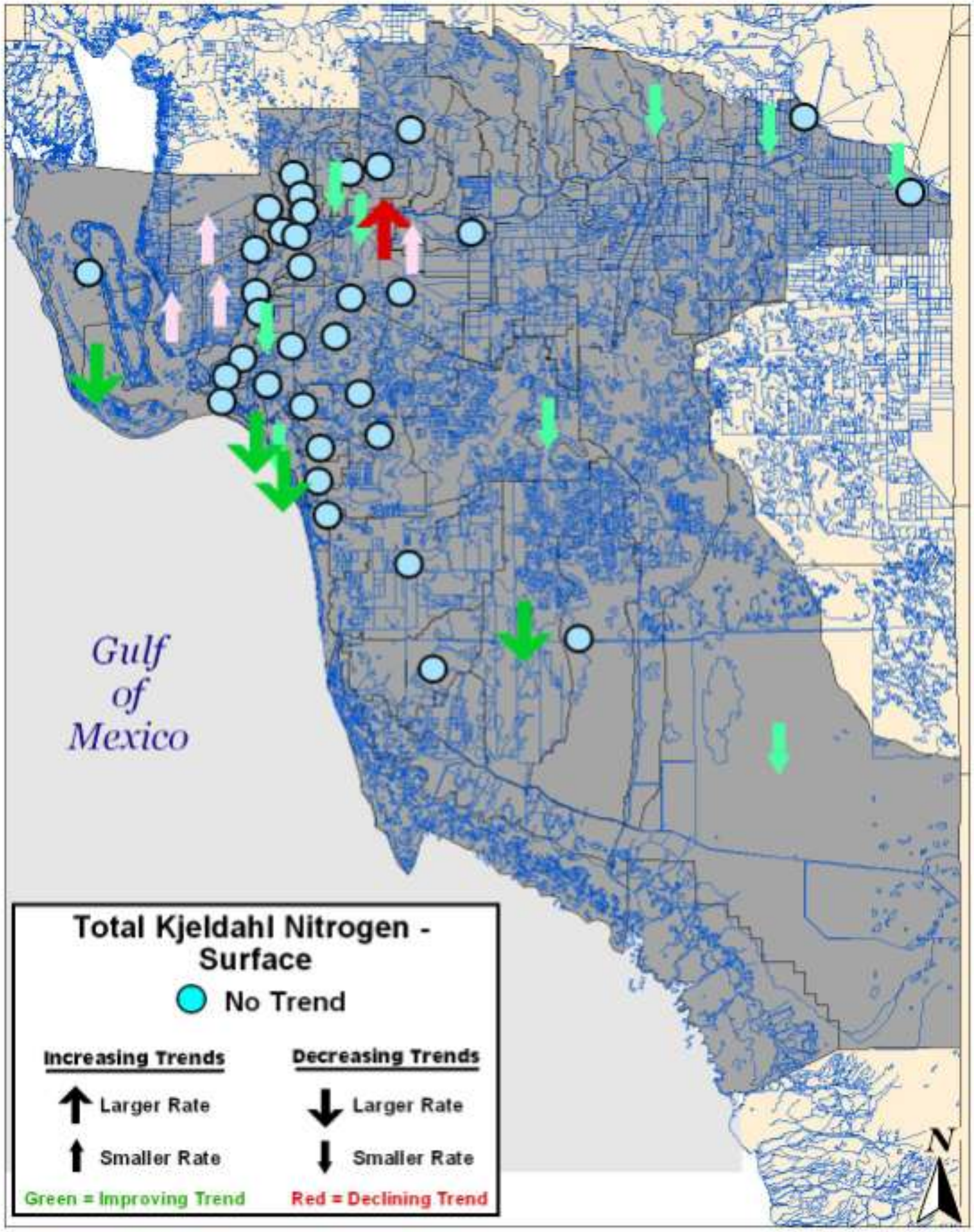


Figure 48: Total Kjeldahl Nitrogen Trends



Janicki Environmental, Inc.
Map Series No. A0356105

Figure 49: Total Phosphorous Trends

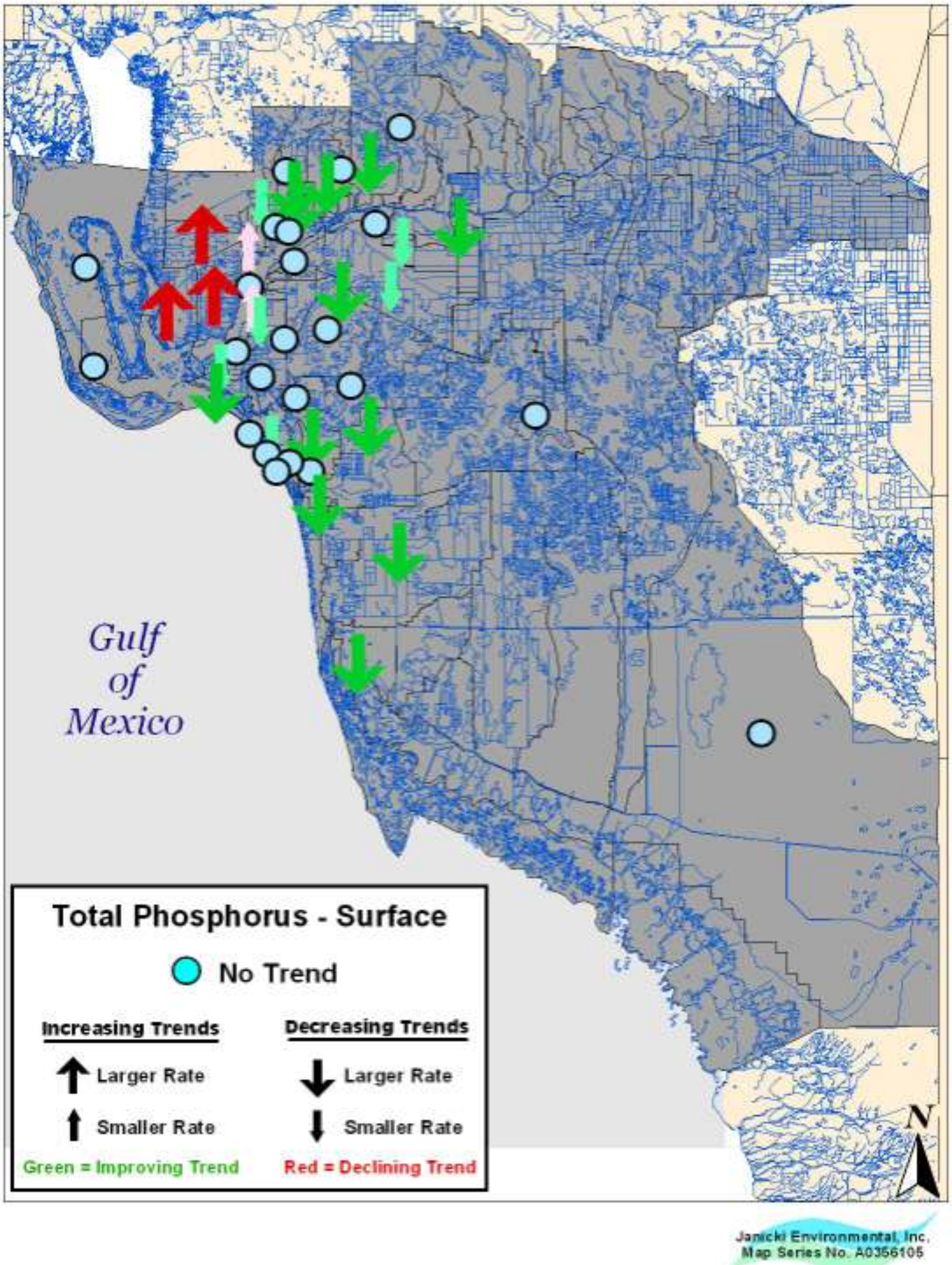
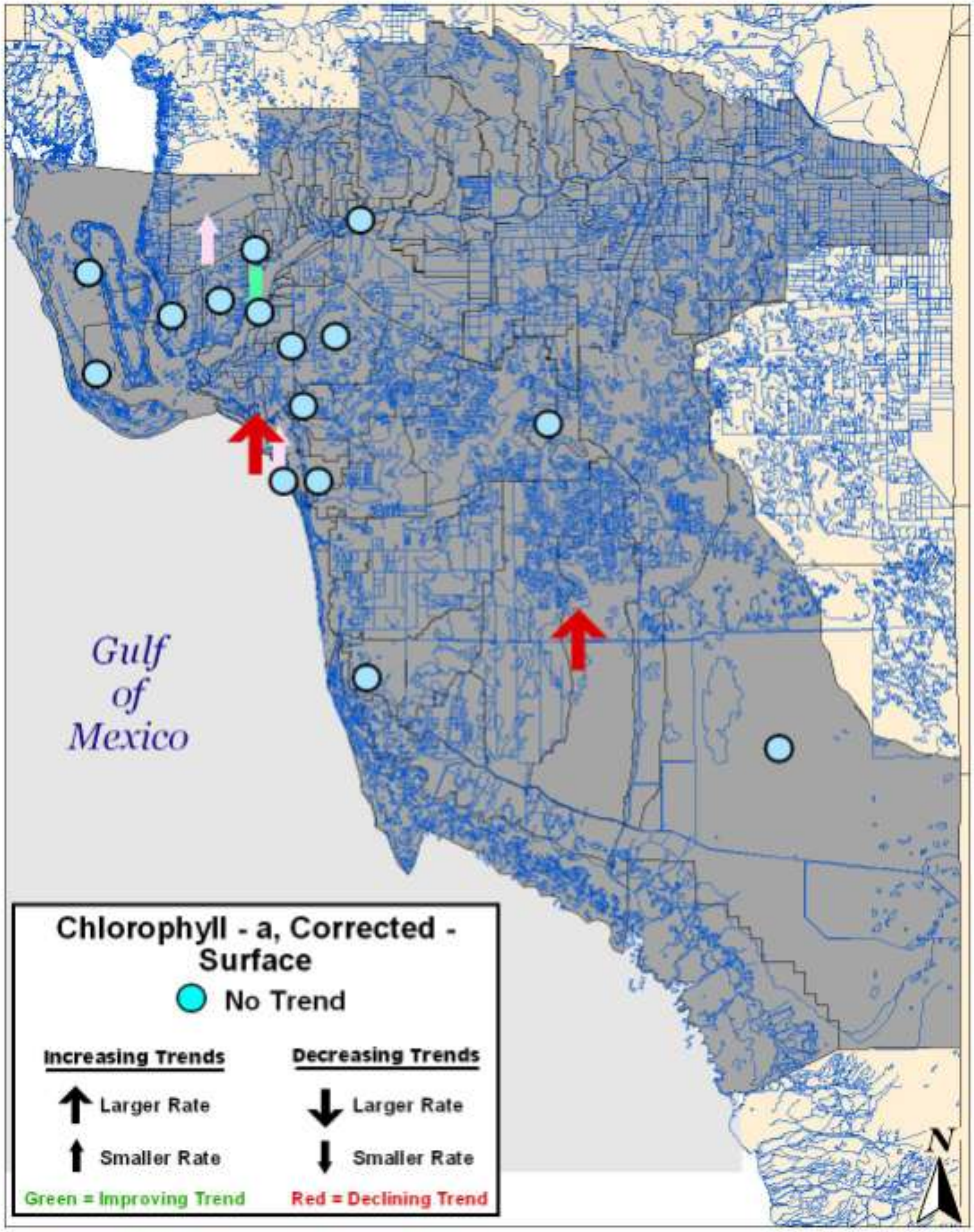


Figure 50: Chlorophyll-a (Corrected)- Surface Trends



Janicki Environmental, Inc.
Map Series No. A0356105

Identified Sources of Pollution

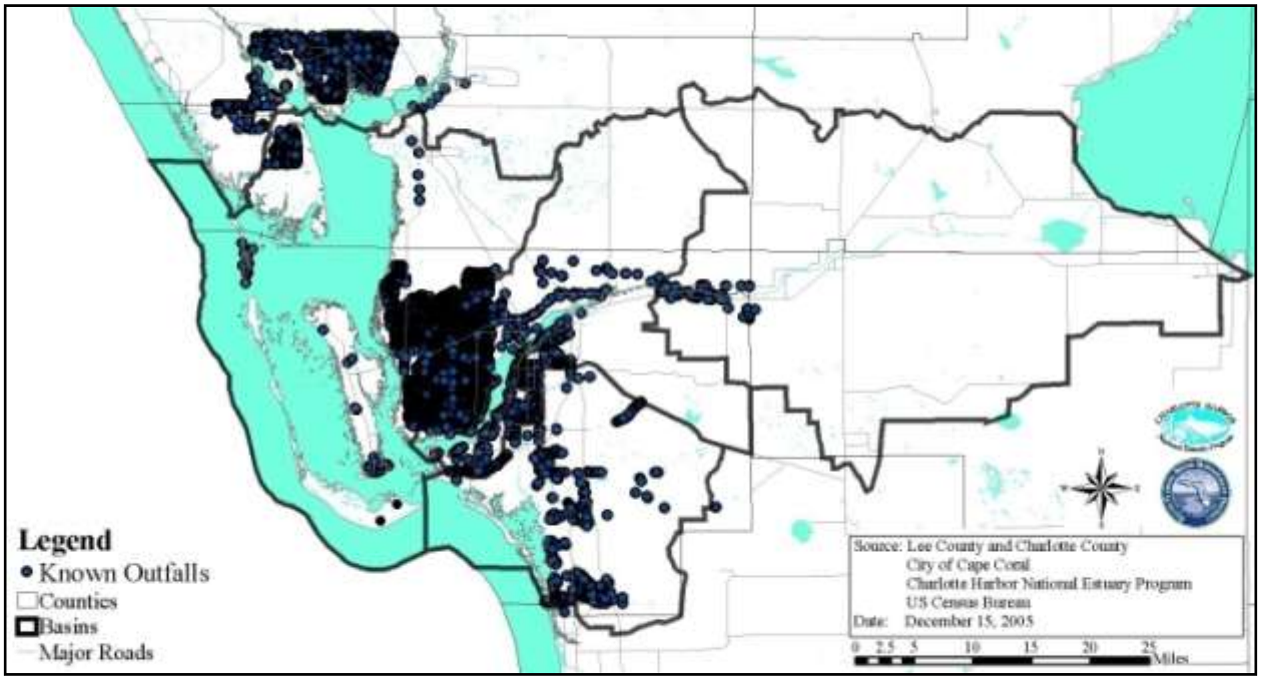
National Pollution Discharge Elimination System (NPDES)

In 1972, the Federal Water Pollution Control Act, also referred to as the CWA was amended to provide that discharge of any pollutant to waters of the United States from any point source is unlawful without a NPDES permit. Phase I of the NPDES Stormwater Regulations required “medium” and “large” municipalities to obtain permit coverage for their respective regulated small municipal separate storm sewer system (MS4). A medium municipality has been defined as any local government with a population greater than 100,000 and less than 250,000. A large municipality is defined as any local government with a population greater than 250,000. Those municipalities with less than 100,000 residents were not regulated under Phase I unless specifically designated by the EPA. Phase II of the NPDES Stormwater Regulations is intended to further reduce adverse impacts to water quality by incorporating new thresholds for construction generic permitting, and new MS4 generic permitting for Phase II communities that include Urbanized Areas. Lee County and Charlotte County have been designated an MS4 by EPA.

Lee County
Lee County received an NPDES permit for its MS4 in October 1997. The permit conditionally authorizes Lee County and the 13 original co-permittees to discharge stormwater to “the Waters of the United States.” Agreements signed between all co-permittees assure cooperation in boundary related issues. Additionally, the County is required to inspect and monitor industrial and construction activities for permit compliance. Lee County Ordinance 98-11 was adopted in June, 1998 providing legal authority for enforcement of the CWA mandate.

Under the NPDES General Permit for Storm Water Discharges Associated with Industrial and Construction Activities, EPA requires the development and implementation of a Storm Water Pollution Prevention Plan (SWP3) designed to reduce pollution at the source. A notice of intent has been issued with Lee County’s SWP3 for all construction work greater than 1 acre per Lee County Development Code 14-477.
Cities within Lee County are co-permittees for the NPDES program. Lee County maintains NPDES information online at: http://www.lee-county.com/npdes/.

Figure 51: Known Outfalls



Designated Brownfields

There are no Brownfield sites that have been designated per the Brownfield Redevelopment Act (Sections 376.77-376.875, FS) within the Spring Creek Watershed. The two Brownfield sites designated in Lee County are in the City of Fort Myers in the Caloosahatchee River watershed.

Wastewater Generating Facilities

Within the study area, there are currently 2 wastewater treatment facilities permitted by the Florida Department of Environmental Protection including domestic wastewater treatment facilities and industrial wastewater facilities shown in Figure 24. Some facilities are required to obtain a NPDES permit, administered through FDEP, while some are not and are regulated solely under state law (FS 403). Out of 162 wastewater facilities in the Lower Charlotte Harbor study area, 29 possess NPDES permits. The wastewater facilities included 117 domestic wastewater facilities and 45 industrial wastewater facilities.

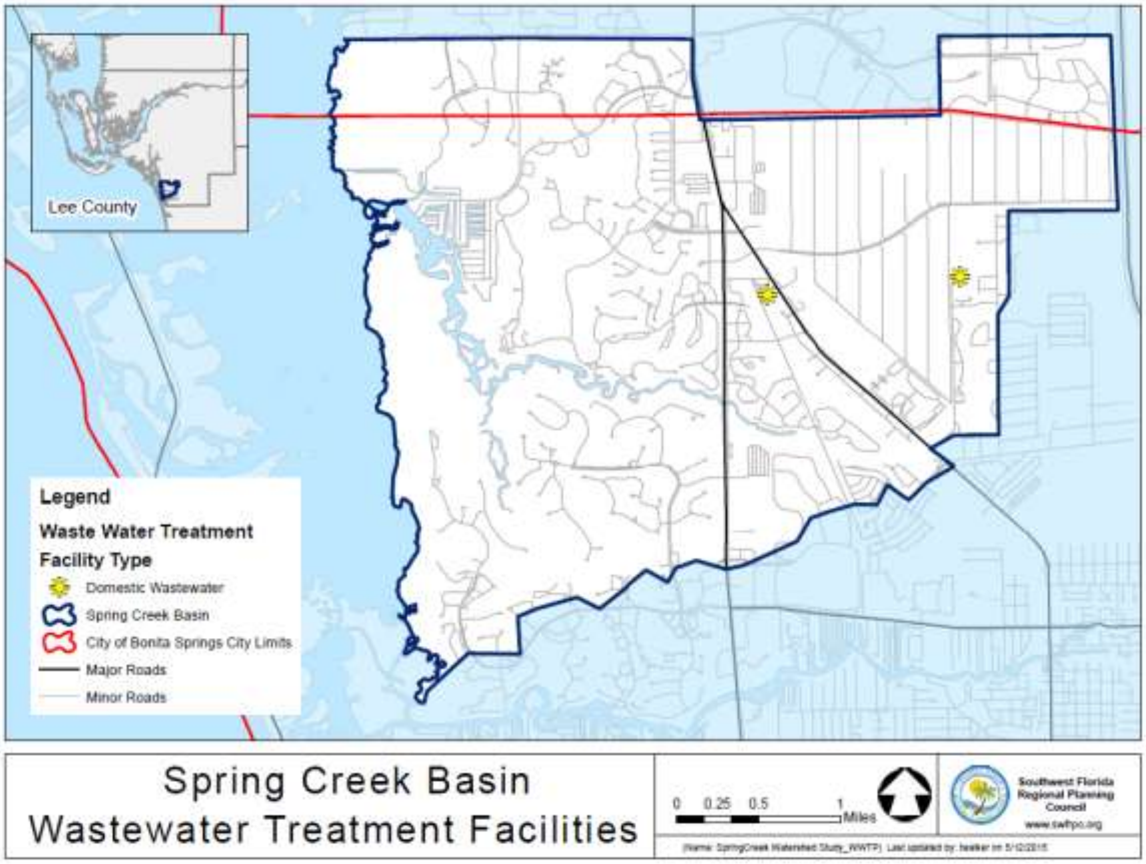
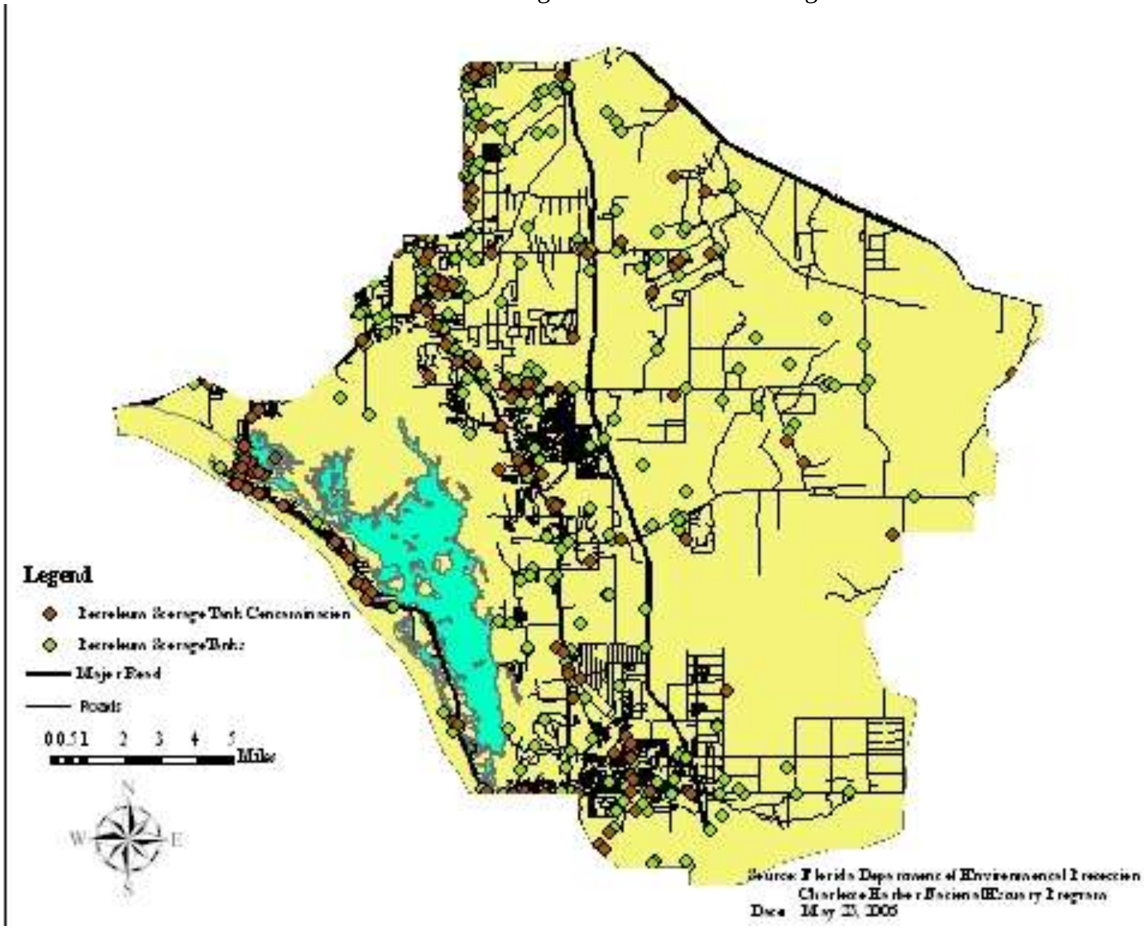


Figure 52: Wastewater Generating Facilities

The domestic wastewater treatment plants generate secondarily treated wastewater that may be permitted to be disposed of in many ways including: surface water discharge; deep well injection; land application; re-use (treated to a higher standard); intermittent surface water discharge; or a combination of these. Intermittent surface water discharge generally means the wastewater is contained within an isolated pond and only reaches surface waters of the state through ground water seepage and transmission, or during a significant storm event.

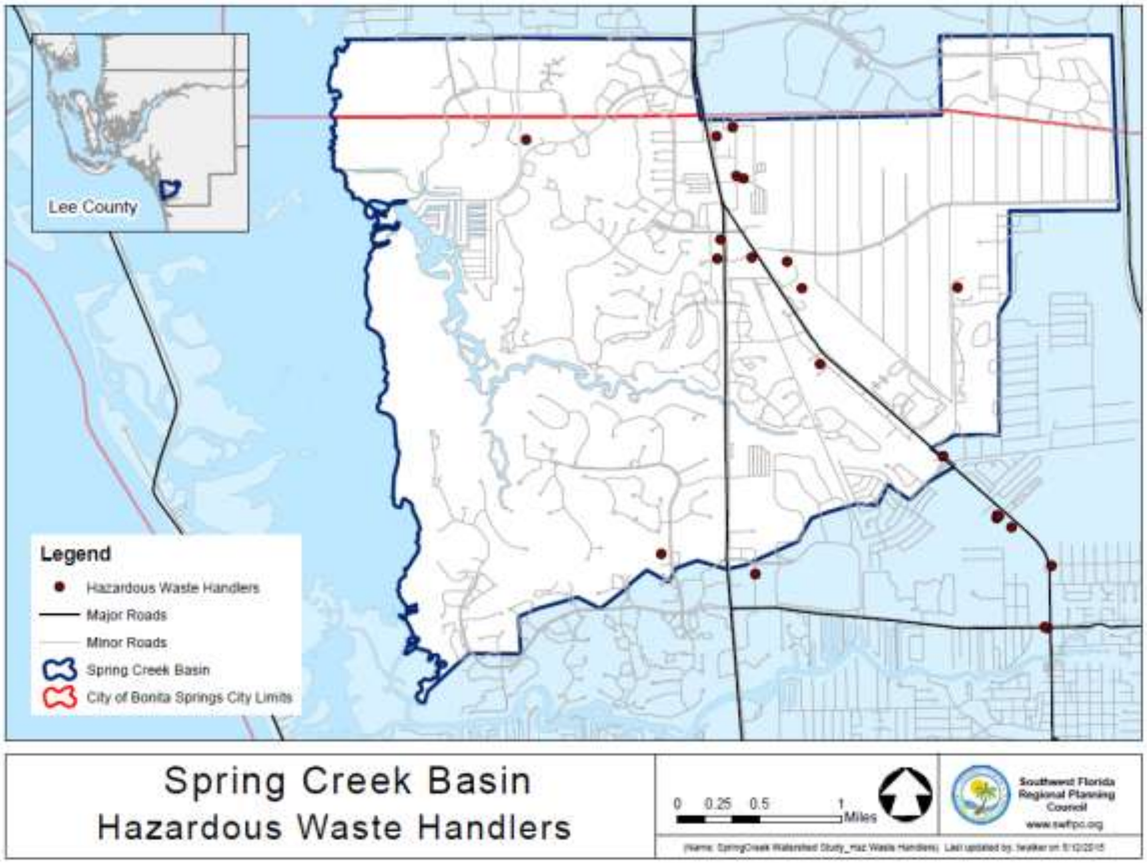
The industrial wastewater permits in the study area serve facilities such as, concrete batch plants (TSS – primarily from site runoff), reverse osmosis plants (typically high in TDS), agricultural processing operations (sugar, citrus, tomatoes), and primarily discharge to groundwater through percolation ponds. Other types of discharge that occur to a lesser extent are: surface water discharge, land application, deep well injection, and re-use.

Figure 53: Petroleum Storage Tanks



Petroleum storage tank facilities within the Estero Bay Watershed study area are regulated by FDEP due to the potential for groundwater contamination. The facilities identified on the map shown above are regulated petroleum storage tank facilities, which include above ground storage tanks greater than 550 gallons in volume, and underground storage tanks greater than 110 gallons in volume. The facilities identified in orange are petroleum storage tank facilities that have experienced confirmed discharges and total 98. These confirmed discharges may be caused by leaks or corrosion in the tank system, equipment failure, operator error (i.e. overfilling of tank), etc. Cleanup of contamination is required to be completed by the property owner under the supervision of FDEP.

Figure 54: Hazardous Waste Handlers



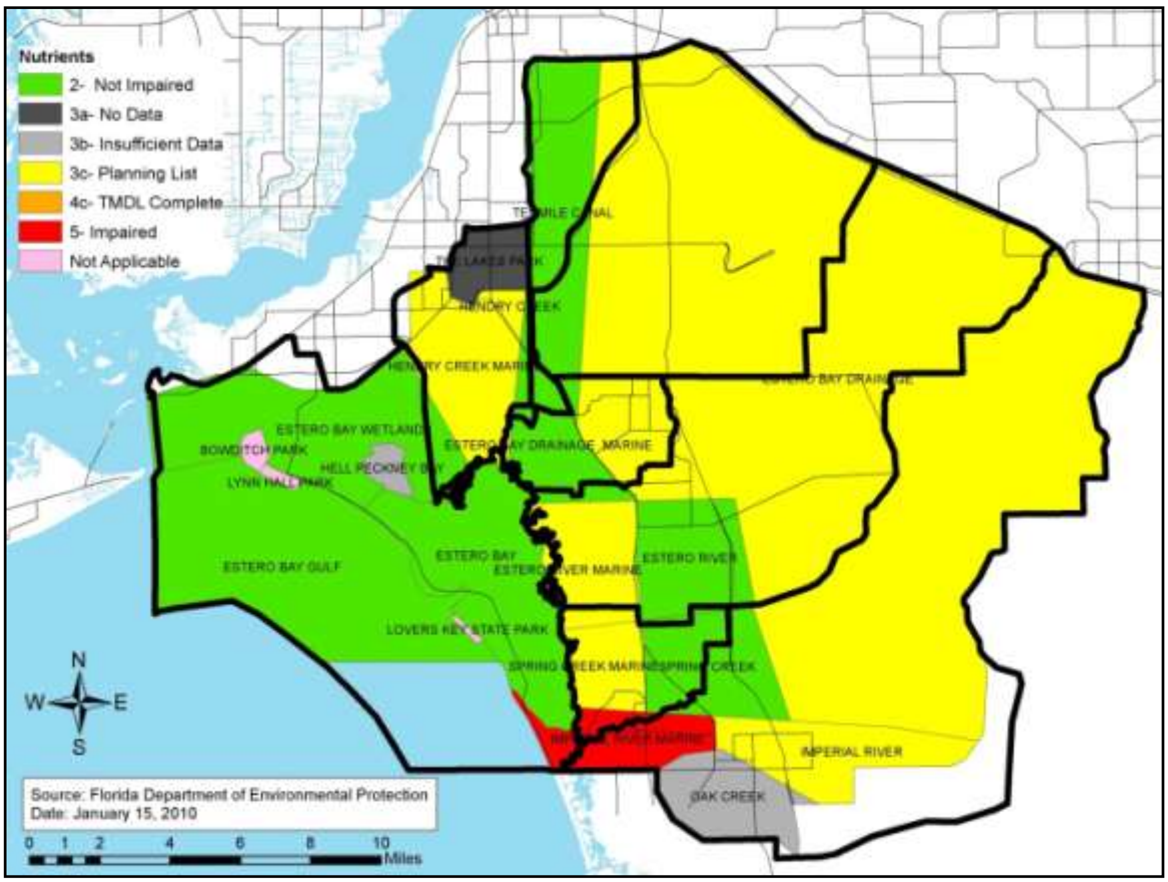
Hazardous waste generators within the Estero Bay Watershed study area are regulated by the FDEP due to the potential threat they pose to human health and natural resources. The facilities identified on the map shown above include small quantity generators, conditionally exempt small quantity generators of hazardous waste, and non-handlers (used oil generator). The designation of small quantity generator includes facilities that generate between 100 kg and 1000 kg of hazardous waste per month. Conditionally exempt small quantity generators of hazardous waste generate up to 100 kg of hazardous waste per month or less than 1 kg of acute hazardous waste. Acute hazardous wastes are substances that have been found to pose significant, irreversible harm to human health, such as arsenic and cyanide compounds. All small quantity and conditionally exempt small quantity generators of hazardous waste, as well as non-handlers (used oil generating facilities) are required to ensure proper disposal of their wastes through pick up by a licensed hauler for its eventual proper disposal or storage. The Spring Creek study area has no large quantity generators, nor any treatment, disposal, or storage sites. The 2009 EBABM State of the Bay found that for Spring Creek, shallow increasing water quality trends were found in surface waters for many parameters (ammonium, biological oxygen demand, conductivity, dissolved silica, fecal coliform, nitrate, nitrite, orthophosphate, total Kjeldahl nitrogen, total nitrogen and turbidity) at three or less stations for each parameter. Shallow decreasing water quality trends were found in surface water for color at three stations. Dissolved oxygen, enterococci bacteria, total suspended solids, and turbidity showed a shallow decrease at one station each.

Parameter: Chlorophyll-a

Chlorophyll-a is a measure of phytoplankton activity in the water column based on the primary photosynthetic pigment of green and other algae. It is a resultant parameter that synthesizes many environmental factors including nutrients, temperature, salinity, trace elements, toxics, tides and relative dilution, including water flows. It is proposed as a presumptive measure of estuarine health for the purpose of determining impaired waters. According the Florida Impaired Waters Rule (62-303), an annual average measurement greater than 11 mg/l in estuarine conditions is considered impaired. An annual average exceeding 20 mg/M^3 in freshwater streams is considered impaired. CHNEP recommended 5.9 mg/M^3 for Estero Bay and the state adopted the standard for implementation in January 2012. The maps shown below is the water quality assessment by FDEP for nutrients as measured at the time by chlorophyll *a*.

The Lee County Environmental Laboratory provided the data for all chlorophyll-a analysis.

Figure 55: Chlorophyll-a FDEP Impairments



Overall estuarine Spring Creek meets chlorophyll-a water quality standards. Between 2009 and 2013, average annual chlorophyll-a dropped in the estuarine segments and average reduction of 39%. The peak monthly chlorophyll-a increased by 49%. Peak months occur in winter, spring and summer.

2009-2013 change

Chlorophyll-A	
average	-31%
peak	49%

Year	Mean	Peak	Month of Peak
2009	5.23	9.38	December
2010	5.28	12.85	July
2011	5.82	26.28	April
2012	6.07	19.35	January
2013	3.61	14.00	May

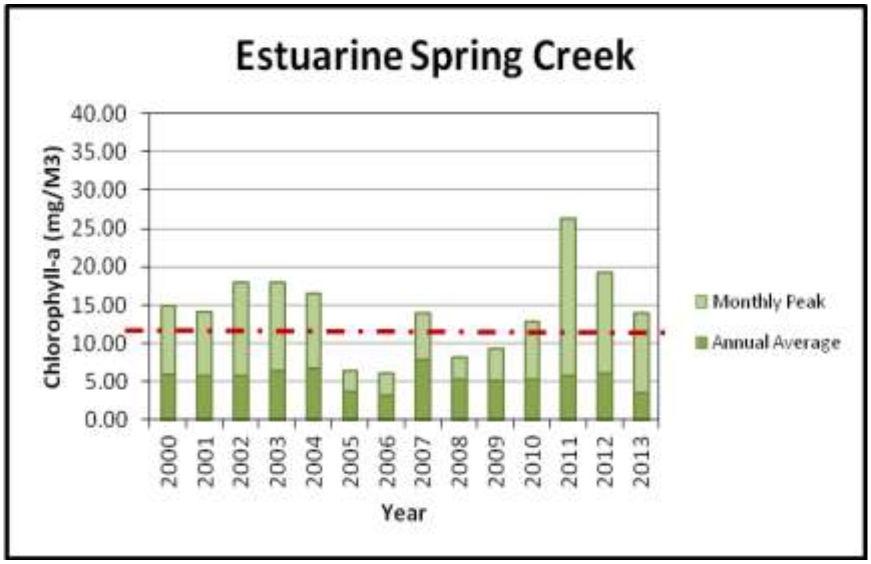


Figure 56: Chlorophyll-a in Estuarine Spring Creek

Overall freshwater Spring Creek meets chlorophyll-a water quality standards. Between 2009 and 2013, average annual chlorophyll-a dropped in the freshwater segments and average reduction of 69%. The peak monthly chlorophyll-a decreased by 45% reduction. Peak months occur in winter, spring and summer with May the most common month, which would be expected naturally.

2009-2013 change Chlorophyll	
average	-69%
peak	-45%

Year	Mean	Peak	Month of Peak
2009	2.18	4.20	May
2010	2.18	6.50	December
2011	1.37	4.80	May
2012	1.21	4.40	May
2013	0.69	2.30	August

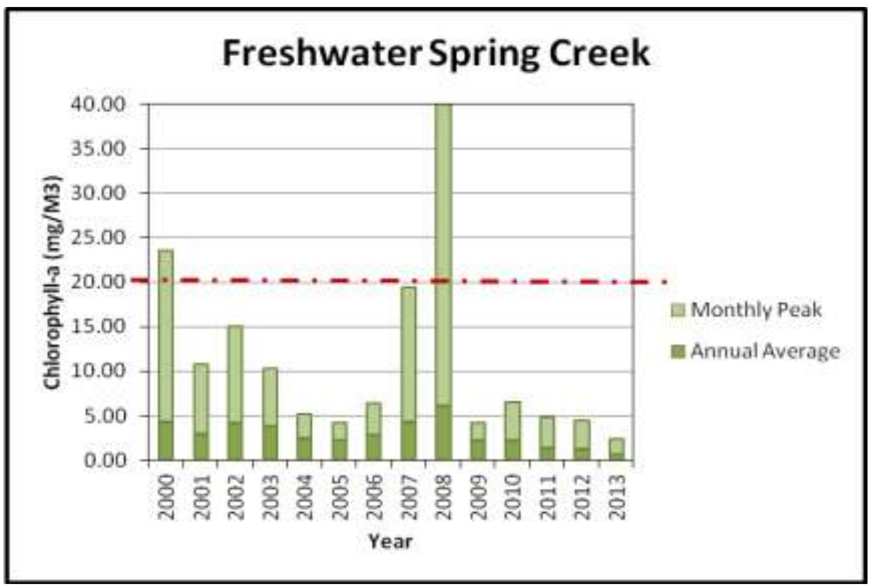


Figure 57: Chlorophyll-a in Freshwater Spring Creek

Copper (Cu) is a measure of all dissolved copper in the water column, including hexavalent, bivalent, and trivalent ions. It is a resultant parameter that synthesizes many environmental inputs of copper including: dissolved copper from roadways; antifouling paints for marine applications; treated wood, such as pilings; aquatic algaecides and lake treatments; architectural sources; marine cathodes; human debris; and natural sources.

In December 2008, the City of Naples, just outside the Estero Bay watershed, enacted a ban on copper-containing herbicides commonly used in city lakes for control of aquatic plants. The ordinance states that, "…amending the existing Code to prohibit the use of copper sulfate or any other copper-containing herbicide in City lakes is likely to provide enhanced environmental protection to Naples Bay, decrease the amount of copper entering the City's lakes and natural waterways, including Naples Bay, thus improving water quality…" (City of Naples 2008). At the time of this writing, the Florida Department of Agriculture and Consumer Services has restricted the City of Naples from enforcing this ban.

According to USEPA National Recommended Water Quality Criteria, the "Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect" (US Environmental Protection Agency 2009). For copper in marine or estuarine systems, the CCC is 3.1 µg/L and in freshwater systems, the CCC is 9.0 µg/L. This appears to be a tightening of the federal standards. The general state standard for copper is 3.7 µg/L in Class III marine and Class II fresh waters.

The Lee County Environmental Laboratory had a methodological change in 2009, with results driven substantially by the methods change. The map of impairments will be the only copper information presented in this report. Estuarine Imperial River and estuarine Spring Creek are the two verified impairments for copper within the Estero Bay basin.

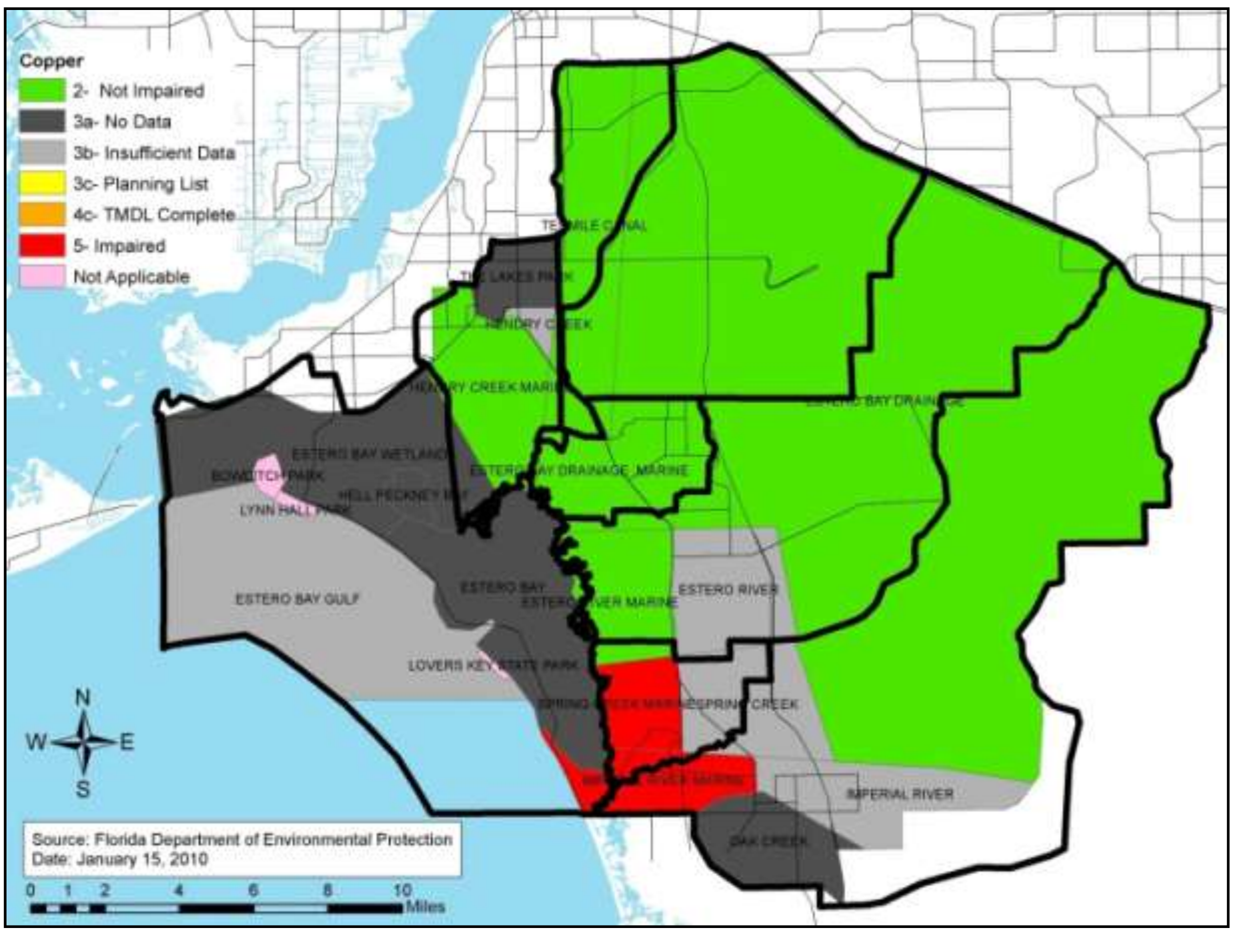


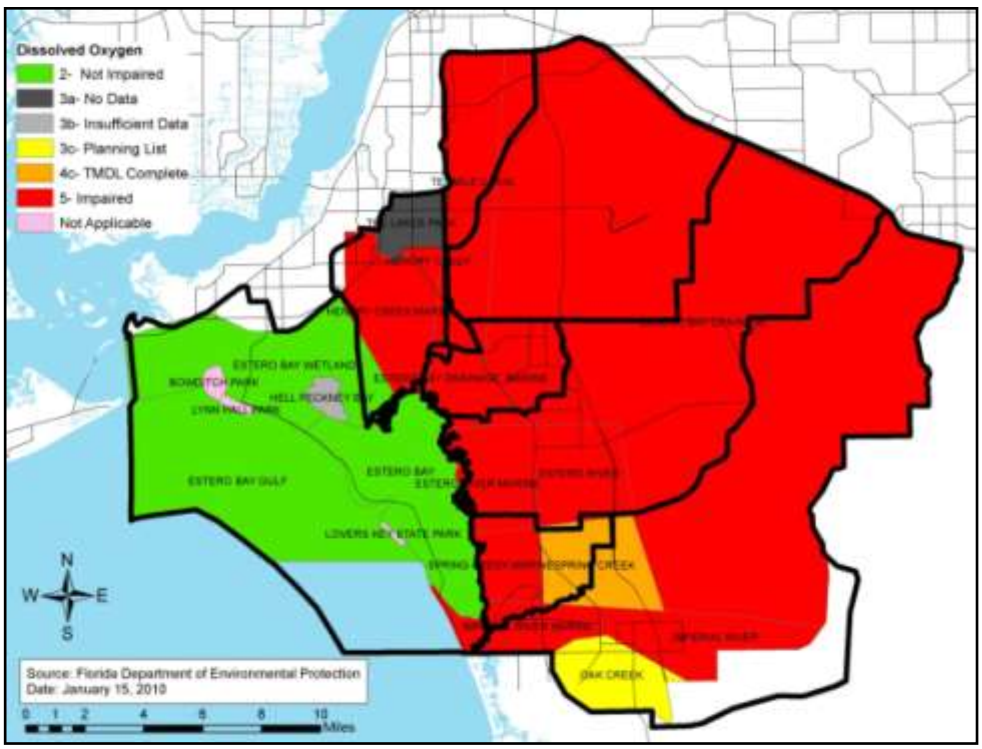
Figure 58: Copper FDEP Impairments

Dissolved oxygen (DO) is a measure of all dissolved oxygen in the water column. DO is vital to aerobic organisms in the aquatic ecosystem, and most higher taxa require higher DO levels for healthy life cycles and successful reproduction. Many factors affect DO including wind mixing, turbulence, flow volumes and rates, biochemical oxygen demand, algal blooms, photosynthesis and respiration, salinity and thermal stratification, anthropogenic eutrophication, and toxic spills.

Florida's water quality standards state that dissolved oxygen in Class III freshwaters, "…shall not be less than 5.0 [mg/L]," and in Class III marine waters, "Shall not average less than 5.0 in a 24-hour period and shall never be less than 4.0." (Florida State Legislature 2008) Some natural estuaries will experience periods of low DO during the night due to community respiration exceeding the level of dissolved oxygen in the water column. This is rapidly recovered by community photosynthesis during the day. Prolonged periods of DO below 4.0 mg/L indicate problems. These may be transient, such as an algal bloom. However, prolonged systemic DO depression from anthropogenic inputs and other excess nutrient loading (such as atmospheric doposition) is not recoverable without source reduction efforts. Conditions below 2.0 mg/L are considered anoxic and can be fatal to most fishes and invertebrates.
The map illustrates the water quality assessment for Estero Bay basin waterbodies.

The Lee County Environmental Laboratory provided the data for all dissolved oxygen data.

Figure 59: Dissolved Oxygen FDEP Impairments



Between 2009 and 2013, average Dissolved Oxygen in estuarine Spring Creek had an average decrease that was negligible at 9%. The monthly minimum Dissolved Oxygen decreased in estuarine Spring Creek by 27%. The most common minimum month was June (60%), however April and November are also represented.

2009-2013 change	
average	-9%
minimum	-27%

Year	Mean	Min	Month of Min
2009	2.8	1.7	November
2010	3.7	2.6	June
2011	2.6	0.6	June
2012	2.3	0.5	June
2013	2.6	1.2	April

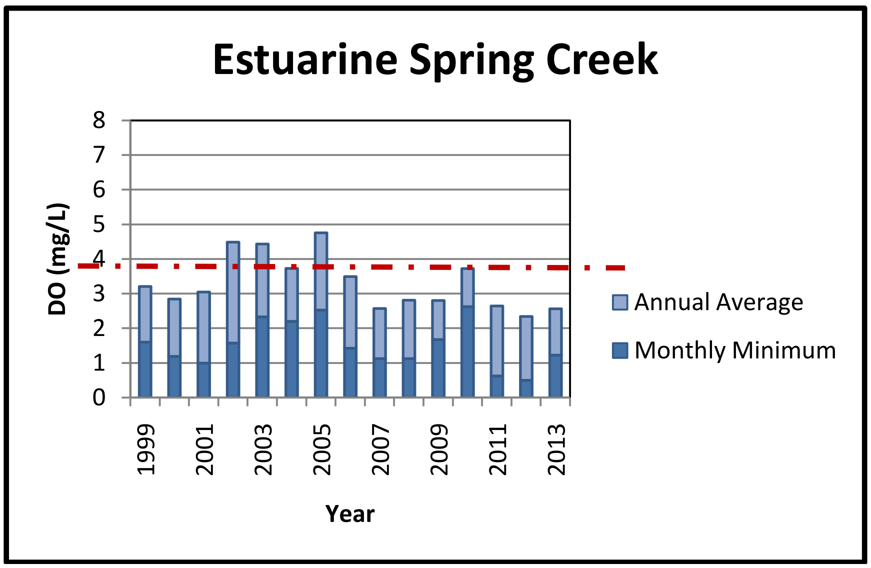


Figure 60: Dissolved Oxygen in Estuarine Spring Creek

Between 2009 and 2013, average Dissolved Oxygen in freshwater Spring Creek had an average increase of 14%. The monthly minimum Dissolved Oxygen decreased in freshwater Spring Creek by 6%. The most common minimum month was July (40%), however June, September, and December are also represented.

2009-2013 Change	
average	14%
minimum	-6%

Year	Mean	Min	Month of Min

2009	4.5	3.2	June
2010	6.8	4.6	September
2011	4.5	0.9	July
2012	5.3	3.0	July
2013	5.1	3.0	December

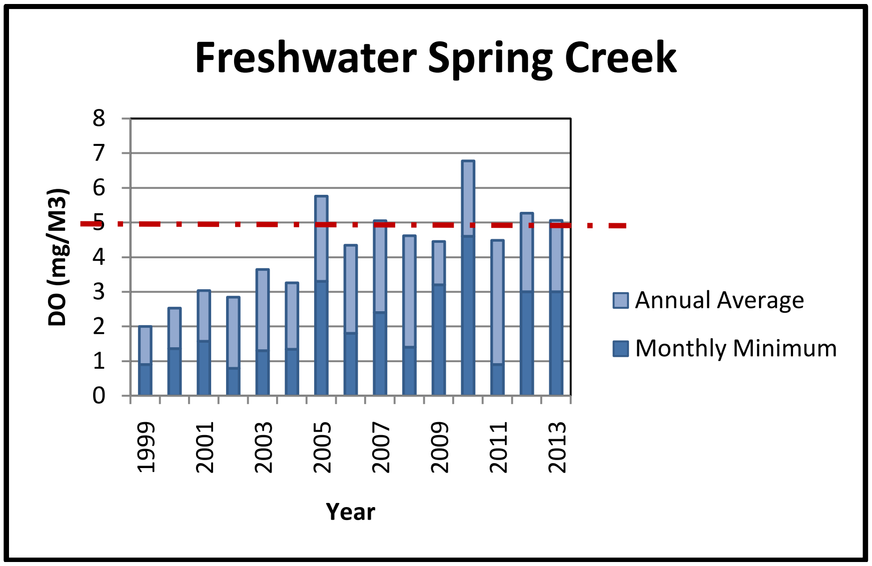


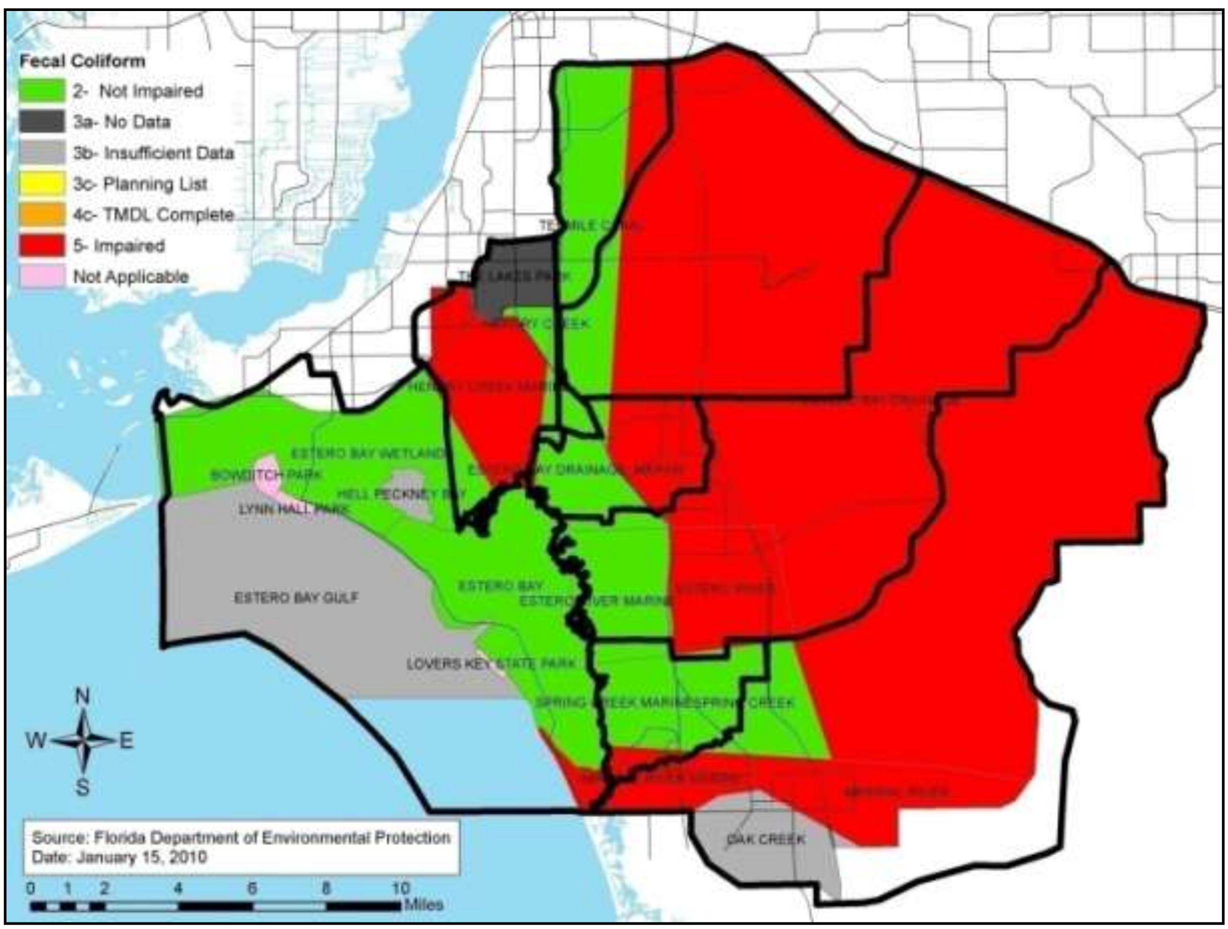
Figure 61: Dissolved Oxygen in Freshwater Spring Creek

Fecal coliform is a measure of bacteriological contamination of the water column based on the activity of *Escheria coli*, commensal bacteria of higher vertebrates. It is a surrogate measure for other more harmful bacteriological and viral contaminants associated with waste material from human and vertebrate fecal discharges. This parameter includes inputs from many environmental inputs of fecal waste including human sewage (from vessel holding tanks, septic tanks, land sludge spreading, and package and other sewage treatment plants), waste from livestock (including cattle and chickens), and waste from wild and feral animals. Fecal coliform can also be naturally high in association with active bird rookeries; therefore, a healthy estuary with normal animal activity will have a natural background level.

According to State of Florida standards, a measurement of more than 800 bacterial colonies per 100 mL on any single day of sampling or a monthly average of 200 colonies per 100 mL indicates impairment in Class III waters. Based on EPA recommendations, Florida's fecal Coliform standards are likely to be amended in the next year or two.

Between 2009 and 2013, average fecal Coliform increased in estuarine Spring Creek Increased an average increase of 53%. The peak monthly fecal Coliform decreased 13%
The most common peak month was September (40%), however June, August, and October were also represented.

Figure 62: Fecal Coliform FDEP Impairments



2009-2013 change
average 53%

peak	-13%

Year	Mean	Peak	Month of Peak
2009	137	497	October
2010	206	391	September
2011	159	281	August
2012	293	1,280	June
2013	210	432	September

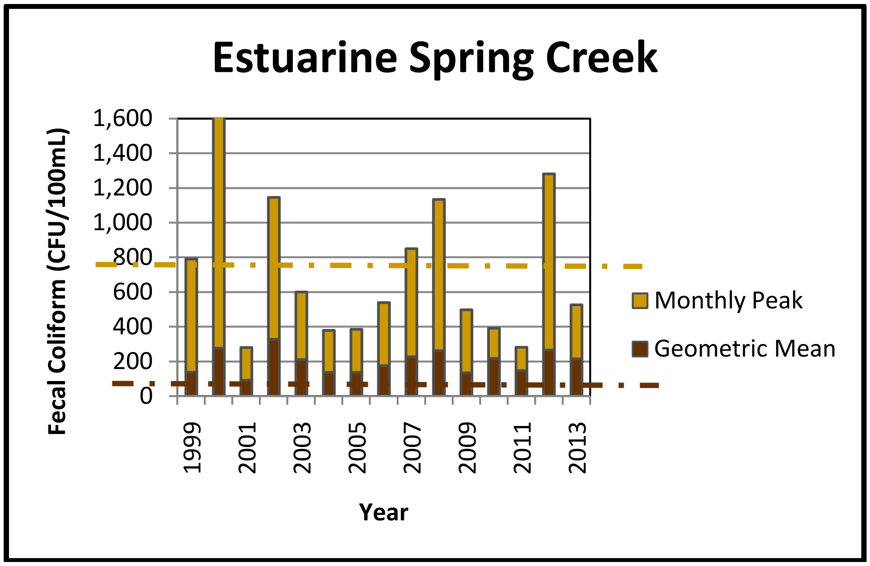


Figure 63: Chlorophyll-a in Estuarine Spring Creek

Between 2009 and 2013, average annual fecal Coliform decreased in freshwater Spring Creek increased 234%. The peak monthly fecal Coliform increased in freshwater, Spring Creek and Imperial River. The average increase was 215%. There was no common peak

average	234%
peak	215%

Year	Mean	Peak	Month of Peak
2009	66	168	August
2010	68	214	June
2011	123	500	July
2012	249	1,300	February
2013	219	530	April

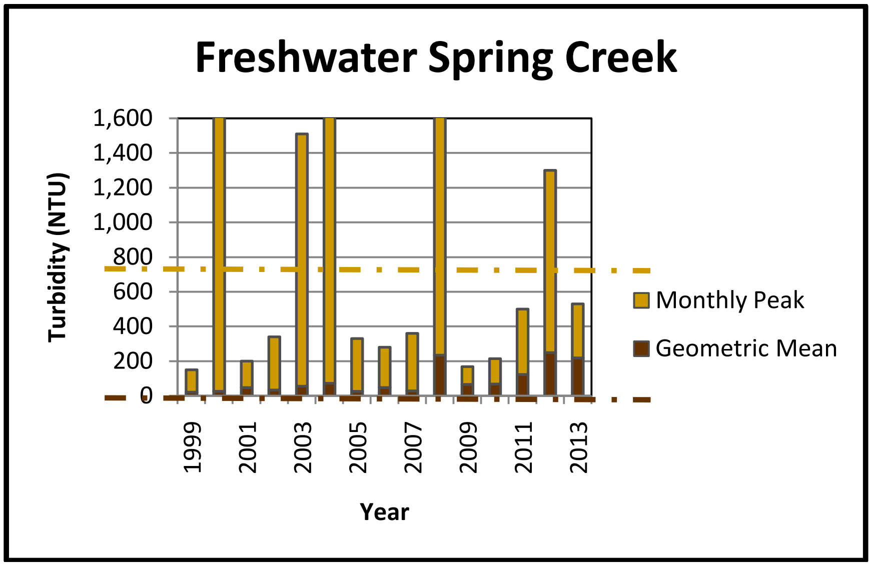


Figure 64: Fecal Coliform in Freshwater Spring Creek

Parameter: Total Nitrogen

Total nitrogen (TN) is a measure of all dissolved nitrogen in the water column, including nitrates, nitrites and ammonia. It is a resultant parameter that synthesizes many environmental inputs of nitrogen, including the dissolved organics from algae, sea grass, mangrove, and phytoplankton productivity. Also included are anthropogenic inputs, such as from agriculture and fertilizer over-application, which may run off into water bodies.

The USEPA Nutrient Criteria for this area, Aggregate Ecoregion XII, the Southeastern Coastal Plain, is 0.9 mg/L for rivers and streams (USEPA 2000). While the state of Florida has in the past had only narrative criteria for nutrients in water bodies, in response to a lawsuit by the Sierra Club, the Conservancy of Southwest Florida, the Florida Wildlife Federation, and others, USEPA recently issued a determination letter requiring the state to determine and adopt numeric nutrient standards for nitrogen and phosphorus in water bodies. USEPA has stated that the state must propose nutrient limits by January 14, 2010 and the resultant rule must be finalized by October of 2010.

The southwest Florida region has been proactive in addressing nutrient pollution at the local level. The Lower West Coast Watersheds Committee of the Southwest Florida Regional Planning Council developed a resolution regarding fertilizer regulation, which was adopted by Lee County as an ordinance in May of 2008. The ordinance regulates the nitrogen and phosphorus content of landscaping fertilizers, establishes a fertilizer black-out period during the rainy season, and establishes a 10-foot no-fertilizer buffer around waterbodies. Most municipalities in Lee County have followed suit, adopting the Lee County standards in whole, or some variation. The Lee County Environmental Laboratory provided the data for all total nitrogen analysis. Because nitrogen standards were not adopted before the last water quality assessment conducted for Estero Bay basin, no such map is available to date.
The Lee County Environmental Laboratory provided the data for all fecal coliform analysis.

Between 2009 and 2013, average annual total nitrogen increased in estuarine Spring Creek by 40%. However it is still below standards for being considered impaired. The peak monthly nitrogen increased an average of39%. The most common peak month was January (40%). Other months included July, September and November.

Change	
average	42%
peak	39%

Year	Mean	Peak	Month of Peak
2009	0.77	1.26	January
2010	1.06	1.42	January
2011	1.19	1.90	November
2012	1.13	1.55	July
2013	1.09	1.75	September

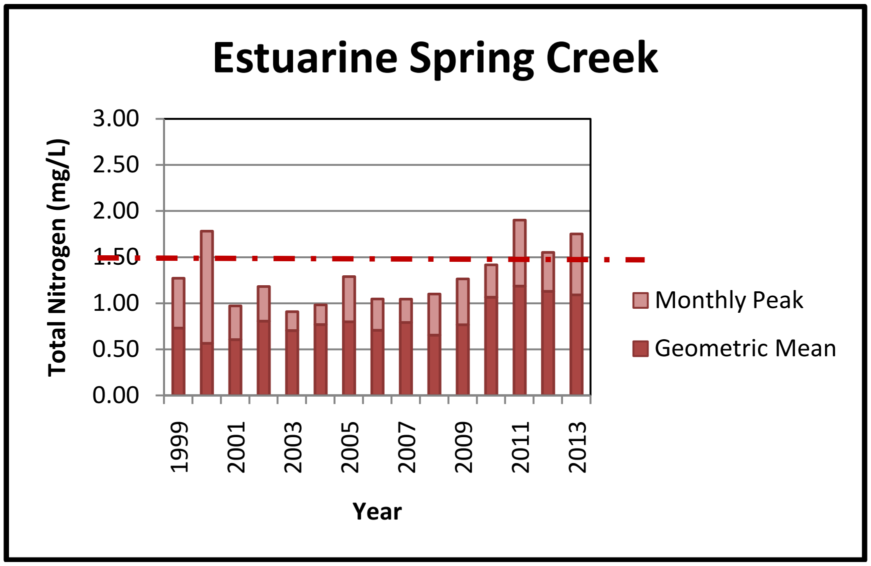


Figure 65: Total Nitrogen in Estuarine Spring Creek

Between 2009 and 2013, average annual total nitrogen increased in freshwater Spring Creek by 54%. The peak monthly total nitrogen increased for an average of 25% A The most common peak month were September (50%) and June (50%).

Change	
average	54%
peak	25%

Year	Mean	Peak	Month of Peak
2009	0.69	1.20	June
2010	0.91	1.50	September
2011	1.08	1.60	June
2012	1.16	1.40	June
2013	1.06	1.50	September

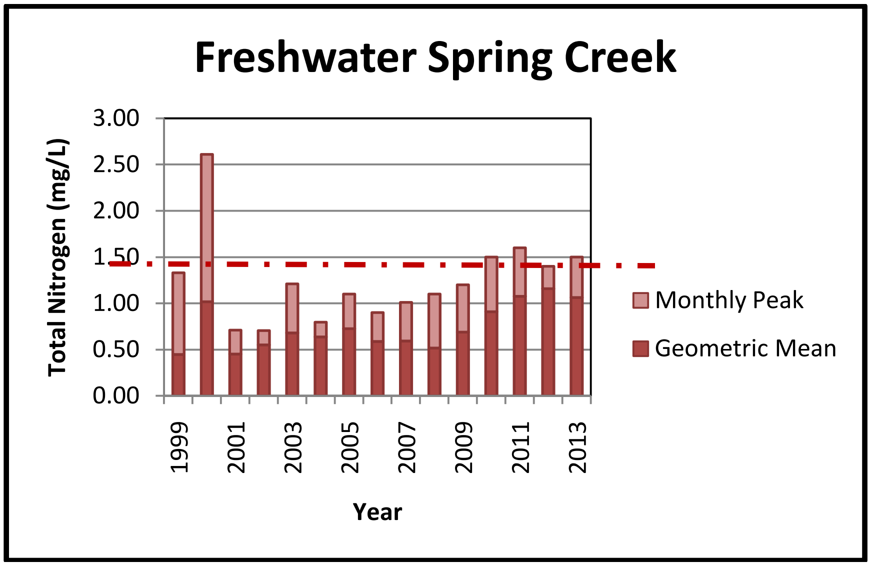


Figure 66: Total Nitrogen in Freshwater Spring Creek

Parameter: Total Phosphorus

Total phosphorus (TP) is a measure of all dissolved phosphorus in the water column, including phosphates. It is a resultant parameter that synthesizes many environmental inputs of phosphates. The USEPA Nutrient Criteria for this area, Aggregate Ecoregion XII, the Southeastern Coastal Plain, is 40.0 µg/L for rivers and streams (USEPA 2000), which is equivilent to 0.04 mg/L. As discussed above, the state of Florida is in the process of developing numeric criteria for this nutrient.

TP, in and of itself, does not identify the source phosphorus in the water column. The main contributor is stormwater runoff containing excess fertilizer from residential and agricultural sources. The fertilizer regulations noted above are intended to help reduce these inputs.

Because phosphorus standards were not adopted before the last water quality assessment conducted for Estero Bay basin, no such map is available to date.

The Lee County Environmental Laboratory provided the data for all total phosphorus analysis.

Between 2009 and 2013, average annual total phosphorus dropped was reduced by 4%. The peak monthly total phosphorus dropped for an average of 26% reduction. The most common peak month was January (40%), and also included May, August and September.

Change	
average	-4%
peak	-26%

Year	Mean	Peak	Month of Peak
2009	0.05	0.11	January
2010	0.04	0.05	August
2011	0.06	0.13	January
2012	0.05	0.09	May

2013	0.05	0.08	September

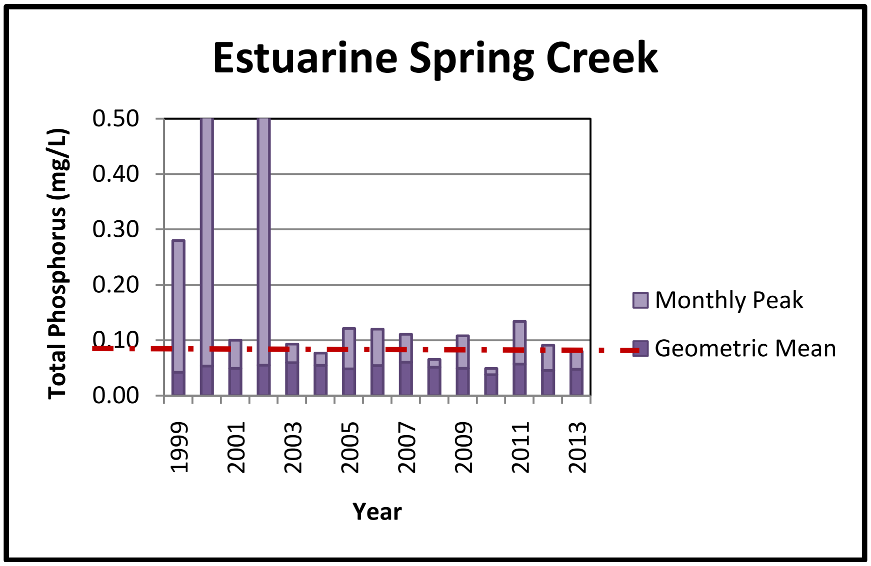


Figure 67: Total Phosphorus in Estuarine Spring Creek

Between 2009 and 2013, average annual total phosphorus dropped in freshwater Spring Creek with an average reduction was of 35%. The peak monthly total phosphorus dropped for a 63% reduction. There was most common peak month was June (40%), and includes March, May and September. This reduction in the geometric mean standard was achieved after adoption of the strict local fertilizer ordinances.

Change	
average	-35%
peak	-63%

Year	Mean	Peak	Month of Peak
2009	0.03	0.13	May
2010	0.02	0.03	June
2011	0.03	0.26	March
2012	0.03	0.18	June
2013	0.02	0.05	September

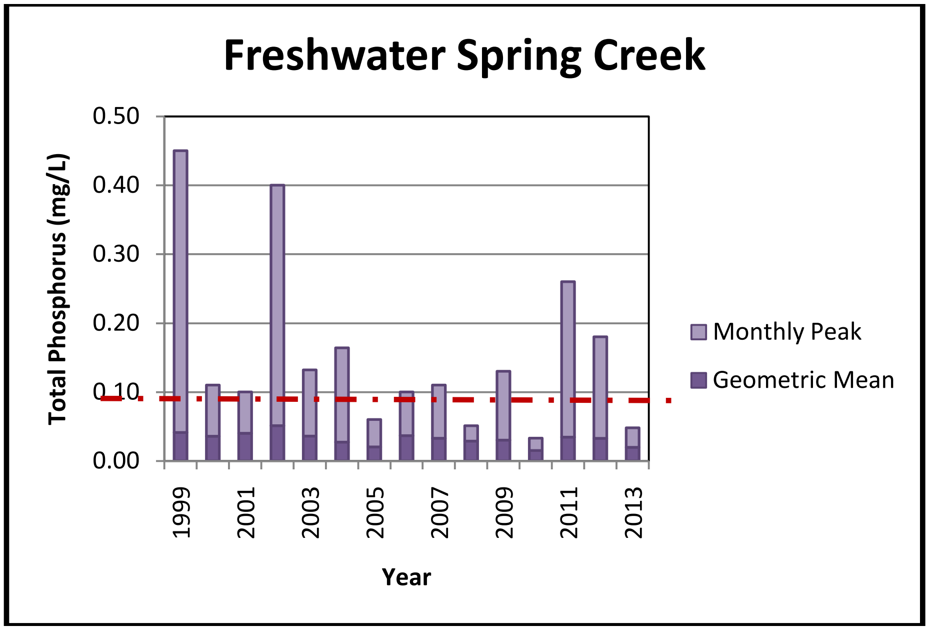


Figure 68: Total Phosphorus in Freshwater Spring Creek

Parameter: Turbidity

Turbidity is a measure of water clarity. It is a resultant parameter that synthesizes many environmental inputs of particles and dissolved materials, including the organics from detritus, plankton productivity, natural suspended particles and pollutants. The USEPA Nutrient Criteria for this area is 1.9 NTU, whereas the state standard is expressed as 29 or fewer NTUs above normal background levels.

Between 2009 and 2013, average turbidity decreased an average reduction of 4%. The peak monthly turbidity increased for an average of 25% reduction. The most common peak month was May (40%) and includes January, May, and November.

Change	
average	-4%
peak	25%

Year	Mean	Peak	Month of Peak
2009	2.87	4.28	January
2010	2.47	3.42	November
2011	3.19	4.06	May
2012	3.02	7.87	July
2013	2.75	5.34	May

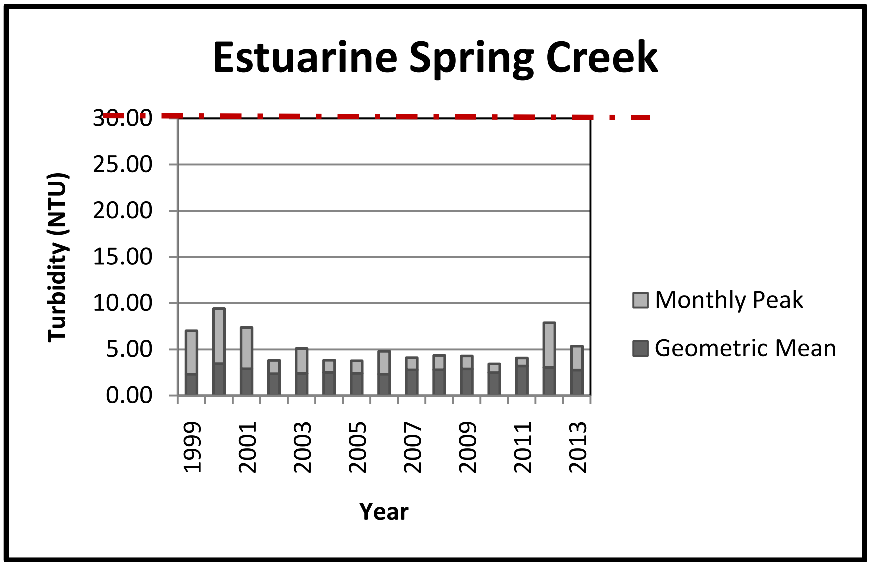


Figure 69: Turbidity in Estuarine Spring Creek

Between 2009 and 2013, average turbidity dropped in all freshwater Spring Creek dropped for an average reduction of 22%. The peak monthly turbidity dropped for an average of 51% reduction. There was no common peak month and included February, March, June, July, and October.

Change	
average	-22%
peak	-51%

Year	Mean	Peak	Month of Peak
2009	2.87	7.57	June
2010	2.17	3.01	October
2011	3.09	4.88	February
2012	3.12	6.09	July
2013	2.23	3.73	March

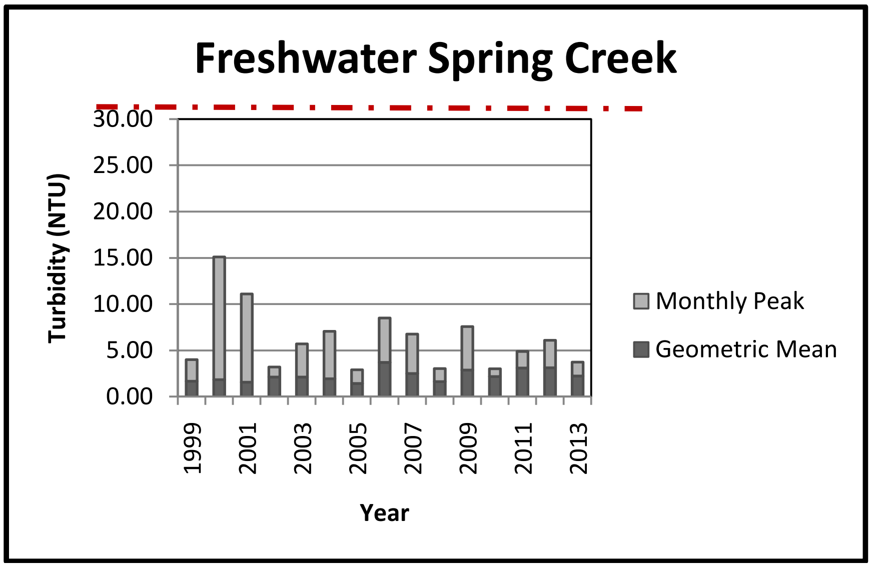


Figure 70: Turbidity in Freshwater Spring Creek

Charlotte Harbor NEP Status and Trends Assessment

The Charlotte Harbor National Estuary Program (CHNEP) completed a water quality status and trends assessment on July 5, 2013, for period of record data through 2011. Estero Bay was among the basins assessed. The report had the following findings and recommendations for Spring Creek.

Spring Creek generally had 7 stations with sufficient data for trend testing within the basin with a period of record either between 1992 and 2011 or beginning in the early 2000's through 2011. Five of the 7 stations in Spring Creek exhibited increasing trends in total nitrogen and total Kjeldahl nitrogen. Three of seven station exhibited increasing trends in dissolved silica. Five of 7 stations exhibited increased trends in Biological oxygen demand. However, despite these degrading trends, chlorophyll concentrations decreasing at 4 of 7 stations and total phosphorus also decreased at 3 of 7 stations. Dissolved oxygen decreased at 3 stations, pH decreased at two stations and conductivity increased at 2 stations. Copper increased at 3 of the 7 stations while lead decreased at a single station in the basin. Other parameters including color and temperature were stable over the period of record.

Table 7: Net Station Improvement and Degradation

Parameter	Estero Bay Random	Coastal Estero	Hendry Creek	Estero River	Spring Creek	Imperial River	2011 Basin Net	2007 Basin Net
BOD	-1	-2	-11	-1	-5	-2	-22	-3
Chl-a corr	0	5	14	0	4	0	23	2
Color	1	12	10	1	0	-1	23	2
Copper			-2	0	-3	-1	-6	
DO	-1	2	-1	-1	-2	-1	-4	25
F Coli		1	-5	1	-2	-2	-7	1
NH3	1	2	-11	-3	-3	-2	-16	-6
NO23	2	0	2	-2	-1	1	2	-7
NO3	0	0	-2	-3	0	0	-5	-5
pH	0	2	-4	0	2	0	0	4
PO4	1	0	10	0	2	1	14	-4
Salinity	0	0					0	9
Conductivity			-7	-2	-2	-1	-12	
Temp	1	0	2	0	0	0	3	-1
TkN	1	0	-15	-5	-5	-5	-29	-5
TN	1	2	-13	-4	-5	-3	-22	-3
TOC	0	10	3			0	13	
TP	1	16	9	0	2	1	29	1
TSS	-1	-8	0	4	-2	-1	-8	5
	6	42	-21	-15	-20	-16	-24	15

good trend
neutral trend
bad trend

Summary of Water Quality Vulnerabilities and Issues of Concern for Spring Creek

Water Quality management issues of concern for the Spring Creek Watershed include:

1) Copper pollution associated with human activities
2) Bacterial pollution as indicated by Fecal Coliform in the Freshwater and Estuarine parts of Spring Creek
3) Increases in Nitrogen in the Freshwater and Estuarine parts of Spring Creek
4) The low Dissolved Oxygen events can likely be improved by addressing the issues of hydrologic flow, nutrients, and anthropogenic oxygen demanding pollution sources

PART 3: Creek and Riparian Habitats

Pre-Development and Recent Land Cover

As part of the Southwest Florida Feasibility Study (SWFFS), a pre-development vegetation map was prepared for the hydrologic modeling effort. The mapping effort began with the soils map. For disturbed soils, archival information was used to identify the likely pre-development vegetative communities.

In the Estero Bay Watershed the ratio of pine flatwood types to each other in the pre-development landscape was 1 hectares of xeric pine flatwoods to 22 hectares of mesic pine flatwoods to 16.5 hectares of hydric pine flatwoods. The total acres of wetlands were 46,873.52 hectares (115,827 acres) including 19,627.25 hectares (48,500 acres) of hydric pine flatwoods. Mesic flatwoods comprised over 40% of the land area before development, with hydric flatwoods making up another 21%. The ratio of wetlands to upland land cover was 1.65 to 1.

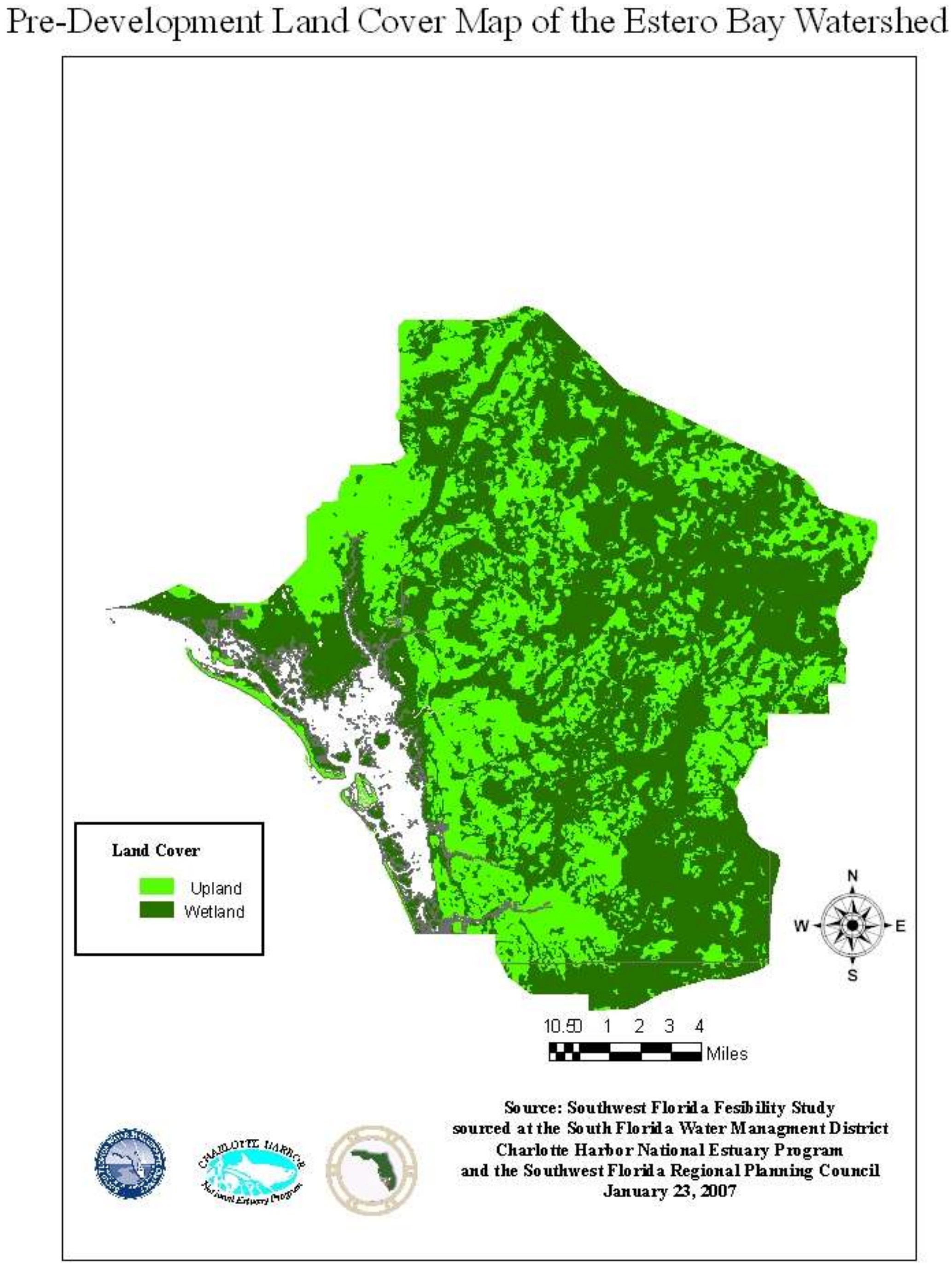


Figure 71: Simplified Pre-Development Vegetation Map

Pre-Development Land Cover Habitat Map of the Estero Bay Watershed

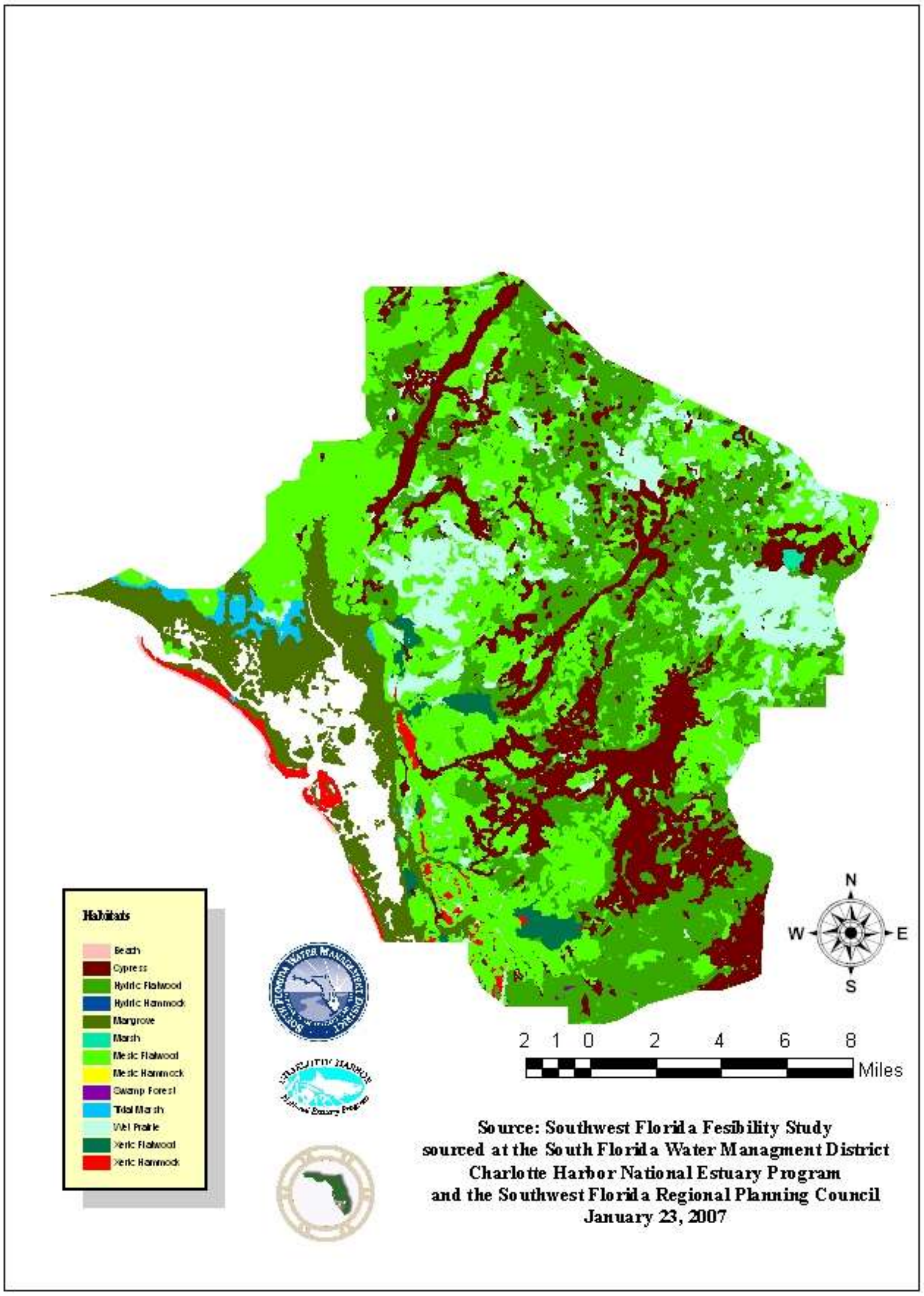


Figure 72: Pre-Development Vegetation Map of the Estero Bay Watershed

Historically the Spring Creek Watershed was 48.1 % mesic pine flatwood, 11.42% cypress forest, 9.22% mangrove swamp, 8.56% wet prairie, 8.27% hydric pine flatwood, 6.75% xeric hammock, 5.42 % xeric pine flatwoods, 1.28% open water, and 0.98% tidal marsh. The ratio of pine flatwood types to each other in the pre-development landscape was 1 hectares of xeric pine flatwoods to 8.88 hectares pine flatwoods to 1.53 hectares of hydric pine flatwoods. The total area of wetlands were 1,102.3 hectares including 237.1 hectares of hydric pine flatwoods. The ratio of wetlands to upland Landcover was 0.63 to 1.

Table 8: Pre-Development General Habitat Types in the Spring Creek Waetrshed (in Hectares)

Upland	Wetland	Open Water
1,727	1,102.3	36.57
60%	38%	1%

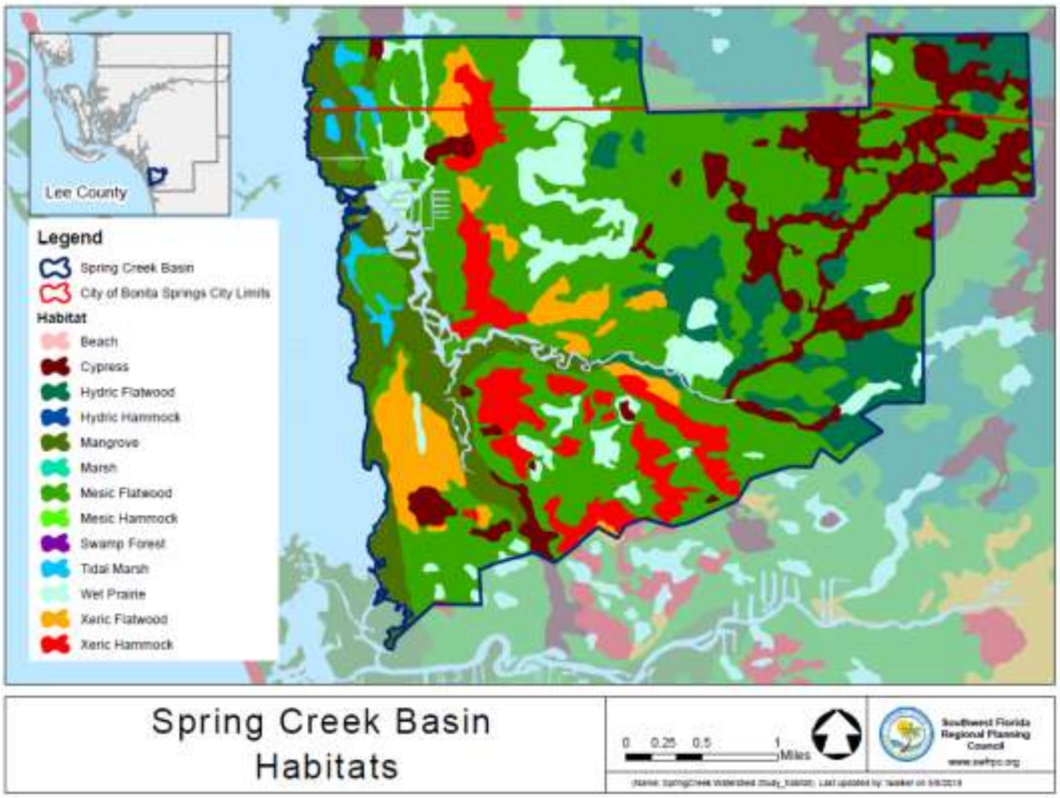


Figure 73: Pre-Development Vegetation Map of the Spring Creek Watershed

Table 9: Pre-Development Vegetation of the Spring Creek Watershed (in Hectares)

Pre-Development Vegetation (in Hectares)

	Predevelopme nt Landcover	Percentage
Mesic Pine Flatwood	1379	48.10%
Cypress	327.4	11.42%
Mangrove	264.4	9.22%
Wet Prairie	245.3	8.56%
Hydric Pine Flatwood	237.1	8.27%
Xeric Hammock (Scrub)	193.6	6.75%
Xeric Pine Flatwood	155.3	5.42%
Open Water	36.57	1.28%
Tidal Salt Marsh	28.1	0.98%
Total	2,866.77	100.00%

The following is a short description of the habitats that occur or occurred in the Spring Creek Watershed

Mesic Pine Flatwoods

The mesic pine flatwoods of South Florida dominated by southern slash pine (*Pinus elliottii* var. *densa*) are of critical, regional importance to the biota of South Florida. They provide essential forested habitat for a variety of wildlife species including: wide-ranging, large carnivores such as the Florida panther *(Puma (=Felis)concolor coryi*) and the Florida black bear (*Ursus americanus floridanus*); mid-sized carnivores; fox squirrels (*Sciurus niger* spp.); and deer (*Odocoileus virginianus).* They provide tree canopy for canopy dependent species including Neotropical migrants, tree-cavity dependent species, and tree-nesting species. Mesic pine flatwoods are also important as the principal dry ground in South Florida, furnishing refuge and cover for ground-nesting vertebrates as well as habitat for non-aquatic plant life (such as upland perennials and annuals).During the summer wet season, the mesic pine flatwoods of South Florida function as the upland ark for non-aquatic animals. Mesic flatwoods serve as ground bird nesting areas; adult tree frog climbing areas; black bear foraging, denning, and travel ways; and essential red-cockaded woodpecker (*Picoides borealis*) foraging and nesting habitat. At the current rate of habitat conversion, the mesic pine flatwoods, once the most abundant upland habitat in South Florida, is in danger of becoming one of the rarest habitats in South Florida. The impact of this loss on wide-ranging species, listed species, and biodiversity in South Florida could be irreparable.

Cypress

The cypress swamps of the Spring Creek watershed were associated with the headwaters of all the branch tributaries of Spring Creek and connected eastward to the greater Flint-Penn Slough cypress strand, as well as some coastal domes and the central slough of the Bonita Bay site. Typical cypress swamp vegetation is dominated by pond cypress (*Taxodium distichum*), with red maple (*Acer rubrum*),dahoon (*Ilex cassine*), swamp bay (*Persea palustris*), coastal plain willow (*Salix caroliniana*), wax myrtle (*Myrica cerifera*), buttonbush (*Cephalanthus occidentalis*), St. John's wort (*Hypericum* spp.), chain fern (*Woodwardia* spp.), poison ivy (*Toxicodendron radicans*), laurel greenbrier (*Smilax laurifolia*), Spanish moss (*Tillandsia usneoides*), and fireflag (*Thalia geniculata*). Typical cypress swamp animals include Florida black bear (*Ursus americanus* *floridanus*), raccoon, river otter (*Lutra canadensis*), raccoon (*Procyon lotor)*, bobcat (*Felis lynx*), gray squirrel (*Sciurus carolinensis*), white-tailed deer (*Odocoileus virginianus*), wood stork (*Mycteria americana*), wood duck (*Aix sponsa*),swallow-tailed kite (*Elanoides forficatus*), barred owl (*Strix varia*), pileated woodpecker (*Drycopus pileatus*), great crested flycatcher (*Myiarchus crinitis*), great horned owl (*Bubo virginianus*), barred owl, and songbirds, chicken turtle (*Deirochelys reticularia*), *st*riped mud turtle (*Kinosternon bauri*),eastern mud turtle (*Kinosternon subrubrum*), eastern mud snake (*Farancia abacura*), cottonmouth (*Agkistrodon piscivorus*), oak toad (*Bufo quercicus*),southern cricket frog (*Acris gryllus dorsalis*), pinewoods treefrog (*Hyla femoralis*), little grass frog (*Pseudacris ocularis*), and narrowmouth toad(*Gastrophryne carolinensis*),

Mangrove

The mangrove forests of South Florida are a vital component of the estuarine and marine environment, providing a major detrital base to organic food chains, significant habitat for arboreal, intertidal and subtidal organisms, nesting sites, cover and foraging grounds for birds, and habitat for some reptiles and mammals. The relationship between mangroves and their associated marine life cannot be overemphasized. The mangrove forest provides protected nursery areas for fishes, crustaceans, and shellfish that are important to both commercial and sport fisheries. The value and central role of mangroves in the ecology of South Florida has been well established by numerous scientific investigations directed at primary productivity, food web interactions, listed species, and support of sport and commercial fisheries. Mangroves are important in recycling nutrients and the nutrient mass balance of the estuarine ecosystem. They are one of the highest primary and associated secondary biologically productive ecosystems in the world. Mangroves provide one of the basic food chain resources for arboreal life and nearshore marine life through their leaves, wood, roots, and detrital materials. This primary production forms a significant part of the base of the arboreal, estuarine, and marine food web. Mangroves have a significant ecological role as physical habitat and nursery grounds for a wide variety of marine/estuarine vertebrates and invertebrates. Many of these species have significant sport fishery and/or commercial fishery value. This tropical ecosystem is a habitat unique in the continental United States. They deserve special protection because of this uniqueness and because of the multiple ecological functions they provide. Mangroves have a significant ecological role as habitat for endangered and threatened species, and species of special concern. For several of these species, the habitat is critical and vital to their continued survival. Mangroves serve as storm buffers by functioning as wind breaks and through prop root baffling of wave action. Mangrove roots stabilize shorelines and fine substrates, reducing turbidity, and enhancing water clarity. Mangroves improve water quality and clarity by filtering upland runoff and trapping waterborne sediments and debris. Unaltered mangroves contribute to the overall natural setting and visual aesthetics of Florida's estuarine waterbodies. Through a combination of the above functions, mangroves contribute significantly to the economy of the coastal counties of South Florida and the State of Florida.

Wet Prairie

The short-hydroperiod wet prairies of the Spring Creek Watershed are associated with inter-ridge swales within and landward of the scrub ridges and the headwaters of the south branch of Spring Creek. These mixed emergent grass/sedge prairies were co-dominated by sparse short saw grass (*Cladium jamaicense*); muhly grass(*Muhlenbergia capillaris);* black sedge (*Schoenus nigricans*); cattails (*Typha* sp), bulrushes (*Scirpus* sp.), maidencane (*Panicum hemitomon)*, beakrush (*Rhynchospora spp*) and spikerush (*Eleocharis* sp.); with submerged marsh bladderwort (*Utricularia* spp.). The soils associated with wet prairies are either entisols, or spodosols, which are poorly drained sandy soils with loamy subsoils, not marl. The mammal fauna of saw grass marshes includes species that are well adapted to the community, including: rice rat (*Oryzomys palustris natator)*, round-tailed muskrat (*Neofiber alleni)*, river otter (*Lutra canadensis)*, and highly mobile species that regularly or seasonally move through the marshes, including the white-tailed deer (*Odocoileus virginianus)*, bobcat(*Lynx rufus)*, and raccoon (*Procyon lotor)*. Birds of the denser wet prairies include common snipe (*Gallinago gallinago*), limpkins (*Aramus guarauna*), bitterns (*Botaurus lentiginosus*), and red-winged blackbirds (*Agelaius phoeniceus*). anhingas, (*Anhinga anhinga),* moorhens (*Gallinula chloropus*) and purple gallinule (*Porphyrula martinica),* The sparser vegetative cover of wet prairies makes them particularly attractive to wading birds (egrets, spoon-bills, ibis and herons) as foraging sites, especially as levels are falling and prey are being concentrated in depressions. Wet prairies are essential to the survival of native tree-frogs in the Spring Creek watershed In general, about 75 percent of the 72 species of South Florida amphibians and reptiles seasonally move from uplands and marshes into seasonally flooded wet prairies at different times during the course of a hydro-year.

Hydric Pine Flatwood

Hydric pine flatwoods are unique to South Florida, and provide essential forested habitat for wildlife including Florida black bear (*Ursus americanus floridanus),* Florida panther (*Puma (=Felis) concolor coryi),* wood stork (*Mycteria americana),* red-cockaded woodpecker (*Picoides borealis),* Everglade snail kite(*Rostrhamus sociabilis plumbeus*), bald eagle (*Haliaeetus leucocephalus),* eastern indigo snake (*Drymarchon corais couperi),* gopher tortoise (*Gopherus polyphemus),* Big Cypress fox squirrel (*Sciurus niger avicennia),* Sherman's fox squirrel (*Sciurus niger shermani),* Bachman's sparrow(*Aimophila aestivalis),* bobcat (*Lynx rufus),* swallow-tailed kite (*Elanoides forficatus),* Florida weasel (*Mustela frenata peninsulae),* limpkin (*Aramus guarauna),* northern harrier(*Circus cyaneus),* southeastern kestrel (*Falco sparverius paulus)* eastern American kestrel (*Falco s. sparverius),*Florida sandhill crane (*Grus canadensis pratensis),* and 900 native plant species including at least 80 rare and endemic plant species. This habitat seasonally functions as both a wetland and an upland. The relatively predictable nature of this hydrologic transformation allows for an abundant diversity of plant life, including both wetland and upland annuals, and supports a diverse invertebrate fauna and, as a result, a diverse vertebrate fauna. The hydric pine flatwoods of South Florida are a distinct habitat in dynamic equilibrium between drought and flood, that is regularly and predictably perturbed by fire and water. The alteration between upland and wetland conditions allows for both upland and wetland plant species to utilize the same habitat through temporal displacement. The latitudinal range of hydric pine flatwoods provides a wide range of microclimates that result in tropical floral components in the south, and temperate-dominated understory in the north and frost-prone interior sites, increasing the overall plant diversity in the understory. As a result the hydric pine flatwoods have the highest plant species diversity of any habitat in South Florida. South Florida pine flatwoods are among the least protected habitats by current distribution of public lands, with only 9 percent protected. If hydric pine flatwoods are not protected, this unique South Florida habitat will be converted to urban, suburban, and agricultural development within a relatively short time period. Regionally, the loss of hydric pine flatwoods habitats of South Florida will critically affect the biodiversity and endemic flora and fauna of South Florida.

Xeric Hammock (Scrub)

Coastal Florida scrub occurred in ridges parallel to the shoreline of Estero Bay and constitute relict beachfronts from higher se-level rise stages along the Gulf Coast in Florida. There are only a handful of coastal scrubs left in the Spring Creek watershed. Florida scrub is a plant community easily recognized by the dominance of evergreen shrubs and frequent patches of bare, white sand. Florida scrub can be identified by the dominance of several species of woody shrubs, especially myrtle oak or scrub oak (*Quercus myrtifolia* or *Q. inopina*), sand live oak (*Q. geminata*), Chapman's oak (*Q. chapmanii*), crooked wood (*Lyonia ferruginea*), and Florida rosemary (*Ceratiola ericoides*); the absence of a tree canopy; the absence of a continuous vegetative ground cover; and the absence of pines (*Pinus elliottii*), wiregrass (*Aristida beyrichiana*), and thick saw palmetto (Serenoa repens). Scrubs occurred on white sand and patches of bare sand with or without scattered clumps of ground lichens. With more than two dozen threatened and endangered species dependent upon scrub, the entire community is itself endangered. The vertebrates that are characteristic of Florida scrub are all endemic to the State of Florida including the Florida scrub jay (*Aphelocoma coerulescens*), the Florida mouse (*Podomys floridana*), the short-tailed snake (*Stilosoma extenuatum*), the scrub lizard (*Sceloporus woodi*), the Florida gopher tortoise (*Gopherus polyphemus*), the Florida worm lizard (*Rhineura floridana*), other subspecies of mole skinks (*Eumeces egregius* sspp.), and the crowned snakes (*Tantilla relicta* spp.). Although these animals are typically encountered in scrub, none are entirely restricted to the community; rather they are animals adapted to xeric habitats including the xeric pine flatwoods. There are also many species of invertebrates that are endemic to Florida scrub including 20 species restricted to scrub within the South Florida Ecosystem. Recovery of the community and its associated plants and animals will depend upon land acquisition and effective land management.

Xeric Pine Flatwood

Xeric pine flatwoods dominated by southern slash pine (Pinus elliotti var. densa) occurs throughout Florida where it usually is associated in bands between xeric oak scrub and wetlands. In South Florida xeric pine once dominated much of the high uplands. High pine and scrubby high pine apparently were the native plant communities of choice for citrus growers in the Estero Bay watershed. Typical animal species in high pine include the Big Cypress fox squirrel (Sciurus niger avicennia), Florida black bear (Ursus americanus floridanus), and Florida panther (Puma (=Felis) concolor coryi). Typical birds are the pine warbler (Dendroica pinus),Bachman's sparrow (Aimophila aestivalis), and brown-headed nuthatch (Sitta pusilla). Typical reptiles are the gopher tortoise (Gopherus polyphemus), southeastern five-lined skink (Eumeces inexpectatus), eastern coachwhip (Masticophis flagellum), eastern indigo snake (Drymarchon corais couperi), Florida pine snake (Pituophis melanoleucus mugitus),and black racer (Coluber constrictor). Typical amphibians include the pinewoods treefrog (Hyla femoralis), the gopher frog (Rana capito), and th spadefoot toad (Scaphiopus holbrooki).

Open Water

Historically the open waters in the Spring Creek watershed included only the creek itself. There were no open water unvegetated ponds, lakes or canals in that landscape. All wetlands were vegetated or tidal saltern without standing water.

Tidal Salt Marsh

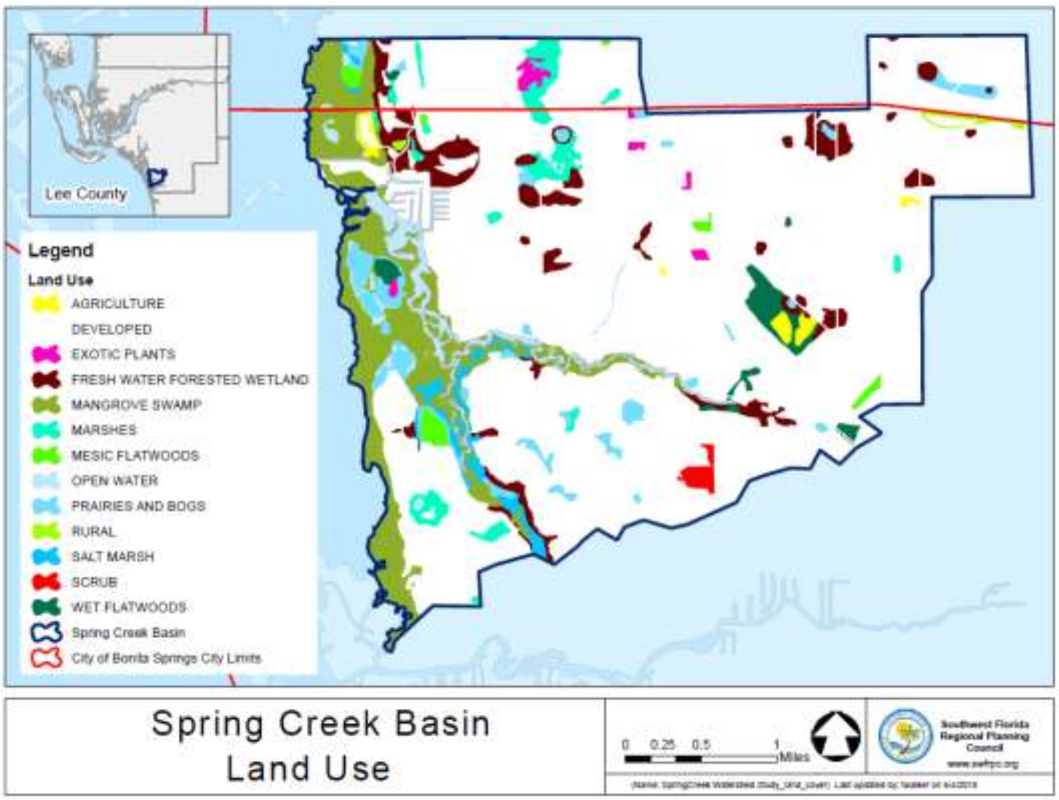
The salt marsh community of the Southwest Florida Ecosystem is one of the most unique salt marsh systems in the United States. The subtropical climate of Florida supports a combination of temperate and tropical salt marsh vegetation that intermix to form an important transitional ecotone that is subject to extremes of temperature, salinity, winds, evaporation, and storm. Ecosystem services of salt marshes include a base of the estuarine detrital food pathway, nurseries and escape from predation habitat for many species of aquatic life including the early life stages of game fish and commercial fish , recreational fishing, commercial fishing and harvesting, hunting, migratory bird habitat, bird watching, other forms of ecotourism such as kayaking, carbon sequestration, storm protection, water quality treatment, stabilization of sediment and shorelines, increases in market-based property appraisal values and aesthetic values. From existing scientific literature, southwest Florida salt marsh provides habitat to a variety of resident and transient organisms including 301 plant species, 422 invertebrate species, 217 fish species, 11 amphibians, 31 reptiles, and 15 mammals; including 6 federally listed and 27 state listed animal species. Monotypic stands of black needlerush (*Juncus roemerianus*) are common in slightly elevated areas with lower ranges of tidal inundation and dominate salt marsh communities around the mid-estuarine transition zones at the mouths of rivers and creeks like Spring Creek. Salt marshes have been directly destroyed or impacted from construction activities for residential and commercial purposes including construction for seawalls, drainage ditches for agriculture and mosquito control, boat facilities, and navigation channels. Man-made hydrological alterations have reduced the amount of freshwater flow from some rivers and creeks such as Spring Creek , while artificially increasing the flow through others (e.g., Caloosahatchee). There are 12 different types of salt marsh in the CHNEP. Seventy percent of the salt marshes of the CHNEP are high marsh and 30% of the salt marshes are fringing marsh. The salt marshes of Spring Creek are black rush (*Juncus roemerianus*) and leather fern (*Acrosticum danaeifolium*) marshes.

Current Conditions

The SFWMD maintains Existing Land Use information using the Florida Land Use and Cover Classification System (FLUCCS). Typically these are updated every 5 years. FLUCCS is the state standard and was developed by the Florida Department of Transportation (FDOT) in cooperation with state agencies. The manual which details the classification system is available at: http://www.dot.state.fl.us/surveyingandmapping/geographic.htm.

The FWC prepares land cover maps from LandSat Imagery. Land cover can be different from land use. For example, the land cover for unimproved pasture can be mesic pine flatwoods.

Figure 75: Current SFWMD Land Cover



For the purposes of this analysis, Land Cover categories were converted to SFWMD Pre-Development Vegetation classifications Overall, in the current condition native habitats have decreased by 79.72% in the Spring Creek watershed from Pre-Development conditions. Looked at another way this means that 20.28% of the Spring Creek watershed is native habitat.

Table 10: Current General Land Types in the Spring Creek Watershed (in Hectares)

Upland	Wetland	Open Water
2,229.52	518.19	62.01
78%	18%	2%

Table 11: Current Land Cover Compared to Pre-Development Vegetation (in Hectares)

	Current Land Cover	Predevelopment Landcover	Hectares Loss	Percentage Loss
Xeric Hammock	8.85	193.6	184.75	95.43%
Xeric Flatwood	0	155.3	155.3	100.00%
Mesic Flatwood	17.74	1379	1361.26	98.71%
Hydric Flatwood	34.35	237.1	202.75	85.51%
Cypress	116.18	327.4	211.22	64.51%
Wet Prairie	77.47	245.3	167.83	68.42%
Tidal Marsh	30.15	28.1	-2.05	-7.30%
Mangrove	260.04	264.4	4.36	1.65%
Open Water	62.01	36.57	-25.44	-69.57%
Exotics	12.26	0	-12.26	NA
Agriculture	20.04	0	-20.04	NA
Urban	2170.63	0	-2170.63	NA
Total	2,866.77	2,866.77	2,866.77	
Native Land Habitats	581.35	2,866.77	2285.42	79.72%

Table 12: Current Land Cover Compared to Pre-Development Vegetation (in Hectares) in order from most frequent to most rare.

Current Land Cover Compared to Pre-Development Vegetation (in Hectares)

	Current Land Cover	Predevelopment Landcover	Hectares Loss	Percentage Loss
Urban	2170.63	0	-2170.63	NA
Mangrove	260.04	264.4	4.36	1.65%
Cypress	116.18	327.4	211.22	64.51%
Wet Prairie	77.47	245.3	167.83	68.42%
Open Water	62.01	36.57	-25.44	-69.57%
Hydric Flatwood	34.35	237.1	202.75	85.51%
Tidal Marsh	30.15	28.1	-2.05	-7.30%
Agriculture	20.04	0	-20.04	NA
Mesic Flatwood	17.74	1379	1361.26	98.71%
Exotics	12.26	0	-12.26	NA
Xeric Hammock	8.85	193.6	184.75	95.43%
Xeric Flatwood	0	155.3	155.3	100.00%
Total	2,866.77	2,866.77	2,866.77	
Native Land Habitats	581.35	2,866.77	2285.42	79.72%

It is clear that significant loss of all the upland and freshwater wetland habitats has occurred. all of the xeric pine flatwoods and most of the xeric hammock, and mesic flatwoods are gone. more than half of the freshwater wetlands are gone particularly at the headwaters of the Creek, Open water has significantly increased by the construction of man-made features created principally for fill to elevate areas to human buildable heights, and secondarily to act as drainage features. With the exception of the mangroves and salt marsh along the Creek native habitat are fragmented into small isolates in an urban/suburban landscape. As a result the Spring Creek Watershed is impacted with a Land Development Index (LDI) value of 5.6 because of the urbanization on the upstream portion. The upstream portion of Spring Creek is also narrower than the downstream portion. Spring Creek widens and becomes more natural with as it moves downstream with mangroves and marsh areas along one of the banks. The creek buffer area is not highly altered with only some channelization at the mouth of the creek and a creek LDI value of 2.8.

Figure 76. Overview of the Spring Creek Study Area (*West-Central Florida Tidal Stream Assessment Study* USF-FCCDR)

Vegetation Survey

The Spring Creek vegetation assessment encompassed 34 vegetation regions from the mouth in Estero Bay to above Highway 41 as shown in 77 through Figure 79. In these regions, 44 species of vegetation were identified. Regions 1 through 32 were dominated by mangroves (*Rhizophora mangle, Laguncularia racemosa* and *Avicennia germinans*) with few other salt tolerant species present. The most upstream mangrove was *Rhizophora mangle, Laguncularia racemosa* and *Avicennia germinans* in Region 34. The first occurrence of Leather Fern (*Acrostichum danaeifolium*) was in Region 12, becoming dominant in regions 31, 32 and 34. Needle Rush (*Juncus roemerianus*) was first observed in Region 13 with the last occurrence in Region 22. Above Region 32 the vegetation communities are populated by many species indicative of dominating freshwater influence.

Figure 77: Overview of Spring Creek Vegetation Assessment Regions Source: *Spring Creek Stream Assessment* USF-FCCDR

Figure 78. Spring Creek Vegetation Assessment Regions 1-20 (*West-Central Florida Tidal Stream Assessment Study* USF-FCCDR)

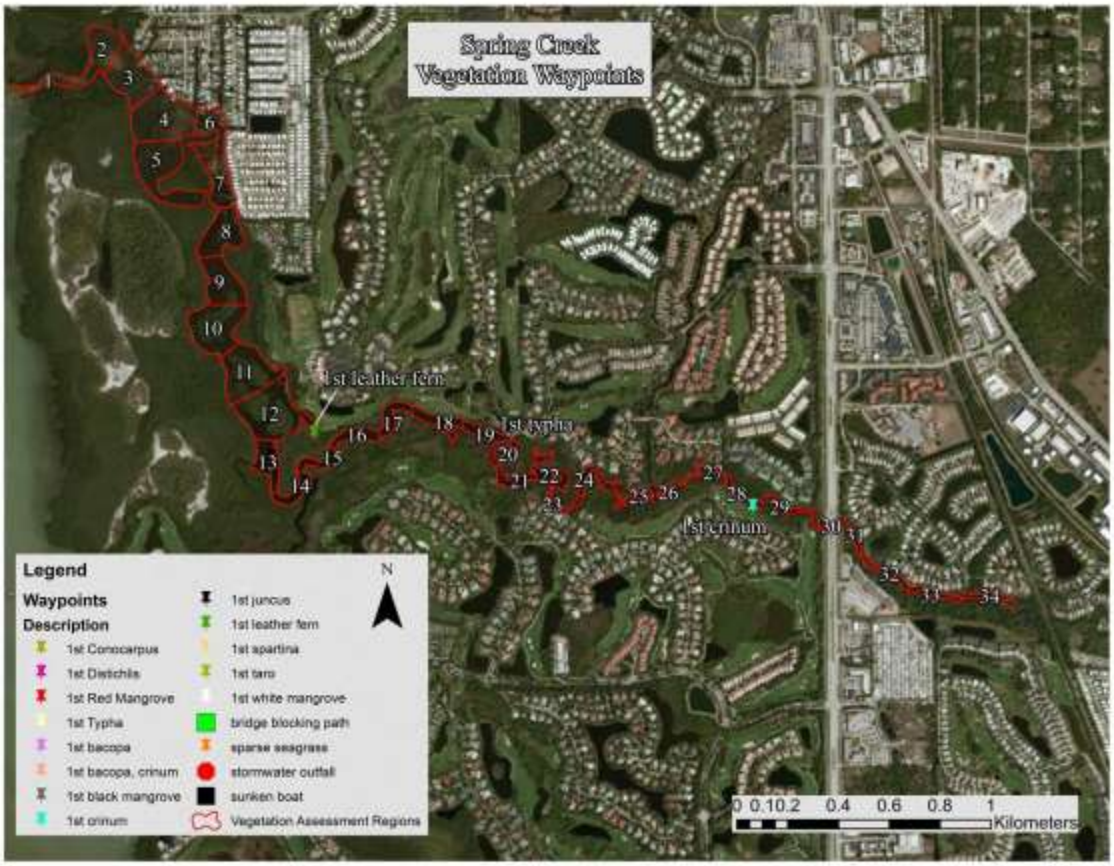


Figure 79. Spring Creek Vegetation Way Posts (*West-Central Florida Tidal Stream Assessment Study* USF-FCCDR)

Public Conservation Lands

Existing Lands under Public or Private Stewardship

The Florida Natural Areas Inventory (FNAI) maintains an inventory and Geographic Information System (GIS) coverage of lands under public and private non-profit management for conservation purposes. The coverage includes contact information and descriptions of the property. By the year 2006, nearly 12,949.94 hectares (32,000 acres) are publicly managed within the Estero Bay Watershed area.

Year 2006 Conservation and Mitigation Areas of the Estero Bay Watershed

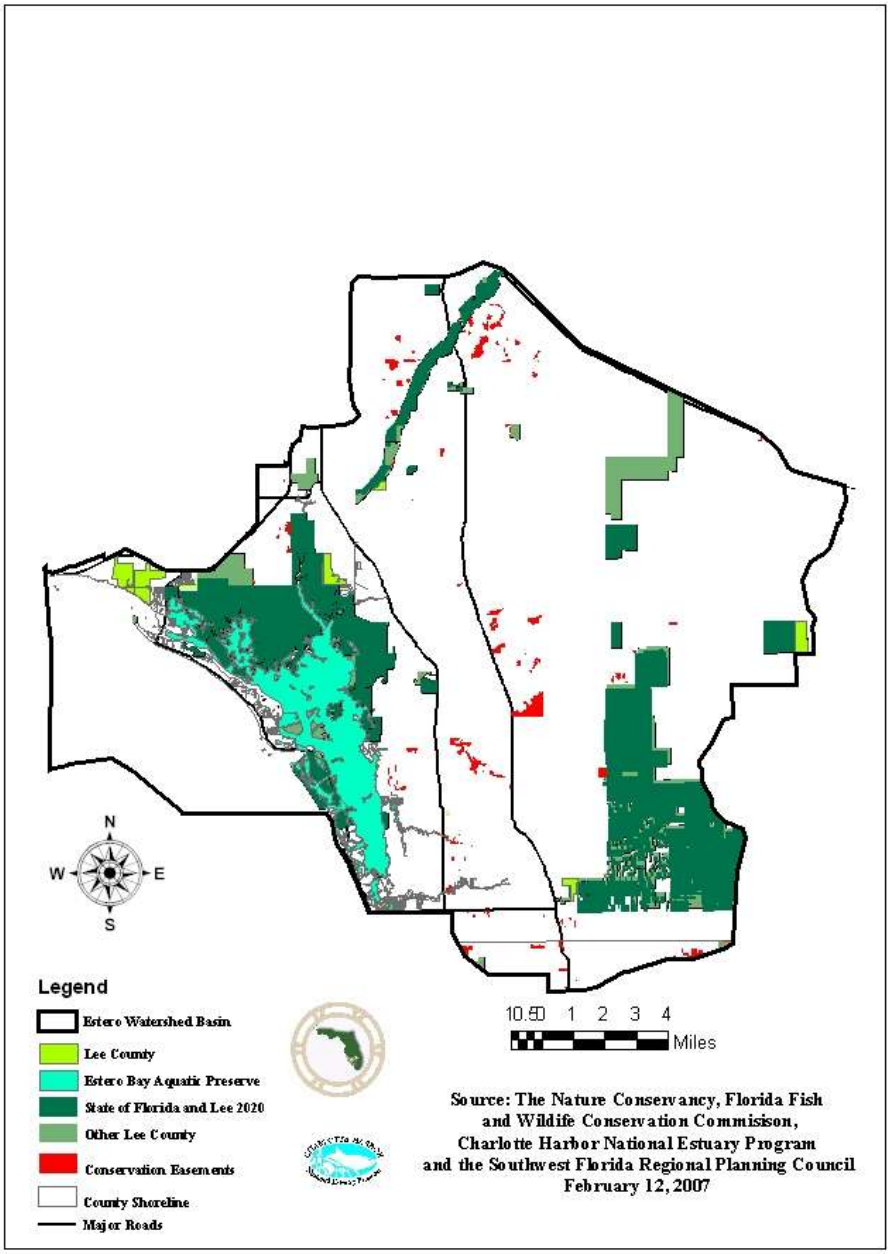


Figure 80: Lands and Waters in Conservation in the Estero Bay Watershed

Several entities have acquired and managed lands in the Estero Bay Watershed for conservation purposes. The SFWMD is steward for 4,953.95 hectares (12,239 acres) which includes the CREW. The State of Florida, through the Trustees of the Internal Improvement Trust Fund owns and manages 4,512.65 hectares (11,151 acres). These purchases have been by-and-large for buffers to the State Aquatic Preserves. An additional 3,422.43 hectares (8,457 acres) is under Lee County ownership and management.

The Spring Creek watershed includes submerged aquatic preserves (Figure 81

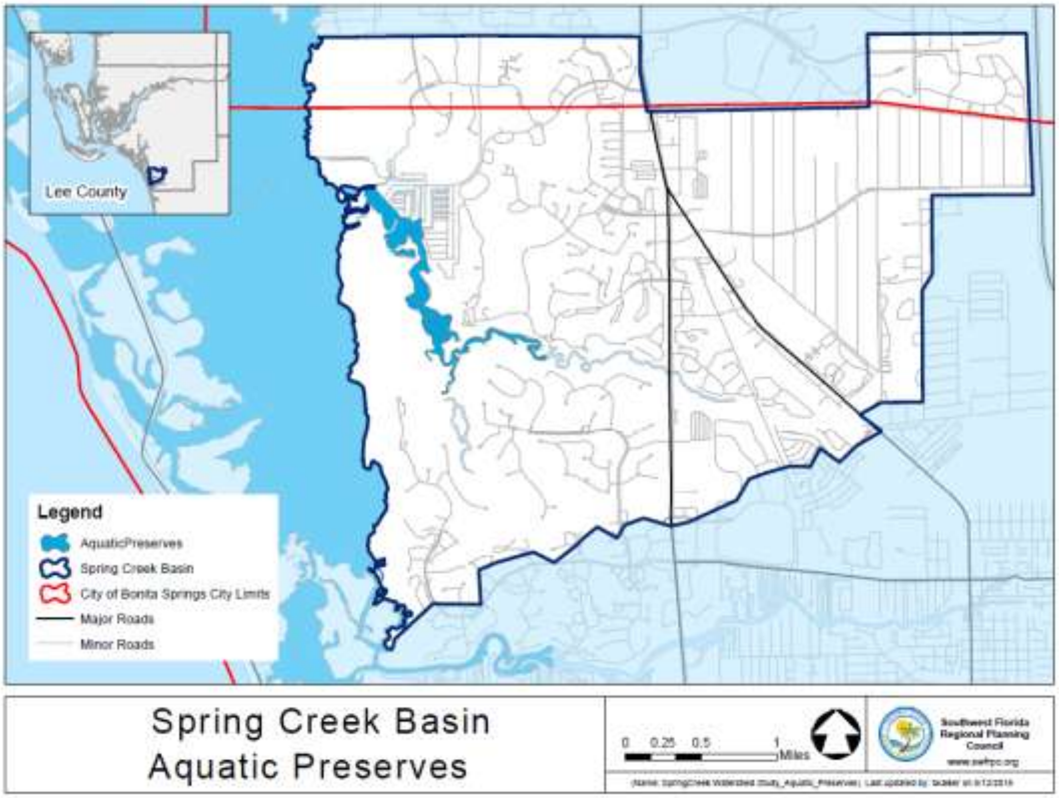


Figure 81: Aquatic Preserve boundaries .

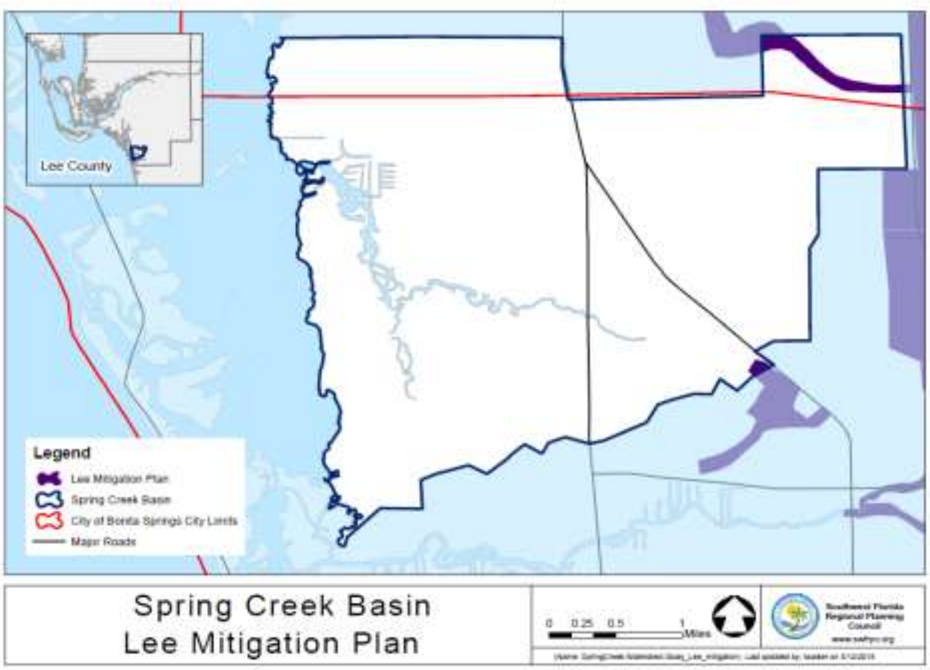


Figure 82: Lee Mitigation Plan Areas in the Spring Creek Watershed.

Table 13: Public Lands Total Acreage in Conservation in the Estero Bay Watershed

OWNER	Acres
City of Fort Myers	101
Lee County	8,457
SFWMD	12,239
State of Florida	11,151
Total	31,948
Total Land Area	183,663
Percentage in conservation	17.4%

Conservation Easements under Private Management

An extra 197.047 Hectares (486.92 acres) are privately managed and are within a conservation easement. These easements are nearly all associated with private development permit requirements. FDEP, Lee County and SFWMD track conservation easements which are transferred to them as a result of development permitting regardless of size using GIS, from which the Figure 83 was derived.

Table 14: Conservation Easements Holders

Easement Holder	Total Hectares
FDEP	28.43
SFWMD	66.57
Lee County	97.02
Various	5.03
Total	197.05

Easements are found on lands with underlying ownerships by Baywoods of Bonita Bay, Bonita Bay, Brooks of Bonita, Hyatt Equities, Keystone Development Group, Leffler & La Flamme, Minto Communities, Pelican Landing, Pueblo Bonita, SRK 50, and WCI Communities.

Figure 83: Conservation Easements in the Estero Bay Watershed

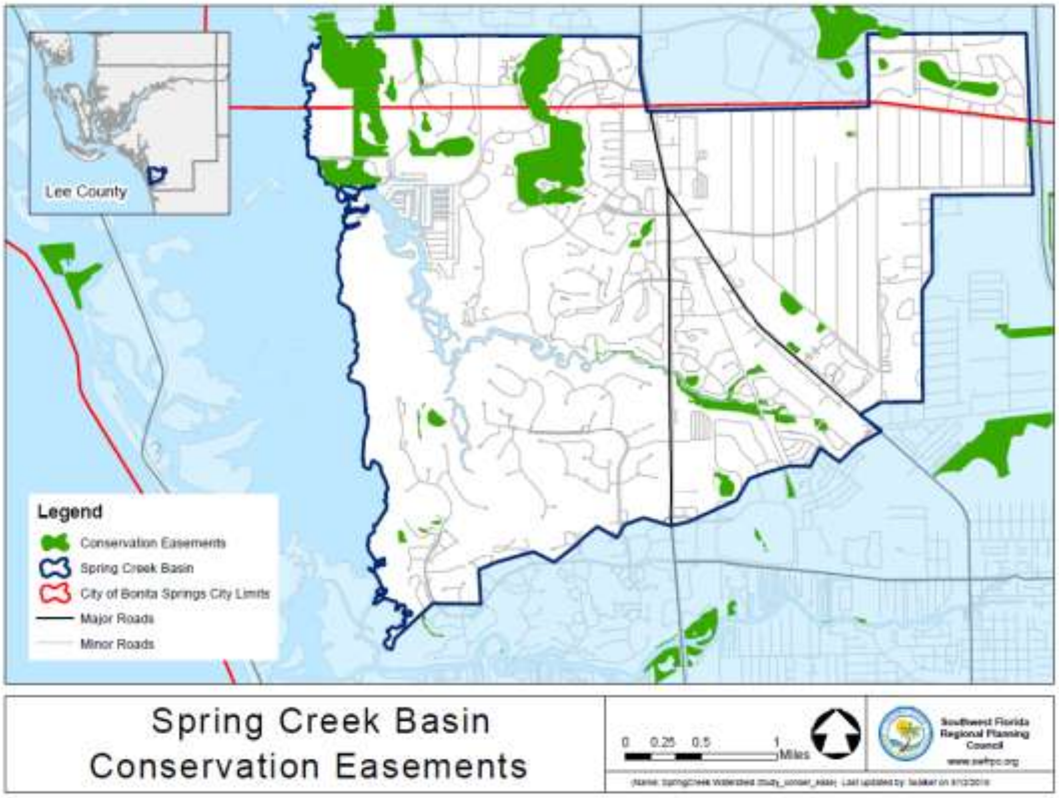


Table 15: Total Acreage Public and Private Areas in Conservation in the Spring Creek Watershed in Hectares

OWNER	Spring Creek
Private/Easements	197.047
State of Florida	22.69
Total	219.737
Total Land Area	2,974.44
Percentage in conservation	7.4%

Strategic Habitat Conservation Areas and Greenways

Using LandSat imagery, habitat use, and listed species sightings, the FWC identified Strategic Habitat Conservation Areas (SHCAs). SHCAs have many areas in common with native lands.

Figure 84: Strategic Habitat Conservation Areas in the Spring Creek Watershed

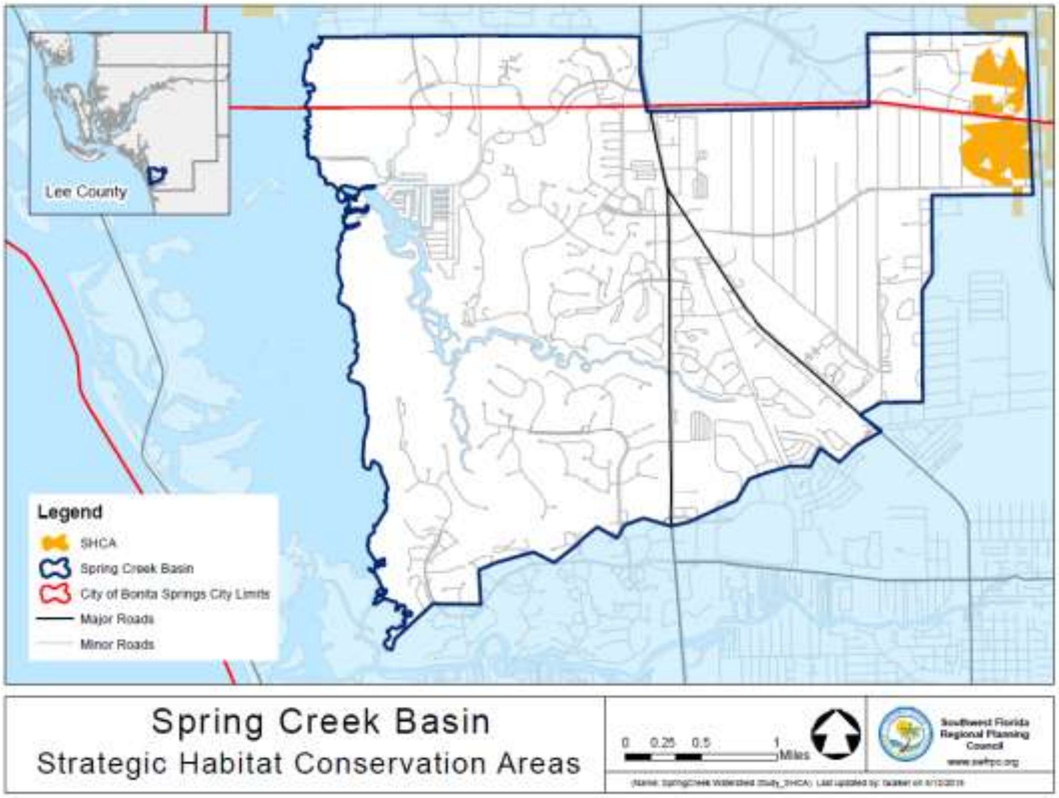


Table 16 Strategic Habitat Conservation Area Species Pertinent to the Spring Creek Watershed

Amphibians and Reptiles	Birds	OTHER COMPONENTS OF BIOLOGICAL DIVERSITY
American crocodile Mammals Florida black bear* Florida panther Big Cypress fox squirrel	American swallow-tailed kite Audubon's crested caracara Black-whiskered vireo Cuban snowy plover Florida grasshopper sparrow Florida sandhill crane Florida scrub jay Limpkin Mangrove cuckoo Mottled duck Red-cockaded woodpecker Short-tailed hawk Snail kite Southeastern American kestrel Southern bald eagle*	Xeric Scrub communities Tropical hardwood hammock communities Wetlands important to wading birds Common egret Little blue heron Reddish egret Roseate spoonbill Snowy egret Tricolored heron White ibis Wood stork

As part of Florida's statewide system of greenways and trails, a series of maps were completed to define opportunities for establishing the Trails and Ecological Greenways Networks. These maps assist in guiding planning and determining appropriate lands for acquisition. They were originally completed during creation of the 1998 Implementation Plan for the Florida Greenways and Trails System and have gone through an update since that time. Figure 85 shows the conservation/ecological opportunities FDEP product. More information can be found at: http://www.dep.state.fl.us/gwt/network/network.htm.

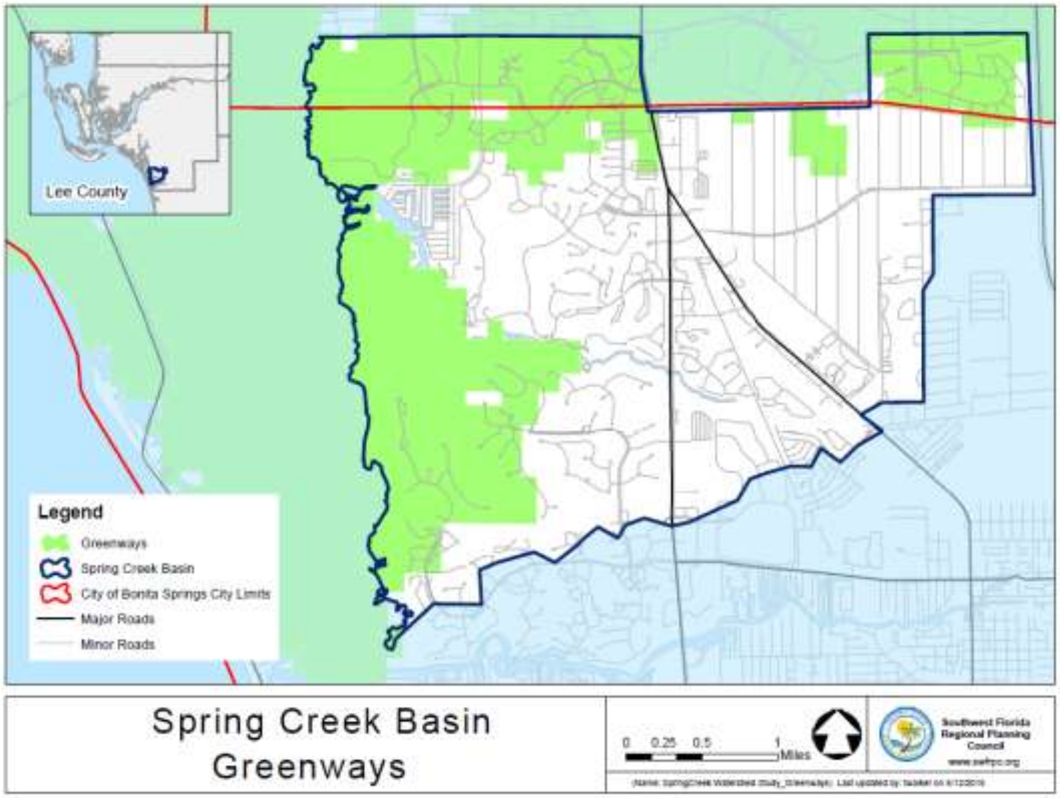
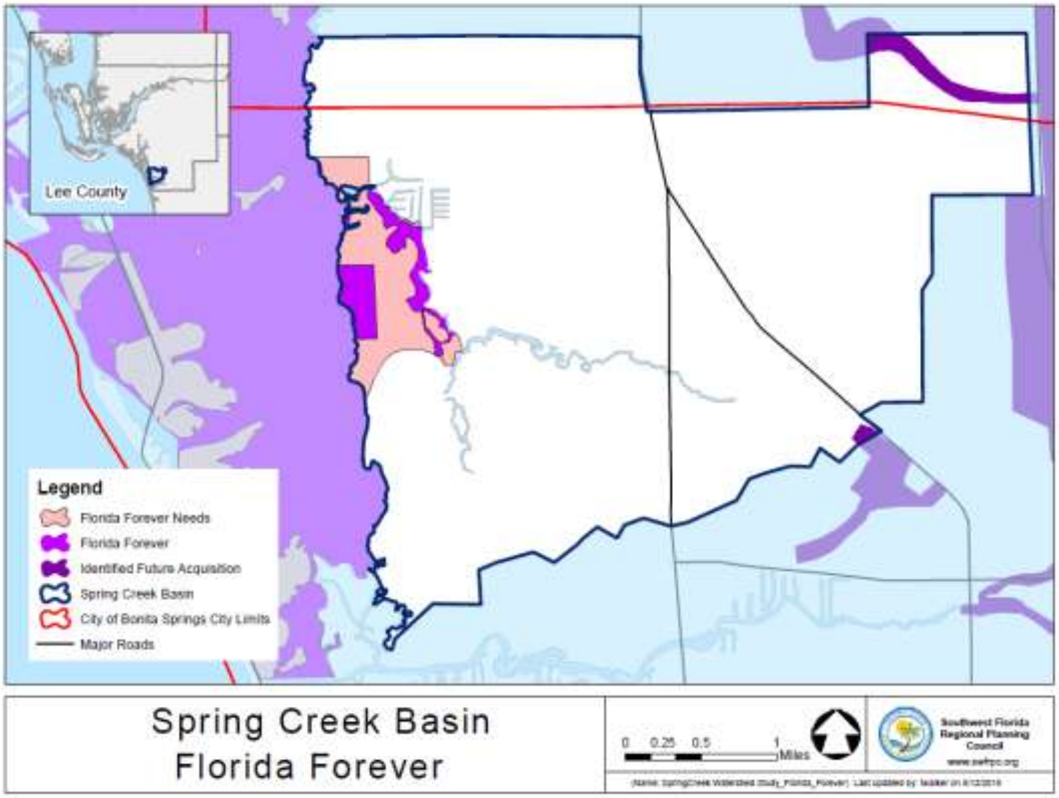


Figure 85: Florida Greenways and Trails Program Conservation/Ecological Opportunities Identified Lands for Potential Future Acquisition

Potential future acquisition sites are identified through the State's Florida Forever program and through the Lee County Master Mitigation Plan, SWF RRCT Restoration Needs, and SWFFS Alternatives Development Group. The predecessor to the Florida Forever program is the Conservation and Recreation Lands (CARL) program.

Figure 86: Identified Lands for Potential Future Acquisition



Sources: Florida Natural Areas Inventory, Southwest Florida Regional Planning Council and Charlotte Harbor National Estuary Program (Lee County Master Mitigation Plan Mapping).

Summary of Habitat Vulnerabilities and Issues of Concern for Spring Creek

Habitat management issues of concern for the Spring Creek Watershed include:

Completing the proposed Florida Forever Land Acquisitions

Removing exotic vegetation from existing conservation easements

Removing exotics along the main channels of Spring Creek.

Removing exotics with the storm water management systems of existing developments with outfalls to Spring Creek.

Creation of filter marshes in appropriate locations

PART 4: Humans and Human Access

Human History of the Estero Bay Watershed

Calusa Period

The Calusa Period spanned from 4,000 BC to 1710 AD. As new archeological data are analyzed the date of the first human habitation of Florida is pushed earlier and earlier. It is currently estimated that the first human habitation of Lower Charlotte Harbor was approximately 10,000 years ago. These first inhabitants were nomadic people who used stone tools and hunted large mammals in the interior plains. Coastal villages developed as climate changed, sea levels rose and fishing skills increased. Farming, pottery skills, and trade with people outside of Florida developed between 3,000 and 500 years ago. Archeological records indicate that copper, iron ore and maize seeds were prized imports, while pearls, shells, and fish bones were the primary exports. During this period, mound building began and ceramic pottery was used to store goods.

The Lower Charlotte Harbor area was the center of the Kingdom of the Calusa. It is thought that this tribe came from Caribbean islands around 2,000 years ago. The Calusas fished the Gulf of Mexico, established settlements near fresh water tributaries, and paddled cypress canoes to colonies in other areas. Archeologists believe nearby Mound Key in Estero Bay may have been the tribes' regional center. The 125-acre island is approximately 33 feet high and covered with massive middens; refuse heaps composed of discarded shells. As had other Indian civilizations living on the Gulf of Mexico, the Calusa built large structural mounds from mollusk shells on which important buildings were constructed. Structures on the mounds ranged from the residence of Chief to temple-like buildings. The Calusa built small canals that served as access to Lake Okeechobee and the Kissimmee River from the Caloosahatchee. The first documented Europeans to visit southwest Florida were the Juan Ponce de León expedition on June 4, 1513. He sailed as far south as Estero Bay. The Calusa attacked the Spaniards' ships after they entered into Charlotte Harbor. After two attacks, the Spanish retreated.

Throughout the 1500s, other Spanish explorers and enterprising pirates sailed Southwest Florida's coastal waters Treasure-laden galleons from Mexico and Central America sailed past Estero Bay. Map-makers named the bay "Estero," the Spanish word for estuary. Some purposely put ashore to rest and refill their water casks, others were driven in by storms and high winds, and still others were shipwrecked when their ships sank to the sea's bottom, overcome by hurricanes.

A tenuous alliance was later formed between the Calusa and the Spanish in 1567. However, the Spanish did not want to help the Calusa against their enemy the Tocobaga and the Calusa were disinterested in Christianity, so the alliance dissolved. Other Spaniards followed, and the Calusa were eventually conquered—but by disease, not warfare. Common European illnesses such as smallpox and influenza spread like wildfire among the sheltered tribes, and the last known Calusa in southwest Florida died in the late 1700s. There is evidence that the last remnants of the tribe subsequently settled in Cuba by the e 1800's.

Cuban Period

The Cuban Period spanned from 1710 to 1836. Southwest Florida, while it remained under Spanish control, was not a center for major settlement. Fishing camps were established by people of direct Spanish and Cuban descent who harvested the bounty of the estuary and brought salted and smoked fish to the urban centers of Cuba and the Spanish Caribbean. Beyond fishing camps, the interior was visited only for hunting trips. Here the Cubans made contact with the Seminoles. The name Seminole is from the Creek word 'semino le', interpreted to translate as 'runaway.' Another, better description of the meaning can be “emigrants who left the main body and settled elsewhere.” The term was first applied to the tribe about 1778. The Cuban populations did not desire to settle in the interior of southwest Florida so conflict with the Seminoles was minimal. The settlement history of southwest Florida by Americans was driven by military decisions associated with the series of Seminole Wars generated by the southward movement of. American settlers from Georgia and elsewhere in the southeastern United States immigrated into Florida even when it was still a Spanish possession. There were three Seminole Wars in Florida; first Seminole War started in 1817 and shortly, thereafter, Spain ceded Florida to the United States.

American Period

The American Period spans from 1817 when Florida became a territory of the United States to the present. The Treaty of Camp Moultrie was signed in 1823, legally establishing large parts of Lower Charlotte Harbor as the promised Seminole territory. By 1840, the Lower Charlotte Harbor area had several forts: Fort Dulany, Fort Denaud, Fort Adams, and Fort Thompson. The last Seminole War ended in 1842 with an agreement that the Seminoles could remain in Florida but were forced further south.

By the mid 1800s, settler families headed south, settling on the high ground created by the Calusas and scrub lands along rivers. They raised citrus, ranched cattle and commercial fished. Frank Johnson, one of Lee County’s early pioneers, settled on Mound Key and began excavating the historic site, gathering Calusa artifacts and gold and items left behind by the Spaniards and Cubans.

In 1904, the Koreshans, a celibate Utopian society that settled by the Estero River, built a post office at their settlement and Estero officially became a town. But three years later, other local citizens protested the incorporation, the neophyte city was dissolved and once again part of unincorporated Lee County.

The Koreshans gradually dwindled in numbers, and when their leader, Dr. Cyrus Teed, died in 1908, the group began breaking up. The four remaining members deeded the major part of the Koreshan property to the State of Florida in 1961. Today, the Koreshan State Historic Site includes several preserved buildings, and fishing, camping, nature study, picnicking and boating are popular activities. Canoe rentals are available and park rangers offer guided walks and campfire programs according to seasonal demand.

Historically, the Estero Bay basin was approximately 1,275 ha (3,150 ac) smaller than today. The boundaries were increased when 10-mile Canal was dredged in the 1920’s. The dredging began as a source of fill to create a dike to prevent parts of Fort Myers from flooding with seasonal sheetflow from undeveloped lands to the east of the city boundary. The canal was extended, dredging through uplands and wetlands and blasting through rock to connect it to Mullock Creek, cutting off the connection of the Six-Mile Cypress Slough to the headwaters of Hendry Creek.

Estero remained a quiet, sleepy citrus and fishing community for the next 50 to 60 years, harboring small retirement communities and mobile home parks. Estero River Heights, the area’s first major development, was built along the river during the late 1960s; today, the neighborhood is filled with mature landscaping and trees, home renovations and price points that reflect its desirable waterfront location.

The first attempt to incorporate Fort Myers Beach occurred in the mid 1940's and failed by a margin of six or seven votes. A second try in the late 40's lost by a larger number, and an attempt in November, 1953 was a total failure. Using a newly written Charter stipulating that no more than two mills on the tax rate could be assessed without a referendum, the 1957 attempt was defeated by a margin of 88 votes. Using the same Charter in the winter of 1960, the effort to incorporate lost by 50 votes with feelings running strong and voting turnout high.

In 1969, a boundary line agreement between the State of Florida and adjacent landward property owners allowed the sale of more than eight hundred hectares (two thousand acres) of aquatic preserve to private ownership. In 1972, Robert B. Troutman, Jr. (an Atlanta attorney) attempted to develop a five hundred million dollar condominium development on 5,240 acres of marshland and mangroves on north shoreline of Estero Bay. Conservationists filed suit against the state to have the boundary line nullified. Between 1969 and 1975, conservationists struggled with developers to protect wetlands, prevent the development and establish the Estero Bay Aquatic Preserve (EBAP). By 1975, the Florida Aquatic Preserve Act was passed and the existing preserves were brought under a standard set of management criteria.

In the 1990's, a settlement agreement between the Responsible Growth Management Coalition and the State of Florida over the siting of Florida Gulf Coast University led to creation of the Estero Bay Agency on Bay Management.

In 1997, Southwest Florida's only four-year university, Florida Gulf Coast University, opened right in the middle of the watershed and east of Estero. Germain Arena and Miromar Outlets opened in Estero in 1998, increasing the population and real estate values. Miromar is a 70-acre, 700,000-square-foot outlet center. Germain, which doubles as a hurricane and emergency shelter housing up to 6,500 people, is the home of the Florida Everblades professional hockey team, the Sea Dragons basketball team, and the Firecats, a minor league arena football team. Growth exploded both east of Interstate 75 and the coastal band flanking US 41.

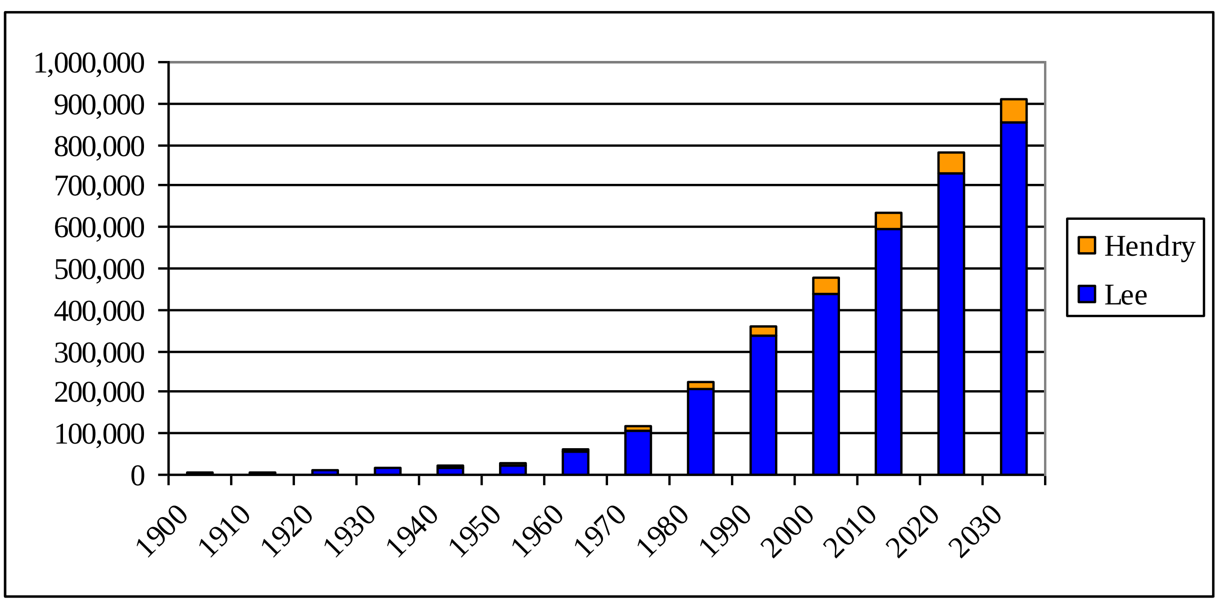
Population and Urbanized Area Growth

The 2010 Spring Creek Basin population is 14,535. The 2000 Spring Creek Basin population was 9,552. This is a 52.16% increase in a decade.

By contrast the entire City of Bonita Springs 2010 population is 43,857. The 2000 City of Bonita Springs population was 32,797. This is a 33.72% increase in a decade.

The historical population growth is based on Lee and Hendry County population because these counties represent 93% of the study area population and most of the population of the two counties resides in the study area. The study area has been experiencing exponential growth and there is a substantial difference in population between coastal and interior counties. The total population is currently over 500,000 residents and is projected to be over 900,000 by the year 2030 (BEBR 2003).

Figure 87: Historic and Projected Population Growth in Lee County with Hendry County by comparison.



The Census Bureau defines an urbanized area as continuous areas of over 1000 people per square mile. The first urbanized area in Lower Charlotte Harbor was defined for Fort Myers/Cape Coral as a result of the 1970 census. The increase of the 1980 urbanized area was not much greater geographically than the 1970. The most geographically significant increase of urbanized area for 1990 was in Cape Coral and Punta Gorda. By the year 2000 the urbanized area had greatly expanded in the Estero Bay watershed (See Figure 82).

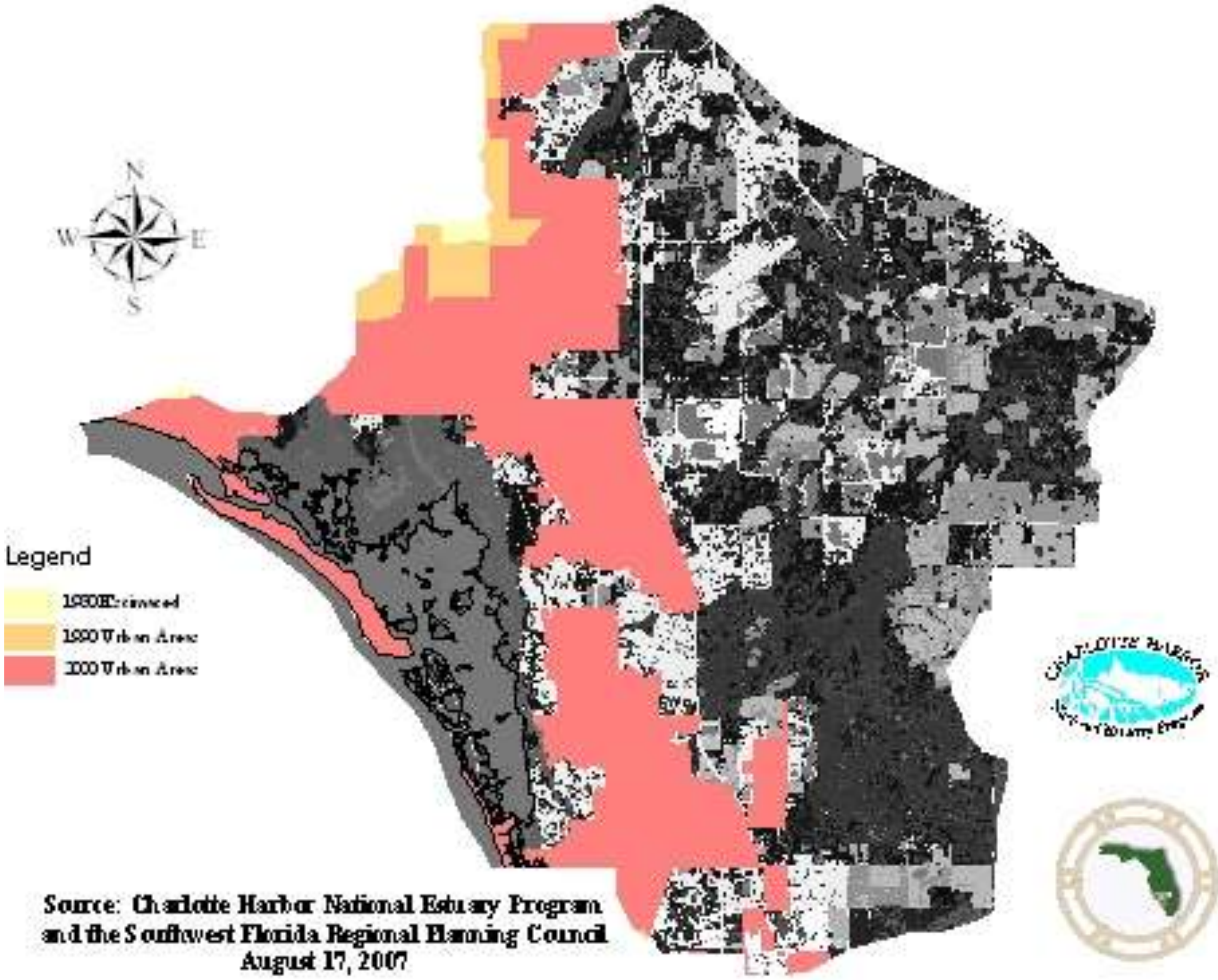


Figure 88: Urbanized Area Growth

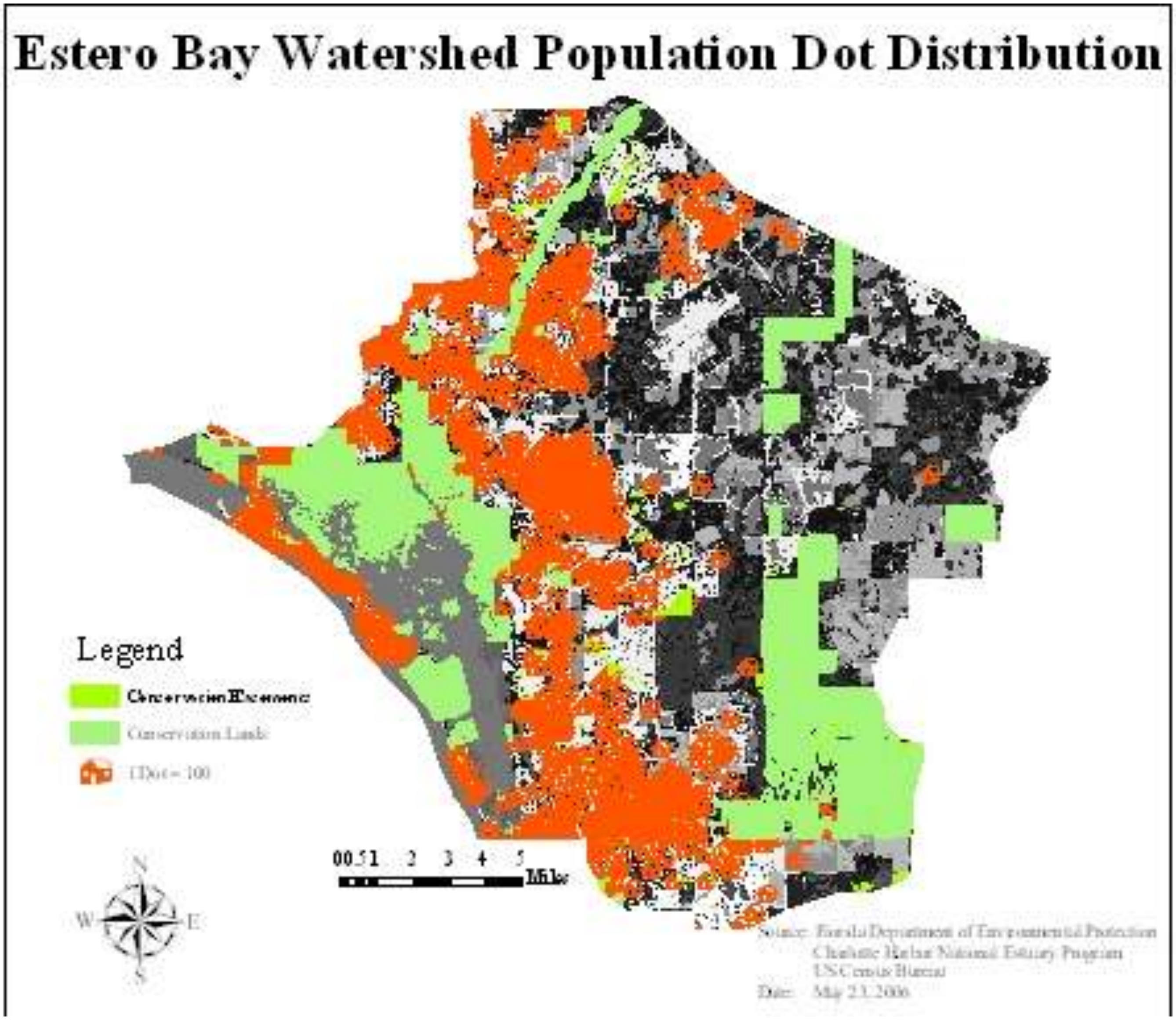


Figure 89: Population Distribution

Projected future growth

The Lee Plan is designed to depict Lee County as it will appear in the year 2020. Given the projected increase in population (to 602,000 permanent and 764,171 seasonal residents) and the probable rate of technological change between the present date and 2020, it is impossible to describe the future face of the county with any degree of certainty or precision. However, the following list of themes will be of great importance as Lee County approaches the planning horizon:

The growth patterns of the county will continue to be dictated by a Future Land Use map that will not change dramatically during the time frame of this plan. With the exception of Cape Coral and Lehigh Acres, the county's urban areas will be essentially built out by 2020 (pending, in some cases, redevelopment). The county will attempt to maintain the clear distinction between urban and rural areas that characterizes this plan. Its success will depend on two things: the continuing viability of agricultural uses and the amount of publicly-owned land in outlying areas.

The county will protect its natural resource base in order to maintain a high quality of life for its residents and visitors. This will be accomplished through an aggressive public land acquisition program and by maintaining and enforcing cost-effective land use and environmental regulations that supplement, where necessary, federal, state, and regional regulatory programs.

The Lee Plan's land use accommodation is based on an aggregation of allocations for 22 Planning Communities. These communities have been designed to capture the unique character of each of these areas of the county. Within each community, smaller neighborhood communities may exist; however, due to their geographic size, a planning community could not be created based on its boundaries. These communities within the Estero Bay Watershed and their anticipated evolutions are as follows: (Amended by Ordinance No. 99-15)

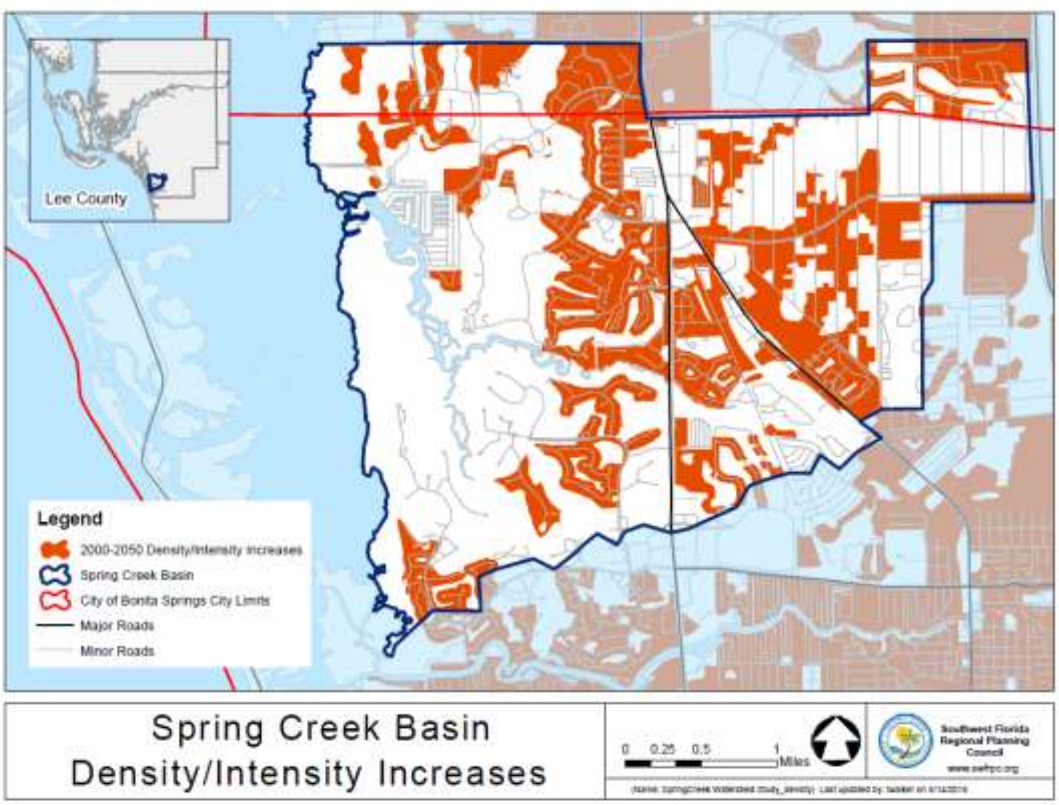


Figure 90: Location of existing and future population density increases

Bonita Springs is one of the fastest growing communities in Lee County and is expected to nearly double in population between 1996 and 2020 with an expected 2020 permanent population of approximately 37,000. The Bonita Community will also remain a seasonal homeowner destination and has an anticipated Seasonal Population of 61,000 in the year 2020. This community will have only 20% of its total land area remaining vacant or in agricultural use in the year 2020. (Added by Ordinance No. 99-15)

Tropical Storms and Hurricanes

Southwest Florida is particularly vulnerable to weather related disasters including hurricanes and coastal storms, tornadoes, seasonal floods, landscape scale wildfires, thunderstorms/high wind, drought/heat waves, coastal erosion, sinkholes, and winter storms and freezes.

Hurricane season (June 1 to November 30) is especially brutal on southwest Florida. No one in the region lives more than 75 miles from the coast, and while storms have effects wherever they strike, they have particularly heavy impacts in coastal areas. Storm surges, wave action, high winds, and heavy rainfall can all combine to produce effects that slow or shut down life in coastal communities, disrupt normal activities, damage property, and injure people (Florida Sea Grant Coastal Storms website).

South Florida is subject to more hurricanes than any other area of equal size in the United States (Gentry 1974). The area is subject to both Atlantic and Caribbean hurricanes. Of the 38 hurricanes that passed over southwest Florida from 1901 to 1971, 30 occurred between August and October (Jordan 1973). Tropical storms strike about once every three years in southern Collier County and once every five years in the northern extents of the Southwest Regional Planning Council area (Bamberg 1980).

The three primary climatic effects of hurricanes are high wind, storm surge, and heavy rain. Wind force increases by the square of the wind speed such that a 93 mph wind exerts four times as much force as a 47 mph wind. When hurricane winds attain 249 mph, as in the 1935 Labor Day hurricane, the effects on forested ecosystems, including tree fall, substrate disturbance, and propagule (cone) distribution, can be devastating.

Hydrometerological hazards associated with hurricanes include coastal flooding caused by storm surge; windstorms due to extremely strong winds; riverine flooding caused by heavy rains; and, tornadoes. The low sea level hugging topography, over population of the near coastal zone and limited to inadequate evacuation and helter systems place southwest Florida in the danger zone for major disaster.

From 1873 to 1993, Southwest Florida experienced forty-nine tropical cyclones of hurricane intensity. The map below shows the hurricanes that passed by and through the Region, including earlier years, going back to 1851 (Southwest Florida Regional Hurricane Evacuation Study 2005).

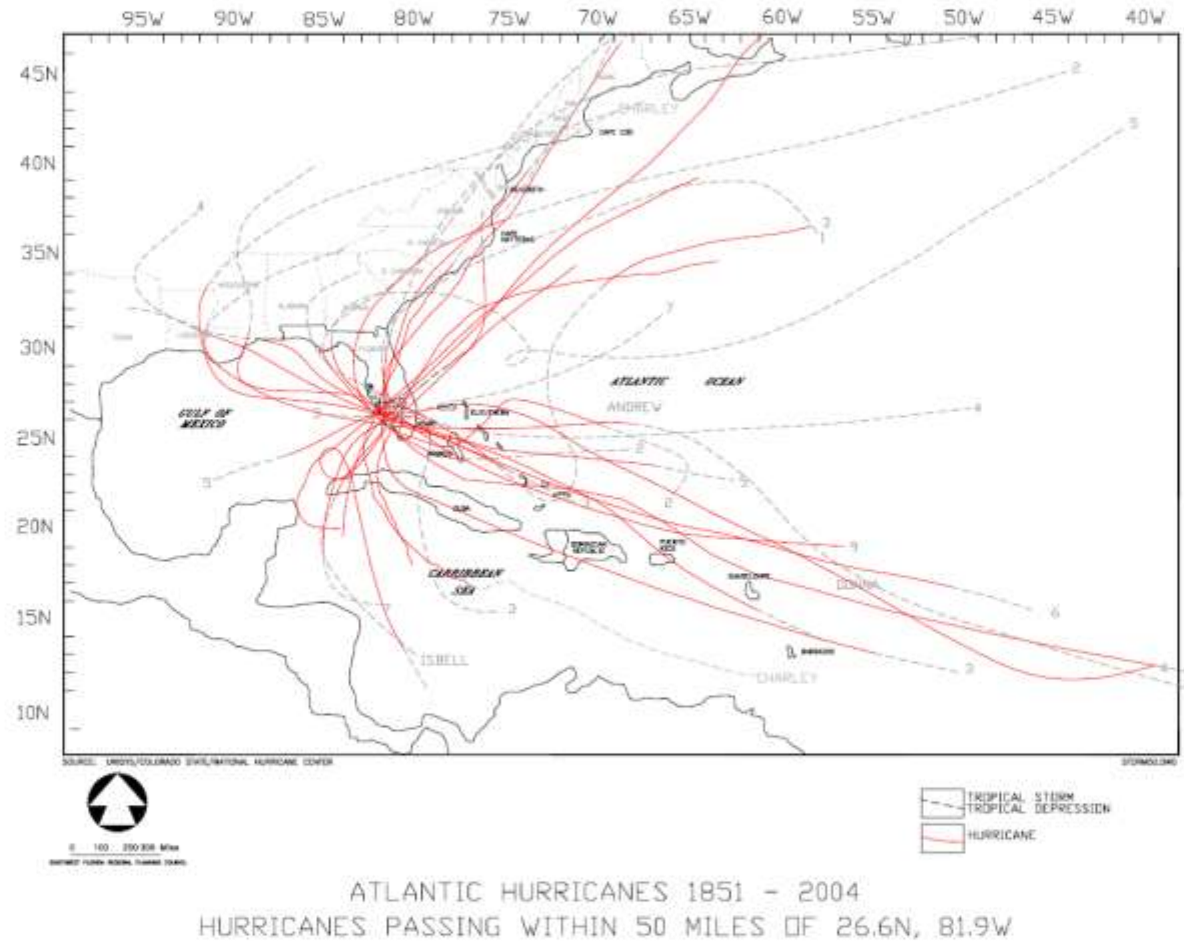


Figure 91: Atlantic Hurricanes 1851-2004 passing within 50 miles of Fort Myers, Florida

Between 1994 and 2004 alone, there were 15 hurricanes and tropical storms. These more recent storms resulted in 16 deaths, 833 injuries, $5.8 billion in property damage and $300.5 million in crop damage.

While studies have shown that there is no clear, long-term trend in the number of tropical storms per storm season (IPCC 2007b; Webster et al. 2005), there have been multi-decadal scale trends in storm frequency. These trends indicate that southwest Florida is currently in an active period (Goldenberg et al. 2001). While storms can occur at any time of year, over 97 percent of North Atlantic tropical storm activity occurs from June to November (Landsea et al. 1994). Storm intensity trends indicate that the power of Atlantic tropical cyclones is rising rather dramatically and that the increase is correlated with an increase in the late summer/early fall sea surface temperature over the North Atlantic (IPPC 2007b).

In the late 1980's the SWFRPC completed hurricane storm surge modeling and maps that have been used by the region and local governments to guide land use decisions, infrastructure investments, and conservation lands acquisition. This early work and resulting decisions have increased resiliency associated with sea level rise.

In 2003 the SWFRPC collaborated with local scientists and EPA's Office of Atmospheric Programs, Climate Change Division, on the "Land Use Impacts and Solutions to Sea Level Rise in Southwest Florida" project. The project resulted in sea level rise projections by probability and year, along with maps that represent the near worst case scenario.

PART 5: Climate Change

Southwest Florida, including the Spring Creek Watershed is currently experiencing climate change. The natural setting of southwest Florida coupled with extensive overinvestment in the areas closest to the coast have placed the region at the forefront of geographic areas that are among the first to suffer the negative effects of a changing climate. More severe tropical storms and hurricanes with increased wind speeds and storm surges have already severely damaged both coastal and interior communities of southwest Florida. Significant losses of mature mangrove forest, water quality degradation, and barrier island geomorphic changes have already occurred. Longer, more severe dry season droughts coupled with shorter duration wet seasons consisting of higher volume precipitation have generated a pattern of drought and flood impacting both natural and man-made ecosystems. Even in the most probable, lowest impact future climate change scenario predictions, the future for southwest Florida will include increased climate instability; wetter wet seasons; drier dry seasons; more extreme hot and cold events; increased coastal erosion; continuous sea level rise; shifts in fauna and flora with reductions in temperate species and expansions of tropical invasive exotics; increasing occurrence of tropical diseases in plants, wildlife and humans; destabilization of aquatic food webs including increased harmful algae blooms; increasing strains upon and costs in infrastructure; and increased uncertainty concerning variable risk assessment with uncertain actuarial futures.

Maintaining the status quo in the management of ecosystems in the face of such likely changes would result in substantial losses of ecosystem services and economic values as climate change progresses. In the absence of effective avoidance, mitigation, minimization and adaptation, climate-related failures will result in greater difficulty in addressing the priority problems identified in the Charlotte Harbor National Estuary Program (CHNEP) Comprehensive Conservation and Management Plan (CCMP): hydrologic alteration, water quality degradation, fish and wildlife habitat loss, and stewardship gaps.

The Comprehensive Southwest Florida/Charlotte Harbor Climate Change Vulnerability Assessment (2009) examines the current climate and ongoing climate change in southwest Florida along with five future scenarios of climate change into the year 2200.

These scenarios include:

a) a condition that involves a future in which mitigative actions are undertaken to reduce the human influence on climate change (Stanton and Ackerman 2007),
b) a 90% probable future predicted by the Intergovernmental Panel on Climate Change (IPCC 2007b),
c) a 50% probable future predicted by IPCC,
d) a 5% probable future predicted by the IPCC, and
e) a “very worst” future in which no actions are taken to address climate change (Stanton and Ackerman 2007). This fifth scenario also corresponds with some of the other worst case scenarios postulated by scientists who think the IPCC estimations are under-estimated (USEPA CRE 2008).

This report also assesses significant potential climate changes in air and water and the effects of those changes on climate stability, sea level, hydrology, geomorphology, natural habitats and species, land use changes, economy, human health, human infrastructure, and variable risk projections, in southwest Florida. Among the consequences of climate change that threaten estuarine ecosystem services, the most serious involve interactions between climate-dependent processes and human responses to those climate changes.

Depending upon the method of prioritization utilized, some climate change effects will be experienced and can be compensated for in the relative near-term. Other effects with longer timelines will be more costly in habitat impact or human economic terms. There are a number of planning actions that, if undertaken now, could significantly reduce negative climate change effects and their costs in the future while providing positive environmental and financial benefits in the near term.

There are crucial areas where adaptation planning and implementation will be needed in order to avoid, minimize and mitigate the anticipated effects to the natural and man-altered areas of southwest Florida. Some effects, such as air temperature and water temperature increases, will be experienced throughout the region. Others, such as sea level rise and habitat shifts, will occur in specific geographic and clinal locations. In the course of the project 246 climate change management adaptations were identified (Beever et al. 2009) that could be utilized to address the various vulnerabilities identified for the region. Future adaptation plans will identify the management measures best suited for each geographic location.

Changes in the climate will occur in the future even if mitigations, such as reductions in greenhouse gas emission, were to be implemented today. The stressors of air temperature and water temperature increases with subsequent changes in air quality and water quality can be expected to continue and the impacts of climate change variability and sea level rise, in particular, are inevitable. Climate change impacts from sea level are already evident in the growing demand for and costs of beach nourishment, increased coastal flooding, and more pronounced storm surges during tropical storm events.

Many of the anticipated consequences of climate change occur via mechanisms involving interactions among the stressors and variables, and therefore may not be widely appreciated by policy makers, managers, stakeholders, and the public. The magnitude of such interactive effects typically declines as each stressor or variable is better controlled, so enhanced adaptive management of traditional estuarine stressors has value as a management adaptation to climate change as well.

Among the consequences of climate change that threaten estuarine ecosystem services, the most serious involve interactions between climate-dependent processes and human responses to those climate changes In particular, conflicts will arise between sustaining natural coastal habitats and coastal private property, since current activities of protecting private shoreline property from erosion with hardening and placement of fill will become increasingly injurious to sub-tidal, littoral, and wetland habitats if continued as climate changes and sea level rises.

Mangrove ecosystems of the CHNEP are particularly threatened by climate change. Based on available evidence, of all the climate change outcomes, relative sea level rise may be the greatest threat to mangroves (Gilman et al.2008). Most mangrove sediment surface elevations are not keeping pace with sea level rise, although longer term studies from a larger number of regions are needed. Rising sea level will have the greatest impact on mangroves experiencing net lowering in sediment elevation, where there is limited area for landward migration. There is less certainty over other climate change outcomes and mangrove responses. More research is needed on assessment methods and standard indicators of change in response to effects from climate change, while regional monitoring networks are needed to observe these responses to enable educated adaptation. Proper adaptation measures can offset anticipated mangrove losses and improve resistance and resilience to climate change. Appropriate coastal planning can facilitate mangrove migration with sea level rise. Management of activities within the catchment that affect long-term trends in the mangrove sediment elevation, better management of other stressors on mangroves, rehabilitation of degraded mangrove areas, and increases in systems of strategically designed protected area networks that include mangroves and functionally linked ecosystems through representation, replication and refugia, are additional adaptation options.

Many management adaptations to climate change to preserve ecosystem services can be achieved at all levels of government at a known, measured expense. One major form of adaptation involves recognizing the projected consequences of sea level rise and then applying policies that create buffers to anticipate associated consequences. An important example would be redefining riverine flood hazard zones to match the future projected expansion of flooding frequency and extent. Other management adaptations can be designed to build resilience of ecological and social systems. These adaptations include choosing only those sites for habitat restoration that allows natural recession landward, providing resilience to sea level rise. Hardening of infrastructure will address both the consequences of climate variability while improving degraded infrastructure with more long-lasting durable structures.

Management adaptations to climate change can occur on three different time scales:

1) reactive measures taken in response to observed or encountered negative impacts;

2) immediate development of plans for adaptive management to be implemented later, either when an indicator signals that delay can occur no longer, or in the wake of a disastrous consequences that provides a window of financially and socially feasible opportunities; or

3) immediate implementation of proactive mitigations, minimizations and adaptations.

The factors determining which of these time frames is appropriate for any given management adaptation include balancing costs of implementation with the magnitude of risks of injurious consequences under the status quo of management; the degree of reversibility of negative consequences of climate change; recognition and understanding of the problem by managers and the public; the uncertainty associated with the projected consequences of climate change; the timetable on which change is anticipated; and the extent of political, institutional, physical and financial impediments.

Monitoring of the effects and results of climate changes will be necessary to assess when and where adaptive management needs to be and should be applied. A critical goal of this monitoring is to establish and follow indicators that signal approach toward an ecosystem threshold that, once passed, puts the system into an alternative state from which conversion back is difficult to impossible. Avoiding conversion into such less-desired alternative states is one major motivation for implementing proactive management adaptation. This is especially critical if the transition is irreversible or very difficult and costly to reverse, and if the altered state delivers dramatically fewer valued ecosystem services. Work to establish environmental indicators are already being done in the CHNEP and can be used to monitor climate change impacts.

One critically important management challenge for southwest Florida is to implement actions to achieve an orderly relocation of human infrastructure and development from shorelines that are at high risk of erosion and flooding, or to preclude development of undeveloped shorelines at high-risk from sea level rise and climate variability effects. Such proactive management actions have been inhibited in the past by:

1) uncertainty over or denial of climate change and its implications;
2) failures to include the true economic, social, and environmental costs of present policies that encourage, allow and subsidize such risky development; and
3) legal tenets of private property rights.

One possible proactive management option would be to establish and enforce “rolling easements” along estuarine shorelines as sea level continues to rise, thereby sustaining the current public ownership of tidal lands. Management adaptations may include ending public subsidies that now encourage and support risky development on coastal barrier and estuarine shores at high risk of flooding and storm damage as sea level rises further and intense storms become more common. Although the flood insurance system as a whole may be actuarially sound, current statutes provide people along the water’s edge in eroding areas of highest risk with artificially low rates, subsidized by the flood insurance policies of people in relatively safe areas. Ending such subsidization of high-risk developments would represent a market-based, free enterprise form of management adaptation to sea level rise. The federal Coastal Barriers Resources Act provides some guidance for eliminating such subsidies for public infrastructure and private development, although this act currently applies only to a specific list of undeveloped coastal barriers and would require extension to all barrier islands and to estuarine mainland shorelines to enhance its effectiveness to protect human and natural resources.

It will be important to include climate change sensitivity, resilience, and adaptation responses as priorities on all relevant government funding programs at local, state and federal levels. In the absence of such actions, for example, climate impacts on estuarine wetlands will likely violate the national "no-net-loss of wetlands" policy (which stems from the current application of the Clean Water Act) in two ways: (a) wetland loss due to climate change will increasingly compound the continuing loss of wetlands due to development and inadequate mitigation; and (b) structural measures used to protect coastal human infrastructure from climate impacts will prevent wetland adaptation to climate change as ecotones are compressed to non-existence.

All federal, state, and local programs need to be reviewed to assess whether projected consequences of climate change have been considered adequately, and whether adaptive management needs to be applied to achieve programmatic goals. For example, Jimerfield et al. (2007) conclude that "There clearly needs to be [a] comprehensive approach by federal agencies and cooperating scientists to address climate change in the endangered species recovery context. The current weak and piece-meal approach will waste precious resources and not solve the problem we are facing."

A new synthetic governance structure that unites now disparate management authorities, stakeholders, and the public may be needed to address major impediments to ecosystem based adaptive management (EBABM) of estuarine services. Because of its reliance on stakeholder involvement, the CHNEP could represent such a vehicle for developing and implementing adoptions to climate change vulnerabilities.

The CHNEP approach considers the entire watershed of its included estuaries. Management plans to control estuarine water quality parameters sensitive to eutrophication, for example, must take a watershed approach to develop understanding of how nutrient loading at many sources along the watersheds transfer downstream to the estuary. Watershed management, by its very nature, prospers from uniting jurisdictions and governments across the entire watershed to develop partnerships that coordinate rule development and implementation strategies. To this end of facilitating management adaptation to climate change, new ecologically based partnerships of local governments could be promoted and supported.

Southwest Florida's growing population and development are replacing natural habitat. Without the proper habitat, plant communities and wildlife disappear. Florida is one of North America's most important reserves of biological diversity. Occupying an important transitional zone between tropical and temperate climates, more than 1,300 fish and wildlife species and about 3,500 plant species can be found in Florida. Preserving this biodiversity in the CHNEP study area requires protection and restoration of regional fish and wildlife habitat. High rates of land conversion and habitat modification create a critical need for regional wildlife habitat planning in the CHNEP watershed (CHNEP CCMP 2008).

A diversity of restored habitats will be needed to restore and maintain listed-species biodiversity in the face of the identified anticipated climate changes. Concentration on protecting coastal wetlands alone will not serve upland species, upland-dependent wetland species, marine species, or indeed, the coastal species as ecotones and habitats shift up-gradient. It will be vital to protect refugia, latitudinal and elevational gradients, habitat heterogeneity, and gene flow/population connectivity. Species will be benefited by reducing other non-climate stresses (e.g. invasive species, pollution, etc), protection of freshwater surface sources, and hydrologic restoration, with riverine and landscape scale migratory corridors, such as the one that is being established from Charlotte Harbor through five major landscape scale acquisitions.

The likely effects of climate change and particularly tropical storms, drought and sea level rise, on southwest Florida ecosystems and infrastructure development are too great for policymakers, property owners, and the public-at-large to stand by and wait for greater evidence before considering strategies for adaptation. It is essential to plan and act now to mitigate, minimize, and adapt to the negative effects of climate change, and to examine the possibilities of providing benefits to human and natural systems by adapting to the changing planet. Development of a Climate Change Adaptation Plan for the Spring Creek Watershed is needed to prepare for these changes.

PART 6: Public Input

We completed initial public meetings with citizens at Cedar Creek, Imperial Harbor, Pelican Landing, and Spring Creek Village during the development of this Vulnerability Assessment. A total of at least 221 citizens participated in the meetings. At least two more meetings will be held with other parts of the community, who have been contacted but who have not yet scheduled a meeting, to complete the coverage of the watershed.

A survey was distributed for the citizens to compete if they wished to. The survey is listed below.

Developing a Spring Creek Restoration Plan for the City of Bonita Springs

Please complete this questionnaire prior to or at the start of the workshop.

Return it to the table where you registered. *Thank you.*

1) Do you live in Florida __________year round or _________seasonally?

2) How many years have you lived in or visited Florida?

3) What is your local zip code?

4) If you live in Florida seasonally, what is the zip code of your other home?

5) If you work, what zip code do you work in locally?

Please circle your responses.

6) Winter in Bonita Springs, Florida is typically the dry, cool season. (a) Do you think winters have been wetter, drier, the same since you began living/visiting here or are you not sure? (b) Have they been cooler, warmer, or the same or not sure?

7) Summer here is typically the warm, rainy season. (a) Do you think summers have been wetter, drier, the same since you began living/visiting here or are you not sure? (b) Have they been cooler, warmer, the same or are you not sure?

8) Is fishing around Spring Creek improving, declining, about the same or are you not sure?

9) Is water quality in Spring Creek improving, declining, about the same or are you not sure?

10) Is water quality in the canals connecting to Spring Creek improving, declining, about the same or are you not sure?

11) Is the presence of wildlife in Spring Creek and its watershed increasing, decreasing, about the same or are you not sure?

Please answer briefly.

12) Have you noticed any changes in the weather (in addition to or other than what was noted above) in the time you've lived in or visited Bonita Springs?

13) Do you think storms are getting more severe or frequent?

14) Do you expect the weather to be better, worse or about the same in the future?

15) What should government do differently to be better prepared for the next hurricane?

16) The next drought?

17) The next flood?

18) Please let us know of any other concerns you have regarding changes in Spring Creek.

Some survey results

Eighty-one citizens have taken the survey. Fifty -four are seasonal residents and 39 year-round residents. On average seasonal residents have been visiting for 22 years and residents have lived in the watershed for 17 years. They are about evenly split on whether winter weather has been changing. They find that summer is wetter and getting warmer or staying the same. The quality of fishing has been declining. The water quality is declining in both the Creek and canals connecting to it. Wildlife is decreasing. Rainy seasons and periods are less predictable.

For the surveys so far the top response to question 18 are as follows.

Top Concerns Form Public Meeting Surveys		
Concern	**Frequency**	**Percentage**
Dredging/clear waterways/overgrowth	15	23%
Water Levels in Creek Declining	6	9%
Mangroves overgrown	6	9%
Water Quality Problems	6	9%
Wildlife Loss	6	9%

Table 17 : Top Written Citizen Concerns

After the additional public meetings a full report of public input will be made in the restoration Plan which will be designed to address these concerns and the identified vulnerabilities. .

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