Lemon Bay

WATERSHED MANAGEMENT PLAN

Sarasota County

Southwest Florida Water Management District

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Project Background and Physical Setting

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Southwest Florida Water Management District

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1.0 PROJECT BACKGROUND AND PHYSICAL SETTING

1.1 BACKGROUND

Sarasota County has six major watersheds in the County: Sarasota Bay, Roberts Bay North, Little Sarasota Bay, Dona and Roberts Bay, Lemon Bay, and the Myakka River. Sarasota County has implemented the Comprehensive Watershed Management Program to address water quality, water quantity, flooding, and natural resources in a holistic manner within each of these watersheds. This program employs an approach consistent with the Southwest Florida Water Management District's (SWFWMD) areas of responsibilities related to water resource management: Natural Systems, Water Quality, Water Supply, and Flood Protection.

The County and SWFWMD are partnering to develop a Watershed Management Plan (WMP) for Lemon Bay, which is an estuary of national significance, as well as a SWFWMD Surface Water Improvement and Management (SWIM) Priority waterbody. Funding is being provided by the Manasota Basin Board. Inclusion of proposed projects, corrective actions, best management practices (BMPs), etc. in the plans does not confer any special status, approval, permitting standing or funding from the District. All proposed projects are subject to regulatory review and permitting. Requests for funding assistance will have to meet the requirements of funding programs and subject to the District's Governing and Basin Boards appropriating funds.

1.2 PURPOSE AND OBJECTIVE

The Lemon Bay WMP is a regional initiative that promotes and furthers the implementation of the *Sarasota County Comprehensive Plan*, the Charlotte Harbor National Estuary Program's (CHNEP) *Comprehensive Conservation and Management Plan (CCMP)*, SWFWMD's *Southern Coastal Watershed Comprehensive Watershed Management Plan*, and the *Lemon Bay Interagency Comprehensive Watershed Management Plan*. The purpose of this initiative is to develop and implement a watershed management plan for Lemon Bay and its watershed to achieve the following objectives:

1. Improve and protect existing water quality.
2. Help develop Basin Management Action Plans (BMAPs) prepared by the Florida Department of Environmental Protection (FDEP) to address adopted Total Maximum Daily Load (TMDL) issues within the Lemon Bay watershed.
3. Identify and provide a more natural hydrologic regime for Lemon Bay and the watershed.
4. Protect existing and future property owners from flood damage.
5. Develop ecosystem goals and targets based on the needs of environmental and biological indicators.

6. Investigate potential sustainable surface water supply options that are consistent with and support objectives from the Sarasota County Comprehensive Plan, the Regional Water Supply Plan, and the Southern Water Use Caution Area Plan.

Sarasota County has embarked on a proactive approach to develop the proper science and community-based vision as a foundation for formulating, evaluating, prioritizing, and implementing watershed management actions. Toward this goal, the Environmental Sensitive Lands Protection Program (ESLPP) has acquired lands including portions of the Lemon Bay Preserve, Lemon Bay Park Addition, Manasota Scrub Preserve, and the Ainger Creek Watershed, which are strategically located in the watershed.

The following sections summarize the physical and societal characteristics of the Lemon Bay watershed.

1.3 WATERSHED

1.3.1 Political Jurisdictions

The Lemon Bay watershed is regulated by FDEP, SWFWMD, two counties (Sarasota and Charlotte), and two local municipalities (Cities of Venice and North Port). Table 1-1 gives the acreage breakdown for each jurisdiction, and Figure 1-1 shows the political boundaries. It is important for all regulatory agencies within a watershed to coordinate their efforts to provide a comprehensive evaluation of the drainage system.

Each regulatory agency is responsible for the health of the bay and has the ability to regulate specific activities throughout the watershed boundary. In general, State regulations are to be followed, unless one of the counties has adopted a more stringent rule; the same policy applies to cities within a county boundary. The more stringent regulations always take precedence.

Although each agency is responsible for the health of the bay, each agency's level of responsibility varies by the level of the agency's governing body. At the county level, Sarasota and Charlotte Counties' responsibilities include:

- ❖ Teaching their citizens what they can do to improve the health of the watershed.
- ❖ Funding and implementing projects to improve water quality, water supply, natural systems, and flood protection.
- ❖ Researching new methods and practices for watershed management.
- ❖ Enforcing existing ordinances and passing additional ordinances to lessen the impacts caused by new developments.

Table 1-1 Political Jurisdiction Acreage

	Alligator		Woodmere		Forked		Gottfried		Ainger		Coastal		Totals	
	Ac	%	Ac	%	Ac	%	Ac	%	Ac	%	Ac	%	Ac	%
Total	6,799	14.3	1,475	3.1	5,863	12.3	7,222	15.1	6,646	13.9	19,676	41.3	47,681	100.0
Lemon Bay Watershed Acreage by County														
Sarasota	6,799	100.0	1,475	100.0	5,863	100.0	7,038	97.5	5,560	83.7	5,574	28.3	32,308	67.8
Charlotte	0	0.0	0	0.0	0	0.0	184	2.5	1,087	16.3	14,102	71.7	15,372	32.2
County Total	6,799	100.0	1,475	100.0	5,863	100.0	7,222	100.0	6,646	100.0	19,676	100.0	47,681	100.0
Lemon Bay Watershed Acreage by City														
North Port	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	69	0.4	69	0.1
Venice	0	0.0	0	0.0	674	3.4	528	2.7	3,339	17.0	1,322	6.7	5,863	12.3
City Total	0	0.0	0	0.0	674	3.4	528	2.7	3,339	17.0	1,391	7.1	5,932	12.4
Lemon Bay Watershed Acreage by Water District														
SWFWMD	6,799	100.0	1,475	100.0	5,863	100.0	7,222	100.0	6,646	100.0	19,676	100.0	47,681	100.0

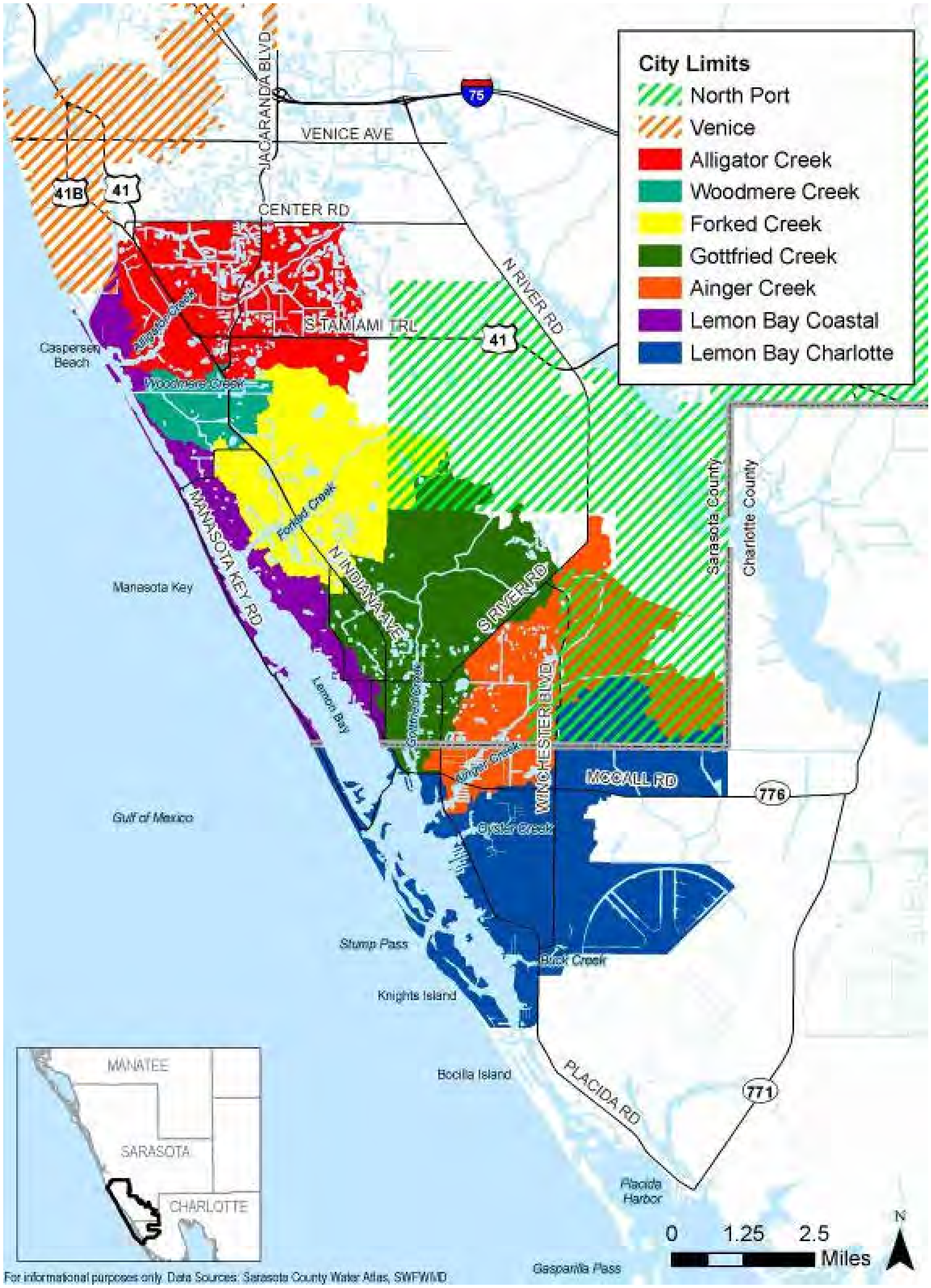


Figure 1-1 Lemon Bay Basins and Political Jurisdictions

This WMP discusses the goals and objectives for Sarasota County and the measures the County is taking to meet these goals. Although not a participant in this plan, Charlotte County is also undertaking measures to meet similar goals for Lemon Bay.

1.3.2 Boundary

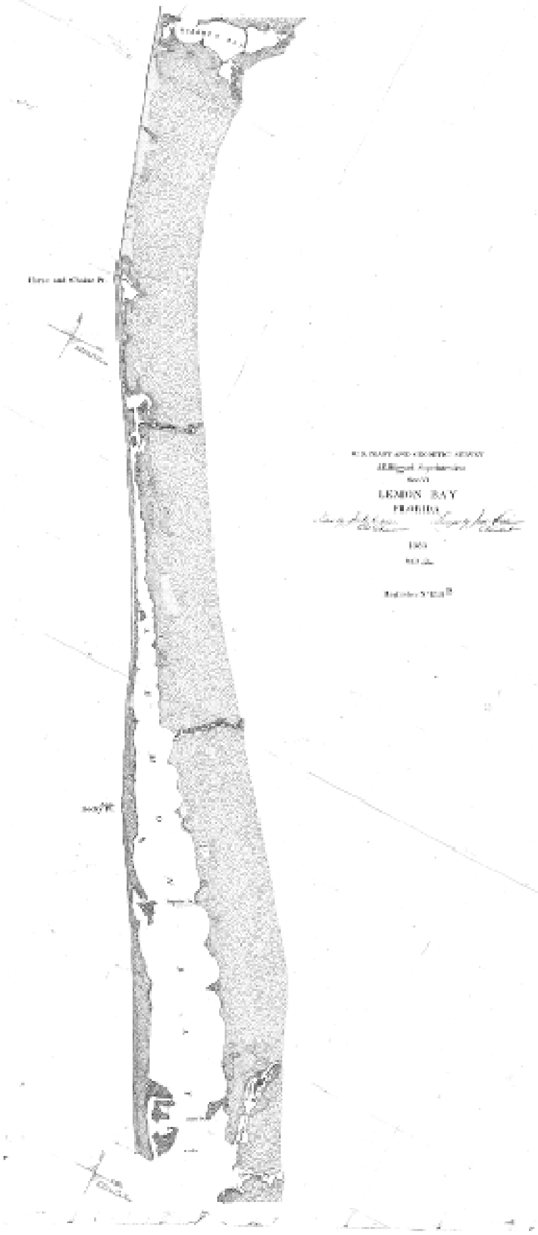
The Lemon Bay watershed includes Lemon Bay, the Alligator Creek basin (6,799 acres), the Woodmere Creek basin (1,475 acres), the Forked Creek basin (5,863 acres), the Gottfried Creek Basin (7,222 acres), the Ainger Creek Basin (6,646 acres), the Lemon Bay Sarasota County Coastal area (5,574 acres), and the Lemon Bay Charlotte County area (14,102 acres).

Figure 1-1 outlines the current geographic watershed and basin boundaries. The watershed is generally bounded by Placido Harbor to the south, the City of Venice to the north, and the City of North Port to the east.

Most of the 47,681-acre watershed is in Sarasota County. However, approximately 32% is in Charlotte County (Table 1-1). Lemon Bay has seven major tributaries that connect to the Bay: Alligator, Woodmere, Forked, Gottfried, Ainger, Oyster, and Buck Creeks. The Alligator, Woodmere, and Forked creeks and their drainage basins are in Sarasota County. The Gottfried, Ainger, and Oyster Creek basins span Sarasota and Charlotte Counties. The mouths of all three creeks are in the Charlotte County portion of the bay; however, most of the drainage basin for Gottfried and Ainger Creeks and a small portion of the drainage basin for Oyster Creek are in Sarasota County. Buck Creek and its drainage basin are in Charlotte County (Table 1-1). This WMP focuses on the five creeks and their drainage basins in the Sarasota County portion of the Lemon Bay watershed.

Presently, more than half of the Lemon Bay watershed is non-urbanized; however, the remaining portions have been impacted by anthropogenic activities. Impacts include degradation to water quality from stormwater runoff, point source discharges, and septic systems; alterations to surface water hydrology from channelization of natural streams and increased imperviousness; reduction of surface water storage; and conversion of natural habitat to agriculture and urban land uses.

Historical maps and surveys suggest that the five Sarasota County tributaries to Lemon Bay were tidal creeks, which did not extend significantly inland in the watershed. Historically, Alligator Creek appears to have been a tidal creek leading to an extended slough system upstream of the present day US 41 (Jones, 2007). These naturally occurring tidal creeks were significantly altered by ditching for mosquito control and development activities.



Historical data are often sparse and inconclusive. Engineering reports and supporting data related to the pre-development era of the Lemon watershed are virtually non-existent. Detailed data with consistent collection methods were not available until the early 1950s. This WMP considered 1948 as the baseline for comparison due to the availability of aerial photographs and soil survey data. The 1948 aerials and 1959 soil surveys were digitally scanned and georectified using ArcGIS. The georectified data were used to develop baseline coverage for land use and seagrass extents. This coverage is considered *historical* for the purpose of this WMP and should not be confused with the term *pre-development* as development and land use changes had already started to occur in the early 1950s.

Figure 1-2 Lemon Bay 1883 U.S. Coast and Geodetic Survey

1.3.3 Topography

The Lemon Bay watershed is relatively flat and ranges in elevation from sea level in the west along the barrier islands and coast to a maximum of approximately 30 feet NGVD at the northernmost inland portion of the Lemon Bay Coastal basin (Figure 1-3). The average slope of the watershed land surface ranges from approximately 0.001 foot/foot in the south to 0.002 foot/foot in the north. The barrier islands are low lying and do not exceed 5 feet NGVD throughout.

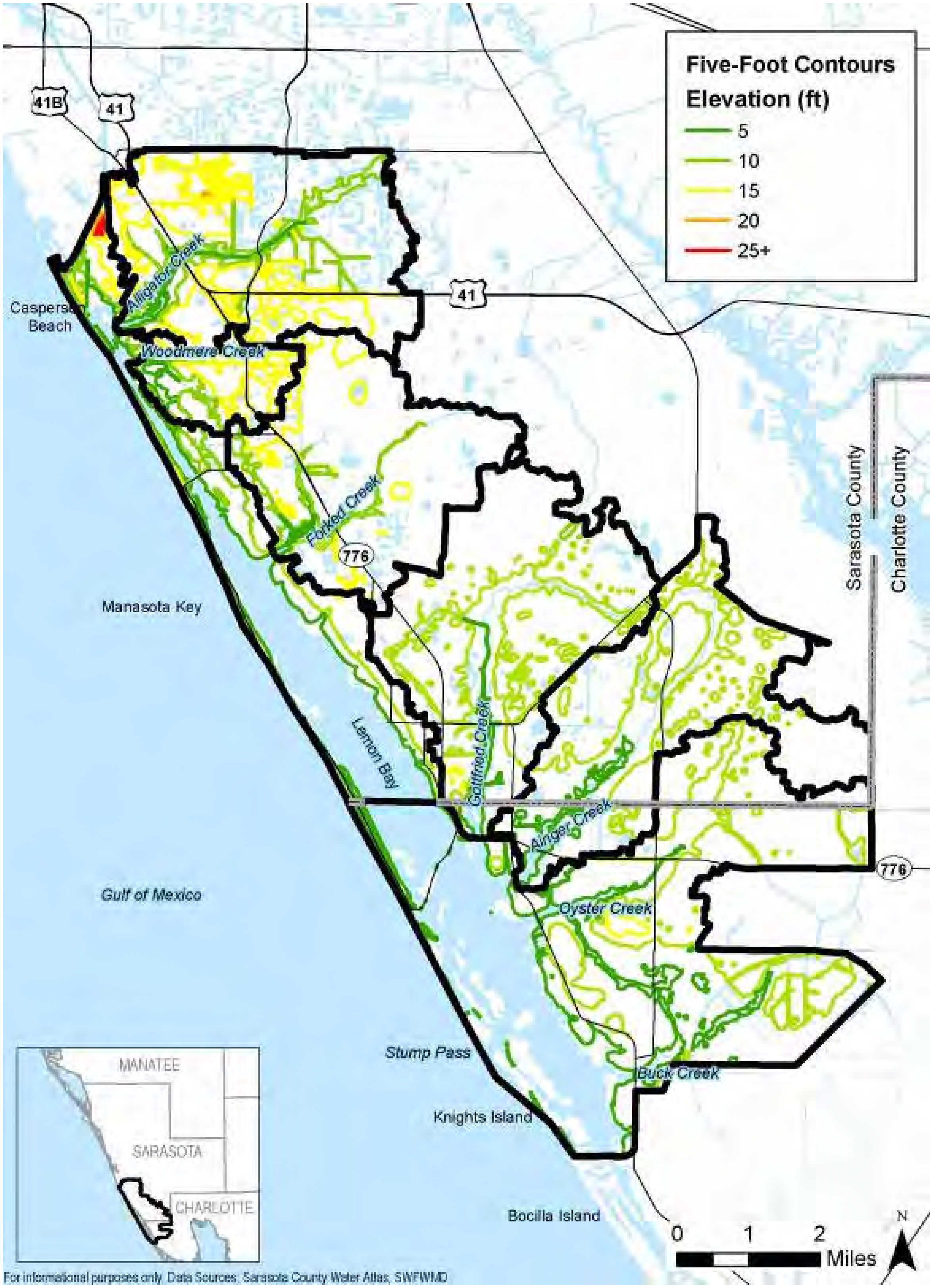


Figure 1-3 Lemon Bay Watershed Topography

1.3.4 Physiographic Region

The Lemon Bay watershed lies entirely within the Southern Gulf Coastal Lowlands subdivision of the mid-peninsular physiographic region of Florida (White, 1970; SWFWMD, 2000). The Gulf Coastal Lowlands is a broad, gently sloping marine plain characterized by broad flatlands with many sloughs and swampy areas (Figure 1-4) (White, 1970). Some of these areas have been drained by ditches and canals, especially near to the coast.

1.3.5 Surface Hydrology

Rainfall and surface water runoff are critical to maintaining the natural resources of any estuarine system and its supporting watershed. Sarasota County's surface water hydrologic setting includes an average annual rainfall of 52 inches, although this can vary significantly from year to year. Intra-annual variability is also high, with about 60% of a typical annual rainfall occurring during the wet season months of June through September.

Widespread alterations to the surface hydrology of the watershed have occurred over the past decades, resulting in significant changes to the volume and timing of freshwater inflows to the bay.

Land surveys from the mid 1800s show that Lemon Bay's coastal creeks and streams did not extend significantly inland from the estuaries and bays. Analysis of the Sarasota County 1847 General Land Office Survey (Figure 1-5) indicates that the inland extent of Forked Creek ended in the general vicinity of the current SR 776. The 1958 NRCS Soil Survey Map (Figure 1-6) supports this, as the map shows bands of moderately drained soils associated with scrub flatwoods at the historical extent of the creeks. It is evident from these surveys that the Lemon Bay watershed was historically a collection of isolated wetlands and pine flatwoods. This land condition allowed excess water in the wetlands to flow into the pine flatwoods during the cyclical wet season. The creeks likely acted as tidal extensions, receiving minimal fresh water inflows even through the wet season.

Gottfried and Ainger Creeks were more defined creek systems on the soils maps. Gottfried Creek was labeled as Deer Creek and is shown as a perennial stream from Lemon Bay to approximately 2,500 feet upstream of Dearborn Street, where it changed to an intermittent stream for a short segment and then was ditched to the north and west. Ainger Creek extended from Lemon Bay upstream approximately 15,000 feet as a perennial stream before transitioning to a slough system

Early residents of the Lemon Bay watershed were plagued by mosquitoes. To alleviate the problem, many ditches were created in the coastal mangroves to extend the natural creeks inland and to connect many of the larger isolated wetlands to the creeks. In addition, many wetlands were filled and impervious surfaces were created to accommodate development.

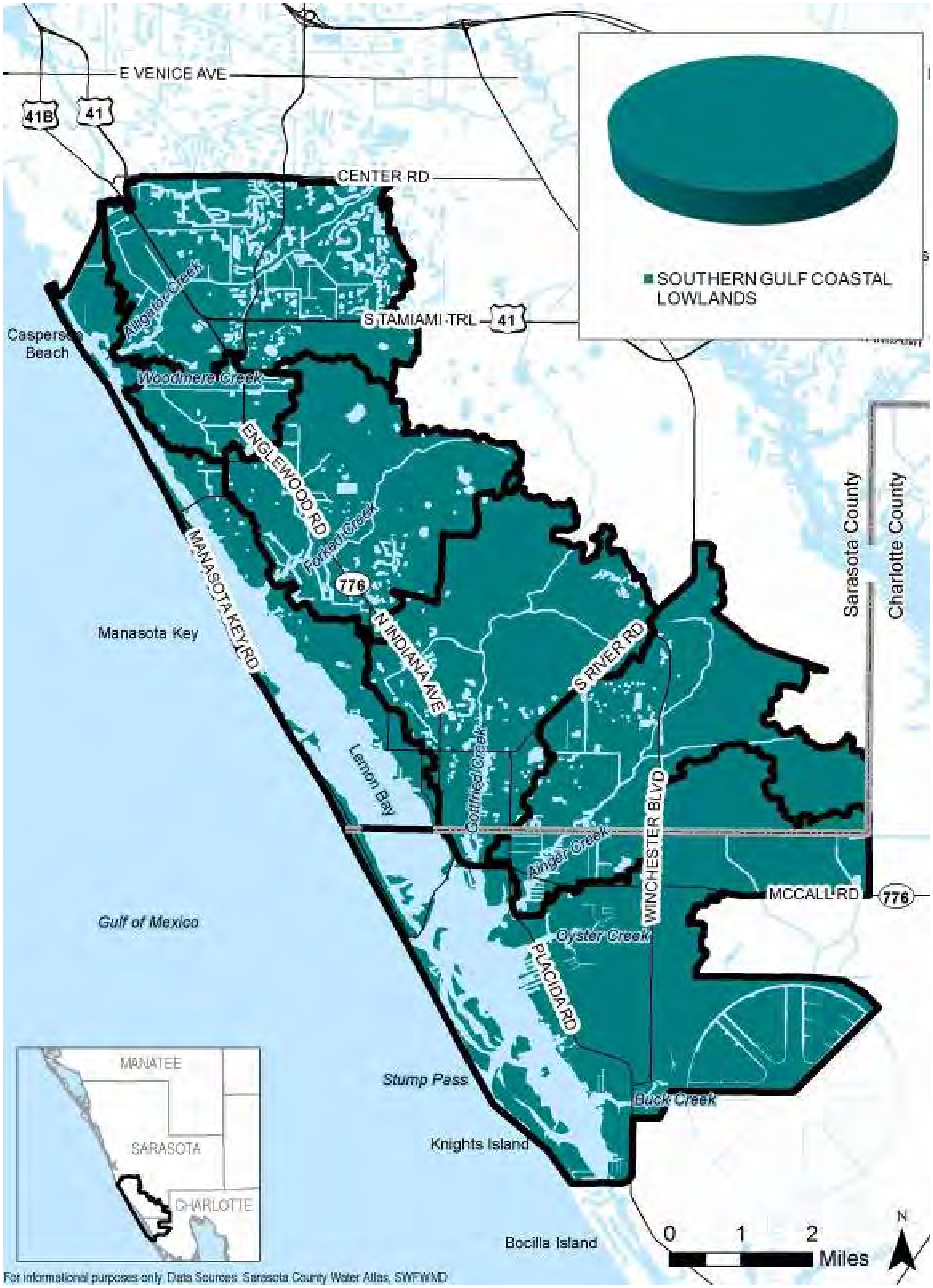


Figure 1-4 Lemon Bay Watershed Physiographic Region

Figure 1-5 1847 Survey (General Land Office Township plat, georeferenced by Sarasota County Division of Watershed Management, 2004)

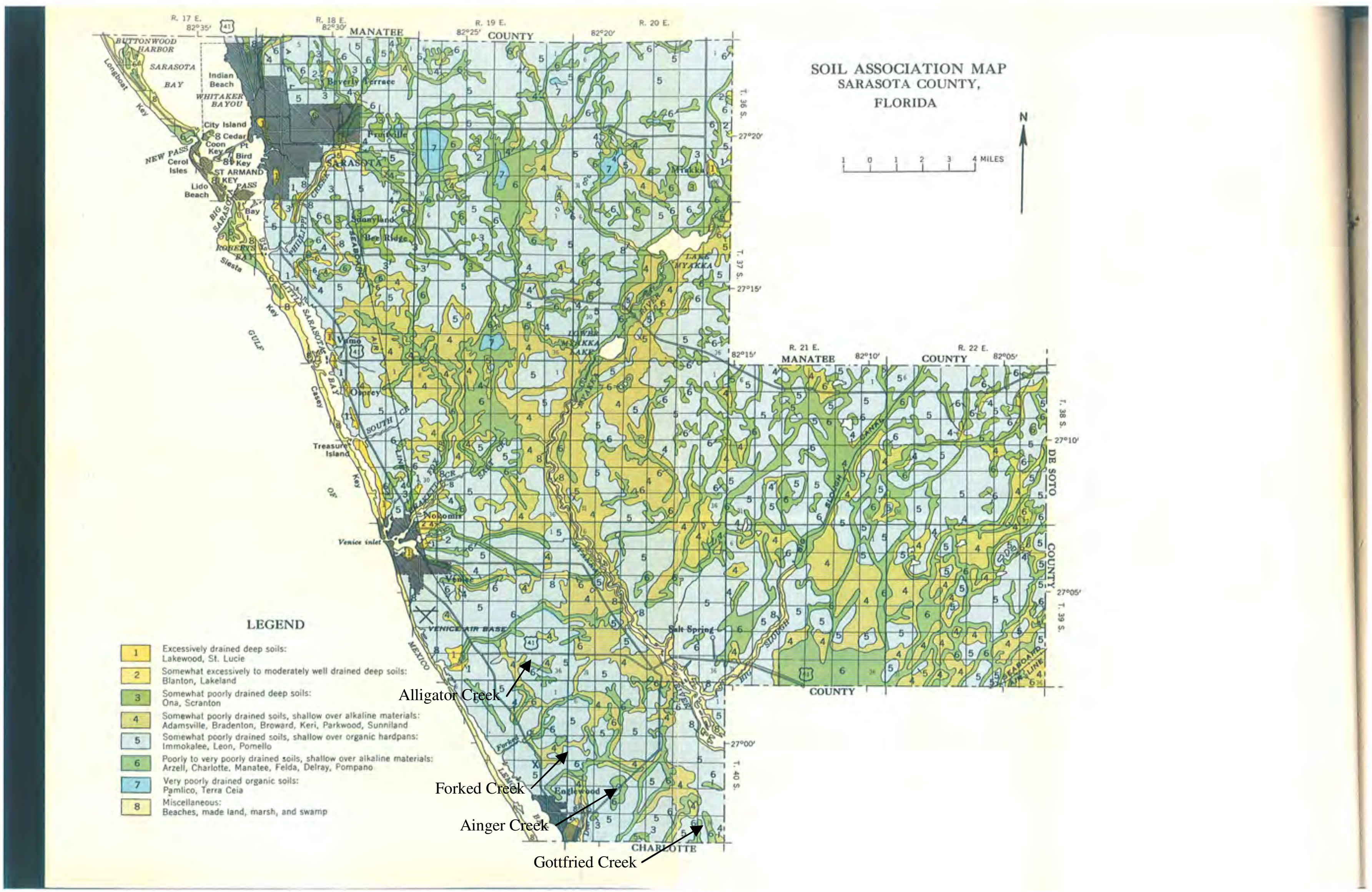


Figure 1-6 1958 Soil Maps (Maps Constructed in 1958 from 1950-53 Soil Surveys and 1948 Aerial Photographs)

Table 1-2 summarizes the current geographic watershed and basin areas for the Sarasota County portion of the watershed. The Lemon Bay Coastal basin flows to Lemon Bay via overland flow and small conveyance channels. Each of the other basin areas discharges to Lemon Bay through a well-defined channel. Sarasota County further delineated the basin into subbasins with the Advanced Interconnected Channel and Pond Routing Model (ICPR) for the Alligator Creek, Woodmere Creek, Forked Creek, Gottfried Creek, and Ainger Creek Basins (Figure 1-7). Basins were not delineated for the Charlotte County portion of the Lemon Bay watershed for this project.

Table 1-2 Sarasota County Basin Areas for Tributaries Discharging to Lemon Bay

Basin	Basin Area (ac)	Percent of watershed
Alligator Creek	6,799	20.2%
Woodmere Creek	1,475	4.4%
Forked Creek	5,863	17.5%
Gottfried Creek	7,222	21.5%
Ainger Creek	6,646	19.8%
Lemon Bay Coastal	5,574	16.6%
Total	33,579	100.0%

Hydrologic alterations within the Lemon Bay watershed include:

- Reducing on-site rainfall storage by filling and ditching natural depressions and wetlands.
- Increasing stormwater runoff rates by channelizing natural streams and creating networks of interconnected ditches that flow to the bay.
- Reducing infiltration by introducing pavement and other impervious surfaces.
- Altering flow patterns by constructing water control weirs and increasing sedimentation in the channel from upland erosion.

1.3.6 Geology and Hydrogeology

Hydrogeologic features of the watershed include the surficial, intermediate, and Floridan aquifers (Figure 1-8 and Figure 1-9). The *surficial aquifer* is an unconfined system that overlies the intermediate aquifer system and ranges in thickness from a few feet to over 60 feet in the study area. Hydraulic properties of the surficial aquifer system determined from aquifer tests, laboratory tests, and model simulations vary considerably across the study area (Barr, 1996).

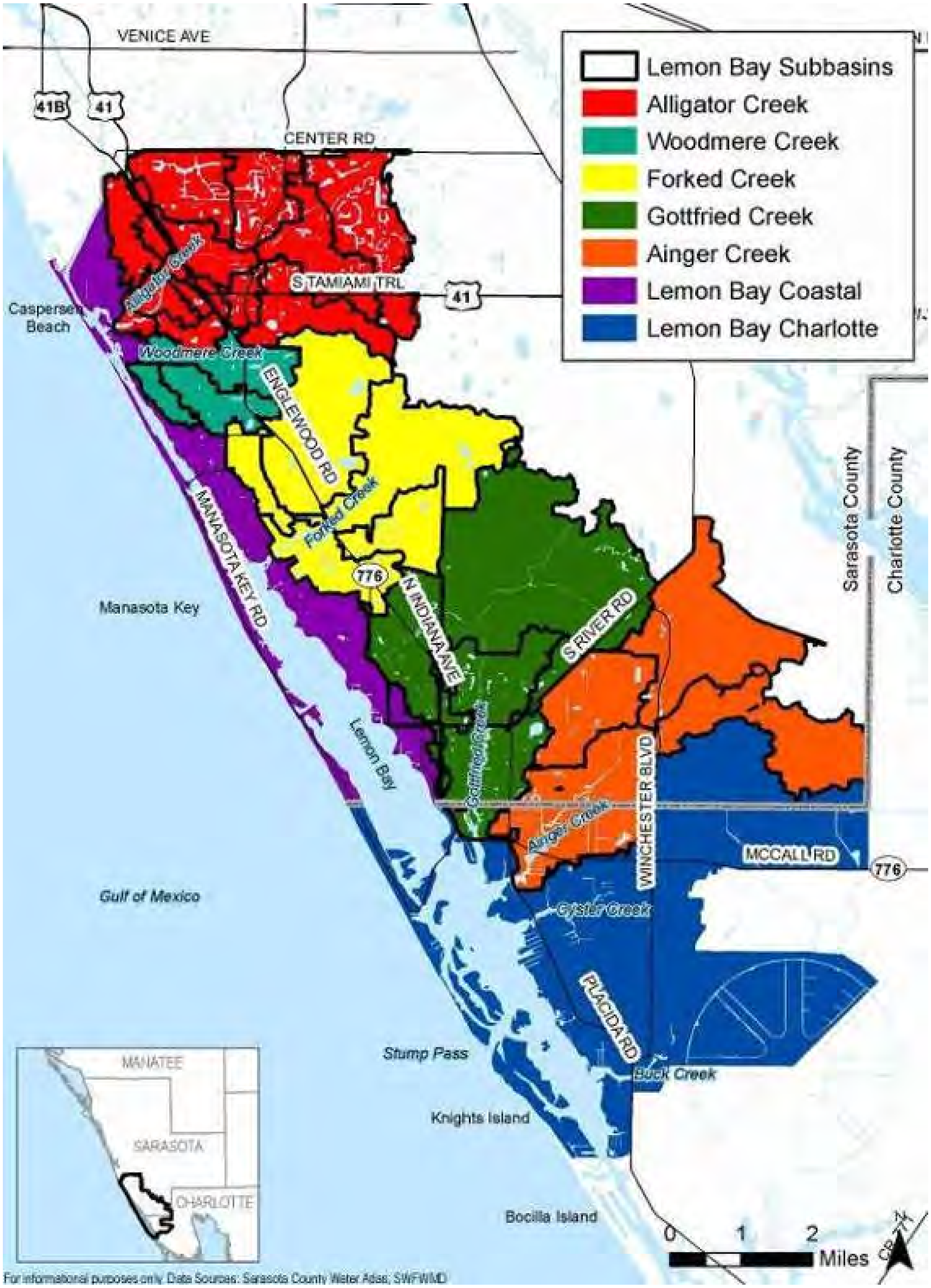


Figure 1-7 ICPR Catchment Delineation for Lemon Bay Basins in Sarasota County

Figure 1-8 Aquifers at Land Surface (FDEP)

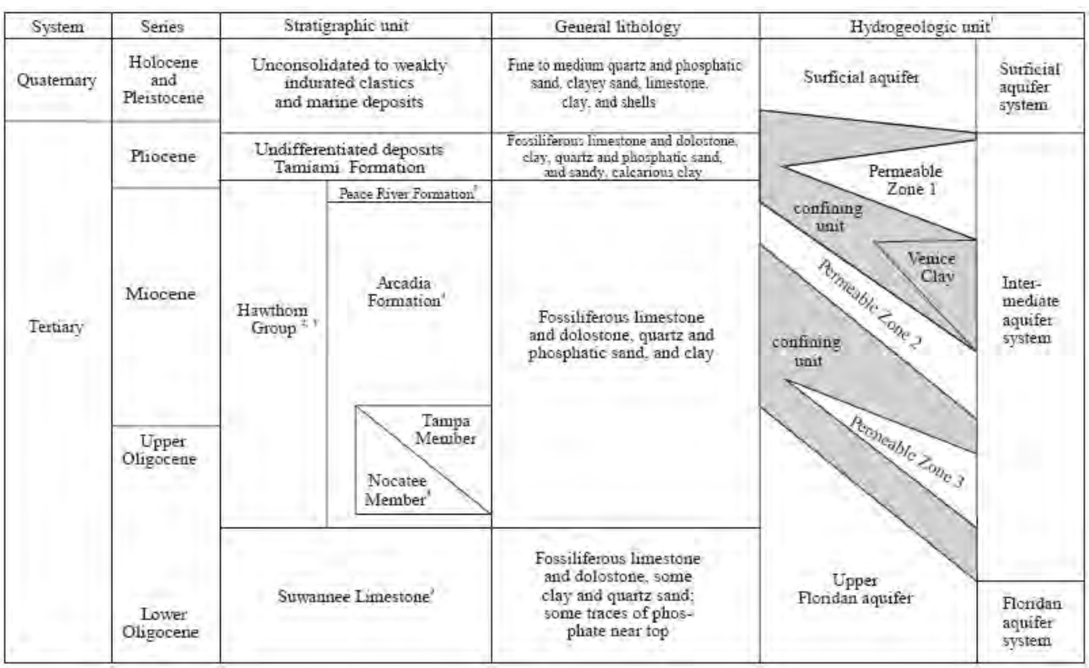


Figure 1-9 Hydrogeologic Framework and Intermediate Aquifer System in Sarasota and Adjacent Counties, Florida (from Barr, 1996)

The *intermediate aquifer system* is a confined aquifer system between the surficial and the Upper Floridan aquifers and is composed of alternating confining units and permeable zones. The intermediate aquifer system has three major permeable zones that exhibit a wide range of hydraulic properties. Horizontal flow in the intermediate aquifer system is northeast to southwest. Most of the study area is in a discharge area of the intermediate aquifer system, meaning that water pressure is higher at lower elevations, causing net upwards flow of groundwater (Barr, 1996).

Under natural conditions shallow groundwater quality ranges from fresh in the surficial aquifer system and upper permeable zones of the intermediate aquifer system to moderately saline in the lower intermediate aquifer. Water quality data collected in coastal southwest Sarasota County indicate that groundwater withdrawals from major pumping centers have resulted in lateral seawater intrusion and upconing into the surficial and intermediate aquifer systems (Barr, 1996).

The intermediate aquifer system is underlain by the Upper Floridan aquifer, which consists of a thick, stratified sequence of limestone and dolomite. The Upper Floridan aquifer is the most productive aquifer in the study area; however, its use is generally restricted because of poor water quality. Interbedded clays and fine-grained clastics separate the aquifer systems and permeable zones (Torres et al., 2001).

1.3.7 Soils and Sediment

The subsurface geology and subsurface features of Lemon Bay and its watershed are directly related to historic sea level fluctuations. The underlying geologic formations developed as the result of physical, chemical, and biological processes. These processes included near-shore deposition of sediment, precipitation of chemicals directly from seawater, and accumulation of the skeletal remains of marine organisms. These geologic formations range in age from the Oligocene epoch (38 to 22.5 million years ago) to the Holocene epoch (10,000 years ago to present) (Sarasota County Planning and Development Services, 2007, p. 2-9).

Surface and near-surface sediments consist of quartz sand, consolidated and unconsolidated shell beds, clays, limestone, and dolomite. Stratified layers of relatively pure limestones and phosphatic clays (clays rich in phosphate, salts of phosphoric acid) developed gradually in the watershed. Quartz sands that eroded from exposed higher land were also deposited. These near-surface sediments, which occur within approximately 1,500 feet of ground elevation, were of major importance to settlement because of their capacity to store and/or contain potable water. In addition to supplying water, the marine sediments provide phosphate and other mineral resources (Sarasota County Planning and Development Services, 2007, p. 2-9).

Much of the “soils” in the watershed, generally described as surficial sediments, represent only slightly weathered parent material, or modern sediments, some of which are still being formed, rather than layers of mixed mineral and organic materials. The soil types in the watershed include limestone rock, calcareous muds (marls), sands (marine terraces), organic materials (peats and muck), and mixed solids (Duever et al., 1979; SWFWMD, 1980).

An additional substrate is made up of altered or Arent soils, e.g., dredge and fill, shell mounds, and landfills (Herwitz, 1977). Examples are the inland and coastal artificially constructed canals. Modification of natural tidal tributaries to finger canals is prevalent in developments. There is a shift away from autochthonous (local) sediment production in the natural waterways to a primarily allochthonous (transported) source of sediments in the canal system. Marls and sand marls generally range from 6 inches to 3 feet in depth, have low relief, and because of low water permeability are often wet (SWFWMD, 1980).

Each individual soil can be classified into a hydrologic soil group (HSG) based on its runoff producing characteristics. The most important of these characteristics is the inherent capacity of the soil to permit infiltration when bare of vegetation.

The four major hydrologic soil groups are:

- **Group A** (low runoff potential)—Soils with high infiltration rates even when thoroughly wetted. The soils are composed primarily of sands and gravel that are deep and well to excessively drained. These soils have a high rate of water transmission. Minimum infiltration rate = 0.30-0.45 inch/hour.

- **Group B** (low to moderate runoff potential)—Soils with moderate infiltration rates when thoroughly wetted. The soils are typically moderately fine to moderately coarse in texture and have a moderate rate of water transmission. Minimum infiltration rate = 0.15-0.30 inch/hour.

- **Group C** (moderate to high runoff potential)—Soils with slow infiltration rates when thoroughly wetted, often with a layer of soil that impedes the downward movement of water. The soils typically have a moderately fine to fine texture and a slow rate of water transmission. Minimum infiltration rate = 0.05-0.15 inch/hour.

- **Group D** (high runoff potential)—Soils with very slow infiltration rates when thoroughly wetted. The soils are primarily clay soils with a high permanent water table or shallow soils over nearly impervious materials, such as a clay pan or clay layer. These soils have a very slow rate of water transmission. Minimum infiltration rate = 0.0-0.05 inch/hour.

Some soils are assigned to two soil groups (e.g., A/D) if part of the area is artificially drained and another part is undrained. The distribution of HSGs for the study area is mapped in Figure 1-10. Only 1% of the soils in the watershed are classified as very well-drained to well drained (HSG A and B), while 25% are classified as poorly to very poorly drained (HSG C or D) (Table 1-3).

Nearly 60% of the soils are well-drained much of the year but during the wet season are poorly drained due to the high water table.

Figure 1-10 Soil Hydrologic Groups (1959 NRCS)

Table 1-3 Hydrologic Soil Groups (1959 NRCS)

HSG	Percent of Basin												Lemon Bay Watershed	
	Alligator		Woodmere		Forked		Gottfried		Ainger		Coastal			
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
A	214.8	3.2	21.4	1.5	21.3	0.4	183.3	2.5	12.1	0.2	230.5	1.2	683.5	1
B	0.0	0.0	0.0	0.0	3,909.5	66.7	0.0	0.0	16.0	0.2	3.1	0.0	3,928.6	8
B/D	5,023.5	74.0	896.2	60.8	379.0	6.5	4,687.4	65.0	4,664.1	70.2	9,003.9	45.6	24,654.1	52
C	196.8	2.9	201.3	13.7	154.3	2.6	519.5	7.2	44.1	0.7	3,196.4	16.2	4,312.4	9
C/D	13.0	0.2	0.0	0.0	1,267.1	21.6	311.5	4.3	330.9	5.0	75.0	0.4	1,997.5	4
D	1,025.1	15.1	336.3	22.8	6.5	0.1	1,362.6	18.9	1,417.7	21.4	1,526.5	7.7	5,674.8	12
W	315.7	4.7	19.5	1.3	124.7	2.1	144.3	2.0	153.9	2.3	5,698.6	28.9	6,456.8	14

1.3.8 Land Use

Land use characteristics of a watershed significantly affect water quality, habitat, and flooding risk. The following describes historical, current, and projected future land use in the Sarasota County portion of the Lemon Bay watershed.

1.3.8.1 Historical

Historical land use within the Lemon Bay watershed was estimated from the USDA 1948 aerials (Figure 1-12) and the NRCS 1959 Soil Survey. Areas identified as major waterways, intensive agriculture (row crops, groves, etc.), or urban were digitized from the aerials. HSG C/D, D, W, and Pineda Fine sand of B/D—which were not previously classified as major waterways, intensive agriculture or urban and built-up—were then classified as wetlands. Depressional wetlands not previously identified as such were then digitized from the aerials. The remainder of the watershed was classified as undeveloped uplands as shown in Figure 1-11 and Table 1-4. Aerial interpretation was not performed for the southeastern portion of the watershed, as historical aerials for a portion of Charlotte County were not available. Although the current watershed boundary was used for the historical analysis, that boundary may have changed from past conditions.

1.3.8.2 Current

The spatial distribution and acreage of different current land use categories were identified using SWFWMD's 2004 land use coverage contained in the District's geographic information system (GIS) library. SWFWMD land use data are based on the Florida Department of Transportation (FDOT) "Florida Land Use and Cover Classification System" (FLUCCS). These FLUCCS classes were aggregated into categories based on hydraulic and hydrologic characteristics (Table 1-5). The predominant land use in the watershed is forest, open area, and park, which comprises over 30% of the watershed. Current land use coverage is shown in Figure 1-13 and listed in Table 1-6.

The Lemon Bay watershed was essentially undeveloped in 1948. By 2004, over 30% of the watershed was built up. On the other hand, the total area of forest, open area, and parks decreased from almost 70% of the watershed to approximately 30%. Wetland coverage in the watershed decreased by almost half. Table 1-7 and Figure 1-15 show the historical to current change in land use.

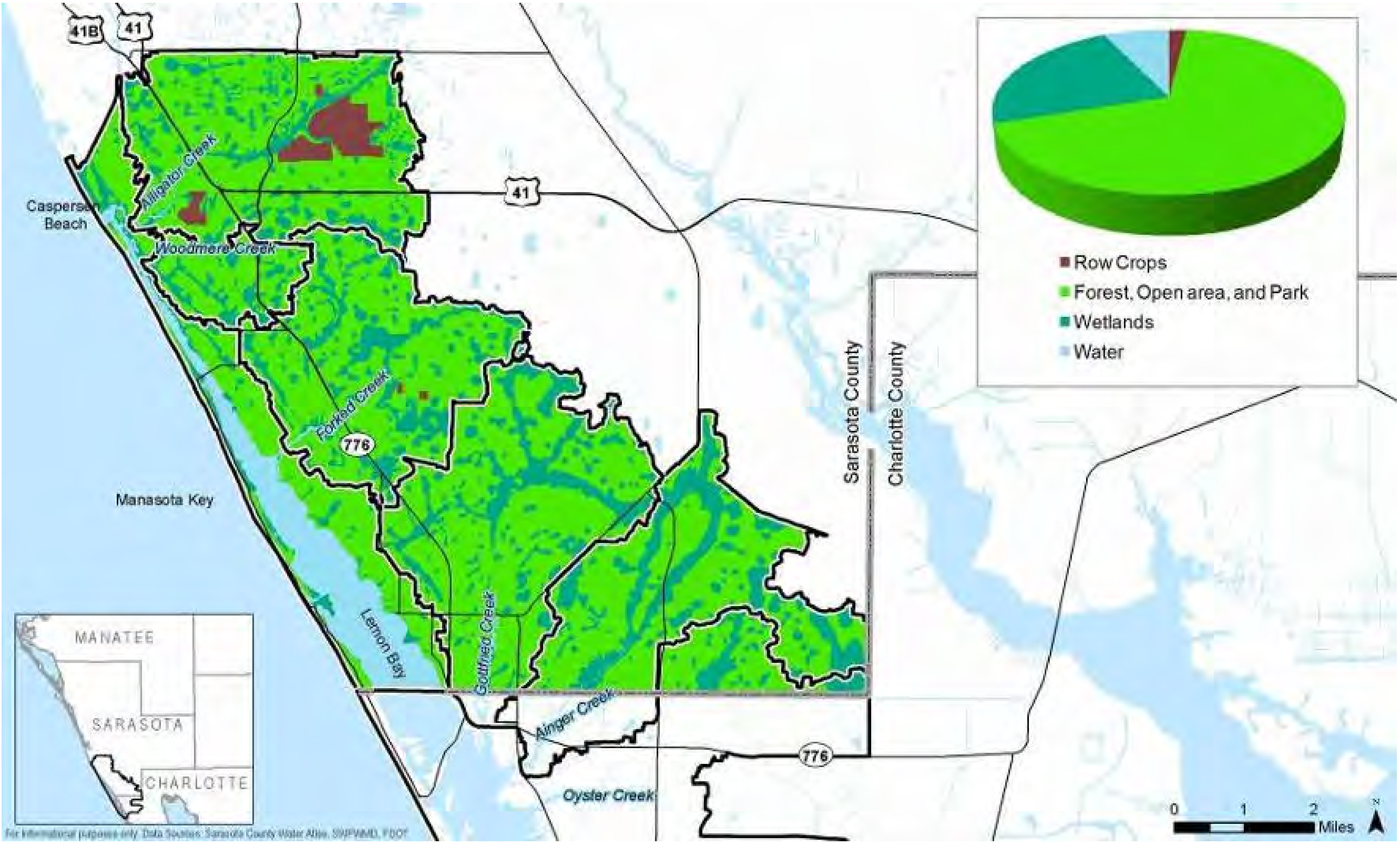


Figure 1-11 Lemon Bay Watershed Historical Land Use (Derived from USDA 1948 Aerials and NRCS 1959 Soils Survey)

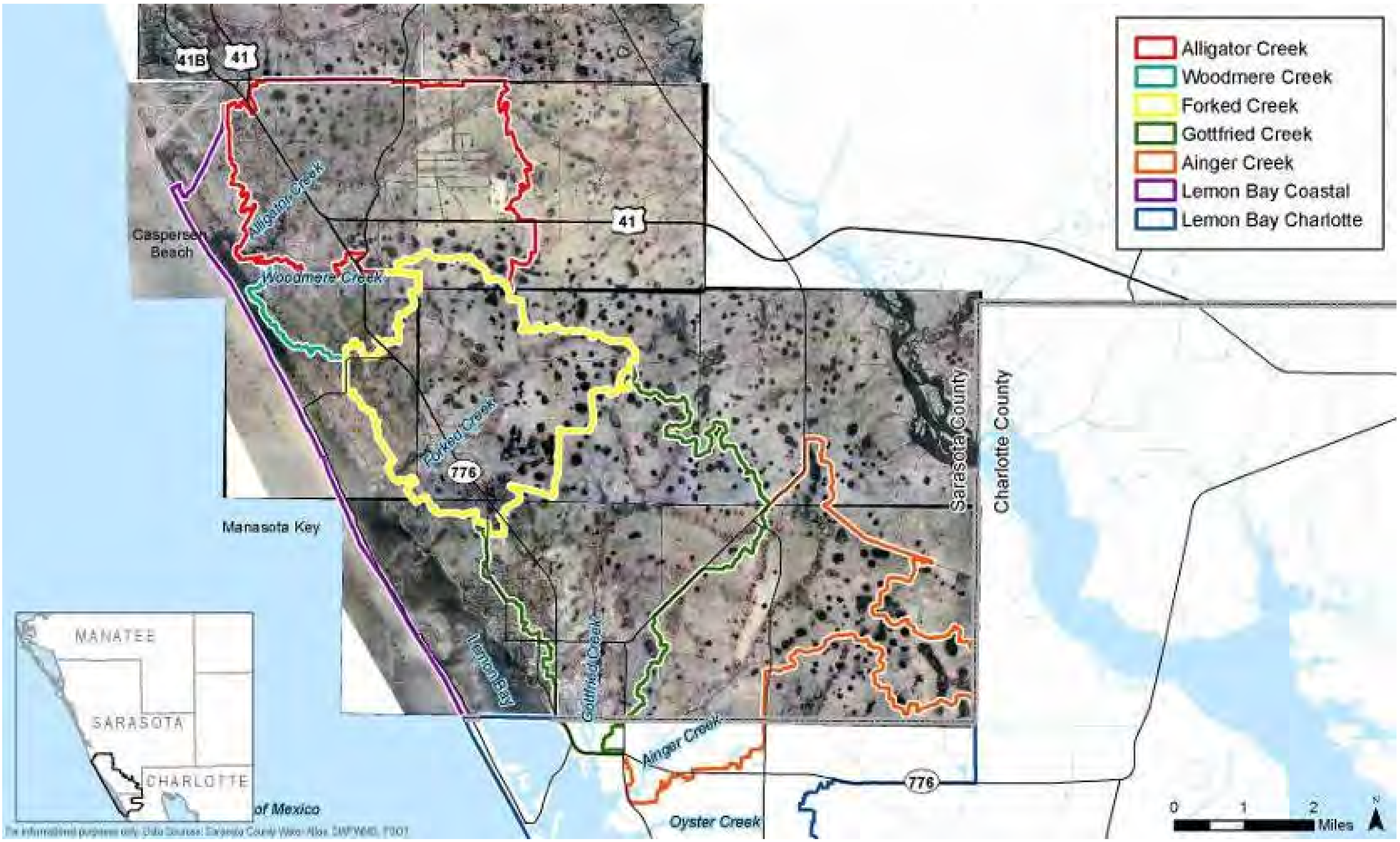


Figure 1-12 Lemon Bay Watershed 1948 Aerial Image

Table 1-4 Estimated Lemon Bay Watershed Historical Land Use* (Derived from USDA 1948 Aerials and NRCS 1959 Soils Survey)

Land Use	Basin												Lemon Bay Watershed	
	Alligator		Woodmere		Forked		Gottfried		Ainger		Coastal			
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Row Crops	602	8.9	0	0.0	17	0.3	0	0.0	0	0.0	0	0.0	619	1.9
Forest, Open area, and Park	4,863	71.5	1,119	75.9	4,298	73.3	5,263	74.8	3771	67.8	2,650	47.5	21,964	68.0
Wetlands	1,313	19.3	356	24.1	1,528	26.1	1,732	24.6	1782	32.1	712	12.8	7,423	23.0
Water	21	0.3	0	0.0	19	0.3	43	0.6	6	0.1	2,212	39.7	2,302	7.1

*The Charlotte County portion of the Lemon Bay watershed is not included in this analysis.

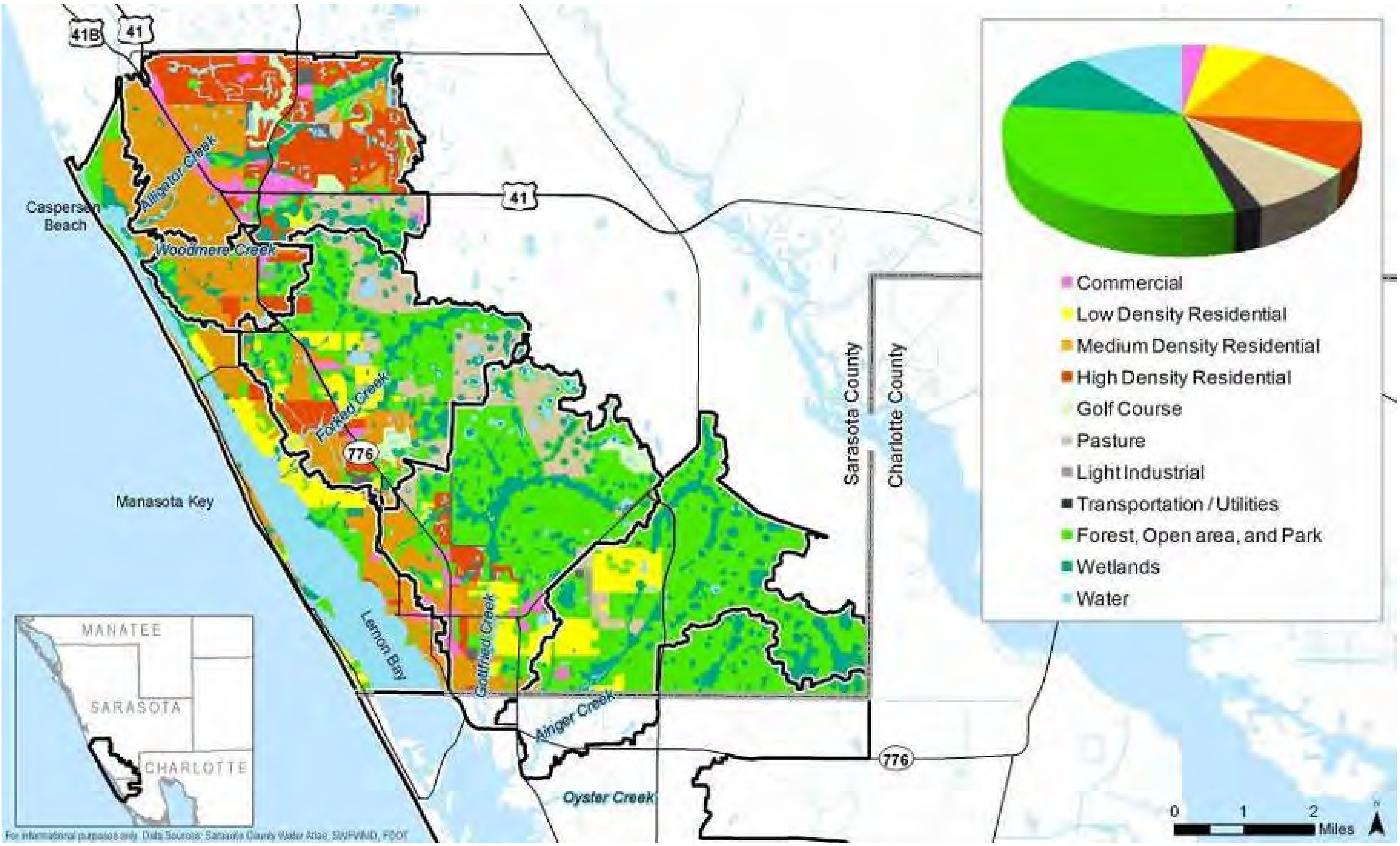


Figure 1-13 Lemon Bay Current Land Use Classification (SWFWMD 2004)

Table 1-5 Lemon Bay Current Land Use Classification (FDOT 1999)

Land Use	FLUCCS
Commercial	1400, 1700
Low-Density Residential	1100
Medium-Density Residential	1000, 1200
High-Density Residential	1300
Golf Course	1820
Pasture	2100, 3300, 7400
Agriculture	2200, 2300, 2400, 2500, 2550
Row Crops	2000, 2140
Light Industrial	1500
Transportation/Utilities	8100, 8200, 8300
Forest, Open Area, and Park	1800, 1900, 2600, 3100, 3200, 4000, 4100, 4110, 4120, 4200, 4340, 4400
Wetlands	6000, 6100, 6110, 6120, 6150, 6200, 6210, 6300, 6410, 6420, 6430, 6440, 6450, 6600
Water	1600, 5100, 5200, 5300, 5330, 5340, 5400, 5410, 5720, 6530

Table 1-6 Lemon Bay Watershed Current Land Use (SWFWMD 2004)

Land Use	Basin												Lemon Bay Watershed	
	Alligator		Woodmere		Forked		Gottfried		Ainger		Coastal			
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Commercial	487	7.2	16	1.1	62	1.1	221	3.1	20	0.4	64	1.2	870	2.7
Low-Density Residential	48	0.7	12	0.8	461	7.9	342	4.9	630	11.3	567	10.2	2,059	6.4
Medium-Density Residential	1,811	26.6	777	52.7	712	12.2	746	10.6	23	0.4	1,475	26.5	5,545	17.2
High-Density Residential	2,010	29.6	209	14.2	355	6.1	270	3.8	0	0.0	56	1.0	2,901	9.0
Golf Course	252	3.7	0	0.0	97	1.7	132	1.9	0	0.0	0	0.0	481	1.5
Pasture	360	5.3	0	0.0	998	17.0	774	11.0	134	2.4	4	0.1	2,271	7.0
Light Industrial	0	0.0	21	1.4	0	0.0	0	0.0	28	0.5	8	0.1	57	0.2
Transportation/ Utilities	299	4.4	27	1.8	107	1.8	157	2.2	63	1.1	24	0.4	677	2.1
Forest, Open Area, and Park	481	7.1	246	16.7	1,928	32.9	3,157	44.9	3,485	62.7	690	12.4	9,987	30.9
Wetlands	584	8.6	133	9.0	899	15.3	892	12.7	1,093	19.7	232	4.2	3,833	11.9
Water	467	6.9	32	2.2	243	4.1	347	4.9	84	1.5	2,454	44.0	3,628	11.2

*The Charlotte County portion of the Lemon Bay watershed is not included in this analysis.

Table 1-7 Lemon Bay Watershed Historical to Current Land Use Changes

Land Use	Basin						Lemon Bay Watershed
	Alligator Creek	Woodmere Creek	Forked Creek	Gottfried Creek	Ainger Creek	Lemon Bay Coastal	
	Current-Historical (Ac)	Current-Historical (Ac)	Current-Historical (Ac)	Current-Historical (Ac)	Current-Historical (Ac)	Current-Historical (Ac)	Current-Historical (Ac)
Commercial	487	16	62	221	20	64	870
Low-Density Residential	48	12	461	342	630	567	2,059
Medium-Density Residential	1,811	777	712	746	23	1,475	5,545
High-Density Residential	2,010	209	355	270	0	56	2,901
Golf Course	252	0	97	132	0	0	481
Pasture	360	0	998	774	134	4	2,271
Row Crops	-602	0	-17	0	0	0	-619
Light Industrial	0	21	0	0	28	8	57
Transportation/Utilities	299	27	107	157	63	24	676
Forest, Open Area, and Park	-4,382	-873	-2,370	-2,106	-286	-1,960	-11,977
Wetlands	-729	-223	-629	-840	-689	-481	-3,590
Water	446	32	224	304	78	242	1,326

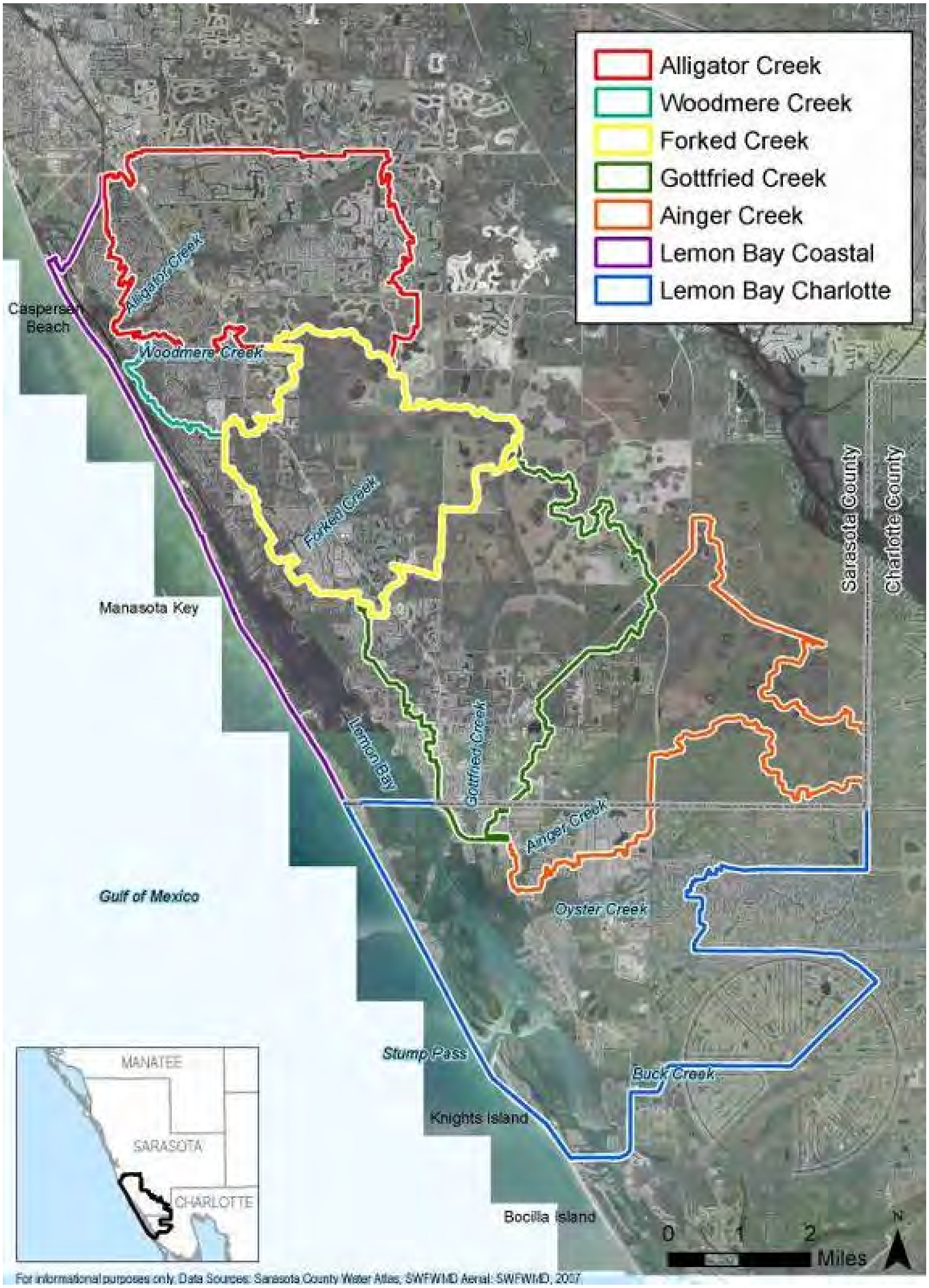


Figure 1-14 Lemon Bay Watershed 2007 Aerial Image

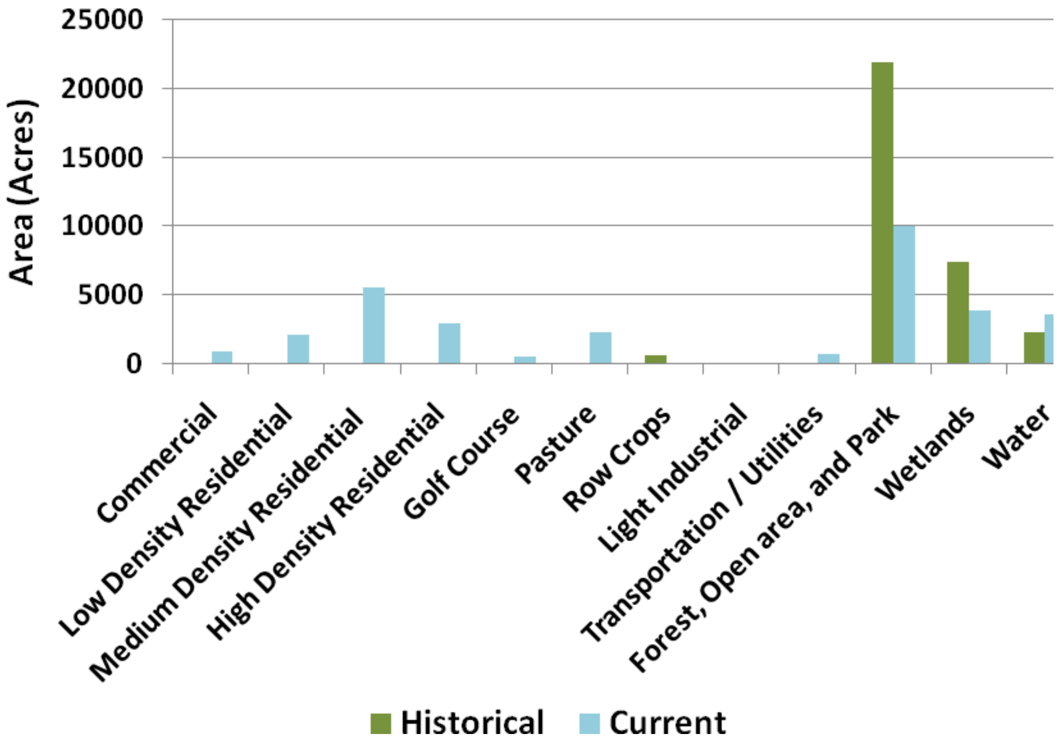


Figure 1-15 Lemon Bay Watershed Historical and Current Land Use

1.3.8.3 Future Land Use

Future land use within the Lemon Bay watershed was estimated from a built-out scenario of SWFWMD's 2004 land use coverage.

Future land use within the Lemon Bay watershed was estimated from a built-out scenario of SWFWMD's 2004 land use coverage. All "developable" land (FLUCCS 1900, 2100, 2140, 2200, 2300, 2400, 2500, 2600, 3100, 3200, 3300, 4100, 4110, 4120, 4200, 4340, 4400, and 7400) that is not conservation, preservation, or an ESLPP protected site was reclassified as medium-density residential. Estimated future land use coverage is shown in Figure 1-16 and Table 1-8.

Between 2004 and the projected future, the forest, open area, and parks were assumed almost entirely built out, increasing the urban and built-up areas in the watershed by over 200%. Table 1-9 and Figure 1-17 show the current to future change in land use.

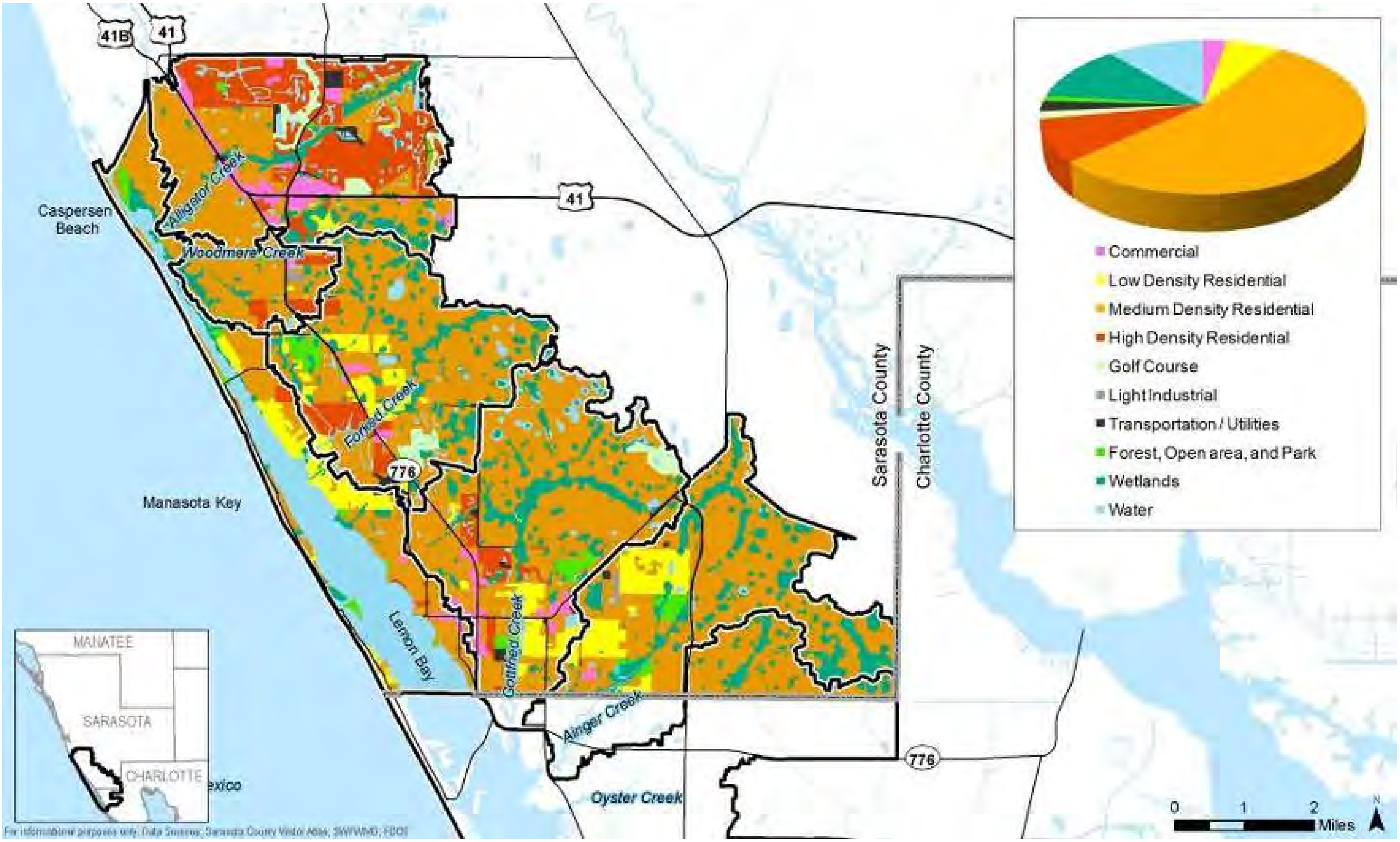


Figure 1-16 Lemon Bay Watershed Future Land Use (Built-out scenario derived from SWFWMD 2004 Land Use)

* The Charlotte County portion of the Lemon Bay Watershed is not included in this analysis.

Table 1-8 Lemon Bay Watershed Future Land Use (Built-out scenario derived from SWFWMD 2004 Land Use)

Land Use	Basin												Lemon Bay Watershed	
	Alligator		Woodmere		Forked		Gottfried		Ainger		Coastal			
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Commercial	487	7.2	16	1.1	62	1.1	221	3.1	20	0.4	64	1.2	870	2.7
Low-Density Residential	48	0.7	12	0.8	461	7.9	342	4.9	630	11.3	567	10.2	2,060	6.4
Medium-Density Residential	2,624	38.6	1,003	68.1	3,520	60	4,541	64.5	3,526	63.4	1,953	35	17167	53.1
High-Density Residential	2,010	29.6	209	14.2	355	6.1	270	3.8	0	0.0	57	1.0	2,901	9.0
Golf Course	252	3.7	0	0.0	97	1.7	132	1.9	0	0.0	0	0.0	481	1.5
Light Industrial	0	0.0	21	1.4	0	0.0	0	0.0	28	0.5	8	0.1	57	0.2
Transportation and Utilities	299	4.4	27	1.8	107	1.8	157	2.2	63	1.1	24	0.4	677	2.1
Forest, Open Area, and Park	29	0.4	20	1.4	119	2	136	1.9	116	2.09	217	3.9	637	2.0
Wetlands	584	8.6	133	9.0	899	15.3	892	12.7	1,093	19.7	232	4.2	3,833	11.9
Water	467	6.9	32	2.2	243	4.1	347	4.9	84	1.5	2,453	44.0	3,626	11.2

*The Charlotte County portion of the Lemon Bay watershed is not included in this analysis.

Table 1-9 Lemon Bay Watershed Future to Current Land Use Changes

Land Use	Basin						Lemon Bay Watershed
	Alligator Creek	Woodmere Creek	Forked Creek	Gottfried Creek	Ainger Creek	Lemon Bay Coastal	
	Future-Current (Ac)	Future-Current (Ac)	Future-Current (Ac)	Future-Current (Ac)	Future-Current (Ac)	Future-Current (Ac)	Future-Current (Ac)
Commercial	0	0	0	0	0	0	0
Low-Density Residential	0	0	0	0	0	0	0
Medium-Density Residential	813	226	2,808	3,795	3,503	478	11,623
High-Density Residential	0	0	0	0	0	1	1
Golf Course	0	0	0	0	0	0	0
Pasture	-360	0	-998	-774	-134	-4	-2,270
Light Industrial	0	0	0	0	0	0	0
Transportation and Utilities	0	0	0	0	0	0	0
Forest, Open Area, and Park	-452	-226	-1,809	-3,021	-3,369	-473	-9,350
Wetlands	0	0	0	0	0	0	0
Water	0	0	0	0	0	-1	-1

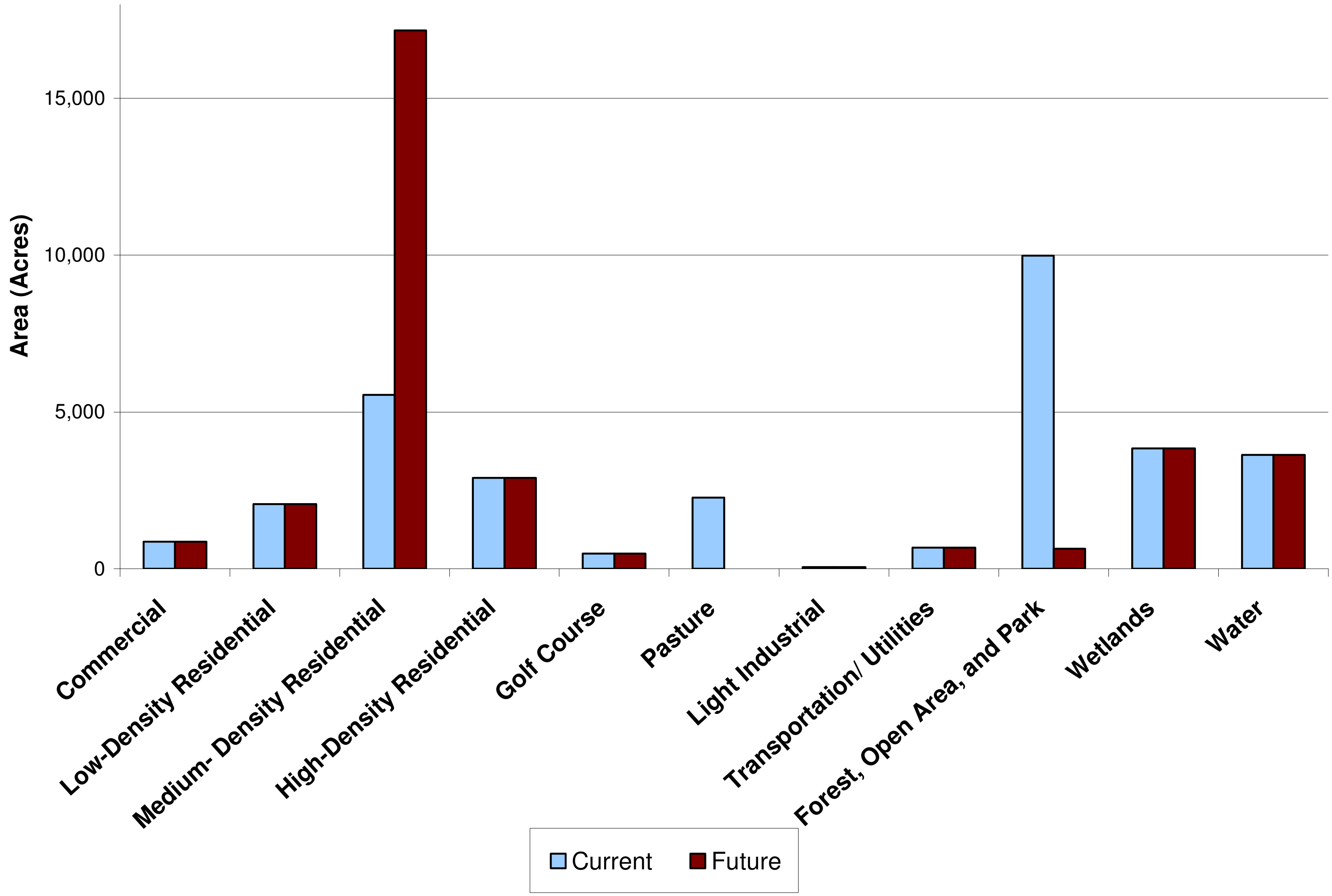


Figure 1-17 Lemon Bay Watershed Current and Future Land Use

1.4 ESTUARY

1.4.1 Boundary

Lemon Bay has two water body identification numbers (WBIDs)—1983A and 1983B (Figure 1-18). The WBIDs are assigned by FDEP and are unique identifiers used to report on Florida's water quality to the EPA.

Lemon Bay is an estuarine system dominated by mangrove, seagrass, and oyster communities. Lemon Bay extends from Alligator Creek to the south end of Knight Island. The Bay is as wide as 1.2 miles in some areas and averages 0.75 mile in width. It is delineated to the north by a dredged canal that connects Lemon Bay to Dona and Roberts Bay and Venice Inlet via the Intracoastal Waterway (ICW). Lemon Bay has a wide variety of physical features—including beaches, mudflats, sand bars, oyster bars, and salt flats—and aquatic features—including marine and estuarine waters, inlets, bays, and tidal creeks (FDNR, 1992).

The entire bay was designated as an aquatic preserve in 1986 (FDNR, 1992), one of 42 aquatic preserves established as of 1992 under the authority of the Florida Aquatic Preserves Act of 1975. The Lemon Bay Aquatic Preserve is considered to be composed of two waterbodies, Lemon Bay and Placida Harbor (Figure 1-19). Lemon Bay stretches the length of the northern two-thirds of the Preserve. Placida Harbor consists of the southern one-sixth of the Preserve, delineated by the narrow constriction in the bay near Bocilla Island (FDNR, 1992).

Figure 1-18 FDEP WBID (Bay Segments) Designation

Figure 1-19 Lemon Bay Aquatic Preserve

The purpose of setting aside aquatic preserves is to preserve unique, natural aquatic areas in the State in their original condition for future generations to use (FDNR, 1992). The Lemon Bay Aquatic Preserve includes approximately 7,667 acres of submerged land in Charlotte and Sarasota Counties and is classified as one of the OFWs (FDNR, 1992). The classification of OFW limits the types of discharges that can be permitted by FDEP. The Bay was considered "pristine" (FDNR, 1992) during the original writing of the management plan, but there have been heavy pressures for development in the Lemon Bay watershed since then.

The western shoreline of Lemon Bay is the shore of Manasota Key, a narrow barrier island that separates the Bay from the Gulf of Mexico and runs along the northern two-thirds of the Bay. A complex of three barrier islands—Little Gasparilla, Bocilla, and Knight Island—forms the southern third of the western shoreline of the Bay (FDNR 1992). The eastern shoreline is broken by seven tidal creeks. Alligator Creek is the northernmost creek and is close to the northern boundary of the Preserve. Located south of Alligator Creek are Forked Creek, Gottfried Creek, Ainger Creek, Oyster Creek, Buck Creek, and Lemon Creek (FDNR 1992). There are also several mangrove islands, all of which have numerous groves of red mangrove forests and fringe vegetation. White and black mangroves are common landward of the red mangrove forests on the shoreline fringes (FDNR, 1992). Stump Pass, toward the southern end of Lemon Bay, is a shallow natural inlet subject to continuous change in alignment and depth but which remains a navigable inlet.

1.4.2 Designated Use

The EPA Clean Water Act requires that the surface waters of each state be classified according to designated uses. Florida has five classes with associated designated uses, which are arranged in order of degree of protection required:

- Class I—Potable Water Supplies
- Class II—Shellfish Propagation or Harvesting
- Class III—Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife (The surface waters of the state are Class III unless described in Rule 62-302.400 FAC)
- Class IV—Agricultural Water Supplies
- Class V—Navigation, Utility and Industrial Use (Currently, there are not any designated Class V bodies of water.)

Only three classifications occur in Sarasota County: Classes I, II, and III. The east side of Lemon Bay from Forked Creek south is classified by 62-302.400 FAC as a Class II waterbody; the remaining portion of the Bay is a Class III waterbody.

East side of Lemon Bay from Forked Creek South is a Class II waterbody.

1.4.3 Bathymetry

The average depth of Lemon Bay, before dredging became common, was 1.2 meters at mean high water (MHW) and increased to approximately 2 meters at MHW after construction of the ICW (FDNR, 1992). Bathymetry data were obtained from the National Geophysical Data Center (NGDC). These data have been used by National Ocean Services to produce and update nautical charts for Lemon Bay. These datasets were compiled from multiple sources, including U.S. National Ocean Service Hydrographic Database, U.S. Geological Survey, Monterey Bay Aquarium Research Institute, U.S. Army Corps of Engineers LiDAR, USGS 3 arc-second DEMs and Shuttle Radar Topography Data, and various other academic institutions (Divins and Metzger, 2006). These data are referenced to the mean low water local vertical datum. Figure 1-20 displays the bathymetry contour for Lemon Bay, indicating that the bay is shallow throughout other than the dredged channel of the ICW, with a maximum depth less than 2 meters at mean low water.

1.4.4 Circulation and Coastal Passes

Lemon Bay receives drainage from Alligator Creek, Forked Creek, Gottfried Creek, Ainger Creek, Oyster Creek, Buck Creek, and Lemon Creek. The Bay also receives direct runoff from adjacent lands. Circulation within Lemon Bay has not been well studied, but much of the Bay is a shallow, well-mixed system with a coastal inlet toward the southern extent, suggesting that replacement times would be low in the southern extent. However, the northern portion of Lemon Bay is constricted and receives drainage from Alligator Creek as well as the ditched channel to Venice inlet. Therefore, it is likely that this portion of Lemon Bay behaves very differently than the more southern extent. A mix of diurnal and semi-diurnal tides result in average tidal amplitudes of ~0.7m, and wind driven currents affect circulation throughout the bay. A circulation model, which will contribute to the knowledge of retention times and circulation patterns in Lemon Bay, is being discussed as part of this WMP.

1.4.5 Sediment

The bulk of the sediments in Lemon Bay is composed of quartz sands and gravel from crushed shell material. According to Estevez (1981, as cited in FDNR, 1992), the overall majority of sediments in the Bay is composed of quartz sand. There are also clay minerals, phosphate minerals, and carbonate minerals that include magnesium calcite, dolomite, and aragonite (FDNR, 1992).

Figure 1-20 Bathymetry Contour for Lemon Bay Based on NGDC Data Referenced to Mean Low Water (Meters)

Lemon Bay sediments consist principally of fine sand, muddy sand, and silt-clay (Culter and Leverone, 1993). The bay bottom has been extensively altered as a result of dredge-and-fill projects, including latitudinal channelization of the entire bay for construction of the ICW. Construction of the ICW resulted in several spoil islands within the Bay, many of which over time have become fringed with mangroves. Dredge holes, which are thought to be remnants of dredging projects for purposes other than navigation, have also been observed in several locations within Lemon Bay. The type of bay bottom sediment varies in relationship to predominant water currents and water depths within the area. Channelized areas act as sinks for fine grain sediments and organic materials (SBEP, 1992). Dredged areas with poor circulation tend to become hypoxic and anoxic over time, reducing capacity to support diverse aquatic life. Hardened shorelines and construction of boat slips and marinas throughout the Bay have also altered bottom sediments.

1.5 PUBLIC LANDS

The Lemon Bay watershed contains 47,861 acres and, with the exception of the northern, southern, and coastal portions, much of the watershed is currently undeveloped. The eastern portion has, however, recently been annexed into the City of North Port and much of the watershed will likely be developed in the next 5 to 10 years. Most remaining natural areas are in the inland portion of the watershed, with only isolated natural areas in coastal areas (Figure 1-21).

Designated natural and conservation areas make up only 17% of the entire watershed area and include Priority Sites, Protected Lands, Public Lands, and Developed Properties Preserves.

Priority sites are unprotected lands identified by the County's ESLPP as priorities for future protection. Priority sites in the County are ranked on environmental criteria, including connectivity, water quality, habitat rarity, land quality, and manageability. ESLPP continually works to acquire and protect natural lands.

Protected lands are those lands protected through the ESLPP program which is funded by a 0.25-mill ad valorem tax that passed by referendum in March 1999 and was extended through 2029 by a second referendum in November 2005 (includes fee simple acquisitions, conservation easements, and lands protected through partnerships between ESLPP and other agencies/authorities).

Public lands are the major public (State, County, City) natural areas in Sarasota County, Florida as defined by Sarasota County Resource Management. Some portion of the area has been identified as having conservation, preservation, or mitigation uses. The Florida Natural Areas Inventory (FNAI) has also identified public lands in the watershed as having natural resource value. These lands are, therefore, being managed by the State, Local, or Federal government for conservation purposes.

Figure 1-21 Lemon Bay Watershed Environmentally Sensitive Lands

Developed properties preserves are preservation, conservation, and mitigation areas in private developments in Sarasota County as depicted in Land Development Regulations site development plans or Sarasota County plat books.

Examples of protected areas and priority protection sites, which are important for sustaining natural resources, include the Lemon Bay Preserve, Lemon Bay Park, Ainger Creek, Manasota Coastal Hammocks, Casperson Beach, Manasota Scrub, and Rosemary Scrub sites that are shown in Figure 1-21 and described below.

The Lemon Bay Preserve is a 195-acre site on the ICW and contains some of the last remaining undeveloped bay shorelines in the County. These lands protect the water quality and estuary of Lemon Bay. They also provide habitat for endangered plant species, many wading birds, and tidal species. In addition, the Lemon Bay Preserve provides significant areas of scrub habitat.

The Lemon Bay Park covers over 200 acres of pine and scrubby flatwoods along the natural bay shoreline. The Park provides quality wetland and pine flatwoods habitat for nesting bald eagles and other wildlife, as well as water quality benefits for Lemon Bay.

The Ainger Creek Protection Priority Site is 420 acres and is adjacent to the western boundary of Myakka State Forest. This site contains riverine wetlands, hammock, and pine flatwoods and supports a variety of wading birds. This site helps buffer the State Forest and Charlotte Harbor State Buffer Preserve to protect the water quality of Lemon Bay. In addition, the Ainger Creek site protects quality habitat directly along the creek.

Tortoise seen on Manasota Key, August 2007

The Manasota Coastal Hammocks Protection Priority Site is 24 acres on the south end of Manasota Key and consists of tropical hardwood hammock, a habitat that has almost been eliminated in Sarasota County, as well as beach, dune, and mangrove communities. The tract also contains several endangered species, including the prickly apple cactus.

Casperson Beach is south of the Venice Airport on Harbor Drive. The southern two-thirds of beachfront have been left in its natural state. A dune restoration system with walkovers has been implemented to preserve the shoreline. In 2000, a successful large-scale exotic removal program eradicated large thickets of Brazilian Pepper from the beach. Brazilian Pepper was the dominant vegetation before it was eradicated.

The Manasota Scrub Preserve is 256 acres of quality scrub jay habitat, pine flatwoods, depression marsh, and large maple marsh. Florida scrub jays, eastern indigo snakes, gopher tortoises, a variety of wading birds, and the Florida mouse inhabit the site. Once an extensive “scrub island,” this part of the County has been heavily developed, leaving only scattered pockets of habitat for the Florida scrub jay, the state’s only endemic bird. The preserve is also a valuable recreational facility.

The Rosemary Scrub Protection Priority Site is 67 acres of predominantly sand pine and rosemary scrub, a rare type of scrub habitat in Sarasota County. It is south of Dearborn Street, between SR 776 and Gottfried Creek, with about a half mile of creek frontage. Although the site is typically very dry, seasonal wetlands with high-quality mangrove and salt marsh habitats occur along Gottfried creek. This site’s proximity to the Bay, undeveloped land to the east, and nearby protected scrub makes it a valuable sanctuary for wildlife in the Englewood urban area. Protecting this natural area along Gottfried Creek is also important for maintaining water quality.

The Englewood Water District (EWD), an independent public agency, owns the entire Rosemary Scrub Protection Priority Site. The area is used as a potable water wellfield, which is compatible with protecting its environmental features. The site has no permanent protection if the current use or ownership changes. The EWD governing board has voted to consider entering into an agreement with Sarasota County to protect the site while allowing the wellfield operations to continue.

1.6 THREATENED AND ENDANGERED SPECIES

Sarasota County’s environmentally sensitive lands provide safe habitat for many threatened and endangered native species, including Florida scrub jays, eagles, gopher tortoises, manatees, and sea turtles. Figure 1-22 show sightings reported in the Lemon Bay Watershed.

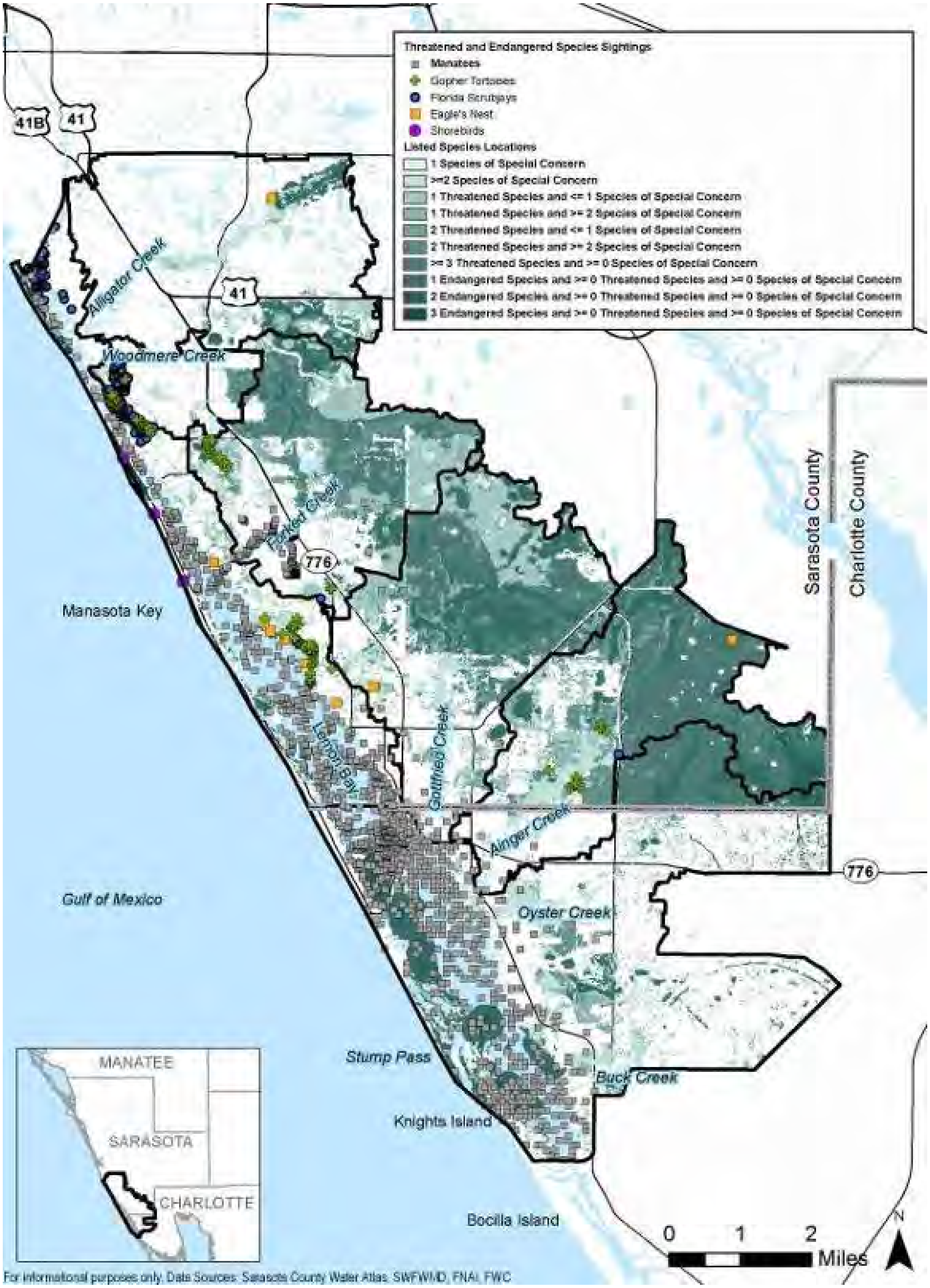
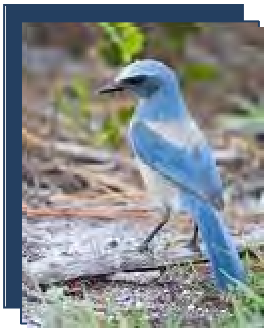


Figure 1-22 Lemon Bay Watershed Threatened and Endangered Species Sightings



The Florida scrub jay was added to the State threatened species list in 1975 and the Federal threatened species list in 1987. Named for its habitat, the scrub jay prefers the sandy, arid Florida scrub. Unfortunately, Florida scrub is a also attractive for its high development potential, which threatens the Florida scrub jay's habitat. To protect the species and reduce regulatory burdens imposed on developers by the Endangered Species Act, Sarasota County is developing a Habitat Conservation Plan (HCP) for the Florida scrub jay. The HCP will define a preserve network and establish a mitigation credit system for developers impacting a scrub habitat (scgov.net).

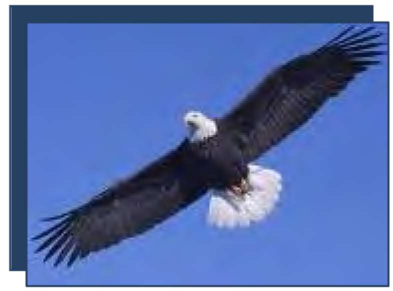


Photo from Sarasota County Online

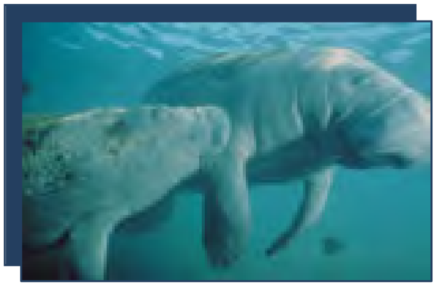
Although removed from the Federal list of Threatened and Endangered Species in August 2007, the bald eagle is still protected by Federal (Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act) and State law (Florida Statute 372.0725). Eagles are very sensitive to human activity and require nesting areas free from human activity. There are approximately 1,133 bald eagles in Florida and 41 reported active nests in Sarasota County (scgov.net). If a nest has been sighted or reported on or near a property, Sarasota County requires proof of coordination with the U.S. Fish and Wildlife Service (USFWS) before a building permit can be issued.

The gopher tortoise is another endangered species that lives in Sarasota County. Like the scrub jay, the tortoise prefers high, dry habitats, such as scrubs, coastal dunes, and pine flatwoods. Habitat destruction from development has reduced their habitat area and diminished the number of surviving tortoises. The ESLPP lands provide a much-needed haven for this creature. In turn, the tortoise's burrow is used by several other threatened species for shelter, such as the indigo snake, gopher frog, and the Florida mouse.

Photos from Wikipedia: (L-R, Gopher Tortoise, Kemp's Ridley Turtle and Leatherback Turtle)

Sarasota County protected lands also provide a safe nesting habitat for sea turtles. Sarasota County has the highest density of sea turtle nesting on the Gulf Coast of Florida and has supported nesting of the Kemp's ridley, loggerhead, leatherback turtle, and the green sea turtles. The ridley and the leatherback are two of the most endangered species of sea turtles. The Sarasota County Comprehensive Plan requires that special measures be taken to protect sea turtles and their habitats (scgov.net).

Sarasota County is one of 13 counties designated as a priority protection site for the West Indian Manatee, which is protected by State and Federal law. Sarasota County adopted a Manatee Protection Plan in September 2003 (scgov.net). The Sarasota County Government Online website (scgov.net) states that the plan includes:



- An inventory of boat facilities
- An assessment of boating and activity patterns
- Manatee sighting and mortality information.
- A boat facility siting plan—to determine the best areas for new marinas, boat ramps, etc.
- Manatee protection measures, such as boating speed regulations in areas with high boat and manatee usage
- Information on aquatic preserves, OFW, ports, manatee refuges, etc. within the county
- An education and awareness program for the public and boaters, divers, and school children.
- A water quality and habitat protection program (including land acquisition, and aquatic plant control plans for manatee areas)

1.7 RECREATIONAL FACILITIES

Sarasota County has more than 200 parks, 109 athletic fields, miles of pristine beaches, and more than 2000 acres of open space parkland. The County owns 52 facilities and maintains public recreational amenities totaling 1,517 acres within the watershed (Table 1-10). In addition, the County will maintain the Diocese of Venice, owned by the City of Venice, in the future. These sites include athletic fields, beaches, natural areas, and neighborhood parks. The parks range in size and land use from urban sites of under an acre to several large natural area parks, the largest of which is the Lemon Bay Park and Environmental Center at 209 acres. The parks are distributed throughout the Sarasota County portion of the watershed, as shown in Figure 1-23.

Table 1-10 Lemon Bay Watershed Area Recreational Facilities

MapID	Name	Park Class	Acres	Owner
1	Alligator Creek Conservation Area	Conservation Land	212.6	Sarasota County
2	Blind Pass Beach (future park)	Beach Access Park	64.8	Sarasota County
3	Casperson Beach	Beach Access Park/Natural Area Park	88.7	Sarasota County
4	Casperson Intracoastal	Neighborhood Park/Natural Area Park	69.0	Sarasota County
5	Challenger Park	Neighborhood Park	3.9	Sarasota County
6	Diocese Of Venice (Future Park)		20.0	City of Venice
7	Englewood Sports Complex	District Park	137.4	Sarasota County
8	Indian Mound Park	Boat Access Park/Natural Area Park	10.4	Sarasota County
9	Kiwanis Park/Buchan Park	Neighborhood Park	6.4	Sarasota County
10	Lemon Bay Park And Environmental Center	Linear Park/Natural Area Park	208.9	Sarasota County
11	Lemon Bay Preserve	Linear Park/Conservation Land	166.1	Sarasota County
12	Manasota Beach	Conservation Land	21.4	Sarasota County
13	Manasota Scrub Preserve	Natural Area Park	140.5	Sarasota County
14	Myakka State Forest		8,366.0	SWFWMD
15	Nightingale Park (So. Venice Park #17)	Neighborhood Park	5.2	Sarasota County
16	Plantation Park	Natural Area Park	24.2	Sarasota County
17	Shamrock Park And Nature Center	Natural Area Park	149.2	Sarasota County
18	Skip Stasko Park (South Venice Park #2)	Neighborhood Park	6.3	Sarasota County
19	South Venice Park #10	Neighborhood Park	4.2	Sarasota County
20	South Venice Park #11	Neighborhood Park	5.7	Sarasota County
21	South Venice Park #12	Neighborhood Park	1.3	Sarasota County
22	South Venice Park #13	Neighborhood Park	5.6	Sarasota County
23	South Venice Park #14	Neighborhood Park	1.6	Sarasota County
24	South Venice Park #15	Neighborhood Park	4.4	Sarasota County

Table 1-10 Lemon Bay Watershed Area Recreational Facilities

MapID	Name	Park Class	Acres	Owner
25	South Venice Park #16	Natural Area Park	3.1	Sarasota County
26	South Venice Park #18	Natural Area Park	0.8	Sarasota County
27	South Venice Park #19	Natural Area Park	0.5	Sarasota County
28	South Venice Park #20	Neighborhood Park	1.7	Sarasota County
29	South Venice Park #21	Natural Area Park	1.2	Sarasota County
30	South Venice Park #22	Natural Area Park	2.2	Sarasota County
31	South Venice Park #23	Neighborhood Park	9.2	Sarasota County
32	South Venice Park #24	Natural Area Park	0.5	Sarasota County
33	South Venice Park #25	Neighborhood Park	7.0	Sarasota County
34	South Venice Park #26	Neighborhood Park	5.4	Sarasota County
35	South Venice Park #27	Neighborhood Park	2.0	Sarasota County
36	South Venice Park #29	Natural Area Park	8.3	Sarasota County
37	South Venice Park #2a	Neighborhood Park	3.2	Sarasota County
38	South Venice Park #3	Neighborhood Park	1.3	Sarasota County
39	South Venice Park #30	Neighborhood Park	3.1	Sarasota County
40	South Venice Park #31	Neighborhood Park	0.2	Sarasota County
41	South Venice Park #32	Neighborhood Park	0.7	Sarasota County
42	South Venice Park #33	Natural Area Park	1.9	Sarasota County
43	South Venice Park #34	Natural Area Park	10.2	Sarasota County
44	South Venice Park #35	Neighborhood Park	3.3	Sarasota County
45	South Venice Park #36	Natural Area Park	3.2	Sarasota County
46	South Venice Park #37	Natural Area Park	1.6	Sarasota County
47	South Venice Park #4	Neighborhood Park	1.3	Sarasota County
48	South Venice Park #5	Natural Area Park	4.9	Sarasota

Table 1-10 Lemon Bay Watershed Area Recreational Facilities

MapID	Name	Park Class	Acres	Owner
				County
49	South Venice Park #6	Natural Area Park	5.6	Sarasota County
50	South Venice Park #7	Neighborhood Park	2.7	Sarasota County
51	South Venice Park #8	Neighborhood Park	3.3	Sarasota County
52	South Venice Park #9	Natural Area Park	4.4	Sarasota County
53	Venice Area Audubon Rookery		3.1	
54	Venice Gardens Playground	Neighborhood Park	10.2	Sarasota County
55	Woodmere Park and Woodmere Paw Park	Community Park	76.1	Sarasota County

1.8 PUBLIC EDUCATION

Sarasota County and other entities promote environmental stewardship and assist individuals, community-based organizations, businesses, schools, and others to undertake watershed restoration initiatives in Sarasota County through public outreach and education. Environmental Services, Citizens Academy, Forestry Division, Neighborhood Services, and Access Sarasota provide many outreach programs, such as community and school educational programs about recycling, and Keep Sarasota County Beautiful manages several outreach programs such as Adopt-a-Road, Adopt-a-Park, and Adopt-a-Shore. The County's Neighborhood Services Department offers classes and workshops on how to improve and maintain communities and provides grants to implement what residents have learned to enhance their neighborhoods' character, value, safety, health, and infrastructure.

The County's Neighborhood Environmental Stewardship Team (NEST) is a volunteer organization partnering with residents to increase awareness of the importance of native habitats and watersheds in our community. NEST's primary purpose is to provide constructive and meaningful activities for people to improve the environmental quality of their watershed and neighborhoods while expanding the knowledge base and advocacy for watershed improvements.

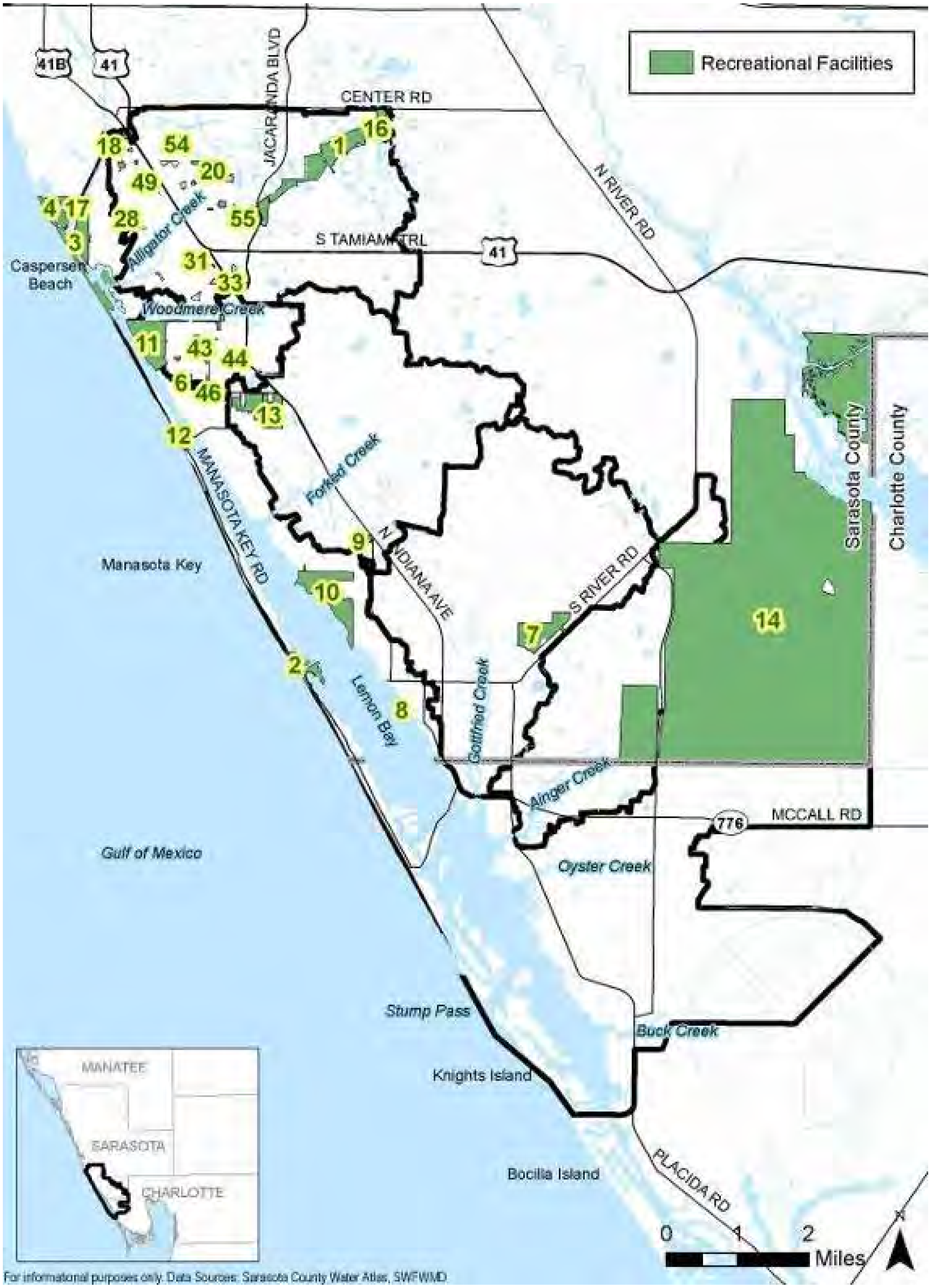


Figure 1-23 Lemon Bay Watershed Area Recreational Facilities

The program encourages people to interact with nature through enjoyable and hands-on activities. The NEST idea was initiated during the development of the Lemon Bay Ecosystem Restoration Project in 2001 as an opportunity for residents (neighbors, civic groups, student organizations) to actively work with land managers and restoration ecologists in restoring the native habitats of the preserve. During this initial project, citizens from the surrounding neighborhoods participated in water quality monitoring, fish sampling, a frog listening network, trash and invasive plant removal, native plantings, and a scrub-jay watch program.

In addition to Sarasota County, organizations such as SWFWMD, CHNEP, FDEP, University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Extension, and many small non-profit organizations play a key role in educational outreach in the Lemon Bay watershed area. Table 1-11 summarizes the various organizations and their respective educational outreach programs.

The following describes some of the partner public education programs:

- SWFWMD offers a multitude of training, incentives, grants, and educational materials. The SWFWMD educational website, www.swfwmd.state.fl.us/education/, offers free materials and expert speakers, current funding opportunities, and web activities that teach readers about watersheds, conservation, and water quality.

- Since 1996 CHNEP has awarded grants to support projects to improve community awareness. Educational projects submitted by Florida residents, organizations, businesses, government agencies, schools, colleges, and universities are supported. The projects vary greatly in scope and scale, ranging from curriculum development to environmental education activities and are distributed through the watershed.

- The UF/IFAS Extension program is a partnership between the University of Florida, State, Federal, and county governments to provide scientific knowledge and expertise to the public (UF/IFAS). The UF/IFAS County Extension is Sarasota offers a multitude of free educational courses to community related to natural resource sustainability, such as Florida Yards & Neighborhoods, the Master Gardener Program, and Rain Barrel Workshops.

Florida House - Photo from sarasota.extension.ufl.edu/fhlc/flahousehome.shtml

The UF/IFAS Extension Program has unique demonstration facility in Sarasota County. The Florida House Learning Center is a model home and landscape that demonstrates green building and sustainable living. It was originally conceived as an educational outreach for water conservation after a severe regional drought in the late 1980s and was organized by IF/IFAS and interested citizens. The Florida House features water and energy-conserving designs and devices, Energy Star® appliances, renewable resources such as cork flooring, recycled plastic carpet, and a "Model Florida Yard." The Florida House is believed to be one of the first such educational demonstration facilities in the country (Florida House Learning Center History, 2007—http://sarasota.extension.ufl.edu/FHLC/FLHouseHistory.shtml).

Table 1-11 Public Outreach Programs

Entity	Outreach Programs
Sarasota County Water Resources	NEST (Neighborhood Environmental Stewardship Team) voluntary association of people—neighbors, civic groups, student organizations, and others who want to better understand and improve environmental conditions in their watershed.
Sarasota County Environmental Services	Recycling (publication; community and school education)
	Discover Natural Sarasota County (publication)
	Keep Sarasota County Beautiful (Adopt-a-Road, Park, Pond, Shore, and Spot; portable pocket ashtrays, Bag-it-in-Your-Car-Day)
Sarasota County Access Sarasota	Public Service Announcements and County Talk (Comcast TV 19 / Verizon 32)
Sarasota County Citizens Academy	Improves communications between citizens and government; Fosters increased citizen involvement
Sarasota County Forestry Division	Neighborhood, Urban, and Canopy Road Tree Programs (design, selection and planting services)
Sarasota County Neighborhood Services	Grant Program (helps residents enhance their neighborhoods' character, value, safety, health and infrastructure)
	Neighborhood University Program (classes and workshops designed to inform residents of Sarasota County on how to improve and maintain their communities and neighborhoods)
Florida Department of Environmental Protection	Florida Yards (FloridaYards.org; a project of the Florida Springs Initiative)
	Green Lodging Facilities Program (recognizes and rewards environmentally conscientious lodging facilities)
	Clean Marinas Program (Clean Marina Designation status awarded to marinas and boatyards that demonstrate continued commitment and protection to the water and marine life.

Table 1-11 Public Outreach Programs

Entity	Outreach Programs
Southwest Florida Water Management District	Florida Friendly Landscapes (education program that promotes the use of Florida-friendly landscaping to homeowners, builders, developers and landscape and irrigation professionals; partner to University of Florida's Florida Yards & Neighborhoods Program)
	Training (interdisciplinary water education programs including Project WET; Healthy Water, Healthy People; Great Water Odyssey; etc.)
	Funding (Mini-Grants, Community Grants)
	Web Activities (Learn about watersheds, Splash! Activities, Water quality monitoring)
	Educational materials (free publications and materials for adults and children including Water Matters, Water Matters Hispanic outreach, Florida Waters, Watershed Excursion, etc.)
	FARMS Program (Facilitating Agricultural Resource Management Systems), an agricultural best management practice cost-share reimbursement program involving both water quantity and water quality aspects; developed with the Florida Department of Agriculture and Consumer Services)
	Water Conservation Hotel And Motel Program (Water C.H.A.M.P.) (helps hotels and motels save water and money while practicing more efficient housekeeping and landscaping)
Entity	Outreach Programs
Other Non-profit Organizations	1000 Friends of Florida, Science and Environment Council of Sarasota County, Florida House Institute,
Charlotte County National Estuary Program	Grant Program (Micro-grants and Educational Outreach Project grants—various projects)
	Field Trips (School Estuary Exploration, Seagrass Education, Sailing Through the Environment)
	Publications (Calendars, Harbor Happenings, Seagrass Annual Data Summary, technical reports)
	Workshops (Sea Turtles Adventure, Waters Edge and Landings Native Landscaping)
Lemon Bay League	Stakeholder meetings to identify priorities for watershed protection.
Lemon Bay Conservancy	Lecture Series (Visiting speakers present information about issues relevant to Lemon Bay; educational material provided to attendees)
	Field Trips (National Estuary Day Kayak Paddle)
Florida Native Plant Society (Mangrove Chapter)	Field Trips (occur monthly, location varies)
	Workshops (occur monthly; various topics and guest speakers)

Table 1-11 Public Outreach Programs

Entity	Outreach Programs
Charlotte Harbor Environmental Center	Wet n' Wild Eco Camp (Lemon Bay/Englewood- features water & wetland education, wading trip, wilderness hiking, native plant and animal identification, field trip)
	Journey Through the Heart of an Estuary (participants take the role of a water drop in the Lemon Bay watershed and follow its Journey from the uplands to creeks and rivers and finally to the estuary)
	Guided Hikes (Alligator Creek Preserve or Cedar Point Environmental Park- guided walk with discussion about water issues, native wildlife, and their integral role in the balance of southwest Florida systems)
	Moms & Tots (monthly; various topics)
	Publications (Citizens Guides, Restoration Needs Assessment in the Charlotte Harbor and Lemon Bay Basins, and the Peace and Myakka River Basins, etc.)
University of Florida IFAS Extension	Florida Yards & Neighborhoods partners with national, state, and local agencies to teach Florida-friendly landscaping
	BMP Training meets the requirements of the Sarasota County Fertilizer Ordinance for landscape company employees who apply fertilizers.
	Master Gardener Program trains volunteer educators to provide information to Floridians about gardening, environmental horticulture, and pest management.
	Rain Barrel Workshops are classes on the construction and use of rain barrels and their environmental benefits. Sarasota County currently sells rain barrels for $37 each after the class.
	The Florida House will re-open in Fall 2010. Florida House is a demonstration facility, which offers education classes and tours.

Chapter 2

Goals and Objectives

August 2010

Sarasota County

Southwest Florida Water Management District

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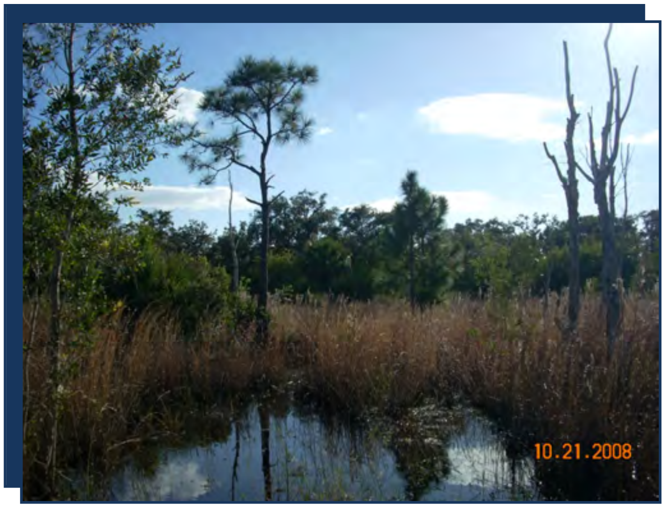
2.0 GOALS AND OBJECTIVES

Each of the objectives established in Chapter 1 is designed to preserve, protect, and/or enhance natural systems and water quality in Lemon Bay ecosystems; support a sustainable water supply; and provide flood protection for the citizens of Sarasota County in conjunction with maintaining aquatic recreational uses and offering public education opportunities in a comprehensive Watershed Management Plan. In summary, these goals and objectives include:



1 Improving and protecting water quality.
2 Providing information to help the Florida Department of Environmental Protection (FDEP) develop Basin Management Action Plans to address adopted Total Maximum Daily Load issues within the Lemon Bay watershed.
3 Providing a more natural hydrologic regime for Lemon Bay and the watershed.
4 Protecting existing and future property owners from flood damage.
5 Developing ecosystem goals and targets based on the needs of environmental and biological indicators.
6 Investigating potential sustainable surface water supply options that are consistent with and support the Sarasota County Comprehensive Plan, the Southwest Florida Water Management District's Regional Water Supply Plan, and the Southern Water Use Caution Area Regional Strategy.

Four watershed areas of responsibility: natural systems, water quality, water supply, and flood protection.

Sarasota County, the Southwest Florida Water Management District, the Charlotte Harbor National Estuary Program, Mote Marine Laboratory, and the Lemon Bay League have developed management plans and technical reports through studies, workshops, and other efforts. For planning purposes, Lemon Bay is considered part of the Charlotte Harbor Estuary in many of these plans and studies. The previous plans are summarized in this section based on the four watershed areas of responsibility.

A summary spreadsheet of previous goals, objectives/strategies, and recommendations is provided in Appendix A.

Previous plans and studies were reviewed within the Lemon Bay WMP framework. The project team, consisting of Jones Edmunds, Janicki Environmental, and County and District staff, evaluated goals, objectives, and recommendations for each area of responsibility. Using previous recommendations, current ecological conditions, and future planning information, the project team developed goals, objectives, and approaches to implement a work flow for Lemon Bay early in the WMP process. The resulting work flow provides a scientific and engineering basis for the final recommendations. The proposed approaches to gather and evaluate data for each area of responsibility are summarized in the following sections. The data evaluation is presented in subsequent chapters and is the basis for proposed conceptual projects and program recommendations provided in Chapter 8.

2.1 NATURAL SYSTEMS

2.1.1 Proposed Goals, Objectives, and Approaches

The primary natural systems goal is to protect, enhance, and restore natural communities and habitats. The proposed objective is to establish critical natural habitat criteria that will used to determine the overall ecological health of Lemon Bay. Five habitat types have been defined for this purpose and the evaluation approach is summarized in Table 2-1. More detail is presented in the Natural Systems section of Chapter 3.

Shorelines, seagrasses, benthos, oysters, and wetlands represent critical natural habitats in Lemon Bay.

2.1.2 Previous Goals, Objectives, and Recommendations

Documents listing natural systems goals and objectives were produced by Sarasota County, Southwest Florida Water Management District, the Charlotte Harbor National Estuary Program, and the Lemon Bay League. A summary of pertinent information is provided.

2.1.2.1 Sarasota County Planning Department

The Environmental Plan (Chapter 2) of the Sarasota County Comprehensive Plan focuses on conserving, maintaining, and restoring natural systems and on the need to coordinate between the Environmental Plan and the other chapters (i.e., roads, sewers, housing). Four primary goals of the Environmental Plan are:

1. Protect, maintain, and, where deemed necessary in the public interest, restore or enhance the natural resources of Sarasota County (including the barrier island, beach, and estuarine system) to ensure their continued high quality and their critical value to the quality of life in the County.

Table 2-1 Lemon Bay Watershed Habitat Summary

Habitat	Description	Anthropogenic Impacts	Approach
Shorelines	Shorelines provide critical transition zones between terrestrial and marine habitats.	Alterations have resulted in a degraded littoral zone and 'hardening' of the shoreline from structures such as concrete seawalls or riprap bulkheads.	Estimate the extent of hardened and of natural shorelines and identify potential shoreline restoration areas.
Seagrass	Seagrasses provide critical habitat for juvenile fishes and invertebrates, stabilize sediments, and are a food source for manatees and sea turtles.	Changes in light penetration, salinity, and nutrients can potentially have a detrimental impact on seagrasses.	Evaluate seagrasses by comparing current and historic aerial surveys for extent of coverage and persistence and establish restoration and protection targets.
Benthos	Benthos support bottom-dwelling organisms such as worms, snails, clams, small crustaceans, and other invertebrates. They are an essential component of the diet of many fishes and wading birds.	Changes in salinity and DO can potentially have a detrimental impact on the benthos.	Examine salinity and DO distributions in Lemon Bay using existing information and relate distribution to areas of concern. Any data gaps should be identified.[1]
Oysters	Oyster reefs serve a number of valuable ecological functions and are an important indicator of estuarine health.	Changes in salinity, nitrogen nutrients (over-nitrification depletes DO), toxic chemicals and metal contaminants, and siltation can potentially have a detrimental impact on the oysters.	Examine historic oyster distribution and establish target restoration sites.
Wetlands	Wetlands are a vital component of any watershed with significant ecological and hydrological benefits.	There has been a significant decline in wetlands from activities such as drainage and clearing for agriculture and urbanization, channeling of streams, and water obstruction and impoundment.	Estimate current and historic extents of freshwater and estuarine wetlands for the watershed and then develop wetland protection and balanced restoration targets.

1) The approach to address DO and salinity is provided in the related Water Quality section (Table 2-2)

2. Support the implementation of the regional Comprehensive Conservation and Management Plans (CCMP) to restore and improve the natural estuarine systems and related coastal components as a member of the Sarasota Bay and Charlotte Harbor National Estuary Programs.
3. Lessen the impact of a destructive storm on human life, public facilities, private structures, infrastructure, and coastal natural resources in Sarasota County.
4. Preserve, protect, and restore the integrity of the natural environment, historic and archeological resources, and neighborhoods and preserve agricultural uses consistent with resource protection.

Specific policies are found in the Comprehensive Plan.

2.1.2.2 Sarasota County Natural Resources

The Natural Resources Department produced the *Land Management Plan for the Alligator Creek Conservation Area (2005)*. The goal is to manage the Conservation area's upland communities to improve habitat value for wildlife and habitat function by controlling nuisance and exotic species, reducing understory vegetation, and developing community coordination.

2.1.2.3 Southwest Florida Water Management District (SWFWMD)

Three documents from SWFWMD are important to natural systems strategies in Lemon Bay: *Charlotte Harbor Surface Water Improvement Plan* (*SWIM*), *Southern Coastal Comprehensive Watershed Management Plan (SCC-WMP)*, and *Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay*.

The SWIM plan outlined two goals: improving the environmental integrity of the Charlotte Harbor study area and preserving, restoring, and enhancing seagrass beds, coastal wetlands, barrier beaches, and functionally related uplands. The plan's objectives are:

- Identify and remove areas of heavy invasive exotic vegetation from the Charlotte Harbor NEP study area.
- Enhance fish and wildlife habitat along shorelines, including canals, lakes, riverine systems, and artificial water bodies.
- Restore freshwater and estuarine wetland areas, especially those adversely impacted by ditching.
- Bring environmentally sensitive land under protection through ownership and/or management, and expand conservation areas, reserves, and preserves.
- Acquire lands to increase wildlife habitat currently privately held within large, undeveloped, platted areas.

Recommended projects to support achieving the SWIM plan goals include implementing the restoration master plan for Alligator Creek; restoring Lemon Bay Park; and continuing other restoration projects.

The primary natural system goal for the SCC-WMP is to protect, preserve, and restore important upland and wetland systems and to establish minimum water levels and flows necessary to maintain these natural systems. Specific objectives/strategies for the SCC-WMP are to continue ongoing efforts focused on protecting and restoring wetlands and to protect natural systems through land-acquisition and land-conservation methods.

The primary goal of *Nonpoint-Source Model Development and Basin Management Strategies for Lemon Bay* in 2004 is to reduce non-point-source loadings into Lemon Bay. Objectives include developing hydrologic restoration programs for the tidal creeks and other entities in areas where manmade alterations have taken place, enhancing floodplain storage, and improving surface water quality. Proposed restoration sites include Alligator Creek, Forked Creek Western Branch, Forked Creek Eastern branch, Manasota Key, Gottfried Creek, River Road Wetlands, and Ainger Creek.

2.1.2.4 Charlotte Harbor National Estuary Program (CHNEP)

The CHNEP developed a CCMP for the estuary (2008). The natural systems focus of the plan is to improve the environmental integrity of the Charlotte Harbor study area. The report contains a number of goals to support the focus statement:

1. Preserve, restore, and enhance seagrass beds, coastal wetlands, barrier beaches, and functionally related uplands.
2. Reduce the severity, extent, duration, and frequency of harmful algal blooms, including red tide.
3. Conserve and preserve sensitive lands to protect habitat.
4. Stop new infestations of exotic pest plants and exotic nuisance animals and bring current infestations to manageable levels.
5. Address fish and wildlife habitat loss, such as degradation and elimination of headwater streams and other habitats caused by development, conversion of natural shorelines, cumulative impacts of docks and boats, invasion of exotic species, and cumulative and future impacts.
6. Address hydrologic alterations, which cause adverse changes to amounts, locations, and timing of freshwater flows; the hydrologic function of floodplain systems; and natural river flows.

Some of the CCMP recommendations that impact natural systems are listed here:

- Re-establish hydrologic watersheds to contribute flows to their historic receiving water bodies.

- Build and restore water conveyances to have shallow, broad, vegetated, and serpentine components that also restore floodplains.
- Implement watershed initiative projects to address hydrologic alterations, loss of water storage, and changed hydroperiod and to improve water quality.
- Develop methods to enhance seagrass recovery from prop scarring.
- Ensure that navigation programs protect the CHNEP study area habitat resources.
- Restore freshwater and estuarine wetland areas, especially those adversely affected by ditching, using the following methods: backfilling ditches, removing spoil piles, eliminating exotic vegetation, and other techniques.
- Enhance fish and wildlife habitat along shorelines, including canals, lakes, riverine systems, and artificial waterways.
- Assess the impacts of canal/lake management activities on fish and wildlife.
- Restore and protect a balance of native plant and animal communities.
- Provide multifaceted environmentally responsible boater education programs.
- Support public involvement programs in habitat and wildlife issues.
- Bring environmentally sensitive land under protection through ownership and/or management and expand conservation areas, reserves, and preserves, including undeveloped platted lots.
- Advocate land acquisition and conservation easement programs.
- Where practical, identify and remove areas of heavy invasive exotic vegetation and exotic nuisance animals.
- Develop a historic and current estuarine mixing model, focusing on salinity and indicator species that are sensitive to salinity changes, and better evaluate proposed capital and operations projects.
- Protect headwater tributaries from elimination and restore these tributary courses and their floodplains where opportunities exist.
- Establish minimum flows and levels (MFLs).
- Participate in Everglades restoration and the Southwest Florida Feasibility Study.
- Re-establish hydrologic watersheds to contribute flows to their historic receiving water bodies.
- Evaluate the impacts of man-made barriers to historic flows.
- Identify the hydrologic and environmental impacts of surface water reservoirs on estuaries within the watershed.

2.1.2.5 Lemon Bay League

The Lemon Bay League is a community-based, non-profit (501.C.3) organization consisting of a diverse group of stakeholders in Sarasota and Charlotte Counties designed to increase civic engagement on planning efforts relating to watershed goals for the Lemon Bay Watershed. The League's broad goal is to develop continuity in planning among multiple agencies and jurisdictions to provide a stewardship plan and a common community vision for the health and sustainability of the watershed.

The Lemon Bay League produced the *Lemon Bay Interagency Comprehensive Watershed Management Plan* (2004). The plan's primary natural systems goal is to enhance, protect, and conserve the hydrologic and ecologic functions of natural systems, including estuaries, freshwater, and groundwater systems. Determining and restoring natural hydrologic regimes and protecting and restoring ecological habitats are the objectives outlined in the plan. Recommendations to achieve the goal include developing watershed budgets, supporting an aquifer storage and recovery feasibility study, implementing a hydrologic restoration program, and implementing stormwater conservation and reuse programs.

2.2 WATER QUALITY

2.2.1 Proposed Goals, Objectives, and Approaches

Primary water quality parameters are: Chlorophyll a, Water clarity, Dissolved oxygen, Salinity.

The primary water quality goal is to protect, maintain, and improve water quality conditions in estuarine and freshwater environments. To evaluate the current health of the bay and estuaries and provide a framework for future evaluation, four primary parameters serve as water quality indicators: chlorophyll *a*, water clarity, dissolved oxygen, and salinity. A detailed discussion of each indicator as well as the interaction and relationships among the indicators is provided in Chapter 4 Water Quality. Identifying critical water quality indicators and establishing living-resource-based targets for each indicator as it relates to the health and vitality of the Lemon Bay system is a primary objective of the plan.

Following is a brief discussion of each indicator and Table 2-2 lists the approaches to develop scientifically sound resource protection targets for each indicator.

Table 2-2 Lemon Bay Critical Water Quality Indicators

Indicator	Approach
Chlorophyll *a*	• Examine relationship between nutrient loads and chlorophyll a levels, taking into account circulation and residence time.
	• Examine the relationship between current and historic conditions and Impaired Waters Rule thresholds.
	• Estimate critical nutrient loads to meet living-resource-based target levels for chlorophyll.
Water Clarity	• Use existing information on water clarity requirements for seagrasses to set targets for water clarity.
	• Examine relationship between nutrient loads, color, turbidity, and chlorophyll.
	• Estimate current nutrient load to meet living-resource-based water clarity targets.
Dissolved Oxygen	• Examine relationships between freshwater input, nutrient load, and biochemical oxygen demand load on bottom dissolved oxygen.
	• Estimate critical freshwater inputs and nutrient loads to meet bottom dissolved oxygen targets.

Table 2-2 Lemon Bay Critical Water Quality Indicators

Indicator	Approach
Salinity	• Examine relationship between freshwater inflows and salinity regimes.
	• Identify appropriate salinity regimes for key/priority natural resources.
	• Maintain critical freshwater inflows to support successful recruitment and growth of oysters and other shellfish and for fishes that utilize the water body as an estuarine- dependent resource.

2.2.1.1 Chlorophyll *a*

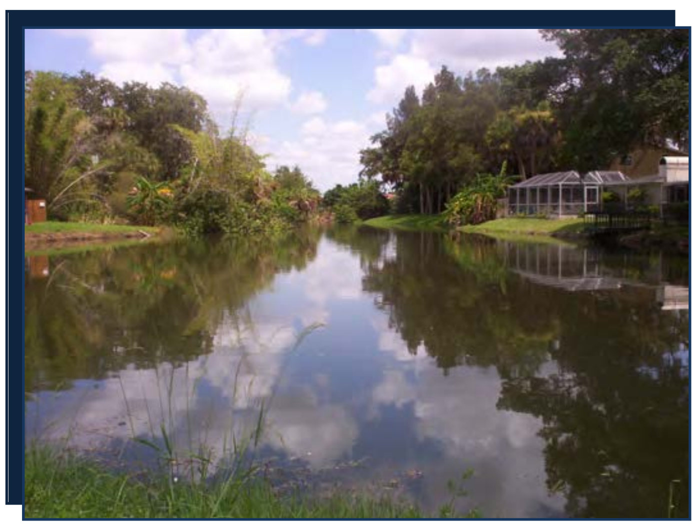
Algae levels are commonly quantified by measuring the chlorophyll *a* (the predominant chlorophyll type found in algae) concentrations in water samples. Excess algae can deplete oxygen levels in the bay waters, cause large-scale algae blooms, and reduce sunlight necessary to maintain seagrasses and other bottom habitat. Higher nutrient loads (nitrogen and phosphorus) from anthropogenic sources affect aquatic and marine systems and can often lead to higher algae levels, which may have undesirable effects on the ecology of the system.

2.2.1.2 Water Clarity

Water clarity is related to turbidity and color. Turbidity is affected by suspended sediments, algae cells, and other minute particles. Color is generally affected by dissolved constituents in the water column (e.g., dissolved tannins lead to 'tea-colored' water). Water clarity affects light penetration. Seagrasses depend on sunlight and are traditionally used as a measure of the overall condition and health of the bay. Reduced light penetration can reduce the quantity and weaken the health of seagrasses and diminish the benthic habitat the vegetation provides for marine life.

2.2.1.3 Dissolved Oxygen

Appropriate dissolved oxygen (DO) concentrations are critical to animals in marine and aquatic systems. Levels of DO are affected by temperature, nutrient load, freshwater inflows, and circulation. Any alterations to these conditions can reduce the amount of oxygen available for aquatic animals; a population may be easily eradicated if oxygen deficit is prolonged. Maintaining minimum levels of DO is important for bay health.



The State of Florida has established the same minimum DO requirement for Marine Class II (Shellfish Propagation or Harvesting) and Class III (Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife) Waters. The east side of Lemon Bay from Forked Creek south is a Class II waterbody; the remaining portion of the Bay is a Class III waterbody.

FAC 62-302.530 (30) states that DO: "Shall not average **less than** 5.0 *(mg/L)* in a 24-hour period and shall never be less than 4.0 *(mg/L)*. Normal daily and seasonal fluctuations **above** these levels shall be maintained."

A large number of DO impairments (levels less than this standard) have been identified and concerns have been raised as to the appropriateness of the existing DO standards in fresh and marine waters. Ongoing research to address these concerns will hopefully result in a more meaningful suite of DO criteria for Florida waters.

2.2.1.4 Salinity

Salinity is a measure of the dissolved salt concentration in a marine system and is a balance of freshwater inflows from streams and groundwater seepage and the oceanic saltwater. Freshwater inflow may be affected by hydrologic alterations of flow patterns or by natural causes such as large storms (decreasing salinity) and drought (increasing salinity) or by anthropogenic activities such as surface or groundwater withdrawals (increasing salinity) or freshwater discharges (decreasing salinity—usually in the vicinity of the discharge).

Salinity levels outside the normal regime for the system, whether high or low, may have a detrimental effect on the marine plants and animals.

Table 2-2 summarizes the water quality indicators and approaches developed to define the current health of Lemon Bay and its estuaries and provide a framework for future evaluation of the watershed.

2.2.2 Previous Goals, Objectives, and Recommendations

Documents containing existing water quality goals and objectives were produced by Sarasota County, the Southwest Florida Water Management District, the Charlotte Harbor National Estuary Program, Mote Marine Laboratory, and the Lemon Bay League. A summary of pertinent information is provided.

2.2.2.1 Sarasota County Planning Department

The Environmental Plan (Chapter 2) of the Comprehensive Plan provides the basis for maintaining and improving environmental quality, including water quality in Sarasota County, as the County seeks a sustainable balance between manmade and natural systems. The plan notes that designation of Lemon Bay as an Aquatic Preserve by FDEP provides additional water-quality protection. Water quality within Lemon Bay varies through the waterways. The northern portion of Lemon Bay and Alligator Creek Drainage Basin are listed as impaired waterways by

FDEP for chlorophyll a concentrations, nitrogen loadings, and bacteria. The following water quality goals and objectives are outlined in the Environmental Plan:

1. Goal: Protect and enhance wherever possible the quality of the estuarine environment throughout Sarasota County.
   a. Objective: Improve surface water quality, including estuarine, freshwater, coastal streams, rivers, and bays.
2. Goal: Support the implementation of the FDEP Lemon Bay Aquatic Preserve Management Plan.
3. Goal: Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their high quality and critical value to the quality of life in the County.
   a. Objective: Protect the quality and quantity of all jurisdictional waters, recognize the ongoing study efforts, and ensure that the current water quality in the County will be improved through 2010.

The Watershed Management Plan (Chapter 4) of the Sarasota County Comprehensive Plan focuses on land use and management and the management of water resources. Two primary goals of the Watershed Management Plan are:

1. Continue to improve and centralize regional wastewater collection and treatment in a safe, clean, efficient, economical, and environmentally sound manner concurrent with urban development.
2. Provide programs that enhance water quality.

The following requirements are specified to meet a water-quality-level-of-service (LOS) criterion in the Plan:

1. The County shall implement a stormwater quality management plan consistent with the National Pollutant Discharge Elimination System requirements.
2. New and existing industrial activities require the development and implementation of a Stormwater Pollution Prevention Plan.
3. No discharge from any stormwater facility should cause or contribute to a violation of water quality standards in Waters of the State.
4. Best management practices should be encouraged for intensive agricultural practices that negatively impact water quality.
5. The County's Basin Master Plans should include evaluation of pollutant loading.

2.2.2.2 Sarasota County Stormwater Environmental Utility

Basin Master Plans were completed in the late 1990s for the Ainger Creek, Forked Creek, Gottfried Creek, and Woodmere Creek subbasins to address water quality LOS. These plans were flood protection driven but did contain water quality components. The goal of the Basin

Master Plan was to identify existing and future LOS deficiencies. The objective was to develop and evaluate stormwater best management practices to address current and predicted LOS deficiencies. Table 2-3 lists the specific project recommendations to address water quality concerns in three of the Lemon Bay subbasins.

Table 2-3 Recommended Water Quality Projects by Subbasin

Subbasin	Project Recommendation
Forked Creek Basin Master Plan	Construct an approximately 400-foot channel, 12 feet wide with 3:1 side slopes, along 5th Street to connect the existing wetland systems.
	Improve channel and clear and snag 1,200-foot-long creek segment from Manasota Beach Road to existing driveway. Design improvements as a longitudinal wetland/slough with 3:1 side slopes to obtain water quality benefits.
	Acquire and improve existing 3-acre wetland.
	Reconstruct about 300 feet of creek channel upstream from a private driveway located approximately 500 feet upstream from SR 776 crossing. Design the system as a longitudinal wetland/slough with 3:1 side slopes to obtain water quality benefits. Provide for erosion control at selected locations along the creek. Sides with slopes steeper than 3:1 should be protected with erosion-control materials.
	Improve about 1,500 feet of creek channel in the Whispering Pines area by reshaping the creek banks to a 3:1 slope or a 2:1 slope with protected side slopes. Stabilize creek banks in areas where structures are located. Design project as a longitudinal wetland/slough to obtain water quality benefits.
	Implement a Regional Stormwater Management Facility in the Forked Creek basin with its outfall approximately 1,300 feet north of Keyway Road crossing on the creek's eastern branch.
Ainger Creek Comprehensive Basin Master Plan	Coordinate with landowner and Sarasota County's Environmentally Sensitive Lands Program to protect the Ainger Creek floodplain.
	Restore water level control structure located just within North Port city limits on SWFWMD property.
	Construct a minimum 50-acre regional stormwater facility.
	Maintain existing systems.
Gottfried Creek Basin Master Plan	Regional water quality facility. Clear, snag, and remove existing spoil berms along the creek banks between the confluence of the main branch with the Englewood lateral and the Park Forest bridge. Place diversion structures to route flows through adjacent wetlands for water quality treatment. (Englewood Lateral Improvement)
	Proposed future regional detention facility: It will cover about 60 acres of currently undeveloped land north of an existing Englewood lateral weir structure. (Englewood Lateral Improvement)
	Construct stormwater detention facility approximately 1,300 feet downstream of the WENG Radio culvert in the Ainger Creek basin. (South River Road Improvement)

2.2.2.3 Southwest Florida Water Management District

Three documents from SWFWMD are important to water quality strategies in Lemon Bay: *Charlotte Harbor Surface Water Improvement Plan* (SWIM), *Southern Coastal Comprehensive Watershed Management Plan*, and *Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay*.

- Identify gaps in water quality data needed to calibrate the appropriate models used to determine Total Maximum Daily Load (TMDL) limits; coordinate monitoring programs; and implement programs to fill data gaps for TMDLs.
- Install or retrofit best management practices to maintain or improve water quality.
- Establish and implement minimum flows for tributaries as detailed within the draft CCMP. Determine maximum cumulative withdrawals.
- Reestablish, where practical, surface flows from sub-basins that do not currently contribute to their historic hydrologic connections.
- Where possible and practical restore groundwater levels to historic seasonal mean levels.

The water quality goals for *Charlotte Harbor SWIM Plan* (2000) are reducing point and non-point sources of pollution to attain the desired use of the estuary and providing the proper fresh water inflow to the estuary to ensure a balanced and productive ecosystem. Objectives include:

Recommendations to implement the plan are develop a linked nutrient budget and water quality model for Lemon Bay, develop a resource-based pollutant-load-reduction goal for Charlotte Harbor, continue the existing short-term water quality monitoring program, continue seagrass mapping efforts, and implement the long-term water quality monitoring program.

The primary water quality goal of the *Southern Coastal Comprehensive Watershed Management Plan* (2000) was to protect water quality by preventing further degradation of the water resource and enhancing water quality where appropriate. Recommended strategies include:

1. Continue and expand ongoing water quality monitoring and data management.
2. Determine the County-wide potential for using high flows as a supplemental potable or non-potable water source through understanding the ecological impacts of flood-control practices elsewhere in the County.
3. Reduce point-source and non-point-source pollutant loads to fresh and estuarine waters, including stormwater and wastewater.

The primary water quality goal of the *Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay* (2004) was to reduce non-point-source loadings into Lemon Bay. Objectives included implementing hydrologic restoration programs for the tidal creeks and other entities in areas where manmade alterations have taken place and converting effluent ponds previously used for wastewater to stormwater treatment ponds in specific mobile home parks and other communities.

2.2.2.4 Charlotte Harbor National Estuary Program (CHNEP)

The CCMP produced in 2008 has multiple water quality goals:

- Reducing point and non-point source pollution.
- Addressing water quality degradation from numerous sources.
- Addressing hydrologic alterations that may cause adverse changes to the amounts, locations, and timing of freshwater flows, the hydrologic function of floodplain systems, and natural river flow.

The recommendations in the CCMP to achieve these goals are:

- Participate in 303(d) TMDL, Reasonable Assurance, and BMAP development and implementation.
- Identify gaps in water quality data needed to calibrate the appropriate models used to assess impairments, determine TMDL limits, and develop BMAPs. Coordinate monitoring programs and implement programs to fill data gaps for impairment assessments, TMDLs, and BMAPs.
- Develop integrated ground and surface water quality and pollutant loading models.
- Reduce nonpoint-source pollutants associated with stormwater runoff. Install or retrofit BMPs to maintain or improve water quality and flows.
- Implement projects to restore or protect water quality to offset anthropogenic impacts.
- Promote conservation and stormwater and intergovernmental coordination within local comprehensive plans to prevent the impacts of increasing levels of impervious surface and fill to achieve either a neutral impact on water quality and loss of groundwater and surface water storage or to achieve restoration based on the condition of the receiving waters.
- Implement the Florida Yards and Neighborhoods program and similar Florida-friendly plant programs throughout the CHNEP study area.
- Increase the use of personal and home BMPs by consumers throughout the watershed to reduce nonpoint-source pollution.
- Develop site-specific criteria for dissolved oxygen, chlorophyll a, turbidity/total suspended solids, salinity and pesticides as applicable.
- Determine the relationship between macro and micronutrients and phytoplankton/algal blooms.
- Provide central sanitary sewers to developed areas within 900 feet of waters such as estuarine shorelines, rivers, creeks, canals, and lakes.

- Assess the bacteria, nutrient load, and base flow impacts of septic tank systems, wastewater treatment plants, and reuse water. Recommend effective corrective action.
- Develop a historic and current estuarine mixing model, focusing on salinity and indicator species that are sensitive to salinity changes, and better evaluate proposed capital and operations projects.

2.2.2.5 Mote Marine Laboratory

Mote Marine Laboratory produced *Tidal Creek Condition Index for Coastal Streams in Sarasota County, Florida* (2006). This plan recommends developing a Tidal Creek Condition Index for tracking the biological health of the County's tidal creeks. Through the joint cooperation of Sarasota County, SWFWMD, FDEP, CHNEP, and Mote Marine Laboratory, metrics were developed, baseline data collection efforts initiated, and preliminary data assessment begun in a parallel timeline with this watershed management plan.

2.2.2.6 Lemon Bay League

The primary water quality goal of the *Lemon Bay Interagency Comprehensive Watershed Management Plan* (2004) is to prevent further degradation of the water resource and enhance water quality where appropriate. Recommendations to achieve the goal include:

- Establishing benchmark water quality data in creek systems.
- Implementing biological characterization in creek systems.
- Implementing hydrologic restoration and sediment management programs.
- Converting decommissioned wastewater treatment plants to stormwater treatment plants.
- Initiating a biosolids handling program.

2.3 WATER SUPPLY

2.3.1 Proposed Goals, Objectives, and Approaches

The primary water supply goal is to support the previous plans strategies to provide reliable and safe water to meet existing and future demands. The proposed objective is to identify water that may be available for beneficial uses while maintaining appropriate water budgets to avoid causing quantity or quality changes that harm the water resources, including surface and ground waters, for Lemon Bay and its watershed. Five approaches to meet the primary goal are:

> *The primary water supply goal is to provide reliable and safe water to meet existing and future demands.*

1. Develop historical, existing, and target water budgets.
2. Identify future demands for potable and non-potable public supply.
3. Determine potential availability of water from alternative sources.
4. Identify potential users, delivery systems, and schedules for water from alternative sources.
5. Identify the lowest water quality suitable for specific uses, provided that its use does not interfere with recovery of a waterbody to its established minimum flow or level and it is not a source that is either currently or projected to be adversely affected.

2.3.2 Previous Goals, Objectives, and Recommendations

Sarasota County, Southwest Florida Water Management District, Charlotte Harbor National Estuary Program, and the Lemon Bay League produced documents containing existing water supply goals and objectives. A summary of pertinent information is provided.

2.3.2.1 Sarasota County Planning Department

The Watershed Management Plan (Chapter 4) of the Sarasota County Comprehensive Plan focuses on land use and management with the management of water resources. Two primary water supply goals of the Watershed Management Plan are:

1. Provide potable water service to Sarasota County residents through the continual evolution of a centralized regional supply, treatment, and distribution system in a safe, efficient, economical, sustainable, and environmentally sound manner concurrent with urban development.
2. Provide programs to ensure safe, efficient, economical, and sustainable water supplies that provide customers with the appropriate water quality for the intended use.

The Plan outlines non-potable water strategies, irrigation strategies, reclaimed water use, and demand management as recommendations to ensure the adequacy of potable water supplies to serve existing and future development.

2.3.2.2 Southwest Florida Water Management District

SWFWMD developed the *Southern Water Use Caution Area (SWUCA) Recovery Strategy* in 2006 in response to growing demands for groundwater withdrawals. Depressed aquifer levels cause saltwater intrusion leading to the potential degradation of a potable water source. Two primary goals of the Recovery Strategy are:

1. Reduce the rate of saltwater intrusion in Hillsborough, Manatee, and Sarasota Counties by achieving minimum aquifer levels for saltwater intrusion by 2025; future efforts should seek further reductions to achieve the ultimate stabilization of the saltwater-freshwater interface.
2. Ensure that there are sufficient water supplies for all existing and projected reasonable beneficial uses.

The six objectives of the Recovery Strategy are:

1. Develop a regional water supply plan to achieve effective water management.
2. Use existing rules to effectively contribute to the Recovery Strategy.
3. Enhance existing rules.
4. Provide financial incentives to encourage conservation and development of alternative supplies to ensure consistency with the Recovery Strategy.
5. Develop and implement water resource development projects that will restore historically lost lake and floodplain storage.
6. Monitor, report on, and analyze cumulative impacts on resources.

Conservation efforts include plugging wells, artificially recharging the aquifer, and retiring water use permits associated with acquired preservation lands. Water reuse initiatives include expanding the use of reclaimed water to reduce the use of groundwater and surface water for non-potable purposes such as irrigation and industrial cooling.

The SWFWMD *Southern Coastal Comprehensive Watershed Management Plan* (2000) has the broad goal of ensuring an adequate supply of the water resource for all reasonable and beneficial uses now and in the future while protecting and maintaining the water and related resources of the District. It includes a number of strategies:

- Requiring consistent water resource/land use planning by local governments.
- Improving coordination between planners.
- Promoting conservation and reuse.
- Improving compliance with water-use restrictions.
- Developing alternative water sources.
- Adopting intermediate aquifer-level protection.

These are accompanied by numerous recommendations.

2.3.2.3 Charlotte Harbor National Estuary

> *The goal of flood protection is to minimize the risk to human safety and property while protecting the natural floodplain.*

The CCMP produced in 2008 has a primary water supply goal of addressing hydrologic alterations, which cause adverse changes to amounts, locations, and timing of freshwater flows and to the hydrologic function of floodplain systems and natural river flows. The recommendations to support water supply are:

1. Identify gaps in flow data based on ecosystem needs and projected need for water withdrawal.
2. Support public involvement programs addressing watershed management issues.
3. Encourage, expand, and develop incentives for the reuse of water that protect water quality and water use.

2.3.2.4 Lemon Bay League

The primary water supply goal of the *Lemon Bay Interagency Comprehensive Watershed Management Plan* (2004) is to ensure safe, efficient, economical, and sustainable water supplies that provide customers with the appropriate water quality for the intended use. The plan presents several strategies, including identifying and evaluating future water supply options, evaluating future water needs and the capacity of existing supplies, and optimizing water use efficiency and supply sustainability. One strategy distinct from other plans is to establish sound business practices to optimize the financial sustainability of water. The following recommendations are found in the plan:

1. Initiate an aquifer storage and recovery feasibility study.
2. Initiate stormwater conservation and reuse program.
3. Convert wastewater treatment plants to stormwater treatment plants.
4. Initiate biosolids handling program.

2.4 FLOOD PROTECTION

2.4.1 Proposed Goals, Objectives, and Approaches

The primary flood protection goal is to minimize flood risk to human safety and property in developed areas while protecting natural and beneficial functions of the remaining floodplain. Meeting the County flooding LOS criteria and revising land development regulations are two proposed objectives of the WMP. Six approaches to meet the flood protection goal are:

1. Document and update the status of stormwater management and conveyance facilities with respect to their permitted or design criteria.
2. Document and update the status of implementation of Capital Improvement Plan projects intended to alleviate existing flooding problems.
3. Refine existing maintenance practices as appropriate to ensure that floodwater conveyance is adequate while minimizing ecological impacts, in a cost-effective manner.
4. Identify implications of new statewide stormwater rules with regard to protection of natural water storage and conveyance areas that currently provide flood protection.
5. Identify and engage major stakeholders (Department of Transportation, U.S. Army Corps of Engineers, other jurisdictions, etc.) with respect to operation and maintenance of surface water drainage systems.
6. Identify and protect natural surface water storage areas that currently provide flood protection, or may provide flood protection to future development.

2.4.2 Previous Goals, Objectives, and Recommendations

Sarasota County, the Southwest Florida Water Management District, and the Lemon Bay League produced documents containing existing flood protection goals and objectives. A summary of pertinent information is provided.

2.4.2.1 Sarasota County Planning Department

The Watershed Management Plan (Chapter 4) of the Sarasota County Comprehensive Plan focuses on land use and management, including the management of water resources. Its primary flood-control goal is that the County shall provide programs that prevent and mitigate the losses, cost, and human suffering caused by flooding and protect the natural and beneficial functions of the floodplain.

Specific objectives outlined in the Plan are:

1. Address the maintenance of existing facility capacity and ensure the adequacy of facilities to meet future needs.
2. Ensure that land development and redevelopment provides for adequate stormwater management.
3. Protect environmentally sensitive lands, conserve natural resources, protect floodplains, maintain or improve water quality, and open spaces, and conserve and protect historic and archeological resources.

2.4.2.2 Sarasota County Stormwater Environmental Utility

Basin Master Plans were completed in the late 1990s for the Ainger Creek, Forked Creek, Gottfried Creek, and Woodmere Creek subbasins to address flood protection LOS. The Basin Master Plan goal was to identify existing and future LOS deficiencies. The objective was to develop and evaluate stormwater best-management practices to address current and predicted LOS deficiencies. Table 2-4 lists the specific project recommendations to address flooding concerns in three of the Lemon Bay subbasins.

Table 2-4 Recommended Flood Protection Projects by Subbasin

Subbasin	Recommendation
Ainger Creek BMP	Acquire additional drainage easement and replace culverts to reduce flood depths associated with Medical Center Blvd and provide additional conveyance capacity.
	Acquire a 60-foot-wide drainage easement, replace culverts, and improve maintenance in Wellington Acres. Construct an overflow swale along the east side of Englewood Hospital to tie into the FP1.
	Acquire public easements in the Englewood Farm Acres lateral catchment to improve maintenance and replace a restrictive culvert.
	Manage floodplain functions adjacent to Ainger Creek Main by setting aside a preservation or conservation area.
	Construct a swale along the north side of Lots 1 through 5 and along the east side of Lots 5 through 7 in Englewood Farm Acres to connect to the existing ditch network to the south.
	Re-establish the north-south drainage ditch along the North Port City Limits to Ainger Creek Main.
	Construct a 50-acre regional stormwater facility to mitigate the impacts of Interstate Industrial Park, Morris Industrial Park, and the commercial and high-density residential area along the south side of River Road.
Gottfried Creek BMP	Remove culvert and improve approximately 300 feet of ditch upstream of Viridian Street. (Englewood Lateral Improvement)
	Replace culvert across Elm Street with double 54-inch culverts. Eliminate culvert located about 50 ft east of Elm Street crossing. Restore about 250 feet of ditch cross section. (Englewood Lateral Improvement)
	Coordinate with FDOT to replace culverts on the north SR 776 crossing downstream from the Viridian Street pond with triple 60-inch RCPs. Replace culverts across the Florida Power easement with double 54-inch pipes. (Englewood Lateral Improvement)
	Clear and snag approximately 250 feet of ditch in the Artist Avenue area. Maintain existing culvert. (Englewood Lateral Improvement)
	Remove erosion deposits and provide erosion protection in about 700 feet of creek channel. Regrade banks to a 3:1 slope. (Englewood Lateral Improvement)
	Replace culverts across Florida Power easement with double 72-inch pipes. (Englewood Lateral Improvement)
	Maintain culvert across River Road. (South River Road Improvement)
	Replace about 300 feet of 29-inch-x-45-inch culvert. (South River Road Improvement)

Table 2-4 Recommended Flood Protection Projects by Subbasin

Subbasin	Recommendation
Forked Creek BMP	Improve facilities to prevent localized flooding in the area around Franklin Street (various localized projects).
	Acquire easements and clear and snag 2,400 feet of channels from Manasota Beach Road to Overbrook Road.
	Install double 30-inch culverts at the inflow of the Overbrook Road pond. Add an additional 30-inch culvert at the outflow.
	Construct a 1,500-foot drainage ditch along Manasota Beach Road and improve existing culverts to double 24-foot RCP.
	Clear and snag approximately 800 feet of creek channel downstream from wetland area.
	Clear and snag approximately 500 feet of creek channel immediately upstream from Dale Lake (SR 776 crossing).
	Clear and snag about 1,000 feet of channel downstream from the Keyway Road culvert. Remove spoil berms where feasible.
	Clear and snag about 300 feet of channel. Provide erosion protection on the creek banks.
	Provide erosion protection on the 800-foot segment of the creek channel along the Brook to Bay Trailer Ranch.
	Provide bank erosion control in secondary channel that runs along the south side of Almeda Isles subdivision.
	Provide bank erosion control in main channel downstream from the Dale Lake outfall.

The goal of the Alligator Creek Flood Protection Improvement Plan (2002) was to create a tool to help determine and prioritize flood protection capital improvement projects within the subbasin. Several priority areas were evaluated and the following locations recommended for stormwater improvements:

1. Scenic Drive outfall to the Intracoastal Waterway
2. Banyan Drive culverts and right-of-way storage facility
3. Briarwood Area conveyance improvements
4. Bal Harbour-Shamrock Blvd drainage improvements
5. Quail Lake-Venice East Blvd interconnecting culverts
6. Venice East Blvd box culvert

2.4.2.3 Southwest Florida Water Management District

The SWFWMD plan *Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay* (2004) mentioned previously has the primary goal of reducing nonpoint source loadings into Lemon Bay. Objectives included hydrologic restoration programs for Alligator Creek, Forked Creek, Manasota Key, Gottfried Creek, River Road, and Ainger Creek.

The SWFWMD *Southern Coastal Comprehensive Watershed Management Plan* (2000) is regional in scale, encompassing portions of Sarasota, Manatee, and Charlotte Counties, and details the four primary areas of responsibility for the District: water supply, flood protection, water quality, and natural systems. The flood protection chapter details a number of strategies and actions to address flooding issues:

1. Enhancing data and information collection.
2. Linking water resource and land use planning.
3. Effectively managing floodplain functions.
4. Establishing ownership, operation, and maintenance responsibilities for flood management systems.
5. Facilitating public education and understanding of flood protection.

The plan's primary goal is to minimize potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood-prone areas and states that SWFWMD shall give preference wherever possible to nonstructural surface water management methods. The plan includes numerous recommendations.

2.4.2.4 Lemon Bay League

The primary flood protection goal of the *Lemon Bay Interagency Comprehensive Watershed Management Plan* (2004) is identical to that of the Sarasota County Planning Department: to prevent and mitigate the losses, cost, and human suffering caused by flooding and to protect the natural and beneficial functions of the floodplain. The objectives outlined in the plan are:

1. Determine the depth and extent of areas susceptible to riverine flooding.
2. Protect existing and future residents from flood damage.
3. Develop and implement cost-effective management strategies to protect the natural functions of the floodplain.

Strategies to achieve these objectives include:

- Developing a watershed budget.
- Completing and updating flood studies.
- Mapping the drainage system and implementing a long-term stormwater maintenance plan.
- Developing local flood mitigation and flood reporting programs.
- Implementing a stormwater improvement program.

The Lemon Bay watershed has many stakeholders vested in the conservation, protection, and restoration of its many natural resources. Previous plans included a multitude of recommendations. To bring into focus current conditions, Chapter 8 of the plan provides revised, updated, and new recommendations to preserve, protect, and/or enhance natural systems and water quality in Lemon Bay ecosystems; support a sustainable water supply; and provide flood protection for the citizens of Sarasota County.

Chapter 3

Natural Systems

August 2010

Sarasota County

Southwest Florida Water Management District

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3.0 NATURAL SYSTEMS

Natural systems are self-sustaining living ecosystems that support an interdependent network of aquatic, wetland-dependent, and upland living resources. The natural conditions of Lemon Bay and its watershed are based on complex interactions and interrelationships among natural processes such as hydrology, nutrient loading, erosion and sedimentation, and vegetation coverage. Functionally intact ecosystems provide many valuable services, including flood control, recreation, water quality improvement, and habitat for plants and animals.

While the Lemon Bay Watershed contains valuable upland and wetland areas, the effects of urbanization have diminished the beneficial functions provided by the watershed's natural systems. Over half of the watershed is comprised of forest, open area, parks, wetlands, and water. Designated natural and conservation areas make up 17% of the watershed (See Chapter 1). The County has identified unprotected lands as priorities for future protection.

This chapter divides natural systems into inland (uplands, streams and creeks, and freshwater wetlands, Section 3.1) and estuarine (Section 3.2) systems and describes the watershed's natural resources. These descriptions are followed by recommended actions to restore, preserve, and improve the natural systems within the watershed. Freshwater flow, integral to the health and function of both freshwater and marine wetlands, is described in Section 3.1.1.

3.1 WATERSHED

A *watershed features* a highly evolved series of processes that convey, store, distribute, and filter water that, in turn, sustain terrestrial and aquatic life (Figure 3-1). A healthy watershed is critical for maintaining healthy ecosystems. The Lemon Bay watershed consists of the bay, a network of surface water drainage systems (stormwater pipes, ditches, streams, and creeks), wetlands, and the surrounding uplands. The condition of the watershed network, uplands, wetlands, and drainage systems ultimately affects the health of the bay.

A watershed is an area of land that water flows across as it moves toward a common body of water, such as a stream, river, lake, or coast.

3.1.1 Critical Natural Resources

The natural resources of land and water are inter-connected. The interactions between uplands, wetlands, streams and creeks, and the bay are critical to the health of the watershed. Upland and wetland areas control the quality as well as the timing and volume of freshwater flows to surface water drainage systems and the estuary. Although these flows provide the bay with essential freshwater, they also contain sediment, nutrients, and other pollutants that can be damaging to the bay.

Figure 3-1 Typical Florida Coastal Watershed

3.1.1.1 Uplands

Uplands are the elevated areas of land within the watershed. Uplands include all areas that are not wetlands. Rain runs from this higher land into surface water drainage systems. The type and condition of uplands influence the amount and the quality of water reaching lakes, streams, wetlands, and estuaries. Vegetated uplands provide natural habitat to many species, slow runoff, prevent soil from eroding, and allow infiltration. When uplands are developed, rainfall runs quickly over paved or impervious surfaces and is unable to infiltrate. This decreases recharge, increases freshwater flow and volume, and decreases water quality. With this increased volume and flow comes increased erosion, and more sediment, nutrients, and other pollutants are carried downstream. Lower than natural salinities also result from increased freshwater volume reaching the bay. The condition of the uplands is the driving force behind the health of everything downstream.

3.1.1.2 Wetlands

Wetlands serve a variety of purposes including attenuating flood flows, maintaining water quality, and providing wildlife habitat. Wetlands develop naturally in response to morphological and hydrological features of the landscape. They occur where surface water collects and/or groundwater interacts with land, inundating the area for extended periods. Wetlands are a significant factor in the health and existence of other natural resources of the watershed, such as rivers and streams, inland lakes, groundwater, wildlife, and estuaries. Wetlands exhibit a richer diversity of plants and animals and greater biological productivity than non-wetland areas around them. Wetlands provide many benefits including flood control by storing runoff; wildlife habitat by providing breeding, nesting, and feeding grounds and cover for many forms of wildlife and waterfowl; subsurface water resources protection and recharging groundwater supplies; pollution treatment; and erosion control by serving as sedimentation areas and filtering basins.

Before the surge of development in the Lemon Bay watershed that began in the 1950s, wetlands were extensive, covering about a quarter of the watershed (Section 1.3.8). The prevalence of wetlands was a result of abundant rainfall and a low, flat terrain. Rainfall ponded in wetlands, where it evapotranspired, infiltrated, or moved slowly by sheet flow toward tidal waters. Historically, much of the land surface in the watershed was likely inundated during the wet season and for several weeks afterwards. With urbanization, though, came the loss of valuable wetlands. Many of the wetlands were drained when the Lemon Bay watershed was ditched for mosquito control and agriculture. Wetland coverage in the watershed declined from an estimated 7,423 acres in 1950 to just 3,833 acres in 2007 (Section 1.3.8). Although the overall area of wetlands in the Lemon Bay watershed has significantly decreased, a variety of wetlands still flourish. Through programs such as the Environmentally Sensitive Lands Protection Program (ESLPP), Sarasota County is working toward saving these important natural resources.

3.1.1.3 Streams and Creeks

In an undisturbed watershed, the groundwater level and stream flow, while fluctuating according to the season and amount of rainfall, is maintained within a normal range. Because the stream bank and channel change over time, streams end up following the familiar meandering pattern that flowing water establishes. The floodplain and wetlands along the stream corridor absorb the occasional high waters and support a variety of wildlife unique to such an area. Wetlands, habitats, and riparian life associated with a stream are adapted to this natural flow regime.

Five major creeks (Alligator Creek, Woodmere Creek, Forked Creek, Gottfried Creek, and Ainger Creek) traverse the low flat landscape of the Sarasota County portion of the Lemon Bay watershed. Historical maps and surveys suggest that these five tributaries to Lemon Bay were tidal creeks that did not extend significantly inland into the watershed; however, these naturally occurring tidal creeks were significantly altered by ditching for mosquito control and development. Channelization of naturally meandering creeks results in increased stream velocities and increased bank erosion. Thus channelization can produce large pulses of freshwater, causing a decrease in bay salinity.

3.1.2 Freshwater Inflow

One of the main functions of the Lemon Bay watershed is to temporarily store and transport water from the land surface to Lemon Bay. In addition to transporting water, sediment, and other materials, pollutants and many types of organisms are also conveyed to the bay (Figure 3-2). Temporary retention or storage at different locations in the watershed is important to maintain an appropriate water budget for a healthy and productive system. Estuary ecosystem health and diversity vary dramatically as a function of their water balance.

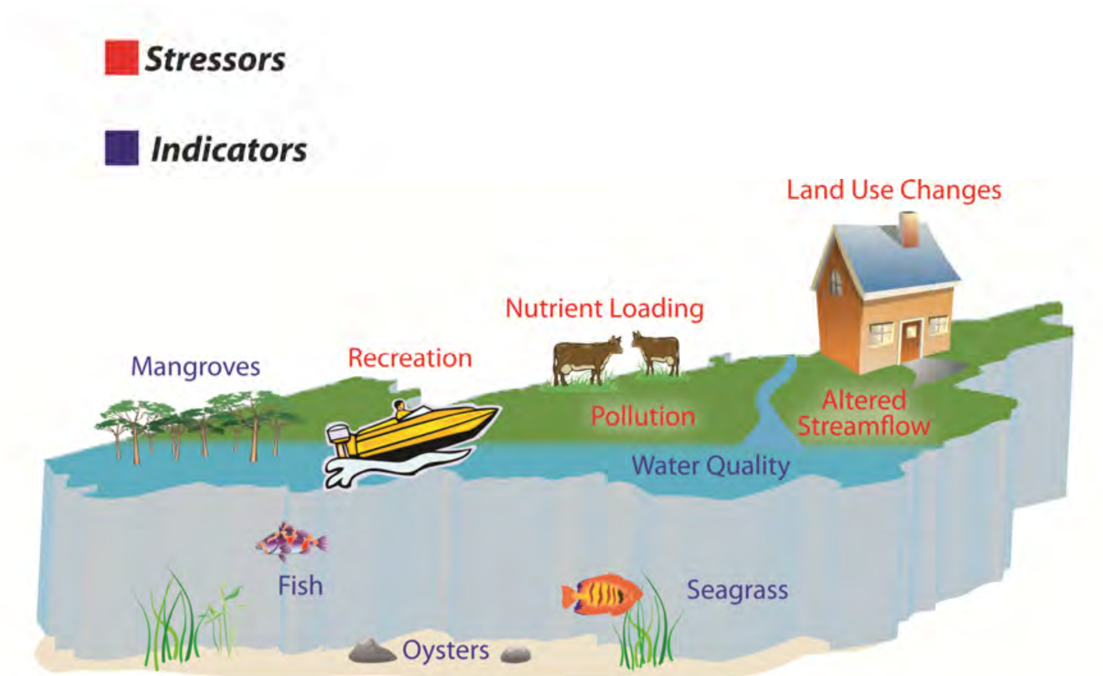


Figure 3-2 Lemon Bay Watershed Stressors and Water Quality Indicators

Activities such as filling and building on floodplains and wetlands and creating ditches and other stormwater conveyances have changed the natural hydrology within the Lemon Bay watershed. This change in hydrology causes stormwater to reach streams, wetlands, and the estuary more quickly and in greater quantity. Higher storm flows can have many effects, such as increased erosion of stream banks, which can disturb riparian vegetation and increase the amount of sediment in the stream. The increased volume also carries with it increased pollutant and nutrient loads. The overall health and productivity of the watershed and its estuary are affected by both the water quantity and quality.

The goals of the Lemon Bay Watershed Management Plan (WMP) are to:

- ❖ Protect, maintain, and improve water quality conditions in estuarine and freshwater environments.
- ❖ Minimize flood risk to human safety and property and protect natural and beneficial functions of the floodplain.
- ❖ Provide adequate and safe water supply to meet existing and future demands.
- ❖ Protect, enhance, and restore natural communities and habitats.

These goals are described in detail in Chapter 2 and are summarized above to emphasize the importance of freshwater flow to the overall management plan for Lemon Bay. To achieve each of these four goals, appropriate water budgets for Lemon Bay and its watershed must be established. The water budgets will make it possible to identify water that may be available for other beneficial uses. Estimating the historical, existing, and future water budgets is the first step toward developing appropriate target water budgets.

This chapter details the historical, current, and future water budgets and identifies increases in surface water volume. A detailed description of hydrologic alterations and recommendations for the target future water budget for Lemon Bay and its basins is also included.

Water resources are increasingly stressed throughout the watershed by urbanization. Urban growth produces an increase in impervious surfaces, greater water withdrawals, and movement of water and wastewater farther away from their sources of origin. Freshwater flow patterns drive physical, chemical, and biological conditions in the estuary. The condition of the freshwater and estuarine ecosystems in the watershed is directly linked to the natural variability in these freshwater flows and volumes that comprise the Lemon Bay watershed water budget. The water budget is the sum of the sources (additions) of freshwater to Lemon Bay minus the sum of the freshwater sinks (losses). There are many sources of freshwater inflows to Lemon Bay, including direct runoff, groundwater discharge, and direct precipitation on the estuary. The primary natural loss of water from the watershed is evapotranspiration (Figure 3-3).

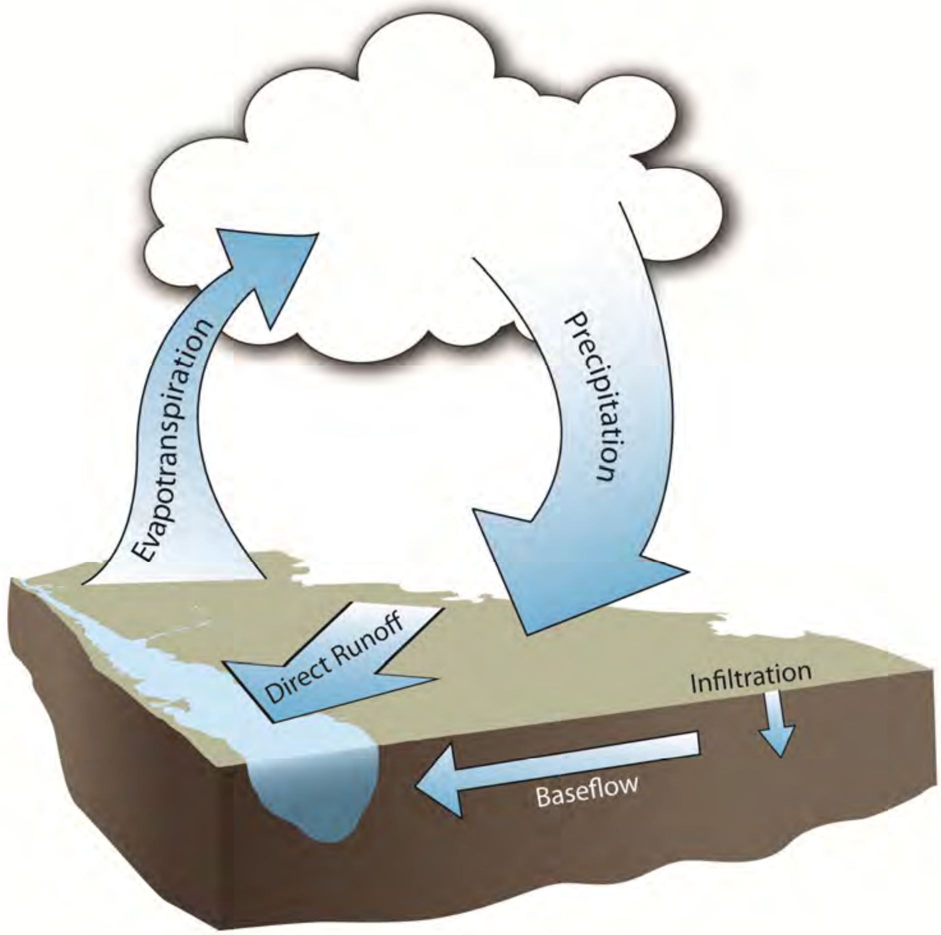


Figure 3-3 Lemon Bay Water Budget Schematic

This Section evaluates the Sarasota County portion of the Lemon Bay watershed to provide a better understanding of watershed hydrology and impacts of land development on the bay. Jones Edmunds developed water budgets for the historical (1948 baseline), current (developed), and future (built-out) conditions of Lemon Bay. A similar analysis of each of the Lemon Bay basins is provided in Appendix E. The water budgets are used to characterize the natural variability in the quantity and timing of freshwater inflows to the bay and to assess how much hydrologic change has occurred or is likely to take place in the future. In conjunction with an investigation of the behavior of ecological indicators, this analysis provides information for a recommended target water budget for Lemon Bay.

3.1.2.1 Water Budget Methodology

Freshwater loads to Lemon Bay were calculated using the *Sarasota County County-Wide Non-Point Source Pollutant Loading Model* (SIMPLE) developed by Jones Edmunds for Sarasota County. SIMPLE is a pollutant-loading model working within a geographic information system

(GIS) framework and capable of simulating runoff, base flow, wet and dry deposition, irrigation, point source, and septic loads. The hydrologic model component is a continuous simulation spreadsheet model designed to feed SIMPLE calculated runoff, calculated base flow, and rainfall volumes using NEXRAD-derived rainfall for the period of interest. The result of the hydrologic engine simulation is a hydrologic lookup table containing monthly rainfall, base flow, and runoff values for all unique combinations of NEXRAD pixel (2-kilometer grid cell), event mean concentration (EMC) land use, and hydrologic soil group (HSG). Complete model development is documented in *Sarasota County County-Wide Non-Point Source Pollutant Loading Model* (Jones Edmunds, August 2005).

The SIMPLE model was used to characterize the hydrological processes throughout the Lemon Bay watershed to provide the watershed's water volume budget on a monthly time-step, summarized as a total volume discharge. Spatial input includes basins, land use, soils, NEXRAD pixels, best management practices (BMPs), irrigation, point sources, non-compliant point sources, and septic input data sets referred to as coverages. Monthly volumes were estimated through three 12-year simulations to address the effect of land-use change for the Lemon Bay basins and watershed. The input coverages were modified to reflect the time series being simulated. The basins coverage and rainfall data for current conditions were used for all three simulations; thus, rainfall was held constant to provide for meaningful comparisons between development conditions, historical, current, and future. In other words, these findings combined with estuarine data were used to recommend a target water budget for the Lemon Bay watershed.

- ❖ Historical Conditions simulation
    - For the Simulation Period, 1948 through 1960 was selected to represent historical conditions. This period preceded the development boom, and aerial photographs needed to develop input parameters are available for this time period. Rainfall from 1995 through 2007 (Current Conditions) was used since rainfall was not an independent variable in the water budget analysis; thus, the historical conditions simulation does not seek to hindcast actual freshwater inflows but rather simulate inflows that would have occurred under identical hydrologic conditions as the Current Conditions simulation. The results provide data suitable for a valid comparison.
    - Land-use coverage was developed from 1948 aerials and SCS Soil Survey.
    - BMP, septic, and irrigation coverages were adjusted to reflect the time series:
        - ➢ BMPs, septics, and irrigation structures built after 1960 were deleted.

- ❖ Current Conditions simulation
  - For the Simulation Period, 1995 through 2007 was selected to represent current conditions because spatially distributed rainfall data required for the model are available for this entire period.
  - Basins, land use, soils, NEXRAD pixels, BMPs, irrigation, point sources, non-compliant point sources, and septic input data sets generated for the SIMPLE model were used.
- ❖ Future Conditions simulation
  - For the Simulation Period, arbitrary years (2015 through 2027) were selected to represent future conditions. As with historical conditions, the Future Conditions simulation is not a forecast of actual flows. Rainfall from 1995 to 2007 (Current Conditions) was used to provide a valid comparison.
  - For land-use coverage as build-out conditions, all "developable" polygons in the 2006 land-use coverage (SWFWMD) not classified as environmentally sensitive land were considered medium-density residential.
  - BMP, septic, and irrigation coverages were adjusted to reflect the time series:
    - ➢ Septics that went offline as of 2008 were deleted.
    - ➢ BMPs and irrigation in place as of 2008 were incorporated to all future years.

The Automated Rainfall Management System (ARMS) data were not used in the water budget analysis because many of the ARMS gauges are in tidally influenced locations. The volume of freshwater passing the gauges in comparison to tidal water is below the margin of error at the gauges for most cases (e.g., base flow volumes would be well below the noise level of measured flows), making that information not as reliable as needed for a water budget analysis. ARMS gauges not in tidally influenced locations typically only measure a very small portion of the area that contributes to the bay system. Extrapolating these gauges over much larger areas introduces an unknown magnitude of error. In addition, the ARMS gauges have only been collecting data for a relatively short period. Ideally, a water budget analysis will have many years of data on which to base statistics so that a wide range of representative conditions are reflected in the analysis. The hydrologic model was calibrated to eight ARMS gauges using a 3-year period of record that contained wet, dry, and average rainfall years. The results of the calibration for both base flow and storm event conditions were such that we had reasonable confidence in using the model results. Using the model allowed us to examine a much longer time series for the water budget, which is advantageous for that type of analysis.

3.1.2.2 Lemon Bay Watershed Current Water Budget

The current water budget for the Sarasota County portion of the Lemon Bay watershed includes all of the freshwater inputs minus the outputs for the entire watershed and bay area based on current conditions. The primary sources of freshwater inflows to Lemon Bay, based on annual average inflows, are direct runoff and baseflow (Figure 3-4). Direct runoff enters the Sarasota County portion of the bay from the surrounding land or via its tributaries, Alligator Creek, Woodmere Creek, Forked Creek, Gottfried Creek, and Ainger Creek.

Next in order of magnitude, direct rainfall onto the bay contributes a substantial annual flow volume to the overall water budget. Point sources, irrigation, and septic tanks contribute to the hydrologic input to a much lesser extent. The Alligator Creek basin currently contributes over a quarter of the direct runoff, 30 % of the baseflow, almost half of the irrigation, and over 40 % of the septic volume (Figure 3-5 and Table 3-1).

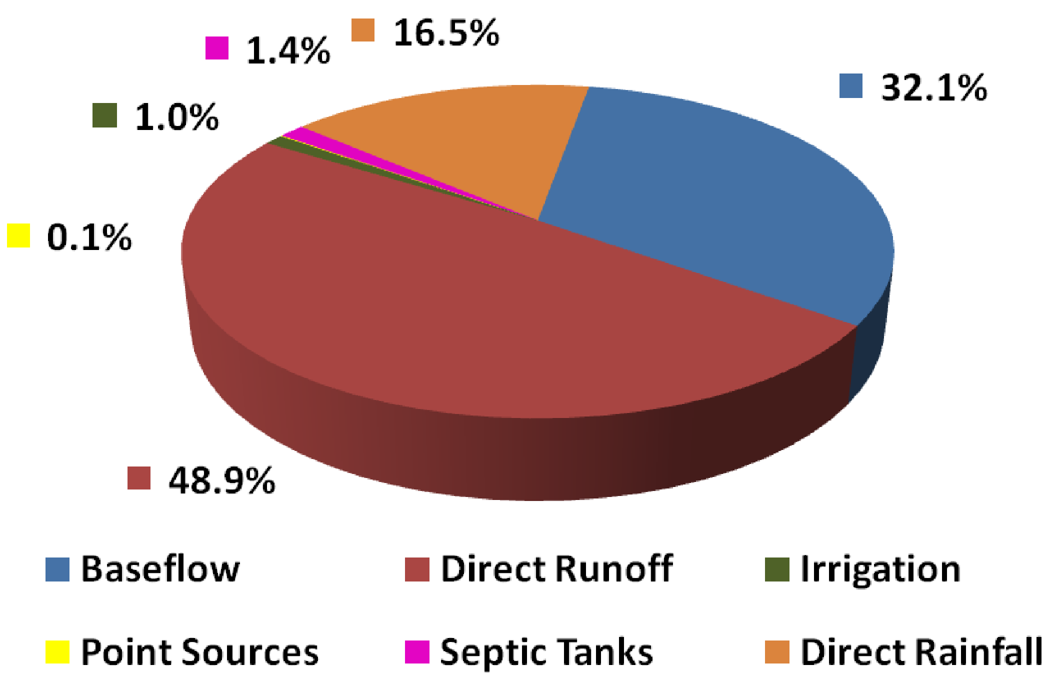


Figure 3-4 Water Budget Components in the Lemon Bay Watershed

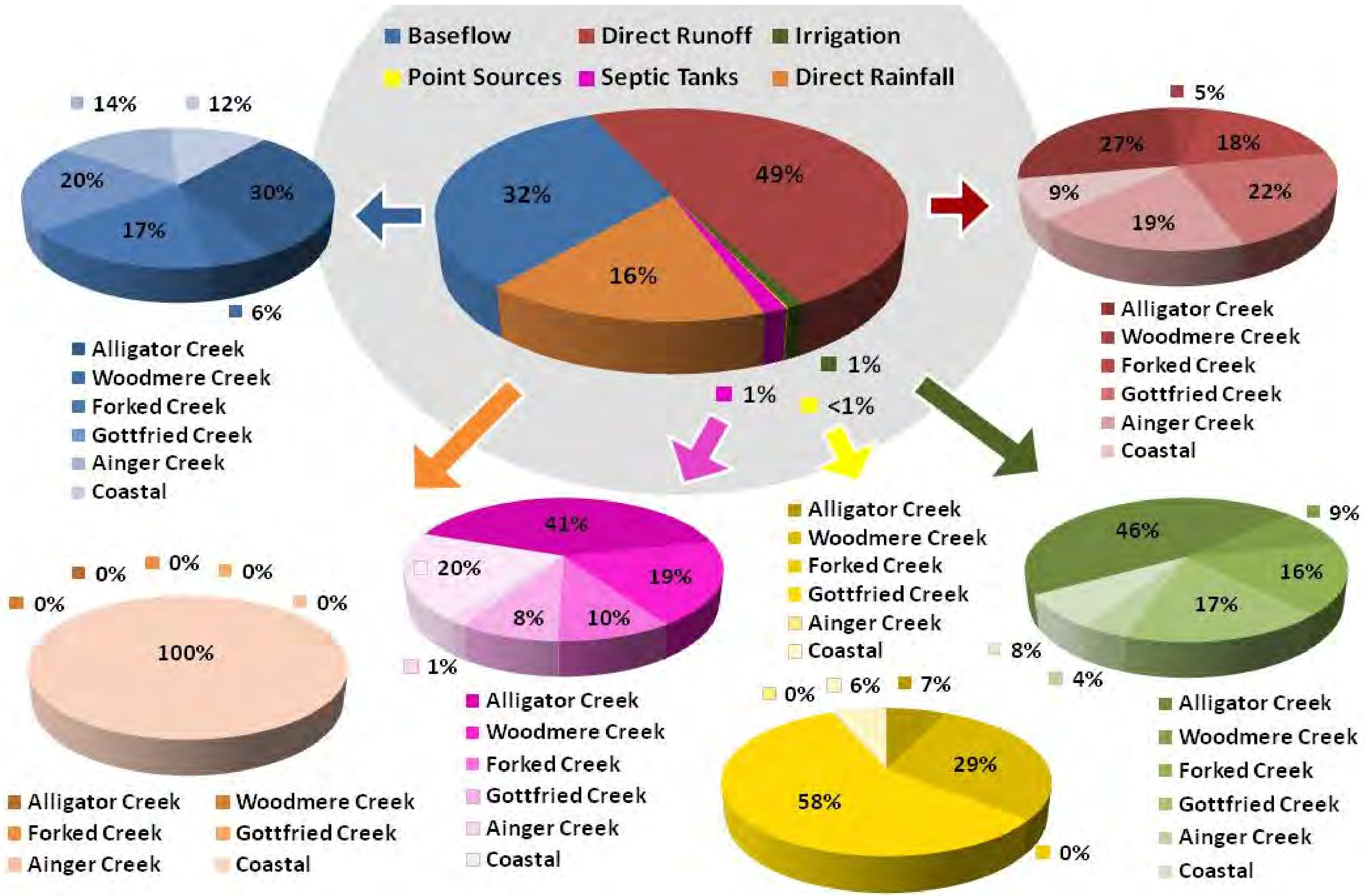


Figure 3-5 Lemon Bay Watershed Water Budget Components by Basin

Table 3-1 Source of Current Total Volume to Lemon Bay

Basin	Source of Volume						
	Direct Runoff	Baseflow	Direct Rainfall	Point Sources	Irrigation	Septic Tanks	Total Volume
Alligator Creek	27%	30%	0%	7%	46%	41%	24%
Woodmere Creek	5%	6%	0%	29%	9%	19%	5%
Forked Creek	18%	17%	0%	0%	16%	10%	15%
Gottfried Creek	22%	20%	0%	58%	17%	8%	18%
Ainger Creek	19%	14%	0%	0%	4%	1%	14%
Coastal	9%	12%	100%	6%	8%	20%	24%

The Coastal and Alligator Creek basins are the primary contributor of freshwater to Lemon Bay. Overall, the Coastal and Alligator Creek basins each contribute 24% of the total volume (Figure 3-6). This large contribution is because the Alligator Creek basin and the Coastal basin are the largest two basins. Further, the Alligator Creek Basin became highly urbanized before many of the existing stormwater regulations were implemented.

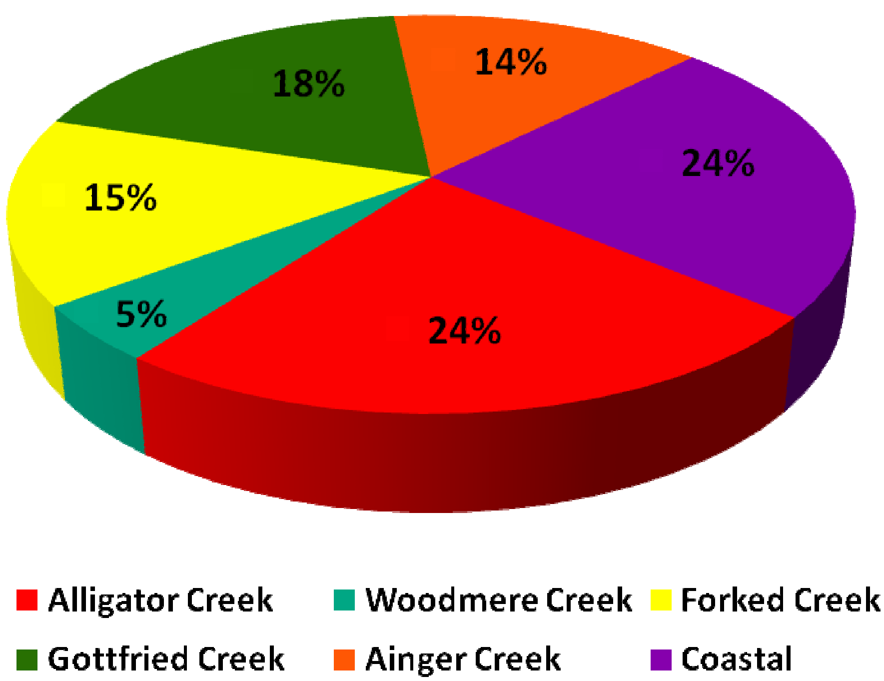


Figure 3-6 Average Annual Current Total Volume Input by Basin

To provide a basin-to-basin comparison of hydrologic loading rate, the average annual volumes were normalized to the basin and subbasin areas. The average normalized total volumes for each basin are shown in Figure 3-7. The Coastal basin has the highest volume per unit area due to the direct rainfall over the bay (100% runoff). The Alligator and Woodmere Creek basins have higher total volumes per area than the Forked, Gottfried, and Ainger Creek basins, likely due the high level of urbanization in these basins. Figure 3-8 shows the average normalized total volumes by subbasin across the watershed. The more developed areas in the north and along US 41 and SR-776 tend to have higher total volumes per acre.

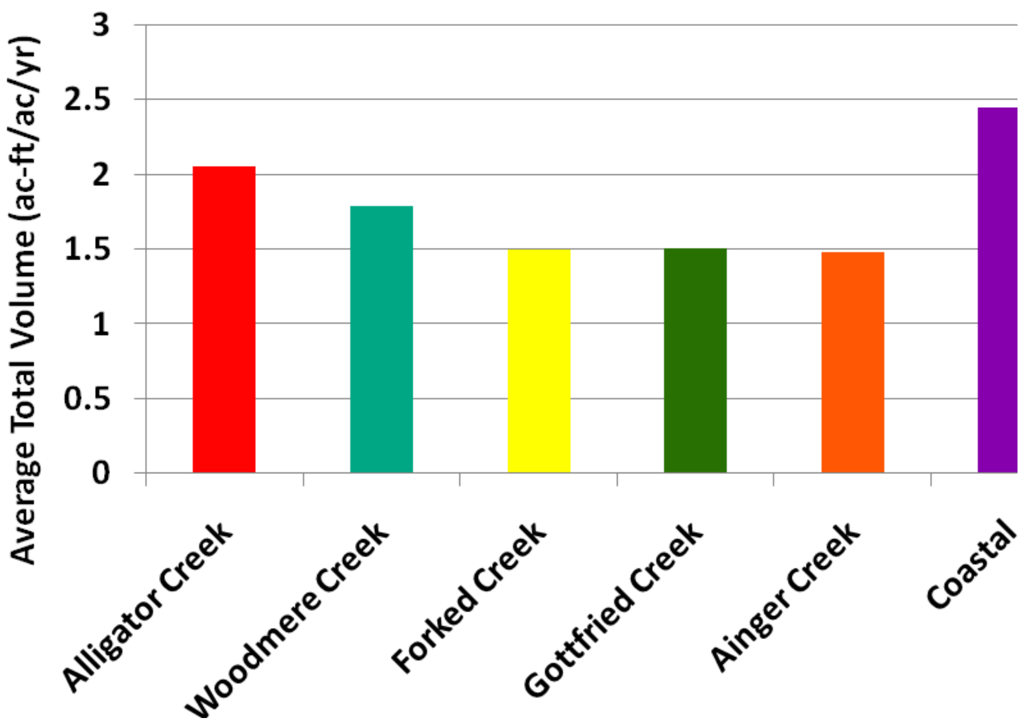


Figure 3-7 Normalized Current Average Annual Volume by Basin

Although it is important to know the sources of flow volume, the total volume and timing of inflows to the bay are important to salinity, sediment, and nutrient loadings in the bay. There is natural variability in the quantity and timing of freshwater inflows to Lemon Bay. Lemon Bay ecosystems have adapted to tolerate a range of conditions; however, water uses and management practices can alter the volume and timing of inflows, causing them to fall outside of this natural range.

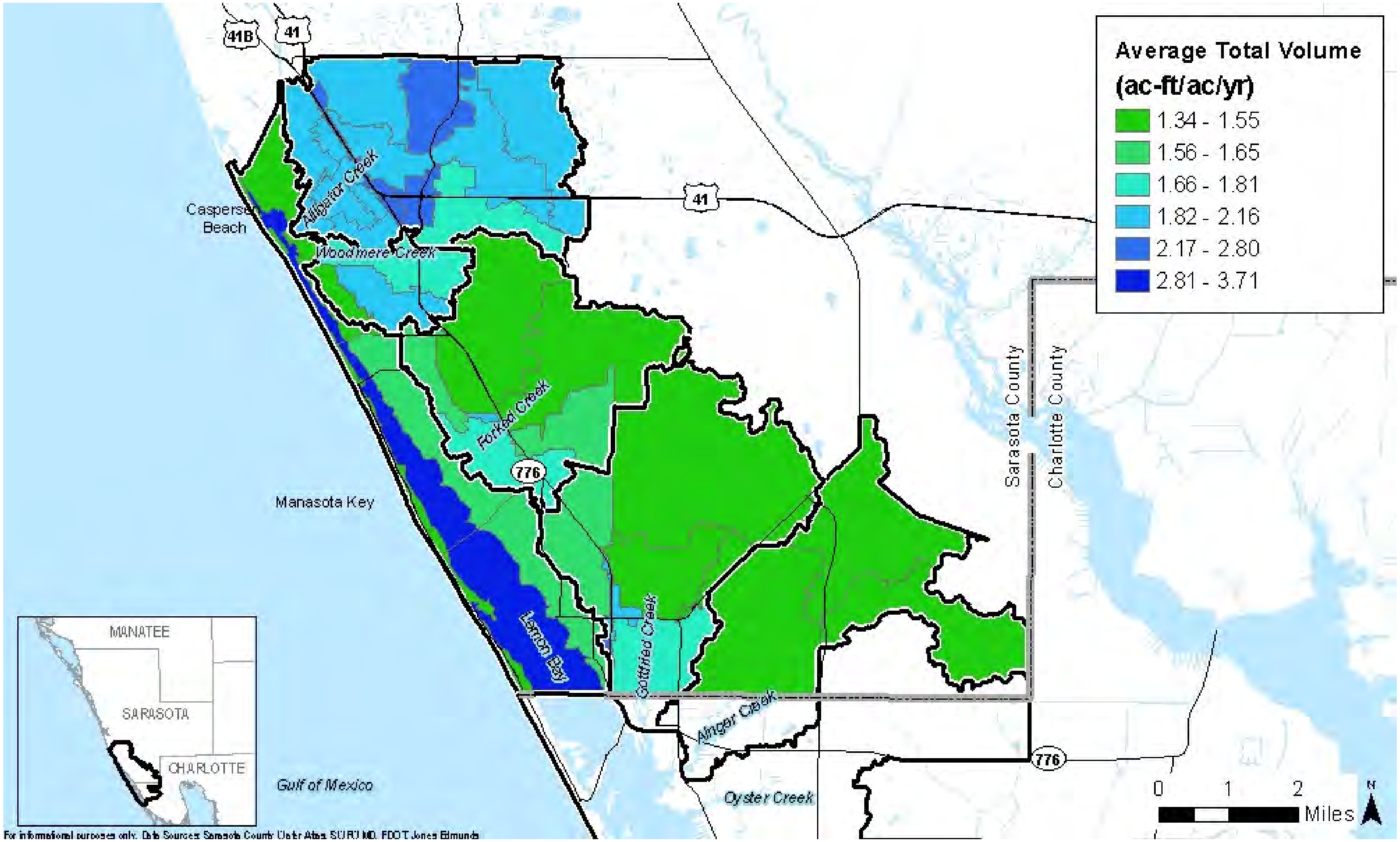


Figure 3-8 Normalized Average Annual Total Volume by Subbasin

The total volume and the overall range of volume fluctuations to Lemon Bay vary substantially from year to year, following the rainfall pattern over the watershed (Figure 3-9). The annual rainfall and freshwater volume totals for the period of record were plotted to more closely examine the inter-annual variations and to determine if a reliable relationship existed between annual rainfall and total volume. The R^2 value in the rainfall to volume plot shows that 96% of the total variation in the current total annual volume is explained by the rainfall (Figure 3-10). The average annual rainfall to total volume conversion factor (for the current simulation period) for the Sarasota County portion of the Lemon Bay watershed is 0.45 (Appendix E).

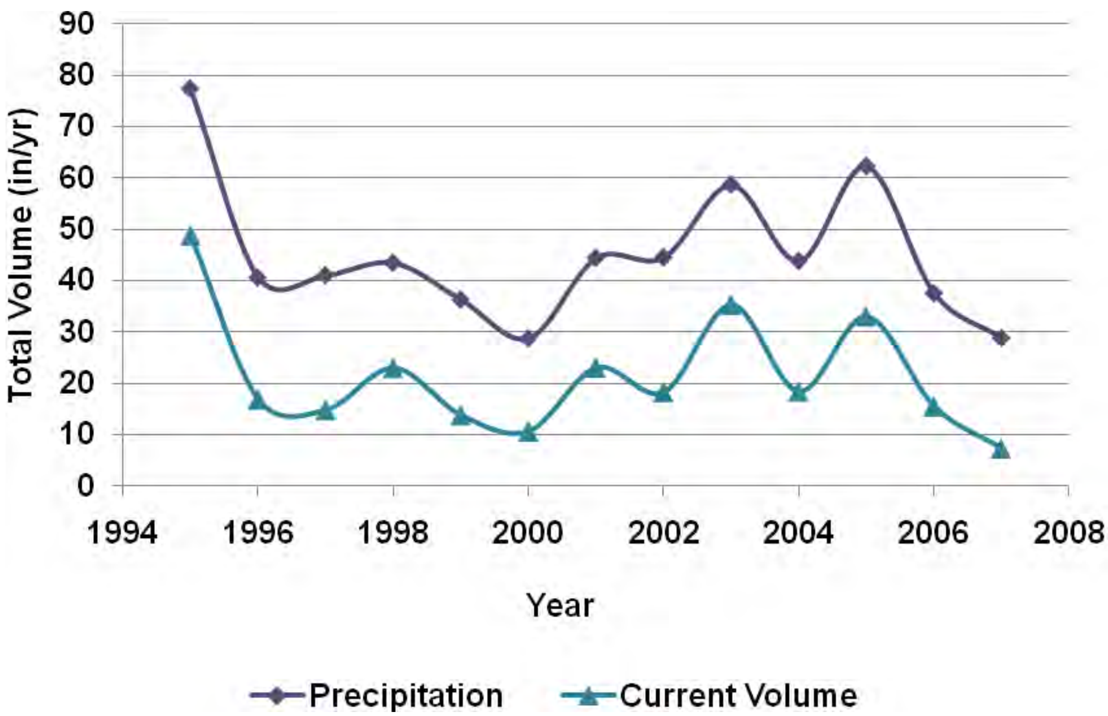


Figure 3-9 Variability of Annual Total Volume and Rainfall in the Lemon Bay Watershed

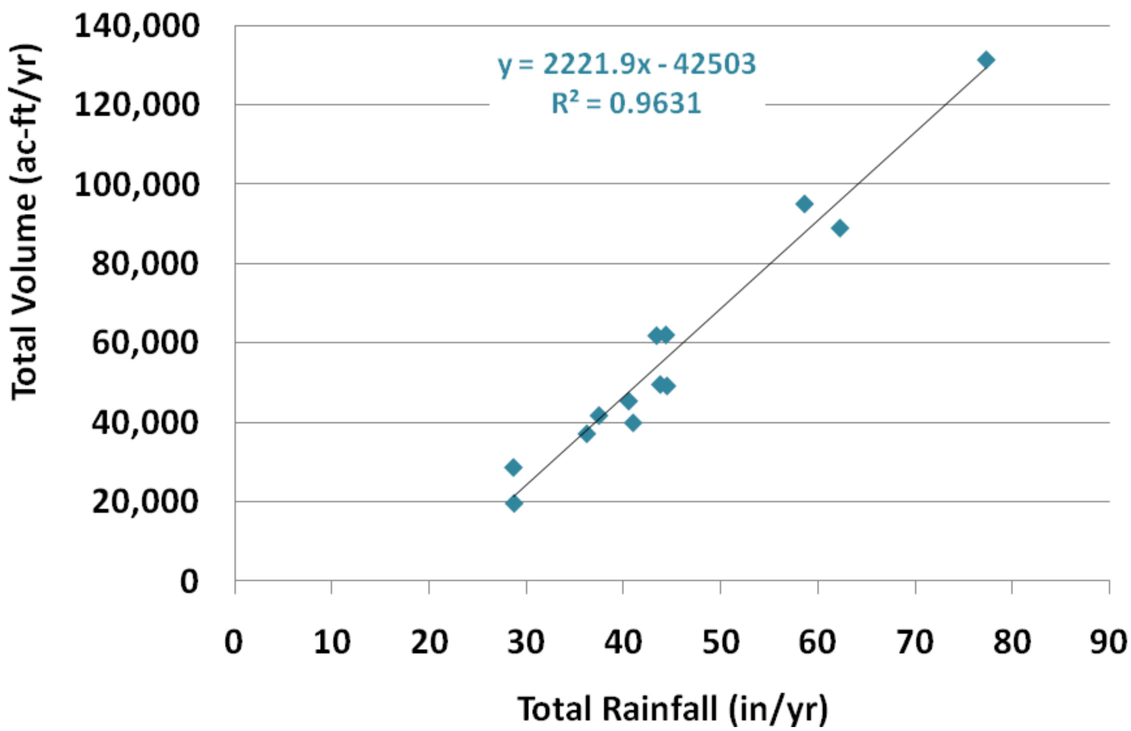


Figure 3-10 Correlation of Annual Total Volume to Rainfall in the Lemon Bay Watershed

The intra-annual timing of the minimum and maximum freshwater volume to the bay demonstrates a distinct seasonal behavior (Figure 3-11). Two distinct inter-annual periods of water-level fluctuation are evident. There is a dry cycle, which generally occurs from November through May, and a wet cycle that takes place from June through October. This is consistent with the seasonal hydrology patterns associated with Sarasota County's subtropical climate. The more dependable relationship between total volume and rainfall occurs during the wet season (Figure 3-12).

Figure 3-11 Variability of Monthly Total Volume in the Lemon Bay Watershed

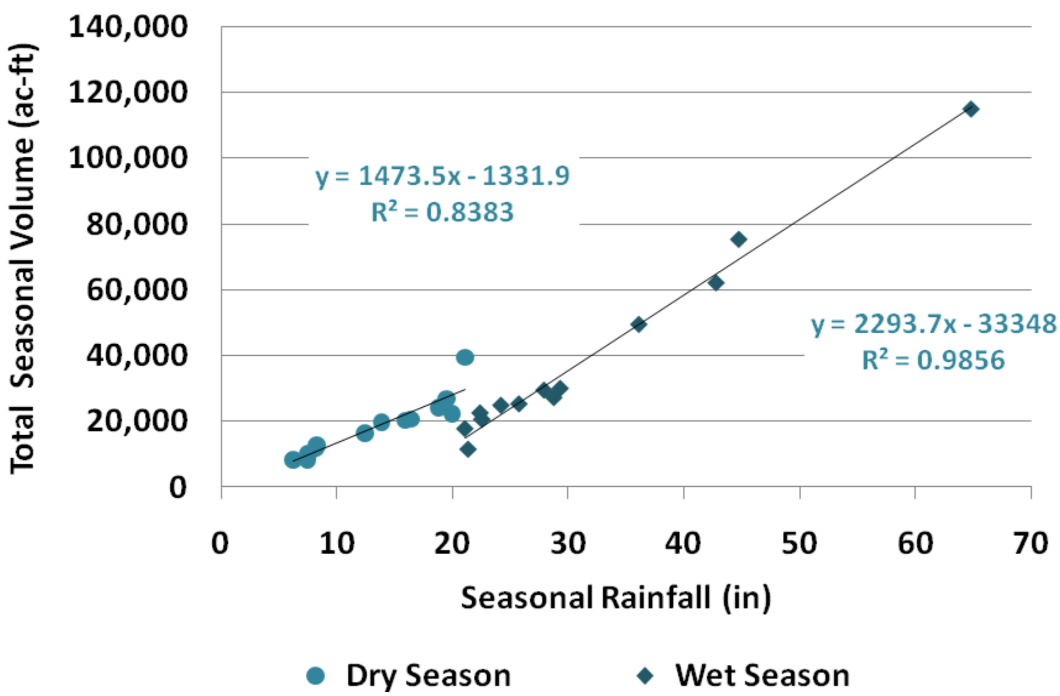


Figure 3-12 Correlation of Seasonal Rainfall to Total Volume in the Lemon Bay Watershed

Using the annual seasonal total volume and rainfall data, the average seasonal total volume to rainfall coefficients were developed for the Sarasota County portion of the Lemon Bay watershed (Table 3-2).

Table 3-2 Seasonal Total Volume Coefficients for the Lemon Bay Watershed

Season	Average Total Volume (in)	Average Rainfall (in)	Average Seasonal Coefficients
Wet	14.58	31.65	0.42
Dry	6.89	13.49	0.51

The relationship between rainfall and total volume at a monthly scale varies. The dependability varies from 0.75 in April up to 0.97 in June (Figures 3-13 through 3-24). The average monthly rainfall to total volume conversion factors for the Sarasota County portion of the Lemon Bay watershed are shown in Table 3-3.

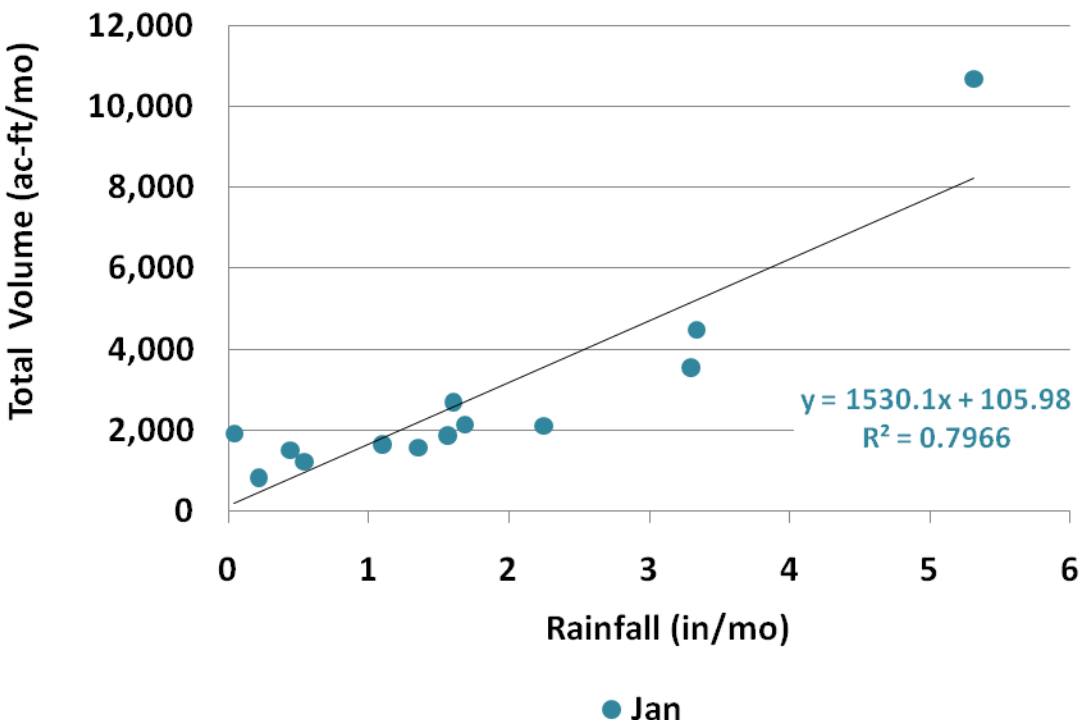


Figure 3-13 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for January

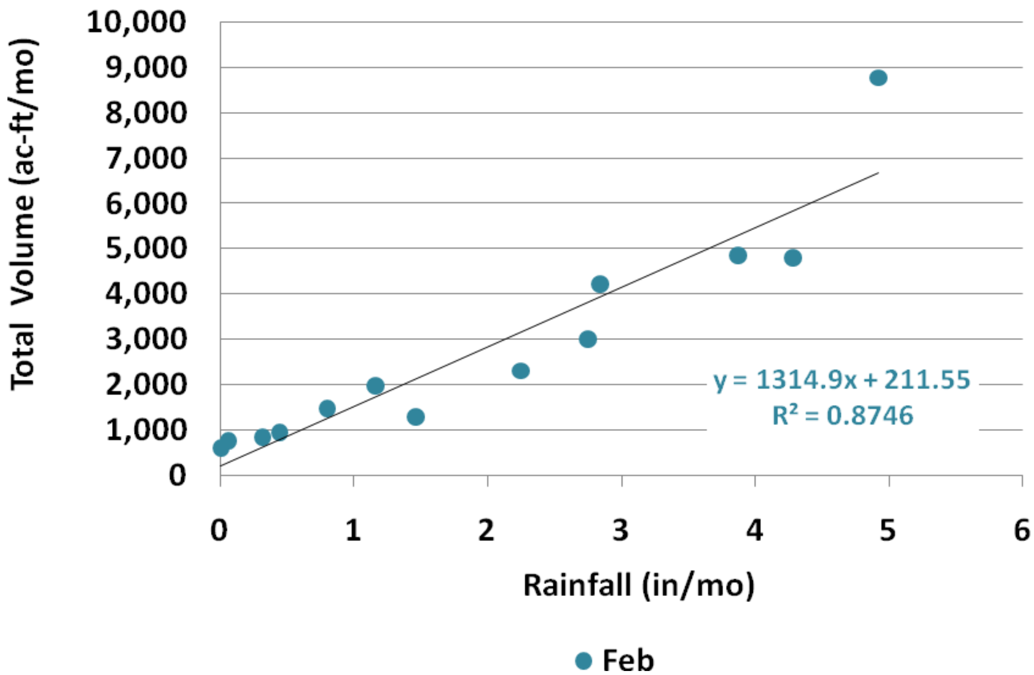


Figure 3-14 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for February

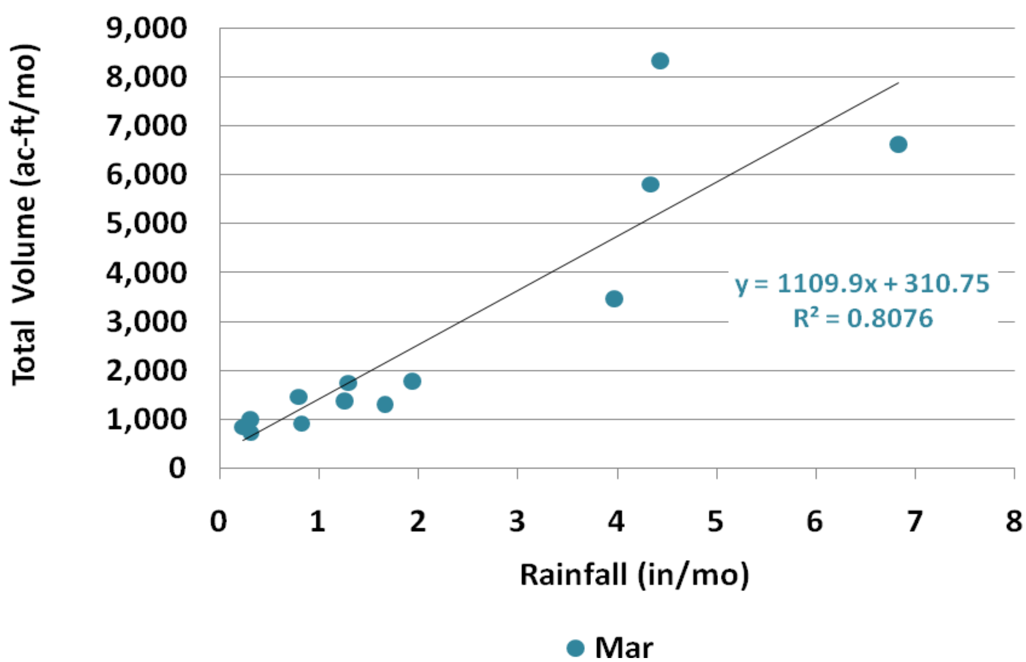


Figure 3-15 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for March

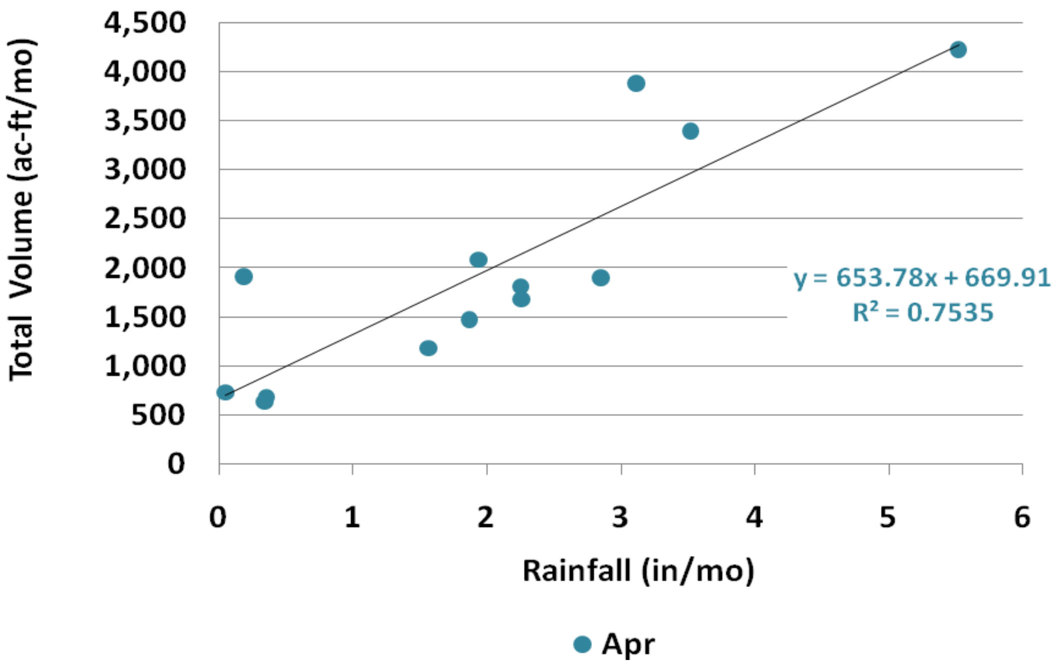


Figure 3-16 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for April

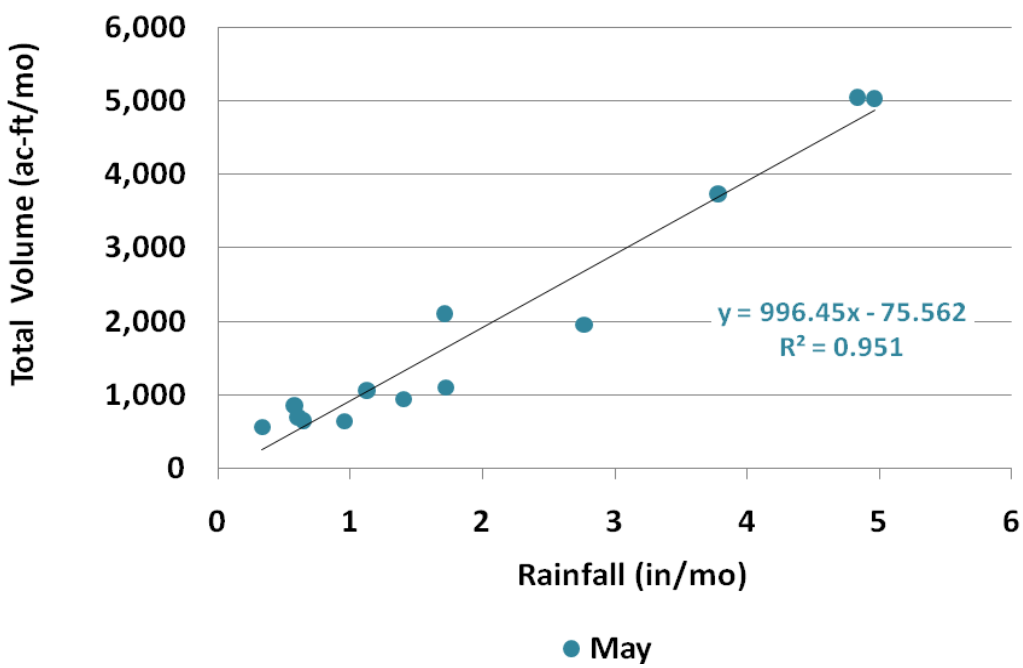


Figure 3-17 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for May

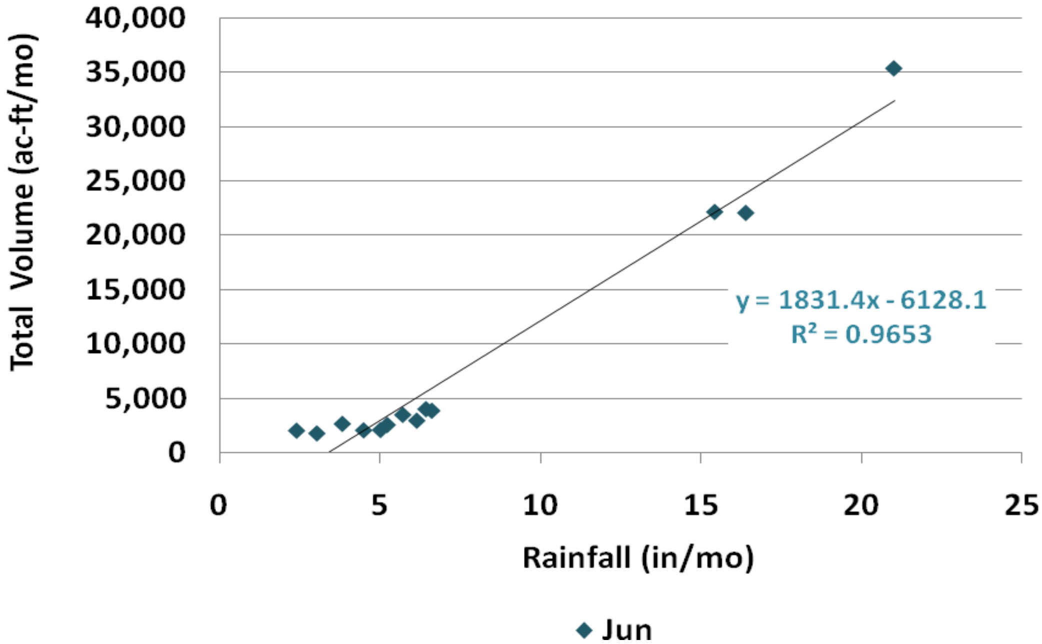


Figure 3-18 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for June

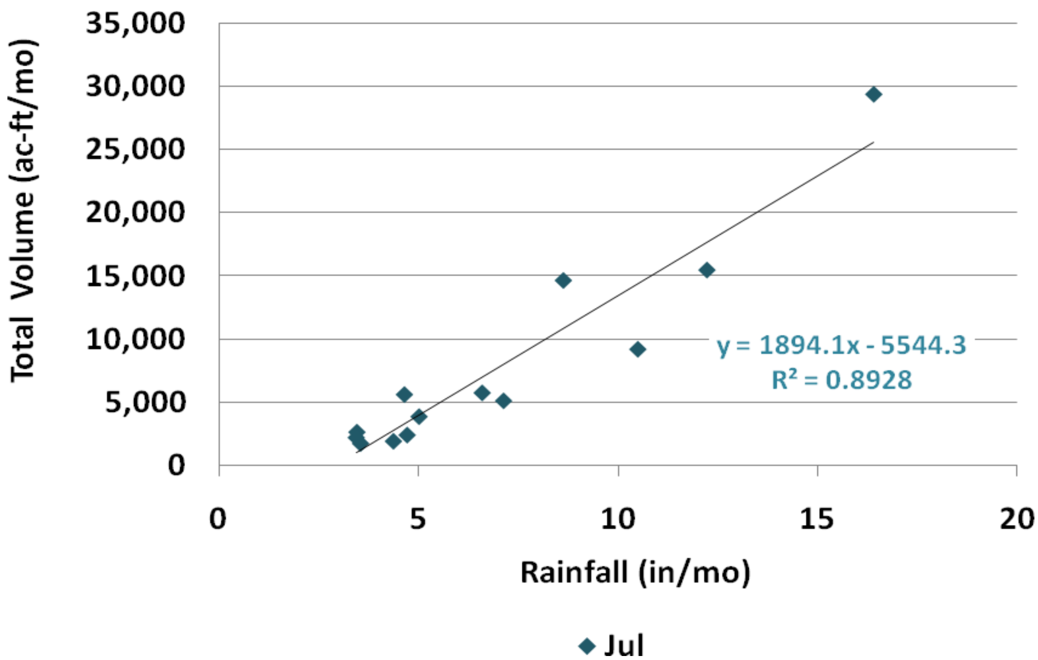


Figure 3-19 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for July

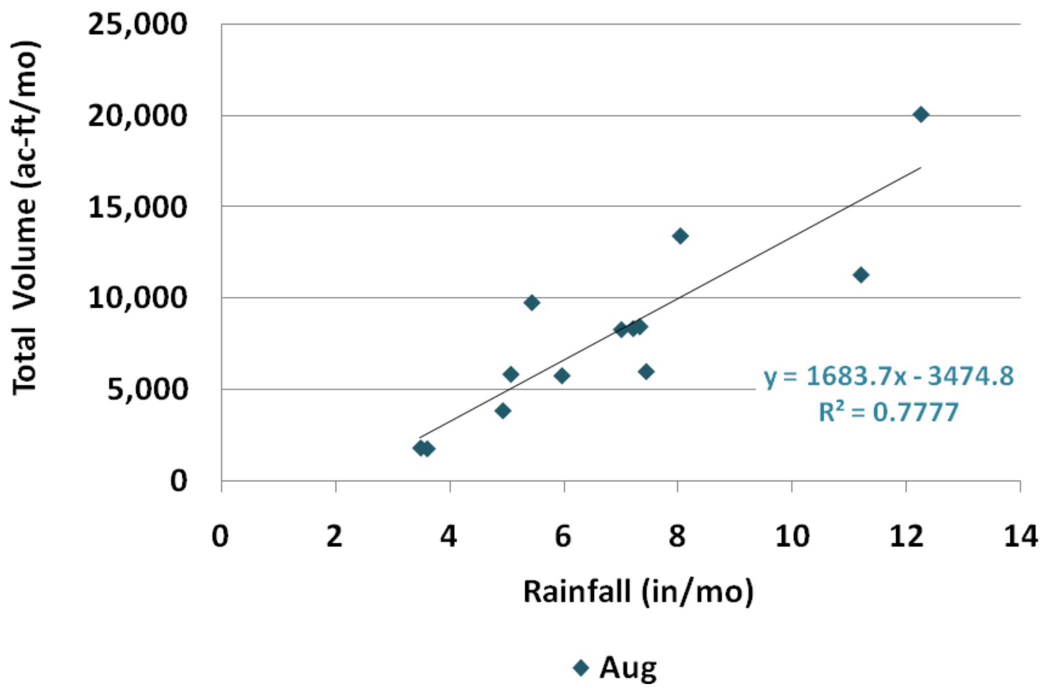


Figure 3-20 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for August

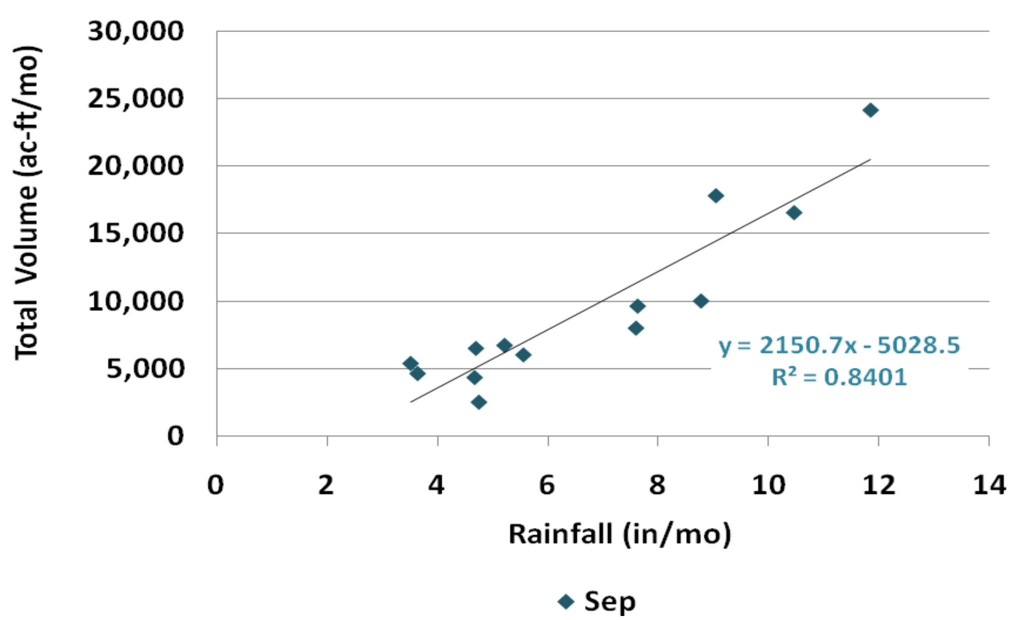


Figure 3-21 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for September

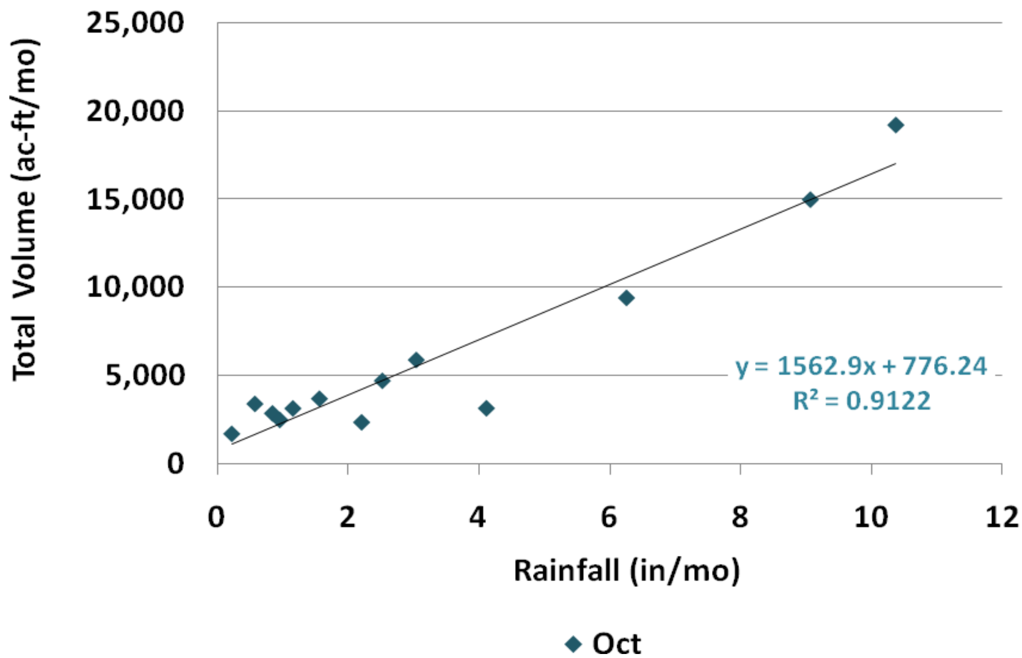


Figure 3-22 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for October

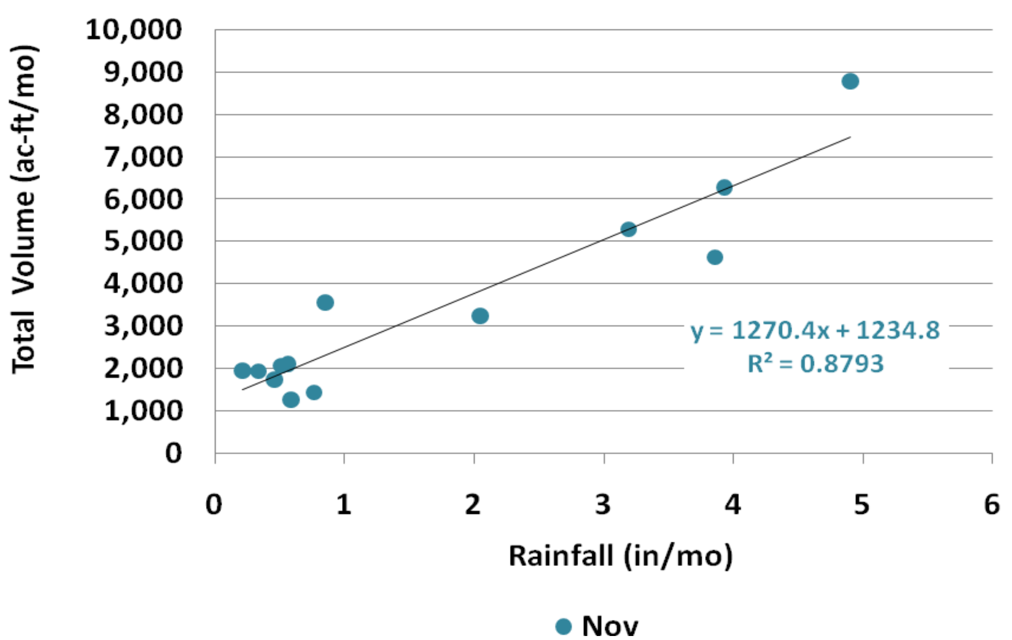


Figure 3-23 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for November

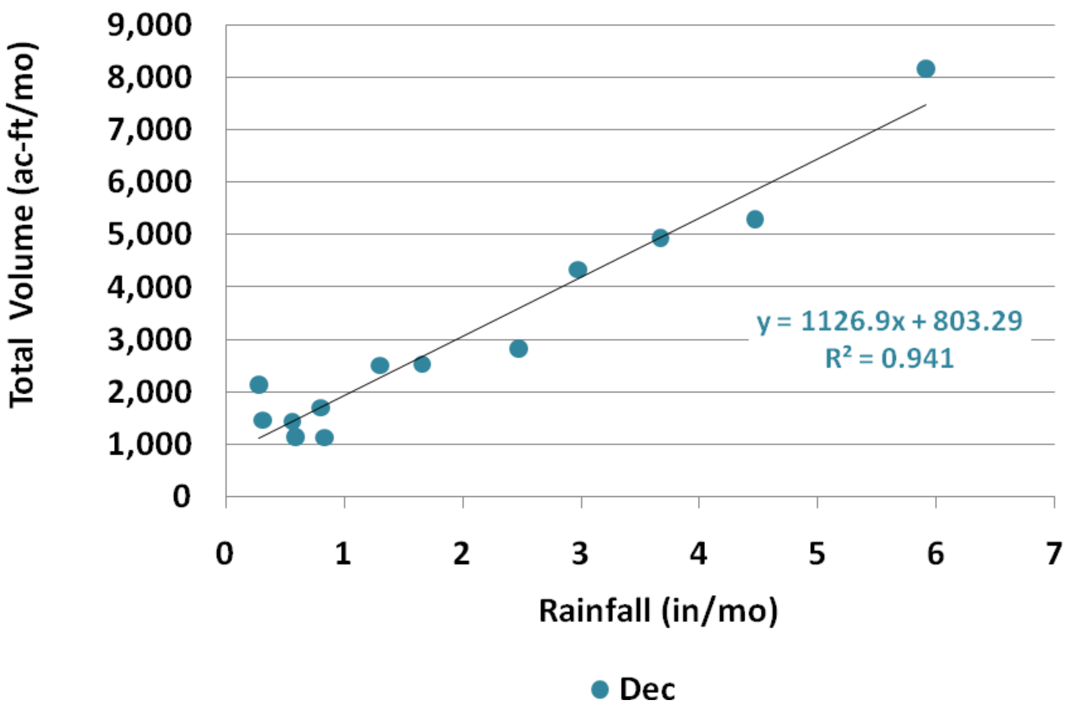


Figure 3-24 Correlation of Rainfall to Total Volume in the Lemon Bay Watershed for December

Table 3-3 Monthly Total Volume Coefficients for the Lemon Bay Watershed

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.03	1.75	0.59
Feb	1.02	1.94	0.53
Mar	1.01	2.17	0.47
Apr	0.73	1.98	0.37
May	0.70	1.96	0.36
Jun	3.04	7.82	0.39
Jul	2.85	6.98	0.41
Aug	2.99	6.84	0.44
Sep	3.50	6.72	0.52
Oct	2.20	3.30	0.67
Nov	1.26	1.71	0.74
Dec	1.13	1.99	0.57

The volume and timing of inflows from direct runoff are also very important, as much of the sediment and nutrient loadings flow into the bay in the runoff. As with total volume, the overall direct runoff to Lemon Bay comes primarily from the Alligator Creek basin (Figure 3-25). Unlike the total volume, however, the hydrologic loading rate (normalized volume) of direct runoff is also greatest in the Alligator Creek basin (Figure 3-26). Figure 3-27 illustrates the spatial distribution of the normalized annual average direct runoff across the subbasins.

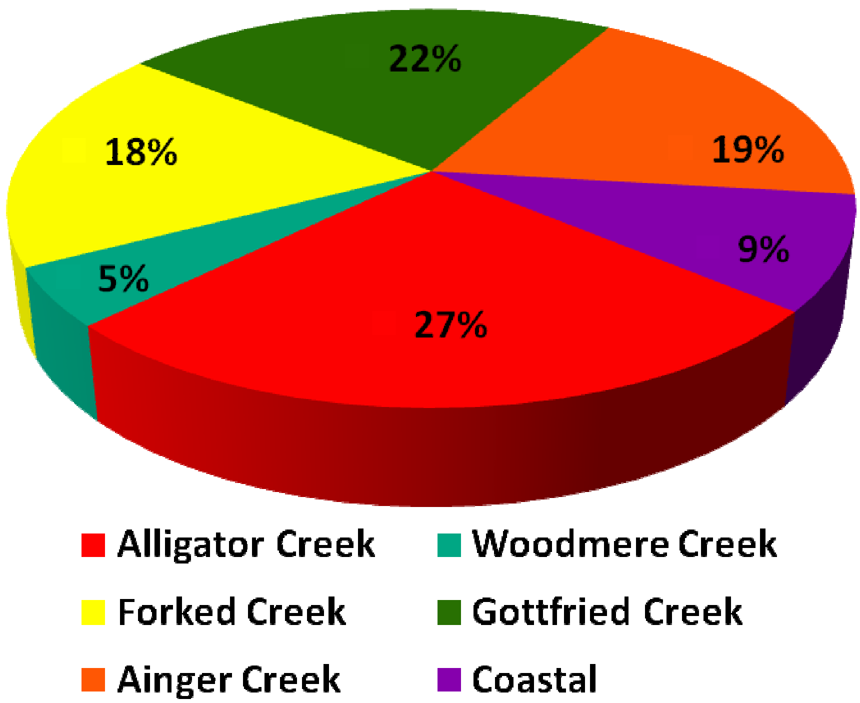


Figure 3-25 Average Annual Current Direct Runoff Input by Basin

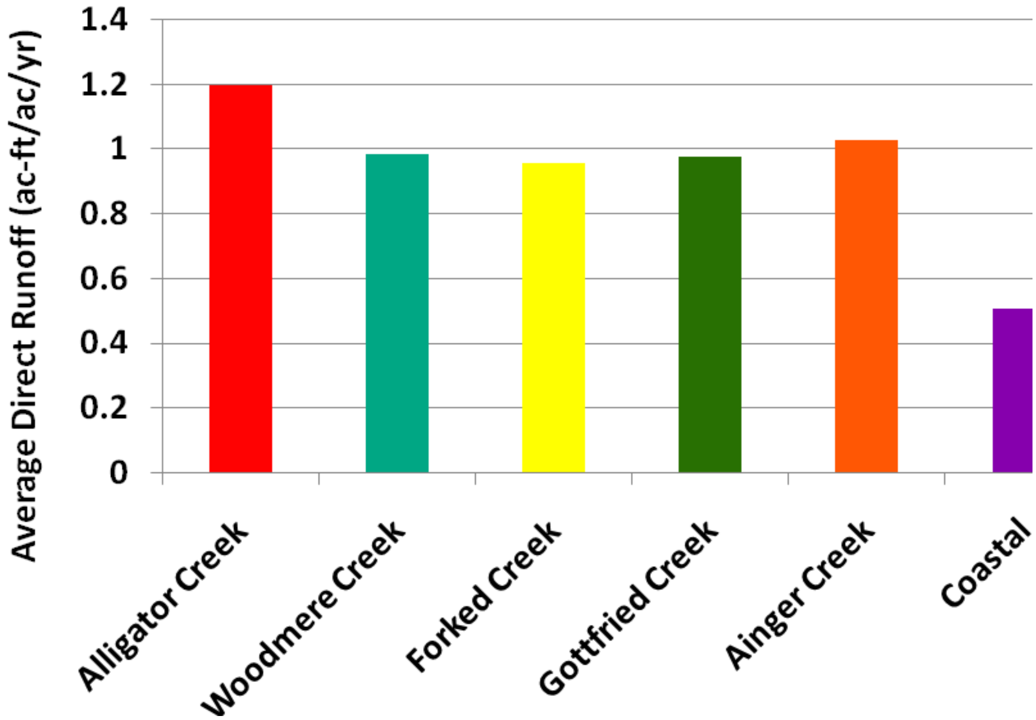


Figure 3-26 Normalized Average Annual Direct Runoff Hydrologic Loading Rate by Basin

Annual variability of total volume, direct runoff, and rainfall are similar (Figure 3-28). The annual rainfall to runoff relationship is also dependable, with an R^2 value of 0.96 (Figure 3-29). From these data, the average annual runoff to rainfall conversion factor for the Sarasota County portion of the Lemon Bay watershed was calculated to be 0.22 (Appendix E).

The intra-annual timing of the minimum and maximum direct runoff volume component of the water budget is consistent, resembling the seasonal behavior observed with total volume (Figure 3-30). There is, though, a more prominent seasonal correlation between direct runoff and rainfall than for total volume and rainfall for the wet and the dry seasons (Figure 3-31). Like with total volume, the strongest correlation between direct runoff and rainfall is during the wet season.

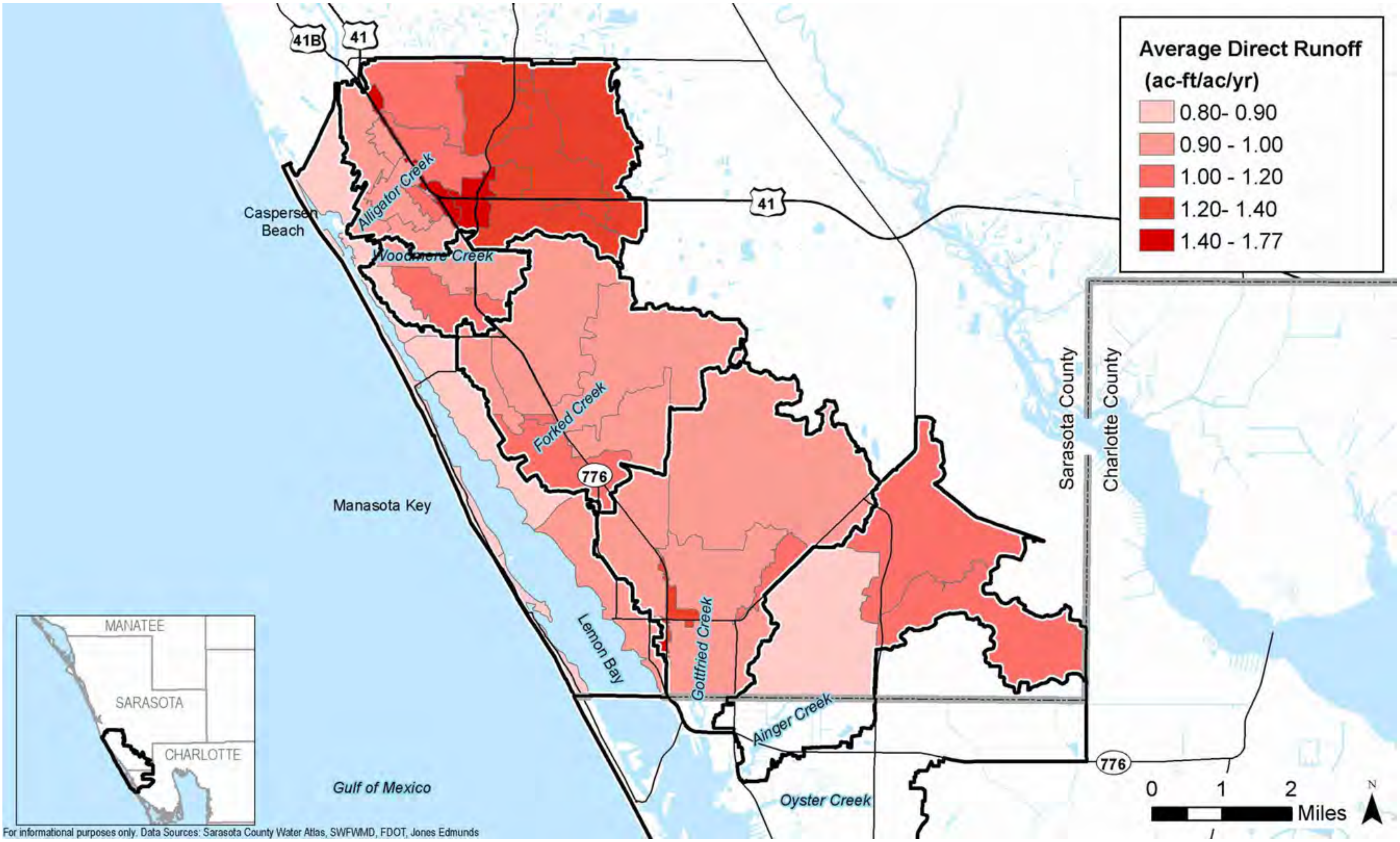


Figure 3-27 Normalized Annual Average Direct Runoff by Subbasin

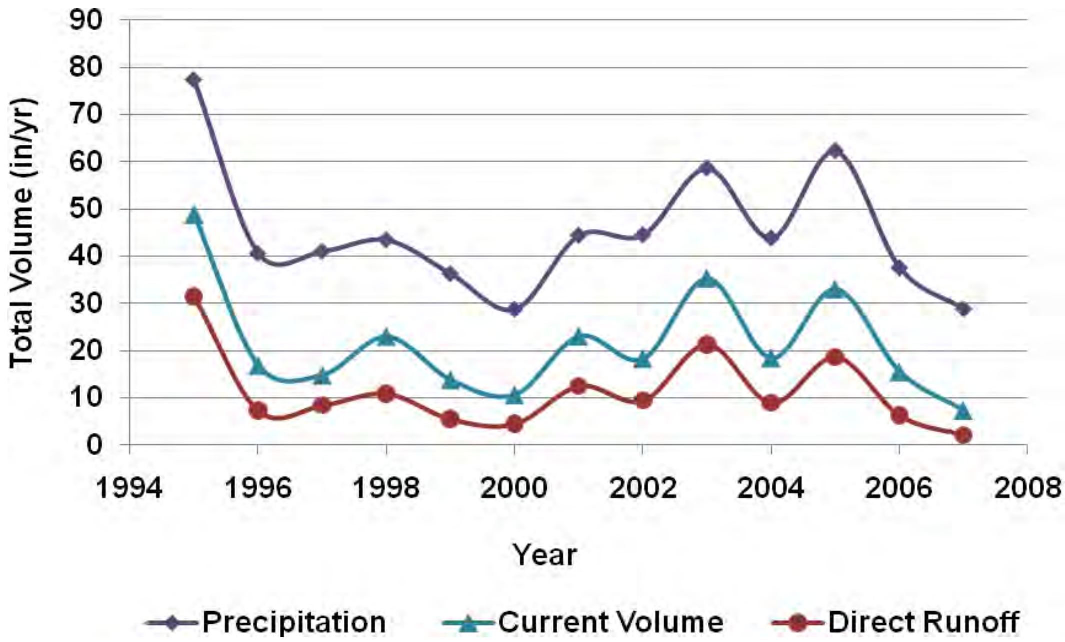


Figure 3-28 Variability of Annual Total Volume, Direct Runoff, and Rainfall in the Lemon Bay Watershed

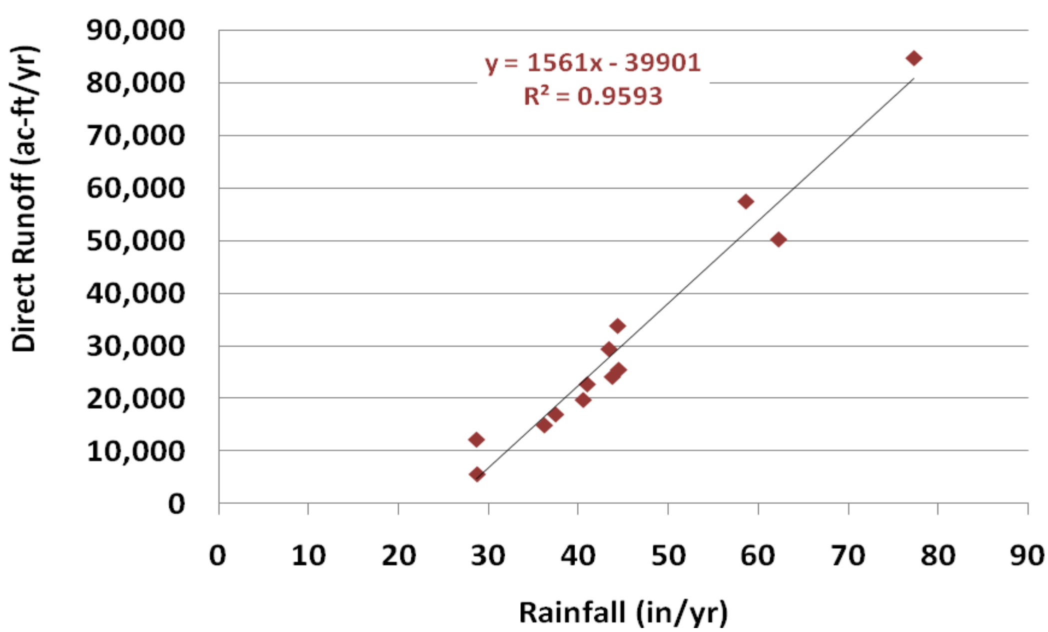


Figure 3-29 Correlation of Annual Rainfall to Direct Runoff in the Lemon Bay Watershed

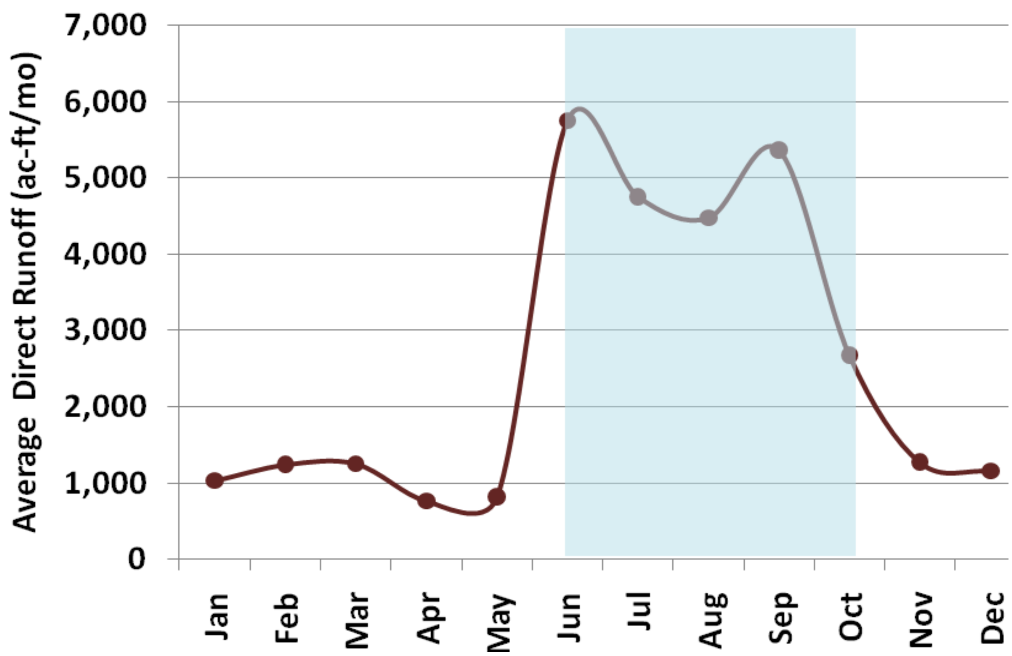


Figure 3-30 Variability of Monthly Direct Runoff in the Lemon Bay Watershed

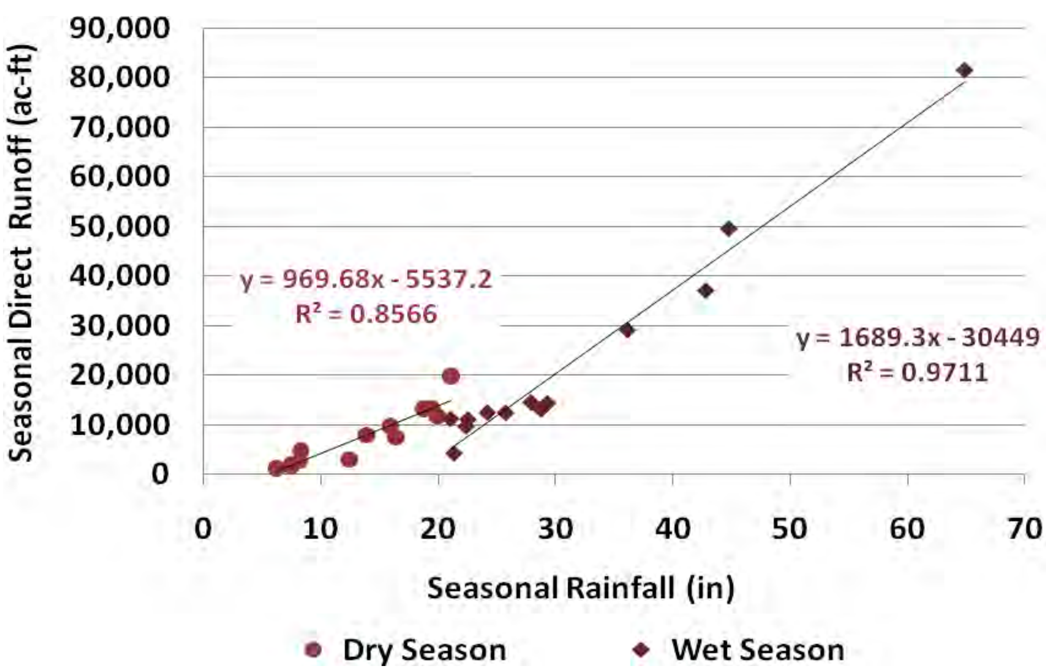


Figure 3-31 Correlation of Seasonal Rainfall to Direct Runoff in the Lemon Bay Watershed

The average seasonal direct runoff to rainfall coefficients for the Sarasota County portion of the Lemon Bay watershed were calculated from the annual seasonal direct runoff and rainfall data (Table 3-4).

Table 3-4 Seasonal Direct Runoff Coefficients for the Lemon Bay Watershed

Season	Average Direct Runoff (in)	Average Rainfall (in)	Average Seasonal Coefficients
Wet	8.55	31.65	0.23
Dry	2.80	13.49	0.18

The relationship between rainfall and runoff at a monthly scale varies. The dependability varies from an R^2 value of 0.75 in April up to 0.95 in June (Figure 3-32 through Figure 3-43). The average monthly direct runoff to rainfall coefficients for the Sarasota County portion of Lemon Bay are shown in Table 3-5. Table 3-6 summarizes these and the total volume to rainfall coefficients.

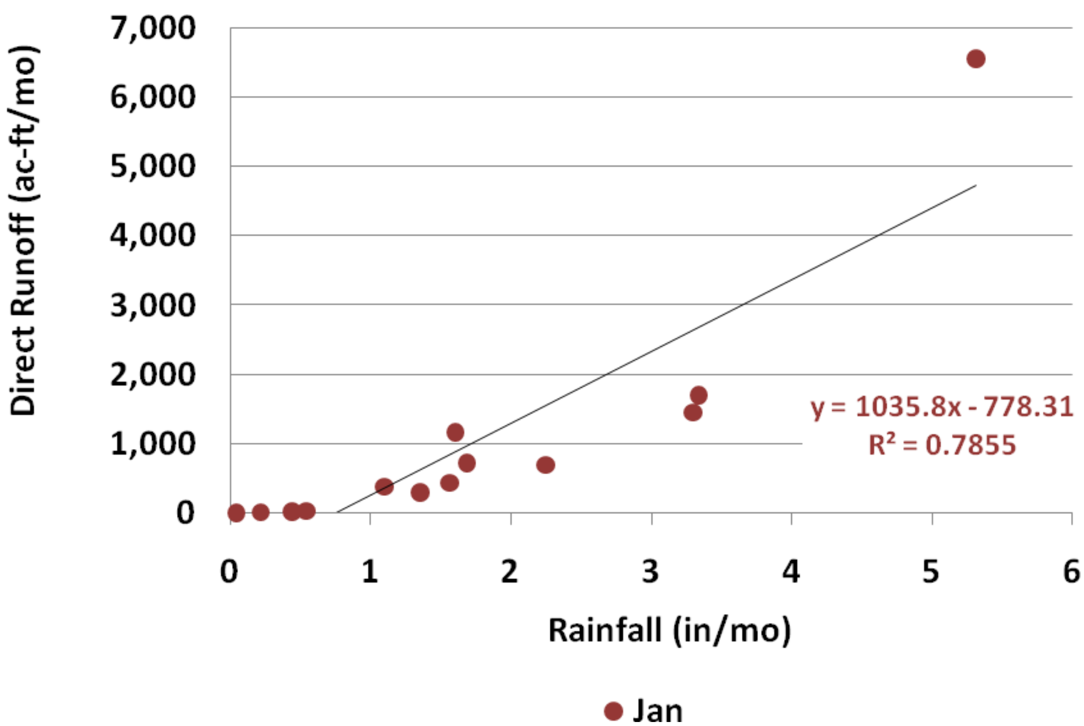


Figure 3-32 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for January

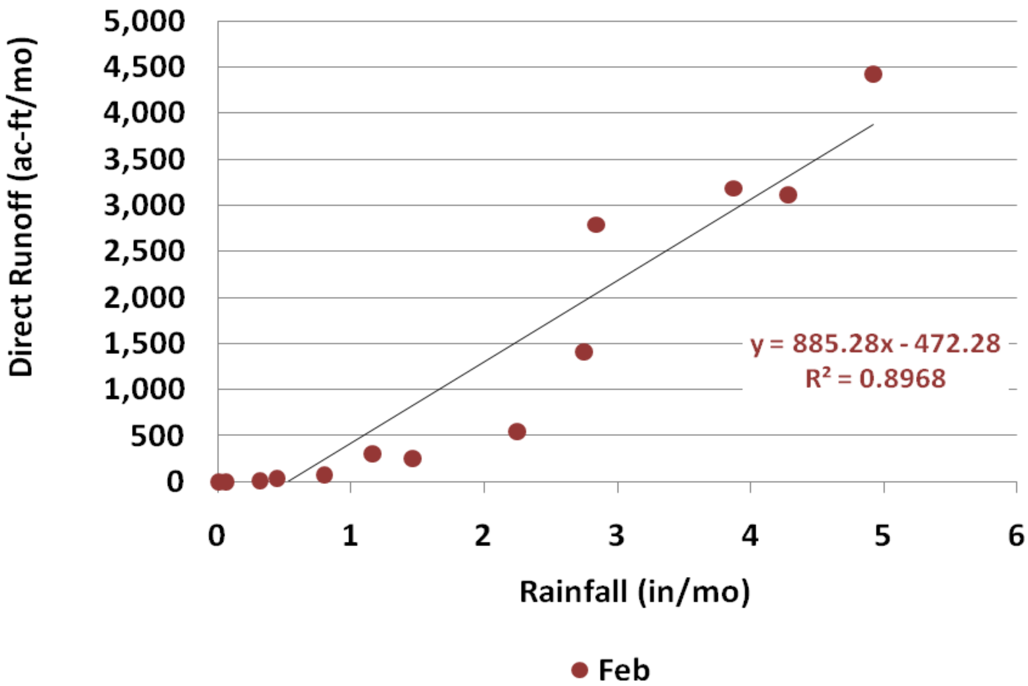


Figure 3-33 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for February

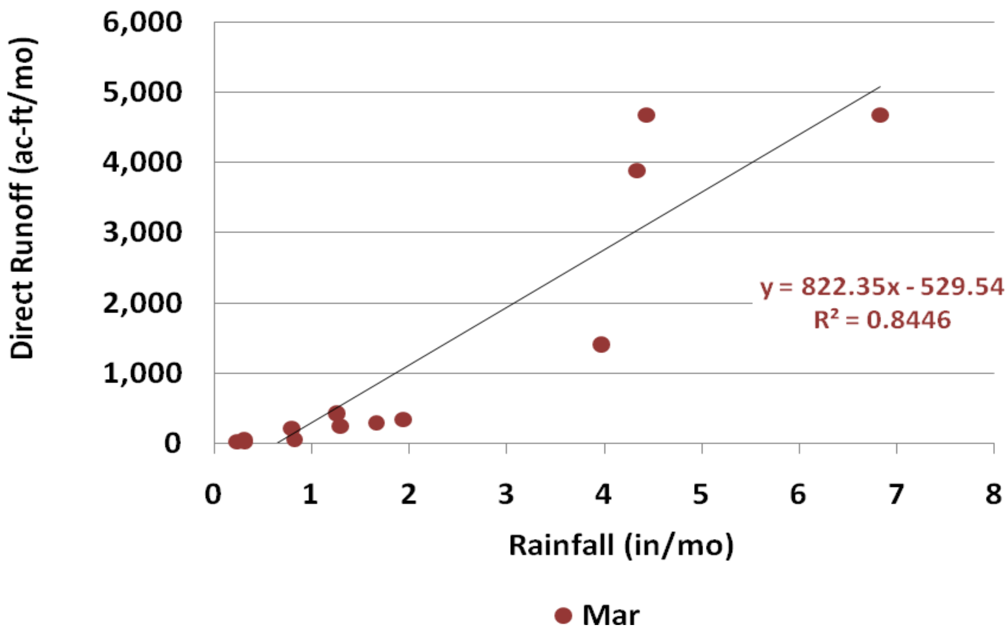


Figure 3-34 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for March

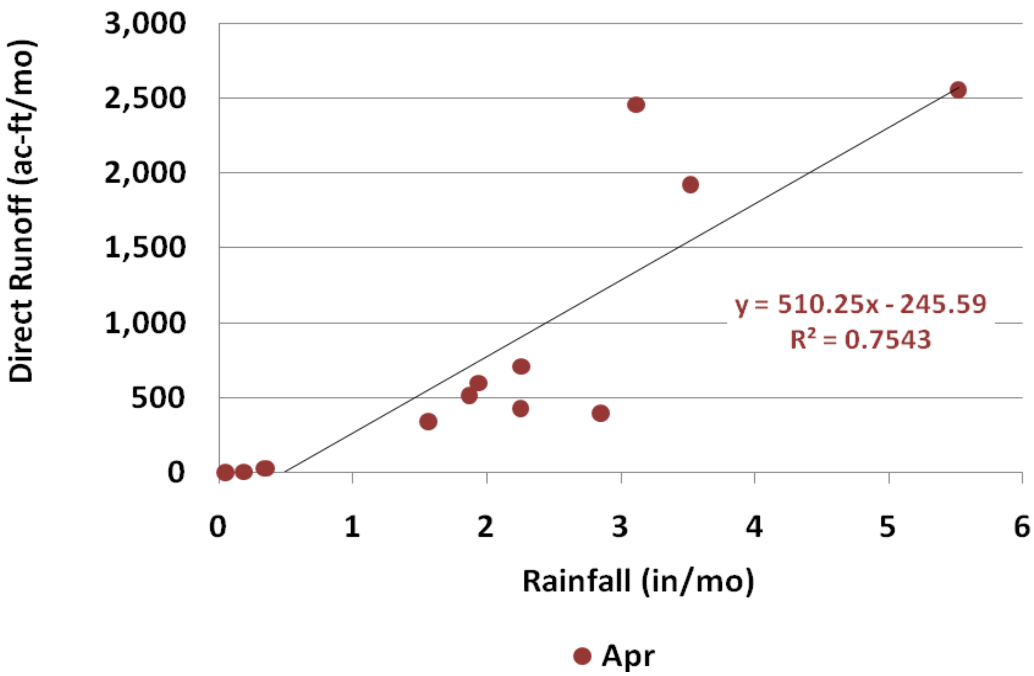


Figure 3-35 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for April

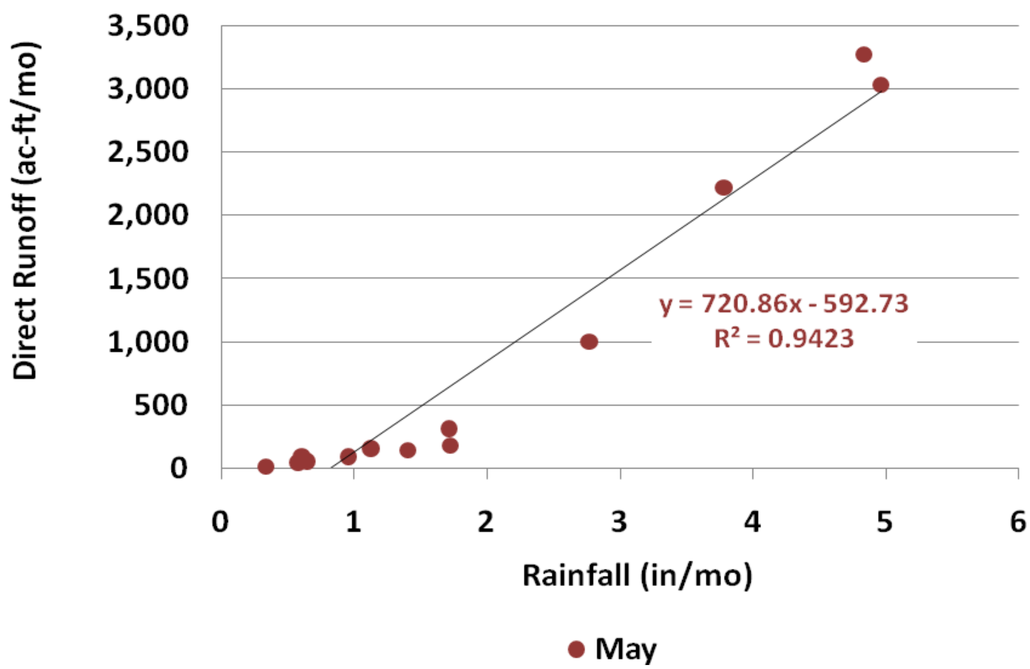


Figure 3-36 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for May

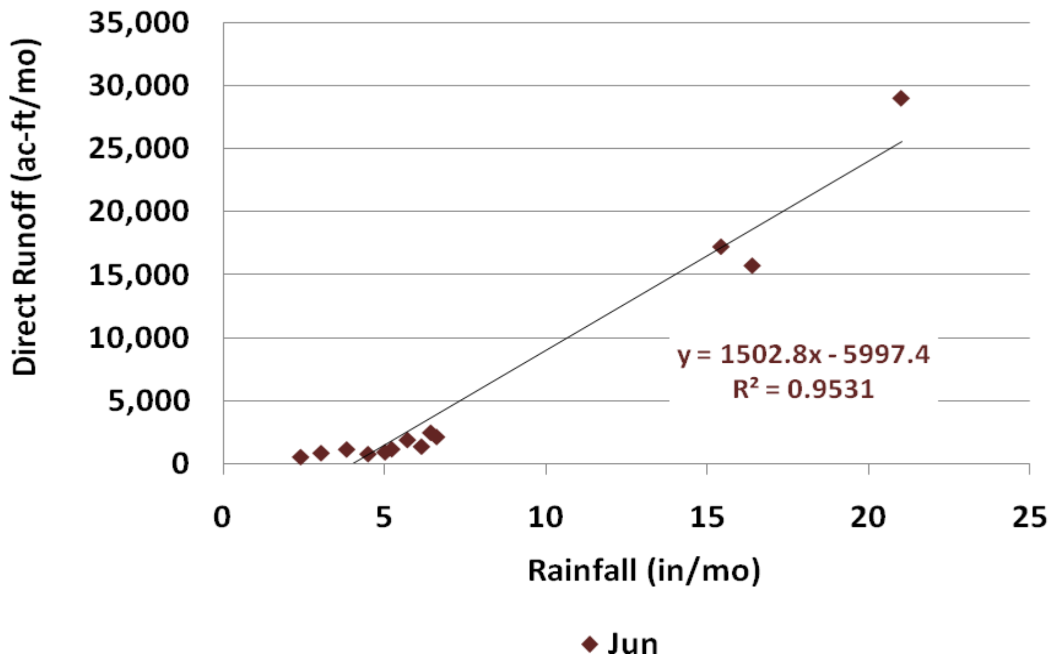


Figure 3-37 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for June

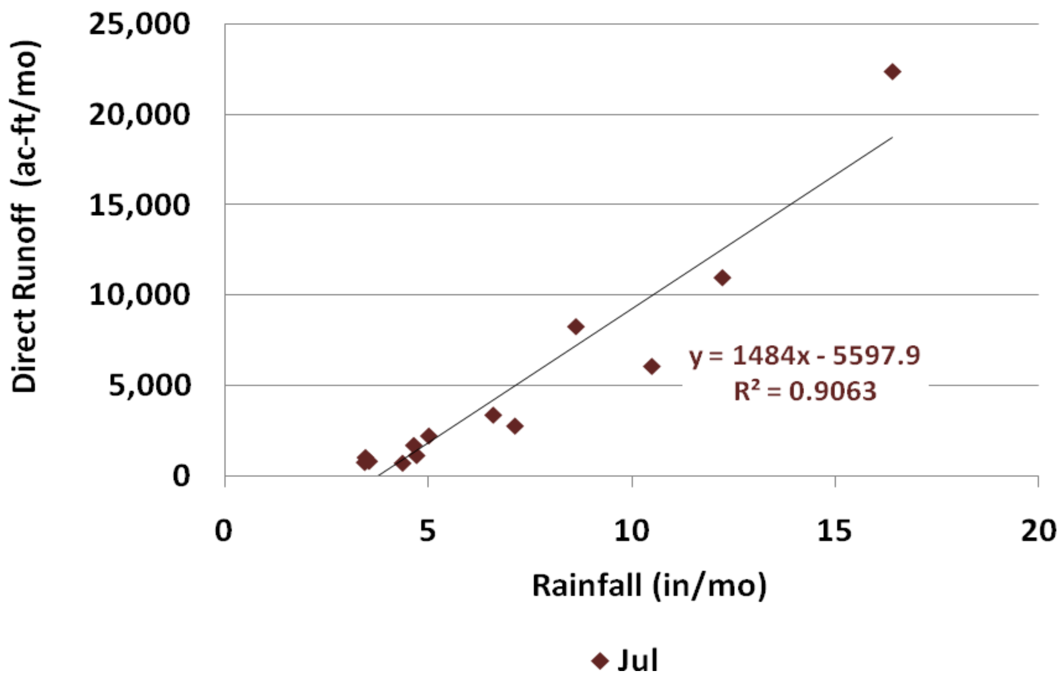


Figure 3-38 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for July

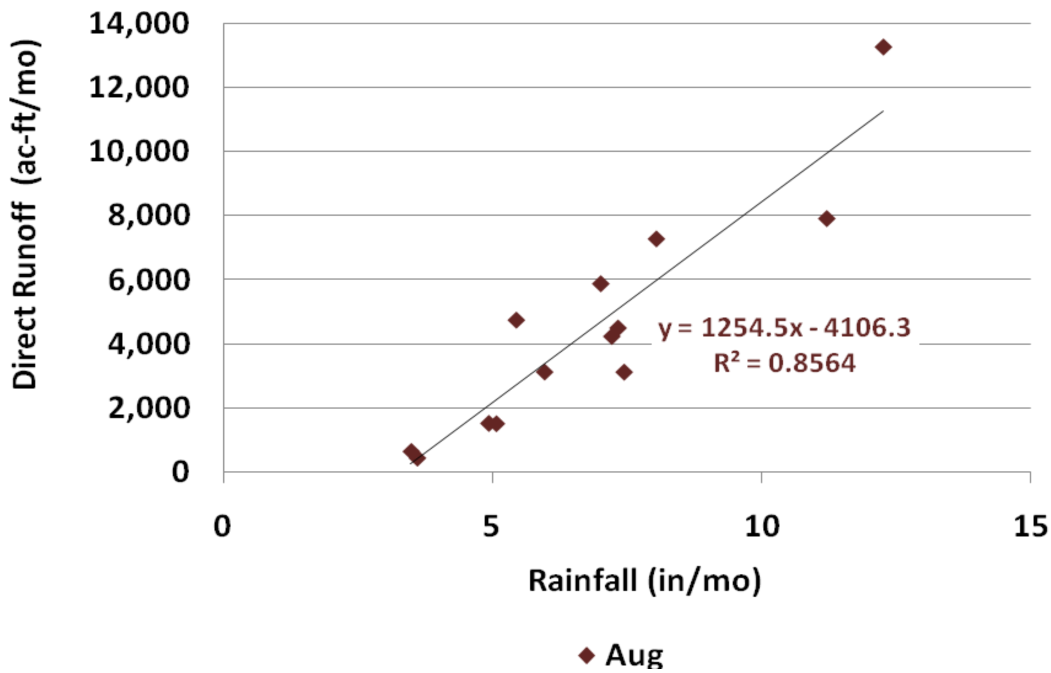


Figure 3-39 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for August

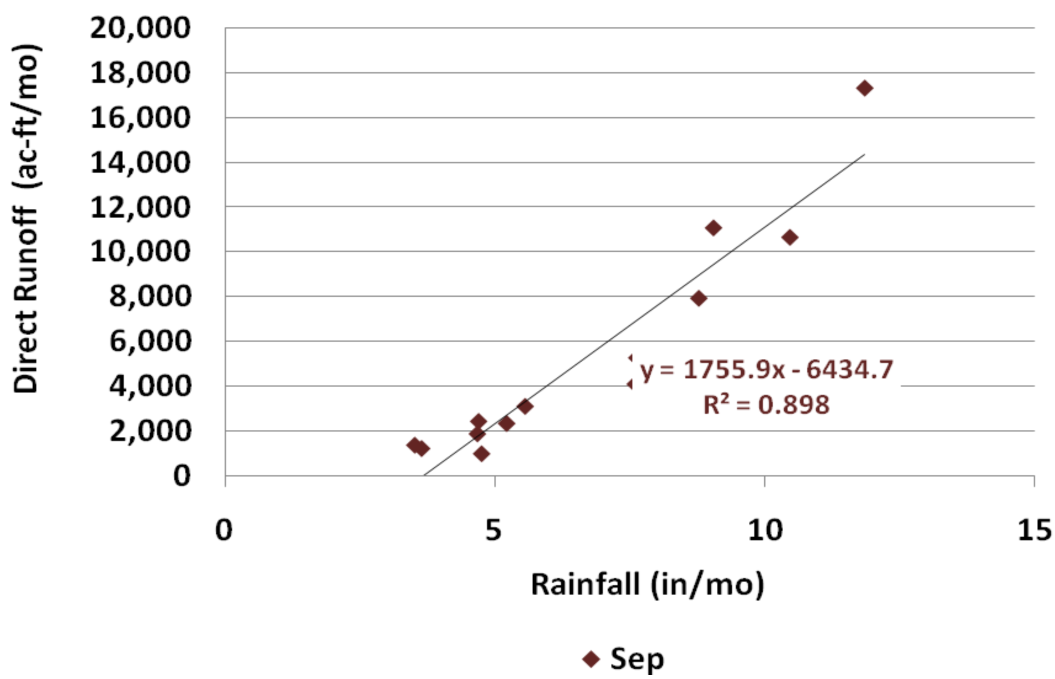


Figure 3-40 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for September

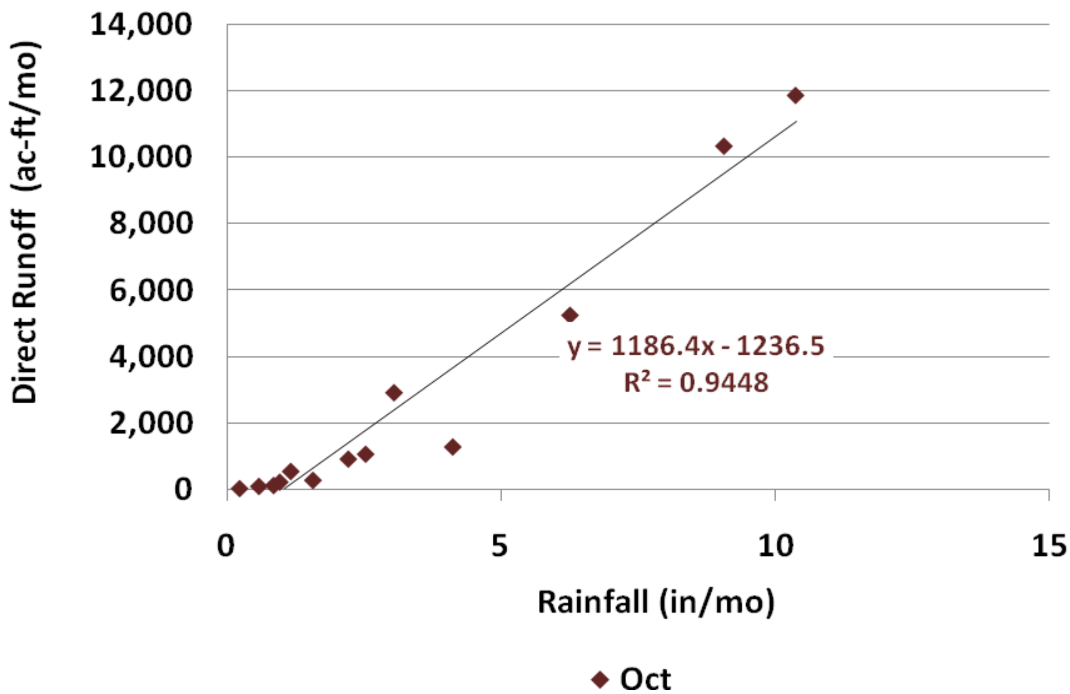


Figure 3-41 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for October

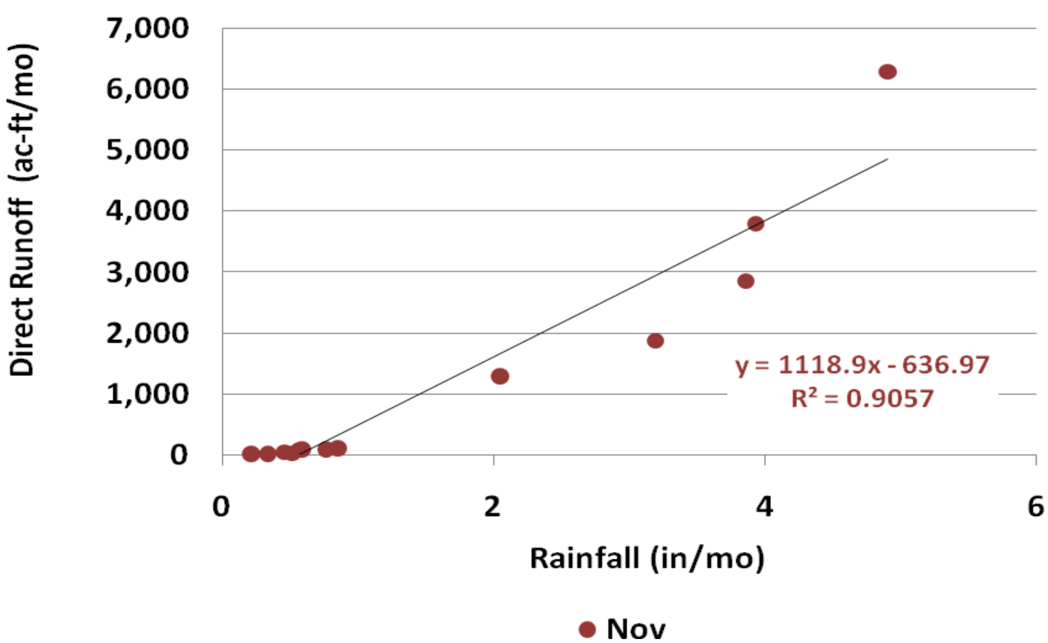


Figure 3-42 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for November

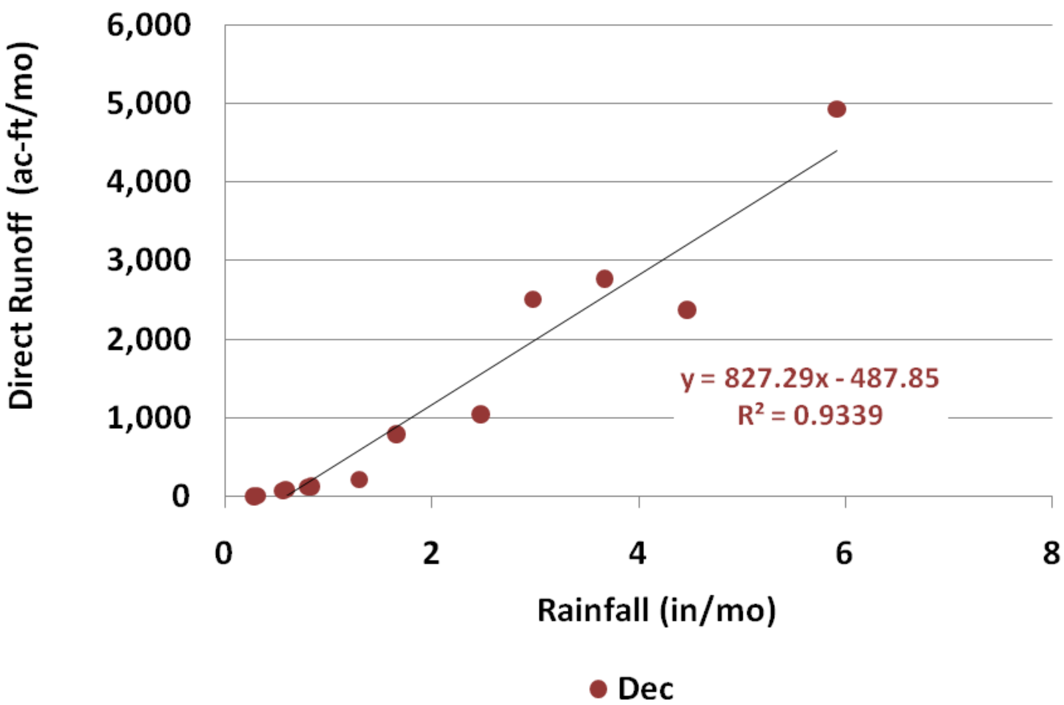


Figure 3-43 Correlation of Rainfall to Direct Runoff in the Lemon Bay Watershed for December

Table 3-5 Monthly Direct Runoff Coefficients for the Lemon Bay Watershed

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.38	1.75	0.22
Feb	0.46	1.94	0.24
Mar	0.47	2.17	0.21
Apr	0.28	1.98	0.14
May	0.30	1.96	0.16
Jun	2.14	7.82	0.27
Jul	1.77	6.98	0.25
Aug	1.66	6.84	0.24
Sep	1.99	6.72	0.30
Oct	0.99	3.30	0.30
Nov	0.47	1.71	0.28
Dec	0.43	1.99	0.22

Table 3-6 Monthly Coefficients Summary for the Lemon Bay Watershed

	Average Total Volume to Rainfall Coefficient	Direct Runoff to Rainfall Coefficient	(Total Volume to Rainfall Coefficient) – (Direct Runoff to Rainfall Coefficient)
Jan	0.59	0.22	0.37
Feb	0.53	0.24	0.29
Mar	0.47	0.21	0.25
Apr	0.37	0.14	0.22
May	0.36	0.16	0.20
Jun	0.39	0.27	0.12
Jul	0.41	0.25	0.16
Aug	0.44	0.24	0.19
Sep	0.52	0.30	0.22
Oct	0.67	0.30	0.37
Nov	0.74	0.28	0.46
Dec	0.57	0.22	0.35

3.1.2.3 Lemon Bay Watershed Water Budget Changes

Changes in the natural freshwater inflow to estuaries can have significant impacts on the health and distribution of plants and wildlife. There is natural variability in the total volume, direct runoff, and the overall range of inflow to Lemon Bay fluctuates annually, seasonally, and monthly. The natural hydrologic regimes of the watershed have evolved over the last several decades, though. With increased urbanization have come significant changes in the components of the water budget of the Lemon Bay watershed. There are notable increases in both the overall volume and direct runoff volume entering Lemon Bay from historical to current conditions. The projected future volume and direct runoff are also estimated to increase significantly. Analysis of the future water budget considered a completely built-out scenario of the potential anthropogenic influences that could affect the overall water budget and direct runoff of the watershed in the future.

There is an increasing trend in total volume in the Lemon Bay watershed from historical through future years (Figure 3-44). The total watershed volume increased each year for all years from historical to current and is estimated to increase annually from current to future conditions (Appendix E). There was a 23% increase in the annual average total volume of the historical to the current water budget. The future annual average total volume could potentially increase over 17% (Figure 3-45 and Appendix E). Results for each of the Lemon Bay basins are located in Appendix E.

The historical and current water budgets are used in Chapter 4 to investigate the influence of flows on salinity in Lemon Bay. The quantitative relationship between salinity and flows are used to make recommendations for an appropriate hydrologic regime, i.e., target water budget.

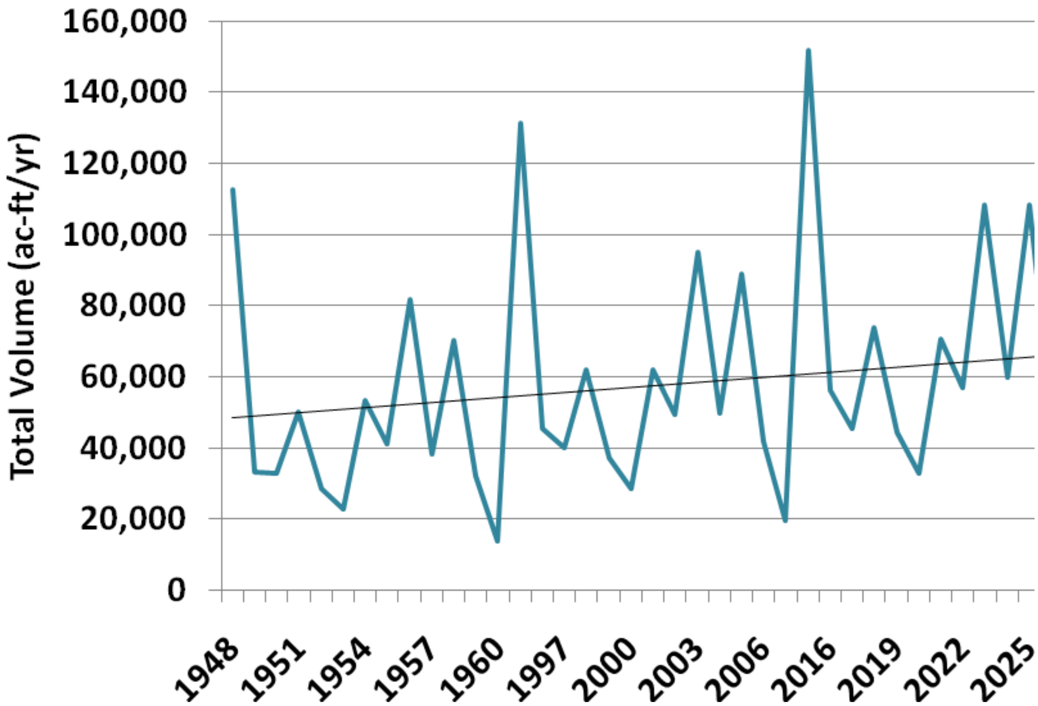


Figure 3-44 Historical through Future – Trend in Total Volume in the Lemon Bay Watershed

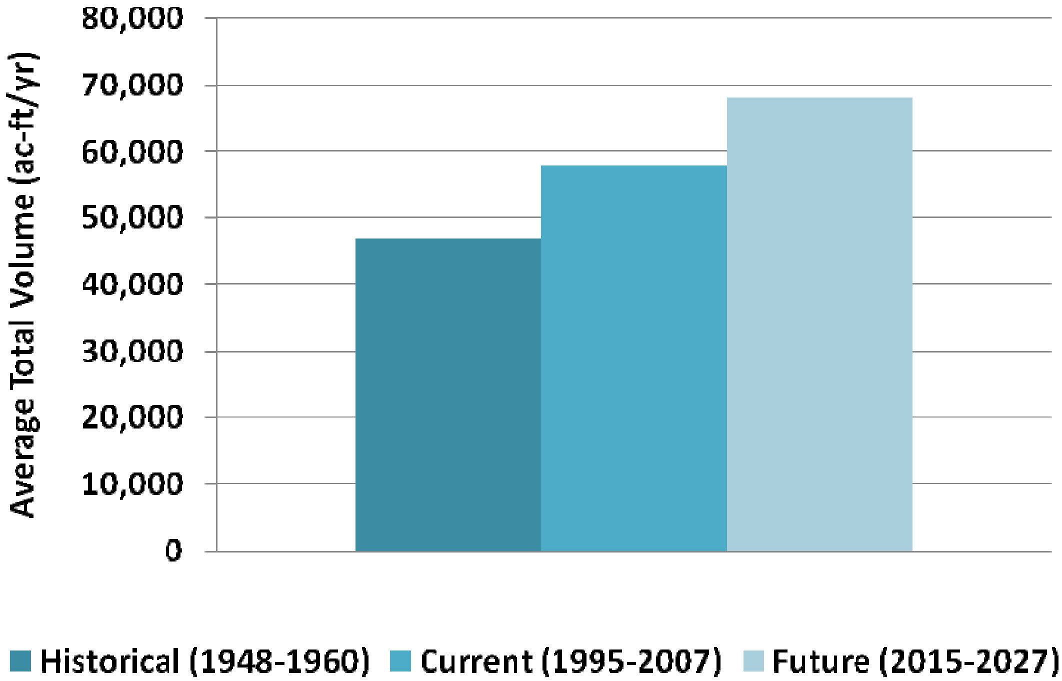


Figure 3-45 Historical, Current, and Future – Average Annual Total Volume in the Lemon Bay Watershed

There is also an annual increase in the normalized (by area) average total volume from historical to current and from current to future conditions (Figure 3-46). Changes in the normalized total volume across the watershed are shown in Figure 3-47. There is a distinct increase in water budget components in the areas of the watershed that became highly urbanized between the historical and current periods of study. Much of this development occurred before Land Development Regulations (LDRs) or Low Impact Developments (LIDs) were implemented.

The current to future normalized average annual change in total volume across the watershed was estimated at a more coarse scale (Figure 3-48). The areas that are currently developed show the smallest change in water budget in the future. Figure 3-48 shows that the areas of the watershed where development could occur in the future have the greatest projected increases in volume. This analysis considered a completely built-out scenario of the potential anthropogenic influences that affect the overall water budget of the watershed in the future and did not take into account LDRs or LID.

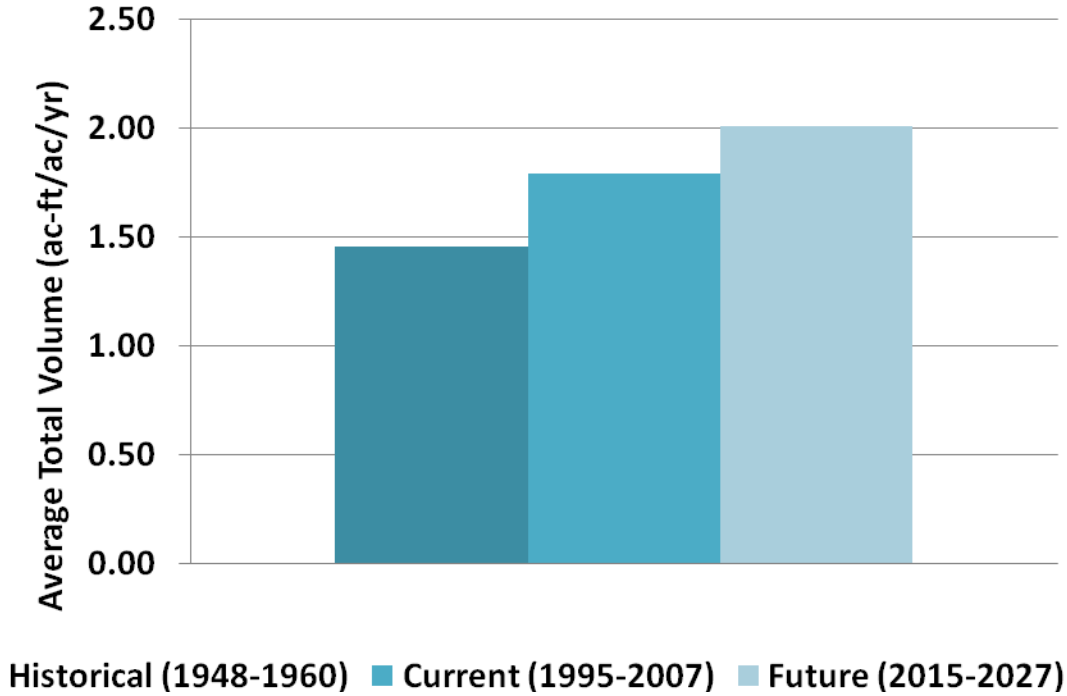


Figure 3-46 Historical, Current, and Future – Normalized Average Annual Total Volume in the Lemon Bay Watershed

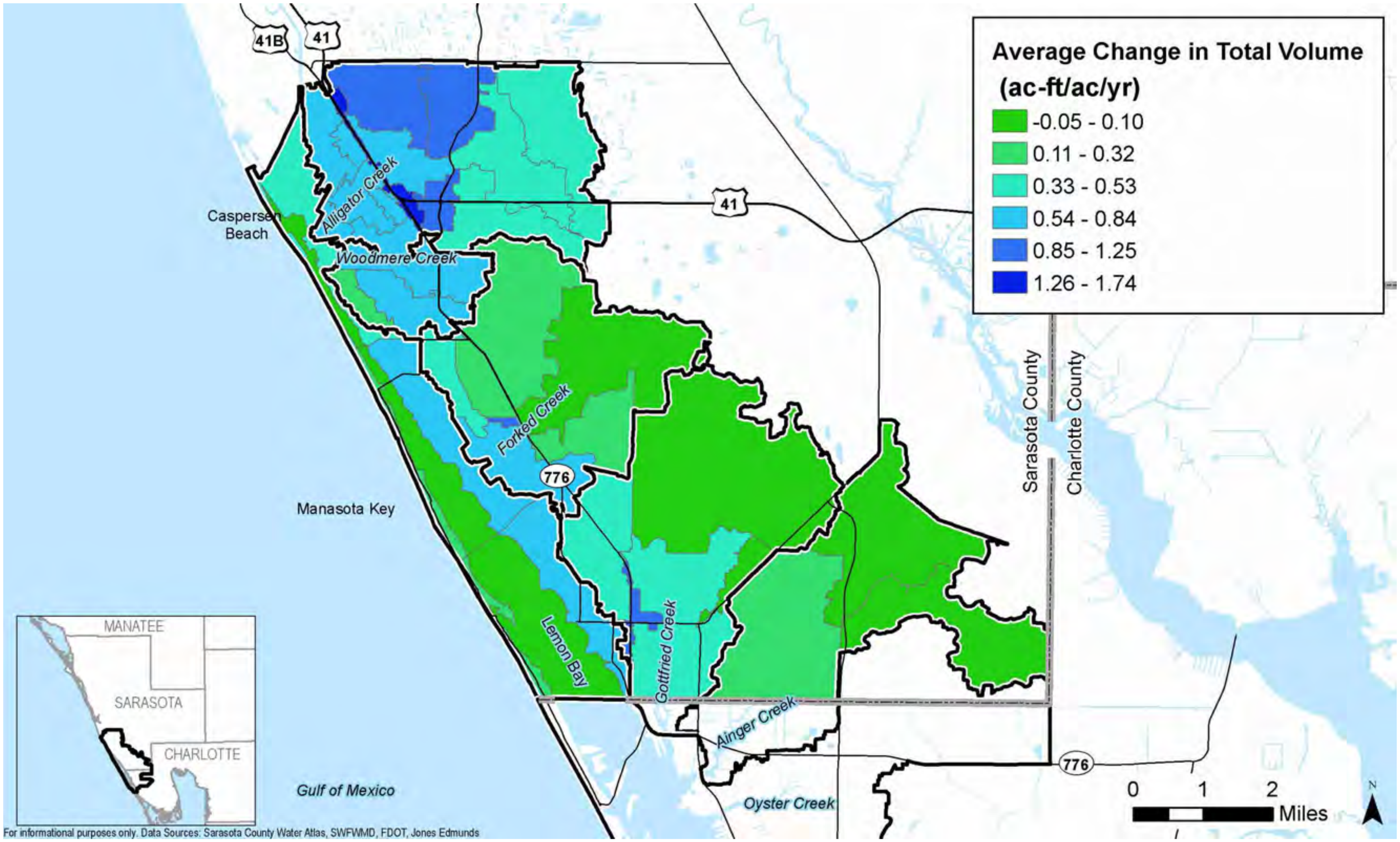


Figure 3-47 Normalized Change in Total Volume (ac-ft/ac) (Current Annual Average Total Volume—Historical Annual Average Total Volume)

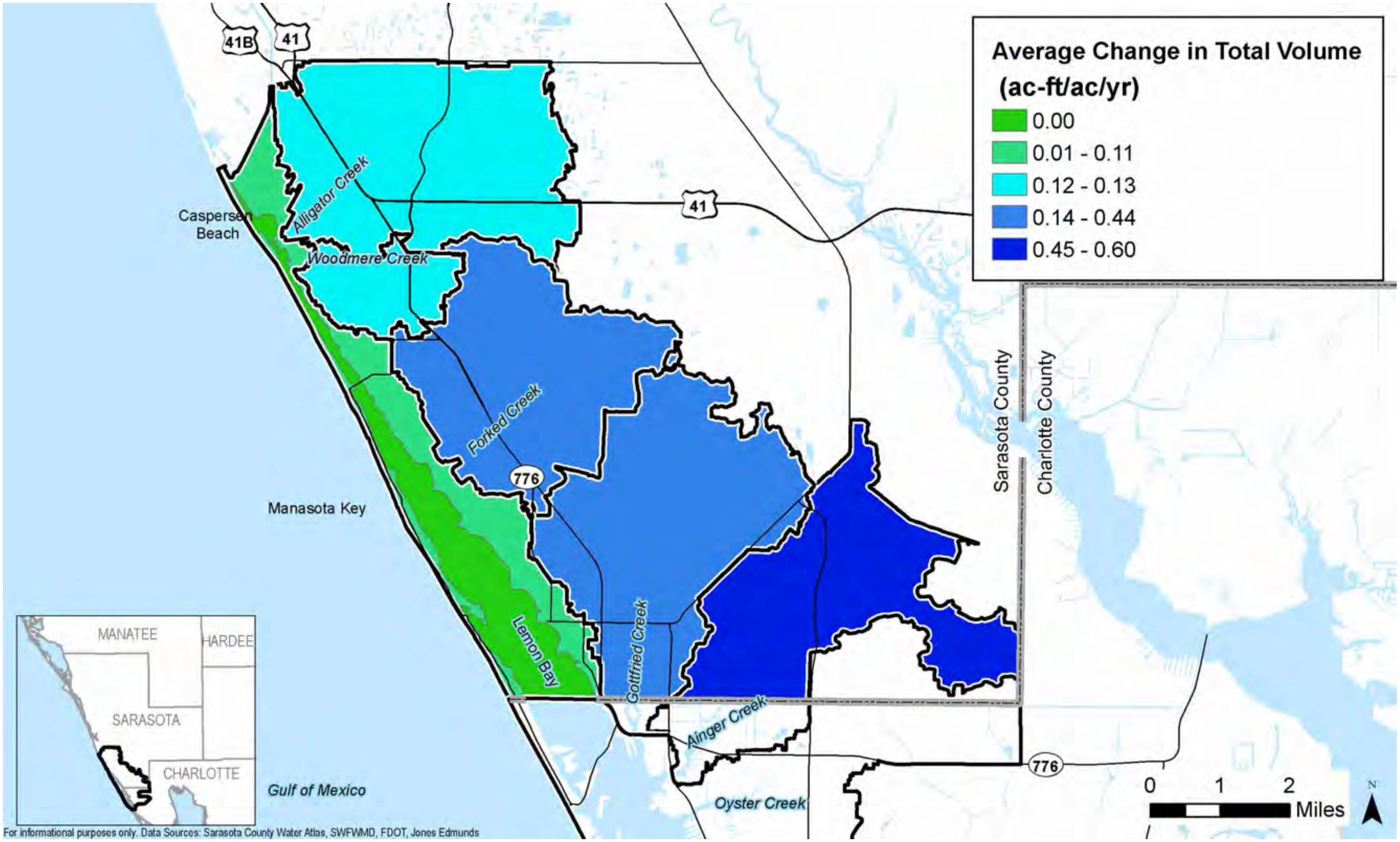


Figure 3-48 Normalized Change in Average Total Volume (ac-ft/ac) (Future Annual Average Total Volume—Current Annual Average Total Volume)

There is also a slight increasing trend in the direct runoff component of the Lemon Bay watershed water budget from historical through future years (Figure 3-49). The direct runoff increased for most years from historical to current and is projected to increase each year into the future (Appendix E). There was an annual average increase of 13% from the historical to current water budget, and this volume s estimated to increase by almost another 12% in the future (Figure 3-50).

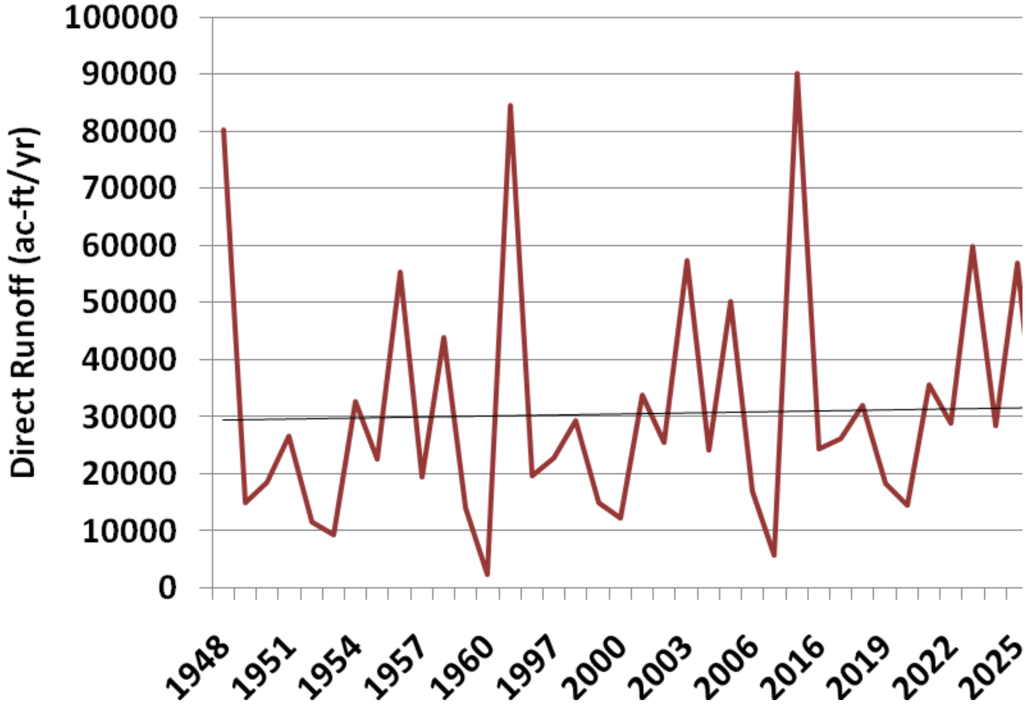


Figure 3-49 Historical through Future – Trend in Direct Runoff in the Lemon Bay Watershed

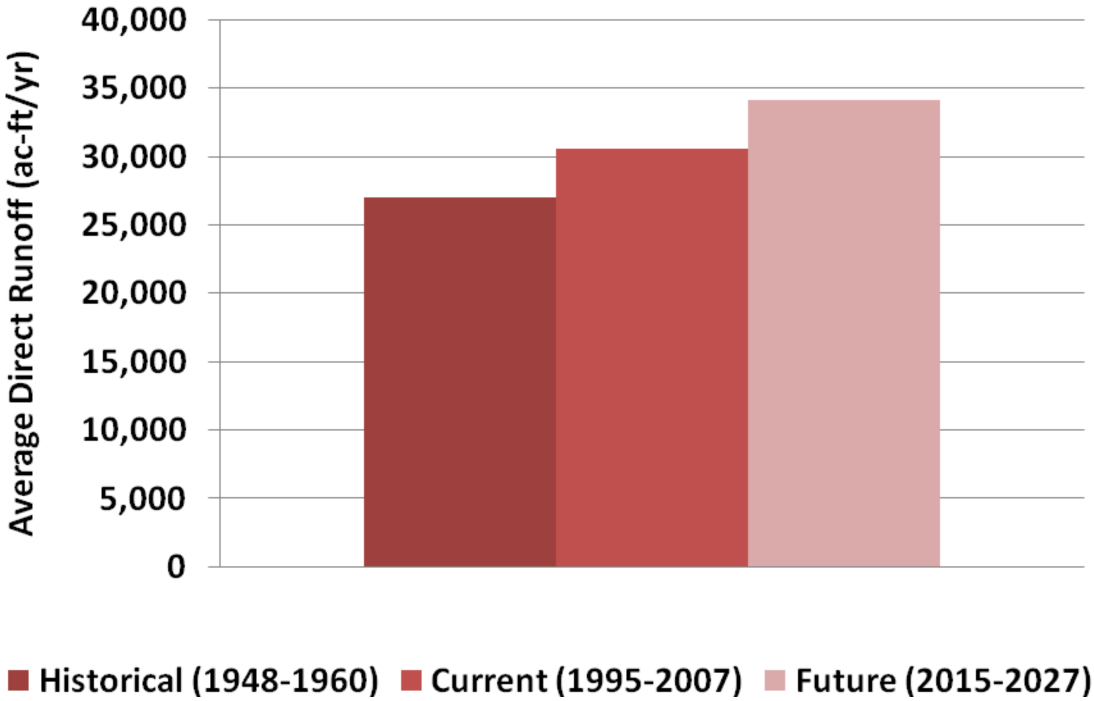


Figure 3-50 Historical, Current, and Future – Average Annual Direct Runoff in the Lemon Bay Watershed

The normalized average direct runoff volume also increases from historical to current and current to future conditions (Figure 3-51). The normalized historical to current average annual change in total direct runoff across the watershed is shown in Figure 3-52. The areas with the largest increases are those that have been developed. The current to future normalized average annual change in direct runoff is shown in Figure 3-53. As with the total volume changes, the areas that are currently developed show the smallest change in direct runoff in the future. Figure 3-53 shows that the areas of the watershed where development could occur in the future are the same areas where the greatest increases in direct runoff are projected.

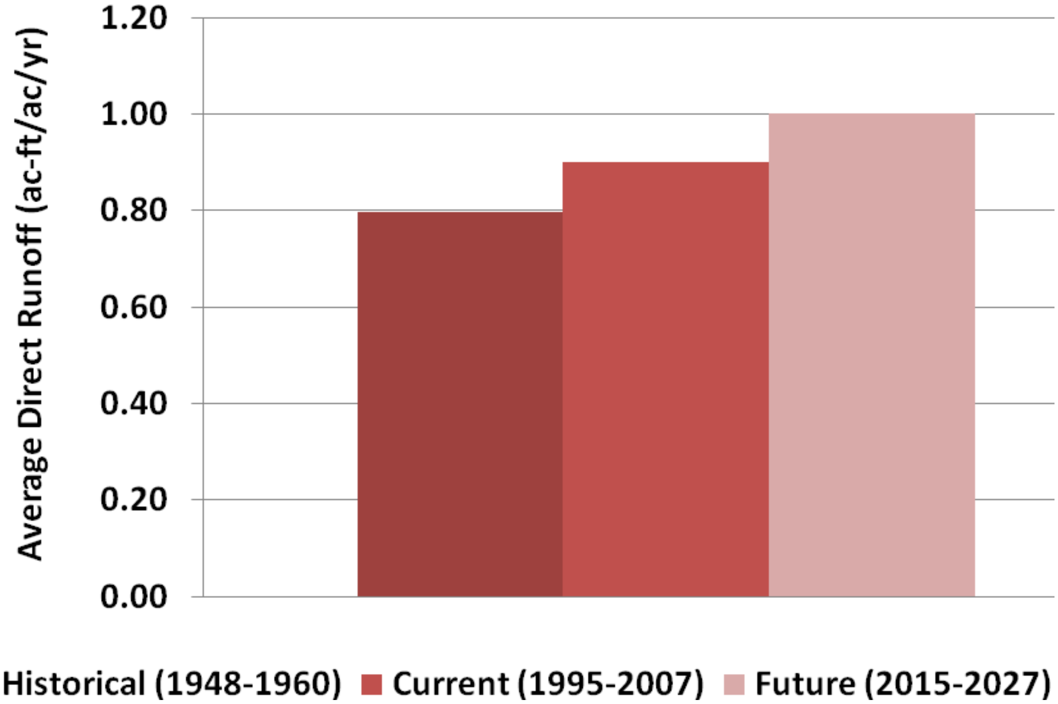


Figure 3-51 Historical, Current, and Future – Normalized Average Annual Direct Runoff in the Lemon Bay Watershed

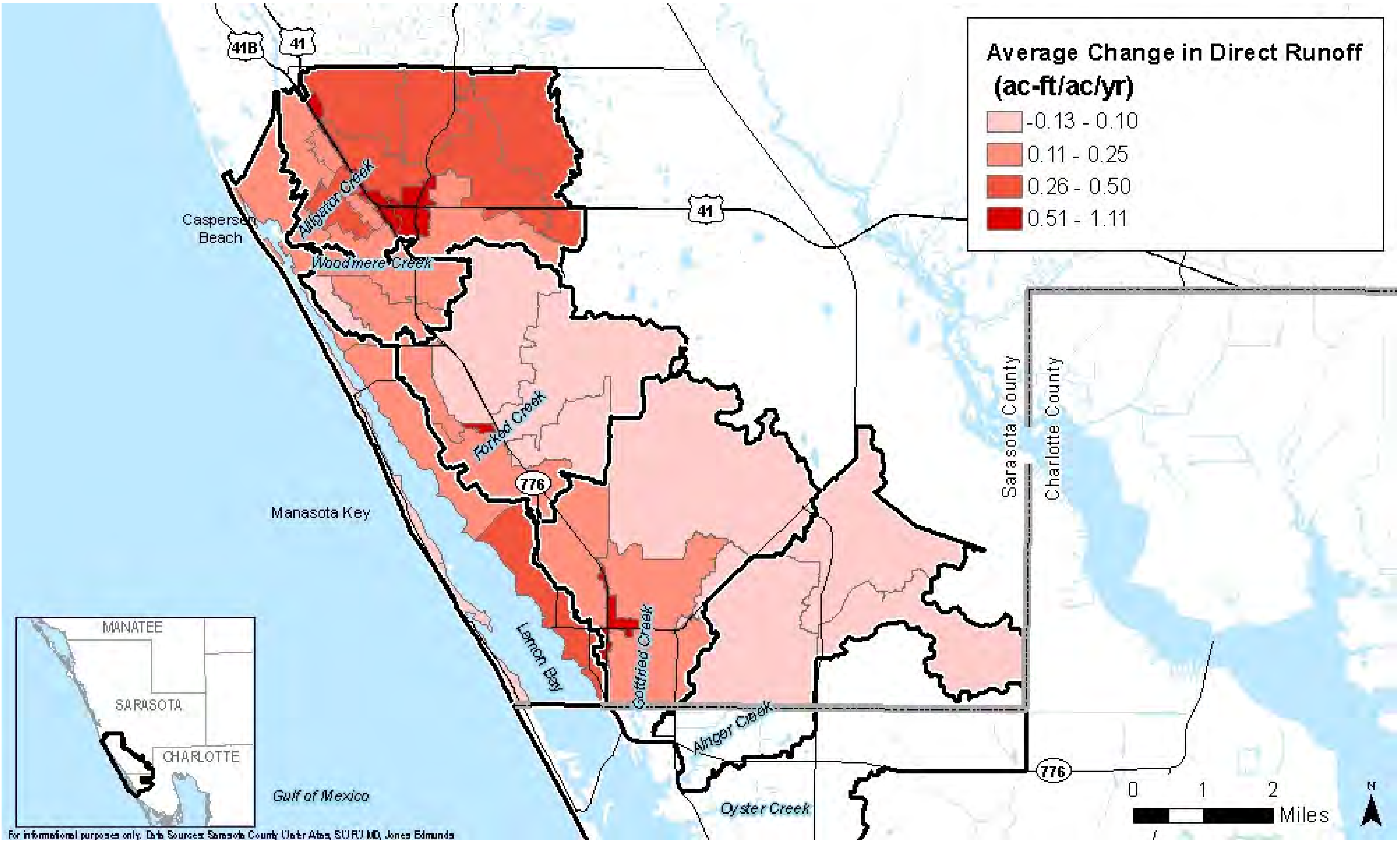


Figure 3-52 Normalized Change in Total Volume (ac-ft/ac) (Current Annual Average Direct Runoff—Historical Annual Average Direct Runoff)

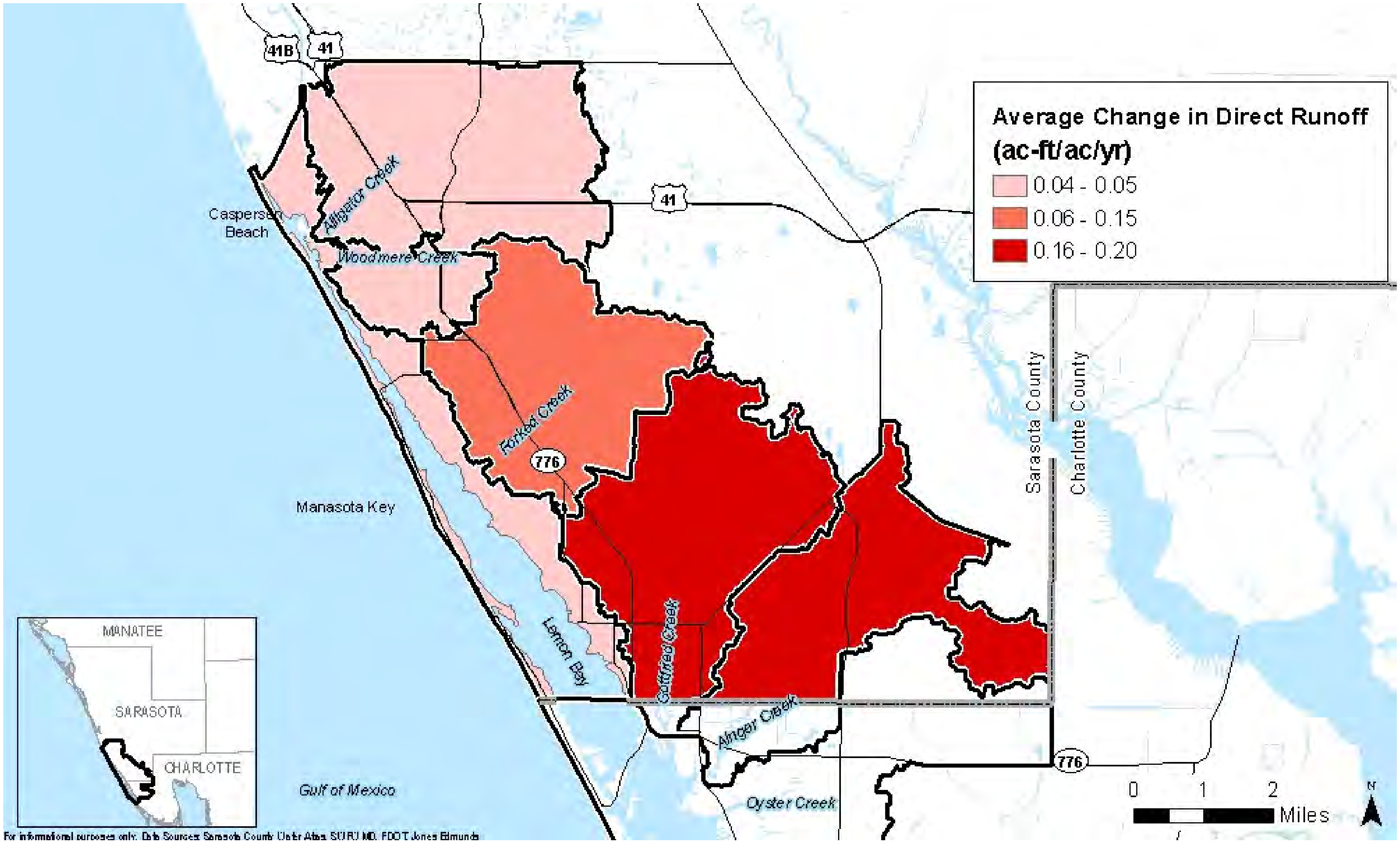


Figure 3-53 Change in Average Total Volume (ac-ft/ac) (Future Annual Average Direct Runoff—Current Annual Average Direct Runoff)

Results of the simulations (historical, current, future) indicate that fluctuations in the total volume and direct runoff volume within each simulation are driven by the rainfall. The changes in total volume and direct runoff between simulations, however, are a result of changes in land use (Figure 3-54). The greatest water budget changes occur in areas of the watershed that were developed before LDRs were implemented in 1981 or were projected to be developed the future.

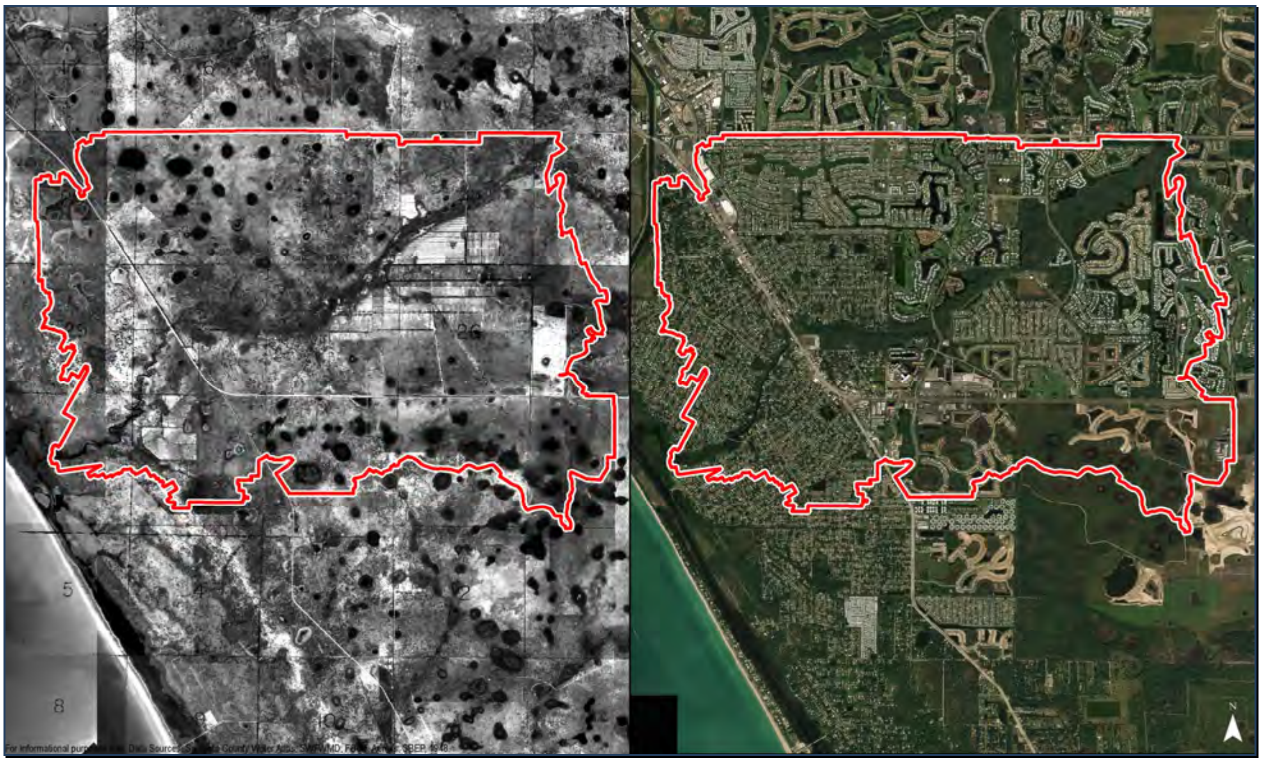


Figure 3-54 Comparison of the Alligator Creek Basin Circa 1948 and 2007

Early development altered the hydrology of the watershed, decreasing storage and infiltration and increasing flows into the bay, which in turn resulted in increased pollutant loading. Although it may not be practical to restore the historical water budget of the Lemon Bay watershed, improvements can be made in developed areas and precautions can be taken to avoid increased flows in the future water budget. Moving forward, LDRs will continue to be enforced and LID projects are recommended for retrofits, redevelopment, and future development to maintain or improve the current Lemon Bay watershed water budget.

3.1.3 Habitat Improvement

3.1.3.1 Introduction

Jones Edmunds completed a desktop GIS analysis and identified potential habitat improvement opportunities on public lands in the Lemon Bay watershed with a focus on improving the watershed's hydrologic, hydraulic, or water quality functions. As a result, an emphasis was placed on public lands that contained wetlands due to their importance and influence on on-site or downstream water quality and quantity. Potential sites were identified by Jones Edmunds based on a GIS desktop assessment using available digital datasets. Data collected at the identified sites during preliminary field assessments and subsequent analysis were used to rank sites based on several factors with an emphasis on improving water quality and quantity on-site or to downstream receiving waters. Any observations of listed wildlife species were recorded but listed wildlife species specific surveys were not part of the preliminary field assessments.

3.1.3.2 Methods

A. Data Compilation and Analysis

Jones Edmunds used GIS to compile and review numerous public lands shapefiles obtained from the Sarasota County GIS library, the Sarasota County Environmentally Sensitive Lands Program (ESLPP), the Charlotte Harbor National Estuary Program (CHNEP), and the Southwest Florida Water Management District (SWFWMD), which included the following:

- Sarasota County conservation easements and preservation or mitigation areas
- ESLPP parcels
- Neighborhood parklands
- Public- and agency-owned lands
  - SWFWMD
  - Airport Authority
  - Hospital
  - School Board
  - Federal
  - State
  - City

Jones Edmunds selected all public lands greater than 1 acre that contained native wetland communities (FLUCCS_ID = 6XXX) and reviewed them in the GIS. Topography and hydrography data sets were then used to review each potential site for connectivity to downstream receiving waterbodies. In addition, emphasis was placed on those sites that were hydrologically connected to off-site wetlands or surface waters.

B. Field Investigations

Jones Edmunds conducted site visits to the potential habitat improvement sites in March 2009 to characterize the vegetation communities, identify any listed wildlife species currently using the site, and determine if the wetlands were hydrologically impacted. If the on-site wetlands appeared to be hydrologically impacted, site-specific activities were identified that could be proposed to enhance or restore the wetlands. The on-site vegetative communities were categorized according to the 1999 Florida Land Use, Cover and Forms Classification System (FLUCCS) developed by the Florida Department of Transportation.

C. Quantifying Habitat Improvement Ecological Lift

In February 2004, the Florida Department of Environmental Protection (FDEP) and State of Florida Water Management Districts adopted (Ch. 62-345, FAC) the Uniform Mitigation Assessment Method (UMAM). The UMAM provides a "standardized procedure for assessing the functions provided by wetlands and other surface waters, the amount that those functions are reduced by a proposed impact, and the amount of mitigation necessary to offset that loss" (62-345.100(2), FAC).

To evaluate and ultimately rank a proposed habitat improvement project, Jones Edmunds needed a methodology to quantify the ecological functional gain that is expected with the proposed habitat improvement project. The State-mandated UMAM provides such a methodology to quantify the ecological benefit or lift that could result from Roberts Bay North presented in this Chapter.

The UMAM provides a "standardized procedure for assessing the functions provided by wetlands and other surface waters."

Jones Edmunds quantified the degree of ecological benefit that could occur from restoring a particular site using the UMAM. To calculate the potential ecological lift, the UMAM requires scoring the current condition of each site as well as the perceived condition of the site after restoration. UMAM is used to quantitatively score the assessment area for three categories: (1) Location and Landscape Support, (2) Water Environment, and (3) Community Structure. These categories are scored on a scale of 0 to 10 (10 being the highest), summed, and then divided by 30, which yields a unitless composite score. For these sites the habitat improvement value is determined by calculating the Relative Functional Gain (RFG), which represents the amount of wetland functions that will be gained with the proposed mitigation. A "time lag" and "risk factor" are incorporated into the calculations of RFG. Time lag represents the amount of time (in years) required for the proposed mitigation to reach maturity and replace the slowest functional value (e.g., wildlife habitat, vegetation structure) that was lost. Time lag values vary from 1.0 (1-year time lag) to 3.9 (greater than 55 years) (Table 3-7).

Using a GPS unit in combination with a review of 2008 digital ortho quarter quadrangle imagery, Jones Edmunds determined the acreage of habitat that would be restored or enhanced in the field. Based on these reviews, we then digitized the approximated enhancement/restoration acreage in GIS over the imagery to be used in the UMAM calculations. The RFG is then multiplied by this acreage to determine the expected credits that can be achieved based on a given habitat improvement project or component. The County could use these UMAM credits to offset capital improvement (CIP) projects that impact existing wetlands within the same basin as the habitat improvement activities are taking place. However, the County may only receive half of the UMAM credits for restoration projects co-funded by SWFWMD or other agencies.

Table 3-7 Time Lag Values Used in the UMAM Analysis

Year	T-factor
< or = 1	1
2	1.03
3	1.07
4	1.10
5	1.14
6 – 10	1.25
11 – 15	1.46
16 – 20	1.68
21 – 25	1.92
26 – 30	2.18
31 – 35	2.45
36 – 40	2.73
41 – 45	3.03
46 – 50	3.34
51 – 55	3.65
>55	3.91

D. Habitat Improvement Opinions of Probable Cost

The cost of restoration was an important evaluation criterion for each site. Once the type of restoration method was determined, Jones Edmunds calculated the cost to implement the specific type of restoration activity. Some sites were determined to benefit large acreages with minimal cost for restoration, whereas other sites would require more costly restoration methods for a small amount of ecological gain.

Compliance monitoring and maintaining exotic plant species within the habitat improvement areas for 4 years were also included in the cost estimate. This assumes that the sites would be permitted through the U.S. Army Corps of Engineers (USACE) and SWFWMD to obtain wetland mitigation credits for wetland impacts associated with County CIP projects. If wetland mitigation credits are not desired, this cost could be removed.

E. Site Ranking

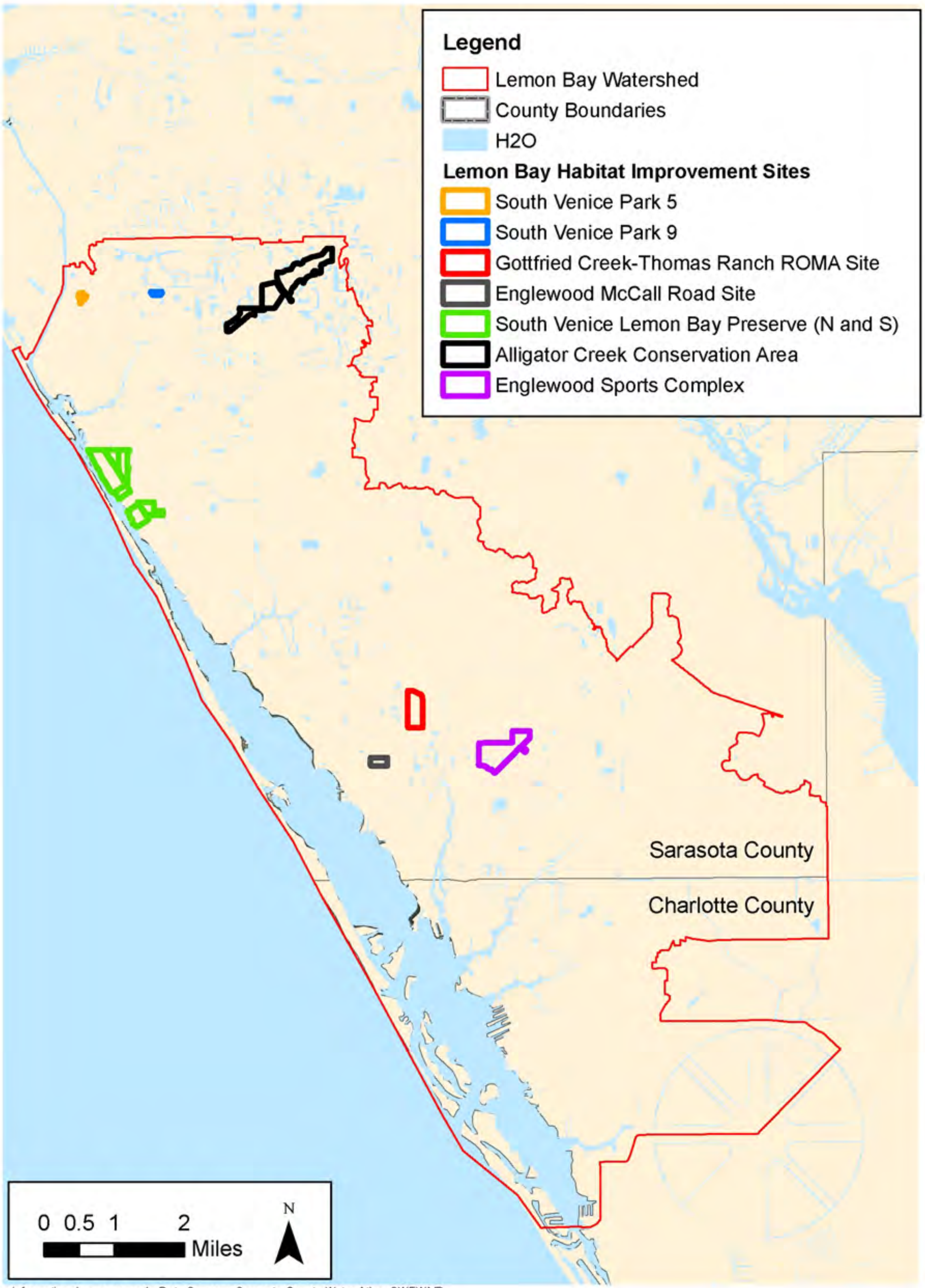
Jones Edmunds ranked sites on a scale of 1 to 5 based on the following three criteria:

1. Ecological lift expected from habitat improvement activities as defined using UMAM.
2. Water quality and quantity improvement to downstream receiving waterbodies.
3. Conceptual opinion of probable cost for implementation.

For example, a project would be scored a 1 if it provides a high ecological benefit, improved downstream water quality or quantity, and a cost-effective approach to habitat improvement. A project would be scored a 5 if it requires costly methods for habitat improvement with low resulting benefits. A site was ranked high in the habitat improvement ranking process (i.e., rank = 1 or 2) if impacts associated with the disturbance were high, habitat improvement would benefit on-site or downstream wetland or surface water quality/quantity, a large land area would benefit from habitat improvement, and the habitat improvement method was fairly simple and cost effective. In contrast, a site was ranked low during the ranking process (i.e., rank = 4 or 5) if a small land area would benefit from habitat improvement, activities did not improve water quality/quantity to on-site or downstream wetlands or surface waters, the activities were complicated and/or expensive, and results from habitat improvement would be minimal.

3.1.3.3 Results and Discussion

Jones Edmunds identified seven potential habitat improvement sites during the initial GIS desktop assessment. However, the Gottfried Creek property was not included in the field assessment as the County is developing a Regional Off-Site Mitigation Area for this recently-acquired property. As a result, five potential habitat improvement sites were identified and assessed within the Lemon Bay watershed (Figure 3-55 and Table 3-8). The sites are presented in Tables 3-8 and 3-9 in ascending order by rank. The following describes vegetation communities, proposed habitat improvements, and preliminary UMAM analysis results and provides conceptual opinions of probable cost for each site.



For informational purposes only. Data Sources: Sarasota County Water Atlas, SWFWMD

Figure 3-55 Location Map for Habitat Improvement Sites

Table 3-8 Identified and Assessed Lemon Bay Watershed Habitat Improvement Sites

Site	Proposed Activity	Hydrologic Benefit On-Site or to Downstream Waterbody	Potential UMAM Credits	Opinion of Probable Cost (2009 $)	Cost per Credit	Rank
South Venice Park 5	NA	NA	NA	NA	NA	NA
South Venice Park 9	NA	NA	NA	NA	NA	NA
Englewood McCall Road Site	Wetland Enhancement; Wetland Buffer Enhancement	Yes	0.9	$158,100	$175,666	1
South Venice Lemon Bay Preserve – North	Wetland Enhancement; Wetland Restoration	Yes	1.0	$181,600	$181,600	2
Alligator Creek CA – Woodmere Park	Wetland Enhancement	No	3.8	$283,800	$74,684	3
Englewood Sports Complex	Wetland Enhancement	No	0.9	$117,500	$130,555	4
South Venice Lemon Bay Preserve – South	Wetland Enhancement; Wetland Buffer Enhancement; Wetland Restoration	No	0.3	$95,300	$317,666	5

Table 3-9 Conceptual UMAM Analysis Summary Table for Proposed Habitat Improvement Sites in Lemon Bay

Site	Mitigation Activity	Assessment Area Acreage	Habitat Type (FLUCCS)	Location and Landscape Support W/Out Mitigation	Location and Landscape Support With Mitigation	Water Environment W/Out Mitigation	Water Environment With Mitigation	Community Structure W/Out Mitigation	Community Structure With Mitigation	Time Lag	Risk Factor	Preservation Adjustment Factor	Relative Functional Gain	Functional Gain Units
Englewood McCall Road Site	Wetland Enhancement	6	6170	3	3	5	8	6	9	1.03	1.25	NA	0.155	0.9
													TOTAL	**0.9**
South Venice Lemon Bay Preserve – North	Wetland Restoration	0.9	6400	6	6	0	8	0	8	1.03	1.25	NA	0.414	0.4
	Wetland Enhancement	3.9	3000	6	6	5	8	5	8	1.03	1.25	NA	0.155	0.6
													TOTAL	**1.0**
Alligator Creek CA – Woodmere Park	Wetland Enhancement	74	6300	4	4	7	7	6	8	1.03	1.25	NA	0.052	3.8
													TOTAL	**3.8**
Englewood Sports Complex	Wetland Enhancement	11	6300	7	7	7	7	6	9	1.03	1.25	NA	0.078	0.9
													TOTAL	**0.9**
South Venice Lemon Bay Preserve – South	Wetland Buffer Enhancement	0.6	1100	6	6	NA	NA	1	8	1.46	1.25	NA	0.128	0.1
	Wetland Enhancement	2	6180	6	7	8	8	6	9	1.03	1.25	NA	0.104	0.2
													TOTAL	**0.3**
ALL SITES TOTAL														**6.9**

A. South Venice Park 5

South Venice Park 5 is a small (approximately 5-acre) City of Venice park that fronts Flower Road in the northwest corner of the Lemon Bay watershed (Figure 3-55). This small park is characterized as Temperate Hardwood (FLUCCS Code 4250). The canopy is dominated by laurel oak (*Quercus laurifolia*) and live oak (*Q. virginiana*) while the understory is dominated by sabal palm (*Sabal palmetto*), elderberry (*Sambucus canadensis*), beautyberry (*Callicarpa americana*), grape vine (*Vitis rotundifolia*), wild coffee (*Psychotria nervosa*), and rustweed (*Vernonia* sp.). A few Brazilian pepper (*Schinus terebinthifolius*) are scattered around the site.

Jones Edmunds assessed soils in the center of the site where elderberry was fairly dense. Organic bodies were found within the upper 6 inches of the soil surface, indicating that the site may have had a higher water table in the past. A very wide (30 feet) and deep (6 feet) ditch runs along the west and south side of this site (Figure 3-56) and is likely dewatering this park site. To reduce this effect, a ditch block had been proposed at the south end of the park (Figure 3-57). However, based on a preliminary review of the County's Interconnected Pond Routing (ICPR) hydraulic and hydrologic stormwater model, any structures that obstruct this ditch will likely increase the probability of upstream flooding. Based on the lack of wetlands, the few exotic or nuisance species present, and the probability of increasing flood potential in the immediate area if a ditch block were installed, no habitat improvement activities are proposed for this site.

Figure 3-56 Large Perimeter Ditch at Venice Park 5

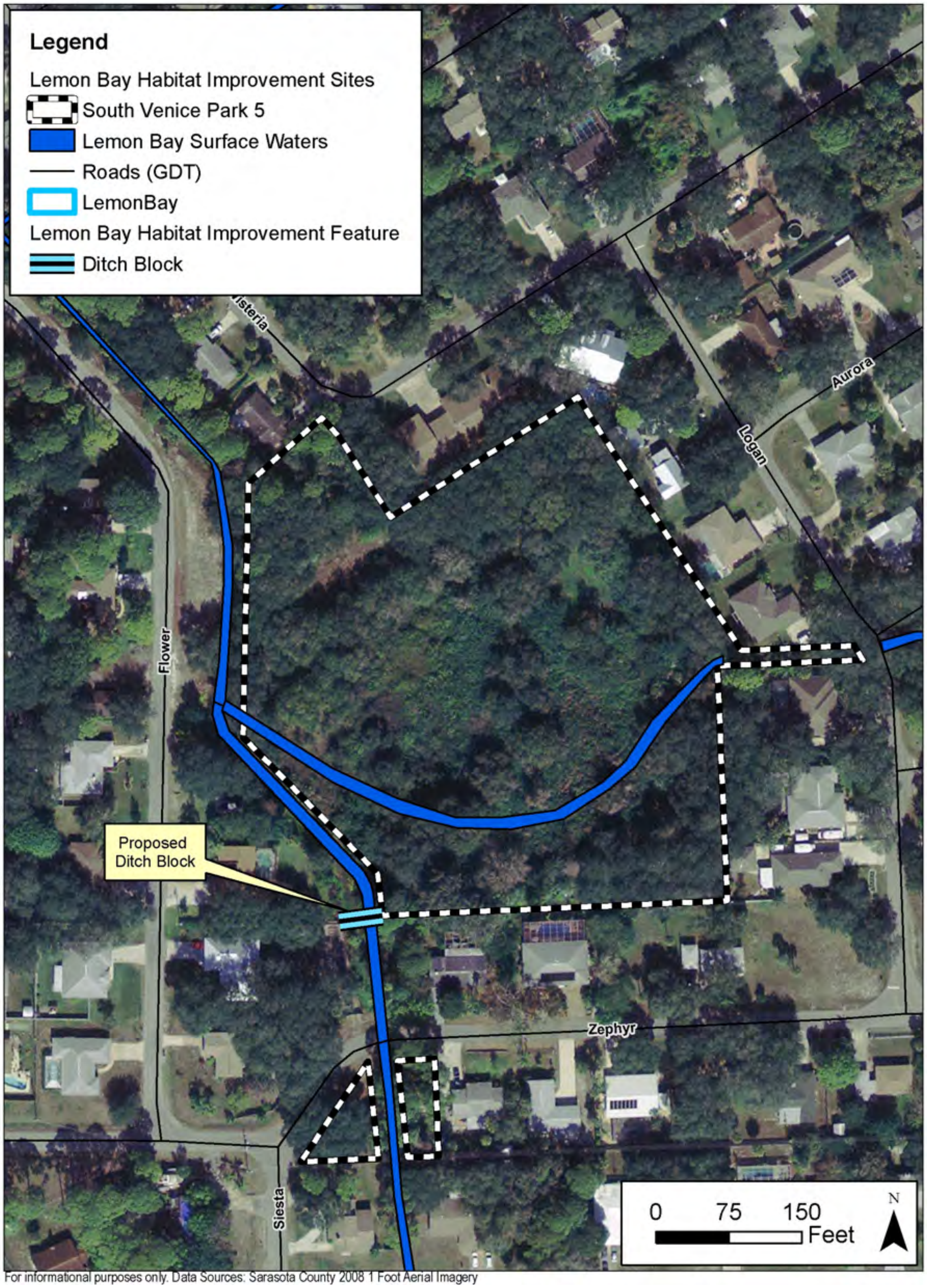


Figure 3-57 South Venice Park 5 Aerial Map

B. South Venice Park 9

South Venice Park 9 is another small urban park in the northwest region of the Lemon Bay watershed (Figure 3-58). The park is between Briarwood Road and Morningside Road east in a neighborhood on the east side of Tamiami Trail South. According to the 2007 Sarasota Native Habitat dataset, a large wetland was present on this site. However, a Jones Edmunds field inspection of the site determined that no jurisdictional wetlands were in the interior portions of the property (Figure 3-59). However, there were two jurisdictional upland cut surface waters, one that runs along the north side of the property and an isolated ditch/pond system on the south side (Figure 3-60). Based on the lack of wetlands, the few exotic or nuisance species present, and the small size of the surface water that could be restored, we propose no habitat improvement activities for this site.

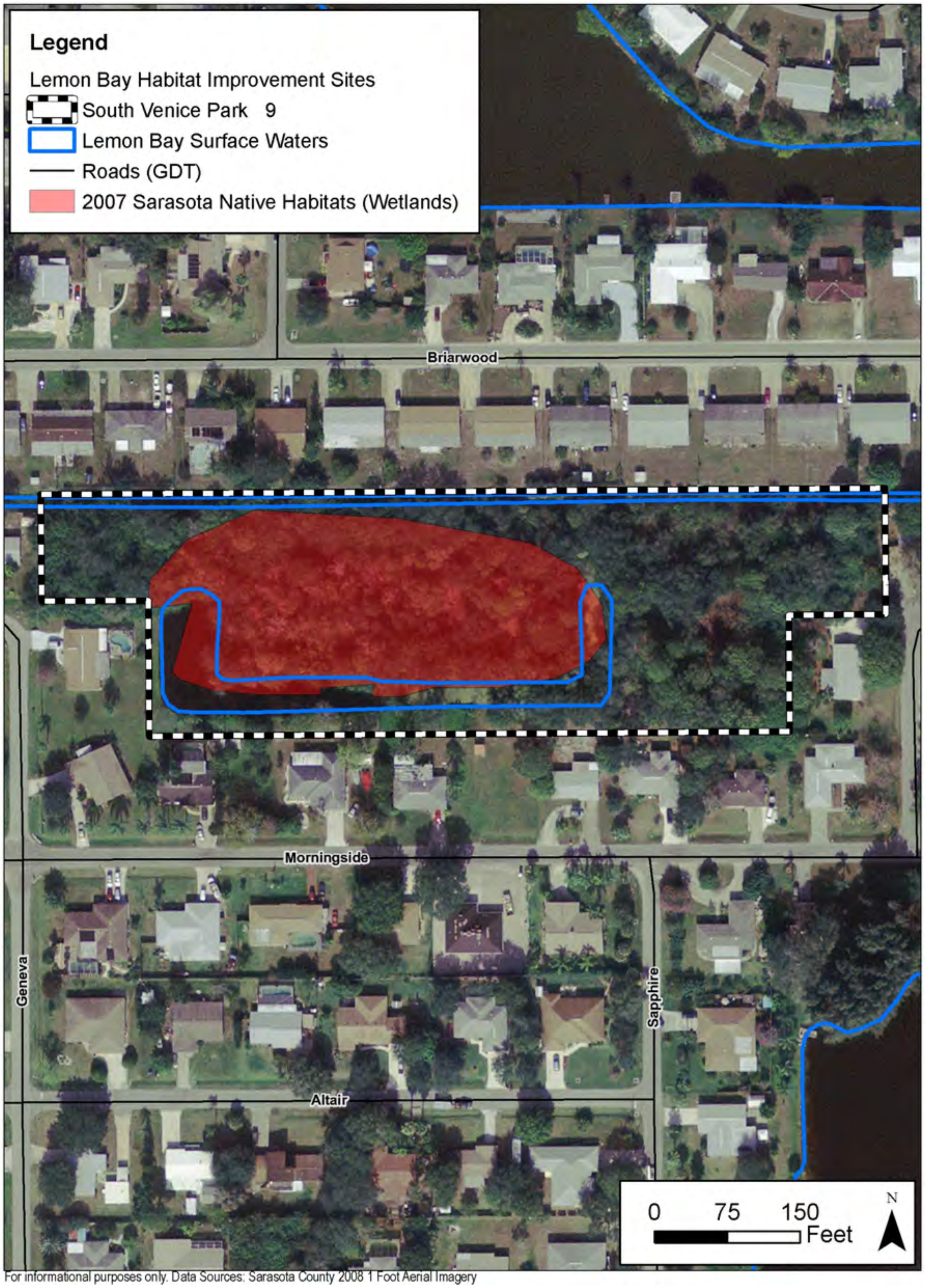


Figure 3-58 South Venice Park 9 Aerial Map

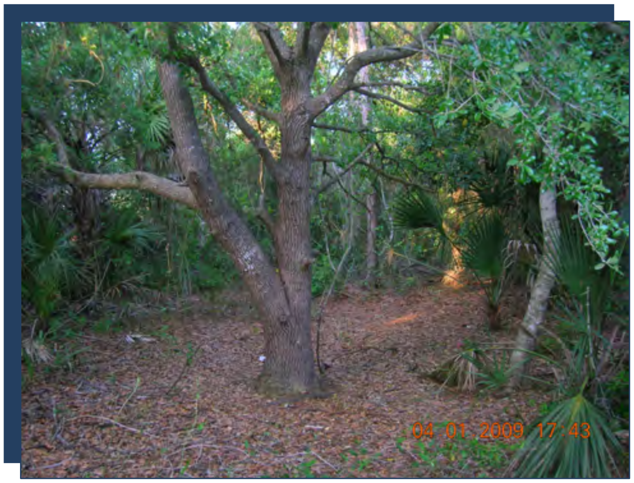


Figure 3-59 Uplands Found throughout South Venice Park 9

Figure 3-60 Ditch found along South Side of South Venice Park 9

C. Englewood McCall Road Site

1. Site Description

The Englewood McCall Road site is an approximately 18-acre County-owned property in the central region of the Lemon Bay watershed (Figure 3-55). It is bound on the west by North Elm Street and the east by North McCall Road (Figure 3-61). The on-site uplands are dominated by Pine Flatwoods (FLUCCS Code 4110) (Figure 3-62). Dominant species include longleaf pine (*Pinus palustris*), saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), bracken fern (*Pteridium aquilinum*), rusty lyonia (*Lyonia ferrunginia*), and grape vine.

An approximately 6-acre medium-quality Mixed Wetland Hardwoods (FLUCCS Code 6170) is located in the central region of the site. This wetland is dominated by red maple (*Acer rubrum*), cabbage palm (*Sabal palmetto*), dahoon holly (*Ilex cassine*), laurel oak, swamp dogwood (*Cornuus foemina*), iris (*Iris* sp.), pepper vine (*Ampelopsis arborea*), and Brazilian pepper seedlings. The exotic and invasive species Australian pine (*Casuarina equisetifolia*), Brazilian pepper, and creeping oxeye (*Wedelia trilobata*) are scattered throughout the wetland. A channelized ditch runs from the southeast corner through this wetland to a stormwater pond in the northwest corner of the property (Figure 3-63). Much pepper vine is encroaching into the wetland, which may indicate that this ditch is affecting the hydrology.

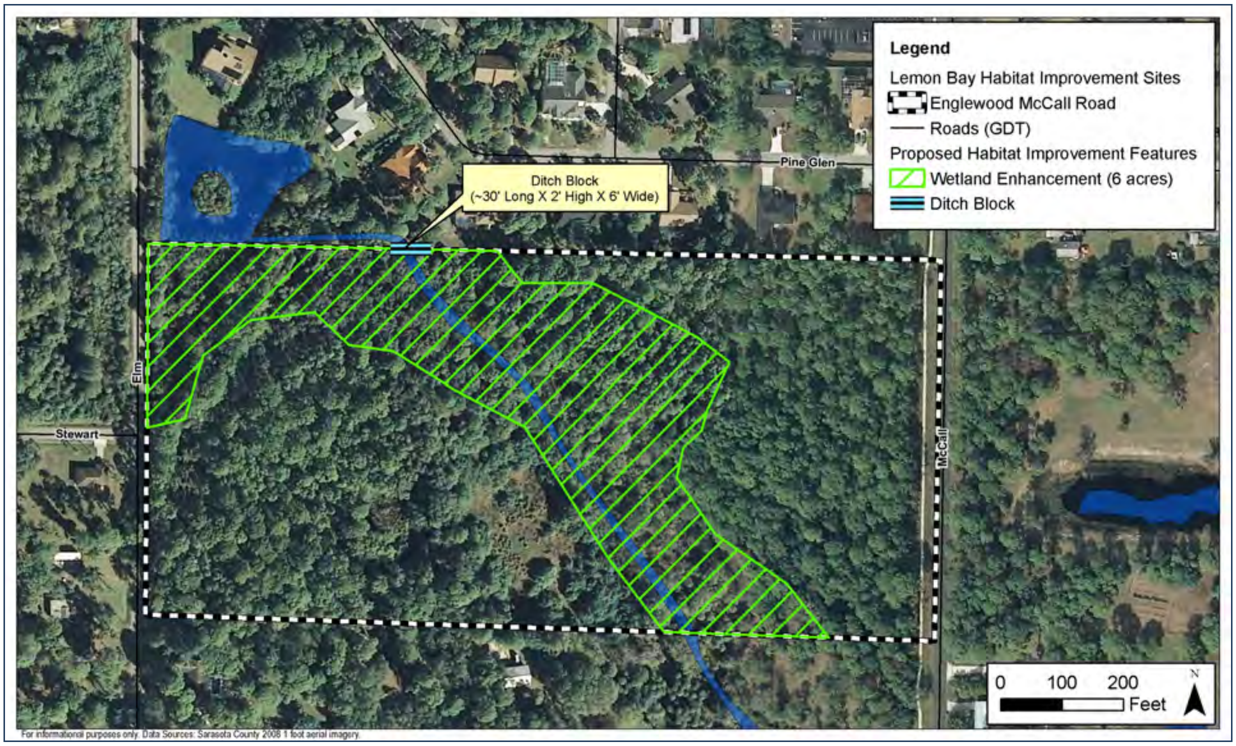


Figure 3-61 Englewood McCall Road Habitat Improvement Conceptual Design

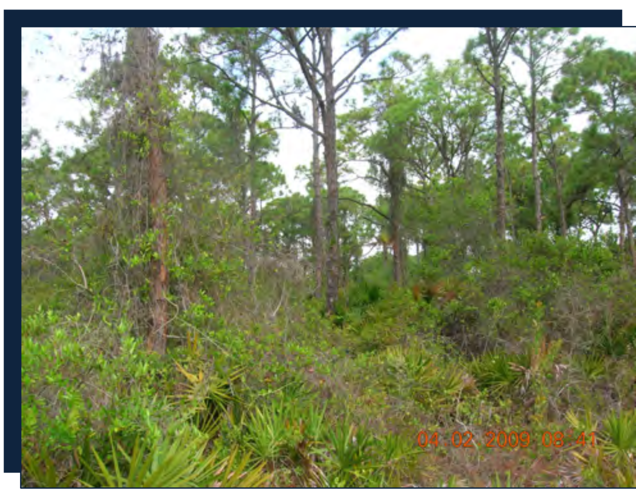


Figure 3-62 Englewood McCall Road Uplands Looking West

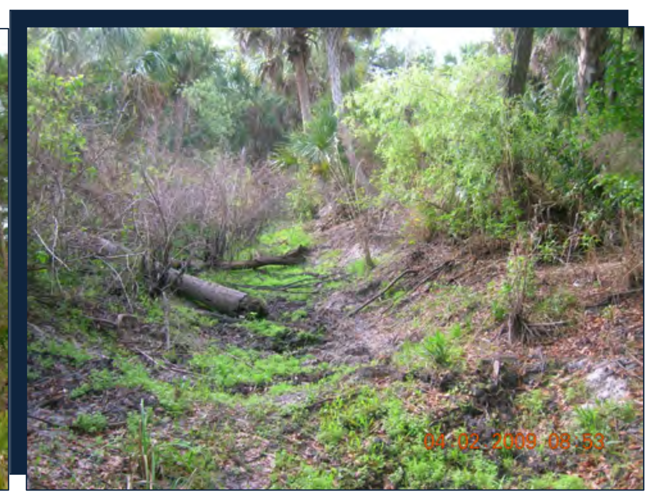


Figure 3-63 Englewood McCall Road Ditch Looking South

2. Proposed Habitat Improvement

Wetland Enhancement—Jones Edmunds proposes exotic species removal and hydrologic enhancement at this site to increase the habitat quality. We propose removing exotic species using a combination of manual removal and herbicide application to ground-cover species such as the abundant Brazilian pepper seedlings and creeping oxeye.

We propose a ditch block at the northern on-site limit of the ditch before it turns west and flows toward the stormwater pond (Figure 3-61). Local residents discussed flooding and high water problems in this area along their backyards during the summer. Installing a ditch block here will help to back water up into the site, rehydrate the on-site wetland and upland areas immediately adjacent to it, and may also reduce these flooding issues downstream of the ditch block. The ditch block will be constructed to span the width of the ditch and tie to existing adjacent grades and will be covered with a geofabric, and rip rap will be placed on both sides. The ditch is contained in the County's ICPR stormwater model. Based on a preliminary review of the model schematic, topography, and the location of the proposed ditch block, it appears that this proposed structure can be designed in such a way that would not increase the probability of upstream flooding of adjacent property owners. However, survey data and modeling of this proposed ditch block would need to be completed to confirm that flooding of adjacent property owners would not occur.

3. UMAM Analysis

Jones Edmunds conducted a preliminary UMAM analysis to quantify the ecological lift expected based on hydrologic enhancement and exotic plant removal discussed above. Wetland enhancement that entails removing exotic and invasive plant species were combined for this analysis because even if they were scored independently they would be scored the same and thus would generate the functional gain. Results of this analysis indicate that approximately 1 UMAM credit may be generated as a result of these activities (Table 3-9).

4. Opinion of Probable Cost

The opinion of probable cost for the proposed activities at the Englewood McCall Road Site is $158,100 (Table 3-10). This cost includes designing and obtaining permitting for the project, up to 4 years of exotic and invasive plant species maintenance, and annual monitoring for 4 years. Based on the preliminary UMAM analysis, this results in a cost per credit of $175,666 (Table 3-8).

5. Ranking

The Englewood McCall Road site ranked 1 due to the relatively low cost per mitigation credit that it would generate. This project will increase the habitat quality for the on-site wetland by removing exotic and invasive species and restoring the hydroperiod of on-site wetlands. The flooding frequency and stage behind homes at the north end of the site may also be reduced.

Table 3-10 Opinion of Probable Cost for McCall Road Habitat Improvement

JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

OWNER:		ESTIMATED BY:		
Sarasota County		**JRM**		
CLIENT:		CHECKED BY:		
Sarasota County		**BJ**		
PROJECT TITLE:		APPROVED BY:		
McCall Road Habitat Improvement				
JONES EDMUNDS PROJECT NUMBER:		DATE:		
19006-015-04 Task 4320		**6/12/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	0.5	$ 13,600.67	$ 6,800
Rubber Mats	EA	70	$ 80.00	$ 5,600
Earthen Ditch Block	CY**	13	$ 390.00	$ 5,200
Sod	SF	180	$ 30.55	$ 5,499
Riprap	SY	7	$ 120.90	$ 806
Geofabric	SY	7	$ 3.50	$ 23
Silt Fence	LF	84	$ 1.20	$ 100
Turbidity Barrier Floating (Multiple Use)	LF	40	$ 12.00	$ 480
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Maintenance of Exotic Species (4 Years)	ACRE	6	$ 500.00	$ 12,000
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 25,000.00	$ 25,000
Subtotal				$ 119,809
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 11,981
Subtotal				$ 131,790
CONTINGENCY		20%		$ 26,358
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 158,100**

D. South Venice Lemon Bay Preserve – North

1. North Site Proposed Habitat Improvement

Wetland Restoration—Sarasota County recently completed a restoration project at this park that entailed regrading areas and installing a weir near Woodmere Creek South Branch. However, some areas were not graded down to wetland grade and thus are not sufficiently hydrated and are impounding water upstream of these areas (Figure 3-64 and 3-65). These areas comprise approximately 0.9 acre and will be graded down to the grade of adjacent wetlands. Native herbaceous wetland plant species found in adjacent Freshwater Marsh (FLUCCS Code 6410) communities such as sand cordgrass, soft rush, and maidencane (*Panicum hemitomon*) will be installed on the graded areas.

Wetland Enhancement—The wetland will be enhanced by hydrologically improving approximately 4 acres by grading down the high areas described above. This will restore the hydroperiod to downstream and upstream wetlands.

2. UMAM Analysis

Jones Edmunds conducted a preliminary UMAM analysis to quantify the ecological lift expected based on the proposed wetland enhancement activity. Results of this preliminary analysis indicate that approximately 1.0 UMAM credits may be generated if the County implements the four habitat improvement activities described above (Table 3-9).

3. Opinion of Probable Cost

The opinion of probable cost for the proposed activities at South Venice Lemon Bay Preserve – North is $181,600 (Table 3-11). This cost includes designing and obtaining permitting for the project, up to 4 years of exotic and invasive plant species maintenance, and annual monitoring for 4 years. Based on the preliminary UMAM analysis, this results in a cost per credit of $181,600 (Table 3-8).

4. Ranking

Due to the hydrologic enhancement that will occur at the site rather than just exotic species removal, this site was ranked 2. It could also potentially generate 1 UMAM credit for the County's use (Table 3-9).

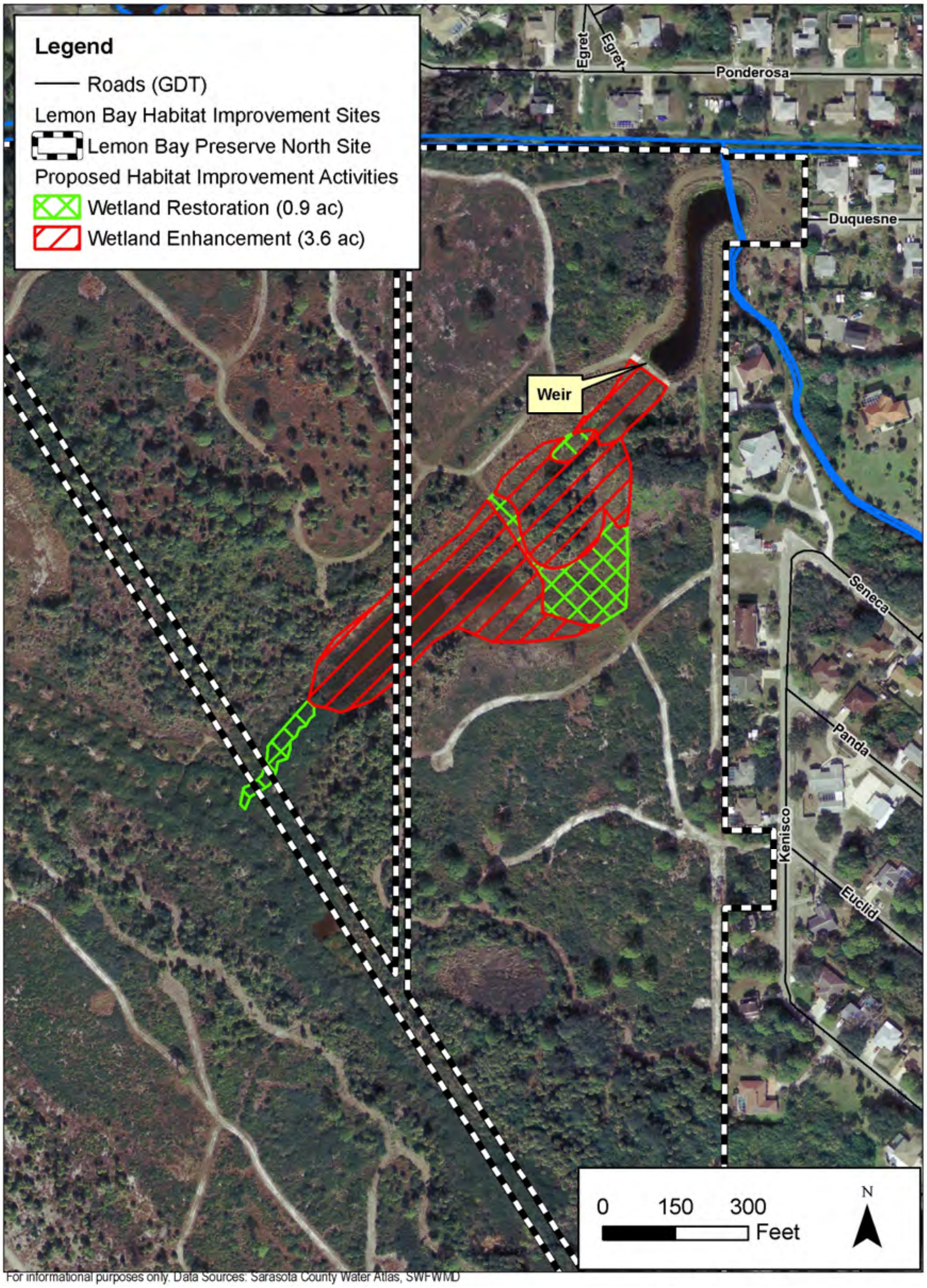


Figure 3-64 South Venice Lemon Bay Preserve North Site Habitat Improvement Conceptual Plan

Figure 3-65 Lemon Bay Preserve North

Table 3-11 Opinion of Probable Cost for South Venice Lemon Bay Preserve – North

JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

PROJECT TITLE:				
South Venice Lemon Bay Preserve Habitat Improvement (North)		ESTIMATED B	**JRM**	
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY	**BJB**	
19006-015-05		DATE:	**6/25/2009**	
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Excavation	CY	1,452	$ 22.96	$ 33,338
Silt Fence	LF	4,000	$ 1.50	$ 6,000
Turbidity Barrier	LF	200	$ 12.00	$ 2,400
Equipment Matting	EA	250	$ 80.00	$ 20,000
Planting	LS		$ 7,000.00	$ 7,000
Subtotal				**$ 68,738**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 6,874
Subtotal				$ 75,612
CONTINGENCY		20%		$ 15,122
Survey				$ 3,437
Geotechnical Investigation				$ 3,437
Design and Permitting				$ 25,000
Monitoring (Baseline and 3 Years)				$ 55,000
Maintenance of Exotic Species (4 Years)	ACRE	1	$500	$ 4,000
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 181,600**

E. Alligator Creek Conservation Area – Woodmere Park

1. Site Description

The Alligator Creek Conservation Area – Woodmere Park property is in the northeast corner of Lemon Bay watershed in the eastern region of the County (Figure 3-55). The County is pursuing the restoration of Alligator Creek in the southwest portion of Woodmere Park by re-creating stream sinuosity. Based on discussions with County staff and that the County was currently pursuing restoration activities in the southwest portion of the park, Jones Edmunds focused the habitat improvement site assessment on the northeast portion of this site where Alligator Creek crosses Venice East Boulevard (Figure 3-66).

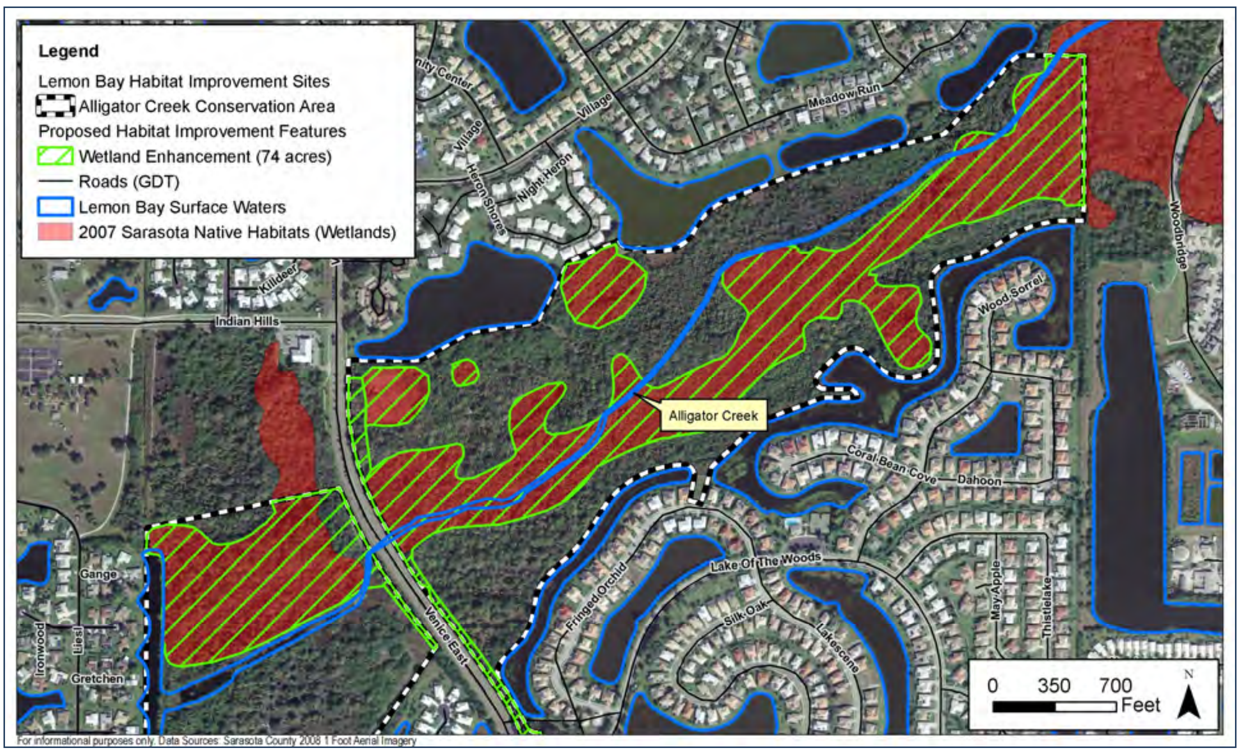


Figure 3-66 Alligator Creek Conservation Area Habitat Improvement Conceptual Plan

Alligator Creek upstream of Center Road is a channelized system with dense Brazilian pepper along the banks. Areas adjacent to the creek are characterized as Mixed Wetland Hardwoods (FLUCCS Code 6170). These wetlands are dominated by red maple, laurel oak, sabal palm, wax myrtle (*Myrica cerifera*), and swamp fern (*Blechnum serrulatum*). Brazilian pepper is also scattered throughout the wetland and along the road frontage. Temperate Hardwood (FLUCCS Code 4250) uplands dominate areas adjacent to wetlands. Even though Alligator Creek has been channelized, no obvious signs of dehydration or hydrologic impacts resulting from this channelization were observed in the wetland. There is a large double box culvert where Alligator

Creek crosses Center Road. No ponding was observed and biotic indicators did not indicate that the wetland around the culvert experienced artificially high stages. Thus, the culvert appears to provide sufficient conveyance capacity based on the lack of upstream ponding.

Wetlands associated with Alligator Creek downstream of Center Road are also characterized as Mixed Wetland Hardwoods (FLUCCS Code 6170). A large ditch runs north- south along the edge of the wetland. This ditch fades out at the north and south ends and thus is not hydrologically connected to any off-site surface water. Dense Brazilian pepper is found along the east side of this ditch. The wetland west of Center Road appears to experience much higher water levels based on the dominance of Carolina willow (*Salix caroliniana*) in several areas that exhibit adventitious roots approximately 2 feet above wetland grade. A large area of cattail (*Typha latifolia*) is on the south side of Alligator Creek.

Based on the lack of biotic indicators indicating hydrologic alteration, ditch blocks or other features are not proposed for Alligator Creek. Recreating sinuosity in the creek would result in considerable damage to the mature canopy on the upstream side of Center Road that has developed since the channelization. Thus, Jones Edmunds proposes no hydrologic habitat improvement projects for this site.

2. Proposed Habitat Improvement

Wetland and Wetland Buffer Enhancement—Jones Edmunds proposes wetland enhancement for approximately 74 acres of wetlands within the Alligator Creek watershed by removing exotic species, primarily Brazilian pepper (Figure 3-66). Exotic species removal will increase the habitat quality of the on-site wetland and reduce the further encroachment of these species.

3. UMAM Analysis

Jones Edmunds conducted a preliminary UMAM analysis to quantify the ecological lift expected based on the proposed wetland enhancement activity. Removing exotic species in this wetland will increase the Community Structure category in the UMAM. We expect that it will take at least 2 years of aggressive treatment to control Brazilian pepper, which is what the time lag factor incorporates and some amount of risk of recolonization by this species will remain. Results of this preliminary analysis indicate that approximately 3.8 UMAM credits may be generated if the County implements the wetland enhancement activity (Table 3-9).

4. Opinion of Probable Cost

The opinion of probable cost for the exotic species maintenance at Alligator Creek Conservation Area is $283,800 (Table 3-12). This cost assumes a cost of $500/acre for manual removal and spraying for the entire on-site wetland acreage. Since not all portions of the wetlands were groundtruthed, a more detailed site assessment should be conducted to determine the total acreage that requires treatment. This cost estimate also assumes 4 years of exotic and invasive plant species maintenance and annual monitoring for 4 years. Based on the preliminary UMAM analysis, this results in a cost per credit of $74,684 (Table 3-8).

Table 3-12 Opinion of Probable Cost for Alligator Creek Conservation Area

OWNER:		ESTIMATED BY:		
Sarasota County		**JRM**		
CLIENT:		CHECKED BY:		
Sarasota County		**BJ**		
PROJECT TITLE:		APPROVED BY:		
Alligator Creek Preservation Area Habitat Improvement				
JONES EDMUNDS PROJECT NUMBER:		DATE:		
19006-015-04 Task 4320		**6/12/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Maintenance of Exotic Species (4 Years)	ACRE	74	$ 500.00	$ 148,000
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 12,000.00	$ 12,000
Subtotal				$ 215,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 21,500
Subtotal				$ 236,500
CONTINGENCY		20%		$ 47,300
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 283,800**

5. Ranking

Although this site will generate the most UMAM mitigation credits (3.8) and have the lowest cost per credit, the site was ranked 3, primarily because exotic plant species removal will not provide downstream water quality or quantity improvements.

F. Englewood Sports Complex

1. Site Description

The Englewood Sports Complex is in the central region of the Lemon Bay watershed off South River Road (Figure 3-55). This property is approximately 137 acres and contains four main on-site wetlands: Wetlands A through D (Figure 3-67). Wetland A is an approximately 8.5-acre Wet Prairie (FLUCCS Code 6430) that is being extensively invaded by melaleuca (*Melaleuca alternifolia*) in a majority of the wetland (Figure 3-68). The wetland was extremely dry and loblolly pine (*Pinus taeda*) saplings were observed in the central portions of the wetland. Wetland A is dominated by St. Johns Wort (*Hypericum fasciculatum*), wax myrtle, Indian camphorweed (*Pluchea* sp.), yellow-eyed grass (*Xyris* sp.), spikerush (*Eleocharis* sp.), bog buttons (*Lachnocaulon* sp.), broomsedge (*Andropogon glomeratus*), and slender golden-top (*Euthamia minor*). High-quality pine flatwoods (FLUCCS Code 4110) dominated by longleaf pine (*Pinus palustris*), loblolly pine, sabal palm, saw palmetto, wax myrtle, grape vine, and shiny blueberry (*Vaccinium myrsinites*) are found adjacent to Wetland A.

Although this wetland appears extremely dry and is being encroached upon by more transitional species such as loblolly pine, slender golden-top, and broomsedge, no ditches or surface water features that may be draining this wetland were found. However, the Englewood Water District has numerous wells immediately west, which may be affecting the hydroperiod of these wetlands (Figure 3-67).

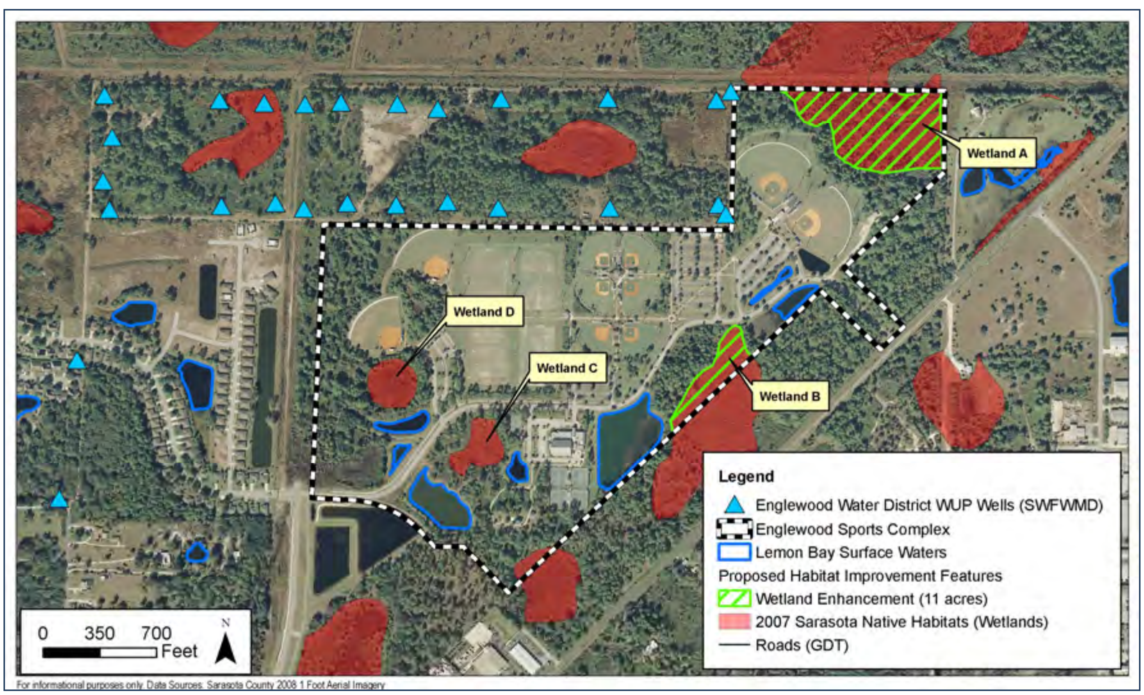


Figure 3-67 Englewood Sports Complex Place Habitat Improvement Conceptual Plan

Wetland B comprises approximately 2.2 acres and is also characterized as a high-quality Wet Prairie (FLUCCS Code 6430). This wetland is dominated by bluestem broomsedge (*Andropogon virginicus*), slender golden-top, sedges (*Cyperus* spp.), soft rush (*Juncus* spp.), and sand cordgrass (*Spartina bakerii*) (Figure 3-69). Melaleuca is in the center of the wetland, and Brazilian pepper is around the perimeter in some areas.

Due to the isolated nature of these wetlands and the lack of drainage features negatively affecting the hydrology, no hydrologic enhancement activities were identified for the on-site wetlands.

Figure 3-68 Englewood Sports Complex Wetland A

Figure 3-69 Englewood Sports Complex Wetland B

2. Proposed Habitat Improvement

Wetland Enhancement

For Wetlands A and B, Jones Edmunds proposes wetland enhancement by removing melaleuca and Brazilian pepper, which comprise approximately 11 acres. Removing these exotic species will increase habitat quality of the on-site wetland and reduce the further encroachment of these species.

3. UMAM Analysis

Jones Edmunds conducted a preliminary UMAM analysis to quantify the ecological lift expected based on the proposed wetland enhancement activity. Removing exotic species in this wetland will only increase the Community Structure category in the UMAM. We expect that it will take at least 2 years of aggressive treatment to control melaleuca, which is reflected in the time lag value. Some amount of risk of recolonization by this species will remain. Results of this preliminary analysis indicate that approximately 0.9 UMAM credits may be generated if the County implements the wetland enhancement activity (Table 3-9).

4. Opinion of Probable Cost

The opinion of probable cost for the proposed activities at Englewood Sports Complex is $117,500 (Table 3-13). This cost includes the design and permitting of the project, up to 4 years of exotic and invasive plant species maintenance, and annual monitoring for 4 years. Based on the preliminary UMAM analysis, this results in a cost per credit of $130,555 (Table 3-8).

5. Ranking

Because of the high cost of implementing the proposed activities and the proposed habitat improvement activities will provide no downstream water quality or quantity improvement, this site was ranked 4. However, these improvements would greatly enhance the habitat value of this park in the areas where they are proposed.

Table 3-13 Opinion of Probable Cost for Englewood Sports Complex Habitat Improvement

JONES EDMUNDS ENGINEERS | ARCHITECTS | SCIENTISTS	Sarasota County
OWNER:	ESTIMATED BY:
Sarasota County	**JRM**
CLIENT:	CHECKED BY:
Sarasota County	**BJ**
PROJECT TITLE:	APPROVED BY:
Englewood Sports Complex Habitat Improvement	
JONES EDMUNDS PROJECT NUMBER:	DATE:
19006-015-04 Task 4320	**6/12/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Maintenance of Exotic Species (4 Years)	ACRE	11	$ 500.00	$ 22,000
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 12,000.00	$ 12,000
Subtotal				$ 89,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 8,900
Subtotal				$ 97,900
CONTINGENCY		20%		$ 19,580
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 117,500**

G. South Venice Lemon Bay Preserve – South

Two potential habitat improvement sites were identified within the South Venice Lemon Bay Preserve Park. They are referred to as South and North.

1. South Site Description

South Venice Lemon Bay Preserve South site is in the northwest region of the Lemon Bay watershed (Figure 3-55). The approximately 5-acre portion of this preserve that was assessed is at the end of Osprey Road and fronts Raven Road on its east side (Figure 3-70). It was a former homestead and the County recently demolished the home. An open grassed area along the west side of the property was the former maintained yard of the residence (Figure 3-71).

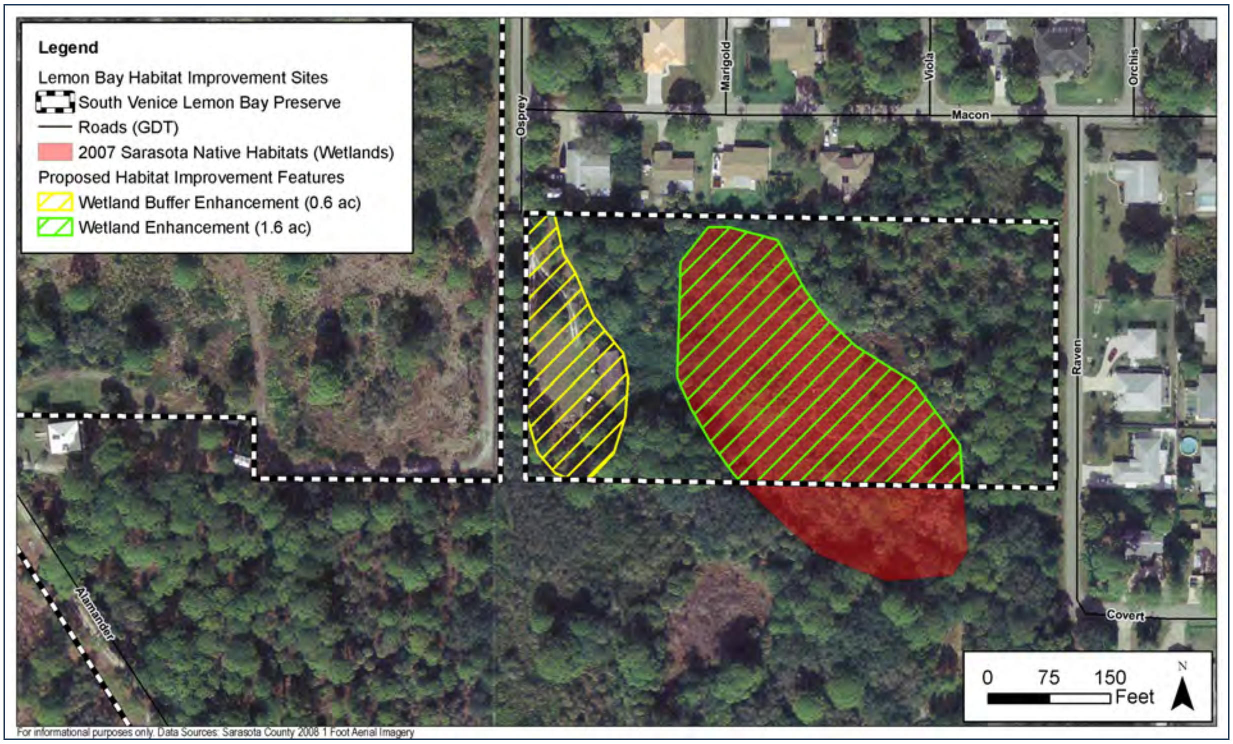


Figure 3-70 South Venice Lemon Bay Preserve South Site Habitat Improvement Conceptual Plan

This property contains an isolated approximately 2-acre wetland characterized as Willow and Elderberry (FLUCCS Code 6180) and is dominated by Carolina willow, saltbush (*Baccharis halimifolia*), primrose willow (*Ludwigia peruviana*), buttonbush (*Cephalanthus occidentalis*), duck potato (*Sagittaria lancifolia*), sand cordgrass, and Virginia chain fern (*Woodwardia virginica*) (Figure 3-72). Several large melaleuca trees are on the east side, Brazilian pepper is on the south side, and extensive areas of creeping oxeye are in the southern and eastern areas of the wetland (Figures 3-72 and 3-74). The adjacent uplands are dominated by high-quality pine flatwoods (FLUCCS Code 4110) (Figure 3-75).

Figure 3-71 Wetland Buffer Enhancement Area at South Venice Lemon Bay Preserve Habitat Improvement Site

Figure 3-72 Wetland Enhancement Area at South Venice Lemon Bay Preserve Habitat Improvement Site

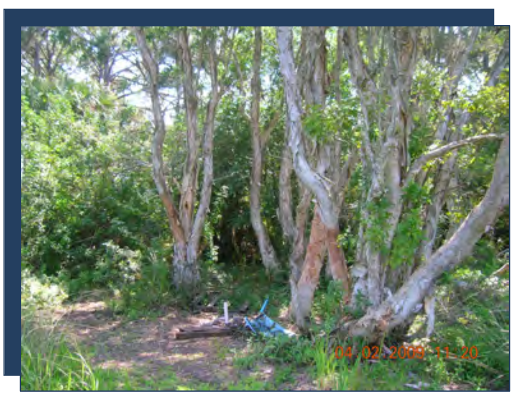


Figure 3-73 Melaleuca at Wetland Enhancement Area at South Habitat Improvement Site

Figure 3-74 Creeping Oxeye at Wetland Enhancement Area at South Habitat Improvement Site

Figure 3-75 Adjacent Upland Habitat at South Venice Lemon Bay Preserve

2. South Site Proposed Habitat Improvement

Wetland Enhancement—Jones Edmunds proposes enhancing the wetland by removing melaleuca, Brazilian pepper, and creeping oxeye from the on-site wetland. Removing these exotic species will increase the habitat quality of the on-site wetland and reduce the further encroachment of these species.

Wetland Buffer Enhancement—We propose wetland buffer enhancement for the former home site along the west side of the parcel. This will improve the habitat quality of this wetland buffer, which will provide greater cover for wetland- and upland-dependent wildlife species and create a naturally vegetated corridor to the remaining portions of the park to the west. These areas are dominated by bahia grass (*Paspalum notatum*) and other ruderal species. The proposed wetland buffer enhancement entails planting native tree, shrub, and herbaceous species found in pine flatwoods. Native pine flatwoods species that could be considered for the wetland buffer enhancement area are listed in Table 3-14.

Table 3-14 Proposed Planting Plan for Honore Trail Park Wetland Buffer Enhancement Area

Common Name	Scientific Name
Longleaf pine	*Pinus palustris*
Wire grass	*Aristida stricta*
Muhly grass	*Muhlenbergia capillaris*
Gallberry	*Ilex glabra*
Saw palmetto	*Serenoa repens*

3. UMAM Analysis

Jones Edmunds conducted a preliminary UMAM analysis to quantify the ecological lift expected based on the proposed wetland enhancement activity. Results of this preliminary analysis indicate that approximately 0.3 UMAM credits may be generated if the County implements the four habitat improvement activities described above (Table 3-9).

4. Opinion of Probable Cost

The opinion of probable cost for the proposed activities at South Venice Lemon Bay Preserve – South is $95,300 (Table 3-15). This cost includes designing and obtaining permitting for the project, up to 4 years of exotic and invasive plant species maintenance, and annual monitoring for 4 years. Based on the preliminary UMAM analysis, this results in a cost per credit of $317,666 (Table 3-8).

Table 3-15 Opinion of Probable Cost for South Venice Lemon Bay Preserve – South

JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

OWNER:	ESTIMATED BY:
Sarasota County	**JRM**
CLIENT:	CHECKED BY:
Sarasota County	**BJ**
PROJECT TITLE:	APPROVED BY:
South Venice Lemon Bay Preserve Habitat Improvement (South)	
JONES EDMUNDS PROJECT NUMBER:	DATE:
19006-015-04 Task 4320	**6/2/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Maintenance of Exotic Species (4 Years)	ACRE	2.6	$ 500.00	$ 5,200
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 12,000.00	$ 12,000
Subtotal				$ 72,200
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 7,220
Subtotal				$ 79,420
CONTINGENCY		20%		$ 15,884
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 95,300**

3.1.4 Vegetative Buffers

3.1.4.1 Introduction

Vegetated buffers are strips of vegetated land that are ecologically and hydrologically connected to adjacent waterways such as creeks, rivers, marshes, and bays. Studies show that vegetative buffer zones protect, restore, and maintain the chemical, physical, and biological integrity of waterways. Vegetative buffers are highly effective at:

- ❖ Removing pollutants delivered in urban stormwater.
- ❖ Reducing erosion and controlling sedimentation.
- ❖ Protecting and stabilizing stream banks.
- ❖ Providing for infiltration of stormwater runoff.
- ❖ Maintaining base flow of streams.
- ❖ Contributing organic matter that is a source of food and energy for the aquatic ecosystem.
- ❖ Providing tree canopy to shade streams and promote desirable aquatic habitat, providing wildlife habitat.
- ❖ Furnishing scenic value and recreational opportunity

The effectiveness of a buffer is contingent upon its width and vegetative cover. Scientific literature supports a minimum buffer width of 100 feet (with 2 more feet per 1% slope) of native forest vegetation to provide sediment and contaminant control, quality aquatic habitat, and minimal terrestrial wildlife habitat. Buffers of at least 300 feet are, however, recommended to protect diverse terrestrial wildlife communities (Wegner, 1999). The technical literature is reviewed in *A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation*, which gives extensive scientific support for establishing and maintaining buffers along streams.

3.1.4.2 Established Buffer Regulations

To protect floodplain functions, including conveyance, storage, wildlife habitat, and water quality functions, Sarasota County's Land Development Regulation Subdivision Technical Manual requires the following:

- ❖ "No net encroachment will be allowed into a floodplain up to that encompassed by the 100-year event or on floodplain-associated soils defined in Sarasota County Comprehensive Plan Future Land Use Policy 1.1.6.
- ❖ Compensating storage shall be equivalently provided between the seasonal high water level and the flood level.

- ❖ Vegetative buffers shall be established between future development and watercourses, including bay waters. Buffer widths shall be measured landward from the top of bank or the landward extent of wetland vegetation.
- ❖ Minimum buffer widths shall be 50 feet.
- ❖ Specific buffer-width standards, or flood plain protection measures, or water quality enhancement measures that are equivalent in water quality treatment and habitat protection to a 50-foot-wide vegetated buffer and the [that] have been imposed or approved through a critical area plan, including a sector plan or corridor plan; a planned development district; a development of regional impact pursuant to Chapter 380, Florida Statutes; a regional watershed plan; or a development permit, as defined in Sarasota County Ordinance [No.] 89-103, as amended, issued by Sarasota County, shall supersede the buffer width standards contained in these regulations.
- ❖ Native vegetation shall not be removed from buffers except as necessary for the following:
    - County maintenance and access
    - Road and utility crossings
    - Nature trails
    - Access to water-dependent uses such as docks
    - Subdivision amenities such as golf course fairways when such crossings are unavoidable"

The Sarasota County Code of Ordinances, Article 4, Zoning Districts states that for parcels zoned as *Open Use Conservation District (OUC):*

- ❖ "The OUC District is intended to retain the open character of the land. This District is further intended to preserve and protect native habitats, wilderness areas, marsh lands, watersheds, water recharge areas, open spaces; park lands (unless otherwise zoned GU), scenic areas, historical and archaeological resources, and beaches. It is to be used to establish wildlife and open space corridors, as buffer areas to lands designated Public Resource Lands on the Future Land Use Map, to protect life and property in areas subject to flooding, and to conserve fish and wildlife. Permitted uses are restricted to conservation and, with certain limitations, recreation and other uses that are not contrary to the open character of the district."
- ❖ "This District is used to implement any designated land use area on the Future Land Use Map of the Comprehensive Plan."

The Special Purpose Overlay Districts *Conservation Subdivision (CS)* section states that for residential development, setback, and buffer requirements:

- ❖ "The landscape buffer shall be 20 feet wide. Landscape buffer areas are required as detailed below to protect and maintain the rural and agricultural character of the area. Landscape buffer areas are common facilities and shall be required as part of the open space around the residential development in a Conservation Subdivision. Vegetation within the buffer area shall generally be maintained in its natural condition, but may be modified to restore the overall condition and natural functions of the area. The minimum landscape buffer shall consist of four canopy trees and six understory trees per 100 lineal feet and a continuous hedge with a minimum height of 3 feet at planting."
- ❖ "The residential development shall be setback a minimum of 100 feet from all Conservation Subdivision property boundary lines and road rights-of-way. The landscape buffer described above shall be located in the required 100-foot setback and abut the entire perimeter of the residential development."

SWFWMD, in its *Environmental Resource Permitting Information Manual, Part B: Basis of Review for 40-D Rules* (SWFWMD, 2002), includes the following language pertaining to buffer widths:

- ❖ "Secondary impacts to habitat functions of wetlands associated with adjacent upland activities will not be considered adverse if buffers with a minimum width of 15 feet and an average width of 25 feet are provided abutting those wetlands that will remain under the permitted design, unless additional measures are needed for protection of wetlands used by listed species for nesting, denning, or critically important feeding habitat."
- ❖ "For projects located wholly or partially within 100 feet of an Outstanding Florida Water (OFW) or within 100 feet of any wetland abutting an OFW, applicants must provide reasonable assurance that the proposed construction or alteration of a system will not cause sedimentation in the OFW or adjacent wetlands and that filtration of all runoff will occur before discharge into the OFW or adjacent wetlands. Reasonable assurance is presumed if, in addition to implementation of the requirements in Section 2.8.2, one or more of the following measures are implemented:
    - Maintenance of a vegetative buffer consisting of an area of undisturbed vegetation that is a minimum of 100 feet in width landward of the OFW or adjacent wetlands. During construction or alteration of the system, all runoff, including turbid discharges from dewatering activities, must be allowed to sheet flow across the buffer area. Concentrated or channelized runoff from upstream areas must be dispersed before flowing across the vegetative buffer. Construction activities of limited scope that are necessary for the placement of outfall structures may occur within the buffer area.

- The structures described below must be installed or constructed at all outfalls to the OFW or adjacent wetlands before beginning any construction or alteration of the remainder of the system. These structures must be operated and maintained throughout construction or alteration of the permanent system. Although these structures may be located within the 100-foot buffer described in subparagraph (a) above, a buffer area of undisturbed vegetation that is a minimum of 25 feet in width must be maintained between the OFW or adjacent wetlands and any structure."

Through the Surface Water Improvement and Management (SWIM) program Model Ordinance project (SWFWMD, 1991); SWFWMD put forth the following recommendations with respect to suggested buffer widths:

- ❖ For maintenance of water quality in "municipal conditions," a minimum buffer width of 15 to 20 meters (49 to 66 feet) for low (0 to 3%) land slope conditions, with buffers as high as 80 meters (263 feet) for higher land slopes in the 60% range.
- ❖ For water quantity maintenance, a buffer width that ranged from 30 feet to 550 feet was recommended. The actual buffer within that range would depend on site-specific hydrologic conditions.
- ❖ For water quality maintenance, buffer widths ranging from 75 feet to perhaps as wide as 450 feet, depending on site-specific measurements of particle size for sediments that could be carried to a water body through runoff. Average conditions in East Central Florida were taken to generally represent conditions within the SWFWMD.
- ❖ For protection of wildlife habitat, buffer widths ranging from 322 feet to 732 feet, depending on the type of water body being targeted for protection and the predominant types of indicator species that utilize the water body for sustenance. Lower buffer widths may be possible for water bodies of lesser quality. Site-specific evaluation would be necessary to set an appropriate buffer width for wildlife habitat protection.

3.1.4.3 Methods

Jones Edmunds estimated naturally vegetated buffer zones around water courses to identify areas in compliance with current County setback regulations. To make this estimate, we completed a GIS analysis of spatial coverages, including SWFWMD's 2007 land use and the County's parcels and water features coverages. A 50-foot buffer was added to the major waterways features in the County's water features GIS coverage. A 50-foot buffer width was selected to correspond with the County's existing LDRs. Areas within this 50-foot buffer were classified as developed where the 2007 land use coverages are urban and built up; transportation, communication, and utilities; and disturbed land. Remaining areas were classified as undeveloped. Results of these efforts show that an estimated 49% of the Lemon Bay watershed currently has undeveloped parcels within a 50-foot buffer area adjacent to its waterways. The developed and undeveloped areas around waterways are highlighted in Figure 3-76. Since much of the development within the watershed likely occurred before the County's current setback requirements, many of the developed parcels do not meet the current requirements.

3.1.4.4 Results and Discussions

To calculate a more refined percent compliance, a detailed study is recommended. This study would entail a GIS analysis of spatial coverages including parcels, year built, zoning, and land use. In addition, visual inspection to measure the widths and types of vegetative cover along waterways is necessary for accuracy. With data from this analysis, the County could identify both areas to be maintained in their natural vegetated state and areas to be targeted for improvements. For the latter properties, we recommend restoring and establishing vegetated buffer zones along waterways.

Figure 3-76 Lemon Bay Watershed – Waterway Buffer Zones

3.1.5 Preservation Area Mapping

3.1.5.1 Introduction

Sarasota County incorporates natural resource protection requirements in its LDRs. One of these requirements is a 30% open space requirement for developments that prioritize natural communities such as wetlands, mesic hammocks, and coastal hammocks. Additional requirements include 30-foot wetland buffers, 33% littoral shelf for stormwater treatment ponds, and a 50-foot buffer around all water courses (Section 3.1.4). Most of these preservation and littoral shelf areas scattered throughout the County are primarily inventoried on hardcopy development plans. To consolidate these protected and important resources into a single easily accessible location, the County has been scanning, georectifying, and digitizing these areas from the hard-copy development plans that date back to the 1980s. The intent is to generate a single County-wide GIS dataset that can be used by County staff for numerous purposes such as future development reviews, land acquisition, compliance, etc.

3.1.5.2 Methods

Jones Edmunds obtained hardcopy plan sets from the County for seven developments in or near Lemon Bay watershed and an ESRI® ArcGIS™ geodatabase containing polygons for preservation and littoral shelves in developments previously digitized by County staff (Table 3-16). The plan sets were scanned into TIFF format and georeferenced in ArcMap™ using a second-order polynomial transformation that requires a minimum of four ground control points (GCP). The Sarasota County 2008 parcel dataset was used for all GCPs when available. If parcels in and around the development were not available, other features such as roads or buildings were used. GCPs were placed until the root mean square error for the transformation of the scanned document was less than 1 foot. More details of the rectification process are outlined in the *Preserve Area Mapping SOP* available from the Natural Resources Department.

Table 3-16 Preservation Area Mapping Developments in Lemon Bay Watershed

Development Name
Boca Royale
Englewood Family YMCA
Hidden Palms – Alligator Place
Lemon Bay Estates
Sarasota National
Skip Stasko Park
Stillwater

Jones Edmunds digitized all conservation easements, preservation areas, wetland buffers, and stormwater littoral shelves from the georectified plan documents at a scale of 1:600. The conservation easement and preservation area polygons were snapped to 2008 Sarasota County parcel boundaries. Keeping the conservation and preservation area features relative to the parcel information allows for easier future adjustments if the land base data changes. Jones Edmunds then attributed polygons based on the *Preserve Area Mapping SOP* and correspondence with the Natural Resources Department. However, all polygons digitized by Jones Edmunds were attributed with "Jones Edmunds" in the *SOURCE* field of the geodatabase.

3.1.5.3 Results and Discussions

Jones Edmunds generated 162 polygons representing preservation areas, conservation areas, wetland buffers, wetlands mitigation areas, or littoral shelves for developments that were built within Lemon Bay watershed since the 1990s (Figure 3-77). The polygons will help County staff keep an inventory of preservation areas in the County and help them make more informed decisions regarding developments adjacent to these protected areas. Results of this task were also used in the *Lemon Bay Public Lands Gap Analysis* to identify future acquisition priorities.

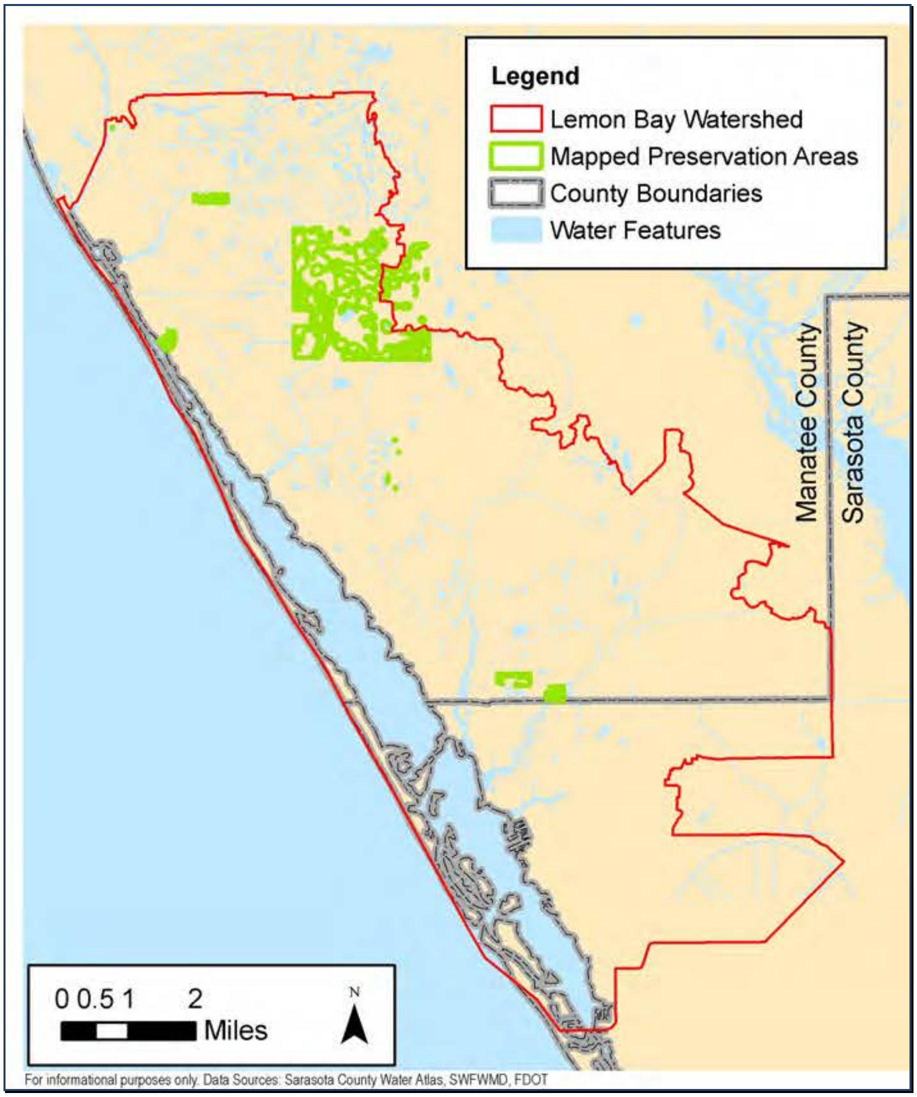


Figure 3-77 Preservation Areas Mapped by Jones Edmunds in Lemon Bay Watershed

3.2 ESTUARY

Estuaries are highly productive natural systems that provide vital habitat for many species of fishes, birds, invertebrates, and plants. Supporting the biodiversity of estuaries is paramount to maintaining estuarine food webs. Natural estuarine systems such as seagrasses, emergent vegetation, oyster reefs, and sediment processes all play an important role in contributing to dynamic estuarine food webs. Healthy estuarine food webs contribute to offshore fisheries production and support valuable economic drivers important to Florida's success.

Estuaries are highly productive natural systems that provide vital habitat for many species of fishes, birds, invertebrates, and plants.

The Lemon Bay watershed includes the Alligator Creek basin, the Woodmere Creek basin, the Forked Creek basin, the Gottfried Creek basin, the Ainger Creek basin, and the Lemon Bay coastal area. The estuarine system is dominated by mangrove, seagrass, and oyster communities and was designated as an aquatic preserve in 1986 (FDNR, 1992). While much of the watershed remains undeveloped, the developed portions of the watershed have impacted estuarine water quality (Tomasko et al., 2005).

The following sections of this chapter identify the valued natural systems found in the Lemon Bay estuary and describe the following aspects of the estuary:

- General ecology.
- Current status with respect to anthropogenic impacts.
- Contributing ecological function.
- Potential use as indicators of estuarine health.

3.2.1 Critical Natural Resources

3.2.1.1 Shorelines

Shorelines define the land-water interface and are ecological transition zones between terrestrial and aquatic life. Shorelines include a littoral zone where diverse habitat types affect the organization of floral and faunal assemblages and the interactions between terrestrial and aquatic plants and animals. Human alteration of estuarine shorelines accompanied the rapid movement of human populations toward coastal environments during the 20th century. Florida's human population expansion in the mid-20th century led to unprecedented shoreline alterations via mechanical dredging and filling of coastal shorelines, which resulted in extensive canalization of coastal areas and hardening of large expanses of previously natural shoreline areas. Shoreline hardening in Florida generally consists of concrete seawalls or bulkheads comprised of concrete or limestone rubble (i.e., riprap). Much of this hardening was intended to define lots for development, increase accessibility to estuarine and coastal waters for recreation, and protect against erosional forces that naturally occur in coastal systems. These shoreline alterations have had profound effects on Florida's natural systems.

In Lemon Bay, shorelines have been altered as a result of natural events and dredge-and-fill projects designed to increase human accessibility to estuarine and coastal waters, primarily for recreation. Characterizing the extent of shoreline modification in Lemon Bay and estimating the change in natural shorelines from historic conditions is important to the WMP. Historical information was available to estimate the extent of historical modified shoreline based on digitized USGS 1:24,000, 7.5-minute quadrangle maps (quad sheets) and aerial photographs from 1948. This information was used to define historic conditions before major shoreline modification occurred in Lemon Bay. Janicki Environmental used GIS (ArcGIS9.1) along with the digitized quad sheets and aerials to delineate modified and natural shorelines as an approximation of historic condition. While the photographs allow for a higher resolution to digitize the location of the shoreline, the quad sheets include a legend that indicates areas known to be mangrove, woods, or brushwood. When combined, these data sources allowed us to estimate the extent of "modified" and "natural" historic shorelines.

Historically, Lemon Bay had 92 kilometers of shoreline, approximately 5.8 kilometers of which were modified (Figure 3-78). To compare this estimate to current conditions, the latest SWFWMD shoreline coverage (2005) was used to visually identify areas that were obviously modified by human activity and also to identify areas where shorelines have naturally been altered. The historical quad sheets are again used here to illustrate the extent of shoreline modification in Lemon Bay. Obvious shoreline modifications in the form of finger-fill canals have taken place along the eastern shoreline in Lemon Bay, notably around Oyster Creek; however, surprisingly much of the canalization along the tidal tributaries occurred before the 1950s (Figure 3-79). Other noteworthy areas of shoreline modification include the bay side of Manasota Key and the southern extension of Manasota Key shoaling the entrance to Stump Pass.

The Charlotte Harbor National Estuary Program (CHNEP) funded a characterization of the existing shoreline in Lemon Bay (Photoscience, 2008). This study provides estimates of the extent of shoreline hardening within the study area. Approximately one-half of the Lemon Bay shoreline is comprised of manmade shoreline in Lemon Bay. The primary classes of manmade shorelines included seawalls and null (indeterminate). Vegetated shorelines in Lemon Bay account for approximately one-half of the total shoreline. Mangroves comprise nearly two-thirds of the vegetated shoreline length in Lemon Bay.

Figure 3-78 Historical Shorelines in Lemon Bay, Florida (1944)

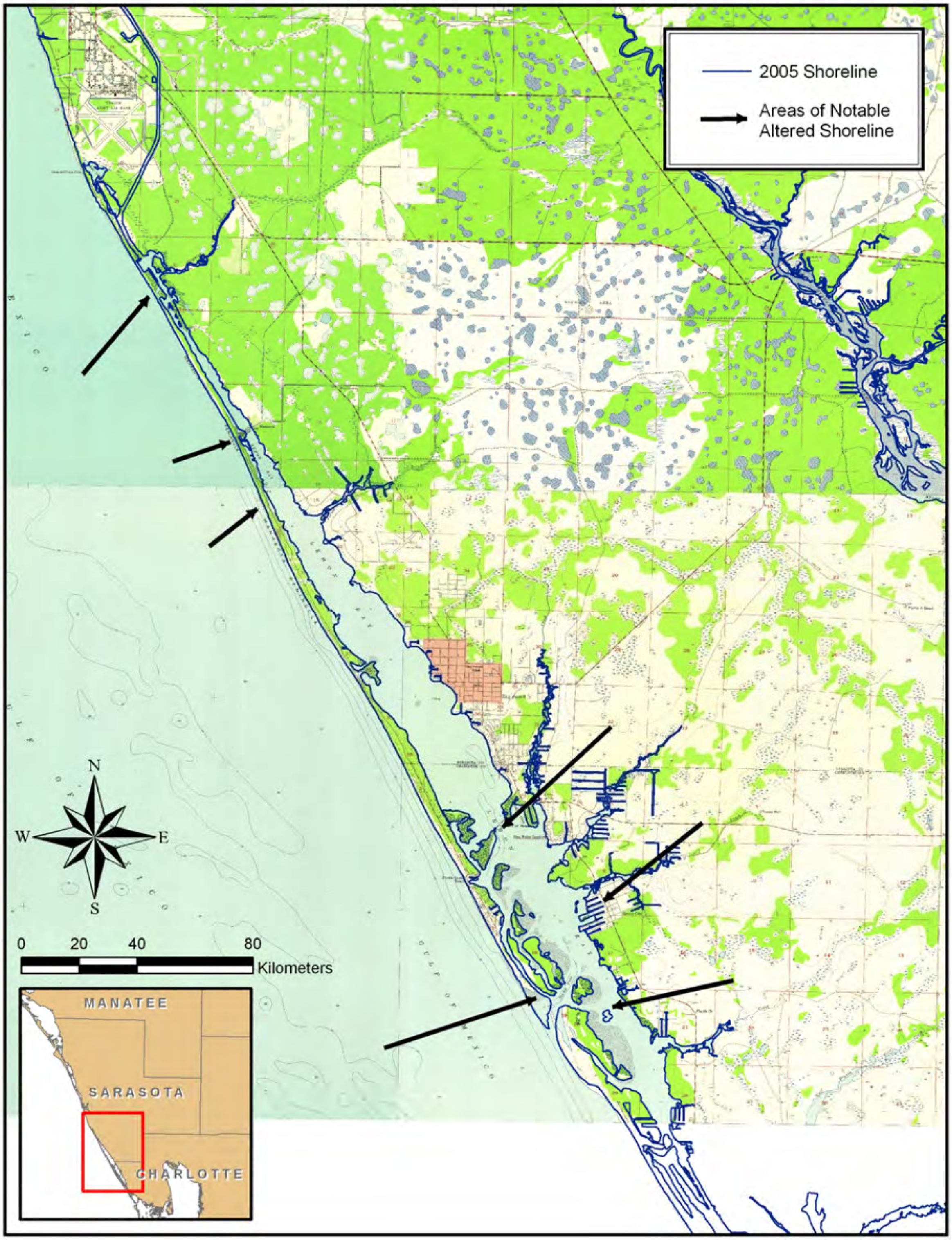


Figure 3-79 SWFWMD 2005 Shoreline Overlaid on 1944 Quad Sheets. Areas of Notable Altered Shoreline Denoted by Black Arrows.

3.2.1.2 Sediments

Sediments are a natural and important part of estuarine processes, and managing sediment accumulation is a large part of the watershed management process in Sarasota County. In fact, as part of the WMP for Lemon Bay, a detailed and specific sediment management plan has been developed (Appendix C). Below is a brief description of how sediments affect the valued natural resources of the Lemon Bay estuary.

Sedimentation creates shoals and substrate for emergent vegetation in estuaries. Sediment characteristics define the types of organisms that inhabit the sediments. For example, animals that build tubes require particular sizes of sediment particles. Some polychaete worms prefer finer-grained sediments while mud-sized sediments generally do not support a healthy benthic community. Amphipod crustaceans that consume bacteria and algae from sand grains are generally not found in muddier sediments. Therefore, sediment characterization is an important part of understanding the estuarine ecosystem functions likely to occur in the estuary. Sediments are also of interest because anthropogenic contaminants (e.g., metals, pesticides, hydrocarbons) can bind to the smaller particles. To the best of our knowledge, there are no sediment contaminant data for Lemon Bay (cf. Seal et al., 1994; Florida Fish and Wildlife Research Institute, unpublished data).

Similar to shorelines, the time scale on which sediment characteristics change in Lemon Bay does not lend itself to routine monitoring but should be understood as a critical element of understanding estuarine system dynamics. Most of the sedimentation in Lemon Bay occurs in the watershed portion rather than the estuary, and therefore discussion of how sediments are managed in the watershed will be addressed elsewhere in this document. The effects of sediments on emergent vegetation and benthos are described in their respective sections in this chapter.

3.2.1.3 Mangroves and Other Emergent Vegetation

Estuaries are often fringed by marshes and, in tropical and subtropical latitudes, mangroves. This emergent vegetation helps to stabilize shorelines; reduces erosion; provides nursery and protective habitat; and can sequester sediments, nutrients, and contaminants that enter the estuary from precipitation and runoff. Emergent vegetation provides habitat for animals that favor estuarine/marine muddy intertidal habitats as well as animals found in terrestrial woodlands (Hutchings and Saenger, 1987). Based on measurements of plant biomass and litter (particularly fallen leaves), mangroves can be highly productive. The litter supports a detritus-based community in the mangrove forest itself and by its export to estuarine and coastal environments (Odum et al., 1982; Hutchings and Saenger, 1987).

Authority for regulating trimming of mangroves by private property owners was established by the 1996 Mangrove Trimming and Preservation Act. Two recent studies of mangroves in Sarasota County have been completed (Sarasota County, 2006 and 2009). The objectives of these surveys included the following:

- Investigating the condition of mangroves in Sarasota County in areas including shorelines open to the bays and some creeks and bayous.
- Determining the level of compliance to the 1996 Act.
- Collecting information requested from the Sarasota County Commissioners to help decide "whether the County should pursue delegation of authority from the FDEP" to regulate trimming and altering mangroves.

The first year of surveys (2004) was limited to inspection of shorelines open to the bays in unincorporated portions of the County. In 2004 the number of sites or parcels inspected was 2,285. Major areas included:

- Roberts Bay North
- Grand Canal
- Little Sarasota Bay
- Blackburn Bay
- Lyons, Dona, and Roberts Bays
- Lemon Bay

County staff inspected parcels of property (a parcel is defined as an individual property listed on County records) where at least 30% of the shoreline was vegetated with mangroves (Figure 3-80). Recent trimming activity was noted, with evidence of cutting within the last year including uniform height across a parcel, obvious cut stems, and comparison with natural vegetation in adjacent areas (Figure 3-81). The height of mangroves was visually estimated and recorded in four categories: <6 ft, 6 to 10 ft, 10 to 20 ft, >20 ft (Figure 3-82). Alleged violations were noted and sent to the FDEP for investigation (Figure 3-83).

Figure 3-80 A Typical Non-Mangrove Shoreline on the Left Compared to a Trimmed Mangrove Shoreline on the Right

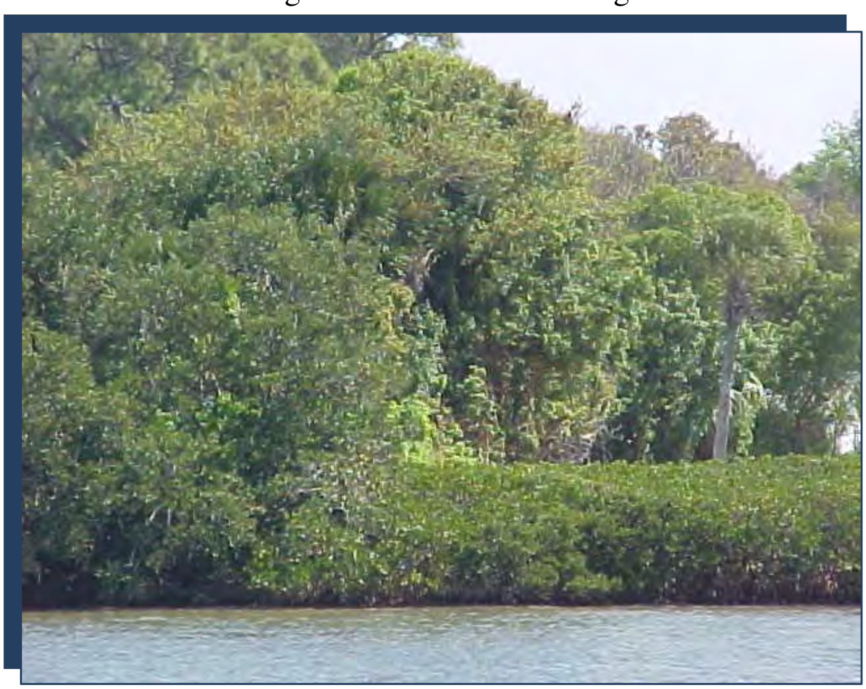


Figure 3-81 Natural Mangrove Shoreline on Left Compared to a Trimmed Mangrove Shoreline on Right

Figure 3-82 Mangrove Shoreline on Left Trimmed to Approximately 6 feet with a Mangrove Shoreline trimmed to < 6 ft. on Right

Figure 3-83 Over-Trimmed Mangroves Showing Signs of Defoliation and Die-back

The following surveys (2005 and 2007) were more comprehensive, expanding the survey area and the information collected. The same methods of surveying were used as in 2004. In addition, parcels with exotic vegetation and parcels with natural shorelines without vegetation that might be candidate areas for establishment of new groves of mangroves were noted (Figure 3-84). Hardened shorelines were not counted in areas considered to have good possibility for establishing new groves. However, established groves that had hardened shorelines on the land-side of the groves were counted in parcels for surveying. The 2005 and 2007 mangrove surveys included all of the shoreline parcels in the 2004 survey, plus additional parcels on shorelines along creeks and bayous in Sarasota County, including Phillippi Creek, Shakett Creek, Alligator Creek, Forked Creek, Gottfried Creek, and others. The 2005 survey included 5,619 sites/parcels and the 2007 study included 5,730 sites/parcels, more than double the amount of sites/parcels in the 2004 study. While an additional 116 sites/parcels were surveyed in 2007, all of those parcels fell within the geographical limits of the 2005 study area.

Figure 3-84 Natural Shoreline Dominated by the Exotic Brazilian Pepper

For a parcel to be considered a mangrove shoreline, mangroves were required to occupy approximately at least 30% of the parcel's shoreline. Fifty-seven percent of the parcels in the Lemon Bay watershed study area met the mangrove coverage criteria to be surveyed in the 2007 Sarasota County Mangrove Trimming study (Figure 3-85). Forty-three percent of the parceled were considered to have non-existent mangrove coverage and were not surveyed in the study.

The results of the 2007 survey are shown in Figure 3-86 and 3-87. Sixty-three percent of the parcels surveyed contained untrimmed mangroves and the other 37% had trimmed mangroves. Ninety-nine percent of the untrimmed mangrove parcels had mangroves over 6 feet (Figure 3-88). Sixty-six percent of the trimmed mangrove parcels contained mangroves trimmed to a height of 6 feet or higher (Figure 3-89). The Lemon Bay watershed study area hosts many opportunities for mangrove enhancement with approximately 400 sites/parcels identified as having planting opportunities and exotic removal (Table 3-17).

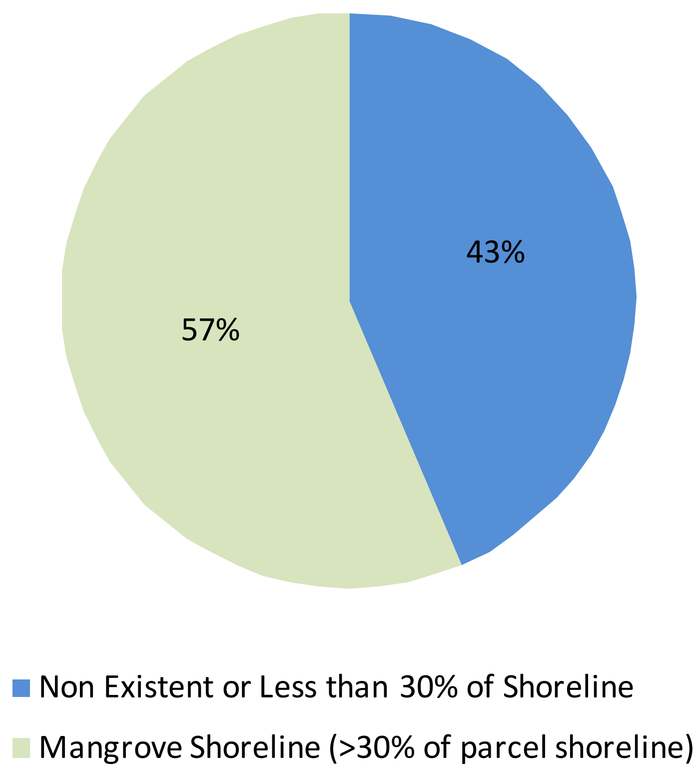


Figure 3-85 Lemon Bay Watershed 2007 Sarasota County Mangrove Trimming Study Shoreline Coverage

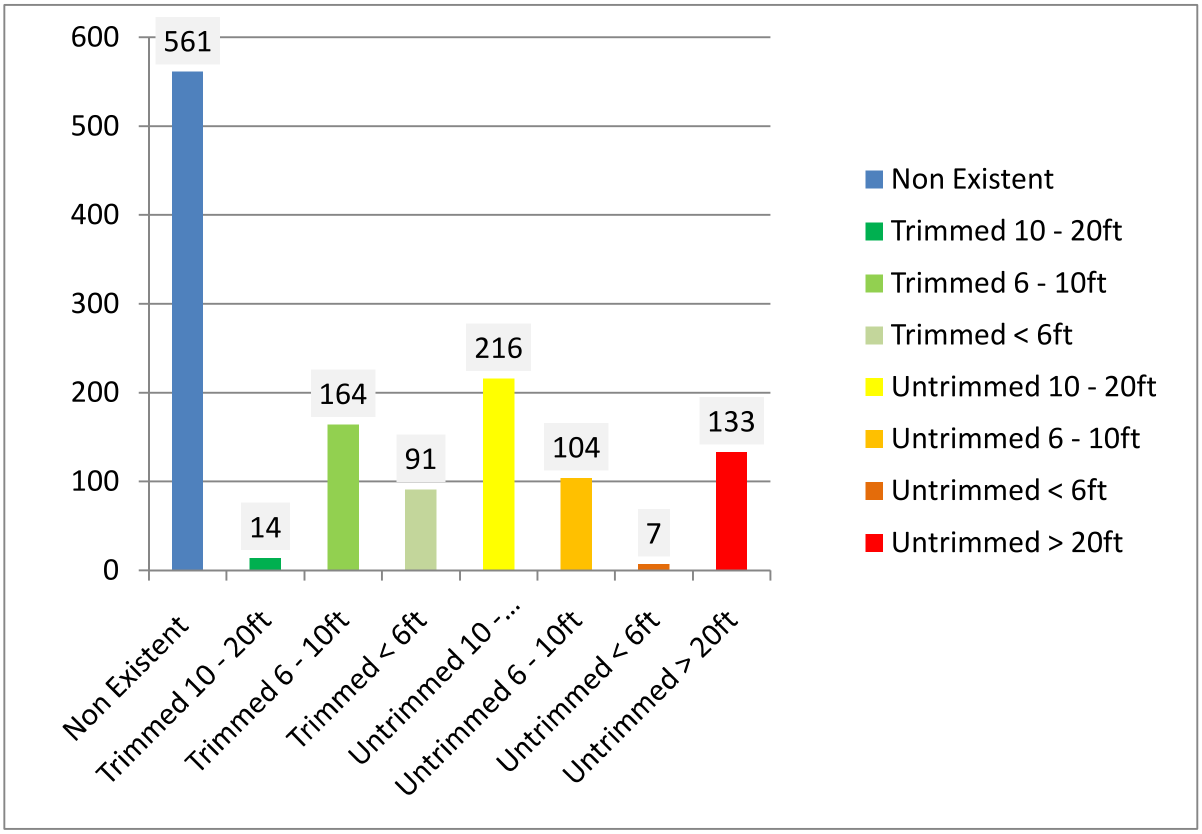


Figure 3-86 Lemon Bay 2007 Sarasota County Mangrove Study Results Summary

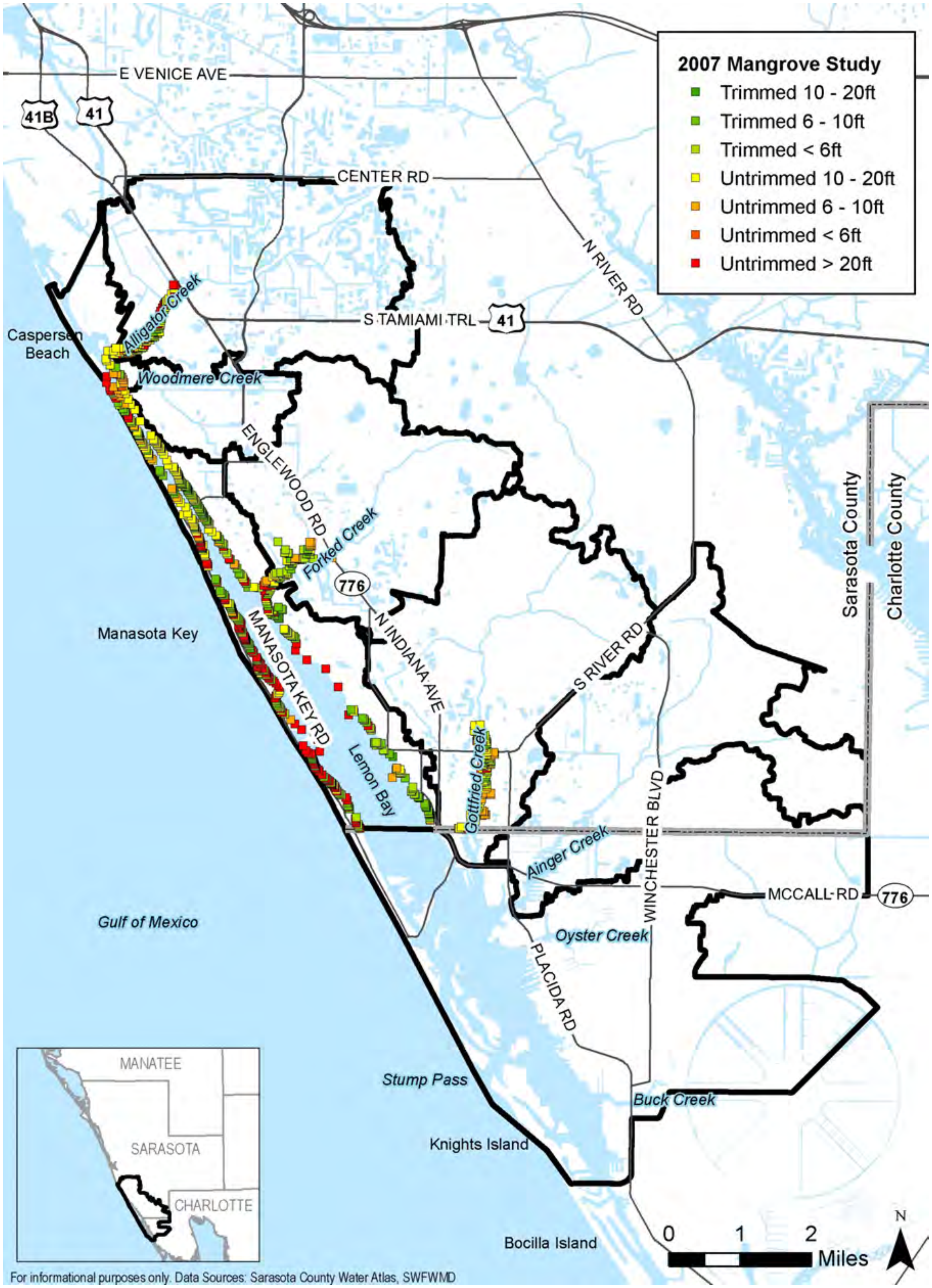


Figure 3-87 Lemon Bay 2007 Sarasota County Mangrove Trimming Study

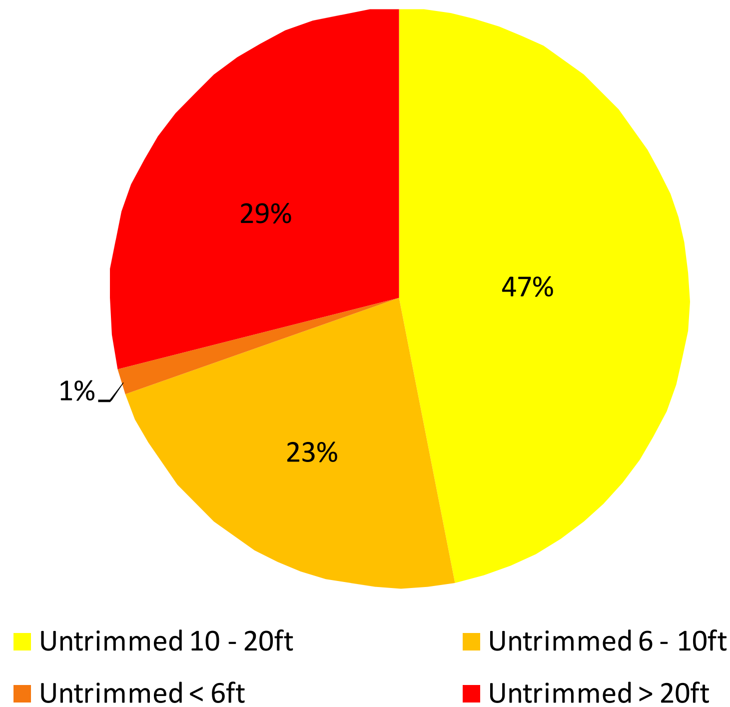


Figure 3-88 Heights of Untrimmed Mangroves

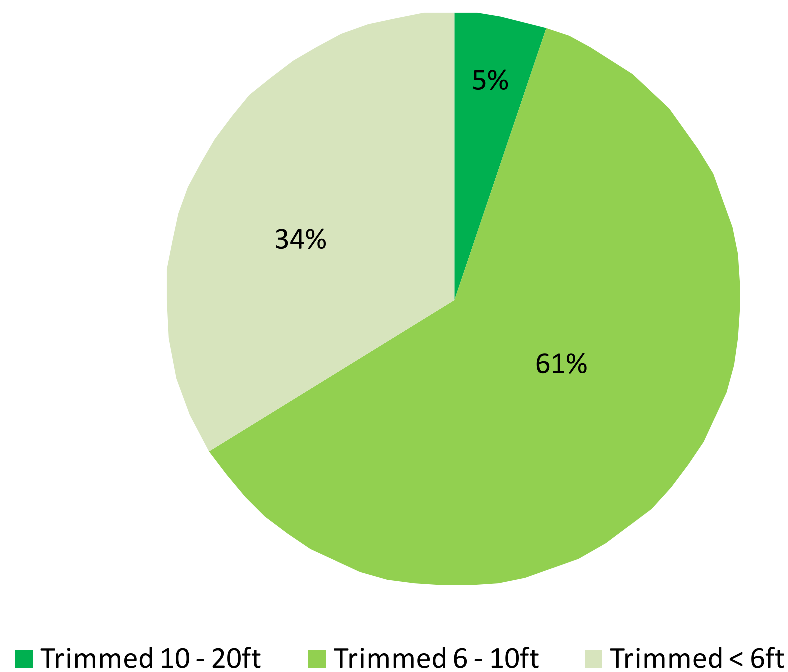


Figure 3-89 Heights of Trimmed Mangroves

Table 3-17 Lemon Bay Mangrove Planting and Exotic Removal Opportunities

	Planting Opportunities	Exotic Removal
Alligator Creek	46	46
Forked Creek	44	44
Gottfried Creek	72	74
Lemon Bay Coastal	240	232
Lemon Bay Watershed Study Area	402	396

*Adapted from the 2007-2008 Sarasota County Mangrove Trimming Study

To estimate the historical extent of mangroves in Lemon Bay for comparison to the current extent, Janicki Environmental used digitized photo-mosaics from the late 1940s to early 1950s along with digitized quad sheets to identify the historic mangrove extent within Lemon Bay. The SWFWMD (FLUCCS) categories for the 2005 land use survey were used to compare current and existing emergent vegetation extents. Aerial photographs of from the 1940s to 1950s were only available for the northern portion of Lemon Bay to approximately Stump Pass (Figure 3-90).

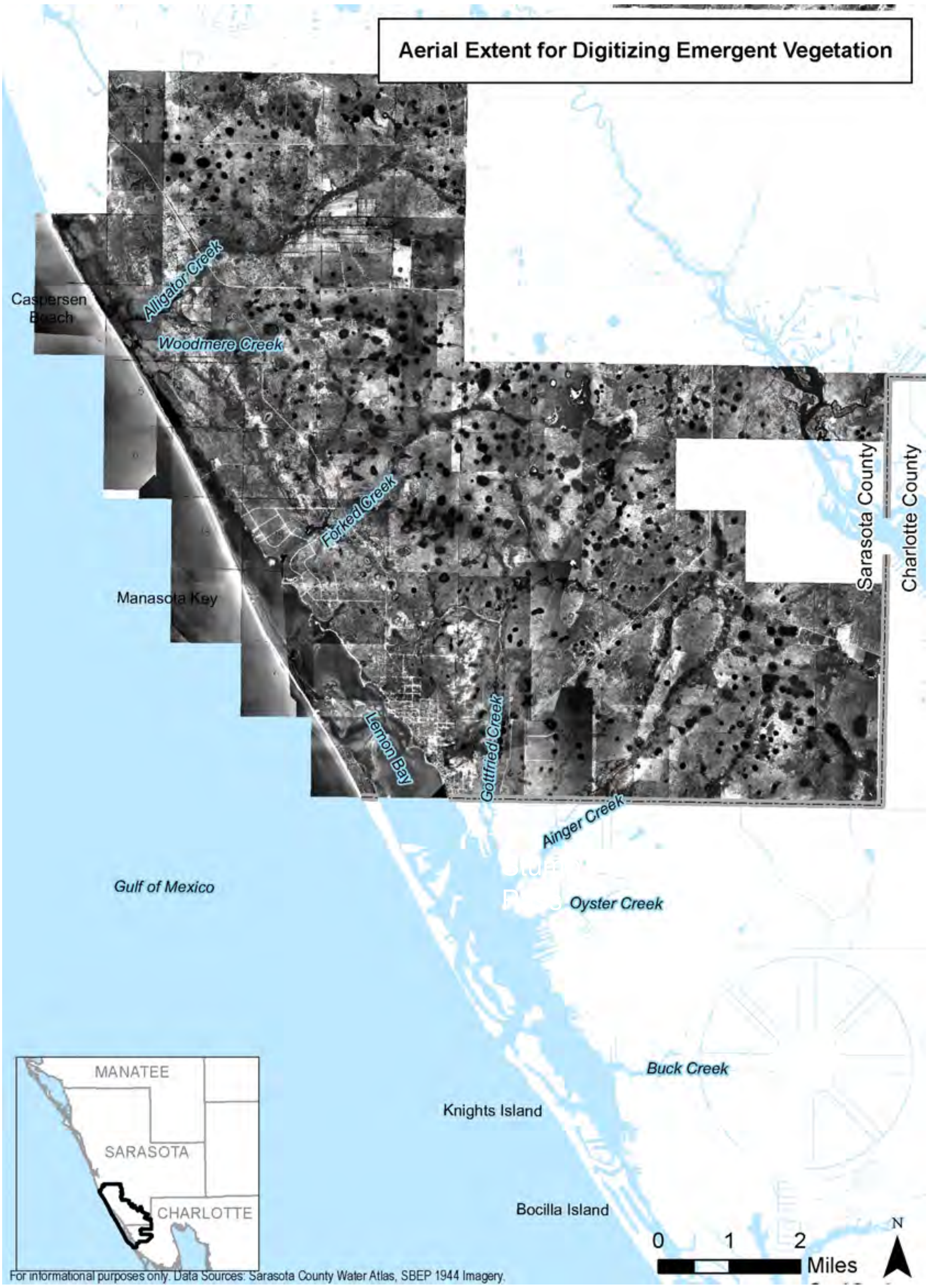


Figure 3-90 Aerial Photographs (1948) Used to Estimate Extent of Emergent Vegetation in Lemon Bay

Note: Aerial Photographs Currently Available Only for North Portion from Stump Pass to Venice Canal

Comparisons of the 1950s estimates of mangrove extents and that classified by the 2005 SWFWMD land use survey, using the extent provided by the 1948 aerial photographs, suggested that much of the mangrove extent that existed in the 1950s still exists. Historical estimates of mangrove extent suggested that 297 acres existed within the study extent, while in 2005 the acreage estimate was 263 acres (Figure 3-91). In the historical extent, the western shoreline of Lemon Bay across from Alligator Creek was designated as mangrove while in 2005 a lesser mangrove extent was documented in this area. Otherwise, the historical and current extents are very similar. Given the uncertainty in photo interpretation of mangrove extents, the difference between historical and current extents suggests that Lemon Bay has not lost substantial mangroves.

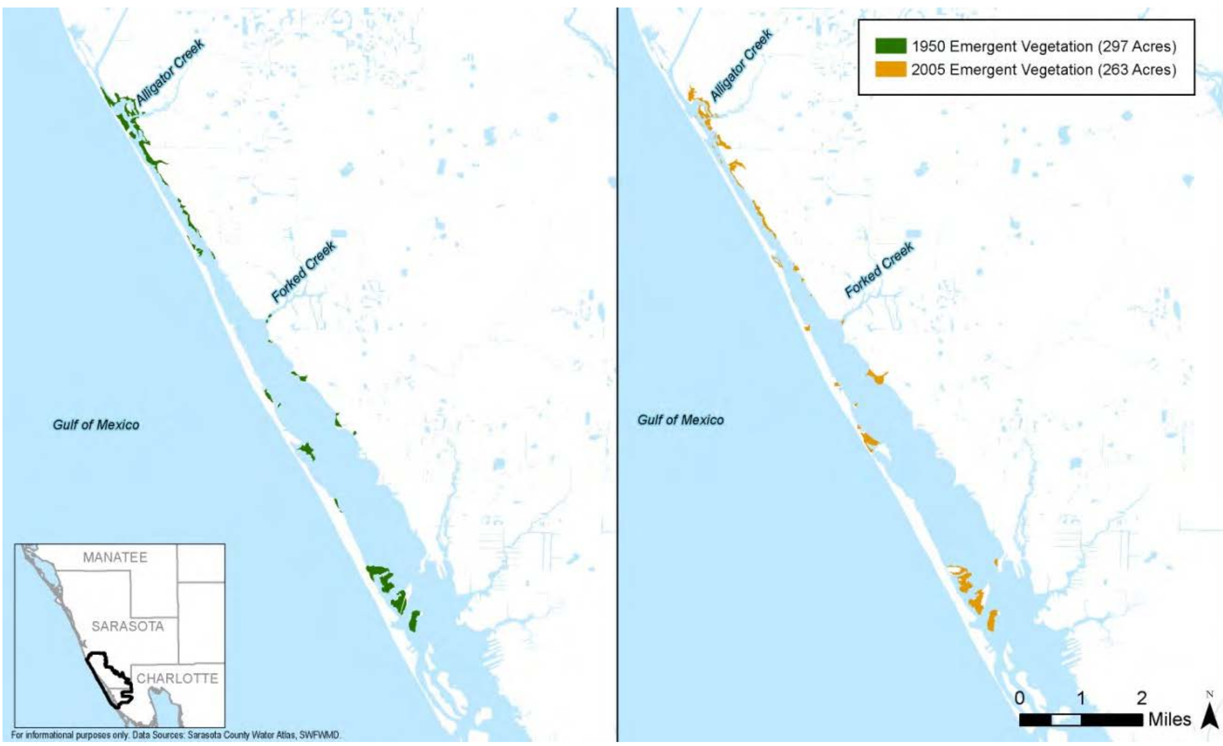


Figure 3-91 Distribution of Mangroves in Lemon Bay, circa 1950 and 2005

Lemon Bay was designated an aquatic preserve with the primary purpose of preserving the biological resources of endangered fringing mangroves and mangrove islands with clam beds, oyster bars, salt marsh, and other habitat (FDNR 1992). The designation of Lemon Bay submerged lands as an aquatic preserve, along with its designation as an OFW and Class II and Class III waterbodies, restricts the types of permitted activities that can take place in the watershed and estuary. While these designations are designed to protect and preserve conditions in the estuary, natural resource monitoring and management activities are required to ensure that natural systems such as the mangroves in Lemon Bay are protected.

3.2.1.4 Tidal Creeks

Tidal creeks are ecologically important because they provide a hydrologic link between uplands and bays and estuaries and provide critical habitat for many organisms including juvenile fishes and blue crabs that utilize the low-salinity habitats and shelter provided by emergent vegetation as nurseries and to avoid predation. In Sarasota County, many of the tidal creeks shorelines have been extensively modified due to anthropogenic activities. Measuring and monitoring the health of tidal creeks are important as an indicator of estuarine natural system function in Lemon Bay.

There are seven major tidal creeks in Lemon Bay: Alligator, Woodmere, Forked, Gottfried, Ainger, Oyster, and Buck Creeks. While the mouths of Gottfried and Ainger Creeks are in Charlotte County, the majority of their watersheds are in Sarasota County. Sarasota County's Environmental Services Business Center sought to develop an easily understood and ecologically valid rapid assessment technique for tidal creeks and, in conjunction with Mote Marine Laboratory, developed a Tidal Creek Condition index (TCCI) (Estevez, 2007). An ecologically-based index of tidal creek ecosystem health is a valuable tool for comparing multiple systems, documenting the ecological condition of a system through time, having independent data for TMDL assessment, and tracking the success of watershed management plans (Estevez, 2007). Five of the seven creeks mentioned above were considered as part of the TCCI.

The TCCI scores of the five Lemon Bay watershed tidal creeks were among the highest of the 15 creeks surveyed. In fact, Forked, Woodmere, and Gottfried creeks had the highest scores of any creek (Figure 3-92). However, multivariate analysis of benthic community structure suggested that the Lemon Bay creeks were not more structurally similar to one another than to other creeks in Sarasota County. Forked Creek and Alligator Creek, both in Lemon Bay had the highest ranking TCCI in 2007, indicating the "best" condition of all Sarasota County creeks.

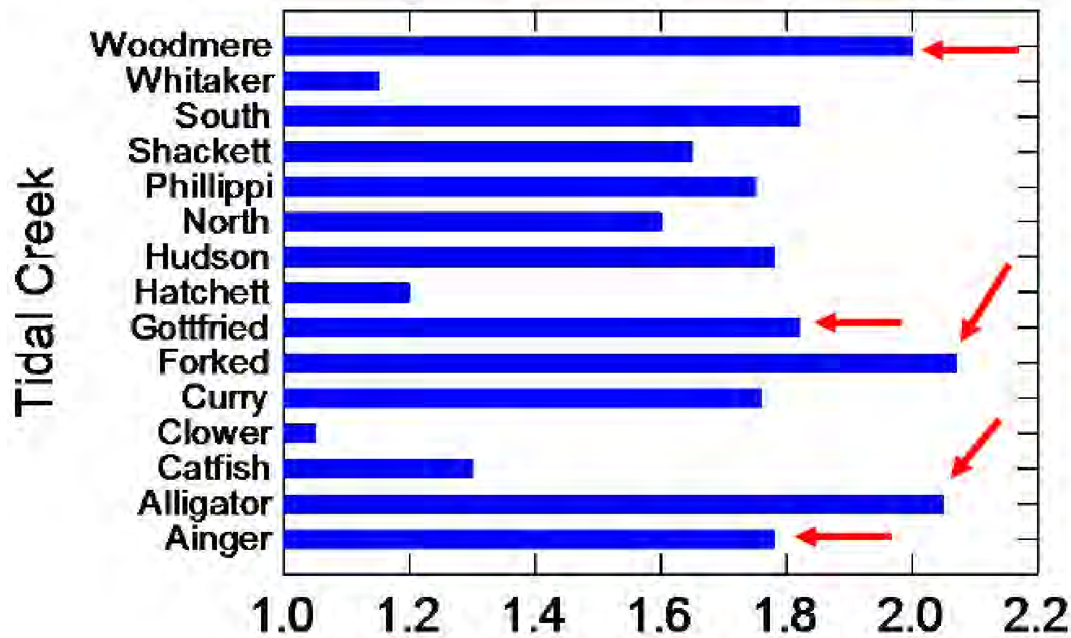


Figure 3-92 Tidal Creek Condition Index (TCCI) Scores for 15 Sarasota County Creeks and Bayous, 2006
Arrows Highlight Creeks in the Lemon Bay Watershed (adapted from Estevez, 2007).

The TCCI has shown to be a robust and beneficial tool to rapidly assess the ecological health of Sarasota County tidal creeks and, as part of the WMP, the TCCI is intended to be incorporated as a watershed management tool to report on the health of the tidal creeks in each of Sarasota County's waterbodies. The index scores will provide a valuable component of the overall assessment criteria for Lemon Bay to ensure its proper stewardship.

3.2.1.5 Oyster Communities

Oysters are an important indicator of estuarine "health" and their status can aid in the identification of water management problems. Oyster reefs serve several valuable ecological functions. They provide habitat for estuarine fauna, including conch, mud crab, fish, and other bivalves (Wells, 1961; Tolley and Volety, 2005) and contribute to improved water quality by filtering between 4 and 40 liters of water per day (Volety et al., 2003).

The oyster's life cycle is illustrated in Figure 3-93. Eggs and sperms are released into the water column, where fertilization occurs. The resulting larval stages (veligers) remain in the water column for about 7 to 10 days. These older larvae then settle out of the water column and attach to other oysters or some other hard surface (hard sand, bridge pilings) (Bahr and Lanier, 1981). These "spat" then grow into adult oysters that may live for up to 10 years. Oysters are suspension (or filter) feeders, and their preferred food is microscopic plants (phytoplankton) (Bahr and Lanier, 1981).

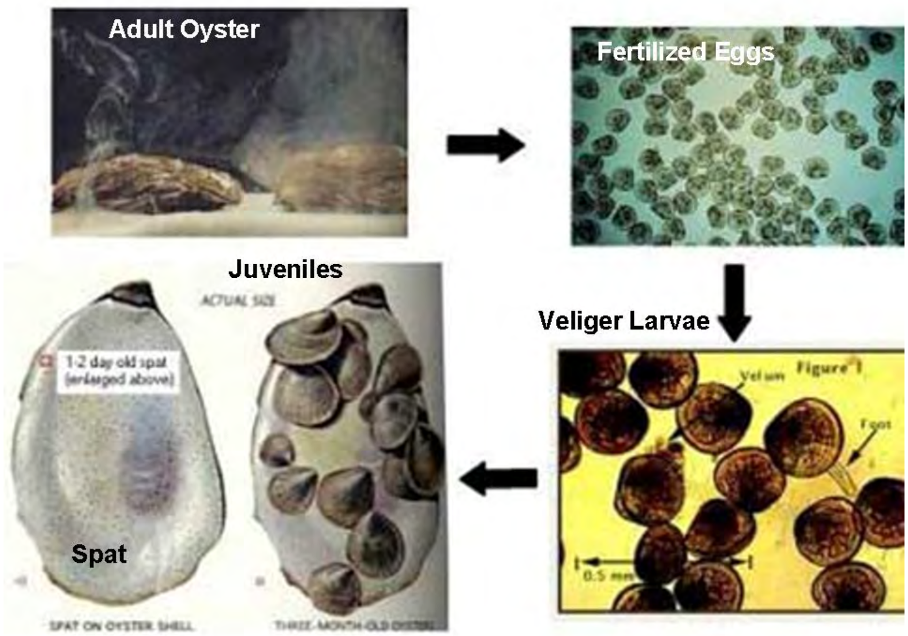


Figure 3-93 Illustration of the Life Cycle of the Eastern Oyster (*Crassostrea Virginica)*

Degradation of oyster habitats includes over-nitrification, which depletes the water of oxygen, hindering the development of oyster larvae; toxic chemicals and metals, which threaten the development of juvenile oysters; and siltation from eroded soil, which smothers oyster beds. Water quality, particularly salinity, can affect the health of oyster beds and control parasitic infestation, which is also detrimental to oyster health and productivity. The location of oyster beds (or reefs) depends on where larvae set and then on the subsequent survival of the spat (i.e., juvenile oysters). Larvae establishment is related to substrate and salinity (Stanley and Sellers 1986). Oysters have specific environmental requirements, including an optimal salinity range of 15 to 25 ppt (Kennedy et al., 1996). Overall salinity ranges have been reported between 10 to 30 ppt, with an ability to tolerate a salinity range of 2 to 40 ppt (Gunter, 1955). However, problems with reproduction can occur with salinities below 10 ppt. Mortality of most spat will occur if salinity falls below 3 ppt. Higher salinity (over 30 ppt) slows the growth rate of oysters and they become more susceptible to predators, parasites, and disease (Stanley and Sellers, 1986).

Oysters are most often found in tidal waters with nearby marshes, mangroves, mudflats, and tidal creeks. The most successful reefs are located in the mid-intertidal zone (Bahr and Lanier, 1981). Oyster reefs provide habitat for a variety of algae as well as vertebrate and invertebrate organisms (Bahr and Lanier, 1981). The oysters themselves may be preyed upon by other animals (e.g., oystercatchers and blue crabs), and the animals and algae that live within and among the oysters contribute to the diets of crabs, fishes, and birds.

Two species of oyster were found in Lemon Bay during a 1992 survey conducted by the Florida Department of Natural Resources (FDNR): the Eastern Oyster (*Crassostria virginica*) and the Flat Tree Oyster (*Isognomon alatus*). Other bivalves found in Lemon Bay included clam species and mussel species, the most common of which was the Atlantic Ribbed Mussel, *Geukensia demissa*. The Oyster Drill Snail, a gastropod, was found to be commonly associated with the oyster bars (FDNR 1992). Surveys of benthic organisms in the Lemon Bay Aquatic Preserve performed by FDNR (1992) showed a wide variety of species in the groups of mollusks, both bivalve and gastropod species, crustaceans, sponges, anemones, jellyfish, and hydra as well as marine polychaetes and nematodes. Oyster bars and reefs were found to be common in the shallow waters of the aquatic preserve, especially near the mouths of the eastern tidal creeks and in scattered locations, including across the Bay from Forked Creek and near the mangrove islands north of Stump Pass. The oyster bars and reefs were found in the middle intertidal zone.

Predation and siltation limit oysters in the subtidal regions of Lemon Bay to small, scattered clumps. In a 1992 survey, the FDNR noted that healthy oyster bars, such as those found in Lemon Bay, could contain more than 50 species of macroinvertebrates, including sponges, Herbst's mud crab (*Panpeus herbstii*), stone crab (*Mennippe mercenaria*), blue crab (*Callinectes sapidus*), and commensal crabs, clams, mussels, anemones, polychaetes, amphipods, and mollusks. Most of the oyster reefs found during the FDNR survey were in waters where shell fish harvesting was prohibited because the concentration of fecal bacteria was very high. At this time no shellfish harvesting is allowed in Lemon Bay, although the area south of Forked Creek is classified by FDEP as a Class II waterbody with a designated use for shellfish propagation and harvesting.

Sarasota County began an oyster monitoring program with annual surveys in 2006. The first survey in Lemon Bay was in fall 2006 at the end of the rainy season. The monitoring program has nine sampling sites in four creeks that flow into Lemon Bay: Alligator Creek (Figure 3-94), Forked Creek (Figure 3-95), and Gottfried and Ainger Creeks (Figure 3-96). These figures, adapted from Jones (2007), illustrate the extensive watershed development that has occurred along the coastal basin in Lemon Bay. The locations of the oyster sampling sites are:

Site	Latitude	Longitude
AL1	27 2 34	82 25 42
AL2	27 2 38	82 25 24
FRK1	26 59 41	82 23 35
FRK2	26 59 52	82 23 19
GOT1	26 56 3	82 20 38
GOT2	26 56 32	82 20 45
GOT3	26 56 58	82 20 45
ANG1	26 59 50	82 20 17
ANG2	26 56 13	82 19 49

Figure 3-94 Alligator Creek Oyster Monitoring Site Locations and 2006 Results (Adapted from Jones 2007)

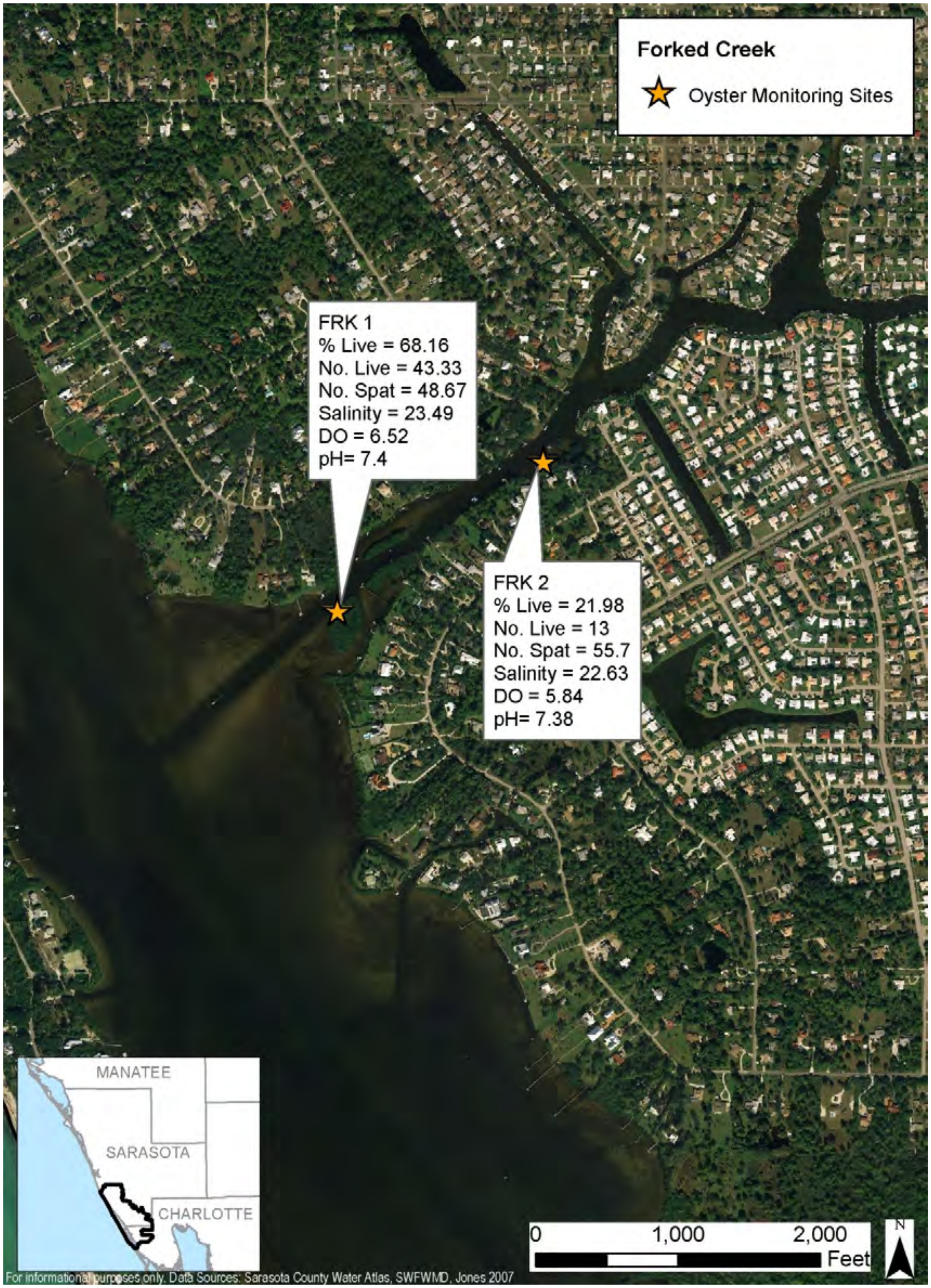


Figure 3-95 Forked Creek Oyster Monitoring Site Locations and 2006 Results (Adapted from Jones 2007)

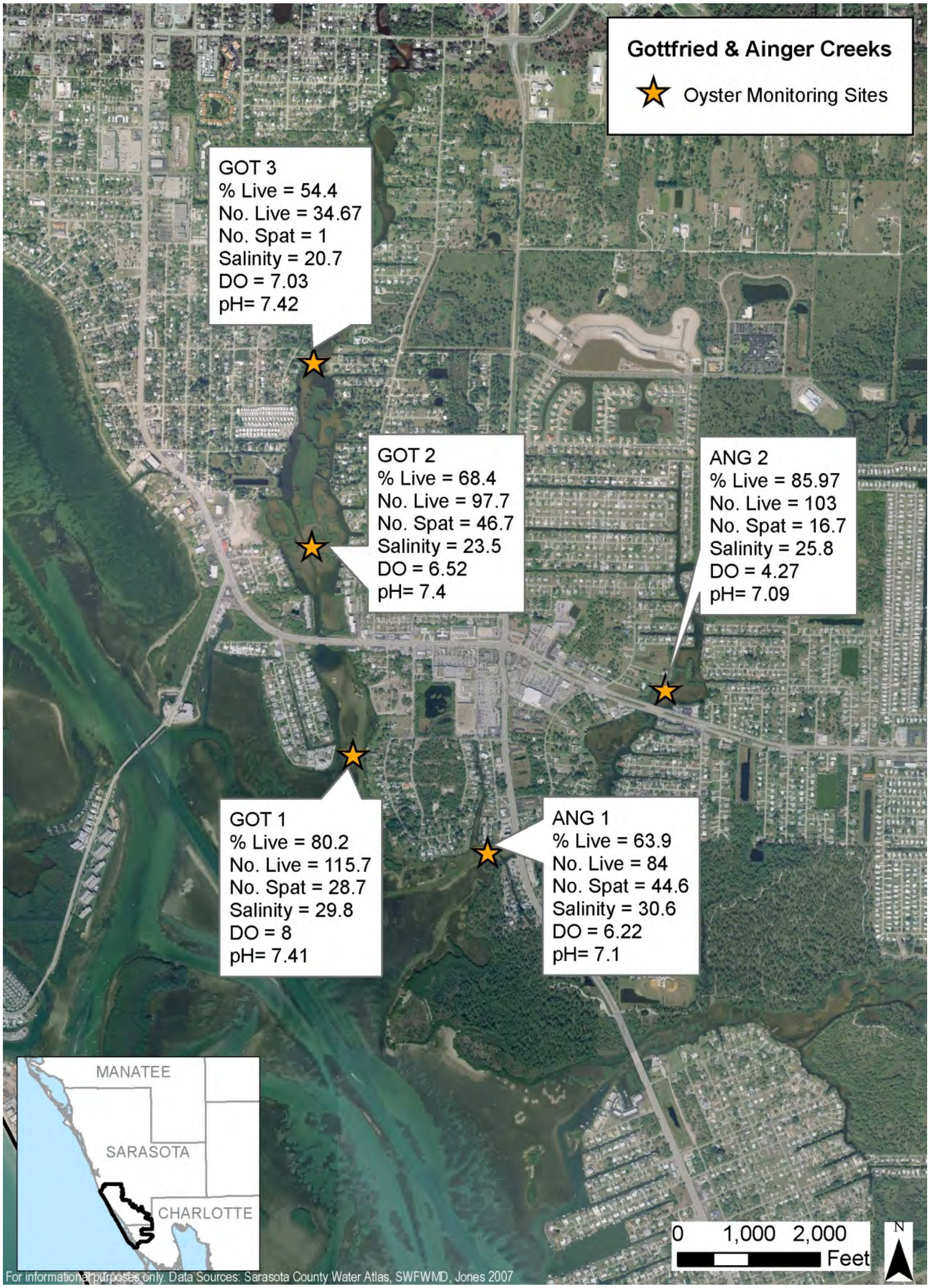


Figure 3-96 Gottfried and Ainger Creeks Oyster Monitoring Site Locations and 2006 Results (Adapted from Jones 2007)

The results of the 2006 sampling showed that the average percent of live oysters ranged from 22% at the lower Forked Creek site to 86% at the lower Ainger Creek. The average percent of live oysters in the southern portion of the Bay was 75% in Ainger Creek and 68% in Gottfried Creek; in the northern portion of the Bay the average percent of live oysters was 45% in Forked Creek and 68% in Alligator Creek. The salinity measured at all of these stations was above 20 ppt during the sampling events (Jones, 2007).

The average number of live adult oysters plus spat ranged from 144 to 580 per square meter in comparison to oyster studies in South Florida, which reported densities of 600 to 1400 live oysters per square meter with 65% to 85% of the community being live oysters.

Jones (2007) developed a scoring methodology to assess the relative health of oyster reefs in Sarasota County. Each site is assigned a numerical score based on the calculated percent live oysters (Table 3-18). All sites within each watershed are then averaged, and a letter score is assigned based on the watershed average numerical scores. Scores for Lemon Bay sites resulted in Ainger Creek being categorized as "on target" with a 3.0 (B) followed by Gottfried Creek with a 2.67 (C), Alligator Creek with a 2.33 (C), and Forked Creek with a 1.5 (D). As a whole the Lemon Bay watershed ranked fair with a score of 2.4 (C) (Jones, 2007).

Table 3-18 Scoring Method for the Sarasota County Oyster Monitoring Program

Percent Live Oysters	Descriptor	Numerical Score	Letter Score
0 - 19.99	Very Poor	0	F
> 20 - 49.99	Poor	1	D
> 50 - 69.99	Fair	2	C
> 70 - 79.99	On Target	3	B
> 80 - 100	Excellent	4	A

Estimating areal extents of oysters based on photo-interpretation is difficult due to the tendency for oysters to co-locate with emergent vegetation such as mangroves and marshes or in tidal creeks where highly colored waters may obscure the reefs at the times the photographs are taken.

The County is successfully using community volunteers to validate aerial seagrass mapping efforts in Sarasota County, and a similar effort could be implemented for documenting oyster habitats in Lemon Bay. However, oyster reefs pose potential hazards to volunteers and their vessels and care must be taken to minimize the potential liability associated with using volunteers for this mapping effort. Further, only trained professional biologists should be used in the actual oyster monitoring to ensure consistency in methods and reporting of results.

3.2.1.6 Seagrass

Seagrasses are a dominant feature of most Florida estuaries and provide enormous value as a natural systems component in Sarasota County. Seagrasses stabilize sediments, provide refuge for juvenile fishes and invertebrates, and serve as a food source for manatee and sea turtles. The microscopic algae (epiphytes) that grow on seagrass blades support an extensive community of grazing organisms. Decaying seagrass blades contribute to a detritus-based food web that plays a particularly important role in the transfer of energy in estuarine and coastal communities. Seagrasses support a diverse and productive macroinvertebrate community that lives on or among seagrasses and in the sediments surrounding seagrasses. These organisms are an important food resource for higher trophic levels.

Six species of seagrasses are found along the Florida Gulf Coast, the three most common of which—*Halodule wrightii* (shoal grass), *Thalassia testudinum* (turtle grass), and *Syringodium filiforme* (manatee grass)—have been documented in Lemon Bay. These plants primarily grow by vegetative reproduction (Zieman and Zieman, 1989). Each of the three species produces horizontal stems (rhizomes) up to 25 cm below the sediment. These rhizomes produce vertical branches with leaves. These seagrasses are also capable of flowering and thereby reproducing sexually.

The District's SWIM section has conducted aerial surveys of seagrass meadows throughout Southwest Florida every 2 or 3 years since 1988 (Kristen Kaufman, personal communication). According to these aerial surveys, the total acreage of seagrass meadows in Lemon Bay remained virtually unchanged through 1999. The boundary definitions used by the SWFWMD to define Lemon Bay are geographically different than the watershed boundary used for this WMP. According the SWFWMD boundary, the seagrass meadows were smallest in 1996 with an estimated 2,576 acres, a 47-acre decrease from its highest previous total area of 2,623 acres in 1994 (Figure 3-97). Lemon Bay experienced a significant increase in acreage between 2002 and 2004, rising to a total of 2,751 acres, but dipped again slightly in 2006 to 2,714 acres. The extent of seagrass beds fluctuates seasonally as part of the natural cycles. Despite the short-term fluctuation in acreage present in these data, there has been an estimated net increase of 135 acres between 1988 and 2006.

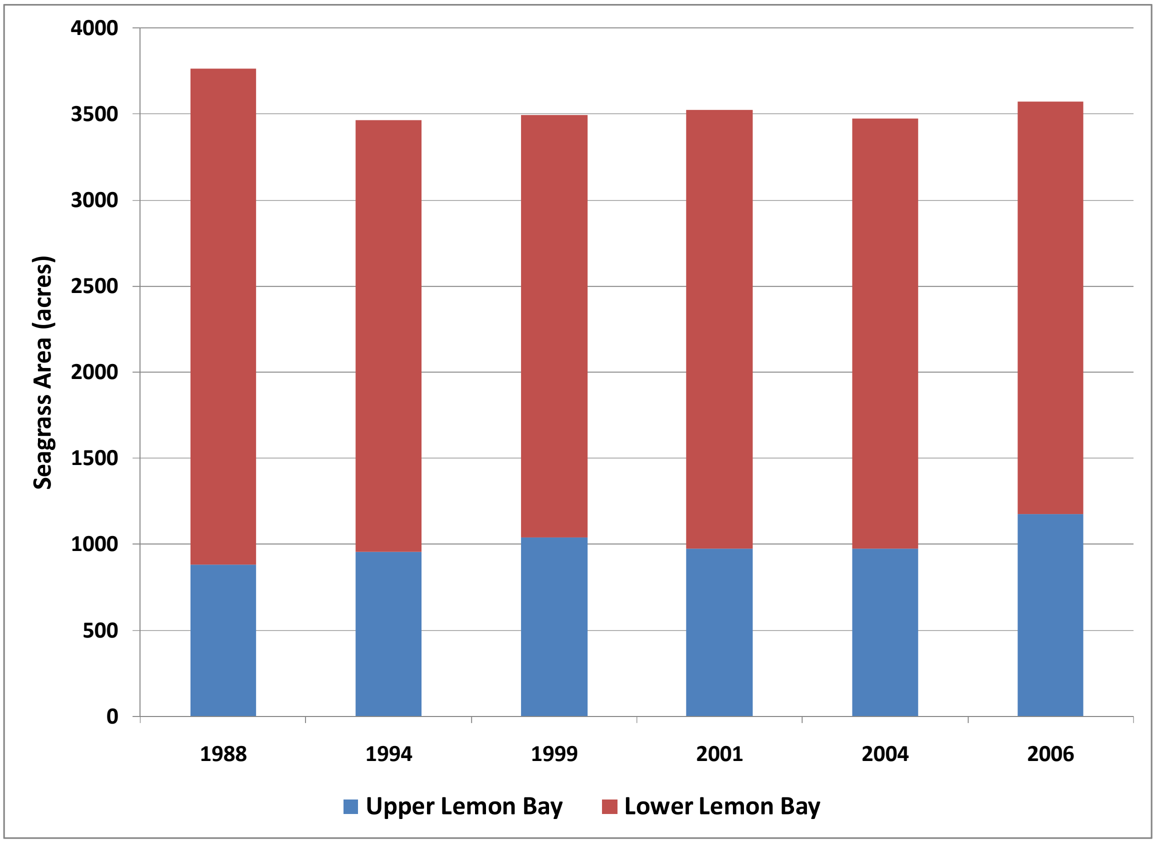


Figure 3-97 Seagrass Acreage Lemon Bay. Source: K. Kaufman, SWFWMD SWIM Program

To estimate the persistence of seagrass from 1998 to 2006, a cartographic grid cell system for Sarasota County estuarine waters was created using 50-m-square cells and overlaid all the SWFWMD seagrass coverages taken since 1988 (Wessel et al., 2007). This grid system allowed the presence or absence of seagrass to be represented within each grid cell by survey year. The persistence of seagrass could then be characterized as to the number of years in which seagrass was present in a particular grid cell. This information is presented for Lemon Bay in Figure 3-98. Seagrasses were most persistent in the larger beds of south-central Lemon Bay. The least-persistent beds occurred from Gottfried Creek north to just above the connection with Forked Creek.

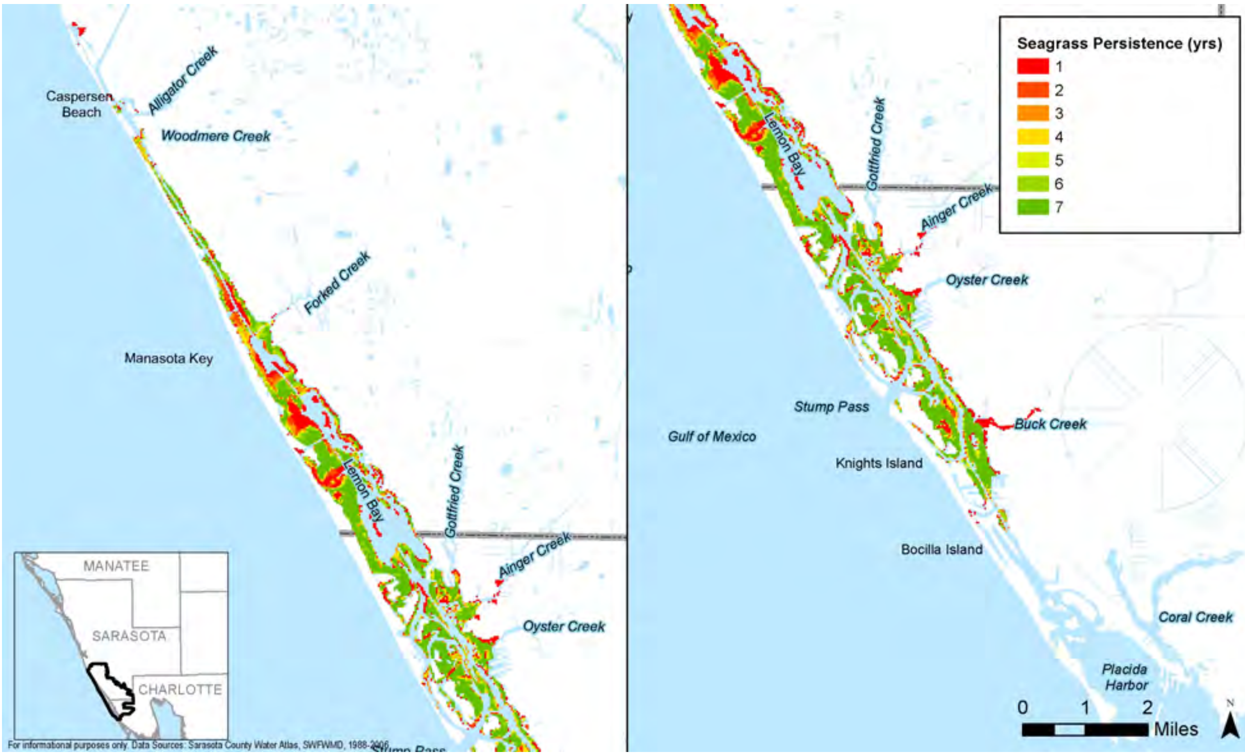
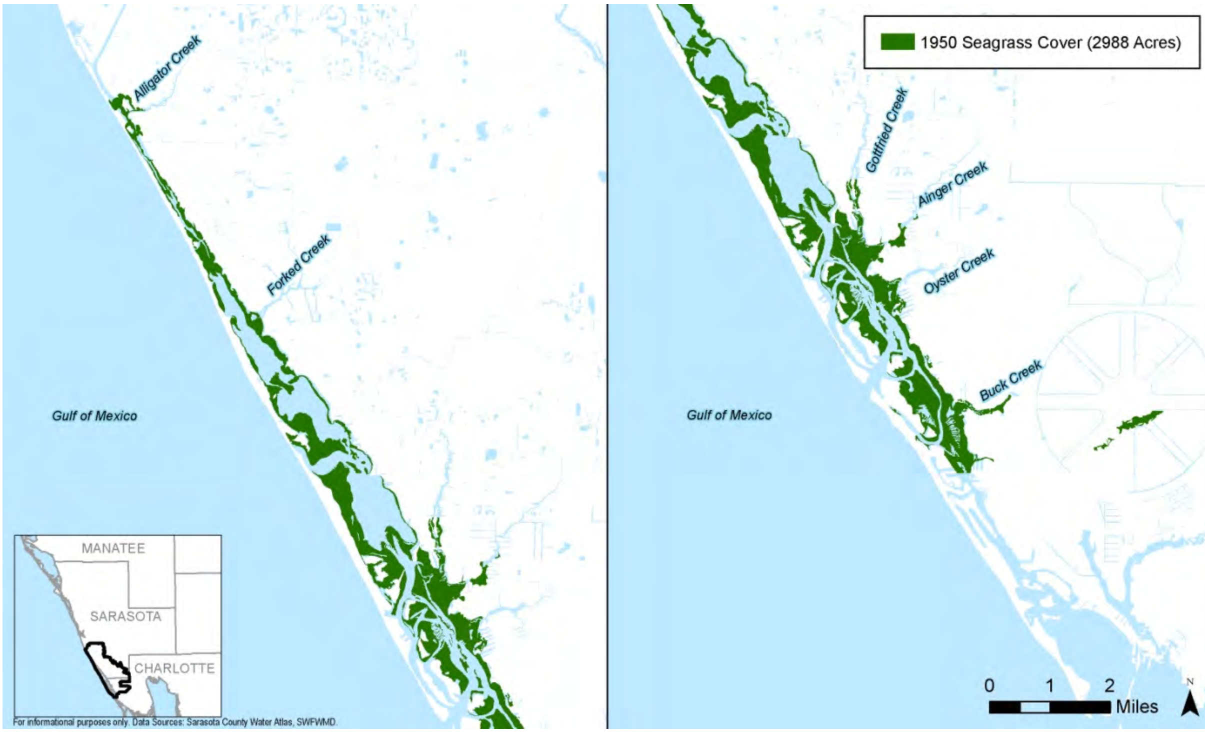


Figure 3-98 Seagrass Distribution and Persistence in Lemon Bay (SWFWMD, 1988-2006)

To directly compare historical seagrass acreage extents to more recent aerial surveys taken by the SWFWMD, we used the watershed management boundary definition to compare current and historic seagrass acreages. The historical seagrass extent was defined by a work product for the CHNEP (PhotosScience, 2007). This study used digitized aerial photographs from the late 1940s and early 1950s to map benthic habitats, including seagrass, oysters, and tidal flats. Historically, seagrasses have been found in all but the deepest channels. Based on a historical seagrass mapping effort, Lemon Bay supported almost 3,000 acres of seagrasses in the early 1950s (Figure 3-99). Seagrass coverage was especially well developed in the central and southern sections of Lemon Bay and less so in deeper waters in the northern portion of the bay north of Forked Creek. The results comparing the historical extent to the 2006 seagrass acreage suggest that the 2006 seagrass extent (2635 acres; Figure 3-99) was 89% of historical estimates, an 11% decrease in acreage.



1950

2006

Figure 3-99 Seagrass Distribution in Lemon Bay, circa 1950 and 2006

Seagrasses have several critical habitat requirements:

- Light
- Salinity
- Tidal amplitude
- Depth
- Wave energy
- Nutrients

The amount and quality of the light reaching seagrass blades are thought to be the primary limiting factor affecting the seagrasses' distribution (Morris and Tomasko, 1993). Different species of seagrass may respond better to specific wavelengths of light (Zieman and Zieman, 1989; Dixon and Leverone, 1991; Dixon and Kirkpatrick, 1995; Dixon and Leverone, 1995; 1997; Dixon and Kirkpatrick, 1999; Dixon, 2000; Dixon, 2002). Without adequate light of the proper wavelengths, photosynthesis is inhibited and plant growth ceases.

The amount of light needed to ensure that seagrasses can grow is expressed as a percentage of the total Photosynthetically Active Radiation (PAR) available just below the water's surface. The decay rate of PAR is exponential with depth and is affected by water quality conditions such as turbidity; suspended solids; water color from humic substances; and the growth of epiphytic algae, bacteria, etc. on the plants themselves.

The specific light requirements of seagrass vary by location and species (Dawes et al., 2004; Lee et al., 2007). For example, the light requirements of *Thalassia* may range from 14 to 24.4%, *Halodule* from 10.0 to 23.0%, and *Syringodium* from 17.2 to 37.0% (Dawes et al., 2004). Note that epiphytes can further reduce the light actually reaching the seagrass blades and are not taken into account in these estimates (Neckles, 1993; Dixon, 2002).

While light is thought to be primarily limiting, other factors contribute to the success of seagrass colonization. Salinities ranging from the mid-20s to mid-30s appear optimum for the species of seagrass commonly found in Lemon Bay. *Halodule* is euryhaline but is intolerant of freshwater or extremely low salinities. *Syringodium* and *Halophila* spp. are more stenohaline, and *Syringodium* is less tolerant of lower salinities. Thalassia prefers relatively high salinities (up to seawater, 35 ppt) and does not do well at salinities in the teens and lower (Zieman and Zieman, 1989). Therefore, excessive freshwater inflows that reduce salinities may adversely affect the health and success of seagrass communities in Lemon Bay. Tidal and wave energies are less of a concern in Lemon Bay as the bay is not exposed to long fetch wind patterns and much of the ICW is a no-wake zone in this area.

Given the ecological requirements of seagrass and their current and historical extents in Lemon Bay, the Lemon Bay WMP incorporates existing information, including current water quality conditions, current depth limits of seagrass in the bay, and current salinity conditions to identify targets for these parameters that optimize the conditions beneficial for seagrass community success in Lemon Bay. Those factors that influence both light attenuation and salinity are discussed in Chapter 4.

3.2.1.7 Benthic Communities

Benthic (bottom-dwelling) organisms live in or on the sediments and other substrates of bays, rivers, etc. The benthos include organisms such as worms, snails, clams, various small crustaceans, and other invertebrate life forms. Unlike the more motile nekton, most benthic invertebrates lack the ability to escape rapid fluctuations in environmental conditions. Because of their generally small size and their abundance, they are an essential component of the diet of many fishes and wading birds.

The benthos include detritivores, suspension feeders, deposit feeders, and predators that process organic material and form an essential link in the transfer of energy to secondary consumers such as fish and birds. Tube-building and burrowing benthic organisms are important in reworking sediments. In this role they may bring suspended sediments into contact with the water column. Nutrients and pollutants are translocated and the sediments can be better oxygenated.

Data on the composition and abundance of soft-sediment infaunal benthos in the Lemon Bay system are limited to only four samples (Florida Fish and Wildlife Research Institute, unpublished data). Sipunculid worms were very abundant in these samples. Mollusks were subdominants and polychaete worms were not among the 10 most abundant taxa. In addition to these quantitative samples, FDNR (1992) provided qualitative observations of epifauna. The only named species were the mollusks *Crassotrea virginica*; *Isognomon alatus*, and *Geukensia demissa*.

The Lemon Bay benthic fauna appears to differ somewhat from other estuarine systems along Florida's West Coast, including Charlotte Harbor (Florida Fish and Wildlife Research Center, unpublished data), Tampa Bay (Grabe et al., 1995), and McKay Bay in Tampa Bay (Grabe et al., 2004). However, the Lemon Bay fauna does share some similarities to that of the northern Indian River Lagoon (Thomas, 1974; Wiederhold, 1976). Lemon Bay shares more structural similarities to a lagoon than to a more open bay system (Emery and Stephenson, 1957)

Amphipods, bivalves, and polychaetes are the most abundant groups in Charlotte Harbor, Tampa Bay, and McKay Bay (Grabe et al., 1995; Grabe et al., 2004; Florida Fish and Wildlife Research Center, unpublished data). Sipunculans, which were very abundant in Lemon Bay and in the northern Indian River Lagoon, are much less abundant in the other west coast estuarine systems (e.g., in Charlotte Harbor the sipunculan Phascolion ranked 88th in abundance) (Florida Fish and Wildlife Research Center, unpublished data).

Estuarine benthic communities are primarily subject to the influences of two habitat variables (salinity and sediment characteristics) and two ecological stressors (dissolved oxygen [DO] and sediment contaminants). The interactions of salinity regime and sediment type ultimately affect the types of animals that can colonize an area of the bay or creek. Low concentrations of DO or high concentrations of sediment contaminants (e.g., metals, pesticides, hydrocarbons) can further restrict the types and numbers of animals that live in the sediments to those that are the most tolerant.

Salinity affects benthic organisms directly and indirectly. Salinity is largely influenced by the amount of freshwater inflow entering the system. During high-flow periods, salinity at a particular location is expected to be lower and may open new habitats for the more motile species that are intolerant of elevated salinities. During low-flow periods, higher salinity waters may facilitate habitat expansion for coastal species.

Many benthic species are limited in range by the physiological challenges and stresses associated with variable salinity environments. Osmotic limitations restrict the ability of many freshwater species from using habitats in downstream portions that are tidally influenced. Marine species also face osmotic problems, which restrict access to upstream freshwater habitats. Estuarine species typically tolerate a wide-range of salinities, although they may have discrete “preferences” for optimal reproduction and growth. In other words, salinity is less of an acute stressor and more a chronic stressor for estuarine invertebrates.

In May 2004, Mote Marine Laboratory conducted a survey of the benthic invertebrate community in Charlotte Harbor, including Lemon Bay, for the Charlotte Harbor National Estuary Program (Mote Marine Laboratory 2007). The purpose of the study was to provide, for each basin within the watershed, a characterization of benthic fauna for each of the principal habitat types within the estuary, including mangrove, saltmarsh, submerged aquatic vegetation (SAV), oyster, and intertidal and subtidal sand and mudflat.

Habitat in Lemon Bay was primarily SAV with several large expanses of intertidal mudflat and subtidal sand. Tributaries to Lemon Bay had SAV habitat at the mouths but were otherwise bare sediments and oyster habitat. Sediments in Lemon Bay were sandy (>70% by volume) with very little clay (≤5%). Salinities in Lemon Bay averaged 36 psu and were typically >34 psu, which is comparable to salinities throughout the watershed, except in the Peace and Myakka Rivers where salinities averaged <20 psu. DO levels in Lemon Bay were relatively high—7.97 mg/L on average compared to 4.0-6.6 mg/L in most of the other basins. Charlotte Harbor (7.04 mg/L) and Peace River (7.65 mg/L) had higher than average DO levels, but only San Carlos Bay was higher (8.1 mg/L) than Lemon Bay.

During the 1-month survey, 390 benthic samples were collected with cores and sweep nets from across the CHNEP watershed. A total of 44,000 benthic invertebrates from 370 taxa were found, though the benthic community was dominated by just eight taxa that comprised just over 50% of all individuals.

Within the CHNEP watershed, Lemon Bay had the highest observed species richness (n=160 taxa) compared to the average of 104 taxa, though coastal Venice, San Carlos, and Estero Bay also had greater than average species richness (n=124-135 taxa). Faunal densities in Lemon Bay, however, were relatively low at 27,591 individuals compared to the average of 47,740 individuals. At the habitat level, species richness in Lemon Bay was substantially higher than that observed of most of the other basins and was, in fact, highest for intertidal sand, subtidal mudflat, oyster, and saltmarsh. Within Lemon Bay, the highest richness was found in subtidal sand and mudflat habitats (n=76 and 62 taxa, respectively), though structured habitats including SAV, saltmarsh, and oyster also supported greater than average numbers of benthic taxa (n=37-42 taxa). More species of benthic invertebrates were collected in these habitats in Lemon Bay than in the same habitats elsewhere in the watershed, with the exception of SAV in Venice (59 taxa) and Pine Island Sound (43 taxa) and subtidal sand habitat in San Carlos Bay (79 taxa). Throughout the CHNEP watershed, the highest abundances were found in oyster, subtidal sand, and subtidal mudflat habitats. This was true for Lemon Bay where faunal abundances in these habitats were approximately twice as high as that observed in the other Lemon Bay habitats; however, compared to the rest of the watershed, these abundances were lower than average. Mangrove and intertidal mudflat and sandbar habitat in Lemon Bay supported very few species and low invertebrate abundances relative to the same habitats in other basins, though intertidal sandbar habitat throughout the CHNEP watershed generally supported low benthic richness and abundance.

Community structure of benthic invertebrates in core samples from most of the Lemon Bay habitats was most similar to that observed for Charlotte Harbor and Venice. The “sweep net” community was also very similar among Lemon Bay, Charlotte Harbor, and Venice, but only for the subtidal bare substrates and SAV habitats. Mangrove and intertidal mud habitats in Lemon Bay had a similar community to that observed in the subtidal mud habitat from Estero Bay; another of the largely enclosed coastal estuaries. The benthic community from oyster habitat throughout the CHNEP watershed was more similar among basins than it was with other habitat types within a basin. Compared to oyster habitat in the other basins, Charlotte Harbor and Venice supported benthic communities that were most similar to those from Lemon Bay.

Since water quality and sediment chemistry conditions are principal driving factors in promoting a diverse and healthy benthic macroinvertebrate community, the goals of the WMP with respect to water quality and sediment management should result in conditions favorable for the success of the macroinvertebrate community in Lemon Bay.

3.2.1.8 Fishes

There is a paucity of fisheries data collected in Lemon Bay proper. However, the mangrove and seagrass communities in Lemon Bay are known to provide shelter and forage for adult and juvenile fish of at least 230 species that depend on these ecosystems (FDNR, 1992). The majority of fish species that are important to commercial and recreational fisheries in Florida depend on estuaries such as Lemon Bay for their juvenile stages. To our knowledge, FDEP, the Florida Fish or Wildlife Conservation Commission, or SWFWMD have not performed any recent fish surveys in Lemon Bay. However, the CHNEP is currently negotiating with the Florida Fish and Wildlife Conservation Commission to perform a synoptic study of Lemon Bay to determine species composition and spatial and temporal variation in community structure (Lisa Beever, personal communication).

Chapter 4

Water Quality

August 2010

Sarasota County

Southwest Florida Water Management District

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4.0 WATER QUALITY

Water quality is a key indicator of the environmental health of estuaries and watersheds. Good water quality promotes a diverse and sustainable natural biota and minimizes risks to human health. Primary water quality constituents of interest in this Watershed Management (WMP) include salinity, dissolved oxygen (DO), nitrogen, phosphorus, chlorophyll, and coliform bacteria. The "quality" of water is largely estimated by the concentrations (or loads) of these constituents. These constituents, in turn, are largely affected by anthropogenic influences throughout the watersheds of most coastal communities. For instance, coastal development has altered the natural hydrology of most coastal watersheds by increasing the amount of impervious surfaces and fragmenting the drainage basins of tidal tributaries, resulting in increased surface water runoff and increased "flashiness" of freshwater inputs into tidal tributaries. These watershed alterations have affected the volume and timing of freshwater inflows into coastal basins, altering natural estuarine salinity patterns and increasing the mass (load) of nutrients and other pollutants into estuarine tributaries. Increased nutrient loads can increase primary production (chlorophyll *a*) in freshwater and estuarine systems and can lead to eutrophication (low DO and high chlorophyll *a*), an indicator of ecosystem degradation. A major goal of this WMP is to characterize water quality throughout the Lemon Bay watershed, identify degraded waters, and evaluate how to improve observed problems within Lemon Bay.

This chapter provides detailed information on the water quality of Lemon Bay including spatial and temporal trends, water quality conditions of concern, establishing water quality targets for water quality indicators, analysis of pollutant loadings, response to pollutant loading, pollutant-loading targets and recommended actions for the proper stewardship of Lemon Bay water quality.

Current water quality monitoring programs conduct monthly sampling events in both the watershed drainage basins and the estuary. The estuarine water quality has been routinely sampled since 1995, while the watershed monitoring program has only been in place since 2006. Historical data were collected in the watershed; however, these programs were discontinued in 1992. Although these historical data are described in this chapter, the relevance of these data to current conditions as well as consistency in methods used in data collection between periods are suspect, and therefore the focus of the water quality assessment is based on recent data (last 10 years) collected between 1998 through 2007. The assessment begins with evaluation of the current conditions and spatial and temporal trends, identifies water quality indicators of concern, and develops water quality targets for these indicators. Assessment of pollutant-loading targets and recommended actions complete the evaluation of how Sarasota County can help to ensure proper stewardship of the valuable natural resources by protecting water quality conditions in Lemon Bay.

4.1 STATUS AND TRENDS

The status and trends of water quality in Lemon Bay and in its major tributaries are discussed in this section.

4.1.1 Estuarine Water Quality

Lemon Bay is a long narrow estuary and appears to have limited tidal exchange with the Gulf of Mexico. Venice inlet to the north is connected to Lemon Bay via a long box cut canal designed to connect Dona and Roberts Bays to Lemon Bay for continuation of the Intracoastal Waterway (ICW). In the southern portion of Lemon Bay in Charlotte County, Stump Pass, a small natural inlet, is the only inlet in Lemon Bay Proper though exchange also occurs via Gasparilla Pass, Gasparilla Sound, and Boca Grande inlet. This section introduces exploratory data analysis by examining descriptive plots and statistics that summarize the spatial distribution patterns within the estuary. Time series plots are used to explore temporal trends, and the Kendall Tau trend test (Reckhow, 1993) is used to objectively assess temporal changes that have taken place in the estuary over the past 10 years in a statistically sound and robust method.

4.1.1.1 Status

The water quality in Lemon Bay was evaluated by first examining the distribution of values and calculating statistics over different temporal scales. Box and whisker plots were generated that compare the overall distribution for water quality parameters within each stratum of the Lemon Bay estuarine sampling segmentation scheme. The box and whisker plots display the preponderance of the distribution beginning with the 5% percentile shown as the lower whisker of the plot as identified in the example provided in Figure 4-1. The 25^{th} percentile is identified by the lower bound of the box, while the center horizontal line represents the median value. The 75^{th} percentile and 95^{th} percentile values are correspondingly represented by the upper bound of the box and whisker, respectively. The box and whisker plots allow the reader to distinguish many characteristics of the data distribution.

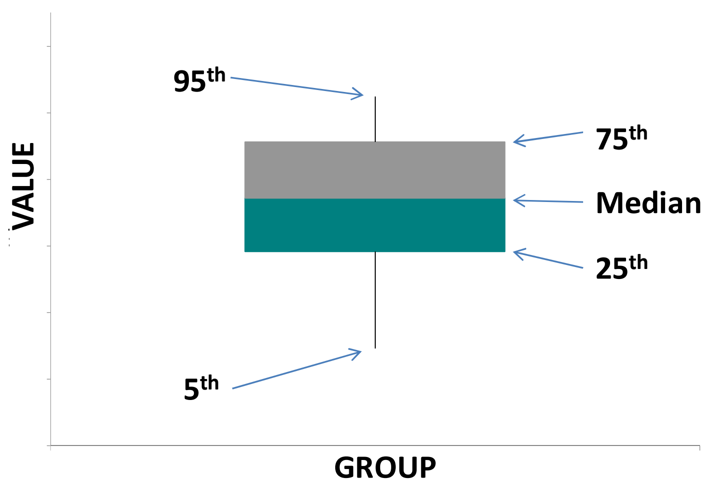

Figure 4-1 Example of a Boxplot Illustrating Aspects of the Data Distribution

The distribution of four common *in situ* water quality constituents in northern Lemon Bay (Figure 4-2) for a 10-year period from 1998 through 2007 is provided in Figure 4-3. Each water quality monitoring stratum within northern Lemon Bay (Stations 1-5) is represented in the boxplot.

Water temperature is evidently quite similar among strata while salinity, bottom DO, and pH exhibit spatial differences. The influence of the Venice Canal and Alligator Creek is evident in these plots as salinity, DO, and pH are reduced in Stratum LB1. Interestingly, DO and pH show nearly identical spatial trends in LB1-LB3, increasing with movement south while salinity is more consistent in these three strata and increases markedly in LB4 and LB5, presumably with the influence of Stump Pass and Gasparilla Sound.

Water quality constituents that represent nutrients (nitrogen and phosphorus) and biological effects (chlorophyll production and light attenuation) were highest in LB2 and LB-3 suggesting that this area receives the largest mixing of freshwater runoff and gulf waters (Figure 4-4). Nitrogen and phosphorus concentrations tended to be highest in LB2 and LB3, while chlorophyll concentrations were highest in LB2–LB4. Interestingly, while TN and chlorophyll *a* concentrations in LB4 remained similar to LB2 and LB3, Total Phosphorus (TP) concentrations and light attenuation were reduced indicating increased light availability in the lower strata associated with the Sarasota-Charlotte County line.

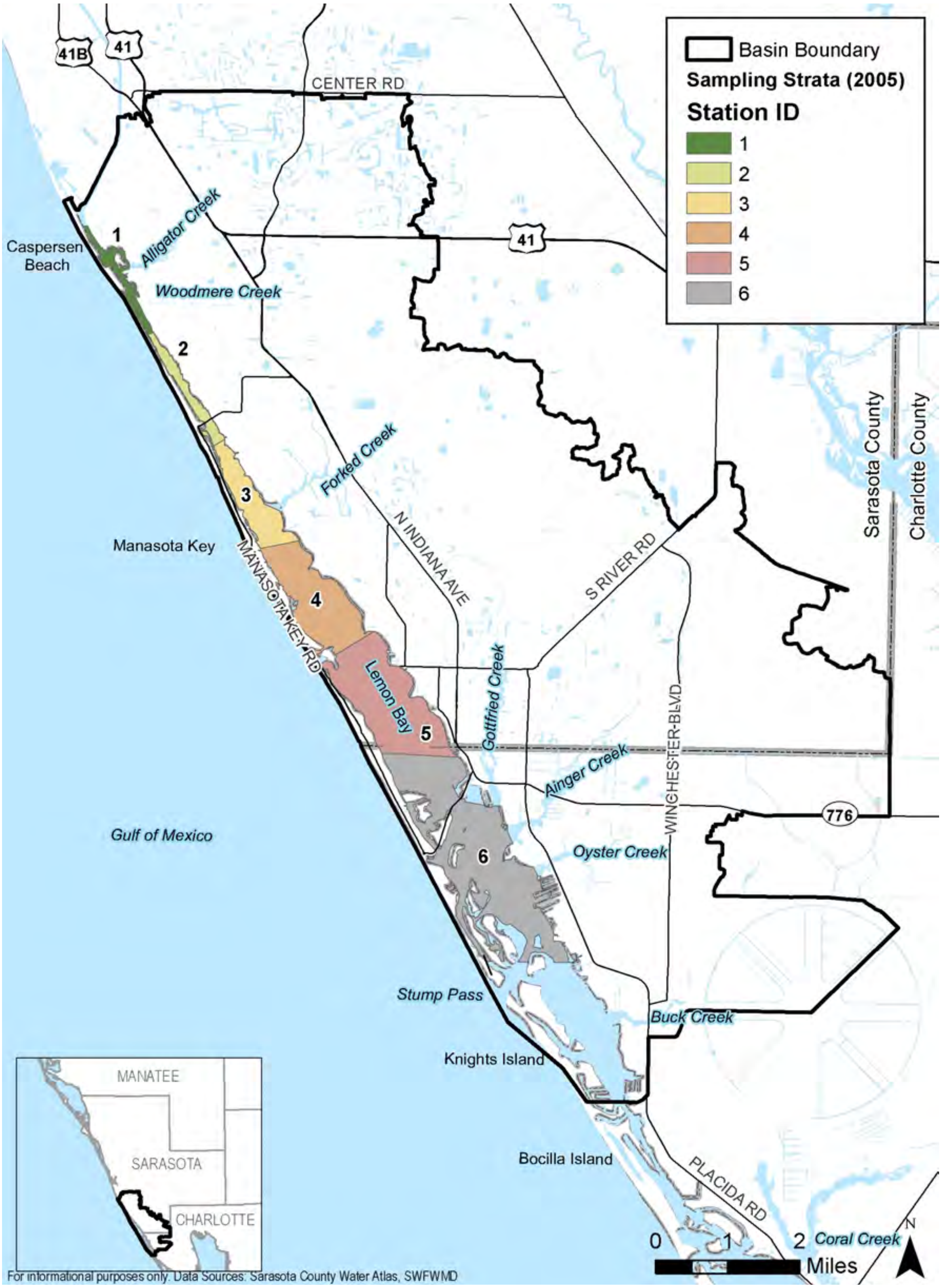

Figure 4-2 Sarasota County Water Quality Sampling Strata in Lemon Bay

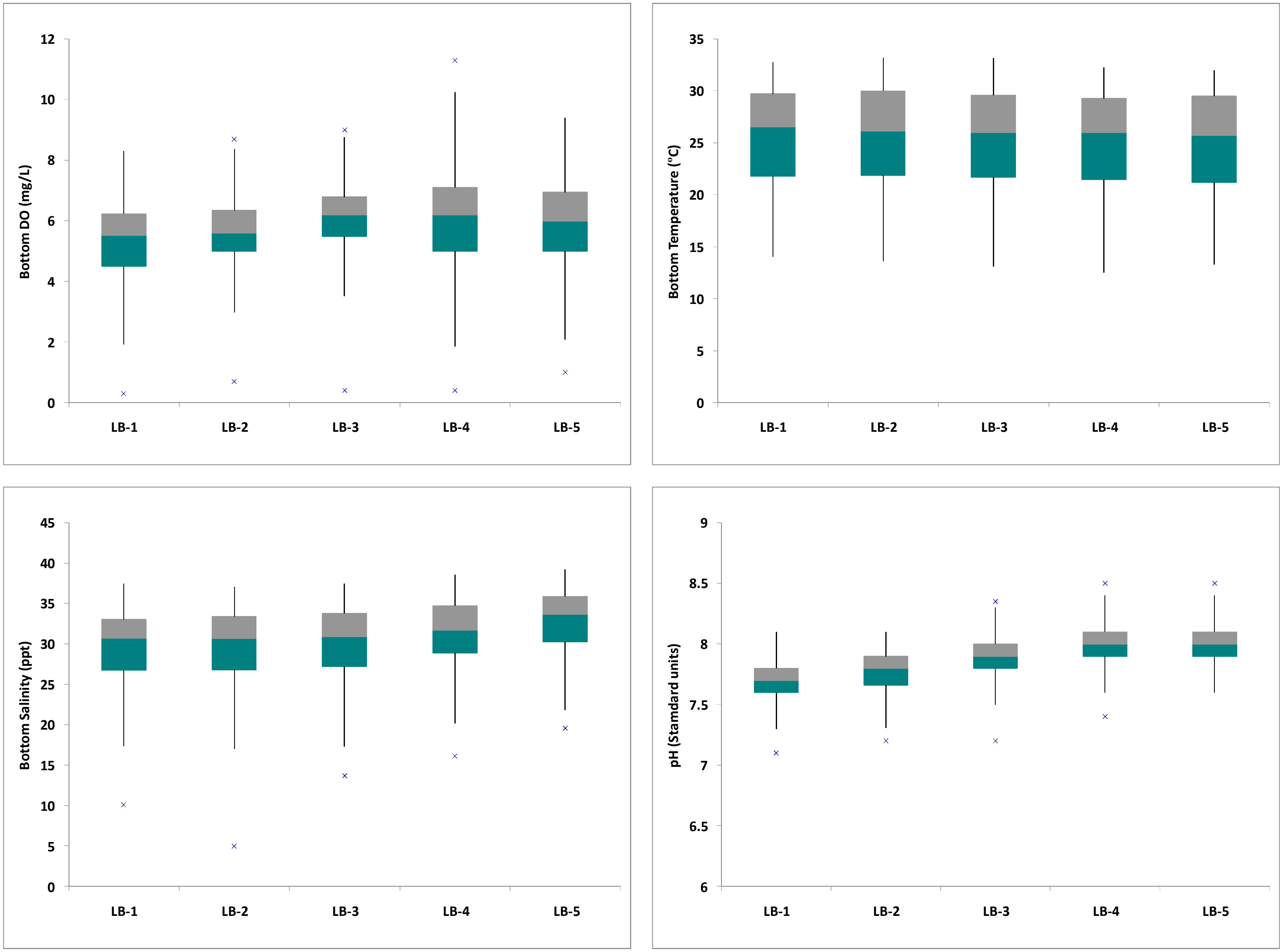

Figure 4-3 Distribution of *in situ* Water Quality Constituents by Stratum in the Sarasota County Portion of Lemon Bay

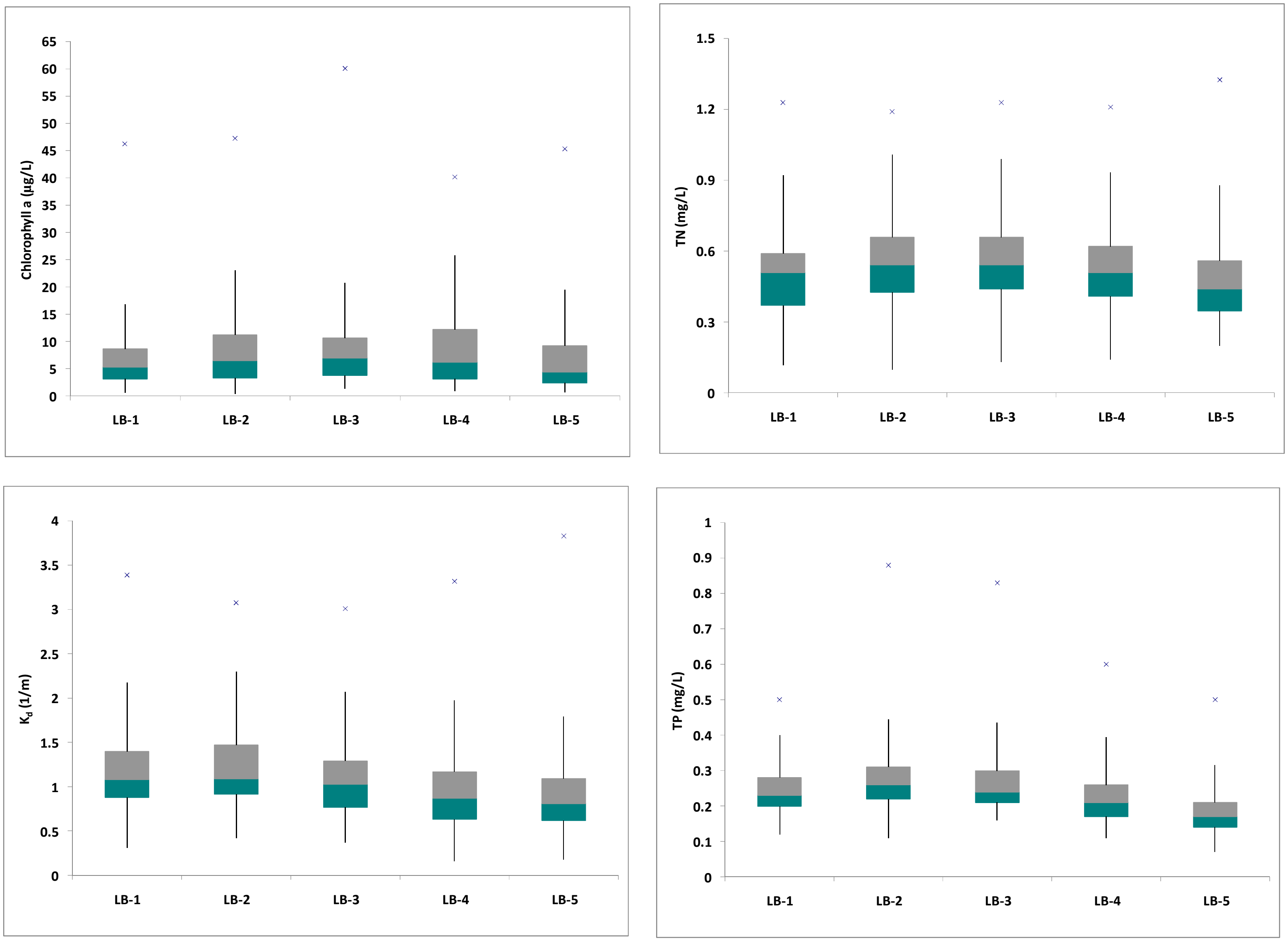

Figure 4-4 Distribution of Nutrient and Biologically Related Water Quality Constituents by Sub-segment Stratum in the Sarasota County Portion of Lemon Bay

4.1.1.2 Trends

Trends in water quality constituents were assessed using graphical plots and the seasonal Kendall Tau trend test (Reckhow, 1993). The Kendall Tau is a non-parametric test that estimates the median slope from all pair-wise comparisons in a time series of data. The statistical test accounts for seasonality and serial autocorrelation before evaluating the statistical significance of the trend in the time series. Therefore, the Kendall Tau is a sophisticated and robust method to evaluate trends in water-quality data that often do not fit the assumptions necessary for the use of parametric statistics (e.g., linear regression).

Time series trends provide information on the temporal variations in water quality and elucidate how changes in environmental conditions such as interannual variations in freshwater inflows impact the water quality constituent of interest. The time scale over which the trend is assessed is important when assessing trends. We chose the last 10 years of data to analyze to this assessment for the following reasons:

- FDEP evaluation uses the previous 7.5 years for evaluation of water quality data for Impaired Waters Rule (IWR) calculations except when assessing conditions relative to historical values.
- Previous analysis suggested that data collected before 1998 in Sarasota County was suspect with respect to several parameters including chlorophyll and light attenuation (PBSJ 2005).
- The data from 1998–2007 were collected by a consistent field crew and analyzed and a single laboratory (Mote Marine Laboratory).

The following water quality constituents were included in the time series analysis:

- Bottom DO
- Surface salinity
- Bottom salinity
- Vertically averaged salinity
- Color
- Biological Oxygen Demand (BOD)
- Corrected chlorophyll *a*
- Light extinction coefficient (Kd)
- Total nitrogen (TN)
- Total Phosphorus (TP)
- Turbidity

Results of the Kendall Tau test in the Sarasota County portion of Lemon Bay suggested that 5 day BOD was significantly improving with a decreasing slope of 0.067 mg/L (Table 4-1). Color, chlorophyll, light attenuation, and turbidity all had negative slopes indicating improving conditions. Surface salinity trends increased while vertically averaged salinity and bottom salinity displayed no trend.

Time series plots with DO, turbidity, salinity, and BOD are provided in Figure 4-5. The smoothed time series trend line is shown on these plots to aid the reader in identifying changes in the moving average value for the water quality constituent. While the moving average trend line is not necessarily linear, the Kendall Tau test is testing for a monotonic trend in the time series. Plots of nutrients (TN and TP) and biologically based constituents (chlorophyll *a* and light attenuation) are provided in Figure 4-6. Nitrogen showed no trend in the Sarasota County section of Lemon Bay, while the other constituents exhibited significant trends in the time series indicative of improving water quality condition. The plots are also informative for examining the covariance of these parameters over time such as the relationship between chlorophyll *a* and light attenuation.

Table 4-1 Results of Seasonal Kendall Tau Trend Test for Selected Constituents in Lemon Bay Based on Data Collected from 1998 through 2007

Parameter	Kendall Tau Slope
Biochemical oxygen demand (BOD) (mg/L)	-0.067
Bottom salinity (ppt)	0.000
Surface salinity (ppt)	0.279
Mean salinity (ppt)	0.000
Bottom Dissolved Oxygen (mg/L)	0.063
Color (PtCo units)	-0.500
Chlorophyll a (µg/L), corrected	-0.420
Light extinction coefficient (K_d) (1/m)	-0.026
Total nitrogen (TN) (mg/L)	0.000
Total phosphorus (TP) (mg/L)	-0.006
Turbidity (NTU)	-0.114
TSS (mg/L)	0.000

*Shading indicates improved water quality.

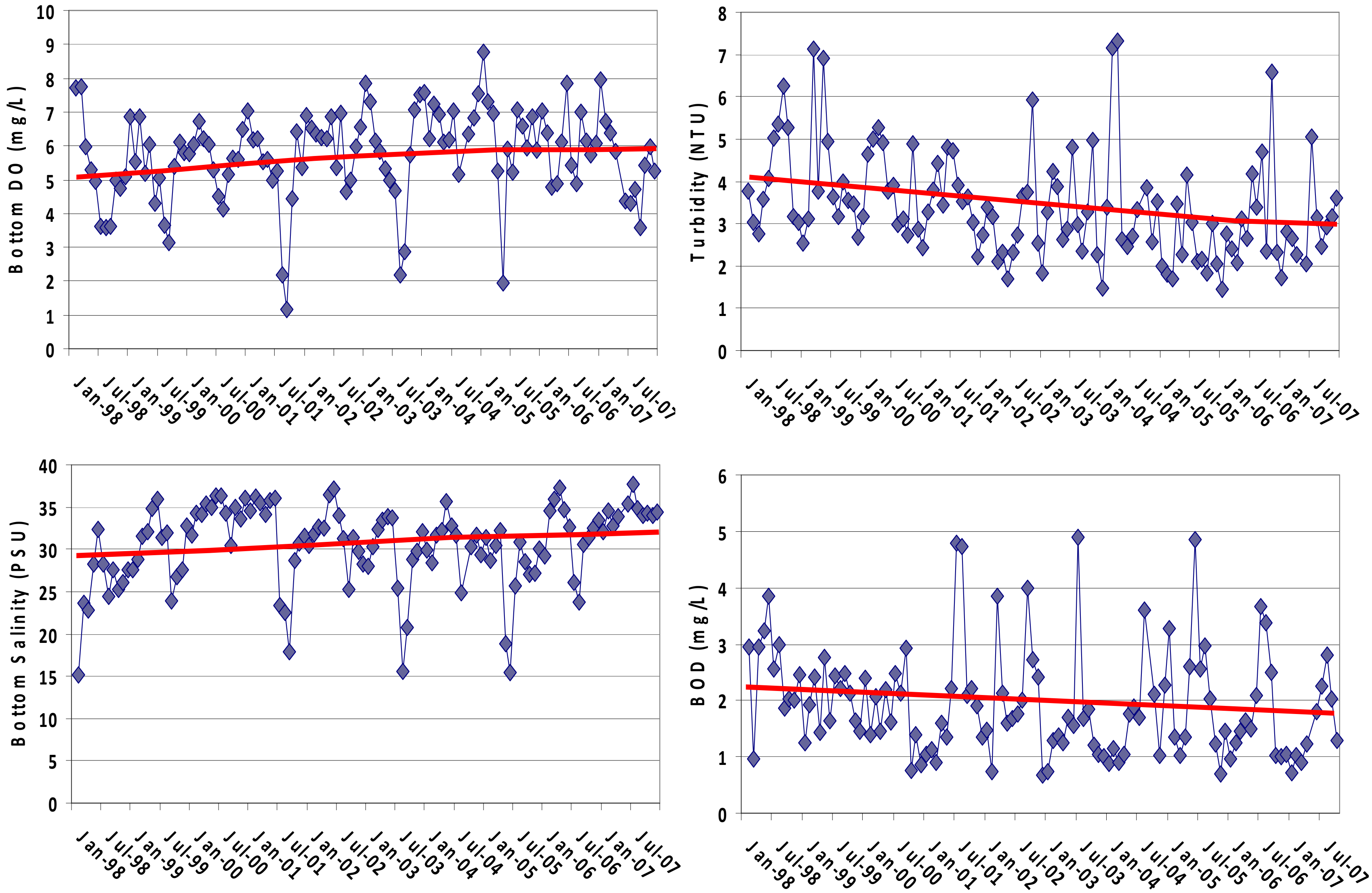

Figure 4-5 Time Series Plots for Dissolved Oxygen, Turbidity, Salinity, and Biochemical Oxygen Demand for Data Collected from 1998 through 2007 in the Sarasota County Portion of the Lemon Bay Estuary

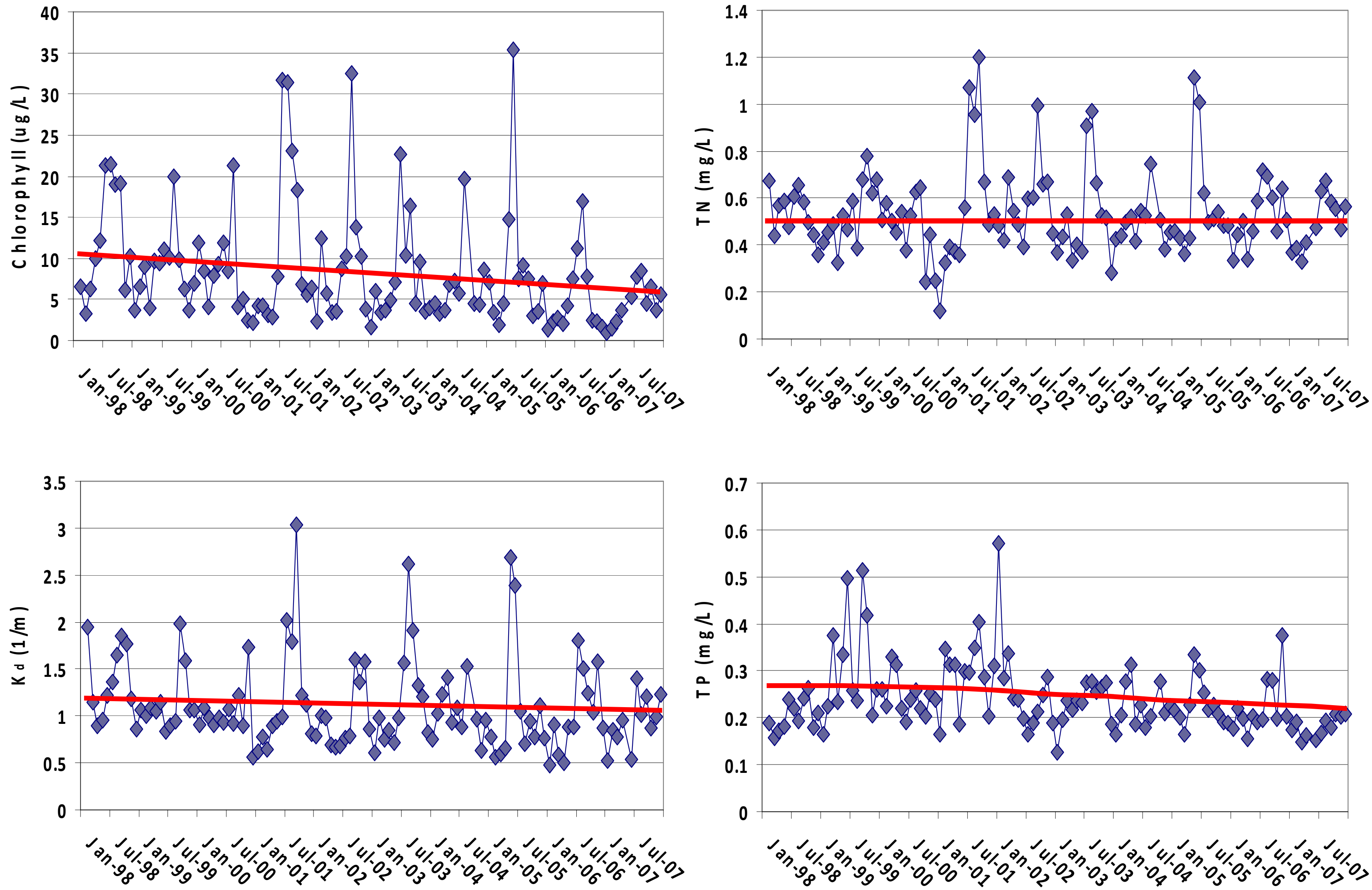

Figure 4-6 Time Series Plots for Chlorophyll *a*, Total Nitrogen, Light Attenuation, and Total Phosphorus for Data Collected from 1998 through 2007 in the Sarasota County Portion of the Lemon Bay Estuary

Estuarine water quality data in the Charlotte County portion of Lemon Bay were also examined for trends. Water quality data were available for nine stations sampled by the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN) (Figure 4-7) and a probabilistic sampling design in the open bay portions of Lower Lemon Bay was sampled monthly since 2002 by the Coastal Charlotte Harbor Water Quality Monitoring Network (CCHMN).

Results of the fixed station trend analysis (Table 4-2) suggested that chlorophyll *a* concentrations were decreasing at three stations: LBV002, LBV004, and LBV005. TP concentrations were also decreasing at three stations but increasing at one station (LBV006), while only one station had a significant decreasing trend in TN concentration.

Trends based on the probabilistic sampling in Lower Lemon Bay suggested increasing salinity, decreasing color and decreasing DO in Lower Lemon Bay (Table 4-3). Detailed results for all seasonal Kendall Tau trend tests can be found in Appendix B.

Figure 4-7 Fixed Station Water Quality Sampling Locations Sampled by the CHEVWQMN Program

Table 4-2 Summary of Kendall Tau trend test results for the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN)

Station	DO (mg/L)	Salinity (ppt)	Turbidity (NTU)	Chlorophyll a (µg/L)	Color (PtCo units)	TN (mg/L)	TP (mg/L)
LBANG1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LBOYS1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LBV001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
LBV002	0.138	-0.410	0.000	-0.473	0.833	0.000	0.000
LBV003	0.000	0.000	-0.152	0.000	0.000	-0.033	-0.006
LBV004	0.000	0.000	-0.180	-0.347	0.000	0.000	-0.005
LBV005	-0.167	0.000	0.000	-0.390	0.000	0.000	-0.005
LBV006	0.000	-1.063	0.000	0.000	2.500	0.000	0.008
LBV007	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 4-3 Kendall Tau Trend Test Summary for Probabilistic Sampling data Conducted by the CCHMN in Lower Lemon Bay 2002–2007

Parameter	Kendall Tau Slope
Turbidity (NTU)	0.000
Chlorophyll *a* (µg/L)	0.000
Color (Pt Co units)	-3.000
DO (mg/L)	-0.192
Salinity (ppt)	0.379
TN (mg/L)	0.000
TP (mg/L)	0.000
TSS (mg/L)	0.000

4.1.2 Watershed Water Quality

As part of Sarasota County's proactive approach to stewardship of their water quality, the Sarasota County Water Resources Department currently monitors surface water quality at 12 sites within the watershed – three in the Alligator Creek subwatershed, two in the Woodmere Creek subwatershed, three in the Forked Creek subwatershed, and four in the Gottfried Creek subwatershed as shown in Figure 4-8.

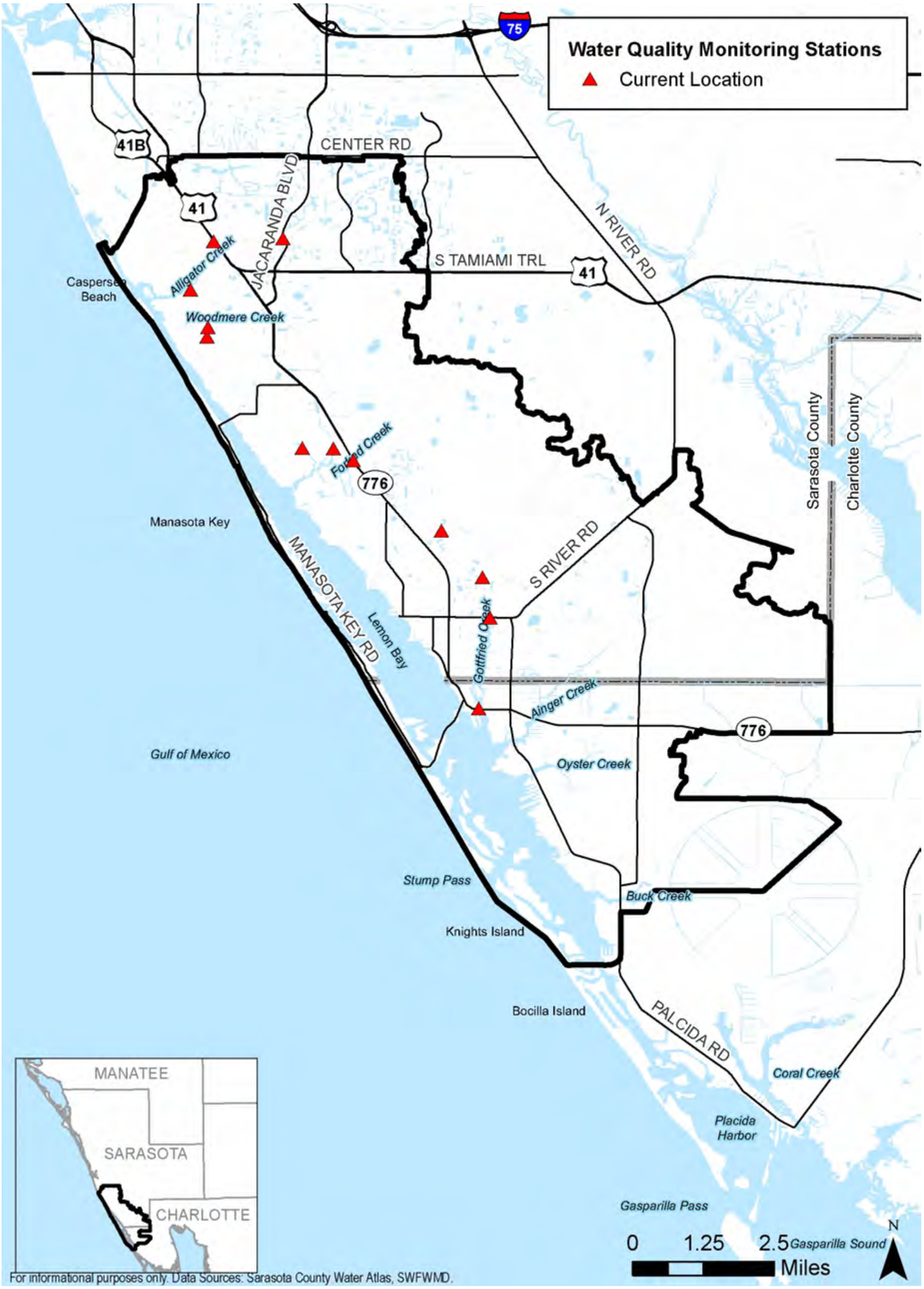

Figure 4-8 Lemon Bay Watershed Water Quality Monitoring Stations (Sarasota County Water Resources)

Historically, other agencies have conducted sampling in the watershed. A review of the County Water Resources Atlas shows that the following sample sites have been used:

- Florida Department of Environmental Protection – 36 sites
- Sarasota County Environmental Services Department – 9 sites
- Charlotte County Environmental Quality Lab – 6 sites
- United States Geological Survey – 6 sites
- Florida Department of Agriculture and Consumer Services – 3 sites
- Florida LAKEWATCH – 3 sites
- Southwest Florida Water Management District – 3 sites

These "historical" sampling programs were initiated after the passage of the Clean Waters Act of 1972 and sampled approximately quarterly between 1973 and 1992. Sampled parameters were similar to those currently sampled. No consistent water quality monitoring data in the Lemon Bay Watershed were collected between 1992 and 2006.

Four representative sites were chosen to compare summary statistics for selected parameters between historical (Table 4-4) and more recent (Table 4-5) data collection efforts. These sites include one station in Alligator Creek at US 41; one station in Forked Creek at state road 776, and two stations in Gottfried Creek, upstream at Wentworth and near the mouth in the Deer Creek tributary. Fecal coliform, TN, and TP concentrations were compared.

The State water quality standard for fecal coliform bacteria in Class III fresh and marine waters is 800 mpn (most probable number) on any day (Chapter 602-302.530, FAC). On average, fecal coliform concentrations were higher than the proposed State standard in both historical data and the more recent data for data collected in Alligator Creek. Historically, Gottfried Creek was below the standard, but recent data suggests that the proposed standard may be exceeded frequently. No recent data were available for fecal coliform at the Forked Creek site (Table 4-5).

Total coliform concentrations in Alligator Creek were also historically higher than the State standard (2700 mpn). In the other creeks, total coliform concentrations did not exceed the State standard frequently. Data on total coliform concentrations are not available for the recent monitoring activity. There are no nutrient criteria currently established under State statute; however, recent TN and TP concentrations were approximately half of their historical values on average except in Gottfried Creek where historical and recent comparisons suggest TP concentrations remain similar.

Many capital improvement projects are currently taking place with the aim to reduce anthropogenic sources of nutrient inputs into Lemon Bay and improve water quality conditions. Wastewater treatment plants that discharge into Lemon Bay are being taken offline. A sediment management plan is being implemented to reduce sediment loads into estuarine receiving bodies. Identifying water quality conditions of concern and developing criteria for these indicators that allow for changes in water quality to be tracked through time as a measure of the success of watershed management efforts are critical to evaluating the success of these watershed management actions.

Table 4-4 Summary Statistics for Select Water Quality Parameters at Representative Fixed Station Locations in the Lemon Bay Watershed between 1972–1992

Station	Value	DO (mg/L)	Fecal Coliform (col/100ml)	Total Coliform (col/100ml)	TN (mg/L)	TP (mg/L)
Alligator Creek at US41	Mean	4.57	614.06	3947.07	1.48	0.39
	Min	1.2	10	100	0.24	0.08
	Max	14.9	5400	80000	3.18	2.3
Forked Creek at 776	Mean	4.9	520.58	1981.53	1.25	0.433
	Min	1.3	10	100	0.18	0.12
	Max	9.7	15000	24000	2.87	1.78
Gottfried Creek at Wentworth	Mean	4.24	330.35	1307.57	1.25	0.56
	Min	1.5	10	100	0.19	0.15
	Max	9	4500	13000	2.59	3.07
Deer Creek at Norton	Mean	4.86	168.12	788	1.05	0.44
	Min	1.1	10	100	0.15	0.12
	Max	8.6	2400	5000	1.99	2.91

Table 4-5 Summary Statistics for Select Water Quality Parameters at Representative Fixed Station Locations in the Lemon Bay Watershed between 2006–2007

Station	Value	Fecal Coliform (col/100ml)	TN (mg/L)	TP (mg/L)
Alligator Creek at US41	Mean	1554.17	0.88	0.20
	Min	10.00	0.29	0.07
	Max	15000.00	1.56	0.30
Forked Creek at 776	Mean		0.69	0.28
	Min		0.39	0.19
	Max		1.62	0.45
Gottfried Creek at Wentworth	Mean	922.50	0.90	0.57
	Min	80.00	0.47	0.24
	Max	2800.00	1.40	1.16
Deer Creek at Norton	Mean	72.50	0.63	0.24
	Min	10.00	0.34	0.14
	Max	120.00	1.26	0.38

4.1.3 Water Quality Conditions of Concern

Lemon Bay has been designated an Outstanding Florida Water (OFW) as a special water and is listed in Chapter 62-302.700(i), FAC (FDEP, 2009c). An OFW is a waterbody designated as worthy of special protection because of its natural attributes. This special designation is intended to protect existing good water quality, i.e., no degradation of water quality is permitted. Most OFWs are areas managed by the state or federal government such as parks, wildlife refuges, preserves, marine sanctuaries, estuarine research reserves, waters within state or national forests, scenic and wild rivers, or aquatic preserves. Generally, the waters within these managed areas are OFWs because the managing agency has requested this special protection. Additionally, a 7,667 acre state aquatic preserve is located within Lemon Bay.

As mandated by the Federal Clean Water Act and the U.S. Environmental Protection Agency (EPA), the FDEP has established criteria for evaluating water quality throughout Florida using a waterbody classification system and evaluative criteria for a host of water quality constituents (Chapter 62-302.530, FAC). FDEP compiles surface water quality data collected throughout Florida using its STORET database and its Waterbody Identification (WBID) system to assess water quality impairment of WBIDs under the IWR (Chapter 62-302.530, FAC).

A TMDL is a scientific determination of the maximum amount of a given pollutant that a surface waterbody can absorb and still meet water quality standards (FDEP, 2009). The basic steps in the TMDL program are as follows:

1. Assess the quality of surface waters—are they meeting water quality standards?
2. Determine which waters are impaired—that is, which ones are not meeting water quality standards for a particular pollutant or pollutants.
3. Establish and adopt, by rule, a TMDL for each impaired water for the pollutants of concern—the ones causing the water quality problems.
4. With extensive local stakeholder input, develop a Basin Management Action Plan (BMAP) that summarizes what actions will be taken by whom to correct impairments.
5. Implement the strategies and actions in the BMAP.
6. Measure the effectiveness of the BMAP, both continuously at the local level and through a formal re-evaluation every 5 years.
7. Change the plan and actions if things are not working.
8. Reassess the quality of surface waters periodically.

The following includes a summary for those waterbodies that have existing TMDLs and a summary of those waterbodies that have been verified impaired but have no existing TMDL.

4.1.3.1 Existing EPA TMDLs in the Lemon Bay Watershed

TMDLs have been established by the EPA for four WBIDs in the Lemon Bay Watershed (Figure 4-9). The TMDLs are shown below with their respective impairments and causative agents.

- Alligator Creek (WBID 2030) nutrients and DO – TN
- Forked Creek (WBID 2039) nutrients - TN
- Woodmere Creek (WBID 2042) nutrients - TN
- Gottfried Creek (WBID 2049) nutrients - TN

Currently, Lemon Bay is a Class III waterbody with designated uses of Recreation, Propagation, and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. The State assesses nutrient impairment using chlorophyll levels in two ways: if an annual average chlorophyll value exceeds 11 µg/L or if the chlorophyll *a* values in 2 consecutive years exceeds historical values by more than 50%.

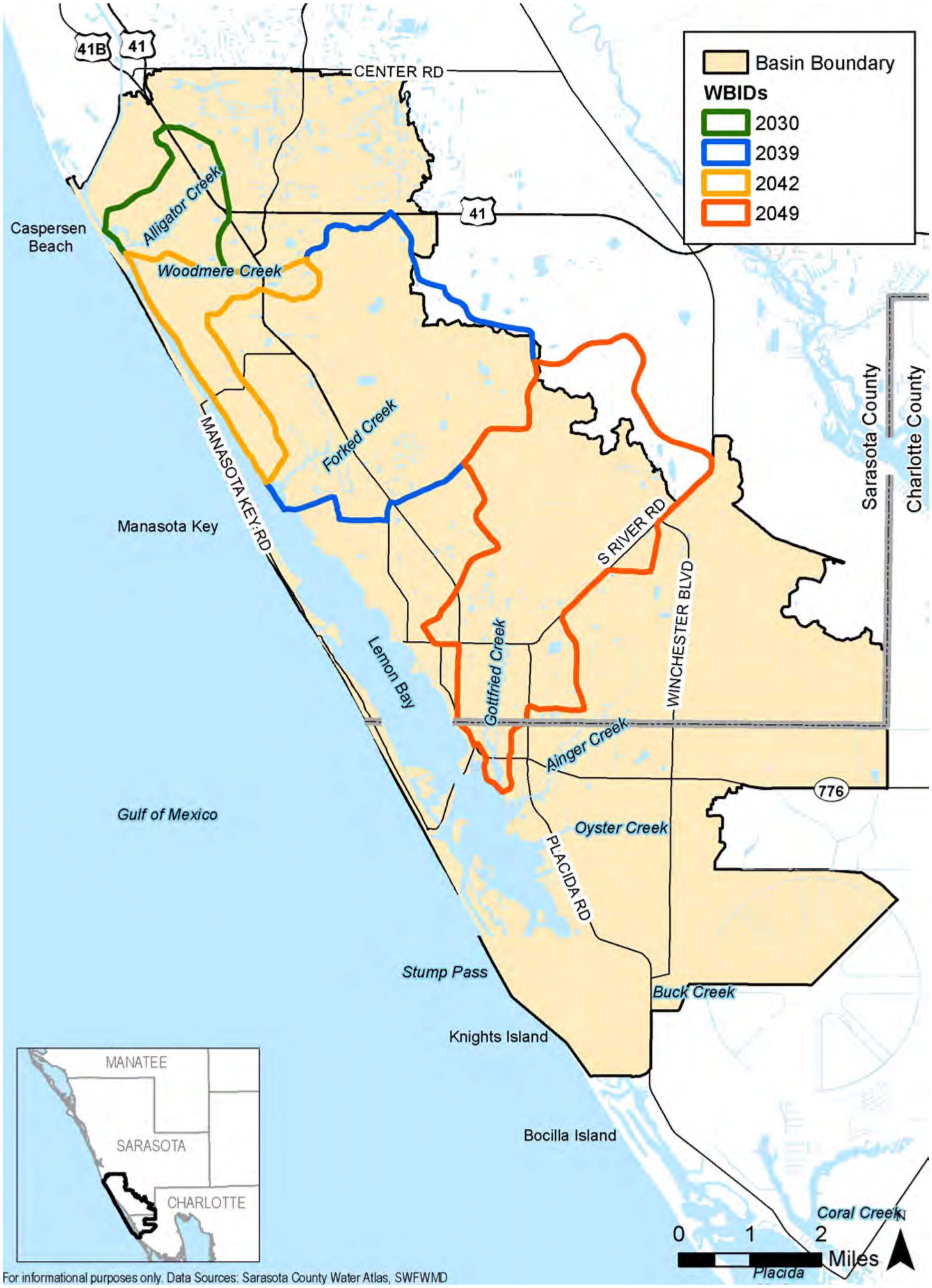

Figure 4-9 Impaired WBIDs within the Sarasota County Portion of the Lemon Bay Watershed

The EPA established TMDLs for Alligator Creek for nutrients and DO in 2005 (EPA, 2006). Nutrient impairment was due to exceedances of the chlorophyll *a* criterion, which was evaluated from the 1998 through 2001 data. Annual average chlorophyll *a* values in Alligator Creek between 1998 and 2001 ranged from 1.0 µg/L in to 48.7 µg/L, with an average of 9.5 µg/L. Chlorophyll *a* levels in Alligator Creek exceeded the threshold 11 times out of 25 samples. Therefore, it is verified as impaired.

To determine the appropriate TMDLs for Alligator Creek, a watershed management model was developed for the study area. The model estimated hydrologic yield as a function of precipitation, land use, and soil type. Land use-specific loadings estimates for TN were developed for the 1998 through 2001 period. The TMDL requirement for this WBID is a 28.2% reduction in annual TN loads, resulting in a decrease from 5,370 kg/year of TN from the 1998 through 2001 period loads to 3,857 kg/year of TN for the target loads.

Alligator Creek was also classified as verified impaired for DO by the EPA in 2005 (EPA, 2006), due to low DO values observed between 1998 and 2000. DO shall not be less than 5.0 mg/L for a 24-hour period, and never less than 4.0 mg/L. DO ranged from 1.2 mg/L to 6.0 mg/L, and averaged 3.4 mg/L. Of the 28 samples collected, 21 were below the DO standard. To address this water quality concern, the same TN load reduction required by Alligator Creek's nutrient TMDL was defined, with the addition of a BOD target load reduction. The existing BOD load is 15,728 kg/year. The TMDL recommends a percent reduction in BOD loads of 57.8%, to 6,632 kg/year.

The EPA established a TMDL for Forked Creek for nutrients in 2005. Impairment was due to exceedances in Algal Growth Potential (AGP) tests conducted in 2005. Results of AGP tests yielded an average of 12.4 mg/L from two tests analyzed in replicate. This value exceeded the EPA standard for AGP tests (10 mg/L) associated with eutrophic waters, which are subject to nuisance algal blooms. The average annual TN load to Forked Creek in 2005 was 4,235 kg/year. To meet the water quality criterion for nutrients, the EPA recommends a 20.0% reduction in TN loads, to 3,387 kg/year.

The EPA established a TMDL for Woodmere Creek (called "direct runoff to the bay" in the EPA TMDL) for nutrients in 2005 (EPA, 2006). Impairment was due to exceedances in AGP tests conducted in 2005. Results of AGP tests yielded values of 11 mg/L and 16.8 mg/L, the latter of which is the average of two tests analyzed in replicate. This value exceeded the EPA standard for AGP tests (10 mg/L) associated with eutrophic waters, which are subject to nuisance algal blooms. The average annual TN load to Woodmere Creek in 2005 was 1,414 kg/year. In order to meet the water quality criterion for nutrients, EPA recommends a 54.7% reduction in TN loads, to 641 kg/year.

The EPA established TMDLs for Gottfried Creek for nutrients and DO in 2005 (EPA, 2006). Nutrient impairment was due to exceedances of the chlorophyll *a* threshold, which was evaluated from the 2002 through 2005 data, and an elevated AGP value from data collected in 2005. Annual average chlorophyll *a* values in Gottfried Creek between 2002 and 2005 ranged from 1.0 µg/L in to 13.1 µg/L out of 3 samples, with an average of 6.1 µg/L. One AGP test yielded a result of 5.1 mg/L. This value was considered to be near the threshold of 6.1 mg/L associated with highly productive waters. EPA determined that these data in concert indicated a high probability of eutrophic waters.

To determine the appropriate TMDLs for Gottfried Creek, the same watershed management model that was used in other basins in the Lemon Bay watershed was applied. Land use-specific loadings estimates for TN were developed for the 2002 through 2005 period. The TMDL requirement for this WBID is a 2.0% reduction in annual TN loads, resulting in a decrease from 3,025 kg/year of TN from the 2002 through 2005 period loads to 2,966 kg/year of TN for the target loads.

Gottfried Creek was also classified as verified impaired for DO by the EPA in 2005, due to low DO values observed between 1998 and 2003. DO ranged from 1.0 mg/L to 8.7 mg/L, and averaged 3.7 mg/L. Of the 27 samples collected, 68% were below the DO standard. To address this water quality concern, the same TN load reduction required by Woodmere Creek's nutrient TMDL was defined, with the addition of a BOD target load reduction. The existing BOD load is 19.2 kg/day. The TMDL recommends a percent reduction in BOD loads of 28.2%, to 16.1 kg/day.

4.1.3.2 Other Impairments within the Lemon Bay Watershed

In 2005, Group 2 Basins were evaluated for exceedances of FAC water quality criteria and, when deemed to be verified impaired, were prioritized as High, Medium, or Low for TMDL development. Group 2 Basins are those watersheds that are assessed for TMDLs during the second year of FDEP's five-year cyclic Basin Assessment program. Group 2 basins were first assessed in 2004 and underwent their second assessment cycle in 2009. Those WBIDs categorized as High Priority were slated for immediate TMDL development in the first cycle of TMDLs in 2005, whereas Medium Priority TMDLs for other impaired WBIDs throughout Lemon Bay were slated for TMDL development in the second cycle in 2009. New verified impaired listings were released in May 2009 and include the following impairments in these WBIDs:

- ❖ Lemon Bay (WBID 1983A)
  - Fecal Coliforms: 34 out of 239 samples exceeded the threshold of 43 MPN (Most Probable Number)/100 mL.
- ❖ North Lemon Bay (WBID 1983A1)
  - Nutrients – Chlorophyll *a*: Annual average chlorophyll *a* values exceeded the 11 µg/L standard for Class 3M waters in 2001 (11.4 µg/L) and in 2005 (11.1 µg/L).
- ❖ Alligator Creek - estuarine (WBID 2030)

- Nutrients – Chlorophyll *a*: The annual average chlorophyll *a* value in 2007 (18.3 µg/L) exceeded the 11 µg/L standard for Class 3M waters.

❖ Alligator Creek - stream(WBID 2030A)
- Nutrients – Chlorophyll *a*: The annual average chlorophyll *a* value in 2007 (33.3 µg/L) exceeded the 20 µg/L standard for Class 3F waters.

❖ Woodmere Creek (WBID 2042)
- Fecal Coliform: Nine out of 21 samples exceeded the threshold of 400 counts/100 mL.

❖ Gottfried Creek (WBID 2049)
- Fecal Coliform: 16 out of 52 samples exceeded the threshold of 400 counts/100 mL.
- Nutrients – Chlorophyll *a*: The annual average chlorophyll *a* values did not exceed the 11 µg/L standard for Class 3M waters but nutrients are listed as the causative pollutant for dissolved oxygen in this same waterbody.
- Dissolved Oxygen - Impaired based on IWR thresholds for total nitrogen, total phosphorus, and biochemical oxygen demand.

❖ Buck Creek (WBID 2068)
- Nutrients – Chlorophyll *a*: The annual average chlorophyll *a* value in 2007 (20.7 µg/L) exceeded the 11 µg/L standard for Class 3M waters.

❖ Coral Creek – East Branch (WBID 2078B)
- Dissolved Oxygen: Twelve out of 28 samples were below the DO standard of 4.0 mg/L.

Coral Creek, which was previously identified as impaired for nutrients due to chlorophyll *a* exceedances in the first cycle of TMDL development in 2005, was delisted for this parameter in the second cycle after it was determined that the original assessment was flawed. FDEP released a TMDL for Coral Creek in June 2009 that addresses the DO impairment.

4.2 WATER QUALITY TARGETS

Arguably the single-most important element of an effective WMP is setting resource protection targets. There are four common approaches to setting targets (Janicki Environmental, 2002):

❖ Targets based on historical conditions
❖ Targets based on reference system conditions
❖ Targets based on regulatory standards
❖ Targets based on the environmental requirements of critical resource(s)

Although one approach may be used by itself, a preferred method is to develop potential targets using more than one approach and to look for unifying results among these approaches to guide water quality target selection (Janicki Environmental, 2002, 2003). The following discusses each of the potential approaches:

- ❖ Historical conditions—If data that describe water quality in historical (undegraded) conditions exist, then that condition can be used as a restoration target. The use of this approach is typically desirable when historical data are available. However, data comparability is often limited due to sample design and methodological differences between historical and current data.
- ❖ Water quality standards—For this approach water quality monitoring data are compared to established standards to identify any samples failing to meet the standards. The presumption is that if water quality does not meet standards, then there is a problem. This approach is straightforward and is acceptable if adopted standards are appropriate. Also, target setting using the standards approach is much less definitive if non-numeric standards are used, for example Florida's nutrient standards. To improve this situation, the FDEP is currently in the process of establishing numeric standards for nutrients (FDEP, 2009a).
- ❖ Reference sites—For the reference site method, conditions at an area of interest are compared to similar but undegraded sites. This method is also useful but is difficult to implement, partially because it is often not easy to identify a suitable reference site and real differences between the sites must be identified. EPA uses the reference site method frequently, most often for freshwater systems. The FDEP Stream Condition Index (SCI) is a reference site example (FDEP, 2007). The benefit of this bioassessment approach is that multiple site characteristics (hydrology, water quality, habitat disturbance, etc.) are integrated.
- ❖ Resource-based—Resource-based target setting is widely accepted as the preferable approach, as it directly ties water quality to the resource of concern. Resource-based targets have been set for many waterbodies both locally (Tampa Bay, Indian River Lagoon, Caloosahatchee River) (Greening and Janicki, 2006; Tomasko et al., 2001; Steward et al., 2005) and nationally (e.g., Chesapeake Bay Program).

Effective watershed management is typically based on preserving existing features or on restoring degraded areas to desirable conditions. A critical initial step in this process is to determine what resources are most beneficial and should therefore receive priority attention. A resource of concern should be desirable and representative of a larger habitat or system. Its extent and status should be measurable and manageable; that is, there should be an available suite of actions that can be used to foster the resource of concern's sustainability. Given the importance of seagrasses in the Lemon Bay estuary, setting water quality targets based on the requirements for their growth and reproduction is preferred. Seagrass meets all of the above criteria. Seagrasses serve significant functions within the estuarine ecosystem. They help maintain water clarity by trapping fine sediments and particles with their leaves and stabilizing the estuarine sediments with their roots. Seagrasses are very effective at removing dissolved nutrients from water that can enter from land runoff. The removal of sediment and nutrients improve water clarity, thereby improving overall ecosystem health. Seagrasses provide nursery habitats for fish, crustaceans, and shellfish, providing a nursery ground for many recreationally and commercially valuable species. They are also food for organisms that inhabit them and marine mammals such as manatees and waterfowl such as ducks. Human activities can harm seagrasses by degrading estuarine water quality and promoting physical disturbances and algal blooms. Reductions in light availability associated with nutrient inputs and sediments can damage or eliminate seagrass habitat. If seagrass is thriving, then it is likely that the system is in general healthy and extensive (and expensive) monitoring of other indicators may not be necessary. Seagrass can be mapped through field reconnaissance and aerial mapping to track its extent over time. Also, the spatial extent of seagrass growth depends on water clarity which is dependent upon other water quality parameters, including chlorophyll *a*, turbidity, and color.

Seagrass targets for Lemon Bay have been established by the Charlotte Harbor National Estuary Program (CHNEP) (Janicki Environmental, 2009). The process for defining targets for each of the CHNEP segments was based on a comparison of the historical (ca. 1950) seagrass coverage to recent surveys conducted by the SWFWMD. A description of the District mapping effort can be found in Kaufman (2006). The CHNEP defined the seagrass target as the larger of either the historical cover or the average of the recent seagrass surveys.

Figure 4-10 presents the seagrass cover data used to establish the Lemon Bay target. Overall, there has been a small difference (380 acres) between the historical and current seagrass coverage. This reduction occurred in Lower Lemon Bay.

The CHNEP established seagrass restoration and protection targets for the Upper and Lower Lemon Bay segments. The targets were defined as either the baseline acreage (adjusted for non-restorable areas) or the mean annual extent from the recent SWFWMD surveys. These targets are:

- ❖ *Upper Lemon Bay*
  - *Protection Target – 1,009 acres*
- ❖ *Lower Lemon Bay*
  - *Protection Target – 2,502 acres*
  - *Restoration Target – 380 acres*

In the following discussion, water quality targets based on seagrass success and desirable salinity conditions, and meeting DO standards in Lemon Bay are defined. These targets will be applied to loading-water quality response models to estimate the loading targets to be addressed by the watershed projects and programs.

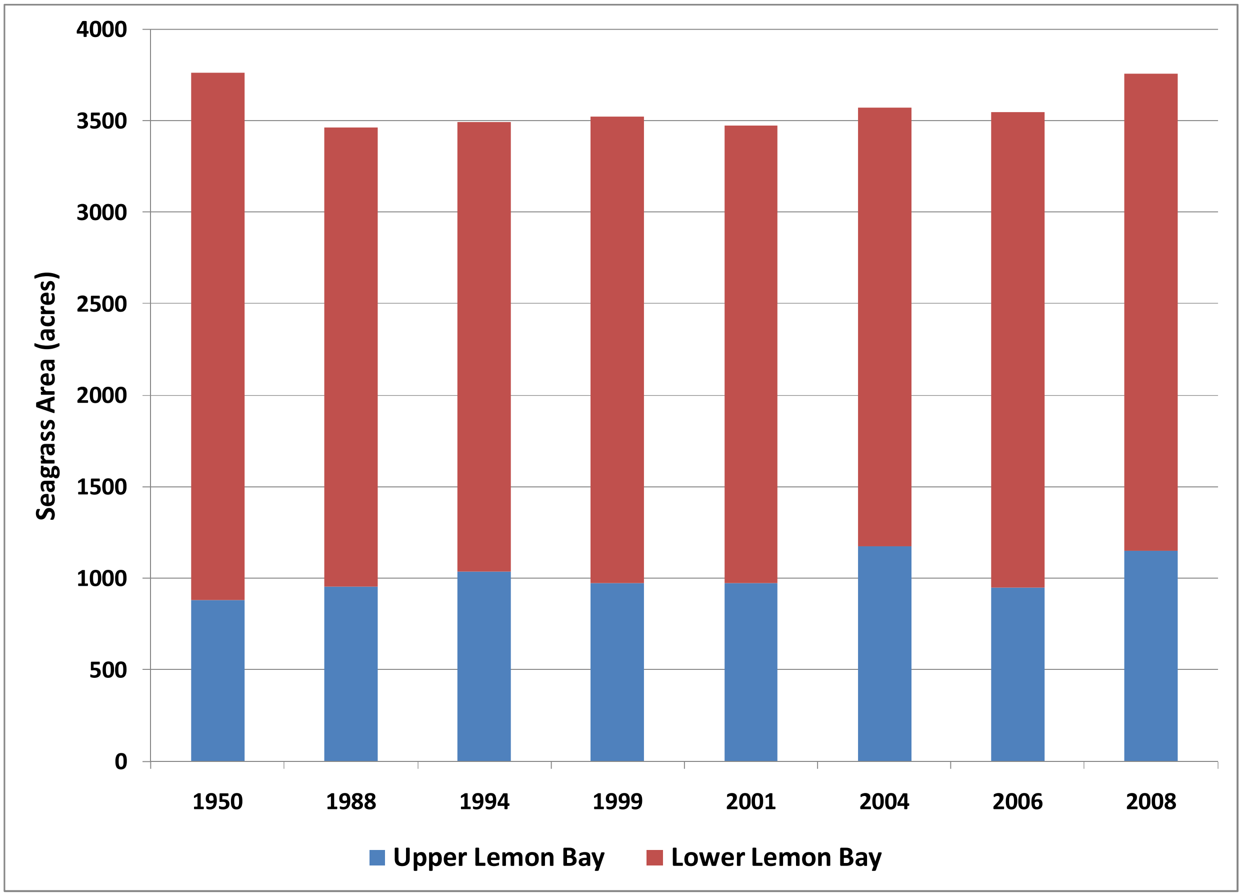

Figure 4-10 Seagrass Cover (acres) from the Historical and Recent Surveys in Lemon Bay

4.2.1 Seagrass-Related and Water Quality Standard-Based Targets

Given the seagrass target for Lemon Bay, the next step in the target setting process is to determine the water quality conditions that are conducive to the protection and restoration of seagrasses. Water clarity, a measure of the amount of sunlight that can penetrate the water, is a significant determinant of seagrass success in a given estuary (Dawes et al., 2004). Clear waters are indicative of a healthy estuary, although many factors impact water clarity. Excess suspended sediments from runoff can negatively impact water clarity. Nutrients, mainly nitrogen and phosphorus, can fuel the growth of photosynthesizing algae. High chlorophyll *a* concentrations can also decrease water clarity. In turn, decreased water clarity can negatively impact seagrass cover, reducing habitat availability to the hundreds of species that depend on them.

Examination of the ambient water quality data shows the interrelationships among chlorophyll, light attenuation, and turbidity in Lemon Bay (Figures 4-11 and 4-12). While light attenuation declines with both increasing chlorophyll and turbidity, more of the variation in light attenuation is related to variation in chlorophyll *a* concentrations as evidenced by the respective coefficients of determination (r^2).

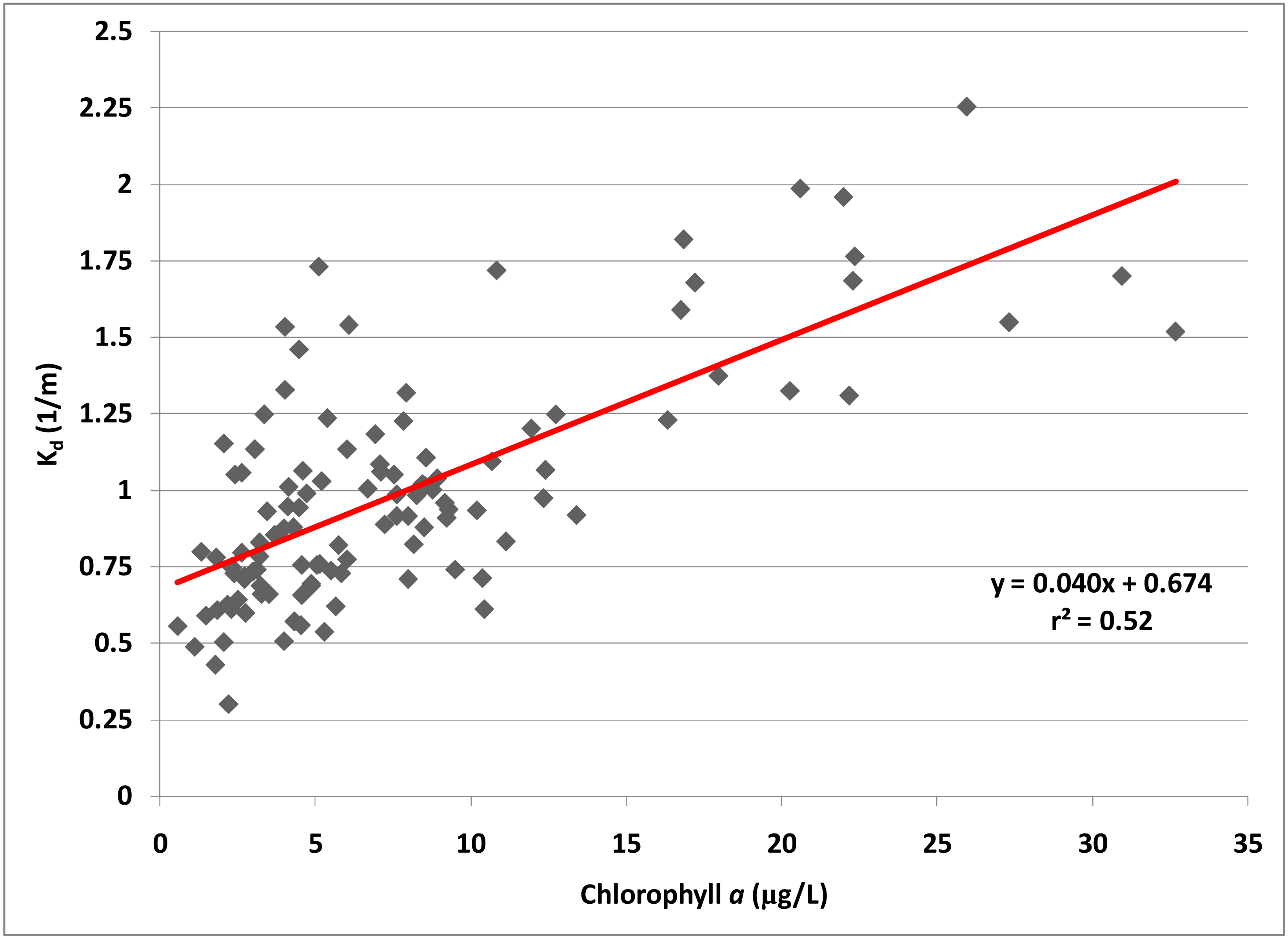

Figure 4-11 Relationship Between Chlorophyll *a* Concentrations and Light Attenuation in Lemon Bay (1998–2007)

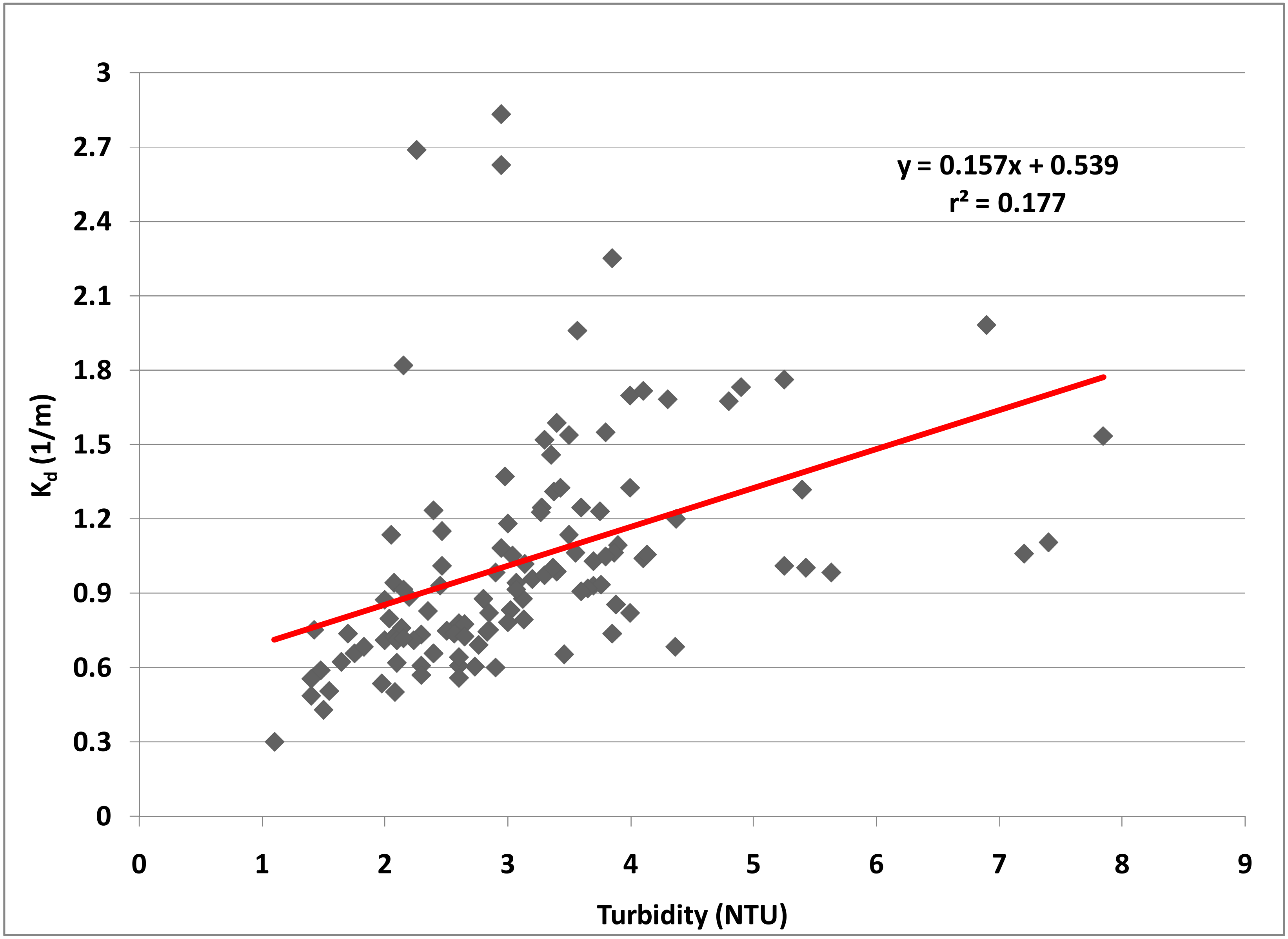

Figure 4-12 Relationship Between Turbidity and Light Attenuation in Lemon Bay (1998–2007)

Water clarity targets were recently suggested for the estuarine waters of Sarasota County (Wessel et al., 2007). These targets were based on a light attenuation target identified by Corbett and Hale (2006) that is protective of seagrasses. Linking this target to the spatial and depth distributions of seagrasses provided segment-specific water clarity targets. This work was completed before the recent establishment of seagrass targets by the SBEP.

As discussed above, the recent seagrass coverage in Lower Lemon Bay was somewhat lower than that estimated for the historical period (ca. 1950). In contrast, the recent seagrass coverage in Upper Lemon Bay was consistently higher than that estimated for the historical period. The latter observation leads to either of two conclusions: the recent water clarity conditions in Upper Lemon Bay are conducive to seagrass growth and reproduction in those waters, or water clarity is not a critical determinant of seagrass cover in Upper Lemon Bay. Since the latter conclusion is not likely, it is reasonable to conclude that the recent water clarity conditions in Upper Lemon Bay are conducive to seagrass growth and reproduction in those waters.

The water quality data available for Lower Lemon Bay are limited to a number of monitoring sites that are less representative of that portion of the bay than are the sites in the upper bay. Therefore, setting water quality targets based on the data from these sites is not recommended.

The following Upper Lemon Bay water quality targets and standard deviations (for chlorophyll *a* and K_d) are:

- Chlorophyll *a* concentration – 7.8 µg/L and 2.2 µg/L
- K_d – 1.07 (m^{1}) and 0.1 (m^{1})
- DO – 4 mg/L

The chlorophyll and K_d levels are the mean conditions during the 2001 to 2007 period, which generally coincides with the period during which the seagrass targets have been set, and represents the recent wide range in rainfall in this region.

The DO target is a water quality standard based target for estuarine waters. Concerns regarding the validity of the existing DO criteria in both fresh and marine waters have been expressed by many, including Sarasota County. Research continues regarding DO in Florida waters, particularly in freshwater streams and estuaries.

The targets and standard deviations defined above have been applied in the development of the watershed report card discussed in Chapter 9.

4.2.2 Salinity Targets

To establish meaningful targets for salinity and eventually freshwater inflows in Lemon Bay, an understanding of how freshwater inflows affect salinity is important. Estuaries are semienclosed coastal bodies of water that have at least one river or stream flowing into them and a connection to the sea. Salinity in estuaries varies from fresher water at the point of the freshwater inflow in the upstream portion of the estuary to more saline water in the downstream portion where the estuary connects to the sea. Circulation patterns, both horizontal and vertical, also influence the spatial variation in salinity observed in estuaries (Figures 4-13 and 4-14).

As expected, increases in freshwater inputs from the watershed result in lower salinities in the estuary, while decreases in freshwater flows results in higher salinities in the estuary. Therefore, estuaries typically have seasonal patterns of higher salinities during the lower flow dry season and lower salinities during the higher flow wet season.

In addition to the seasonal pattern of salinity in estuaries, there is also a daily variation due to the tides. As the tide rises, salinities in the estuary increase as more saline water enters the system from the sea; as the tide falls, salinities decrease (Hardisty, 2007).

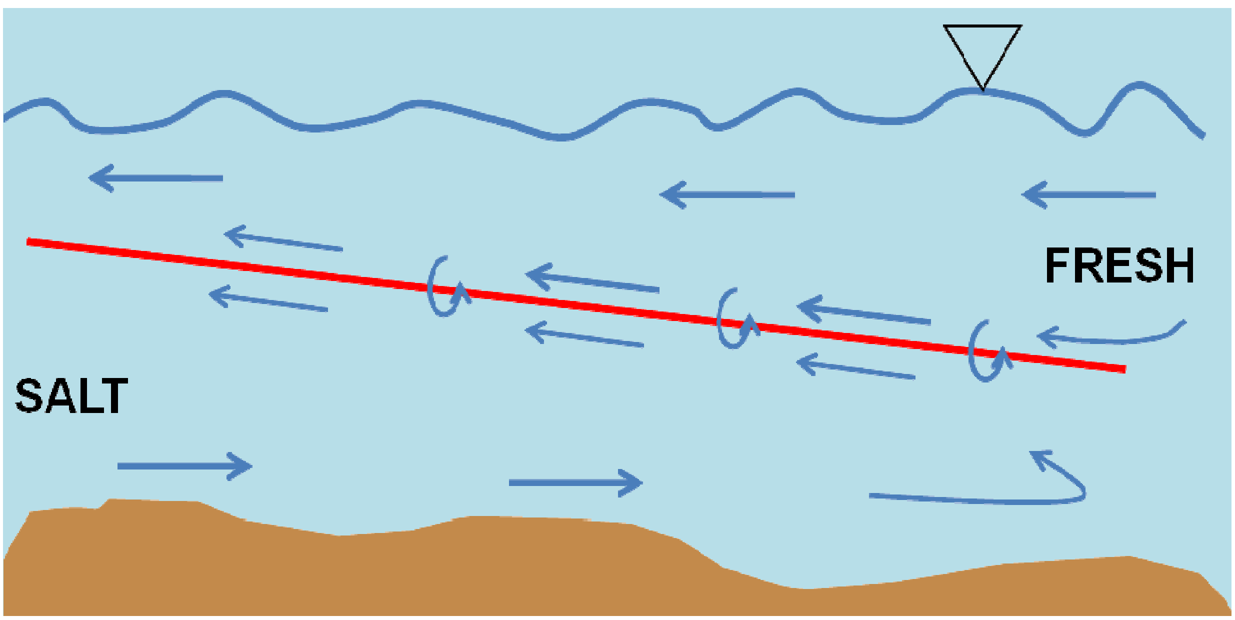

Figure 4-13 Conceptual Depiction of Vertical Tidally-Averaged Circulation Pattern (modified from Goodwin, 1987)

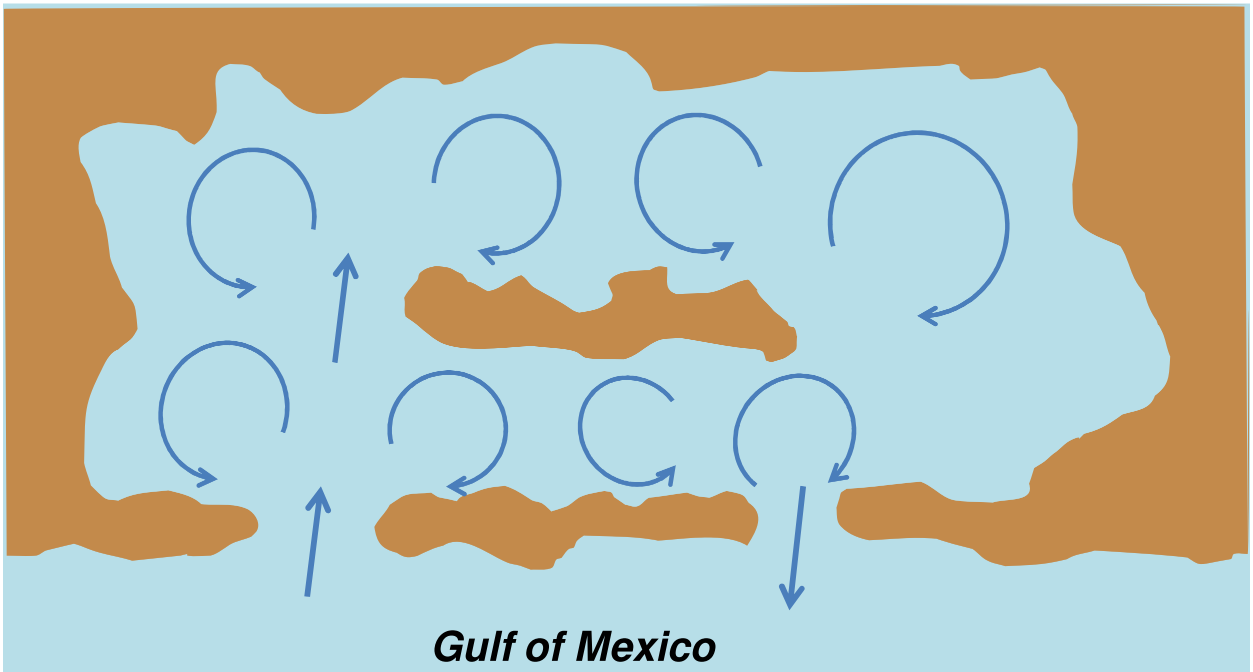

Figure 4-14 Conceptual Depiction of Horizontal Tidally-Averaged Circulation Pattern (modified from Goodwin, 1987)

In addition to influencing salinities in an estuary, freshwater inflows also influence residence time. Residence time represents the amount of time that it takes for the water in the estuary to be replaced. Increases in residence time can result in depleted DO levels and increased accumulation of sediments (Nedwell and Raffaelli, 1999; Wolanski, 2007). Changes in residence time resulting from temporal variation on freshwater inputs have been shown to affect the likelihood of excessive algal blooms (SWFWMD, 2008a; Janicki Environmental, 2008b).

Estuaries provide habitat for many organisms including fishes and benthic macroinvertebrates and therefore are characterized by their high diversity and primary production (Hobbie, 2000). Because salinity in estuaries varies considerably on daily and seasonal time frames, many organisms that inhabit estuaries can tolerate large variations in salinity. However, many of these organisms cannot tolerate completely fresh or very saline water, which is why they inhabit the brackish water of estuaries.

Temporal and spatial variations in salinity can have a direct impact on the composition and distribution of biota within an estuary (Hobbie, 2000; Wolanski, 2007)—for example, fishes (Janicki Environmental 2004a and 2008a; SWFWMD, 2008a) and benthic macroinvertebrates (Janicki Environmental 2007a and 2008b).

Human activity has significantly impacted many estuaries in the United States, often resulting in less available estuarine habitat because of pollution and physical alteration of systems (NRC, 1994). Human activities can lead to either reductions or increases in freshwater inflows to an estuary. Two examples in southwest Florida are the estuarine portion of the lower Hillsborough River and Dona Bay.

Recent analysis has shown that human activity has led to a decline in freshwater inflows to the lower Hillsborough River (SWFWMD, 2008b). The decline in freshwater inflows led to a loss of oligohaline habitat (water less than 5 ppt) in the lower Hillsborough River. To address the reduction in oligohaline habitat in the lower Hillsborough River, the minimum flow for the system was modified to maintain sufficient oligohaline habitat.

In Dona Bay, canal construction in the watershed adjacent to the historical Dona Bay watershed resulted in a large seasonal increase in freshwater inflows to Dona Bay (SWFWMD, 2009). The increase in freshwater inflows has negatively impacted seagrass and oyster populations in Dona Bay. The draft minimum flow for Dona Bay has recommended Minimum Flows Levels that would allow small flow reductions in Fox and Salt Creek.

Since salinity can vary significantly over a wide range of temporal and spatial scales and that many estuarine organisms can tolerate large variations in salinity, defining a salinity *target* must necessarily account for these givens. Therefore, we recommend that a target salinity regime, that accounts for these givens be defined. Target freshwater input targets can then be defined based on the empirical relationship between salinity and freshwater inflows.

4.2.2.1 Relationship between Flows and Salinity in Lemon Bay

In Chapter 4.1.1 we described the individual status and trends of the primary water quality parameters affecting the health and productivity of the Lemon Bay estuary. This includes the waterbody Segments 1–5, and all of the subbasins in Sarasota County. Many of the natural systems described in Chapter 3.2.1 have preferred conditions for success within the natural variation in estuarine systems. For example, the preferred range of salinity for the health and success of oysters has been identified as 14–28 ppt (Kennedy et al., 1996). Salinities less than 10 ppt inhibit the success of oyster larvae, while salinities higher than 30 ppt decrease growth rates and increase the likelihood of parasitic infection (Stanley and Sellers, 1986). Turtle grass, *Thalassia testudinum,* is another species that has salinity preferences within estuarine environments and generally prefers salinities above 20 ppt (Zieman and Zieman, 1989). Many estuarine fish taxa that use the Lemon Bay estuary have preferential salinities as well (Serviss and Sauers, 2002). Therefore, the timing and volume of freshwater inputs into the Lemon Bay estuary are important to providing one of the primary environmental requirements for the success of these important natural resources.

To evaluate the effects of hydrologic loadings on estuarine salinities, monthly freshwater volume estimates from the *Spatially Integrated Model for Pollutant Loading Estimates* (SIMPLE) model were related to empirical data on salinities from the ambient monitoring program. The sum of all monthly freshwater volumes from all basins in the watershed (including direct rainfall to the estuary) was calculated for each month in the time series from 1995 through 2007. These freshwater volumes were then matched to the empirical data averaged monthly across all measurements. The objectives of this process were to:

- ❖ Relate hydrologic volumes from SIMPLE model output to estuarine salinities.
- ❖ Identify differences in hydrologic loading between historical, current, and future conditions (See the Water Budget Section in Chapter 3 for a description of conditions used in the SIMPLE model).
- ❖ Estimate differences in salinities between historical, current, and future conditions.
- ❖ Establish potential hydrologic loading targets protective of salinity regimes.

To accomplish this, a predictive linear regression model was developed that estimated the bay-wide average salinity as a function of inflow volumes from the Sarasota County portion of the watershed. The regression included antecedent freshwater inputs including the freshwater volume loading to the estuary in the month preceding the salinity measurement as well as the current month's freshwater volume input. A seasonality term was also included to account for the differential effects of freshwater inputs throughout the year because of evapotranspiration, mixing, and differences in tidal amplitude as the result of the mixed semi-diurnal nature of tides in southwest Florida.

The regression relationship developed based on the empirical data was then used to predict salinities during historical and future conditions such that these hydrologic scenarios could be compared with respect to estimating the changes in estuarine salinity regimes in Lemon Bay based on anthropogenic alterations to land-use characteristics that altered the natural hydrology.

Monthly average salinities in the Sarasota County portion of the Lemon Bay estuary ranged from 10.2 ppt to 37.7 ppt with a median salinity 31.6 ppt based on empirical data. Model predictions suggested that every 1000 acre feet of freshwater introduced into Lemon Bay monthly would decrease the salinity averaged across Segments 1–5 by approximately 1 ppt (Figure 4-15). While Figure 4-15 displays the generalized relationship between freshwater inflows and predicted salinities, the regression equation also depended on the freshwater volume reaching the estuary in the month preceding the salinity measure as well as the time of year when the salinity measurement was taken. The model performed reasonably well for its intended purpose with an r^2 value of 0.66 and 62% of the differences between observed and predicted salinities (i.e., the residuals) were less than 2.5 ppt (Figure 4-16).

The regression described above was used to hindcast the salinity distributions in Lemon Bay under the historical conditions defined in Chapter 3. A cumulative distribution curve was produced to present the historical salinity distributions in Lemon Bay (Figure 4-17). This curve represents the target salinity regime for Lemon Bay.

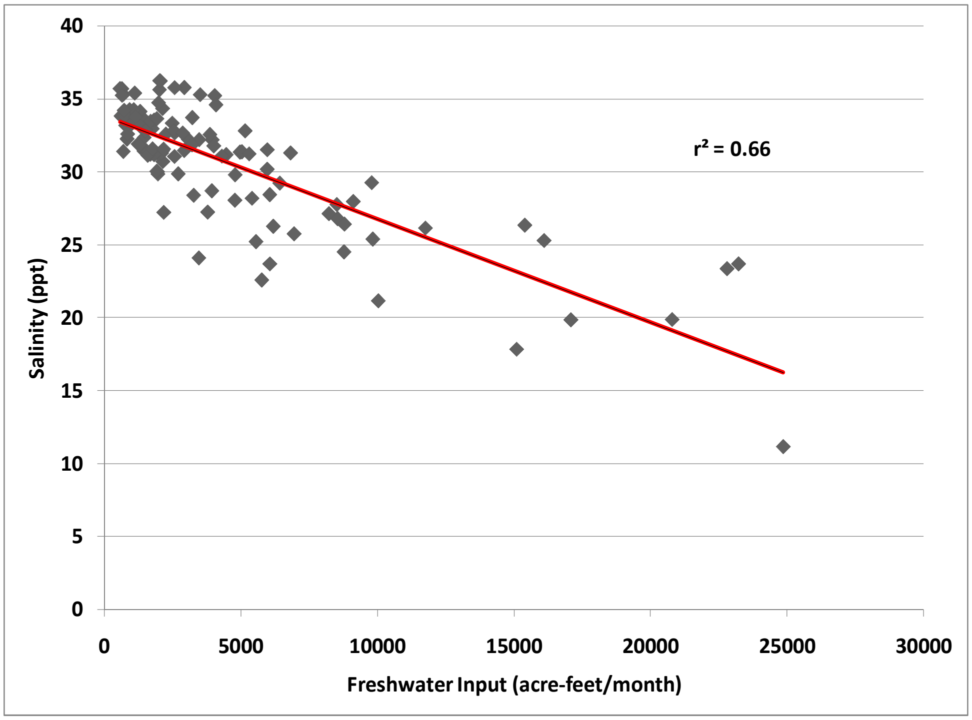

Figure 4-15 Relationship Between Freshwater Volume (acre-feet/month) and Average Predicted Salinities in the Lemon Bay Estuary

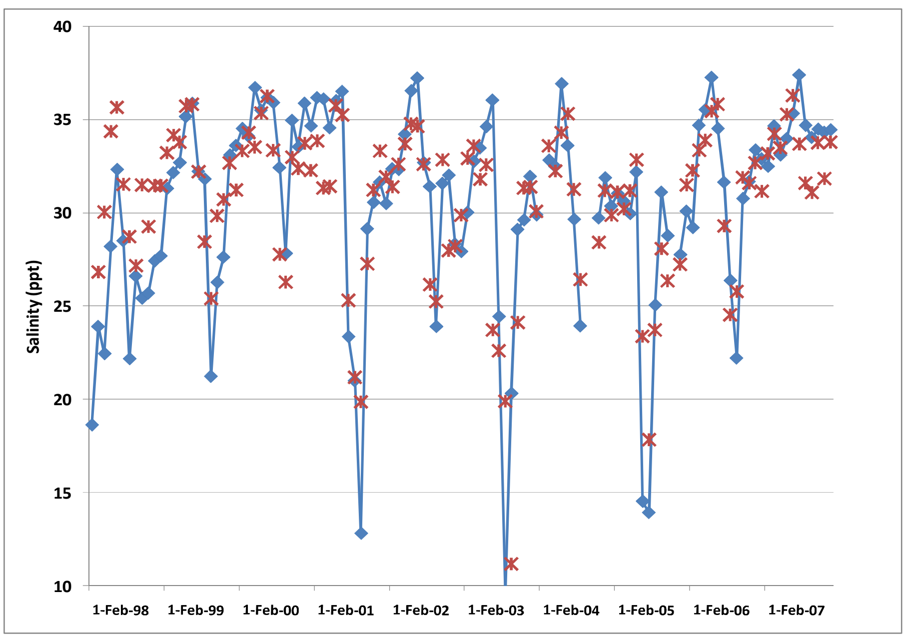

Figure 4-16 Time Series of Predicted (line) and Actual (star) Bay-Wide Salinity Values Between 1998–2007

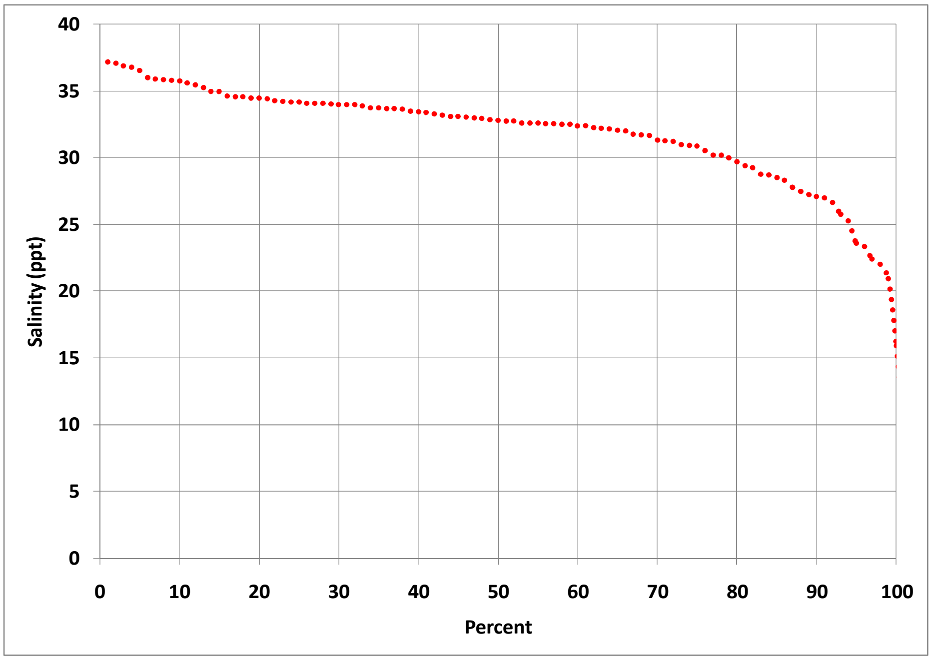

Figure 4-17 Hindcast of Historical Salinity Regime Based on the Relationship Between Historical Flows and Bay-Wide Salinity in the Lemon Bay Estuary

Cumulative distribution curves were produced to describe the differences between the historical and current distributions of hydrologic volumes. The SIMPLE model predictions indicate that current hydrologic volumes to the bay tended to exceed the historical volumes (Figure 4-18). This resulted in historical salinity values that were typically higher than current salinities, and the distribution of salinities has shifted by ca. 2 ppt between historical and current conditions (Figure 4-19). The proposed target water budget for Lemon Bay is therefore, the historical hydrologic regime.

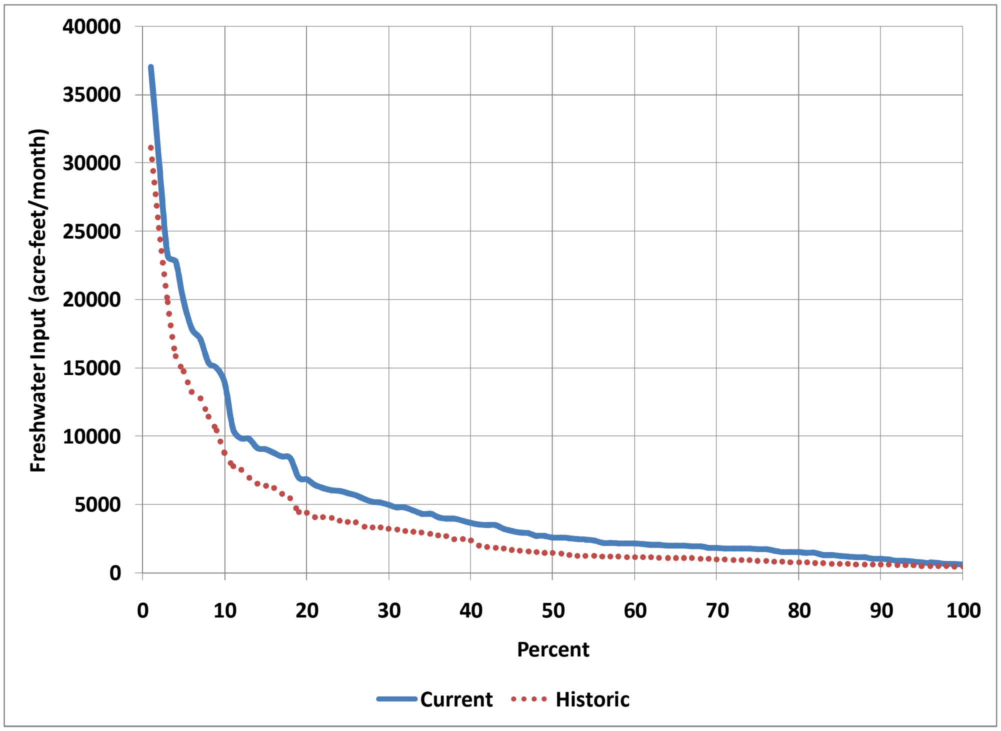

Figure 4-18 Comparison of Historical and Current Freshwater Input Distributions

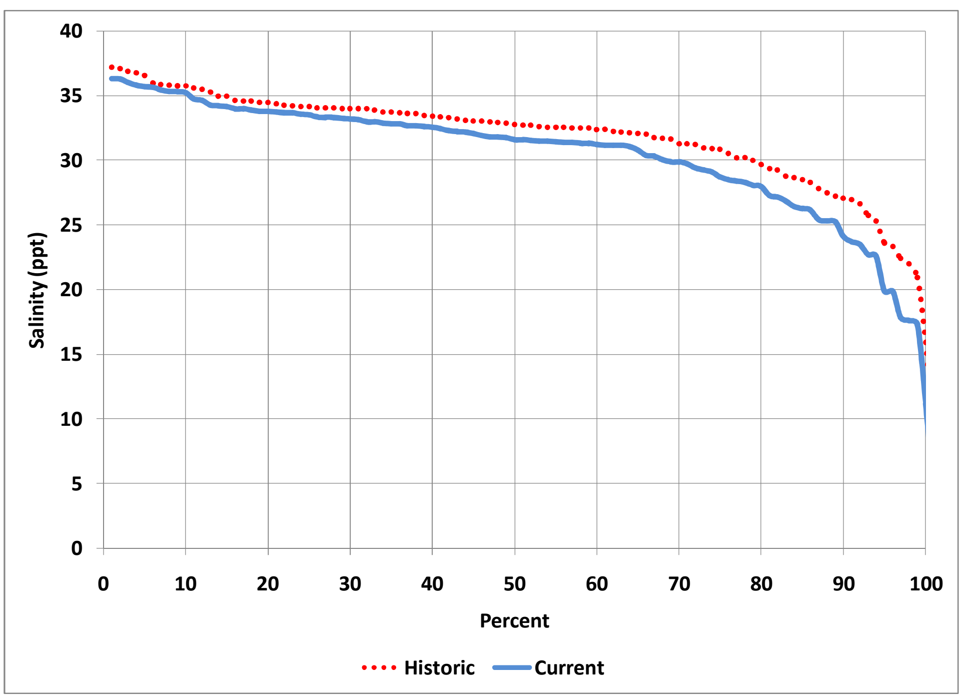

Figure 4-19 Comparison of Historical and Current Salinity Distributions for the Lemon Bay Estuary

A difference of 2.5 ppt was chosen as a conservative estimate of a biologically relevant change in salinity in an estuarine environment given the dynamic nature of salinity variation in an estuarine system. This difference also corresponds with a difference that would be outside the uncertainty of the regression model predictions. The differences between the historical and current conditions was calculated for each date in the time series and tabulated to define the proportion (percent) of days in a month when the difference was larger than 2.5 ppt. Differences in salinity greater than 2.5 ppt occurred primarily in the wet season between August and October, indicating that the greatest changes to estuarine salinities were decreased salinities in the wet season (Figure 4-20).

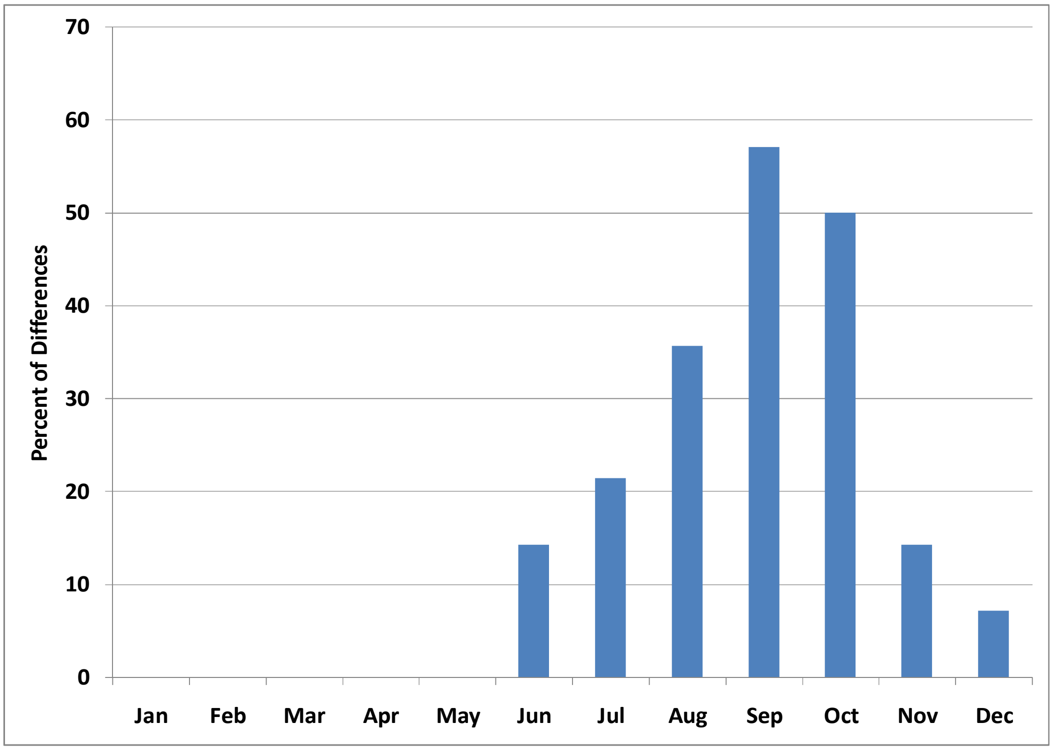

Figure 4-20 Percent of Predicted Differences in Salinity Greater than 2.5 ppt by Month over a 14-Year Simulated Rainfall Record

Despite the observation that salinities were different between historical and current conditions and that those differences appeared to be largest during the summer, the current salinities in Lemon Bay remained in the polyhaline to euhaline range with summertime median and average salinities above 25 ppt throughout Lemon Bay (Figure 4-21). While spatial differences exist with respect to the influence of freshwater volume loadings into Lemon Bay, with lower salinities found in the northern portions of the estuary, these salinities do not appear to be detrimental to the critical natural resources inhabiting the estuary (e.g., mangroves, seagrasses, and oysters). Attempts to mitigate the effects of increased freshwater volumes entering Lemon Bay for retaining historical salinity regimes should concentrate on capturing wet season discharges from the watershed. These aspects of the water budget are described in detail in the watershed portion of the natural systems section dealing with the water budget.

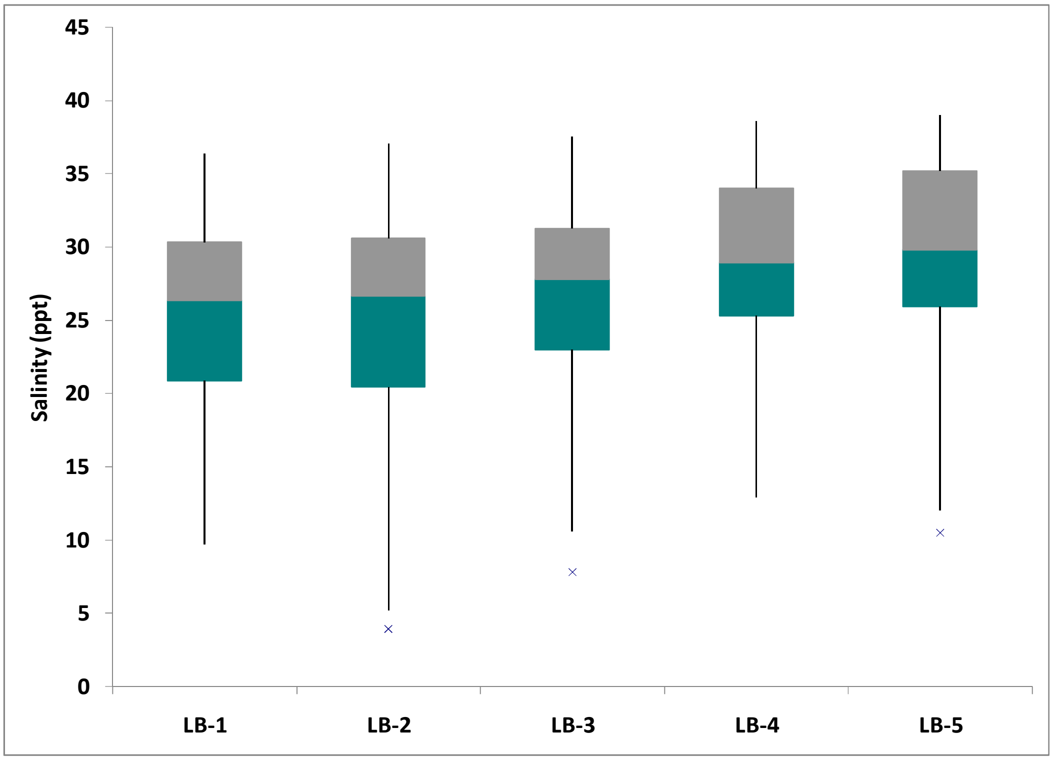

Figure 4-21 Distribution of Summer (i.e., July–October) Salinities in Lemon Bay by Stratum

4.3 POLLUTANT-LOADING ANALYSIS

A thorough understanding of the nature, sources, and spatial and temporal variability in pollutant loads is necessary if an effective watershed plan is to emerge. This understanding will aid in a further understanding of the manner and degree to which the receiving waters will respond to the pollutant loadings.

A generalized conceptual relationship between watershed inputs and water quality responses is provided in Figure 4-22. Altered freshwater inputs can significantly alter salinity patterns in estuaries and alter the community structure of biota within the system. Additionally, estuarine residence time depends on freshwater inputs and can influence the water quality responses in the estuary to changes in watershed loadings.

Since the current concentrations are somewhat higher than historically, the current salinities as a result are correspondingly lower, especially in the summer months.

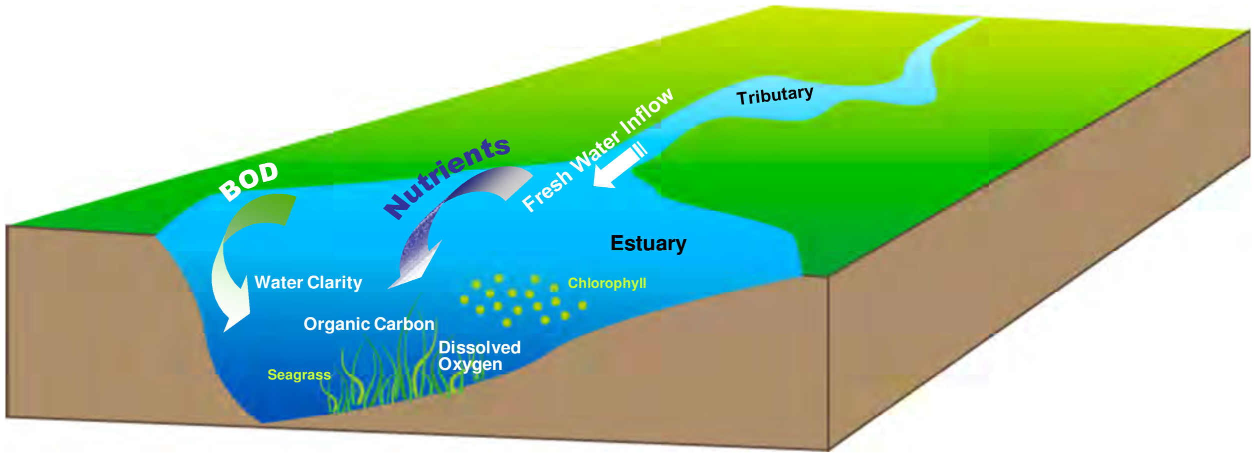

Figure 4-22 Conceptual Illustration of Watershed Loadings and Principal Indicators of Estuarine Health in Florida Estuaries

Water quality in a waterbody is influenced by the pollutants that reach the waterbody. Pollutants come from many sources, including runoff from land, groundwater flows, atmospheric deposition, and point sources. To improve water quality, managers must identify the pollutants that are responsible for the degradation in water quality. For example, in nearby Tampa Bay, nitrogen was identified as the pollutant that was significantly contributing to decreases in water quality in Tampa Bay. This decline in water quality resulted in numerous adverse impacts. The elevated nitrogen loadings contributed to increased chlorophyll concentrations in the bay and a corresponding reduction in water clarity and seagrass abundance. Thus, management actions have been taken to reduce nitrogen inputs into the bay, and these management actions have contributed to an improvement in water quality.

Before management actions are implemented, resource managers must identify the pollutants that are responsible for the degradation of water quality. After the pollutants have been identified, the sources of these pollutants must be identified and quantified. The quantification of loading sources allows managers to focus their resources on those sources that make the greatest contribution to the problem. As expected, not all pollutant sources will be easy to manage. For example, loadings from atmospheric deposition can often originate outside the watershed and can therefore be difficult to manage. Point sources, on the other hand, are discrete sources of pollutant loadings that can generally be located and quantified with certainty.

With many watersheds, direct runoff (also known as nonpoint source runoff) represents a significant amount of the total load from the watershed. Direct runoff is the result of rainfall and is affected by land use and soils. Management of direct runoff is complicated due to the nature of runoff and the number of entities involved. Therefore, to control direct runoff, actions must be taken in concert with landowners and land custodians. This involves individuals from the owner of a single-family home to the city, county, state, and federal governments who are responsible for huge tracts of land including roadways, recreation areas, and conservation areas. State and local governments can also have a significant impact on direct runoff through the adoption of ordinances that relate to construction projects. For example, by requiring adequate water retention areas (retention ponds, swales, etc.) as part of new construction, direct runoff can be greatly reduced as a portion of rainfall is sequestered and allowed to infiltrate the soil instead of directly running off into surface water ways.

4.3.1 Estimation of Pollutant Loading to Lemon Bay

To better understand the influence of loadings to Lemon Bay, a pollutant-loading model, the SIMPLE, was developed for the watershed. Sarasota County contracted with Jones Edmunds & Associates, Inc. to determine hydrologic yield and loading estimates for a wide array of pollutants, including nutrients, metals, coliforms, and—specific to the present analysis—total nitrogen (TN) loads, BOD loads, and total suspended solids (TSS) loads, throughout the watershed. The model's spatial domain is divided into basins and subbasins throughout the watershed, as seen in Figure 4-23. The temporal range for the model's application was from 1995 to 2007, with output produced at monthly intervals, which is roughly equivalent to the response time to these pollutant loads observed in Sarasota County's bays and estuaries (Jones Edmunds, 2008). An in-depth description of the model can be found in Jones Edmunds (2008).

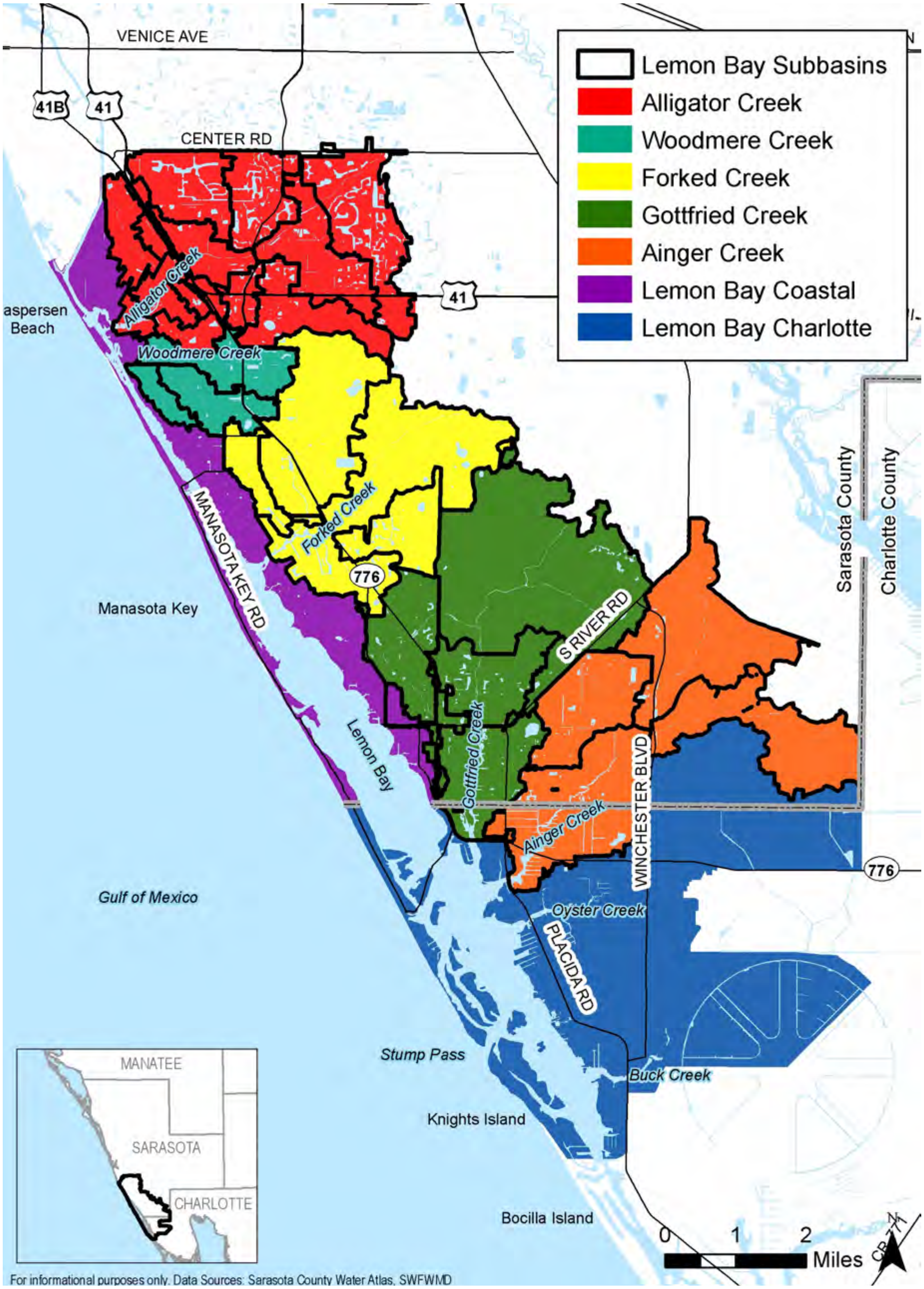

Figure 4-23 Model Spatial Domain Depicting Subbasins and Basins for Lemon Bay

The SIMPLE estimates loads from the following sources:

- Hydrologic model: The SIMPLE incorporates a hydrologic engine originally used in the Braden River Surface Water Resource Assessment (Jones Edmunds, 1997). Input data requirements for the SIMPLE hydrologic model include freshwater flows, NEXRAD rainfall, evapotranspiration rates, water surface elevations, land use, soils, and groundwater data.
- Direct runoff module: To calculate loads based on direct runoff, data on NEXRAD rainfall, land use, soils, and best management practices (BMPs) were integrated into the SIMPLE. Land use data from 1990 and 2004 were used to estimate temporal change in the watershed and to determine runoff coefficients between pre-development and development conditions. Soils were used to estimate infiltration and runoff characteristics in the watershed. The BMP spatial data, like the land use component, were constructed to reflect temporal changes in their coverage between the pre-development and developed conditions. Each unique NEXRAD pixel/land use/soil combination was joined with Event Mean Concentrations to determine loadings estimates.
- Baseflow module: Baseflow was calculated as part of the hydrologic model and was determined as a function of each unique NEXRAD pixel/land use/soil combination, as described in the direct runoff module. This module also includes an evapotranspiration term.
- Irrigation module: This module considers three sources of irrigation water: groundwater/potable, stormwater, and reclaimed water, with different concentrations used for each source. The potable and reclaimed water concentrations were set based on FDEP requirements, while stormwater, which is not yet regulated, was assumed to have concentrations similar to baseflow. The SIMPLE assumed that all residential, agricultural, commercial, and golf course land uses were irrigated.
- Point-source module: This module considers 38 non-delegated wastewater treatment plants (WWTPs) averaging less than 0.05 MGD, and 17 larger, delegated WWTPs, which discharge between 0.1 and 6.0 MGD, in the watershed. The smaller facilities typically serve small communities, campgrounds, and parks, while the delegated point sources serve larger municipalities. The method of calculating point source loadings was based on flow and concentration. Monthly data received from Sarasota County (non-delegated) and FDEP (delegated) were used to calculate loadings for the point source module.
- Septic tank module: Sarasota County provided Jones Edmunds with the spatial location of the approximately 45,000 septic tanks in the County. However, 80,000–90,000 septic tanks are estimated; the undocumented septic tanks were accounted for based on current septic and sewer coverages and the Sarasota County parcel coverage. Average flow rates were based on land use, either residential or non-residential, while three concentration levels were assigned

(high, medium, and low), depending on soil type, the presence of BMPs, and the distance from the nearest conveyance.

Nitrogen loadings due to atmospheric deposition were estimated as follows. *Total atmospheric deposition* is defined as the sum of wet deposition (rainfall) and dry deposition (gaseous constituent interaction and dust fallout) directly to the surface of the bay. Deposition of pollutants to the watershed of the bay is incorporated into nonpoint source loading estimates.

Three data types are needed to estimate total atmospheric deposition:

- ❖ An estimate of the hydrologic load directly to the surface of the bay via precipitation.
- ❖ An estimate of the pollutant concentration in that precipitation.
- ❖ An estimate of dry deposition, either from empirical data or model-based estimates.

The hydrologic loads to the surface of the bay via precipitation were estimated in the same manner as for the hydrologic modeling effort. NEXRAD-derived rainfall provided by the SWFWMD was used to derive monthly rainfall totals to the bay surface.

Precipitation-weighted mean monthly rainfall TN concentration data were obtained from the National Atmospheric Deposition Program (NADP) Verna Wellfield site in Sarasota County. The TN loadings from precipitation were estimated by multiplying the monthly precipitation-weighted mean TN concentrations from the Verna site and the monthly bay surface hydrologic loads to estimate monthly wet TN loads to the bay.

An estimate of dry deposition was also needed to develop total atmospheric deposition to the bay surface, as the total deposition is the sum of wet (rainfall) and dry deposition. The Sarasota Bay National Estuary Program initiated an intensive atmospheric deposition monitoring program in September 1998 that lasted 1 year. From the atmospheric nitrogen concentration data collected during this 1-year monitoring period, dry deposition was estimated to make up approximately 29% of the total atmospheric deposition directly to the surface of Sarasota Bay (SBNEP, undated).

Another estimate of atmospheric deposition TN loading to the surface of Sarasota Bay was provided by a modeling effort using the CALMET/CALPUFF modeling system (Poor, 1999). The model results predicted that approximately 89% of the total nitrogen deposition to the surface of Sarasota Bay was from dry deposition. The predicted wet deposition to the surface of the bay was an order of magnitude less that that measured at the nearby Verna NADP site (Poor, 1999). Importantly, the modeling effort indicated that Sarasota Bay and Tampa Bay shared the same airshed (EPA, 2000).

Since a longer term record of atmospheric deposition data collection exists for Tampa Bay and since the two bays share the same airshed, dry deposition data collected as part of the Tampa Bay Atmospheric Deposition Study (TBADS) were used for this effort. This study was conducted for a 10-year period (August 1996 through June 2006) and included sampling elements for both wet and dry atmospheric deposition at an intensive monitoring site located on the Gandy Bridge Causeway. The data available from TBADS have been used to estimate atmospheric deposition to Tampa Bay. These data include precipitation nitrogen concentration data, wet and dry deposition rates, and an estimate of the ratio of dry:wet deposition (Poor, 2000; Pribble et al., 2001). Seasonal ratios of dry:wet deposition were derived from the TBADS data, with the wet season ratio of 0.66 indicating that dry deposition makes up approximately 40% of the total deposition in the wet season, and the dry season ratio of 1.05 indicating that dry deposition makes up approximately 51% of the total deposition in the dry season. Both of these seasonal proportions are greater than that from the 1-year Sarasota Bay study, which found 29% of the total deposition was due to dry deposition. However, the lower value from the 1-year Sarasota Bay study may be an artifact of the much shorter data collection period, and the longer-term record from the TBADS study is assumed to provide a more accurate representation of the typical contribution from dry deposition over a longer period of time for the airshed including Sarasota Bay and Tampa Bay.

Using monthly precipitation nitrogen concentrations from the Verna NADP site and the NEXRAD-derived monthly rainfall, the equation for wet deposition of nitrogen is as follows:

$$Nwet_m = [N]_m * H_m$$

where:

$Nwet_m$ = wet deposition of nitrogen for each month m,

$[N]_m$ = mean precipitation-weighted nitrogen concentration in the rainfall measured at the Verna Wellfield for each month m, and

H_m = estimated hydrologic load from rainfall for each month m to the bay surface.

Dry deposition was estimated using the TBADS-derived seasonal dry:wet deposition ratio, which was 1.05 for the dry season (months 1-6, 11, and 12) and 0.66 for the wet season (months 7-10), as follows:

$$Ndry_m = \text{Seasonal Deposition Ratio} * Nwet_m$$

where:

$Ndry_m$ = dry deposition of nitrogen for each month m, and

$Nwet_m$ = wet deposition of nitrogen for each month m.

The total atmospheric deposition to a surface of the bay was given as the sum of the wet and dry deposition, as follows:

$$Ntot_m = Nwet_m + Ndry_m$$

where:

$Ntot_m$= total atmospheric deposition of nitrogen for each month m to the surface of the bay.

The monthly TN loadings were then summed over each year to provide annual loadings from atmospheric deposition directly to the surface of the bay.

To calculate hydrologic yield and loadings estimates for subbasins in the Charlotte County portion of the Lemon Bay watershed, land uses were compared between basins in Charlotte County and those for which the SIMPLE had already been developed in Sarasota County. The goal of this exercise was to identify the basins in Sarasota County that have similar land-use characteristics to basins in Charlotte County. After identifying the basins that have similar land-use characteristics, the unit area loadings were extended from Sarasota County basins to apply to the Charlotte County basins.

Based on the land use comparison, the following associations were made in extending Sarasota County unit area yield and loadings to Charlotte County basins:

- The Charlotte County portion of Lemon Bay Proper was based on Subbasin 102.
- The Charlotte County portion of Lemon Bay Coastal, including islands located in the bay, was based on Subbasin 43.
- Coral Creek was based on Ainger Creek.
- Buck Creek was based on Alligator Creek.
- The Charlotte County portions of Oyster, Ainger, and Gottfried creeks were based on Alligator Creek.

The unit areal yields and loads were then multiplied by the total number of acres in each of the Charlotte County basins to determine freshwater yield and loading estimates for these portions of the Lemon Bay watershed.

4.3.1.1 Analysis of the Sources and Temporal and Spatial Variability in Pollutant Loadings to Lemon Bay

An understanding of the relative importance of the sources of pollutant loads to Lemon Bay and the spatial and temporal and temporal variability in these loads provide a critical basis for the WMP development. Given limited resources, knowledge of “How much” and “Where” justifies the appropriate prioritization of management actions.

4.3.1.2 Source Attribution

The majority of the TN loading to Lemon Bay from 1995 through 2007 was from direct runoff (70.4%), base flow (19.5%), and atmospheric deposition (5.3%) (Figure 4-24). The remaining TN loadings were from septic, irrigation, and point sources, accounting for 3.9%, 0.8%, and 0.2%, respectively. There was clear intra-annual variation of the relative contributions of TN loads (Figure 4-25). Direct runoff contributions were greatest during the summer months concurrent with the highest seasonal freshwater inputs. Conversely, during the dry season septic contributions were greater than during the wet season.

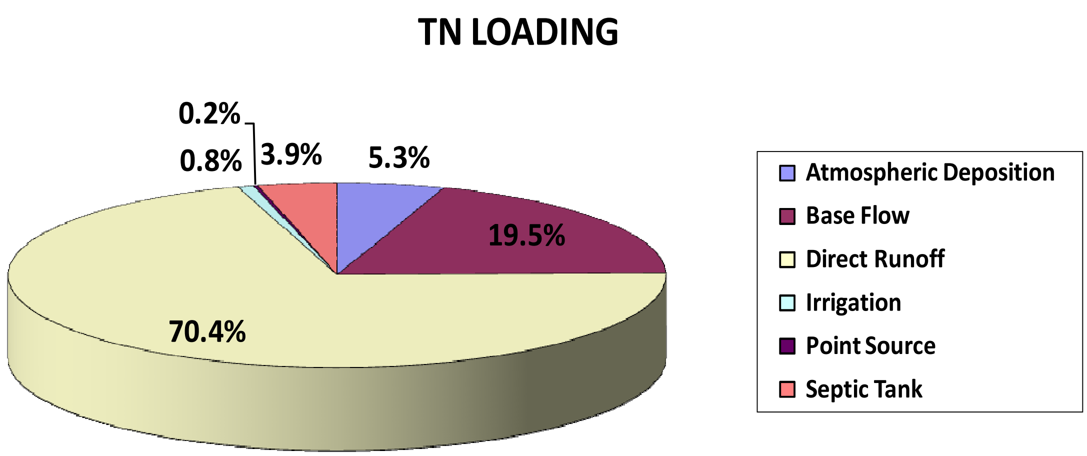

Figure 4-24 Relative Contributions from Each Source of TN Loads to Lemon Bay (1995–2007)

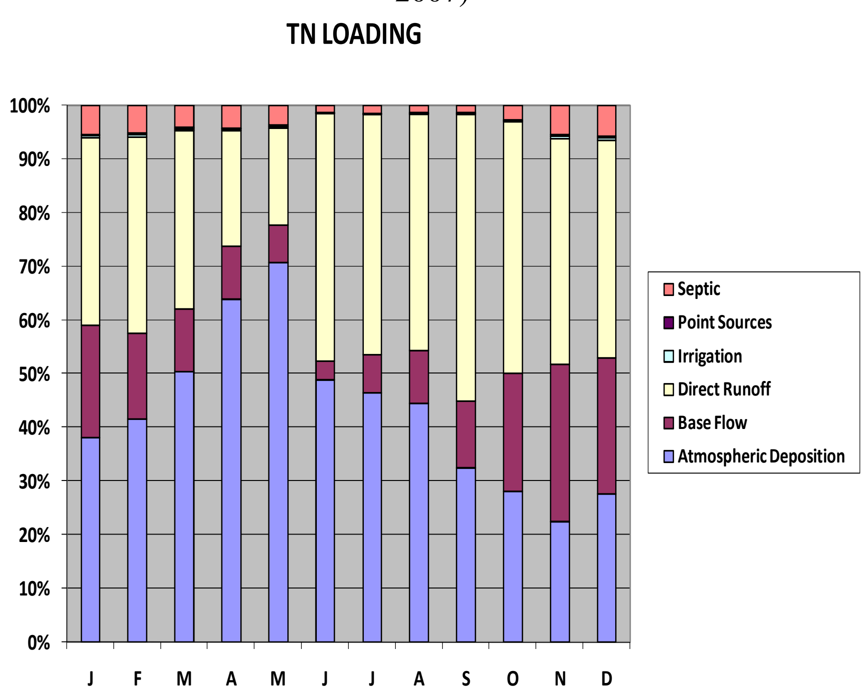

Figure 4-25 Monthly Variation in the Relative Contributions from Each Source of TN loads to Lemon Bay (1995–2007)

Similar analyses of the source attribution of TSS and BOD loads were completed. The majority of the TSS loading was from direct runoff (86%) and base flow (13%) (Figure 4-26). The remaining TSS loadings were from septic, irrigation, and point sources, accounting for 0.8%, 0.1%, and 0.04%, respectively. Seasonally, direct runoff contributions were greatest in the summer while base flow TSS loads were greatest during the dry season (Figure 4-27).

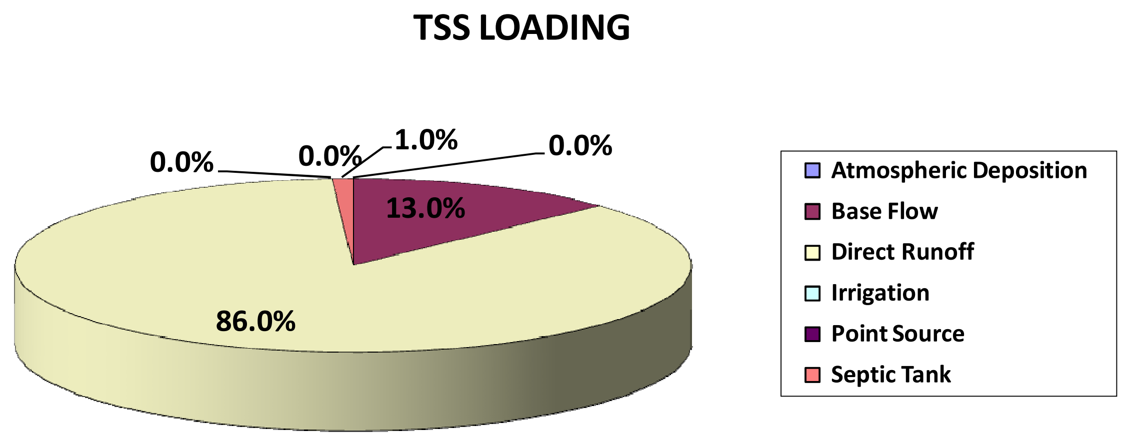

Figure 4-26 Relative Contributions from Each Source of TSS loads to Lemon Bay (1995–2007)

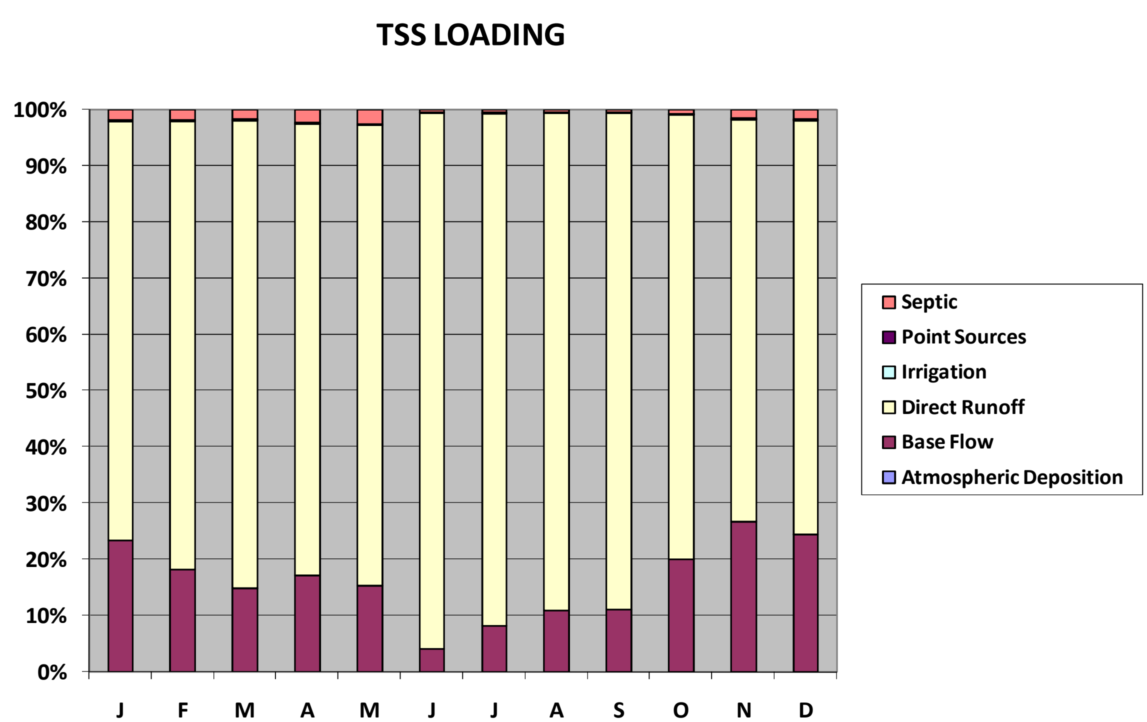

Figure 4-27 Monthly Variation in the Relative Contributions from Each Source of TSS loads to Lemon Bay (1995–2007)

The majority of the BOD loading was from direct runoff (74.6%) and base flow (18.3%) (Figure 4-28). The remaining BOD loadings were from septic, point sources, and irrigation, accounting for 6.6%, 0.3%, and 0.3%, respectively. Seasonal variation in BOD loads from direct runoff and base flow was similar to that observed for both TN and TSS (Figure 4-29).

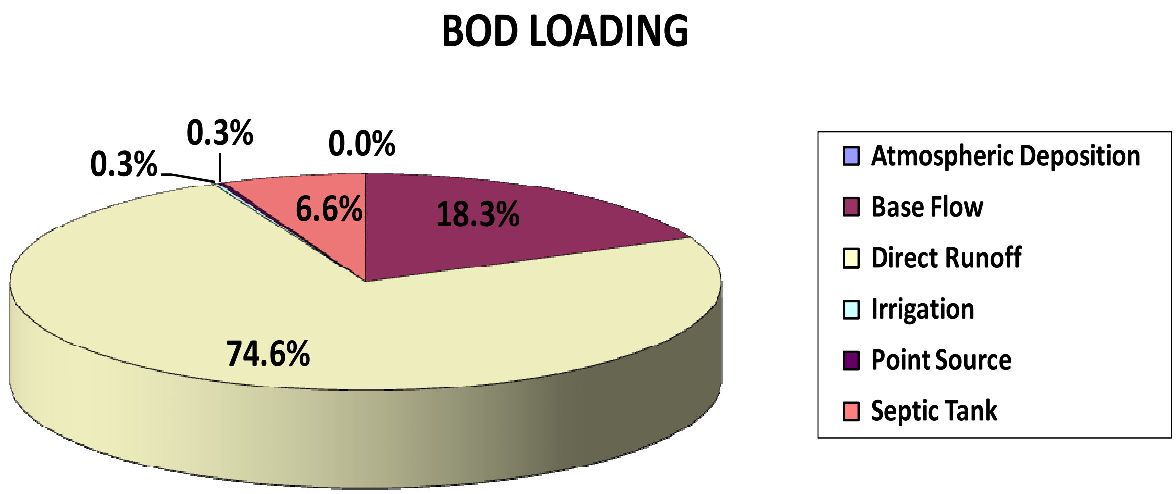

Figure 4-28 Relative Contributions from Each Source of BOD Loads to Lemon Bay (1995–2007)

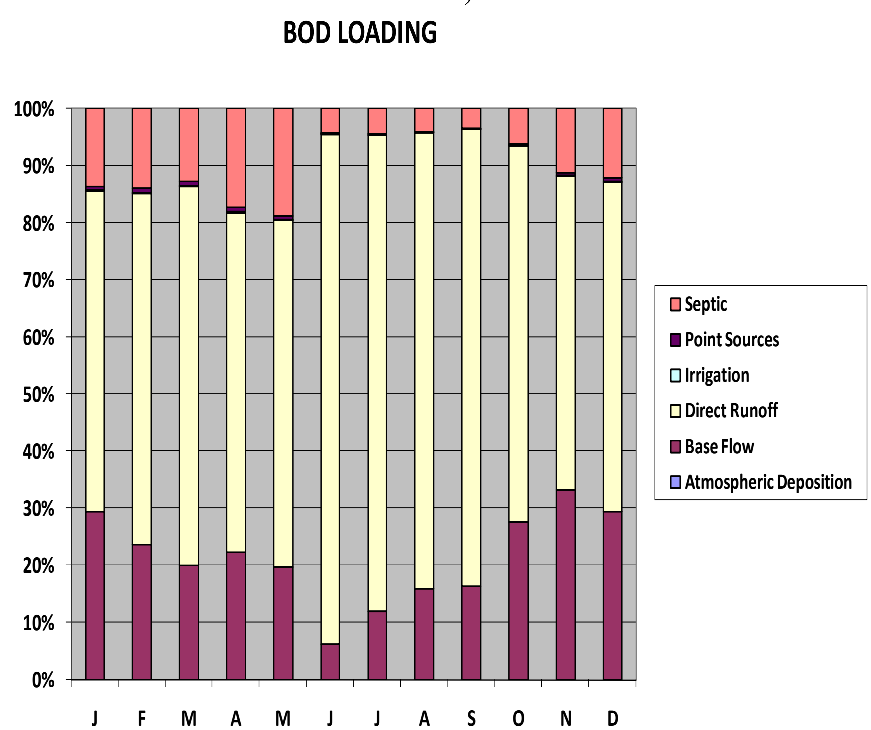

Figure 4-29 Monthly Variation in the Relative Contributions from Each Source of BOD Loads to Lemon Bay (1995–2007)

4.3.1.3

4.3.1.4 Temporal Variability in Pollutant Loads to Lemon Bay

Pollutant loads can vary significantly over time and an understanding of this temporal variability is essential. Longer-term trends in loads can indicate changes in the nature of the watershed draining to the waterbody of concern. Seasonal variation in loads can also be an important determinant of the water quality responses in the receiving waterbody.

The total annual TN loads to Lemon Bay varied significantly from a maximum of 424 tons in 1995 to a minimum of 48 tons in 2007 (Figure 4-30). The average annual TN load to Lemon Bay was 171 tons per year. Since direct runoff is the largest contributor to TN loads, large variations in annual loads are expected as rainfall varies from year to year. As a result of the seasonal variation in rainfall, TN loads are typically higher in the wetter summer months (Figure 4-31).

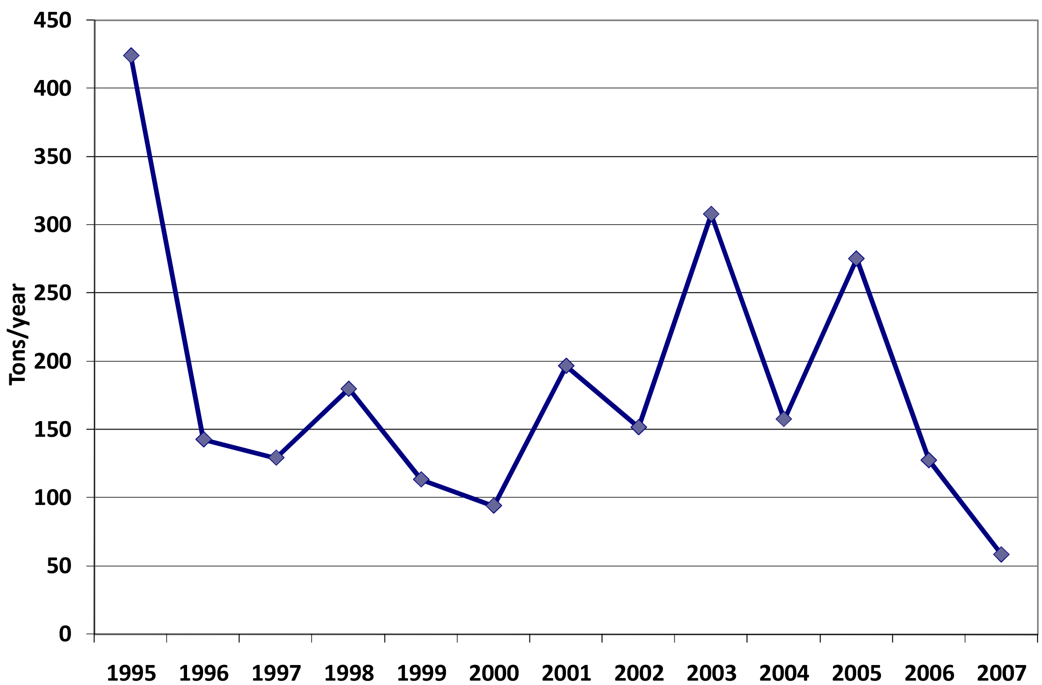

Figure 4-30 Interannual Variation in TN loads to Lemon Bay (1995–2007)

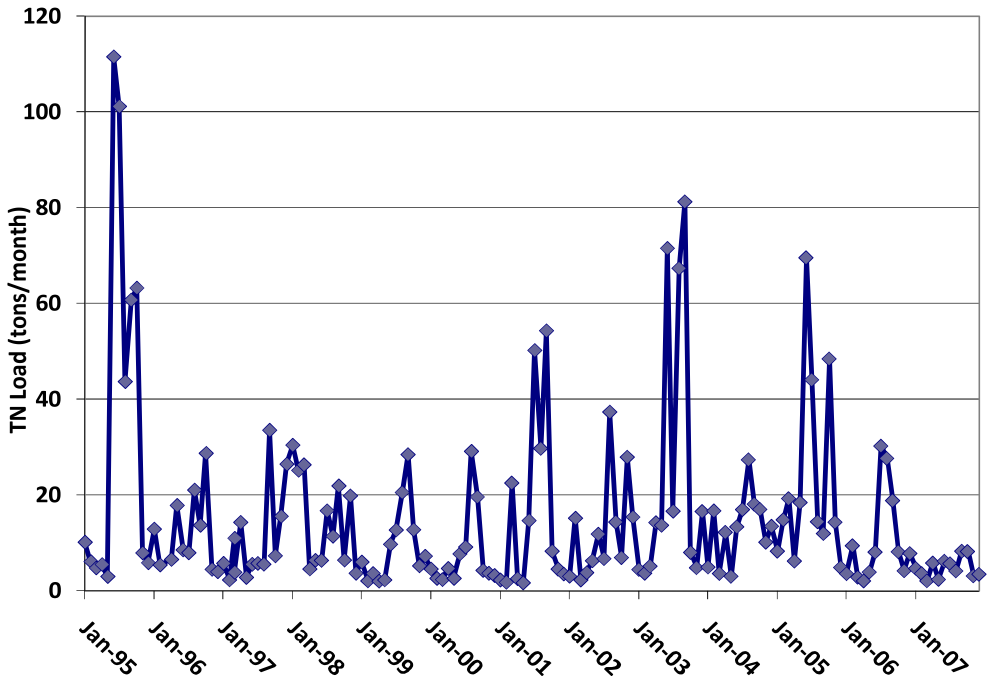

Figure 4-31 Monthly TN loads to Lemon Bay (1995–2007)

The total annual BOD loads to Lemon Bay varied significantly from a maximum of 1239 tons in 1995 to a minimum of 174 tons in 2007 (Figure 4-32). The average annual BOD load to Lemon Bay was 513 tons per year. Since direct runoff is the largest contributor to BOD loads, large variations in annual loads are expected as rainfall varies from year to year. As a result of the seasonal variation in rainfall, BOD loads are typically higher in the wetter summer months (Figure 4-33).

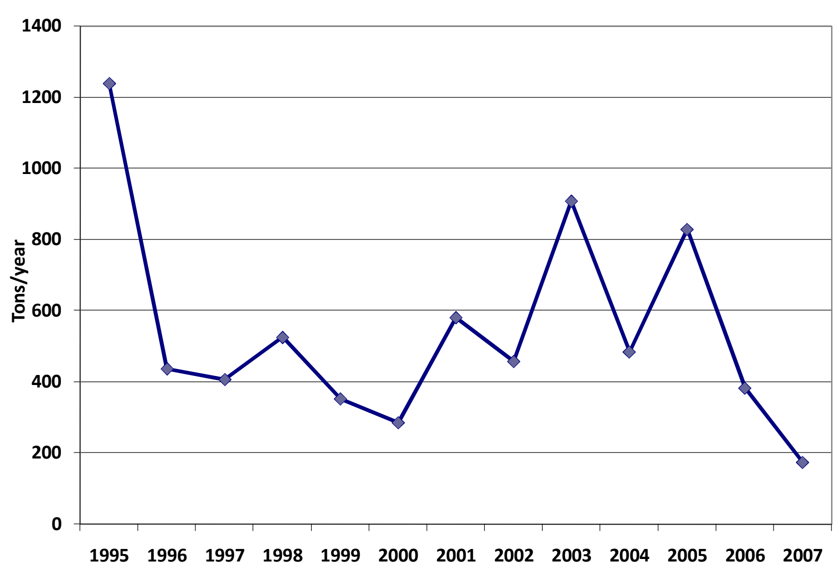

Figure 4-32 Interannual Variation in BOD loads to Lemon Bay (1995–2007)

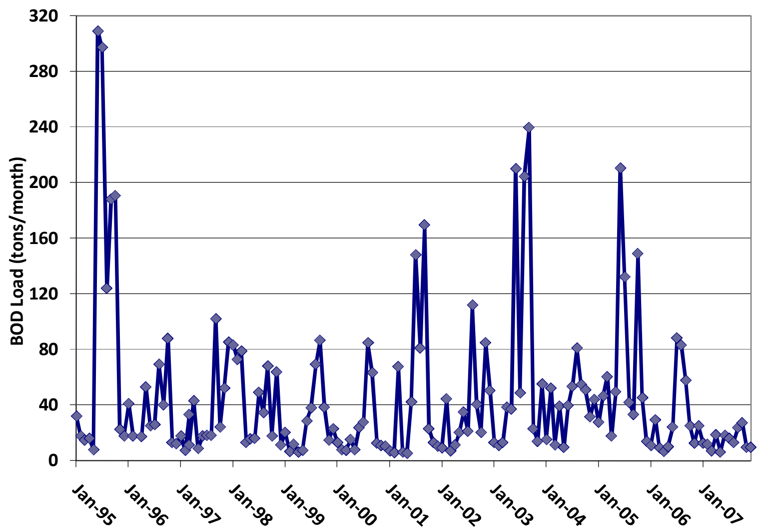

Figure 4-33 Monthly BOD Loads to Lemon Bay (1995–2007)

The total annual TSS loads to Lemon Bay varied significantly from a maximum of 7301 tons in 1995 to a minimum of 787 tons in 2007 (Figure 4-34). The average annual TSS load to Lemon Bay was 2819 tons per year. Since direct runoff is the largest contributor to TSS loads, large variations in annual loads are expected as rainfall varies from year to year. As a result of the seasonal variation in rainfall, TSS loads are typically higher in the wetter summer months (Figure 4-35).

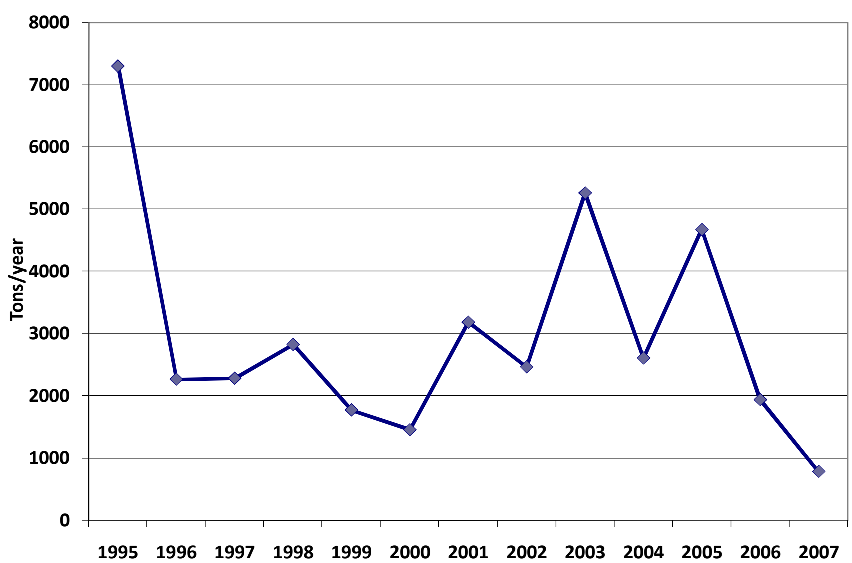

Figure 4-34 Interannual Variation in BOD Loads to Lemon Bay (1995-2007)

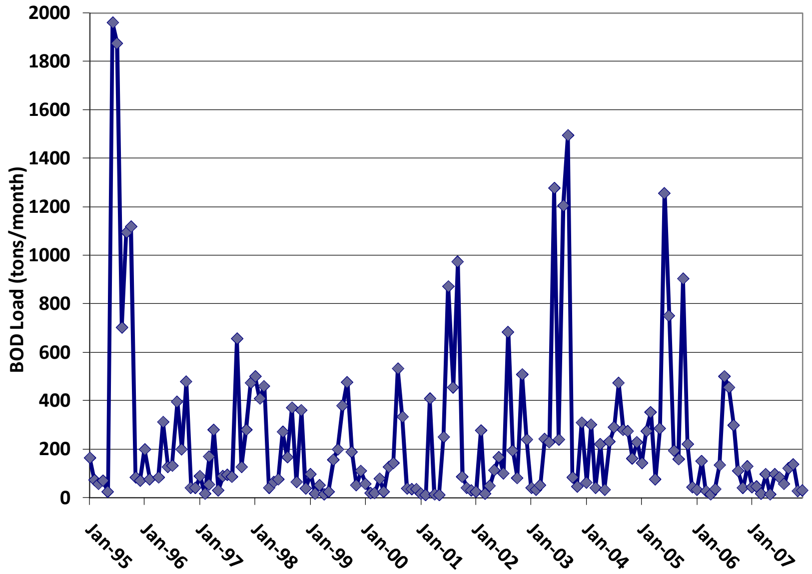

Figure 4-35 Monthly BOD Loads to Lemon Bay (1995-2007)

4.3.1.5 Spatial Variability in Pollutant Loads to Lemon Bay

In addition to an understanding of the temporal variability in pollutant loads, an understanding of the spatial variability in these loads is critical. With this understanding comes the focus for the potential projects and programs to address these loads. The following loading estimates provided by the SIMPLE model are analyzed:

- Total nitrogen (TN) loads
- BOD loads
- Total suspended solids (TSS) loads

The spatial variation in the pollutant-loading estimates is examined in two ways. First, the average annual total loadings (expressed as tons/year) from each basin in the Lemon Bay watershed are discussed. Secondly, unit area loads from each subbasin (expressed as lbs/acre/year) are presented and examined.

A. TN Loads

The average annual TN loads to Lemon Bay are presented in Figure 4-36. Approximately 60% of the TN load to the bay was generated by four basins: Buck, Alligator, Oyster, and Gottfried creeks.

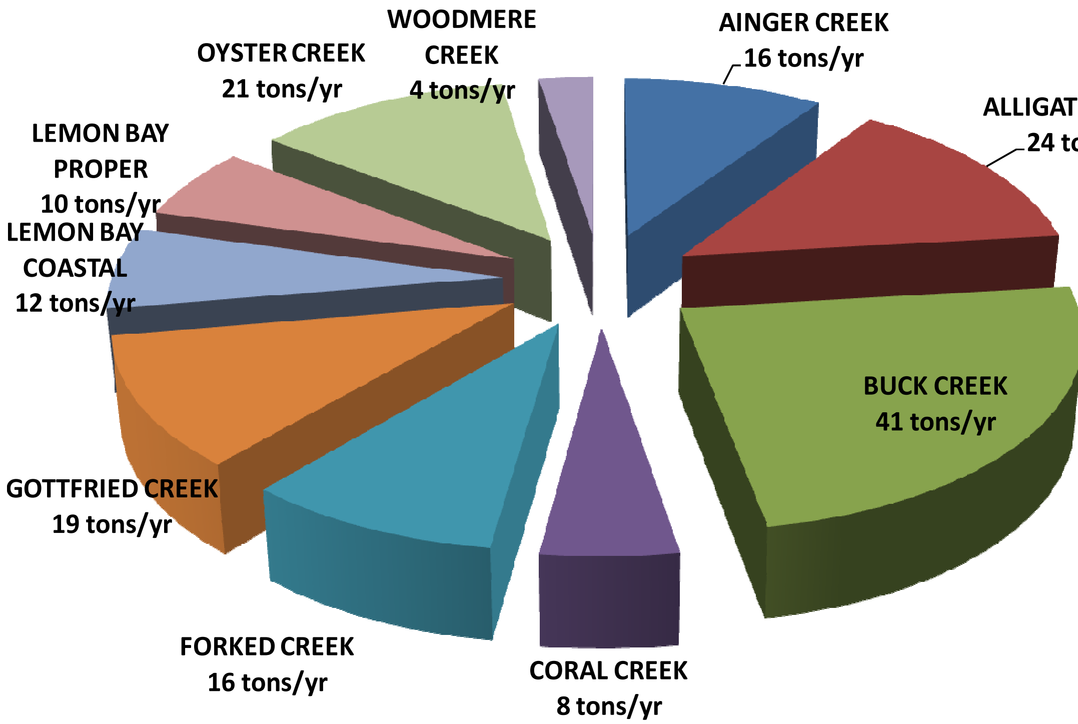

Figure 4-36 Average Annual TN Loads by Basin to Lemon Bay (1995–2007)

Average annual unit area loads were also analyzed for the subbasins of Sarasota County. The average annual unit area TN loads (lbs/acre/year) are highest in Alligator Creek Subbasins 4 and 5, Gottfried Creek Subbasin 34, and Forked Creek Subbasin 25, all of which are located in the watershed's most urbanized regions (Figure 4-37). Of all of the basins, Alligator Creek has the highest proportion of subbasins that have moderate to high unit area loads. As discussed previously, the Alligator and Woodmere creek basins are highly urbanized (>70%). The Ainger, Forked, and Gottfried creek basins have more natural areas (forested and water/wetlands land uses) relative to the highly urbanized basins mentioned above. Unit area TN loads from the majority of subbasins within the Ainger Creek, Gottfried Creek, Forked Creek, and Lemon Bay Coastal basins were relatively low to moderate. The lowest unit area TN loads are found in Subbasins 3, 35, 3 in the Ainger Creek basin, where the largest proportion of forested and water/wetlands land cover exists.

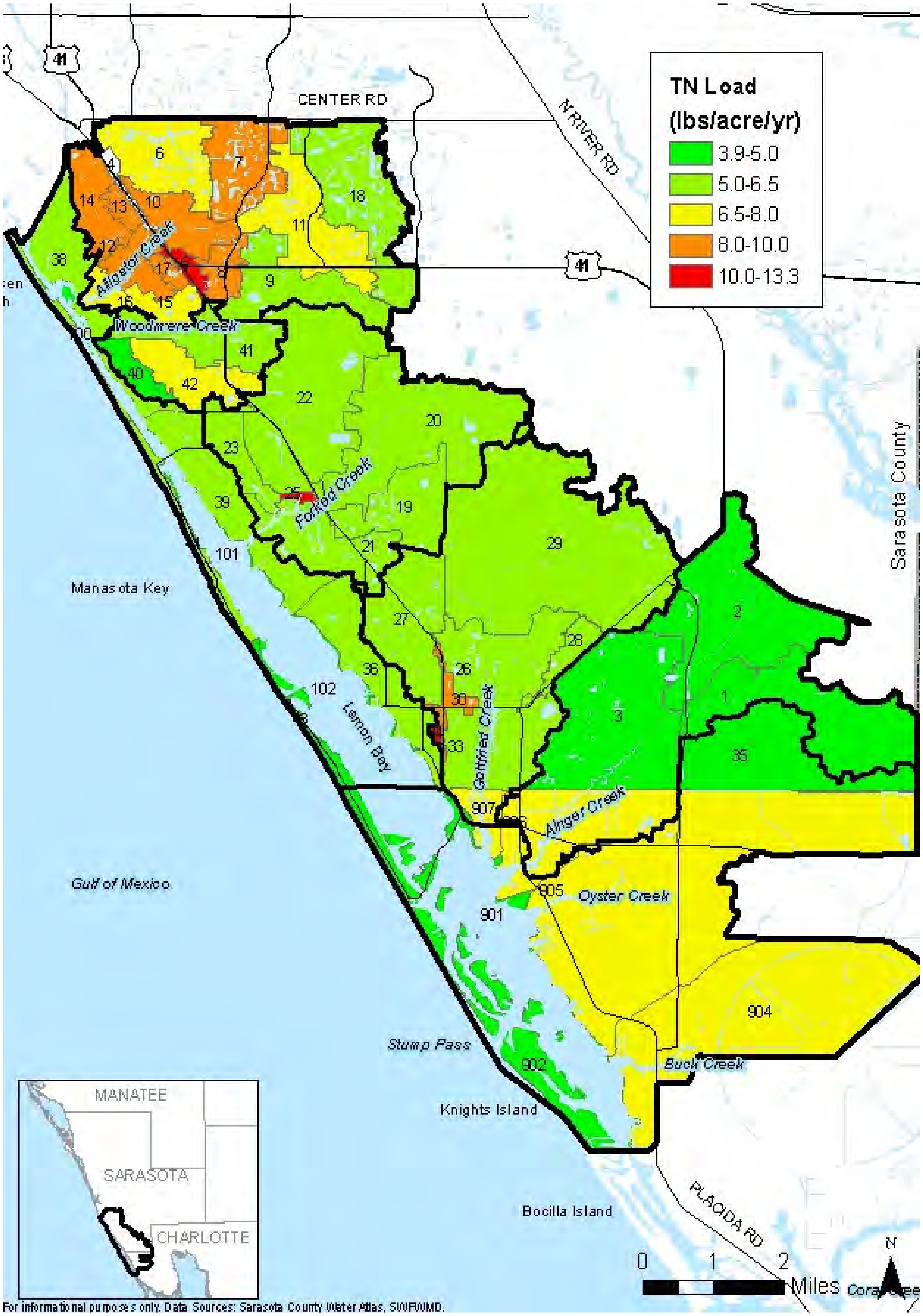

Figure 4-37 Average Annual Unit Area TN Loads (lbs/ac/year) by Subbasin in the Lemon Bay Watershed (1995-2007)

B. BOD Loads

The average annual BOD loads to Lemon Bay are presented in Figure 4-38. Nearly 70% of the total BOD load to the bay was generated in four basins: Buck, Alligator, Oyster, and Gottfried creeks.

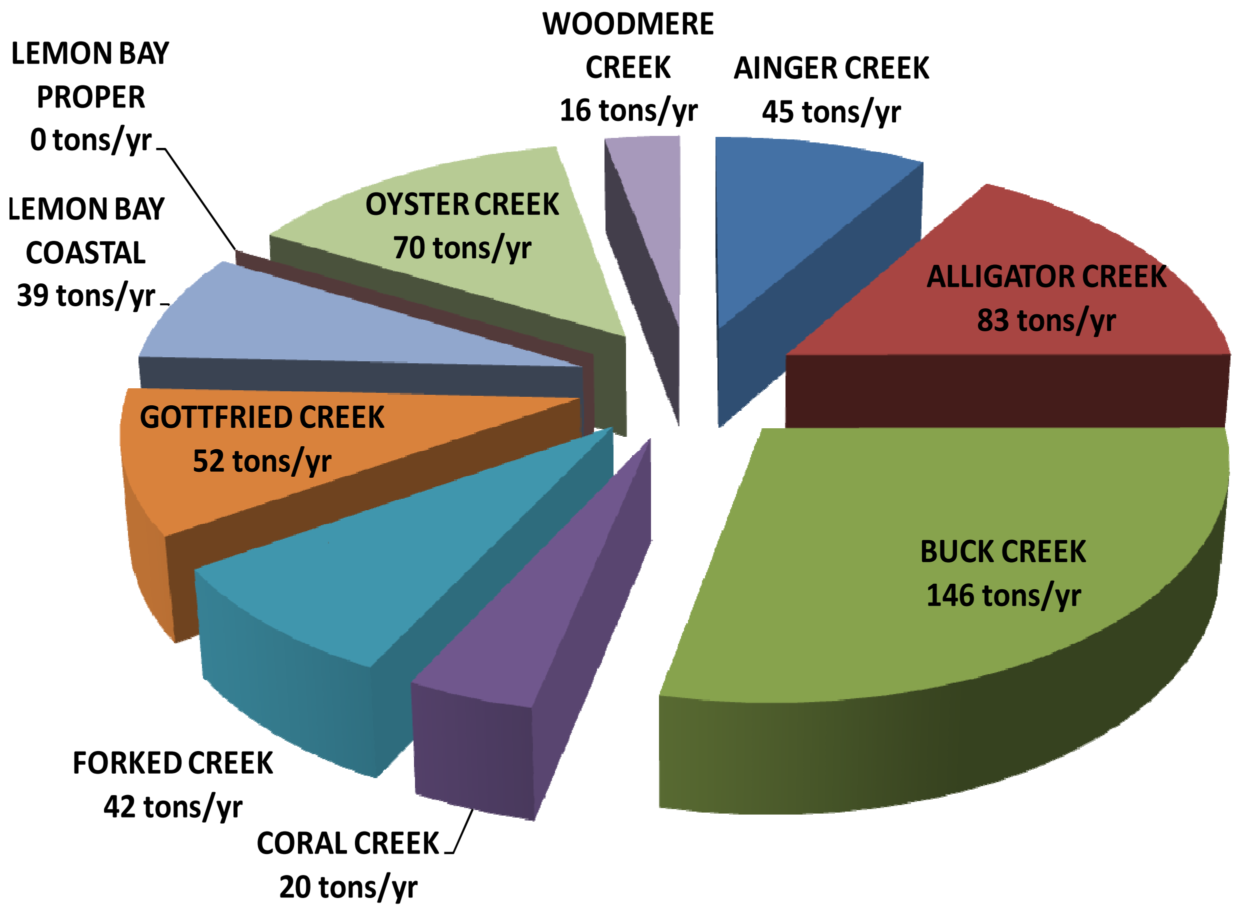

Figure 4-38 Average Annual BOD Loads by Basin to Lemon Bay (1995-2007)

Average annual unit area BOD loads (lbs/acre/year) are highest in the Alligator, Buck, Oyster, and Woodmere creek basins, all of which are located in the watershed's most urbanized regions (Figure 4-39). As shown in Chapter 1, agricultural land uses are most predominant in the Forked and Gottfried creek basins. Unit area TN loads from Forked Creek, Gottfried Creek, and Lemon Bay Coastal basins were relatively low to moderate. The lowest unit area TN loads are found in the Coral and Ainger creek basins, where the largest proportion of forested land cover exists. These results suggest that urbanized basins are more likely to contribute higher BOD loads than those of a more agricultural or natural character.

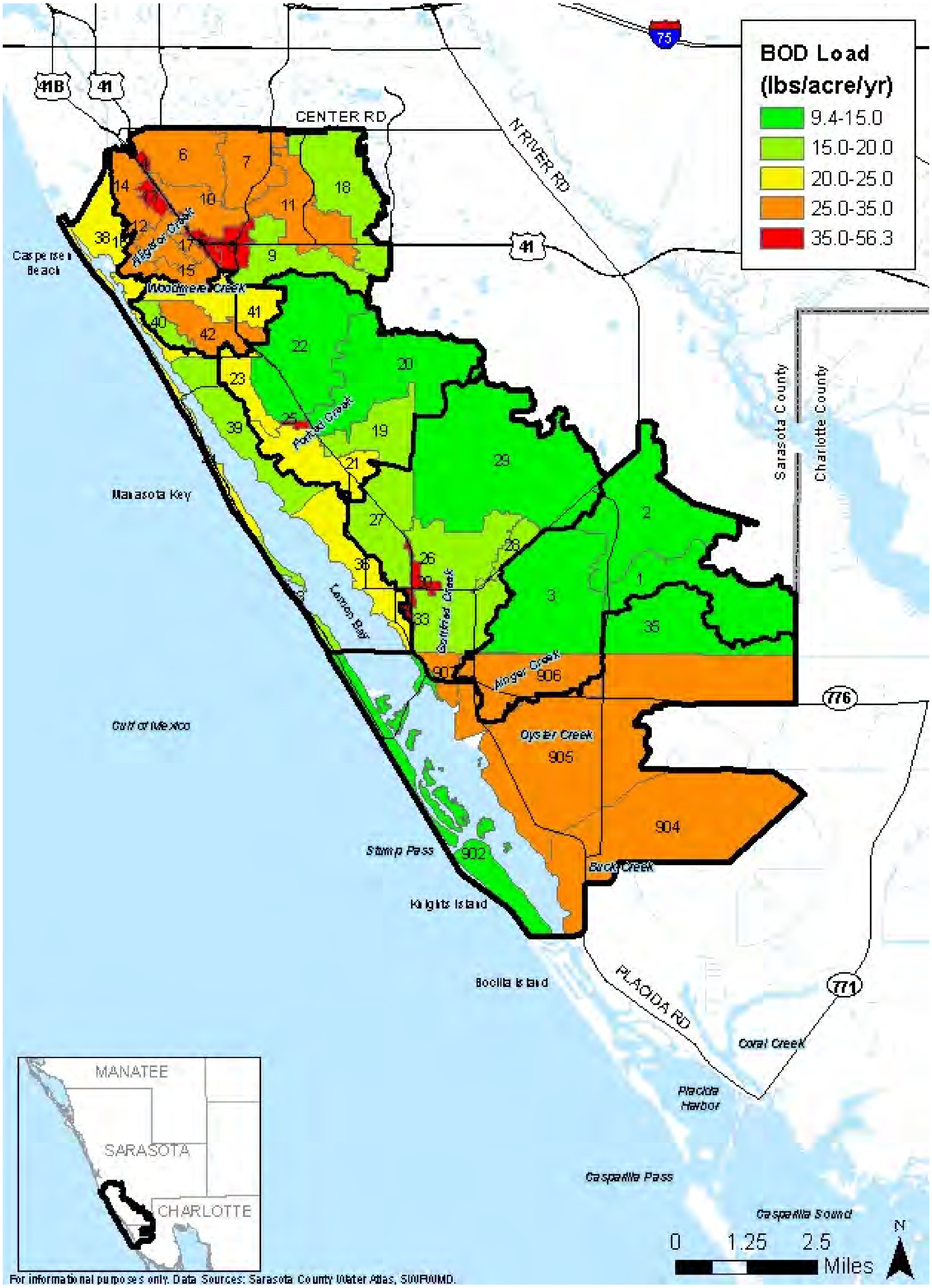

Figure 4-39 Average Annual Unit Area BOD Loads (lbs/ac/year) by Subbasin in the Lemon Bay Watershed (1995-2007)

C. TSS Loads

The average annual TSS loads to Lemon Bay are presented in Figure 4-40. Nearly 70% of the total TSS load to the bay was generated in four basins: Buck, Alligator, Oyster, and Gottfried creeks.

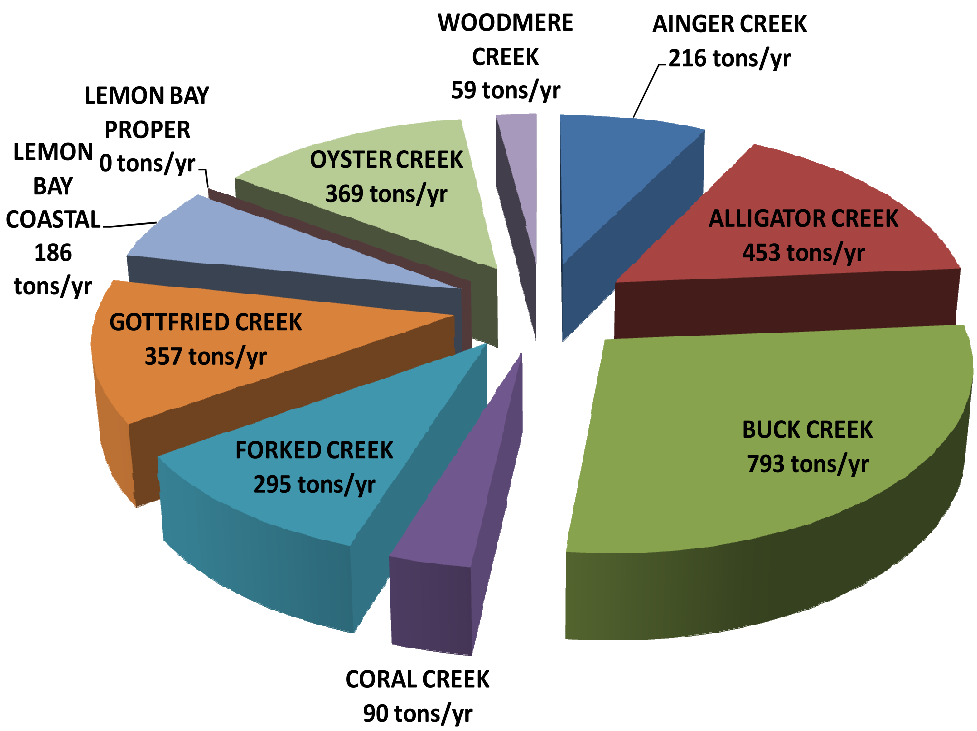

Figure 4-40 Average Annual TSS Loads by Basin to Lemon Bay (1995–2007)

The annual average unit area TSS loadings are shown in Figure 4-41. The highest unit area TSS loadings occur in Alligator and Buck creek basins (140 lbs/acre/year), followed by Oyster Creek (119 lbs/acre/year), Forked Creek (107 lbs/acre/year), and Gottfried Creek (104 lbs/acre/year). Woodmere Creek and Lemon Bay Coastal basins had moderate unit area TSS loadings, 85 and 84 lbs/acre/year, respectively. Ainger and Coral creek basins had the lowest unit area TSS loadings, and they are the basins with the greatest percent of land classified as forested and water/wetlands.

The annual average unit area TSS loadings are shown in Figure 4-41. Subbasins 4, 5, 25, 34, and 8 are the top five subbasins for unit area loadings for both BOD and TSS. These results suggest that urbanization may be a key indicator for likely high values of both constituents, as all five of these subbasins are predominantly urbanized. As with TN and BOD unit area loads, unit area TSS loads from the majority of subbasins within the Ainger Creek, Gottfried Creek, Forked Creek, and Lemon Bay Coastal basins were relatively low to moderate. The smallest per unit area TSS loads are seen in Subbasins 35, 1, and 2, where the proportion of forested land uses is highest.

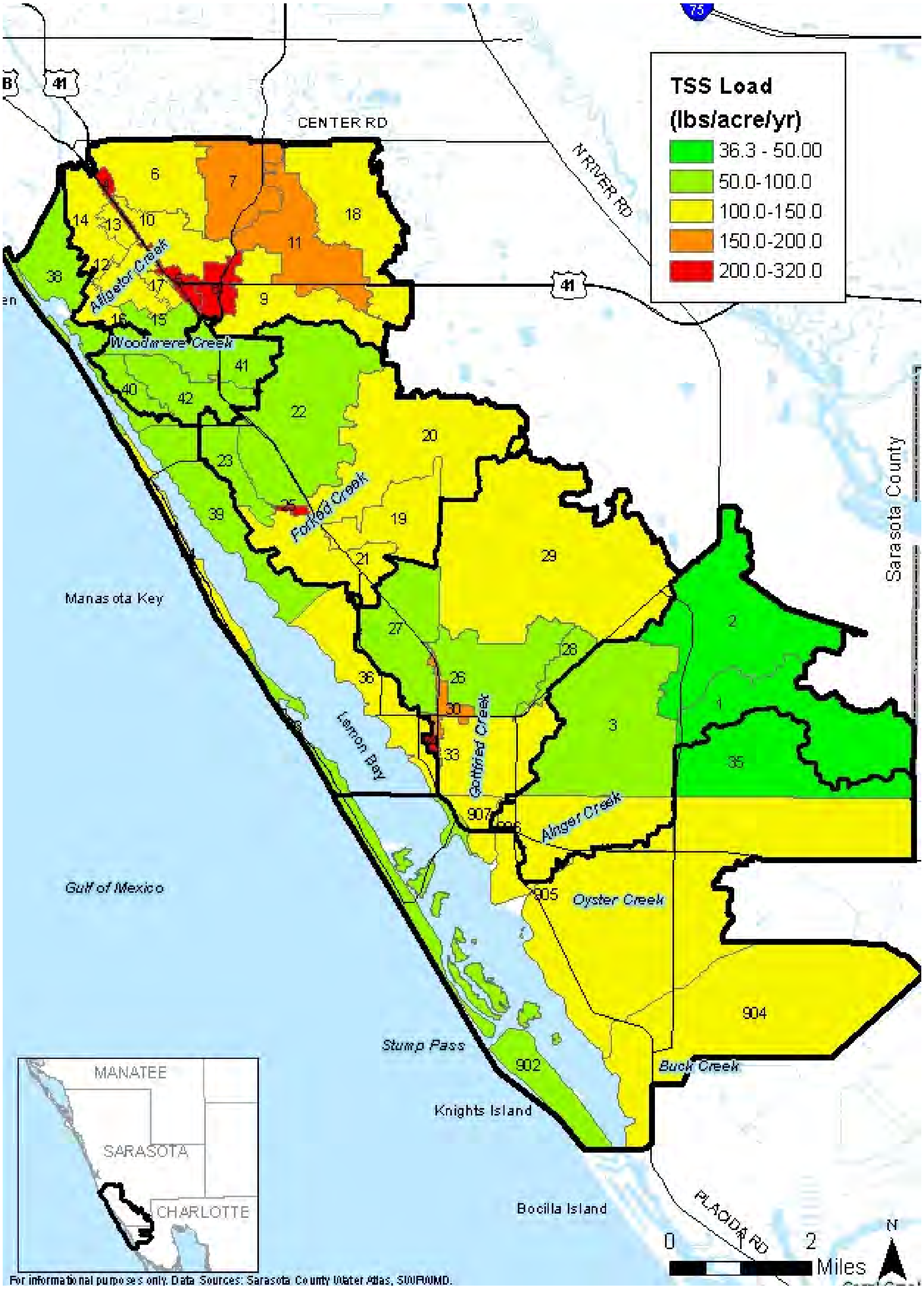
TSS Load
(lbs/acre/yr)
36.3 - 50.00
50.0-100.0
100.0-150.0
150.0-200.0
200.0-320.0
CENTER RD
N RIVER RD
Sarasota County
Manasota Key
Gulf of Mexico
Lemon Bay
Alligator Creek
Woodmere Creek
Forked Creek
Gottfried Creek
Ainger Creek
Oyster Creek
Buck Creek
Stump Pass
Knights Island
Bocilla Island
PLACIDA RD
MANATEE
SARASOTA
CHARLOTTE
0
2
Miles
N
For informational purposes only. Data Sources: Sarasota County Water Atlas, SWFWMD.

Figure 4-41 Average Annual Unit Area TSS Loads (lbs/ac/year) by Subbasin in the Lemon Bay Watershed (1995-2007)

The following conclusions can be drawn from the observations of spatial variability in pollutant loadings:

- Generally, the largest basins (Buck, Alligator, Oyster, and Gottfried creeks) are consistently the largest contributors of hydrologic yields and pollutant loads.
- The most urbanized basins generally have the highest unit area hydrologic yields.
- The highest unit area TN loads are observed in the highly urbanized basins of Buck, Alligator, Oyster, and Woodmere creeks.
- As with TN unit area loads, high values of BOD unit area loads are seen in the most urbanized portions of the watershed.
- High TSS unit area load estimates are seen in the more urbanized regions, while lower TSS unit area loads are seen in the basins that have greater proportions of forested and water/wetlands land classifications.
- These results will help target priorities for BMP development.

4.4 ANALYSIS OF THE RESPONSES IN LEMON BAY TO POLLUTANT LOADINGS

4.4.1 Nutrient Loading to Estuaries

The consequences of increased nutrient loading to an estuary include increased episodes of noxious blooms, reductions in aquatic macrophytes communities, and hypoxia and/or anoxia, often leading to substantial shifts in ecosystem processes (Nixon, 1995; National Research Council, 2000; Cloern, 2001; Paerl et al., 2003). Nitrogen and phosphorus are the nutrients of greatest concern because they most often control eutrophication and their inputs are often anthropogenic (Paerl et al., 2003). The single largest global change in the N cycle results from synthetic inorganic fertilizers that became widely used after the 1950s. In addition to widespread use of fertilizers, increased use of fossil fuels and production of N-fixing crops have dramatically increased nitrogen loading across the globe (Seitzinger et al., 2002).

Before the 1990s in the United States, phosphorus loading was dominated by point sources, specifically wastewater. With the successful effort to reduce P loading in wastewater, non-point-source loading has increased in significance (Howarth et al., 2002). As in most estuarine systems (National Research Council, 2000), N is the limiting nutrient in Tampa Bay. Strong empirical evidence based on annual water quality sampling in the region and bioassay results points to the importance of nitrogen in controlling algal biomass and growth in this estuary (Johansson, 1991). Therefore, the focus of nutrient reduction in Tampa Bay is N loading. Currently, no specific nutrient-reduction laws are mandated by any U.S. government agency, although certain mandates under the Clean Water Act are acting to implement water quality standards and reduce TMDLs (Boesch, 2002). Every watershed is unique, and standards must account for the individual characteristics of each. This makes enacting and implementing nutrient-reduction strategies very difficult, especially given the need to determine how to achieve locally desired resource-management goals.

The EPA's National Estuary Programs have been instrumental in establishing site-specific goals and implementing these goals through the participation of national, regional, and local agencies; governments; and private entities. The central process of eutrophication is not a single focused issue but rather a multitude of factors that combine to cause water quality issues that change depending on ecosystem location and sources of pollution. One commonly used way to assess and control eutrophication is to identify indicators, such as seagrass growth and coverage and primary production, for managing estuarine systems. Light availability is the principal factor limiting seagrass distribution (Gallegos, 2001). Managing primary production as a result of increased nitrogen loading has a direct effect on surface irradiation depth. For example, in the Chesapeake Bay, Dennison, and others (1993) established habitat requirements for submerged aquatic vegetation based on TSS, chlorophyll *a* concentrations, and median photosynthetically active radiation. A similar management approach was also used in the Indian River Lagoon (Gallegos and Kenworthy 1996; Kenworthy and Fonseca, 1996) and Tampa Bay (Janicki and Wade, 1996; Greening and Janicki, 2006).

The Sarasota Bay Estuary Program (SBEP) is developing a scope of work that will define the methodology to be used to set water-quality targets for the Sarasota Bay system. In addition, FDEP will be establishing numeric nutrient criteria for estuarine waters over the next year. We expect these criteria to be expressed as loadings and to include an adjustment for variation in residence times.

4.4.2 Influence of Circulation and Residence Times

Understanding the relationship between nutrient loading and estuarine response requires knowing the potential influence of estuarine circulation and residence times. Estuarine circulation is driven primarily by tidal exchange and freshwater inflow and results in the transport of water quality constituents (e.g., salinity, nutrients, DO) within the system. The passes connecting Sarasota Bay to the Gulf of Mexico provide avenues for tidal exchange, with the resulting circulation within the estuarine system depending on the locations and sizes of these passes. This section briefly summarizes circulation within the system, including discussion of the simulated effects of the opening of Midnight Pass.

The northern region of the Sarasota Bay system connects to Tampa Bay through Anna Maria Sound. South of Anna Maria Sound, Longboat Pass connects the north end of Sarasota Bay to the Gulf, with New Pass connecting to the Gulf near the southern end of Sarasota Bay. Big Sarasota Pass provides the largest connection to the Gulf, between Sarasota Bay and Roberts Bay, and Venice Inlet is south of Little Sarasota Bay. Midnight Pass provided a connection to the Gulf near the middle of Little Sarasota Bay until 1983, when the pass was closed (ATM and ECE, 2004). South of Venice Inlet the ICW connects the Sarasota Bay system to Lemon Bay, which is tidally influenced by the Gulf through Stump Pass in the southern third of Lemon Bay.

The strongest currents in the system are found in the passes during incoming and outgoing tides, with the areas between the passes generally experiencing much weaker currents (Sheng, 1992). A three-dimensional model of tidal circulation in the Sarasota Bay system developed by Sheng and Peene (1991) showed that the areas between the passes, where the tidal signals entering from adjacent passes meet, are areas of very small current velocities. Consequently, these areas have relatively poor flushing rates. Modeling efforts identified Palma Sola Bay, Middle Sarasota Bay, and Middle Little Sarasota Bay as having the lowest flushing rates in the Sarasota Bay system (Sheng, 1992).

Lemon Bay is connected to Dona and Roberts Bay and the Venice Inlet to the north via the ICW. Stump Pass connects Lemon Bay to the Gulf of Mexico near the southern end of the bay. The bay is very shallow, with a maximum depth of less than 2 m, with the exception of the dredged ICW. Freshwater inflows to the system are from several tidal creeks. Flushing rates are likely relatively large in the area adjacent to Stump Pass near the southern portion of Lemon Bay. We expect that there is poorer flushing in the northern portion of the bay, as the northern region is removed from Stump Pass so that the tidal signal is diminished from the south, and a reduced tidal signal is likely coming through the ICW connection to the north. Flushing rates in the northern portion of the Lemon Bay are likely more strongly influenced by freshwater inflows from Alligator Creek, Woodmere Creek, and Forked Creek than are flushing rates in the southern portion of the bay near Stump Pass.

4.4.3 Nutrient Loading and Its Impact on Estuaries

Tides and rivers offer a constant flow of water and nutrients that provide a beneficial environment for primary producers that form the base of the maritime food web. Watershed-driven nitrogen inputs from watersheds adjacent to coastal and estuarine waters can have significant impact on estuarine function. High rates of nutrient inputs from the land often stimulate very high rates of primary productivity. Due to high primary productivity, estuaries provide breeding and nursery grounds for many species of fish and shellfish. Hundreds of marine organisms, including commercially viable fish and shellfish such as shrimp, crabs, and trout, depend on estuaries during different stages of their lifecycles to provide valuable habitat (EPA, 1999).

In estuarine systems functioning without large anthropogenic disturbances, dissolved nutrients in river discharge constitute the primary nutrient source for many estuaries that receive significant freshwater input. Since the 1970s many scientists and managers have been studying the deterioration of estuarine ecosystems via increases in nutrient loads and accompanying eutrophication (Paerl et al., 2006; Bricker et al., 2008; Fisher et al., 2006). The targeting of nutrient inputs from other points sources such as sewage outfalls and industrial effluent was met with much success, yielding improved water quality following implementation of advanced waste water treatment (Greening and Janicki, 2006). Unfortunately, population growth and the growing need for agricultural output have led to an increase in non-point-source pollution. It is estimated that human activity has increased the total rate of formation of reactive nitrogen globally by 33 to 55% through increases in agriculture via synthetic fertilizer (Howarth, 2008). Increases in reactive nitrogen have also resulted from increases in the encouragement of biological nitrogen fixation associated with agriculture and the inadvertent creation of reactive nitrogen through reaction with oxygen as fossil fuels are burned (Howarth, 2008; Paerl et al., 2006).

Excess nitrogen in estuarine ecosystems has led to increased rates of primary production, termed *eutrophication* (Nixon, 1995). Understanding the impacts of eutrophication and how anthropogenic impacts affect the structure and function of estuaries continues to be a research goal for scientists and managers worldwide (Paerl et al. 2006). Eutrophication has resulted in documented cases of reduced biodiversity, habitat degradation, and food web alterations (Nixon, 1995; Rabalais and Turner, 2001; Paerl et al., 2006; Bricker et al., 2008). Large-scale drivers of estuarine productivity include non-point and point source inputs from the watershed, riverine flow, and atmospheric deposition.

Symptoms of water quality decline are typically chlorophyll *a* and microalgae, low DO, loss of submerged aquatic vegetation, and occurrences of Harmful Algal Blooms (HABs) (Bricker et al., 2008) Chlorophyll *a*, a pigment used in photosynthesis, serves as a measure of biomass (abundance) of phytoplankton in estuaries. Planktonic algae provide a food source of filter-feeding bivalves (oysters, mussels, scallops, clams) and zooplankton (including the larvae of crustaceans and finfish). Chlorophyll *a* concentrations can also be used as a measure of overall ecosystem health. High amounts of chlorophyll *a* in estuarine waters are a primary indicator of nutrient pollution because excess nutrients fuel the growth of algae. High chlorophyll *a* values can have adverse impacts on aquatic life and human recreation.

DO is a very important limiting factor impacting estuarine systems. DO can be used as an indicator of the health of the ecosystem. Cultural eutrophication (nutrient excess leading to overproduction of microalgae and associate trophic imbalances) is common in estuaries near human population centers. Under conditions of eutrophication, DO can exhibit extreme diel cycles. Photosynthesis via algae elevates DO levels in the water during the day, but at night when respiration is high the DO can drop dangerously low. Eutrophication can lead to periodic or long-term hypoxia (water column oxygen concentrations less than 2 mg O_2/L) and anoxia in estuarine ecosystems. Fishes, crabs, and shrimp will attempt to move away from hypoxic conditions, and few marine animals survive in prolonged exposure to it. DO levels are often quite variable in estuarine system due to fluctuations in temperature, salinity, basin morphology, and overall productivity.

Seagrasses serve significant functions. They help maintain water clarity by trapping fine sediments and particles with their leaves, and they stabilize the estuarine sediments with their roots. Seagrasses are very effective at removing dissolved nutrients from water that can enter from land runoff. The removal of sediment and nutrients improves water clarity, thereby improving overall ecosystem health. Seagrasses offer habitats for fish, crustaceans, and shellfish, providing a nursery ground for many recreationally and commercially valuable species. They are also food for organisms that inhabit them and marine mammals such as manatees and waterfowl such as ducks. Human activities can harm seagrasses by degrading estuarine water quality and promoting physical disturbances and algal blooms. Reductions in light availability associated with nutrient inputs and sediments can damage or eliminate seagrass habitat.

How any particular estuary will respond to excess nitrogen loading depends on numerous factors including freshwater inflow, residence time, and clarity or light attenuation (Howarth and Marino, 2006). Estuarine nutrient concentrations depend on freshwater inflow because freshwater is a source of nutrients. The rate of freshwater inflow can influence hydraulic residence time and hence the time available for nutrients to react in the estuary (Bricker et al., 2008). Flow may affect chlorophyll by increasing chlorophyll abundance via enhanced nutrient supply, changing the location of peak chlorophyll abundance or decreasing chlorophyll abundance and residence time. During times of low freshwater inflow, the chlorophyll maximum is typically located farther upstream than during times of high flow. Low flow also allows a longer residence time for chlorophyll and other nutrients. Longer residence times tend to promote slower-growing taxa, which include dinoflagellates, cyanobacteria, and HABs (Pickney et al., 1999). Increased nutrient loading is associated with higher flows and is typically followed by increased algal biomass. During high flow conditions, flushing is more rapid and residence time in the river is reduced (Flannery et al., 2002; Jassby et al., 1995). These conditions tend to favor fast-growing phytoplankton such as chlorophytes (green algae) and various flagellates (Pinckney et al., 1999) At times, depending on the morphology of the river, high flows can be excessive. Very high flows may not result in higher chlorophyll abundance due to the relationship between the residence time of water in the system and uptake and growth rates of the phytoplankton community. Reductions in flow can also impact community composition with less-desirable species such as HABs occurring during times of low flow and longer residence times (Bricker et al., 2008).

Water clarity is a measure of the amount of sunlight that can penetrate the water. Water clarity is measured with a device called *a Secchi disk*. The measurement, named the *Secchi depth*, is the measure of water clarity and the depth at which sunlight is able to penetrate the water. Clear waters indicate a healthy estuary, although many factors impact water clarity. Excess suspended sediments from runoff and rainfall can negatively impact water clarity. Nutrients, mainly nitrogen and phosphorus, can fuel the growth of photosynthesizing algae. High chlorophyll *a* concentrations associated with high algal biomass can decrease light penetration, decreasing water clarity. Decreased water clarity can negatively impact the estuary in many ways. Reduced light transmission can decrease seagrass abundance, which can affect the entire food web. Decreases in seagrass reduce habitat to the hundreds of species that depend on the seagrass.

The successful management of coastal ecosystems requires long-term monitoring and accurate quantitative tools for managers, scientists, and the public at the local and regional levels to easily understand and apply basic principles of ecosystem management. Wide-scale nutrient reduction aimed at controlling ecosystem scale eutrophication needs to span freshwater and marine ecosystems. Additionally, managers must recognize that primary productivity and growth responses could take longer times (years to decades) for improved water quality but that implementing these reductions is imperative.

4.4.4 Response in Lemon Bay to Variation in Nutrient Loading

The nexus between understanding the relationship between nutrient loading and response in the estuary and effective resources management is the ability to develop a tool that quantitatively links loading and response. The approaches that have been taken to develop such tools have ranged from complex, mechanistic models (EPA, 1995; Cerco and Cole, 1995; EPA, 2001; EPA, 2006) to empirical models (Boynton et al., 1995; Boynton et al., 1996; Brush et al., 2002). Empirical modeling approaches have been used for several Florida estuaries, including Tampa Bay (Janicki and Wade, 1996), Sarasota Bay (Tomasko et al., 1996), Lemon Bay (Tomasko et al., 2001) and Indian River Lagoon (Steward and Green, 2007).

We have used an empirical approach to quantify the relationship between nutrient (nitrogen) loading and chlorophyll *a* in Lemon Bay. The data used to develop this empirical model have been examined earlier in this chapter. These include the loading data provided by the SIMPLE model for 1998 to 2007 and ambient water quality data provided by the County's monthly monitoring program.

Initially, a series of potential loading variables were calculated:

- Current month loading
- Lagged monthly loading (e.g., last month's load)
- Cumulative monthly loading (e.g., the sum of the last months' loads)

The variation in these potential explanatory variables was compared to the variation in mean monthly chlorophyll concentrations. We found that the relationship between this month's mean chlorophyll and the cumulative load from this month and the previous month provided the best fit model. Monthly-specific intercept terms were then added to the model to account for the effect of seasonal variation in water temperature and incident light on chlorophyll *a*. Given the same monthly TN loads, we expect that chlorophyll *a* concentrations should be highest during the summer months when water temperature and incident light are greatest.

A plot of the relationship between the natural log transformed chlorophyll *a* and 2-month cumulative TN loads is given in Figure 4-42. A multiple regression technique was applied to these data. The slope of the overall model was significantly greater than 0 ($p < 0.0001$) and the coefficient of determination (R^2) was 0.50. Therefore, the variation in TN loads from the Lemon Bay watershed accounted for 50% of the variation in chlorophyll *a* concentrations in the estuary. Figure 4-43 presents a plot of the observed chlorophyll *a* concentrations from Lemon Bay and those predicted by the regression on TN loads.

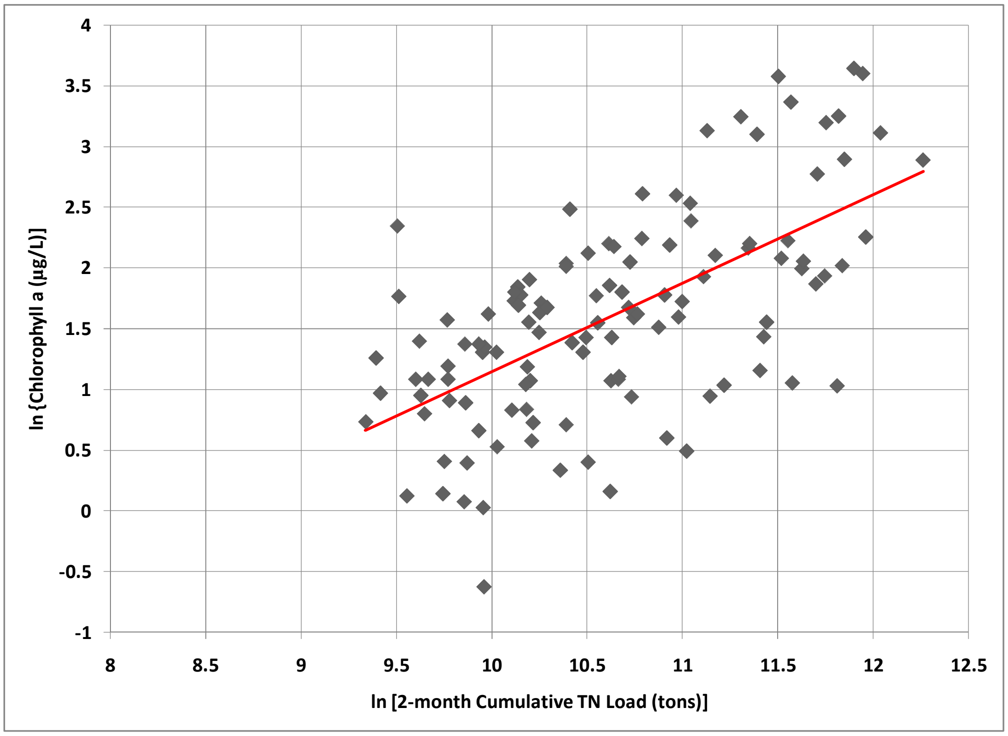

Figure 4-42 Relationship Between ln-Transformed Chlorophyll *a* and 2-Month Cumulative TN Loads Data from Lemon Bay (1998–2007)

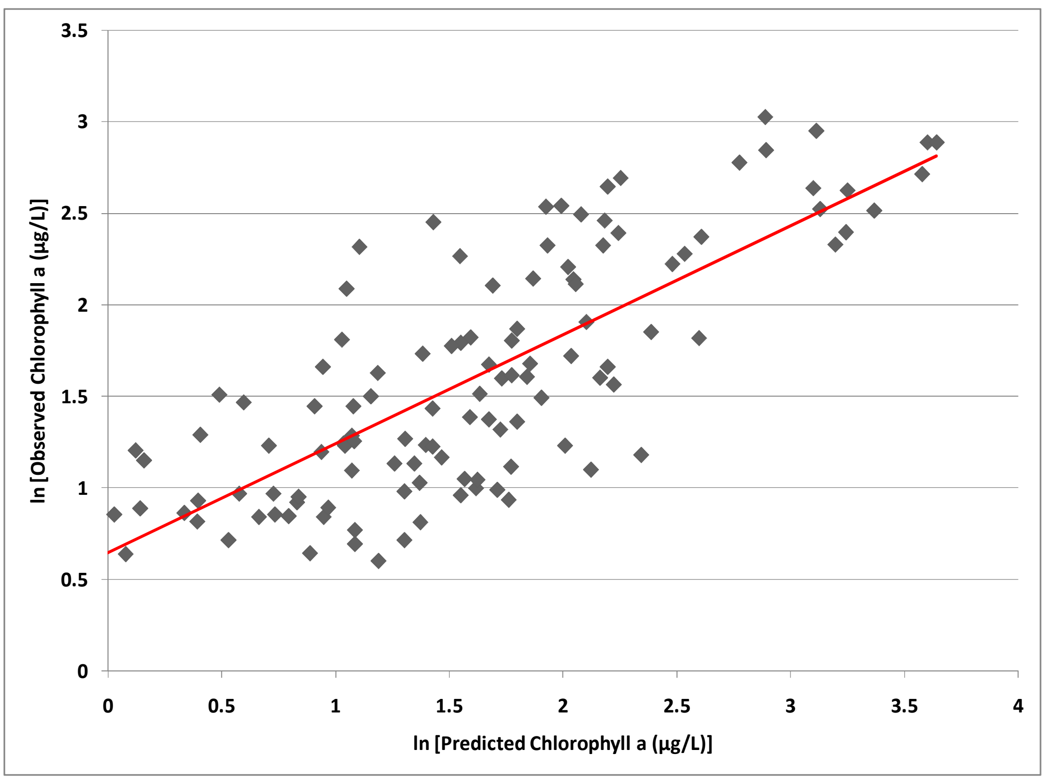

Figure 4-43 Comparison of Predicted and Observed Chlorophyll *a* Concentrations from Lemon Bay (1998–2007)

Further analysis of the chlorophyll-TN load relationship included an examination of the residuals (the differences between the predicted and observed chlorophyll concentrations). We examined plots of the residuals against potential confounding variables to identify any apparent patterns. If there is no relationship between the residuals and any confounding variable, the plot will show more or less equal probability of either under- or over-predictions across the range of values of the confounding variable. This diagnostic tool can identify whether inclusion of any of these variables may improve the model predictions. In this case the plot of the model residuals with the mean monthly turbidity in Lemon Bay shows a clear pattern (Figure 4-44). The probability of an over-prediction increased with increasing turbidity.

Given these results, the model was reformulated to include the effect of turbidity. As before, the slope of the overall model was significantly greater than 0 ($p < 0.0001$) and the R^2 increased to 0.66. Therefore, the new model accounts for nearly 70% of the variation in chlorophyll *a* concentrations in the estuary. Figure 4-45 presents a plot of the observed chlorophyll *a* concentrations from Lemon Bay and those predicted by the regression on TN loads.

The results of the empirical modeling approach indicate that the management of nitrogen loading from the Lemon Bay watershed will be essential if future changes in the watershed lead to potential increases in loads.

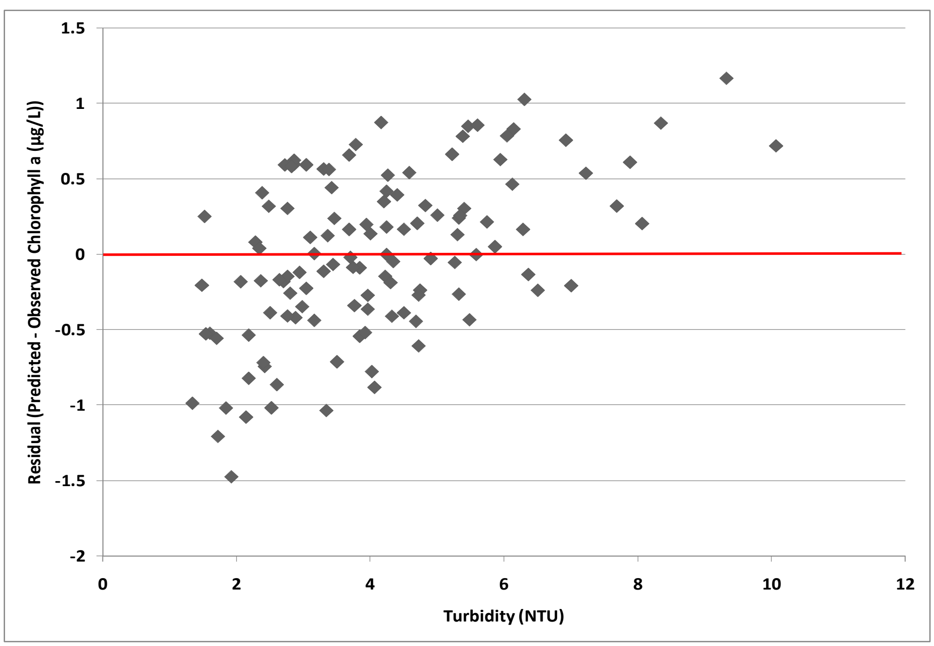

Figure 4-44 Comparison of Residuals from the Chlorophyll-TN Load Model for Lemon Bay to Mean Monthly Turbidity Concentrations

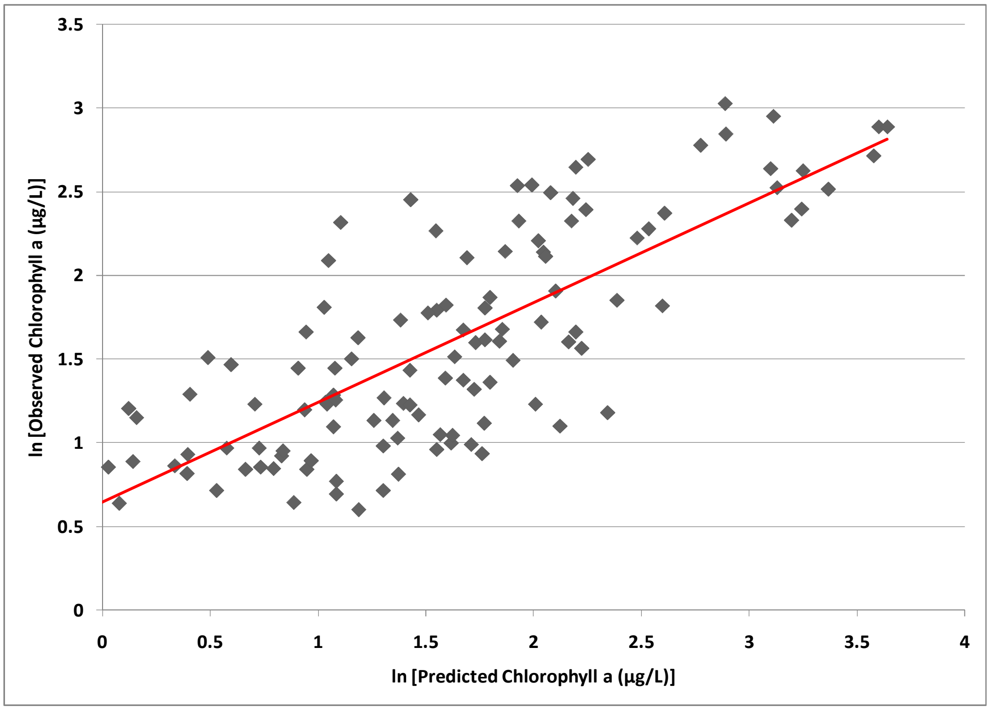

Figure 4-45 Comparison of Observed Chlorophyll *a* Concentrations from Lemon Bay to the Predicted Concentrations from the Model Including Mean Monthly Turbidity

4.4.5 Relationship Between Water Quality in Lemon Bay Tributaries to Variation in Pollutant Loading

As discussed above, several tributaries in the Lemon Bay watershed have been identified and verified as impaired, including Alligator Creek, Forked Creek, and Woodmere Creek. The following examines the water quality data from these tributaries and links them to loading estimates from the SIMPLE model.

Alligator Creek has been identified as impaired due to low DO and elevated chlorophyll. Figure 4-46 presents a time series of Alligator Creek DO data from the FDEP Impaired Waters database. Most of the available data were collected before 1993. DO excursions below 4 mg/L are apparent during both that period and during the recent data collection. Figure 4-47 presents the relationship between DO and BOD loading from the Alligator Creek basin. There is no clear relationship between DO and BOD loading during the period for which both data types were available. Similarly, there was no apparent relationship between chlorophyll *a* and TN loadings In Alligator Creek (Figure 4-48).

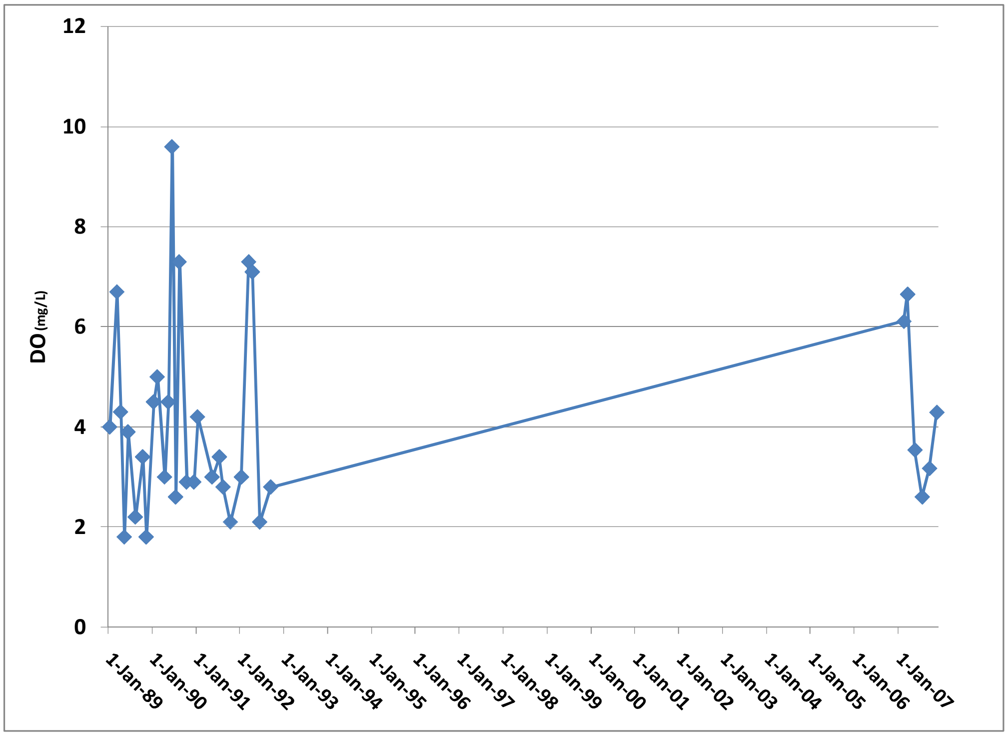

Figure 4-46 Time Series of DO Concentrations from Alligator Creek

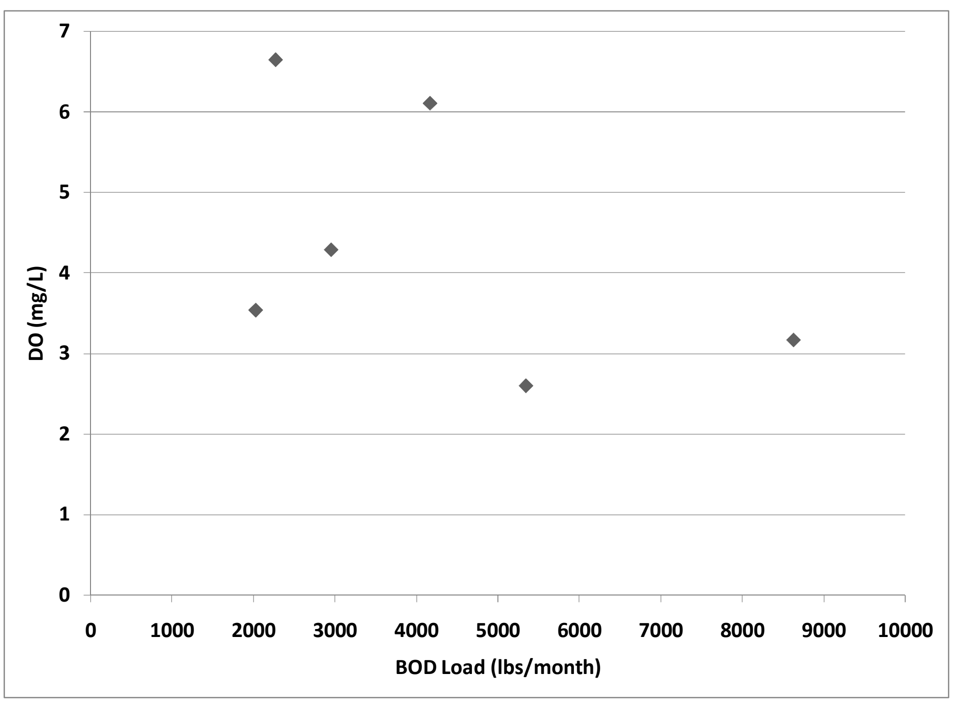

Figure 4-47 Relationship Between DO Concentrations and BOD Loadings from Alligator Creek Basin

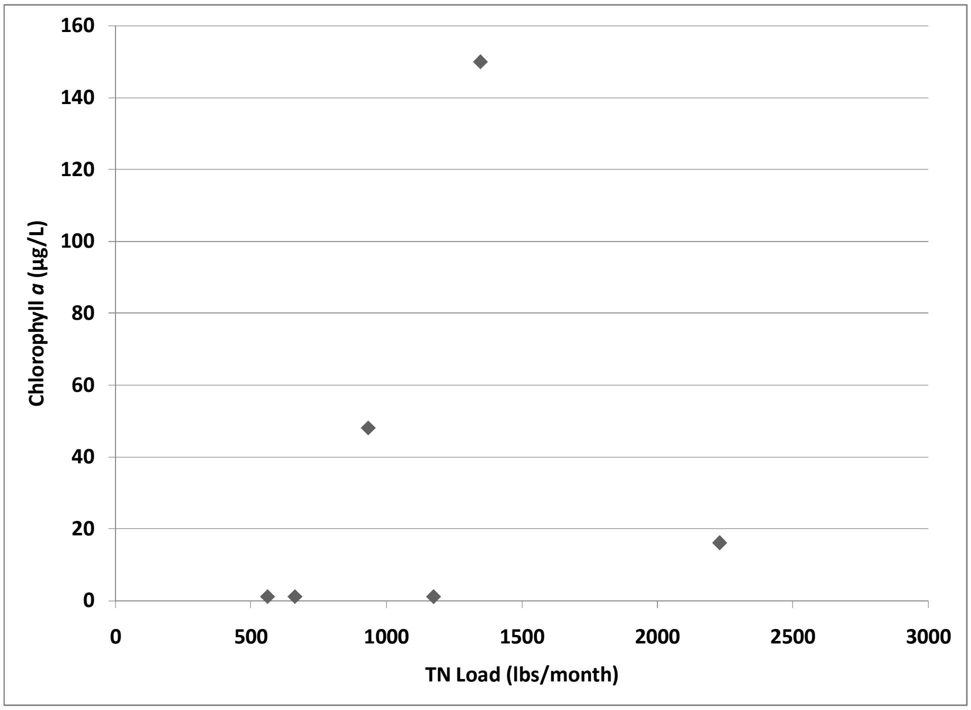

Figure 4-48 Relationship Between Chlorophyll *a* Concentrations and TN Loadings from Alligator Creek Basin

Forked Creek has been identified as impaired due to elevated chlorophyll *a* concentrations. The chlorophyll *a* data in the FDEP Impaired Waters database included a number of both corrected and uncorrected values (Figure 4-49). There are very apparent discrepancies in these data, including much higher corrected values. This is unexpected since the correction for phaeophytin should result in lower concentrations than the uncorrected estimates. Also, the highest chlorophyll *a* concentrations, both corrected and uncorrected, were observed when TN loads were relatively low (Figure 4-50). Setting a TMDL will therefore be problematic for this waterbody.

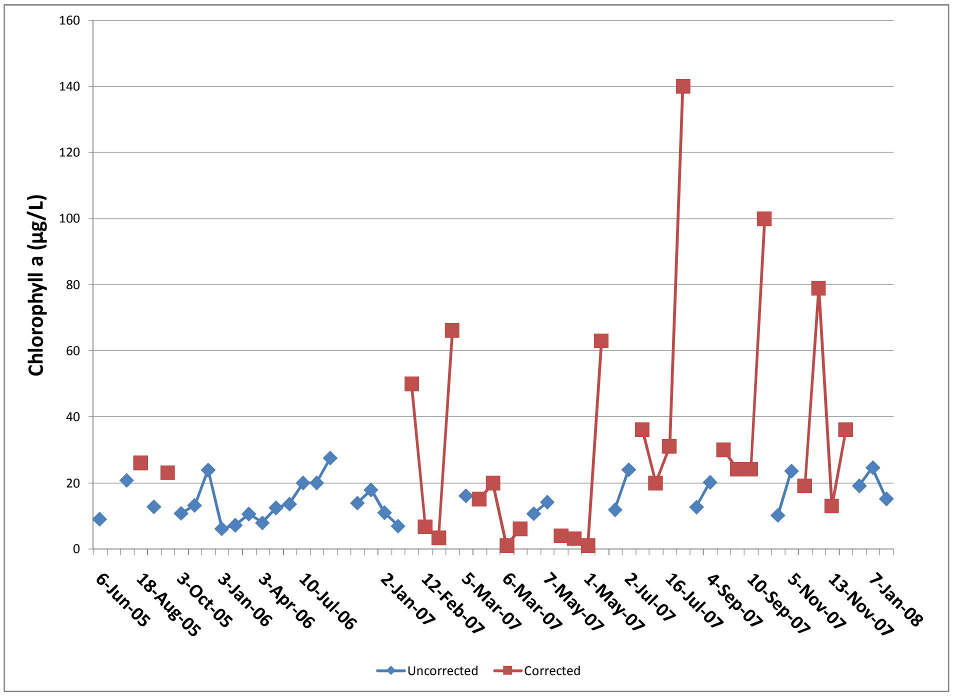

Figure 4-49 Relationship Between Corrected and Uncorrected Chlorophyll *a* Cata from Forked Creek

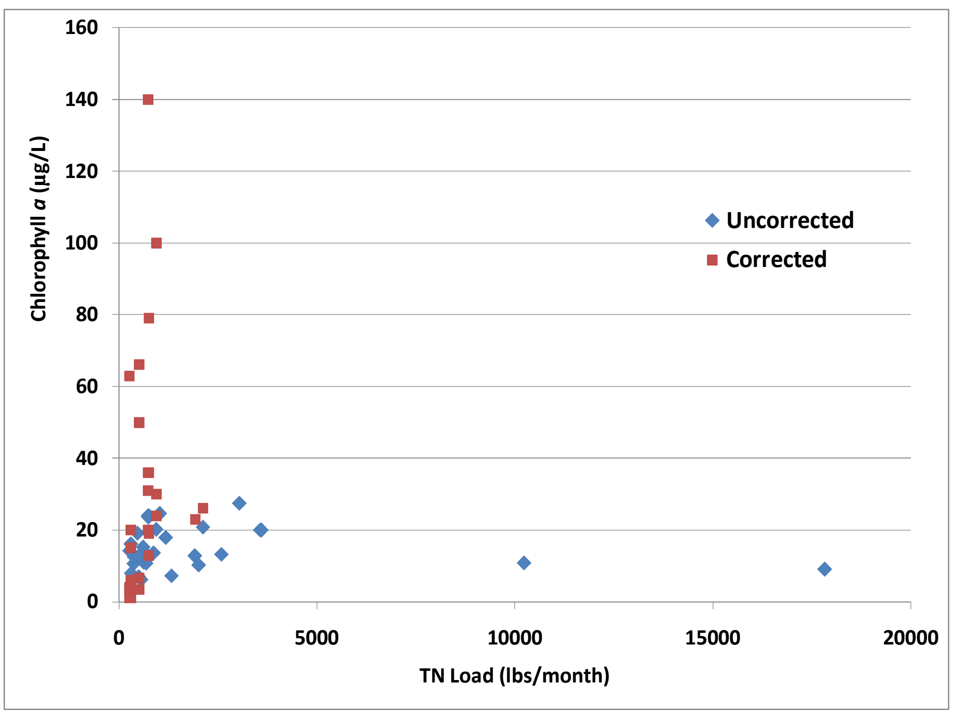

Figure 4-50 Relationship Between Chlorophyll *a* and TN Loads from Forked Creek

Woodmere Creek has been identified as impaired due to elevated chlorophyll *a* concentrations. Figure 4-51 presents a time series of Woodmere Creek chlorophyll *a* data from the FDEP

Impaired Waters database. With the exception of two dates, the chlorophyll *a* concentrations were less than 20 µg/L. Figure 4-52 presents the relationship between chlorophyll *a* concentrations and TN loading from the Woodmere Creek basin. There is no clear relationship between chlorophyll *a* concentrations and TN loading during the period for which both data types were available.

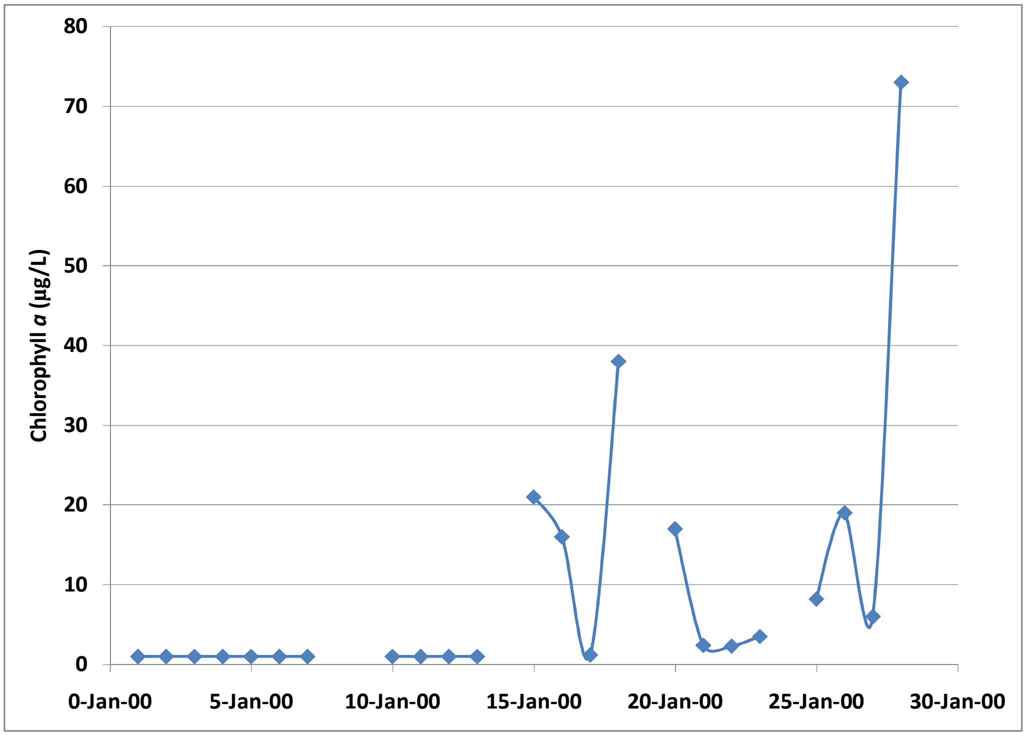

Figure 4-51 Time Series of Chlorophyll *a* Concentrations in Woodmere Creek Basin

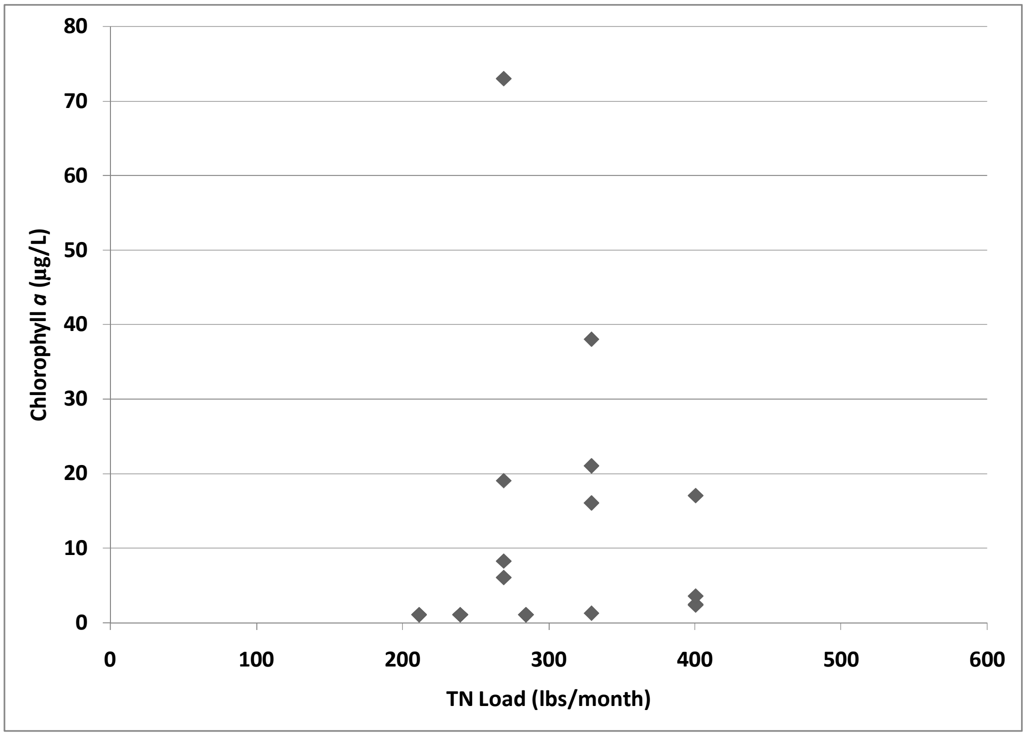

Figure 4-52 Relationship Between Chlorophyll *a* Concentrations and TN Loadings from Woodmere Creek Basin

4.4.6 Freshwater and Pollutant-Load Targets and Reduction Goals for Lemon Bay

As discussed in Section 4.2.2.1, comparing the historical and current water budgets shows that wet season flows are greater under current conditions. This increase in flow results in a modest change in salinity in Lemon Bay. Projects or programs that can contribute to a reduction of wet season flows (i.e., during August through October) should be considered.

Also as discussed in Section 4.2, the recent seagrass coverage in Lemon Bay meets or exceeds that estimated for the historical period (ca. 1950). Based on these observations, the chlorophyll *a* concentration target is 7.8 µg/L and the K_d target is 1.07 (1/m). The chlorophyll and K_d levels are the mean conditions during 2001 to 2007, which generally coincide with the period during which the seagrass targets have been set and represent the recent wide range in rainfall in this region.

The analyses presented above indicate that meeting the chlorophyll *a* target for Lemon Bay will depend on managing nitrogen loading to the bay. It logically follows that if the current water quality conditions have been adequate to maintain seagrass coverage at desired levels, the nitrogen loading is also at levels adequate to maintain the chlorophyll *a* concentrations at or near their desired levels. Therefore, the proposed nitrogen loading target is 95 tons/year, which is the average TN load for the period 2001–2007.

The proposed nitrogen loading target is 95 tons/year.

4.4.7 Comparison of the Proposed Nitrogen Loading Target to Future Nitrogen Loading to Lemon Bay

Future loading estimates were developed following the methodology presented in Chapter 3, Section 3.1.2.1. The SIMPLE model was used to develop estimates for what is essentially a "built-out" scenario. This entailed applying a land-use coverage that reflected build-out conditions where all "developable" polygons in the 2006 land-use coverage not classified as an environmentally sensitive land was converted to medium-density residential with a wet detention BMP (35% removal efficiency for total nitrogen). Current BMPs, septic tank removal, and irrigation practices were also applied to the future load scenario. Future changes in atmospheric deposition follow methods used recently to estimate future atmospheric deposition loads to Tampa Bay (Janicki Environmental, 2008). Finally, the same rainfall record used to estimate the current loadings was used to drive the model. While many potential stormwater control rules/policies are currently under discussion and review, none of these has been applied to this "built-out" scenario. Therefore, if any of these rules/policies are implemented, it can be expected that future loads will be less than those used in our analyses.

Figure 4-53 compares the current and future TN loads to Lemon Bay. The built-out scenario loads are predicted to be consistently higher than the current loads. Clearly there are years when the 95 tons/year target is exceeded under both scenarios. This is not unexpected as year-to-year rainfall variation strongly influences the temporal variability in nitrogen loading. It was shown previously that the interannual variation in chlorophyll *a* concentrations reflects the variation in rainfall. An important observation is that while there are years when rainfall and nitrogen loads are relatively high and there is a concomitant increase in chlorophyll *a,* the bay responds (i.e., chlorophyll *a* concentrations drop) when the rainfall and nitrogen loads recede.

The average annual difference in the built-out nitrogen loads and the target is 15 tons/year if wet detention is the predominant BMP. This means that maintenance of desirable chlorophyll *a* concentrations in Lemon Bay will depend on precluding this potential 21 tons/year increase. There are two critical considerations when evaluating these estimates. First, as discussed above, this is a build-out condition that if it is to occur will be in the distant future. Second, there will be years when the target is exceeded. Examining the monitoring data collected by the County will help in understanding why an exceedance has occurred and whether the bay is trending in an unwanted manner.

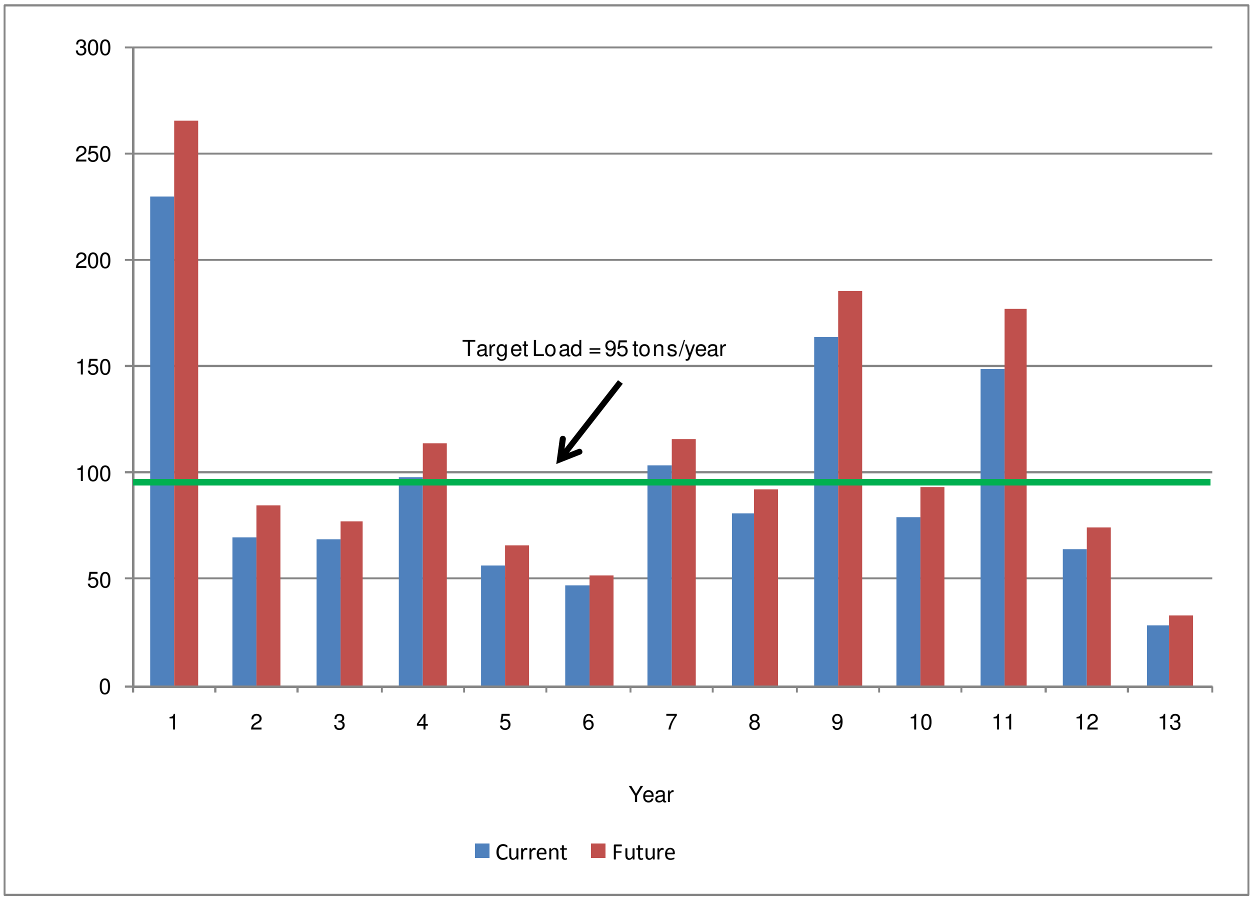

Figure 4-53 Comparison of Current and Future Annual Loads to the Target TN Load for Lemon Bay

4.5 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations regarding water quality in Lemon Bay include the following:

- Overall, water quality in Upper Lemon Bay is good as evidenced by the chlorophyll *a* concentrations, water clarity, and resulting seagrass coverage.
- While the nitrogen loads to Lemon Bay exceed the target loads when rainfall is high, the bay responds in the following year with lower chlorophyll *a* concentrations and nitrogen concentrations. Further research into the interrelationships between chlorophyll *a* concentrations and nitrogen loads to water residence times in the estuary can provide insight into the bay's responses to varying nitrogen loads.
- Comparison of the historical and current hydrologic regimes for Lemon Bay shows higher volumes under current conditions. This has apparently resulted in somewhat lower current salinities. Despite the observation that salinities were different between historical and current conditions and that those differences appeared to be largest during the summer, the current salinities in Lemon Bay

remained in the polyhaline to euhaline range with summertime median and average salinities above 25 ppt. The historical hydrologic regime is recommended as the target water budget for Lemon Bay.

4.5.1 Recommended Water Quality Improvement Programs

4.5.1.1 Septic Replacement Program

Septic systems have the potential to contribute significant pollutant loads to the primary receiving waters in the Lemon Bay watershed. The highest concentrations of septic systems in the watershed are located in the upland areas closest to Lemon Bay in the Alligator Creek, Woodmere Creek, Forked Creek, and Gottfried Creek basins.

The lots served by onsite septic systems in the Alligator Creek and Woodmere Creek basins are in the Sarasota County service area. This portion of the County is commonly referred to as South Venice. The South Venice area was originally platted in the 1950s. The area is also served by private well, encompasses approximately 3,300 acres, and is considered a medium-density residential area with approximately 8,000± lots. Approximately 85% of the lots in this area use a septic system to dispose of wastewater.

The South Venice area was included in the South County Wastewater Improvement Program (SCWIP), which evaluated whether existing wastewater treatment practices affect water quality in the project area (Roberts Bay Nort, Little Sarasota Bay, Blackburn Bay, and Upper Lemon Bay) and recommended that Sarasota County provide central sewers for those sub-areas with average acreage sizes less than 0.5 acres (Hazen and Sawyer, 2004)

The SCWIP recommendation to replace septic systems in certain areas is based on their analysis of compliance with Ordinance No. 83-83, which relates to the design, construction, installation, utilization, operation, maintenance, and repair of septics. The SCWIP found that only 24% of all developed parcels (3,052 out of 12,653) have been permitted post 1983 and thus meet current code separation requirements. SCWIP also determined that the majority of the soil types found in the project area are severely limited for use of conventional septic system drainfields due to high groundwater.

We further recommend the continuation of the Septic Replacement Program for portions of Lemon Bay based on the SCWIP evaluation and recent fecal coliform TMDLS (see Section 5.1.2.2). Fecal coliforms may pose a special health risk for infants, young children, and people with severely compromised immune systems (epa.gov). Septic systems that are not properly installed or maintained can increase fecal coliform counts in Lemon Bay and its tributaries.

The lots served by onsite septic systems in the Forked Creek, Gottfried Creek, and Lemon Bay Charlotte basins are in the Englewood Water District (EWD) service area. EWD developed a master plan to provide sanitary sewer service in 1988. As of January 2010, 82% of all EWD customers are connected to a central sewer system.

4.5.1.2 Street Sweeping Recommendations

Street sweeping is a proven, effective practice to improve water quality. The effectiveness of street sweeping and its value as a County maintenance practice is discussed in detail in Chapter 7. Projects LBWQ03, 10, and 13 highlight how street sweeping can be implemented to improve water quality. Street sweeping for water quality improvement should be evaluated further and should take into account County funding for maintenance practices, local and state jurisdictions related to streets and highways, and the implementation recommendations presented in Chapter 7, such as sweeping frequency related to season. Program recommendations are not ranked with the other project recommendations in this chapter but are further evaluated in Chapter 8.

We recommend street sweeping in three basins in the Lemon Bay Watershed—Alligator Creek, Forked Creek, and Gottfried Creek. While street sweeping in general is beneficial, these three areas have been identified as hot spots for TSS, TP, and TN in the watershed, and bi-monthly street sweeping in these basins will improve water quality, habitat, and flood control conditions by removing sediments and their associated pollutants from streets before they enter the stream systems.

A. LBWQ03 (LBS09) – AC: General Street Sweeping

The US 41 transportation corridor shows the highest TSS, TP, and TN loads in lb/ac/yr (Figure 4-54 and Table 4-6) in the watershed.

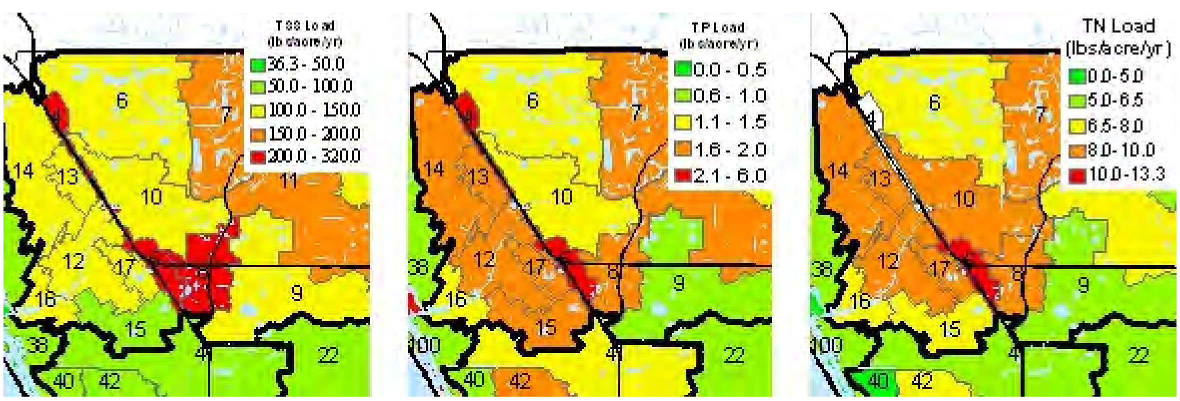

Figure 4-54 TSS, TP, and TN Loads Along US41 in the Alligator Creek Basin

B. LBWQ10 (LBS18) – FC: General Street Sweeping

Two of the subbasins in Forked Creek ranked 3 and 10 for TSS, one subbasin ranked 1 in TP, and one subbasin ranked 4 in TN lb/ac/yr in the watershed. See Table 4-6 for pollutant-load values from the SIMPLE model.

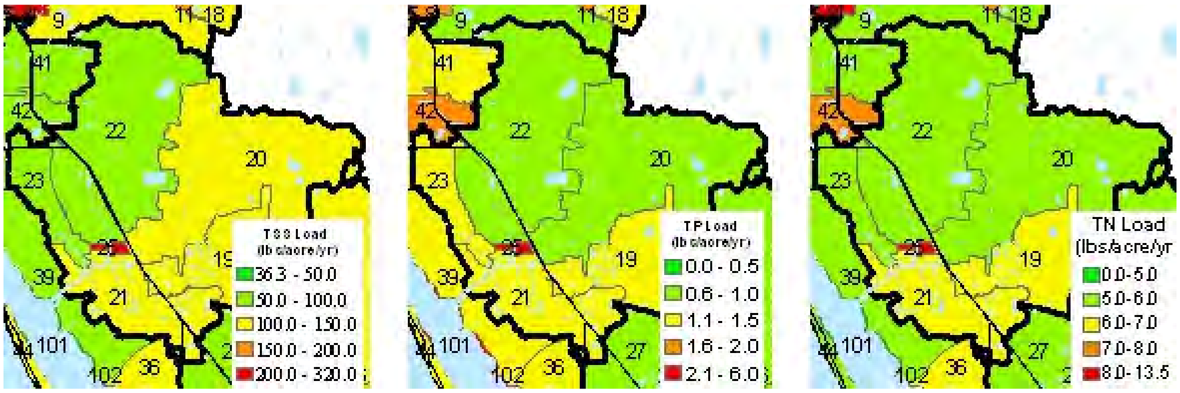

Figure 4-55 Forked Creek TSS, TP, and TN Loads

C. LBWQ13 (LBS21) – GC: General Street Sweeping

The limited space available in this traffic corridor will not readily accommodate traditional stormwater BMPs. Sand from the roadways is a large contributor to the TSS pollutant load. Metals and toxic organic chemicals from vehicle usage that are attached to sediment particles can also be removed by street sweeping. The subbasins ranked 4 and 7 (Figure 4-56 and Table 4-6) in TSS lb/ac/yr runoff in the watershed.

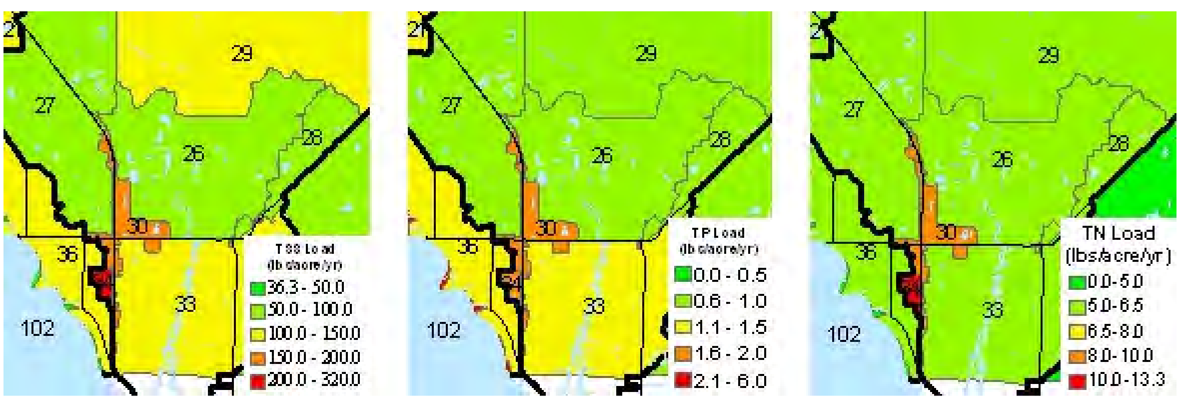

Figure 4-56 Gottfried Creek TSS, TP, and TN Loads

4.5.1.3 Recommended Water Quality Improvement Projects

A. Introduction

Jones Edmunds identified potential water quality improvement opportunities in the Lemon Bay watershed with a focus on improving the watershed's water quality functions. Five potential sites were identified by Jones Edmunds based on a GIS desktop assessment using available digital datasets. Fourteen sites were initially identified as part of the Sediment Management Plan but were reclassified to water quality projects during the analysis. Detailed information for the reclassified sites can be found in Appendix C. However, a brief summary, cost estimate, and ranking are provided in this section.

B. Methods

1. Data Compilation and Analysis

Jones Edmunds used GIS to compile and review data developed from the Pollutant Loading Model results together with aerials and other base data obtained from the Sarasota County GIS library and SWFWMD. Specifically, these datasets included the following:

- ❖ Jones Edmunds pollutant-load results (TSS,TP, and TN)
- ❖ 1948 USDA aerials
- ❖ 2007 SWFWMD aerial imagery
- ❖ Public- and Agency-owned lands
  - SWFWMD
  - Airport Authority
  - Hospital
  - School Board
  - Federal
  - State
  - City

2. Field Investigations

Jones Edmunds conducted site visits to the water quality improvement sites in October 2008 to characterize the project areas and to identify and determine potential water quality treatment options. Site investigations for the reclassified sediment projects are detailed in Appendix C.

3. Quantifying Pollutant-Load Removal

The results of the SIMPLE model were used to calculate pollutant-loading rates in pounds per acre per year by catchment area. To calculate the range of pollutant removal by BMP, the loading rates were multiplied by the contributing area to create a pounds-per-year value. The pounds-per-year values were multiplied by the minimum and maximum reported efficiencies for the BMP to give a range of potential pounds per year of pollutant removed from stormwater runoff.

4. Opinions of Probable Cost

Cost of treatment was an important evaluation criterion for each site. Once the type of treatment method was determined, Jones Edmunds calculated the cost to implement the specific type of treatment activity. Some sites were determined to benefit large acreages with minimal cost for treatment, whereas other sites would require more costly treatment methods for a small amount of water quality improvement.

5. Site Ranking

Sites with a low cost to implement and high pollutant removal estimate were ranked higher than sites with a high cost and low pollutant removal estimates. Sites were ranked 1 through 12, with 1 being the highest ranked. To develop the ranking, Jones Edmunds divided the project cost by the high and low value in the range of pollutant removal estimates for each project to get a high and low cost per pound of pollutant removal. The high and low costs per pound of removal were averaged. The average cost per pound of removal is the value that was used to rank the sites.

4.5.1.4 Recommended Projects

Five potential water quality improvement sites were identified during the initial GIS desktop assessment. Fourteen projects were identified during the Sediment Management Plan analysis. The locations of these projects are shown in Figure 4-57. Three of the sediment projects are discussed in Appendix C as general program recommendations for street sweeping some projects were combined or not recommended. As a result, 12 potential water quality improvement projects were identified and assessed within Lemon Bay watershed. The following sections describe site evaluations, proposed elements, and benefits for each project. Pollutant removal estimates, conceptual level opinion of probable costs, and ranking for each site are summarized in Tables 4-6, 4-7, and 4-8. The project names include the water quality conceptual project id (LBWQXX), the sediment project ID (LBSXX), if applicable, the basin initials (e.g. AC represents Alligator Creek), and the site name.

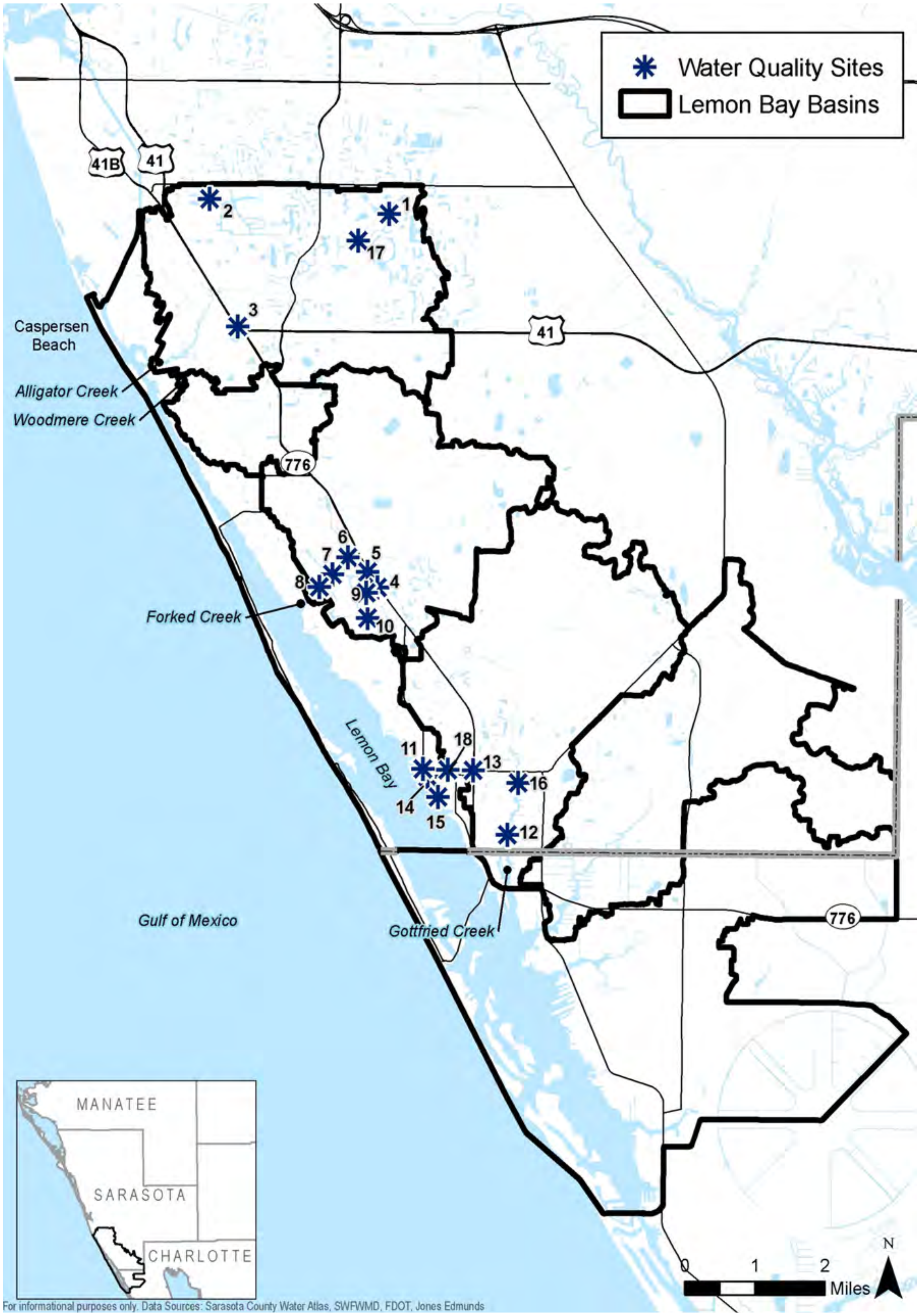

Figure 4-57 Lemon Bay Watershed Water Quality Improvement Site Locations

A. LBWQ01 – AC: Alligator Creek Stream Restoration

Figure 4-58 Alligator Creek Historical Stream Restoration Aerial Map

1. Site Evaluation

Historical aerials show the flowpath of Alligator Creek previous to 1950 was more sinuous adjacent to Venice East Blvd. Restoring the historical flow regime will reduce velocities thus encouraging nutrient uptake and settling.

2. Proposed Project Elements

❖ Re-create the historical flowpath of Alligator Creek by installing strategic blocks to reroute water employing low-impact construction techniques involving minimal earthwork and clearing.

3. Project Benefits

A sinuous channel will reduce flow velocities through the system, thus providing a higher level of riparian treatment.

Figure 4-59 1944: Natural Creek and Floodplain

Figure 4-60 1948: Ditching for Agriculture

Figure 4-61 Existing Creek Rerouted Through Pipes, Stormwater Ponds, Drop Structures, and Ditches

Figure 4-62 Comparison of Alligator Creek 1944, 1948, Existing

B. LBWQ02 (combined with LBS04) – AC: Lake Magnolia and Banyan Drive

Figure 4-63 Lake Magnolia and Banyan Drive Aerial Map

1. Site Evaluation

The Banyan Drive stormwater pond discharges to Lake Shamrock/Lake Magnolia, which is currently being evaluated by Sarasota County for water quality improvements. The pond currently provides limited treatment for an approximately 40-acre drainage area. A geotechnical evaluation of the site will determine if a biofiltration, bioretention, or linear wet pond would be most appropriate. The site for the sediment removal box is the discharge to the lake for a 30-acre basin.

2. Proposed Project Elements

- Construct a bioretention system.
- Add an additional control structure to discharge into the lake system.

3. Project Benefits

The bioretention system will provide a higher level of treatment to a drainage area of approximately 40 acres and improve the water quality of the discharge to the impaired lake system.

C. LBWQ04 - FC: Waterford Drive

Figure 4-64 Waterford Drive Aerial Map

1. Site Evaluation

A 1700-ft channel discharges to a Forked Creek tributary through a 15-inch culvert at this location. The channel segment carries runoff from approximately 30 acres of a medium-density residential area. The swale is the only water quality treatment BMP.

2. Proposed Project Elements

- ❖ Replace drainage swale with a biofiltration system.
- ❖ Install a control structure at the outfall.

3. Project Benefits

The benefits of biofiltration include decreased surface runoff, increased groundwater recharge, and increased pollutant removal through a variety of processes.

D. LBWQ05 – FC: Lemon Bay Plaza

Figure 4-65 Lemon Bay Plaza Aerial Map

1. Site Evaluation

Approximately 10 acres of impervious area including rooftops, parking lots, and truck loading areas from Lemon Bay Plaza drains to a Ditch Bottom Inlet (DBI) system at the north end of the site. The system discharges directly to Forked Creek.

2. Proposed Project Elements

- ❖ Replace DBI system with a biofiltration system.

3. Project Benefits

The benefits of biofiltration include decreased surface runoff, increased groundwater recharge, and increased pollutant removal through a variety of processes.

E. LBWQ06 (LBS13) – FC: Overbrook Drive

Figure 4-66 Overbrook Drive Aerial Map

1. Site Evaluation

The bridge west of Forked Creek Drive on Overbrook Road was replaced in 2008. Accumulated sediment south of the bridge is visible in 2007 aerial photographs. Stormwater runoff flows directly to the channel through a driveway culvert/roadside swale system. Overbrook Road is in good repair, but several of the local neighborhood roads are pitted and graveled with accumulated sediment on the pavement and at the edge of the pavement.

2. Proposed Project Elements

- ❖ Construct a stormwater treatment pond.

❖ Build supporting infrastructure.

3. Project Benefits

The retention pond will capture roadway runoff and reduce the sediment and pollutant loads reaching the canal system.

F. LBWQ07 (LBS14) – FC: Fairview Drive

Figure 4-67 Fairview Drive Aerial Map

1. Site Evaluation:

Fairview Drive ends in a small roundabout less than 40 feet from Forked Creek. Residential properties line the street and the small area between the roundabout, and the creek provides a local-scale opportunity for stormwater treatment.

2. Proposed Project Elements

- Add a stormwater pond at the end of the roadway to provide treatment to stormwater runoff.
- Add bioretention swales for treatment.

3. Project Benefits

The contributing area is 1.2 acres and a stormwater pond would retain and provide treatment for local roadway runoff in this neighborhood.

G. LBWQ08 (LBS15) – FC: Bridge Street

Figure 4-68 Bridge Street Aerial Map

1. Site Evaluation

Bridge Street ends less than 100 feet from Forked Creek. The flow travels down the slope of the roadway directly to the creek.

2. Proposed Project Elements

- ❖ Construct a dry stormwater pond at the end of the roadway to provide stormwater runoff treatment.
- ❖ Add mangroves and riprap to the shoreline to provide additional stability.

3. Project Benefits

Within the 100 feet that is currently overland flow, a small stormwater pond would retain the roadway runoff from small rain events, reducing the amount of pollutants being carried directly to the creek.

H. LBWQ12 (LBS20) – GC: Cortes Drive

Figure 4-69 Cortes Drive Aerial Map

1. Site Evaluation

This site is located at the end of Cortes Drive off of South Oxford Drive. A drop inlet with a pipe discharging directly to the tidally-influenced creek is located between the end of the cul-de-sac and the mangroves. The roadway is in poor condition with accumulated sediment and gravel on the surface and along the edge of pavement. Much of the sediment on the roadway is crumbling roadway material.

2. Proposed Project Elements

- ❖ Add a stormwater pond at the end of the roadway to provide treatment to stormwater runoff.
- ❖ Add bioretention swales to provide attenuation and treatment.
- ❖ Replace damaged discharge structure.

3. Project Benefits

A stormwater pond will capture roadway runoff and reduce pollutants from reaching the canal system.

I. LBWQ14 (LBS23) – LBC: Cherokee Drive

Figure 4-70 Cherokee Drive Aerial Map

1. Site Evaluation

Stormwater runoff from the sloped roadway flows directly to Lemon Bay at this location. Swales with driveway culverts are located on both sides of the road and discharge directly to the bay as well.

2. Proposed Project Elements

- ❖ Construct a stormwater pond.
- ❖ Add riprap and erosion control along the shoreline.
- ❖ Regrade roadside swales.

3. Project Benefits

The small stormwater pond will capture roadway runoff and reduce pollutants reaching the canal system.

J. LBWQ15 (LBS24) – LBC: Magnolia Avenue

Figure 4-71 LBC: Magnolia Avenue

1. Site Evaluation

A large wetland, located to the east of Magnolia Avenue, provides some treatment for stormwater runoff.

2. Proposed Project Elements

- ❖ Treat limestone on West Palm Grove Avenue.
- ❖ Construct a stormwater pond.
- ❖ Create a bioswale on the east side of Magnolia Avenue for additional treatment of stormwater runoff.

3. Project Benefits

The small stormwater pond will capture roadway runoff and reduce pollutants from reaching the canal system. Bioswales serve to remove sediment and nutrients in runoff by slowing overland flow.

K. LBWQ16 (LBS19) – GC: Court Street-Langsner Street

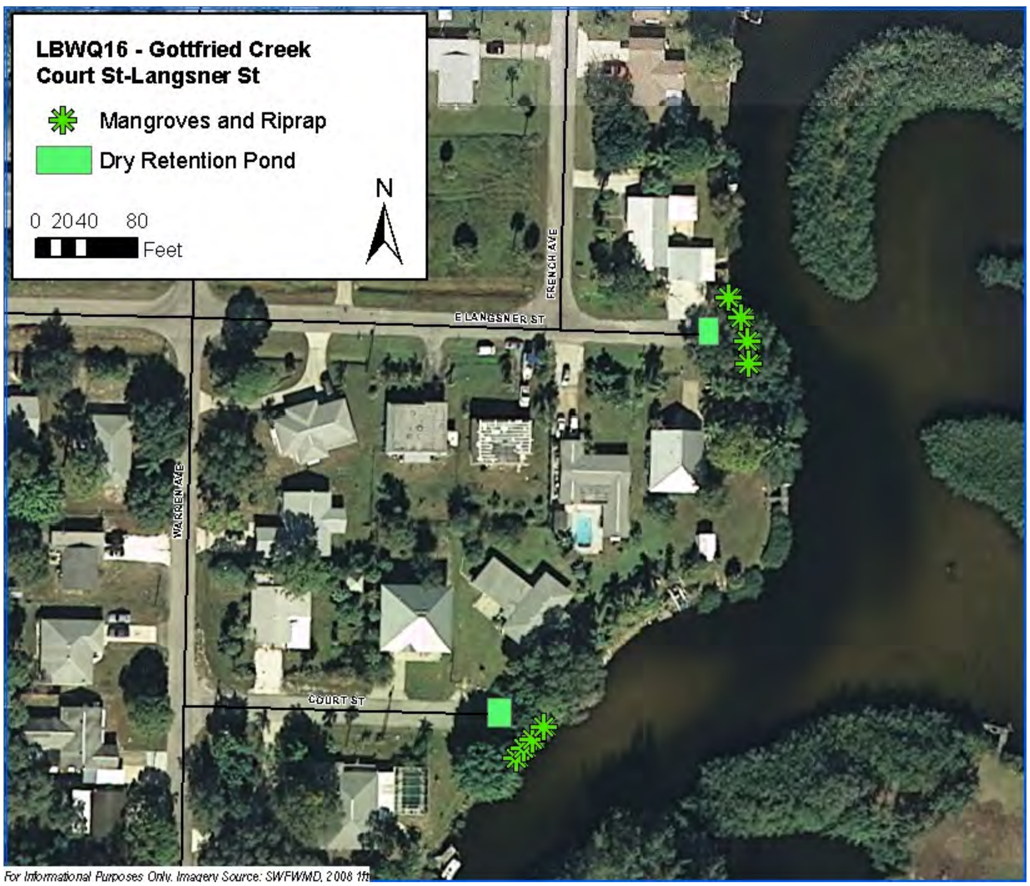

Figure 4-72 Court Street-Langsner Street Aerial Map

1. Site Evaluation

Court and Langsner Streets are roadways that end within 100 feet of Gottfried Creek. The roadways are in poor repair and have excess gravel and fine sediment accumulated on the surface. The roadways are sloped to direct stormwater runoff directly to the creek without treatment.

2. Proposed Project Elements

- ❖ Add dry retention ponds at the end of the roadway to provide treatment.

- ❖ Add mangroves and riprap to the shoreline to provide additional stability.

3. *Project Benefits*

The small dry pond will capture roadway runoff and reduce pollutants from reaching the canal system. Mangroves will provide additional bank stabilization.

L. LBWQ17 (LBS25) – AC: Venice Boulevard Low Impact Development (LID)
This project was evaluated and designed by others.

1. *Site Evaluation*

Venice East Blvd is between Center Road and US 41 and is surrounded by medium-density residential on the north end, commercial development on the south end, and Alligator Creek in the center. The location for the demonstration project was chosen because of the diversity of the terrain and proximity to the creek. The proposed project intends to demonstrate the effectiveness of bioretention areas.

2. *Proposed Project Elements*

- ❖ Plant a wide vegetative palette.
- ❖ Develop soil amendments.

3. *Project Benefits*

The proposed project intends to demonstrate the effectiveness of bioretention areas and will demonstrate techniques which can be used to retrofit existing neighborhood streets that currently have no stormwater treatment.

M. LBWQ18 (LBS26) LBC: Dearborn Street

This project was evaluated and designed by others.

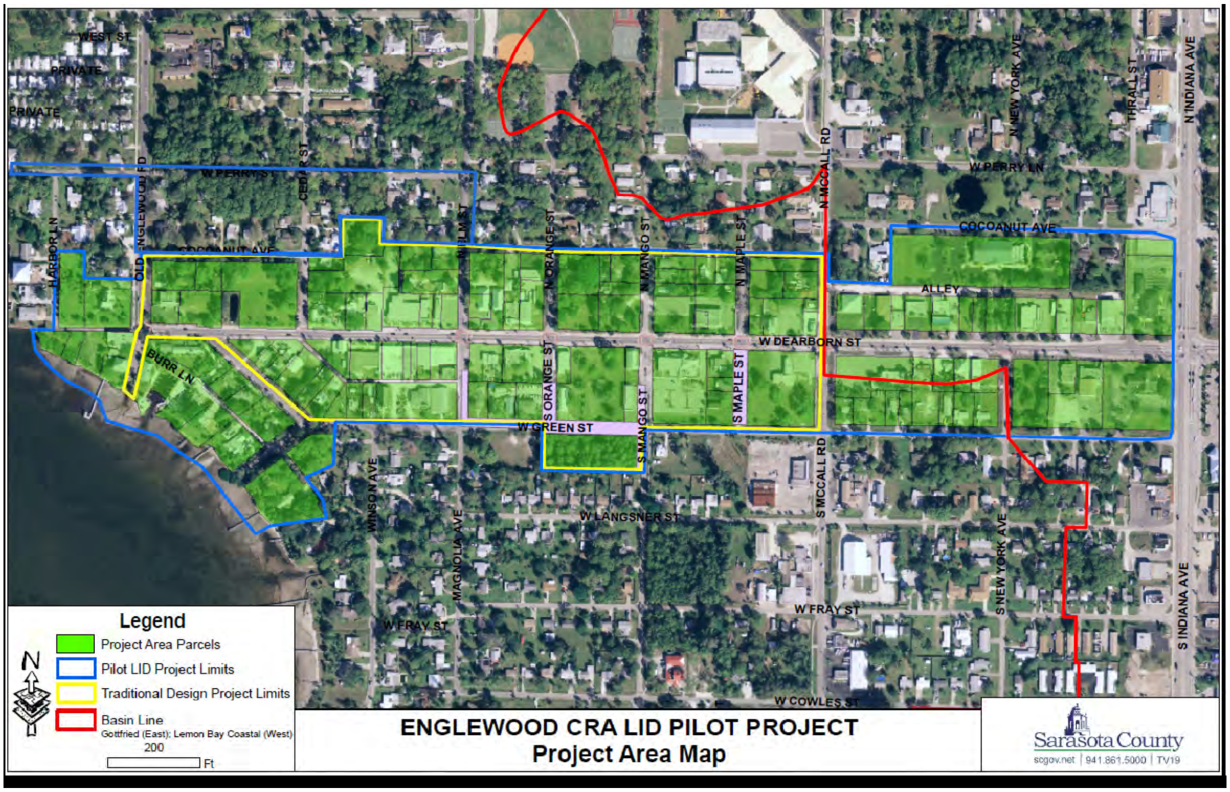

Figure 4-73 Dearborn Street Aerial Map

1. *Site Evaluation*

This area is designated as the *Englewood Community Redevelopment Area* and includes the area parallel to West Dearborn Street from CR 776 west to Lemon Bay bound by Cocoanut Avenue on the north and Green Street on the south. Stormwater runoff receives minimal treatment before discharging to Lemon Bay. As part of the redevelopment, the County is moving forward with the Dearborn Street Low-Impact-Development Pilot Project to provide stormwater treatment from this area within the right-of-way and County-owned parcels. The project encompasses approximately 50 acres.

2. *Proposed Project Elements*

- ❖ Replace existing ditch system with bioretention areas.
- ❖ Add vegetated swales, engineered soils, and perforated pipe all surrounded by an impermeable liner.
- ❖ Provide for cistern use, stormwater harvesting, and pervious pavement.

3. *Project Benefits*

The proposed project intent is to capture the runoff as close to the source as possible in bioretention areas. The bioretention areas will capture roadway runoff and reduce pollutants from reaching the bay.

4.5.1.5 Results and Discussion

A. Pollutant-Load Removal Estimates

Jones Edmunds reviewed the spatial results of the SIMPLE mode to determine hot spots for TN, TP, and TSS in the watershed. The hot spots were part of the GIS desktop analysis used to identify potential projects. Table 4-6 summarizes the average annual loading in each subbasin. Figures 4-74, 4-75, and 4-76 show the conceptual project sites in relation to the spatial results of the average annual loads by subbasin for TN, TP, and TSS.

The results of the SIMPLE model were used to calculate normalized pounds per acre per year value by catchment area. To calculate the range of pollutant removal by BMP, the normalized results by catchment from the SIMPLE model were multiplied by the contributing area to create a pounds-per-year value. The pounds-per-year values were multiplied by the minimum and maximum reported efficiencies for the BMP to give a range of potential pounds per year of pollutant removed from stormwater runoff. Table 4-6 shows the estimated range of pounds per year of pollutant removed by the proposed BMP.

Table 4-6 Annual Average Pollutant Loads (lb/ac/yr) and Rank									
Subbasin ID	Basin Name	ICPR Group	Area (ac)	TSS (lb/ac/yr)	TSS Rank	TP (lb/ac/yr)	TP Rank	TN (lb/ac/yr)	TN Rank
1	AINGER CREEK	AIC-EAST	1548.33	42.19	39	0.43	39	4.78	36
2	AINGER CREEK	AIC-NRTH	1958.70	44.33	38	0.44	38	4.41	38
3	AINGER CREEK	AIC-STH	2052.44	52.58	36	0.62	37	3.92	39
4	ALLIGATOR CREEK	AC-41NW	73.18	319.98	1	2.24	2	13.34	1
5	ALLIGATOR CREEK	AC-41SE	113.51	277.32	2	2.20	3	12.22	2
6	ALLIGATOR CREEK	AC-BRIAR	815.10	102.96	23	1.44	16	7.18	17
7	ALLIGATOR CREEK	AC-JAC	721.57	162.03	8	1.72	8	8.24	12
8	ALLIGATOR CREEK	AC-LAT1	243.22	228.95	5	1.54	13	9.19	5
9	ALLIGATOR CREEK	AC-LAT2	799.60	105.68	21	0.87	29	5.32	31
10	ALLIGATOR CREEK	AC-LOW	457.47	128.81	14	1.38	17	8.29	11
11	ALLIGATOR CREEK	AC-MID	948.17	198.82	6	1.73	7	7.82	14
12	ALLIGATOR CREEK	AC-SVMD	323.12	134.66	11	1.59	11	8.37	10
13	ALLIGATOR CREEK	AC-SVNE	101.81	127.60	15	1.85	5	9.11	6
14	ALLIGATOR CREEK	AC-SVNW	446.02	114.39	17	1.72	9	8.44	9
15	ALLIGATOR CREEK	AC-SVSE	235.42	96.77	25	1.58	12	8.00	13
16	ALLIGATOR CREEK	AC-SVSW	138.56	130.08	13	1.46	15	7.61	15
17	ALLIGATOR CREEK	AC-TRPN	88.53	142.18	9	1.78	6	8.85	8
18	ALLIGATOR CREEK	AC-UP	1293.83	118.10	16	1.13	22	5.32	30
19	FORKED CREEK	FC-BOCA	719.31	130.14	12	1.19	19	6.10	20
20	FORKED CREEK	FC-EAST	1952.02	101.54	24	0.82	31	5.59	26
21	FORKED CREEK	FC-LOWER	813.19	140.45	10	1.35	18	6.34	18
22	FORKED CREEK	FC-MID	1966.30	92.27	28	0.81	32	5.28	33
23	FORKED CREEK	FC-WEST	382.66	90.89	29	1.08	23	5.95	21
25	FORKED CREEK	LBP-FC	29.12	262.44	3	2.46	1	10.11	4
26	GOTTFRIED CREEK	GC-MID	942.70	71.19	35	0.86	30	5.29	32
27	GOTTFRIED CREEK	GC-NOLAT	1007.38	87.79	32	0.99	27	5.65	24
28	GOTTFRIED CREEK	GC-RIVER	213.49	88.70	30	0.70	36	5.51	28
29	GOTTFRIED CREEK	GC-UPPER	3758.43	109.70	19	0.81	33	5.25	34
30	GOTTFRIED CREEK	GC-776	148.63	182.90	7	1.54	14	8.87	7
33	GOTTFRIED CREEK	GC-LOWER	941.71	109.83	18	1.00	26	5.48	29
34	GOTTFRIED CREEK	GC-LOWER	25.80	247.30	4	1.86	4	10.56	3
36	LEMON BAY COASTAL	LBC-LOWER	886.92	109.15	20	1.14	21	6.28	19
38	LEMON BAY COASTAL	LBC-UPPER	895.18	95.54	26	0.96	28	5.64	25
39	LEMON BAY COASTAL	LBC-MID	977.88	71.73	34	1.02	25	5.56	27
40	WOODMERE CREEK	LBP-WC	220.86	50.86	37	0.72	35	4.85	35
41	WOODMERE CREEK	WC-NORTH	696.78	88.13	31	1.16	20	5.93	22
42	WOODMERE CREEK	WC-SOUTH	557.05	94.50	27	1.65	10	7.37	16
43	LEMON BAY COASTAL	LBC-LOWER	219.60	71.96	33	0.79	34	4.73	37
44	LEMON BAY COASTAL	LBC-MID	278.78	104.77	22	1.04	24	5.78	23

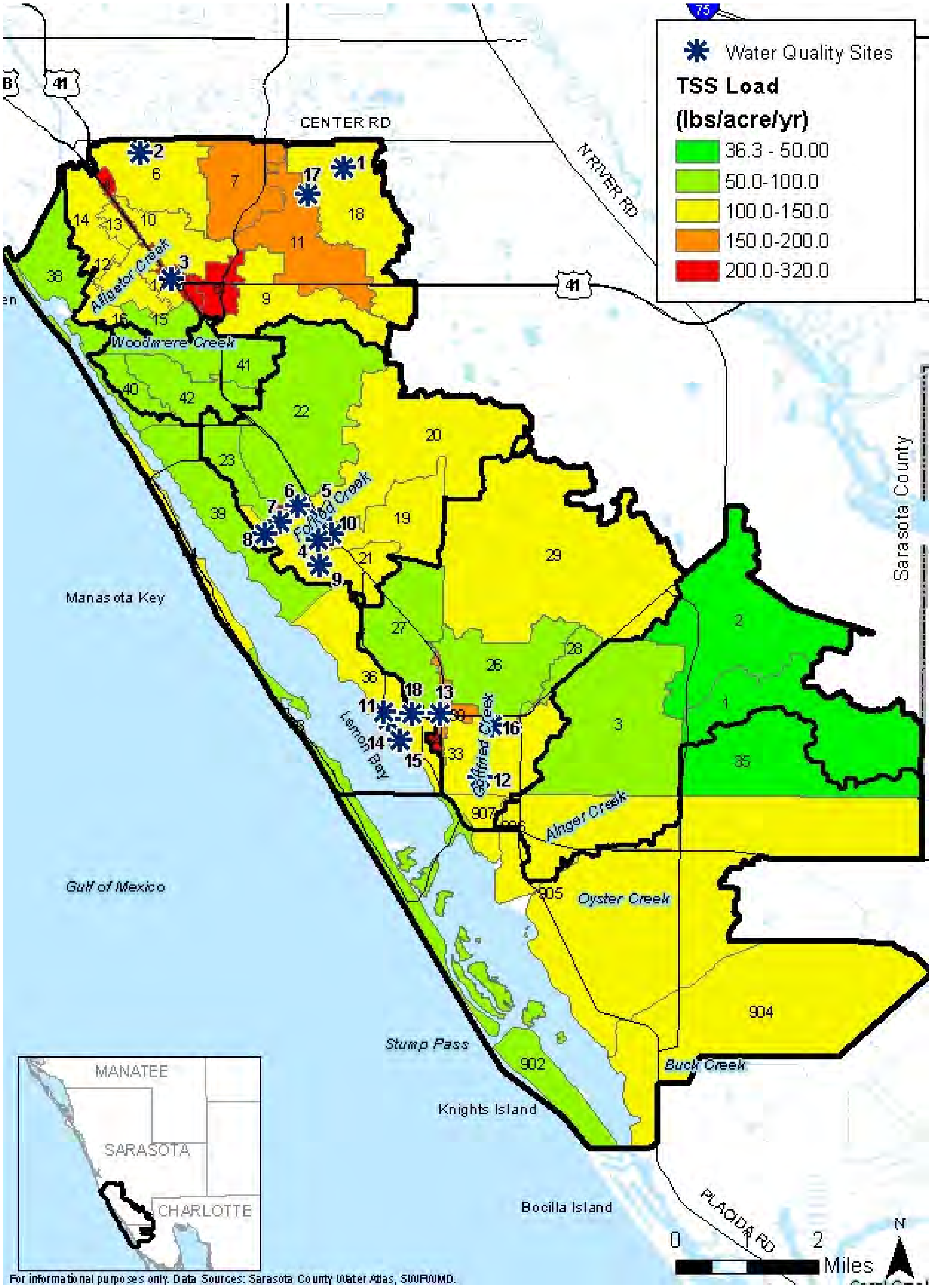

Figure 4-74 Lemon Bay Watershed Water Quality Conceptual Site Locations Overlaid on the Average Annual TSS Load per Unit Area Results

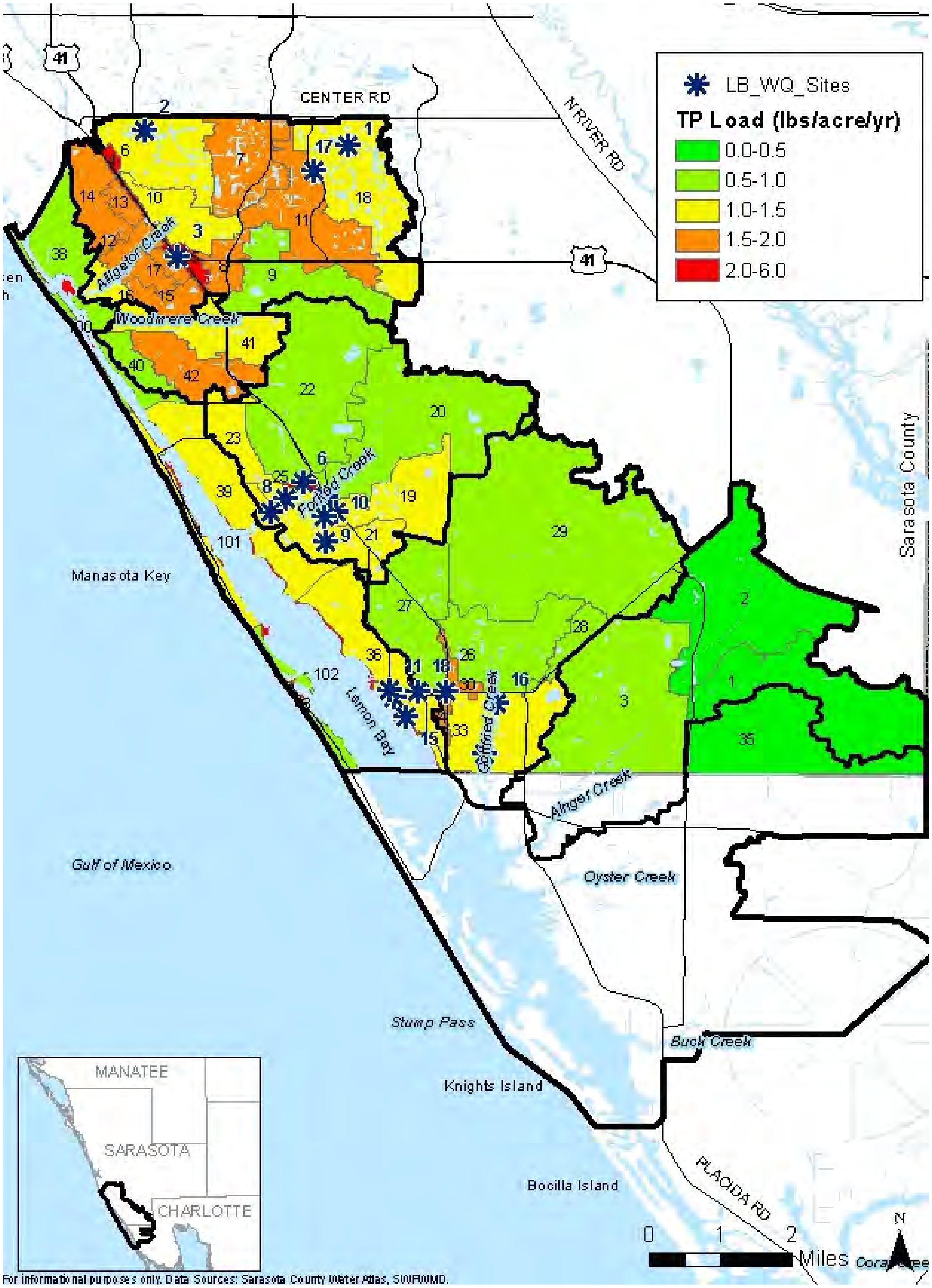

Figure 4-75 Lemon Bay Watershed Water Quality Conceptual Site locations Overlaid on the Average Annual TP Load per Unit Area Results

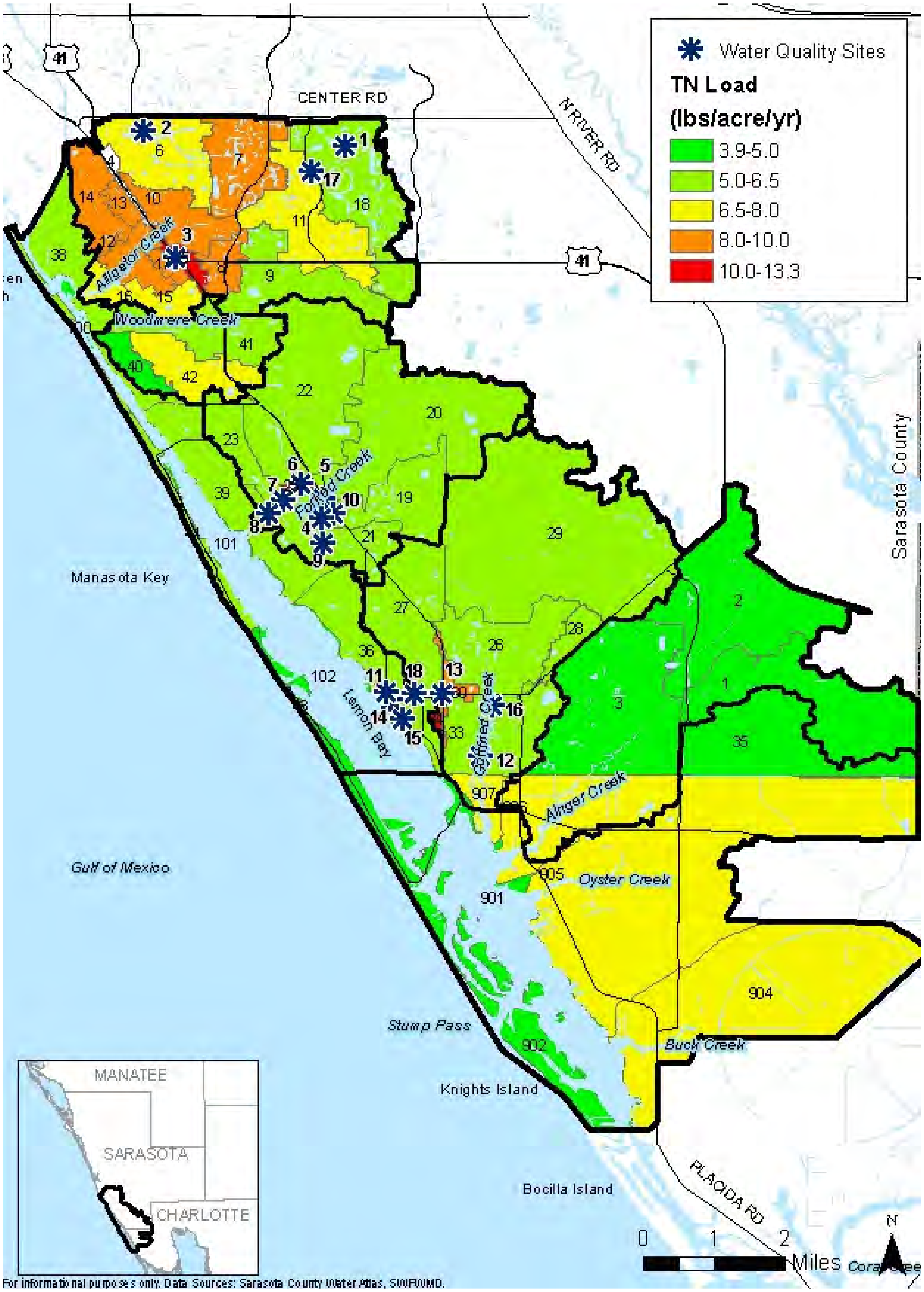

Figure 4-76 Lemon Bay Watershed Water Quality Conceptual Site Locations Overlaid on the Average Annual TN Load per Unit Area Results

Table 4-7 Estimated Pollutant-Load Removal by Proposed BMP							
Project ID	Basin	Project Name	BMP Type	Estimated Drainage Area	Estimated Pollutant Removal (lb/yr) (rounded)		
					Total Suspended Solids	Total Phosphorus	Total Nitrogen
LBWQ01	Alligator Creek	Stream Restoration	Sinuous Channel	50.0	600 - 6900	0 - 5	50 - 210
		Total			600 - 6900	0 - 5	50 - 210
LBWQ02	Alligator Creek	Lake Magnolia & Banyan Dr	Bioretention System	40.0	800 - 3300	0 - 5	110 - 170
(LBS04)			Sediment Removal Structure	30.0	1200 - 2300	0 - 5	30 - 60
		Total			2000 - 5600	0 - 5	145 - 230
LBWQ03	Alligator Creek	General	Street Sweeping	190.0	15700 - 31000	50 - 100	500 - 1100
(LBS09)		Total			15700 - 31000	50 - 100	500 - 1100
LBWQ04	Forked Creek	Waterford Dr	Biofiltration System	30.0	2500 - 4100	0 - 0	100 - 150
		Total			2500 - 4100	0 - 0	100 - 150
LBWQ05	Forked Creek	Lemon Bay Plaza	Biofiltration System	10.0	800 - 1300	0 - 0	0 - 50
		Total			800 - 1300	0 - 0	0 - 50
LBWQ06	Forked Creek	Overbrook Dr	Stormwater Treatment Pond	10.0	1400 - 2500	5 - 20	0 - 70
(LBS13)		Total			1400 - 2500	5 - 20	0 - 70
LBWQ07	Forked Creek	Fariview Dr	Dry Retention Pond	1.2	100 - 200	0 - 10	0 - 10
(LBS14)		Total			100 - 200	0 - 10	0 - 10
LBWQ08	Forked Creek	Bridge St	Dry Retention Pond	1.0	100 - 100	0 - 5	0 - 10
(LBS15)		Total			100 - 100	0 - 5	0 - 10
LBWQ10	Forked Creek	General	Street Sweeping	25.0	1000 - 1900	0 - 10	35 - 80
(LBS18)		Total			1000 - 1900	0 - 10	35 - 80
LBWQ12	Gottfried Creek	Cortes Dr	Dry Retention Pond	2.5	200 - 300	0 - 5	10 - 15
(LBS20)			Bioswale	2.5	100 - 200	0 - 5	5 - 10
		Total			300 - 500	0 - 5	15 - 25
LBWQ13	Gottfried Creek	General	Street Sweeping	56.0	3100 - 6000	10 - 20	110 - 250
(LBS21)		Total			3100 - 6000	10 - 20	110 - 250
LBWQ14	LB Coastal	Cherokee St-Dearborne St	Dry Retention Pond	0.5	0 - 100	0 - 5	0 - 5
(LBS23)		Total			0 - 100	0 - 5	0 - 5
LBWQ15	LB Coastal	Magnolia Ave	Dry Retention Pond	0.7	100 - 100	0 - 5	0 - 5
(LBS24)			Bioswale	5.0	100 - 400	0 - 5	10 - 20
			Limestone Treatment	0.7	10 - 40	0	0
		Total			200 - 600	0 - 5	15 - 25
LBWQ16	Gottfried Creek	Court St-Langsner St	Dry Retention Pond	3.5	300 - 400	0 - 3	15 - 20
(LBS19)		Total			300 - 400	2 - 3	15 - 20

B. Conceptual Level Cost Estimates

Table 4-8 Conceptual Level Estimates of Probable Cost

Project ID	Description	Total Project Cost+	Construction Cost	Engineering Design Services*	Annual Maintenance Cost
LBWQ01	AC: Alligator Creek-Venice Blvd	$142,000	$109,000	$33,000	$0
LBWQ02	AC: Lake Magnolia and Banyan Dr	$771,000	$628,000	$143,000	$4,700
LBWQ04	FC: Waterford Dr	$468,000	$381,000	$87,000	$1,500
LBWQ05	FC: Lemon Bay Plaza	$430,000	$350,000	$80,000	$1,500
LBWQ06	FC: Overbrook Dr	$334,000	$272,000	$62,000	$0
LBWQ07	FC: Fairview Dr	$44,000	$17,000	$27,000	$2,500
LBWQ08	FC: Bridge St	$69,000	$41,000	$28,100	$1,500
LBWQ12	GC: Cortes Dr	$43,000	$16,000	$27,000	$2,500
LBWQ14	LBC: Cherokee Dr	$73,000	$45,000	$28,000	$1,000
LBWQ15	LBC: Magnolia Ave	$56,000	$29,000	$27,000	$2,500
LBWQ16	GC: Court St-Langsner St	$62,000	$34,000	$28,000	$1,000

+ Total Project Cost includes Mobilization and Contingency costs along with Construction Costs and Engineering Design Services

* Design Services include Survey, Geotechnical Investigation, Engineering Design, and Permitting

C. Ranking of Potential Projects

Table 4-9 Ranking of Potential Projects

Project ID		Location	Pollutant Removal Estimate (lb/yr) TSS		TP		TN		Total		Total Project Cost	Cost per lb/yr Range		Average $/lb	Rank
LBWQ12	LBS20	GC: Cortes Dr	300	500	0	5	15	25	315	530	$43,000	$135	$81	$109	1
LBWQ01		AC: Alligator Creek Stream Restoration	600	6,900	0	5	50	210	650	7,115	$142,000	$219	$20	$119	2
LBWQ04	LBS04 *	FC: Waterford Dr	2,500	4,100	0	0	100	150	2,600	4,252	$468,000	$180	$110	$145	3
LBWQ16	LBS19	GC: Court St-Langsner St	300	400	0	5	15	20	315	425	$62,000	$198	$147	$171	4
LBWQ15	LBS24	LBC: Magnolia Ave	200	600	0	5	15	25	215	630	$56,000	$261	$89	$175	5
LBWQ06	LBS13	FC: Overbrook Dr	1,400	2,500	5	20	0	70	1,405	2,590	$334,000	$238	$129	$183	6
LBWQ02		AC: Lake Magnolia and Banyan Drive	2,000	5,600	0	5	145	230	2,145	5,835	$771,000	$359	$132	$246	7
LBWQ07	LBS14	FC: Fairview Dr	100	200	0	10	0	10	100	220	$44,000	$442	$201	$320	8
LBWQ05		FC: Lemon Bay Plaza	800	1,300	0	0	0	50	800	1,349	$430,000	$538	$319	$428	9
LBWQ08	LBS15	FC: Bridge St	100	100	0	5	0	10	100	115	$69,000	$719	$625	$645	10
LBWQ14	LBS23	LBC: Cherokee Dr	0	100	0	5	0	5	1	110	$73,000	$73,000	$664	$36,832	11

Chapter 5

Water Supply

August 2010

Sarasota County

Southwest Florida Water Management District

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5.0 WATER SUPPLY

5.1 INTRODUCTION

Developing a sustainable water supply is a goal of Sarasota County and is addressed as an element of this Watershed Management Plan (WMP). The sustainable water supply component of the WMP focuses on stormwater-derived alternative water supplies since potable and reclaimed sources are covered under the County's Comprehensive Plan and water and wastewater master plans. These alternative supplies focus on offsetting the use of potable water for irrigation.

A general finding from Chapter 3 is that a significant amount of stormwater in the watershed could be beneficially used while maintaining flows to the Bay and creek system. The task involved identifying opportunities and developing conceptual water supply plans for excess stormwater runoff. These plans provide a foundation for developing stormwater-harvesting projects that will help the County meet their sustainable water supply goals.

Harvesting stormwater runoff provides a source for an alternative water supply while maintaining flows to Lemon Bay and the creek system.

The County and the Southwest Florida Water Management District (SWFWMD) work in conjunction to develop alternative water supply projects and options to meet the demands within the local government's jurisdiction. The process is consistent with Subsection 373,061(7) (a) FS as outlined in the 2010 *Draft SWFWMD Regional Water Supply Plan (RWSP)* Executive Summary states "within 6 months following approval of an RWSP, the District is to notify each local government covered by the RWSP. Within 1 year after the notification, each local government is required to provide to the District notification of the alternative water supply projects or options which it has developed or intends to develop; an estimate of the quantity of water to be produced by each project; and the status of project implementation, including development of the financial plan. The information provided in the notification is updated annually and a progress report is provided to the District." The report continues, "Section 163.3177(6) (c) F.S. also indicates, within 18 months after Governing Board approval of a RWSP, local governments in the Planning Region must update their comprehensive plans incorporating a work plan detailing alternative and traditional water supply projects, including conservation and reuse, necessary to meet the demand within the local government's jurisdiction, covering at least a 10-year planning period."

Jones Edmunds reviewed the County Comprehensive Plan, both master plans, and SWFWMD's RWSP to understand how the alternative water supplies analyzed in the WMP may best fit into the County and regional plans. No projects in the RWSP are specific to the Lemon Bay watershed. However, some of the pertinent excerpts from those plans are included in this chapter to help illustrate how the projects and programs discussed here fit within larger planning efforts. The following are guiding principles developed for SWFWMD's RWSP from 2001 to 2006:

- *An emphasis on conservation*: Conservation is treated as a potential source of water for all major use types (e.g., agriculture, public supply, industrial, etc.).

- *An emphasis on reclaimed water:* Reclaimed water is a major source type that has been investigated to meet future demands. This includes evaluation of new reclaimed water projects and an investigation into how existing reclaimed water projects can be made more efficient.

- *The role of constraints such as minimum flows and levels*: Potential water supply options included in this RWSP have been identified and screened using a number of criteria. Before these or any other future water supply options are implemented, projects must meet the conditions of a new water use permit from SWFWMD.

- *Avoiding the need for mitigation of new withdrawal impacts*: All the water supply development options contained in the RWSP are designed to minimize the need for future mitigation. A number of the projects are intended to help offset impacts of existing projects.

- *Realistic demand projections*: SWFWMD used the best available information in the development of estimated future water demands within the Planning Region. This information included significant input from all major use sectors and other experts in the field.

- *Existing state policy on "Local Sources First":* SWFWMD's RWSP seeks to maximize local sources consistent with existing State policies and SWFWMD rules. According to the RWSP, sources located within the Planning Region are sufficient to meet all projected reasonable and beneficial demands through the planning period. Therefore, sources outside the Planning Region were not investigated.

- *Changes in water resources legislation.* Senate Bill 444, passed during the 2005 legislative session, substantially strengthens requirements directed at identifying and listing water supply projects. Changes made by the legislation are intended to foster better communication among water planners, city planners, and local utilities. Local governments are now able to develop their own water supply assessments and the Water Management Districts are required to consider them when developing their RWSPs. Local governments are directed to incorporate alternative water supply projects that they choose from the RWSP into the capital improvement elements of their comprehensive plans. The Water Management Districts are required to develop the RWSP in coordination with local water supply authorities. An additional provision of the bill was the creation of the Water Protection and Sustainability Program, a trust fund that provides state matching funds to water management districts and local governments or private entities for the construction phase of alternative water supply projects.

❖ *Expanding agricultural conservation programs*. By 2025, SWFWMD intends to work with the agricultural industry to reduce water use in the Southern Water Use Caution Area (SWUCA) by 40 MGD through agricultural water conservation measures. The Florida Department of Agriculture and Consumer Services (FDACS) and SWFWMD have developed the Facilitating Agricultural Resource Management Systems (FARMS) program. FARMS is an agricultural best management practices (BMPs) cost-share reimbursement program that involves both water quantity and quality aspects. FARMS is intended to expedite implementation of production-scale agricultural BMPs that will help agriculturalists reduce groundwater use from the Upper Floridan aquifer, improve water quality, and restore and augment the area’s water reach this ambitious goal. The SWFWMD is also continuing to fund agricultural research projects. Since 1979, the SWFWMD has funded nearly 150 projects that help growers conserve water.

❖ *Water supply planning efforts by coalitions of local governments*. Water supply planning efforts have been undertaken by alliances of local governments and water supply authorities. In addition to developing new water supply options, these entities took the planning level information in the 2001 RWSP and over the next 5 years refined it to provide more detailed information on the cost and feasibility for the water supply options in their local areas of interest. The 2006 RWSP has been structured to incorporate much of the detailed information developed from these planning efforts. SWFWMD has coordinated closely with these efforts and in some cases has provided funding.

❖ *Assisting the recovery of groundwater resources through conjunctive use*. Public water supply systems that are capable of conjunctive use have access to both groundwater and alternative sources such as surface water or desalinated seawater. In areas where the recovery of groundwater levels is necessary, it is important to have the ability to reduce groundwater withdrawals when possible. Maximizing the use of alternative sources when available can achieve reductions while ensuring demands are met. For example, water suppliers with access to both groundwater and surface water can maximize the use of surface water during periods of high flows, which enables reductions in groundwater use. Additionally, the development of off-stream reservoirs and aquifer storage and recovery (ASR) for storage helps sustain yields of surface water sources well beyond high rainfall periods, which allows for further reductions in groundwater use. Through the optimized use of all available sources, it may be possible to accelerate the process of achieving the desired rate of groundwater level recovery. SWFWMD will be working with water utilities and water supply authorities to explore the feasibility of implementing a conjunctive use approach to managing their water supplies.

- *Meeting future demand through land-use transitions*. In the SWUCA, land uses such as agriculture and mining are being displaced by residential and commercial land uses. Water needs of expanding residential and commercial land uses will likely be met in many areas by alternative supplies, such as the harvesting and storing the wet season flow of rivers, reclaimed water, and conservation. Because the land uses being replaced rely almost entirely on groundwater, there will be a net reduction in groundwater use. A portion of this groundwater will be retired to help meet the minimum aquifer level aimed at minimizing salt-water intrusion. The remainder can be used to meet the demands of residential and commercial development in areas where access to alternative supplies is limited.

- *Advances in the SWFWMD's scientific understanding of the resource; the Atlantic Multidecadal Oscillation*. Based on an emerging body of research, SWFWMD scientists have recently recognized that the region experiences prolonged wet and dry cycles that last an average of approximately 30 years. These cycles, known as the Atlantic Multidecadal Oscillation (AMO), are caused by multidecadal periods of warming and cooling of the North Atlantic Ocean's surface waters. Periods of warmer ocean temperature generally result in increases in rainfall over peninsular Florida. AMO has profound implications for SWFWMD's water supply planning efforts. For example, harvesting and storing the wet-season flow of rivers is the alternative source with the greatest potential to meet future water supply needs. Since river flows are largely rainfall dependent, the 30-year rainfall cycles result in significant variations in river flows. The region is currently in the wet portion of the AMO cycle and river flows during the wet seasons will be higher, on average, than flows in the dry portion of the cycle. In determining minimum flows, assessing the impacts of land uses, and planning for water supply projects for rivers, scientists and engineers must base their conclusions on flow data that encompasses both wet and dry periods. Assessing the rivers based on the current high rainfall conditions could result in minimum flows that are set too high and yield projections that will be impossible to achieve during the dry portion of the cycle.

The following are policies developed for the *Sarasota County Comprehensive Plan*:

ENV Policy 4.6.9 Water conservation shall be given priority in the design of plantings for public rights of way. Recycled water shall be utilized for irrigation purposes wherever possible.

WATER Policy 1.3 Continue to explore and use alternative and supplemental water resources to conserve and replace the use of traditional potable water supplies.

WATER Policy 1.3.1 The County shall continue implementation of the reuse policies in the Wastewater Management Plan in order to reduce the demand on potable water supplies and withdrawals from ground water aquifers.

WATER Policy 1.3.2 The County shall reclaim treated wastewater for irrigation purposes as its primary method of disposal for treated wastewater. The use of deep well injection or surface water discharge shall be used only when opportunities to use reclaimed water for irrigation is not available.

WATER Policy 2.3.2.2.IV.(e) By 2007, Sarasota County shall provide design standards for low impact design (LID) measures to mitigate the effect of impervious surfaces and stormwater pollutants on increased runoff volumes. LID design measures may include, but are not limited to, bio-retention areas, porous pavement, roof gardens, rainwater/stormwater recycling, etc.

WATER Objective 3.3 Continue to implement programs to conserve potable water resources.

WATER Policy 3.3.4 New development shall prioritize meeting irrigation needs through (1) demand management strategies, (2) reclaimed water, if available, (3) rain water or stormwater, and finally, (4) community ground water wells.

The County will need to expand its reclaimed water system to beneficially use all its reclaimed water according to its *Draft Wastewater Master Plan Report*. An excerpt from the report's *Executive Summary*, in which this need is described, is provided below:

The County has an extensive system of reclaimed water storage and transmission pipelines. The primary means of effluent management is the reuse of reclaimed water for irrigation. The County does not have the facilities or the number of customers to reuse all reclaimed water. A typical reclaimed water irrigation system without significant storage will be capable of reusing about 50 percent of the reclaimed water produced due to seasonal supply and demand. The County currently reuses about two thirds of the *reclaimed water produced, since there are large storage ponds available. Since all reclaimed water cannot practically be reused, other means of disposal must be provided. The County has plans for adding a deep injection well (DIW) at the Central County Water Reclamation Facility (WRF). That DIW, plus the existing DIW capacity available in the North and South County, will provide sufficient backup disposal to irrigation.*

This report presents a number of reclaimed water enhancement projects that could be implemented by the County to improve service to existing irrigation customers and to expand the amount of reclaimed water reused. To maintain the 2:1 reuse to DIW disposal ratio, it would be necessary to have a similar volume of long-term reclaimed water storage available and to have a proportional number of reclaimed water customers. The current volume of reclaimed water storage available is equivalent to about 45 days of the reclaimed water produced. Additional storage could be provided by more ponds at new locations or by ASR wells. Ponds require large land areas and siting may be a problem. ASR wells have the advantage of a small land area to provide a large amount of storage; however, there are technical issues with ASR wells that make permitting of additional wells problematic.

The beneficial end-use of harvested stormwater is generally irrigation.

The beneficial end-use of both reclaimed water and harvested stormwater is generally irrigation. The "excess" reclaimed water leads to a complicating factor for implementing stormwater harvesting as the transmission system is more developed and reuse of reclaimed water (instead of discharging or injection) is viewed as more environmentally and regulatory friendly. When considering irrigation as the end-use of an alternative water supply and knowing a higher nutrient concentration is associated with reclaimed water than stormwater, the preferred order of use is reclaimed water before harvested stormwater from a pollutant-loading to the environment perspective.

For this WMP, all the projects are identified as stormwater-harvesting projects. Although the conceptual plans discuss stormwater harvesting, some of these projects may be better suited as reclaimed water projects if infrastructure and availability of reclaimed water is determined to be more beneficial and cost effective than using harvested stormwater.

While augmentation of reclaimed water with harvested stormwater is permittable (62-610.472(3), FAC), design and operational issues associated with this type of system will require special attention. Specifically, a one-way flow device must be installed so reclaimed water is not introduced to the stormwater system, a condition that is not permittable. From an operational standpoint, disinfection must be provided and the fecal coliform and total suspended solids limits established for high-level disinfection must be met (62-600.440(5), FAC) for the treated surface water or stormwater supply before mixing with the reclaimed water.

5.2 POTENTIAL PROJECTS

Stormwater-harvesting opportunities in the County can be divided by scale: regional, sub-regional, and local. Regional scale projects impact water supply for the entire watershed; local scale projects are implemented by homeowners for individual property conservation and use such as rain gardens and cisterns; sub-regional scale projects impact communities such as irrigation systems within a subdivision.

At the largest (i.e., regional) scale, stormwater may be available as a potable water supply or as a supplement to a potable water supply, such as the opportunity with the Venice Minerals reservoir in Dona Bay watershed. Historical dredging projects, mostly agriculturally based, diverted flow from the Myakka River to the Dona Bay estuary. A 2007 report prepared for Sarasota County discusses the amount of excess freshwater that has been added to the estuary by the Cow Pen canal diversion. A project is planned to harvest the excess freshwater from Cow Pen and divert it to a reservoir at Venice Minerals to restore a more natural hydrologic regime to the watershed and create a potable water supply alternative. At the next largest (i.e., subregional) scale, stormwater may be available largely as a non-potable irrigation source or supplement. Opportunities at the subregional scale will typically serve a limited number of larger entities, such as a residential development or a golf course. At the smallest (i.e., local) scale, stormwater-harvesting opportunities are typically confined to the individual property owner. Regardless of scale, the following four components are necessary components to implement a stormwater-harvesting project:

- Sustainable supply—There needs to be a sufficient volume of stormwater to satisfy all or a significant percentage of the intended end use. In general, the amount of supplemental supply typically needed increases as the scale decreases. The available volume must be in excess of what is needed to sustain a healthy downstream ecosystem, which is covered in Chapter 4.

- Storage—The timing between the availability of stormwater and the needed end use rarely coincide. Thus, storage is required to bridge the timing gap between supply and demand. Larger storage volumes translate to higher rates of using harvested stormwater but at larger costs.

- Transmission/distribution system—Distance and elevation differences between the supply/storage location and the end use must be overcome with a transmission/distribution system. At the regional scale the relative cost of this component is typically not as large since the distribution system to the end user usually exists. At the local scale, the distribution system is typically simple to construct and maintain. The transmission/distribution system at the subregional scale is often the limiting factor for stormwater-harvesting opportunities because of the relatively high cost of the component—particularly for retrofits.

- End use—A beneficial end use is necessary to implement a stormwater-harvesting project. At the regional scale, the end use is typically as a potable water source. At the subregional and local scale, it is typically as a supplemental irrigation source. Although end uses for stormwater are somewhat widespread throughout the Lemon Bay watershed, the challenge is to cost-effectively match them with the other three components—sustainability, storage, and transmission/distribution. Regardless of whether the end use of the stormwater is potable or non-potable, effective conservation measures should remain in place.

Although not listed as a necessary component above, treatment in some form is usually needed in stormwater-harvesting projects at the two larger scales. The type of treatment varies by end use.

The following subsections present potential projects at the three scales discussed above.

5.2.1 Regional-Scale Projects

Conditions for regional-scale stormwater-harvesting projects are not highly favorable in this watershed for two primary reasons. First, the watershed consists of six major basins that are relatively small, and one of the basins, Lemon Bay Coastal Fringe, does not have a primary stream system. Second, the most favorable storage locations in terms of having the largest contributing area are in largely built-out portions of the watershed and have highly brackish water.

The only potential stormwater-harvesting projects that could be considered regional-scale projects are in Forked Creek, Gottfried Creek, and Ainger Creek—where they would serve as supplemental or primary irrigation sources in the Lemon Bay watershed. Those projects are discussed below.

5.2.1.1 Forked Creek Regional Stormwater Harvesting (LBWS01)

Based on the connectivity in the County's ICPR model, the Forked Creek regional stormwater-harvesting site—shown in Figure 5-1—has a contributing surface area of approximately 2.3 square miles, which is marginal in size for a regional-scale watershed. The land use is predominantly undeveloped, agricultural, and low-density residential land uses.

This project offers the possibility of providing a supplemental alternative water supply (most likely for irrigation to agricultural uses east of the storage location under current conditions), the ability to restore the water budget in the basin closer to historical conditions, and the ability to reduce pollutant loads. One disadvantage is that the magnitude of the potential demand is currently unknown. As shown in Figure 5-1, the potential agricultural users to the east currently have water use permits for surface and groundwater withdrawals. Another slight disadvantage from a pollutant-loading perspective is that the contributing area served by the project is not projected to have relatively high loads, due in part to the relatively low runoff volumes. Also, none of the property in the vicinity of where the regional facility would be best suited is owned by the County.

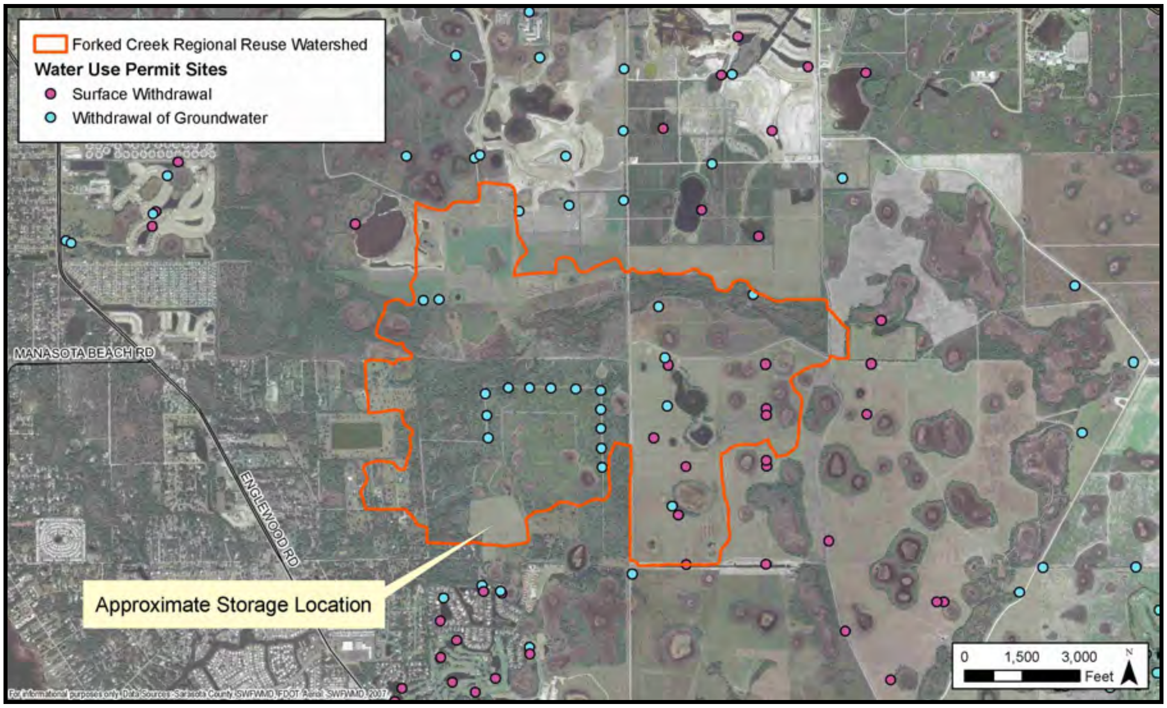

Figure 5-1 LBWS01—Forked Creek Regional Stormwater Harvesting

Other benefits from this project partly depend on the amount of water that can be beneficially used. Flood protection benefits will be relatively small (on the order of 0.1 foot near the storage facility) since this would likely need to be designed and permitted as an off-line storage facility. The estimated average annual reuse water volume that would be achieved is 190 ac-ft/year, which corresponds to a total nitrogen reduction of approximately 750 lb/year.

5.2.1.2 Gottfried Creek Regional Stormwater Harvesting (LBWS02)

Based on the connectivity in the County's ICPR model, the Gottfried Creek regional stormwater-harvesting site has a contributing surface area of approximately 7.3 square miles of predominantly undeveloped and agricultural land uses. The approximate location of the site and that of the contributing watershed is shown in Figure 5-2.

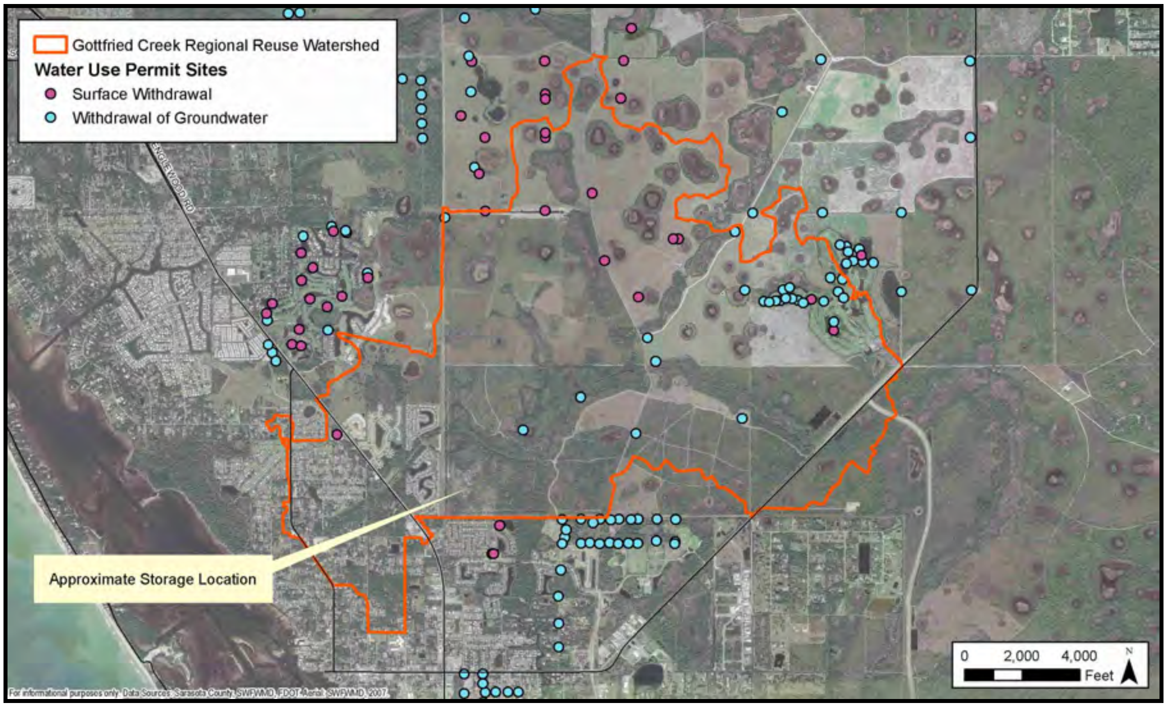

Figure 5-2 LBWS02—Gottfried Creek Regional Stormwater Harvesting

Similar to LBWS01, this project can serve as a supplemental alternative water supply, help to restore the historical water budget, and reduce pollutant loads. The most likely current uses would be for agricultural irrigation north and east of the storage location and possibly the golf course near the eastern edge of the watershed. As shown in Figure 5-2, those users currently have permitted surface and groundwater withdrawals, so the actual demand for the harvested water is unknown. Also similar to LBWS01, the contributing area served by the project is not projected to have relatively high loads and none of the property in the vicinity of where the regional facility would be best suited is owned by the County.

Flood protection benefits will be relatively small since this would likely need to be designed and permitted as an off-line storage facility. The estimated average annual harvested water volume that would be achieved is 500 ac-ft/year, which corresponds to a total nitrogen reduction of approximately 2,100 lb/year.

5.2.1.3 Ainger Creek Regional Stormwater Harvesting (LBWS03)

Based on the connectivity in the County's ICPR model, the Ainger Creek regional stormwater-harvesting site has a contributing surface area of approximately 10 square miles of predominantly undeveloped, agricultural, and low-density residential land uses. The approximate location of the site and that of the contributing watershed is shown in Figure 5-3.

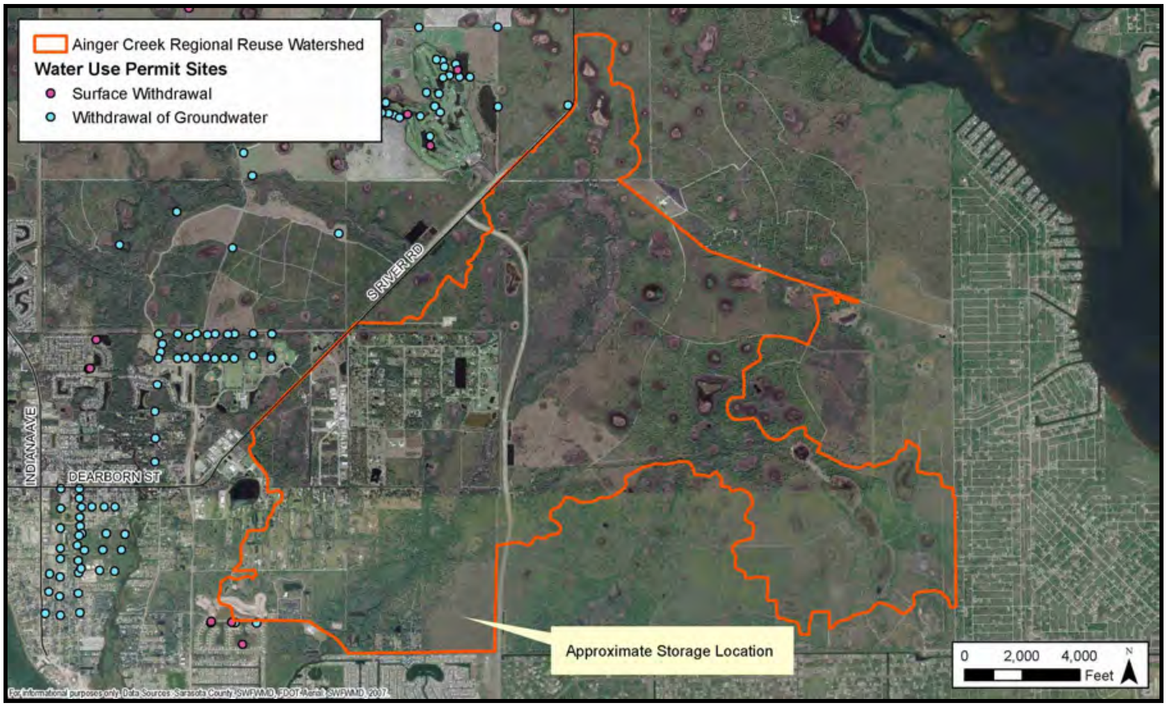

Figure 5-3 LBWS03—Ainger Creek Regional Stormwater Harvesting

This project has similar benefits and challenges to LBWS01 and LBWS02. One difference (potential disadvantage) from LBWS03 is that the majority of the current end use opportunities within the watershed and the site itself are within the Myakka River State Park. The estimated average annual harvested water volume that would be achieved is 1,200 ac-ft/year, which corresponds to a total nitrogen reduction of approximately 4,000 lb/year.

5.2.2 Subregional-Scale Projects

Subregional-scale stormwater-harvesting opportunities in the Lemon Bay watershed exist largely as projects that can provide a non-potable irrigation source or supplement. Subregional-scale projects will typically serve one or two larger users (e.g., a golf course). Sustainable supplies are relatively plentiful throughout the watershed since the water budget analysis indicates that there is a greater average annual discharge under existing conditions than under historical conditions and since there is an abundance of potential withdrawal locations. Because of the relatively small storage footprint required for a stormwater-harvesting system, an abundance of potential storage locations throughout the watershed would also rely on retrofitting existing ponds or constructing new ponds on available property. A significant portion of the subregional-scale harvesting opportunities identified in this subsection are also within areas that could be served by the regional-scale projects.

Transmission/distribution is one of the most limiting factors for stormwater-harvesting opportunities in this watershed. Irrigation systems that use stormwater cannot be connected to potable distribution systems because of concerns over potential contamination of the potable source. Retrofitting most existing urban land uses (e.g., residential development) with separate or disconnected irrigation systems is typically cost-prohibitive. Therefore, subregional opportunities were limited to areas where separate distribution systems already exist or where retrofitting the distribution system may not be cost-prohibitive. The complicating factor of excess reclaimed water was discussed previously in this chapter.

With the information above, Jones Edmunds screened the Lemon Bay watershed for potential subregional stormwater-harvesting opportunities. The areas served by reclaimed water as estimated for the SIMPLE-Monthly model input or that are close to a reclaimed transmission line were not included in the screening process. The screening focused on larger neighborhoods with neighborhood associations, schools, parks, recreational fields, libraries, cemeteries, and other locations provided by the County. Using the criteria discussed below, Jones Edmunds established a scoring system for ranking the potential locations as stormwater-harvesting projects. The criteria have cost and feasibility implications. In each case, a higher score indicates a more favorable value with respect to the harvesting opportunity at the site.

- ❖ Distribution—This criterion reflects the relative difficulty of constructing a stormwater-harvesting distribution system, with values ranging from 0 to 2. A value of 0 represents a new distribution system that would need to be constructed in an area with many site constraints. A value of 2 represents a distribution system that is largely built and that only needs a relatively small number of additions or improvements.

- ❖ Availability of onsite storage—Values in this category range from 0 to 2, with 0 representing that all storage would need to be constructed, 1 representing that usable storage is present but significant expansion would be required, and 2 representing that it may be possible to use existing storage with little to no modification.

- ❖ Harvesting demand—Values in this category range from 0 to 3, with 3 representing the highest irrigation needs in terms of volume over the site area. These values are largely based on the rates from the irrigation feature class developed for the SIMPLE-monthly model.

Points were assigned to each category. Because of their relative respective impacts to cost using the value ranges discussed above, a weighting factor of 2 was applied to distribution and availability of onsite storage. After applying the weighting factor, Jones Edmunds summed the values in the three categories for an overall score. The 53 sites evaluated are shown in Figure 5-4. Unweighted scores for each criterion and total weighted scores are shown in Table 5-1. The polygon labels in Figure 5-4 correspond to the project IDs in Table 5-1, except that the leading "LBWS" has been removed for readability. The projects in Table 5-1 are sorted by total score.

Table 5-1 Summary of Potential Subregional Stormwater-Harvesting Projects

Project ID	FLUCCS Description	Area (acres)	Distribution	Demand	Storage	Total
LBWS13	PARK	137.4	2	3	2	11
LBWS26	GOLF COURSE	143.3	2	3	2	11
LBWS27	GOLF COURSE	93.7	2	3	2	11
LBWS04	LIBRARY	2.9	2	2	2	10
LBWS06	SCHOOL	18.0	2	2	2	10
LBWS23	PARK	9.2	1	2	2	8
LBWS55	CROPLAND AND PASTURELAND	966.7	2	2	1	8
LBWS21	PARK	6.3	1	1	2	7
LBWS38	OPEN LAND	10.6	1	1	2	7
LBWS39	OPEN LAND	3.4	1	1	2	7
LBWS46	OPEN LAND	2.8	1	1	2	7
LBWS09	PARK	2.2	1	0	2	6
LBWS22	PARK	7.0	0	2	2	6
LBWS29	PUBLIC LAND	166.1	1	0	2	6
LBWS32	PUBLIC LAND	222.7	1	0	2	6
LBWS34	OPEN LAND	9.8	1	0	2	6
LBWS35	OPEN LAND	3.8	1	0	2	6
LBWS36	OPEN LAND	7.9	1	0	2	6
LBWS41	OPEN LAND	3.2	1	0	2	6
LBWS43	OPEN LAND	2.2	1	0	2	6
LBWS44	OPEN LAND	5.1	1	0	2	6
LBWS45	OPEN LAND	35.1	1	0	2	6
LBWS47	OPEN LAND	10.1	1	0	2	6
LBWS57	CROPLAND AND PASTURELAND	161.2	1	1	1	5
LBWS10	PARK	4,525.4	1	0	1	4
LBWS12	PARK	3.2	1	0	1	4
LBWS14	PARK	5.4	0	0	2	4
LBWS19	PARK	3.3	0	0	2	4
LBWS24	PARK	3.2	0	0	2	4
LBWS25	PARK	6.4	0	0	2	4
LBWS37	OPEN LAND	41.3	1	0	1	4
LBWS40	OPEN LAND	4.2	0	0	2	4
LBWS05	SCHOOL	9.5	1	1	0	3
LBWS20	PARK	3.9	1	1	0	3
LBWS15	PARK	21.4	1	0	0	2
LBWS28	PUBLIC LAND	10.3	1	0	0	2

Table 5-1 Summary of Potential Subregional Stormwater-Harvesting Projects

Project ID	FLUCCS Description	Area (acres)	Distribution	Demand	Storage	Total
LBWS30	PUBLIC LAND	97.6	1	0	0	2
LBWS31	PUBLIC LAND	72.3	1	0	0	2
LBWS07	PARK	140.5	0	0	0	0
LBWS08	PARK	10.2	0	0	0	0
LBWS11	PARK	8.3	0	0	0	0
LBWS16	PARK	5.6	0	0	0	0
LBWS17	PARK	4.9	0	0	0	0
LBWS18	PARK	3.1	0	0	0	0
LBWS33	PUBLIC LAND	77.7	0	0	0	0
LBWS42	OPEN LAND	28.6	0	0	0	0
LBWS48	CROPLAND AND PASTURELAND	9.7	0	0	0	0
LBWS49	CROPLAND AND PASTURELAND	694.4	0	0	0	0
LBWS50	CROPLAND AND PASTURELAND	23.4	0	0	0	0
LBWS51	CROPLAND AND PASTURELAND	81.0	0	0	0	0
LBWS52	CROPLAND AND PASTURELAND	46.0	0	0	0	0
LBWS53	CROPLAND AND PASTURELAND	4.8	0	0	0	0
LBWS54	CROPLAND AND PASTURELAND	177.9	0	0	0	0
LBWS56	OTHER OPEN LANDS <RURAL>	4.3	0	0	0	0

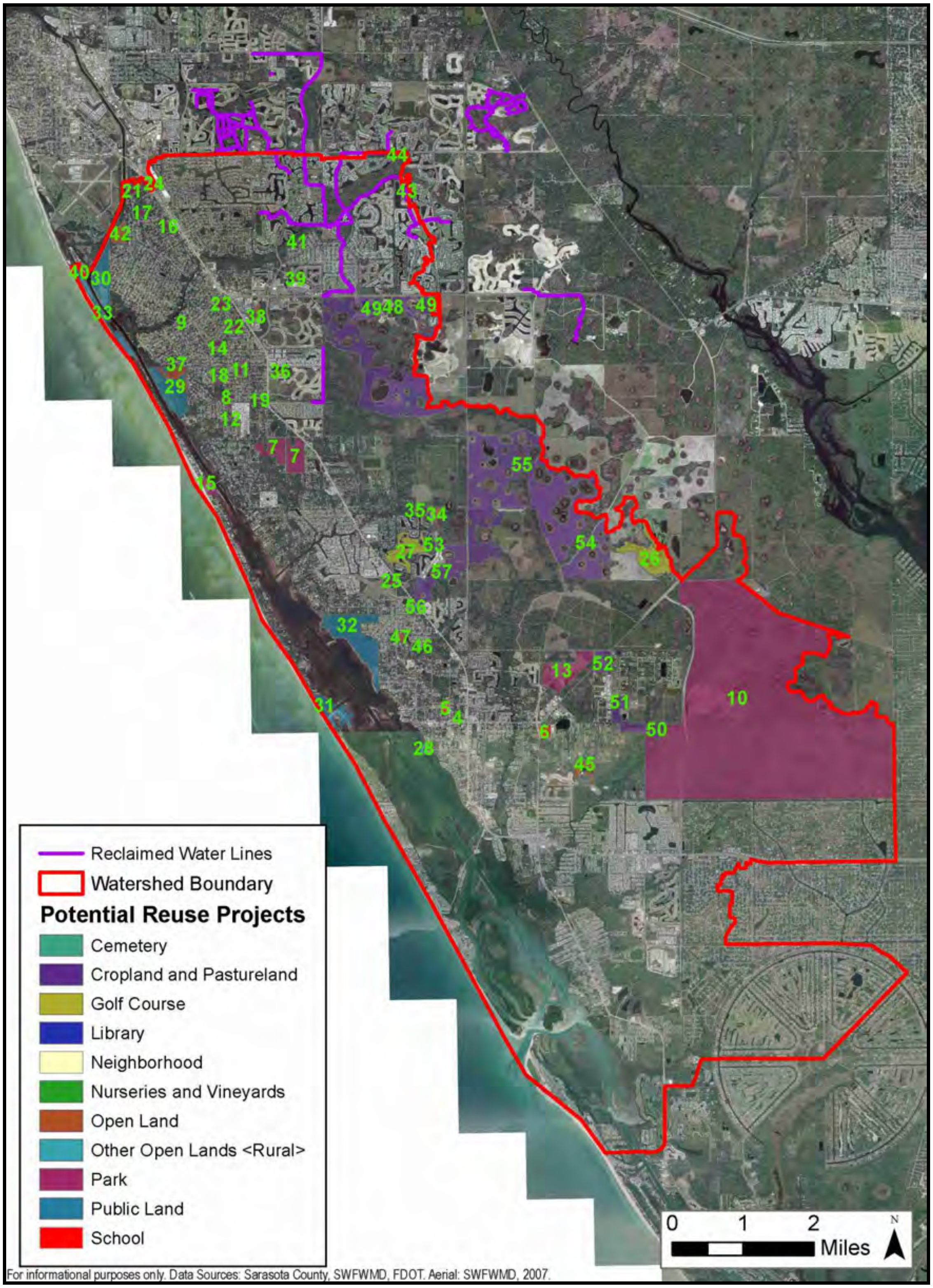

Figure 5-4 Location of Potential Subregional Stormwater-Harvesting Projects

5.2.3 Local-Scale Projects

Local-scale stormwater-harvesting projects typically consist of pond pumps, cisterns, or rain barrels that serve individual properties. Since local-scale stormwater-harvesting projects typically consist of construction on private property, the County is unlikely to participate directly in the construction of most of these projects. However, local-scale harvesting projects are still worthy of consideration since they provide the same potable-water offset, freshwater balance, and pollutant-loading reduction benefits as any other form of harvesting.

Photo: Hillsborough County Cistern, Courtesy of Jack Merriam, SC

In September 2009, Resolution 2009-178 was passed that allowed Sarasota County Water Resources to implement a rain barrel water conservation program by making rain barrels available for purchase to Sarasota County residents for wholesale cost of $37.00 each. The rain barrels provided are 55-gallon, food-grade quality, recycled polyethylene barrels. Harvested stormwater collected in the barrels is considered non-potable. To implement the program, Stormwater Environmental Utility staff partnered with UF/IFAS Sarasota County Extension (http://sarasota.extension.ufl.edu/FYN/Rainbarrel.shtml). The County Extension received grant funding from SWFWMD for a part-time Florida Yards and Neighborhoods Homeowner Outreach Educator for 1 year. Public education and workshops were scheduled for 2010. The following topics were included as part of public education to residents:

- ❖ Rainwater harvesting can reduce the use of potable water and provide cost savings on water and wastewater utility bills.
- ❖ Rain barrels help to reduce stormwater runoff by diverting and storing runoff from impervious areas such as roofs, decreasing the undesirable impacts of runoff.
- ❖ The use of rain barrels is a sustainable practice that serves as water conservation.

Regardless of the funding assistance provided, the local-scale projects will depend on how well the individual property owners maintain and operate their systems. A storage device that is never used for irrigation during dry periods is not a worthy investment.

In June 2009 the County Health Department implemented a procedure for converting abandoned septic tanks into cisterns based on 64E-6.011, FAC. This conversion allows a single-family residence to convert an abandoned septic tank to a cistern by permit within 90 days of connecting the building plumbing to sanitary sewer. Laboratory sampling and health department inspection are required for this procedure, and the water collected in the tank must be used for non-potable irrigation purposes only. Local-scale harvesting would be more cost-effective and provide a beneficial use for the large number of septic tanks that are no longer needed because of the septic tank phase-out program in this watershed.

Local-scale projects will vary in efficiency based on the amount of storage provided and how the stored water is used for beneficial purposes. Based on some typical values, an individual homeowner may achieve roughly a 5% reduction in average annual flows and loads by using rain barrels at each downspout on a guttered house. Although estimates for reductions using larger cisterns are more variable because of the differences in cistern sizes that may be applied, a reduction of approximately 15% for cisterns may be a reasonable value to use for planning purposes.

Potential regional and subregional scale projects were all assigned an LBWS## for consistency throughout this report. Local-scale stormwater-harvesting projects will collectively be identified in the analysis in this chapter and the Project Analysis (Chapter 8) as LBWS57.

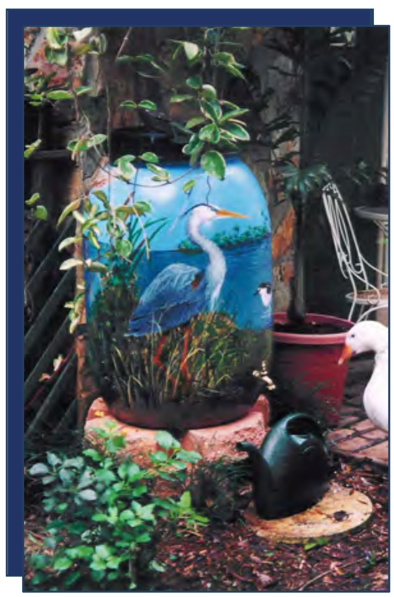

Photo: UF and Hillsborough County

5.3 RECOMMENDATIONS

Even though the benefits could be significant, none of the regional projects is recommended at this time for several reasons. First, the projects are in excess of the freshwater reduction goals needed for this watershed. Second, the end uses are uncertain and many may have a finite demand period. Third, many of the end uses may be served more cost-effectively through subregional harvesting. However, as land uses change in the future, these projects may be worthy of re-evaluation.

Jones Edmunds recommends stormwater harvesting for the six top-ranked subregional-scale projects shown in Figure 5-5 through 5-11. Estimates of average annual volumes and nitrogen reductions for the six projects are shown in Table 5-2. The Estimates of Probable Costs for construction for these projects as well as the estimated cost per million gallons of volume reduction of freshwater and the associated cost per pound of nitrogen removal from the system are provided in Tables 5-3.

Throughout the watershed, participation in local-scale stormwater-harvesting projects (LBWS57) through the public outreach and cost-savings program offered by Stormwater Environmental Utility and IFAS continuing through the end of 2010 is recommended. An evaluation at the end of the project will offer information on whether the program should move forward, be modified, or discontinued. The original rollout effort engaged the entire County, moving forward, targeting specific areas to improve education and continued usage of the alternative water supply.

In the future, a potential method the County could use to encourage and support local-scale rain barrel stormwater harvesting projects is through some form of funding assistance or homeowner rebate program.

One approach, which results in a lower amount of funding assistance, is to provide funding assistance to the local-scale projects based on a similar $/gallon harvesting rate that is achieved at the subregional scale. Depending on the assumptions used, this approach translates to approximately $1/gal of storage provided. This rate may be considered to be at the lower end of the range since it is taken from larger-scale projects that do not have as many constraints and that would have lower overall unit costs.

Another approach is to provide funding assistance at a rate similar to less feasible and more expensive neighborhood retrofit projects since that type of project would typically be needed in the areas where rain barrels would often be used to achieve similar benefits. Depending on the assumptions used, this approach translates to a rebate of up to $10/gal of storage provided. Thus, a range of possibilities exists for future funding assistance of ongoing local-scale harvesting projects.

Another local-scale recommendation is to encourage the septic-to-cistern process during the septic replacement/abandonment conversion. Active public outreach and education could assist homeowners in the permitting and testing phases of the process.

To further the sustainability goals set forth by the County in its policies, regulations, and comprehensive plan, reclaimed water and stormwater/rainwater harvesting should be used where possible to offset traditional sources used for irrigation such as potable water and groundwater. The County's comprehensive plan water policy 3.3.4 states:

"New development shall prioritize meeting irrigation needs through (1) demand management strategies, (2) reclaimed water, if available, (3) rain water or stormwater, and finally, (4) community ground water wells."

These types of strategies work well not only for new development but can be applied to private irrigation utilities, existing neighborhoods, and individual homes. For these measures to be effective, interagency cooperation is required at the state and local level to eliminate or incentivize the use of these alternatives as opposed to allowing individual groundwater wells as an alternative. One method that has proven to be successful has been establishing an irrigation utility at the beginning of a new development, constructing a central irrigation system, and limiting or prohibiting individual groundwater wells through deed restrictions. This structure requires an active management strategy and resource management to ensure that the type of water used follows the principles and hierarchy established by the water policy. Demand management strategies include limitations on the amount of water and time of day for irrigation, appropriate plant placement, and drought-tolerant plant selections. Also, demands have been adjusted by the changing community perspective with a general shift away from traditional lawns to a more natural landscape.

As examples, Lakewood Ranch, Stonybrook of Venice, and the Grand Paradiso communities were planned and developed with sustainable community principles. A development-wide piping system designed to supply reclaimed water and use stormwater harvesting to irrigate yards and common areas was installed during construction. A private irrigation utility was set up as a provider to administer and maintain the system and serve the customers. Community wells are used to supplement supplies when demands cannot be met through other means. The community wells also have meters to track the amount of groundwater used. Grand Paradiso has a development-wide restriction that does not allow private wells. Encouraging the establishment of private utilities and the prioritization and hierarchy for supplies can help the County achieve its sustainability goals as well as offset potable water demand.

Table 5-2 Recommended Stormwater-Harvesting Projects								
Project ID	Description	Area (acres)	Distribution	Demand	Storage	Total	Approximate Average Annual Volume Reduction (acre-feet)	Approximate Average Annual Nitrogen Reduction (lbs)
LBWS13	PARK	137.4	2	3	2	11	92	299
LBWS26	GOLF COURSE	143.3	2	3	2	11	107	526
LBWS27	GOLF COURSE	93.7	2	3	2	11	70	344
LBWS04	LIBRARY	2.9	2	2	2	10	5	15
LBWS06	SCHOOL	18.0	2	2	2	10	30	113
LBWS23	PARK	9.2	1	2	2	8	6	20

Table 5-3 Summary of Estimates of Probable Cost				
Project ID	Project Name	Project Cost*	Cost per Million Gallons Volume Reduction ($/MG)	Cost per Pound of Nitrogen Reduction ($/lb)
LBWS04	Elsie Quirk Library	$212,000	$130,000	$14,000
LBWS06	Heritage Christian Academy	$342,000	$35,000	$3,000
LBWS13	Englewood Sports Complex	$1,657,000	$55,000	$6,000
LBWS23	South Venice Park	$214,000	$109,000	$11,000
LBWS26	Myakka Pines Golf Club	$1,794,000	$51,000	$3,000
LBWS27	Boca Royale Golf and Country Club	$1,544,000	$68,000	$4,000

*Project costs include construction materials, engineering design services, survey, and geotechnical investigation.

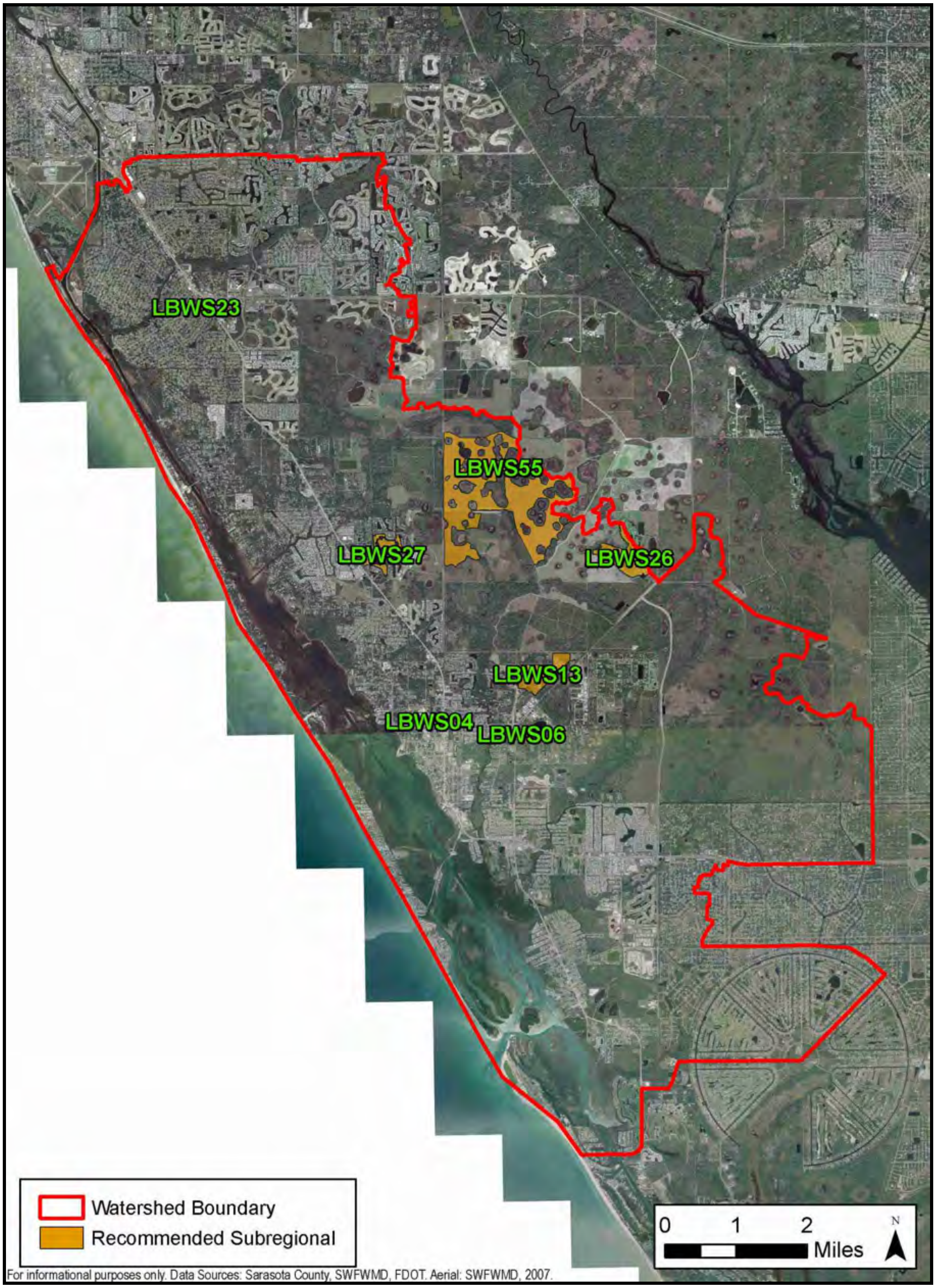

Figure 5-5 Recommended Subregional Stormwater-Harvesting Projects

Figure 5-6 LBWS04—Elsie Quirk Library

Figure 5-7 LBWS06—Heritage Christian Academy

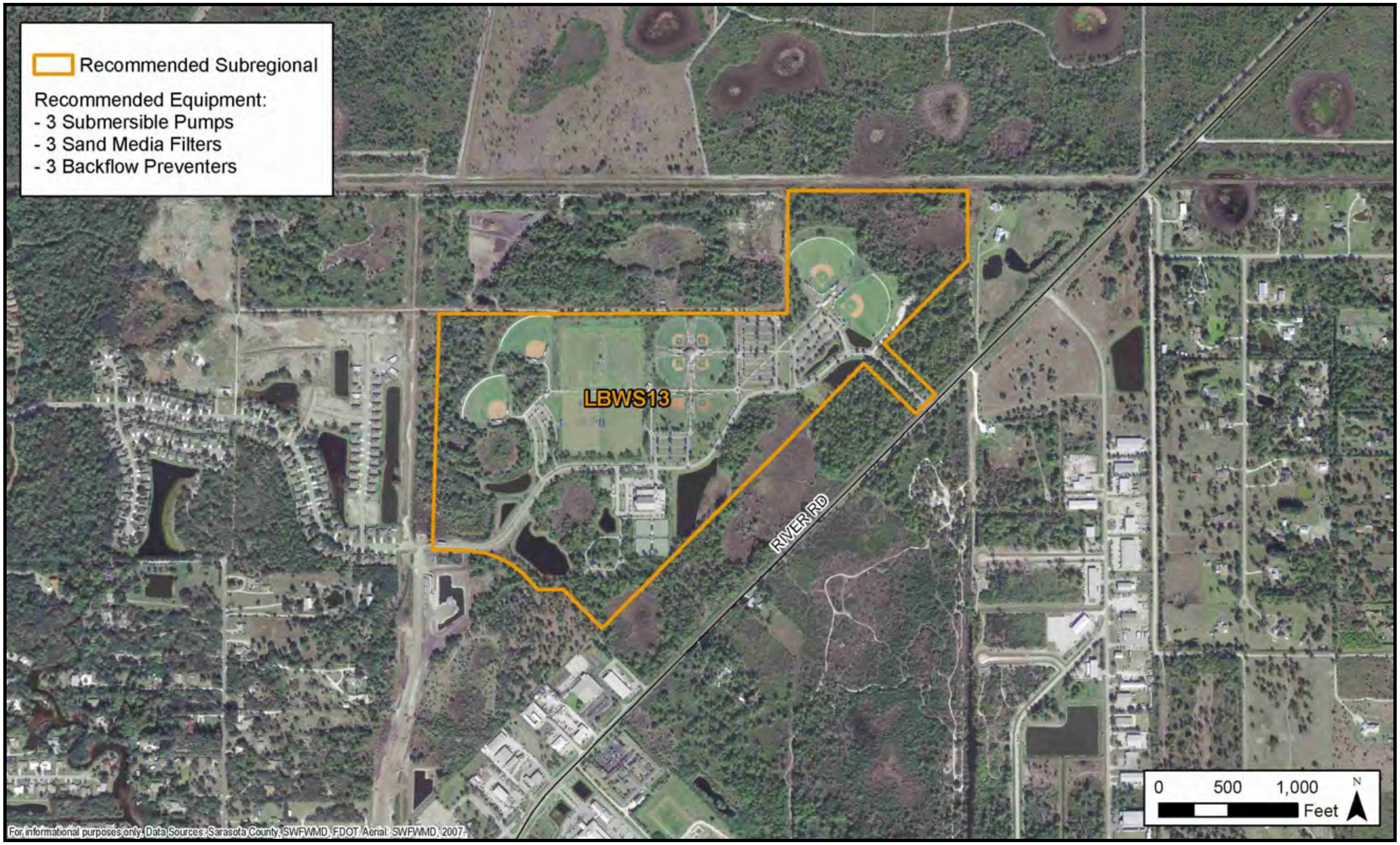

Figure 5-8 LBWS13—Englewood Sports Complex

Figure 5-9 LBWS23-South Venice Park #23

Figure 5-10 LBWS26—Myakka Pines Golf Club

Figure 5-11 LBWS27—Boca Royale Golf and Country Club

Chapter 6

Flood Protection

August 2010

Sarasota County

Southwest Florida Water Management District

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6.0 FLOOD PROTECTION

The relatively flat and low-lying topography of Sarasota County is inherently flood prone. The Lemon Bay watershed was historically a collection of isolated wetlands and pine flatwoods. This land condition allowed excess water in the wetlands to flow into the pine flatwoods during the cyclical wet season. The creeks likely acted as tidal extensions, receiving minimal freshwater inflows.

Development has changed the natural environment within the Lemon Bay watershed. Increased impervious surfaces throughout the watershed, especially in the heavily urbanized Alligator Creek, Woodmere Creek, and Coastal basins, have decreased the infiltration of rainwater and gutters and storm sewers speed runoff to the channels. As a result, more water runs off more quickly, and drainage systems, including creeks, can become overloaded. The combination of heavy precipitation and an overloaded drainage system can result in flooding. In addition, the Lemon Bay Coastal basin, including Manasota Key and the coastal mainland, is tidally influenced constituting the area a storm surge zone.

The County's goal with regard to flood protection is to minimize flood risk to protect human safety and property in existing developed areas while protecting natural and beneficial functions of the remaining floodplain. This Watershed Management Plan (WMP) does not contain new analyses of flood conditions; instead it provides an overview of flood-protection-related activities. This overview includes a background section followed by a description of the two most significant flood-protection-related policies and programs in the County: the Sarasota County Comprehensive Plan and the Sarasota County Land Development Regulations (LDR).

6.1 BACKGROUND

Historically, the Lemon Bay watershed consisted of pine and palmetto flatwoods with scattered isolated wetlands that sometimes connected during the rainy season. This diverse landscape provided significant flood storage capacity as well as a slow meandering natural flow of water from land to Lemon Bay. Alligator, Woodmere, Forked, Gottfried, Ainger, Oyster, and Buck Creeks acted as tidal extensions of the Lemon Bay estuary. Freshwater inflows were likely limited to surficial groundwater during the rainy season and sheet flow during extremely wet conditions or flood events.

Those natural patterns began to be interrupted and altered during the early 20th century, as the area's population grew and more development occurred. Early residents of the Lemon Bay watershed were plagued by mosquitoes. To alleviate the problem, many ditches were created in the coastal mangroves to extend the natural creeks inland and to connect many of the larger isolated wetlands to the creeks. In addition, many wetlands were filled and impervious surfaces were created to accommodate development. As a result, flood storage capacity was reduced and flood flows increased in magnitude, raising flood stages and decreasing water quality in our creeks and bays. Since much of the watershed is now densely populated, flooding affects homes, businesses, and agriculture located in the flood plains, especially those areas developed before the adoption of County LDRs in 1981 (Figure 6-1).

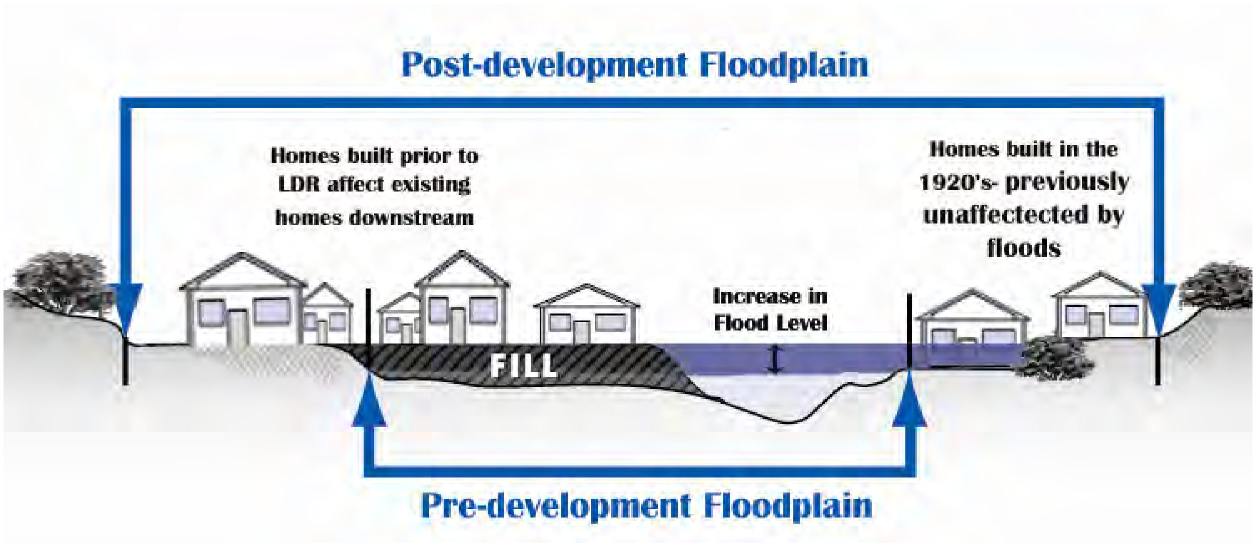

Figure 6-1 Floodplain Changes Schematic
(adapted from *www.dnr.sc.gov*)

Sarasota County recognizes its flooding problems and the need for improvements to the existing system. The County took the first step toward developing a stormwater program in 1981 with the creation of the Stormwater Management Division. The first LDRs were also implemented, requiring stormwater controls to be designed for a 25-year storm (8 inches of rain in 24 hours). In 1987, the Sarasota County Stormwater Master Plan was adopted. The Sarasota County Stormwater Environmental Utility (SEU) was established in 1989 to implement the plan.

By the early 1990s, Sarasota County SEU initiated a countywide basin master planning project to develop hydrologic and hydraulic models to identify problematic flooding areas for all of the County's major watersheds. These models are also used to evaluate possible drainage improvements to the County's stormwater system. The Basin Master Plans for the Alligator, Woodmere, Forked, Gottfried, and Ainger Creek basins were completed between 1987 and 2000 (Appendix A).

In the mid 1990s the LDR were modified to require storm systems designed for a 100-year storm (10 inches of rain in 24 hours). The County also started the first stormwater capital improvement assessments. The County then completed feasibility analyses for projects in problem areas identified in the Basin Master Plans. Several of these projects are included in the County's Capital Improvement Element. By the late 1990s, the SEU Strategic Plan was adopted and revenue bonds were issued to fund stormwater improvement projects. Today, several capital improvement projects, such as stormwater control structures, retrofit projects, and retention and detention ponds, are occurring throughout the watershed (Figure 6-5).

6.2 FLOOD PROTECTION STATE LEGISLATION AND LOCAL ORDINANCES

The following sections contain excerpts from the Sarasota County Comprehensive Plan. The Sarasota County Comprehensive Plan is an official public document adopted by the Board of County Commissioners to guide decision making related to the physical development of the County. The plan covers legislation that has been adopted, planning studies and mitigation efforts, and levels of service for stormwater quality and quantity.

6.2.1 Legislation

The five Water Management Districts, including the Southwest Florida Water Management District (SWFWMD) were initially created by the State of Florida to control flooding. The Governing Board of the SWFWMD is authorized in Chapter 373 and other chapters of the Florida Statutes to direct a wide range of programs, initiatives, and actions. These programs include such things as flood control, regulatory programs, water conservation, education, and supportive data collection and analysis. SWFWMD’s goals flood protection, water quality, and natural systems are:

- To minimize the potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood prone areas.
- To protect water quality by preventing further degradation of the water resource and enhancing water quality wherever possible.
- To preserve, protect, and restore natural systems to support their natural hydrologic and ecologic functions.

Sarasota County supports the following state regulations through its Comprehensive Plan and a series of ordinances.

- Chapter 40D-2, Florida Administrative Code, includes stormwater system design criteria.
- Chapter 40D-4 and Chapter 40D-40 FAC, state that the SWFWMD governs surface water permitting and stormwater runoff.
- Chapter 40D-4 limits peak discharge rates for new development. Rules also stipulate that activities affecting floodplains and floodways will not cause adverse impacts, such as increased flooding.

6.2.2 Ordinances

Sarasota County Ordinance No. 81-12, "Land Development Regulations," as amended, provides regulations that guide development as it pertains to the force of flowing water and drainage of runoff. These regulations require that post-development conditions, such as peak stage and discharge, do not exceed those under pre-development conditions for the 100-year storm. Additionally, Ordinance No. 81-12, as amended, requires that new development provide for the treatment of the first 1 inch of runoff. The Water Pollution Control Code, Ordinance No. 96-020, as amended, provides regulations to prohibit discharge to surface water, groundwater, or the stormwater conveyance system that causes pollution.

Sarasota County established an SEU in 1989 (Ordinance No. 89-117, as amended). The SEU is responsible for funding, planning, constructing improvements, and maintaining the County's storm and surface water management facilities.

The Ordinance provides funding for the operation of the Utility by enacting a "user fee." Each parcel of land is charged an annual fee based on the characteristics of the parcel and its relative contribution to stormwater runoff. An associated "credit" program was enacted that enables "credits" to be granted against the "user fee" for properties that maintain their drainage facilities in full-functioning condition. The SEU is also responsible for permitting proposed changes in the watershed.

Sarasota County adopted a floodplain management ordinance (Ordinance No. 2003-085, as amended). This ordinance adopts the current Federal Emergency Management Agency (FEMA) Flood Insurance Study and the Sarasota County Flood Studies. Minimum lowest finished floor elevations for new construction and substantial improvements are required to be either at or above the base flood elevation (BFE) as determined by FEMA or 1 foot above the 100-year flood stages established by Sarasota County.

6.2.3 Flood Protection and Floodplain Management

To protect existing structures with the first habitable floor elevation at or just above the estimated 100-year flood elevation, as required by FEMA and Ordinance No. 92-055, as amended, new developments are required to consider the impacts of a 100-year storm event. Unless properly managed, the increased volume and rate of runoff, as well as the change in timing from upstream new developments, can increase 100-year flood elevations, thus impacting structures built to previously lower flood elevations.

Sarasota County LDR, Ordinance No. 81-12, as amended, regulates development activities within the 100-year floodplain by withholding approval "unless the developer submits substantial and competent evidence that all lands intended for use as building sites can be used safely for building purposes, without undue hazard from flood or adverse soil or foundation conditions." In addition, the LDR requires that the applicable basin flood prediction model be used as the basis of review to ensure that development proposals of 35 or more total acres or 8 acres or more of impervious surface will not result in an adverse increase in off-site flood stages.

Since Fiscal Year 1993, the Capital Improvement Program (CIP) contained funding for projects throughout the County. This program is well underway and is directed at addressing flood protection level of service (FPLOS) deficiencies. FPLOS deficiencies include flooded homes and businesses as well as flooded streets. To date, the primary focus of the stormwater improvement program has centered on flooded homes and businesses, with a secondary focus on street flooding. As this program reaches a point of diminishing returns in terms of addressing flooded buildings, it is likely to focus more on remaining street FPLOS deficiencies.

6.2.4 Planning Studies and Efforts

The drainage plans and programs from the early 1920s through the 1960s emphasized the removal of surface waters from the land, primarily for mosquito control and agricultural uses. Concern for water quality did not begin emerging as a major concern until the late 1960s.

In 1972, U.S. Public Law 92-500, the "Federal Water Pollution Control Act," was enacted to focus on non-point pollution. The program, managed by the Southwest Florida Regional Planning Council, made recommendations for improving surface water quality of the County

In 1984, the Board of County Commissioners recognized major inadequacies in the existing stormwater management system and authorized the preparation of a Stormwater Master Plan. The purpose of the Stormwater Master Plan was to assess the need for improving major drainage systems in the developed portions of the County. The objectives of the plan included:

- Assessing the adequacy of primary stormwater conveyance systems in developed or developing basins.
- Estimating the cost for public stormwater improvements as watersheds are developed to ultimate use.
- Prioritizing stormwater management needs of each basin within a framework of the needs within the entire County.
- Developing a plan or identifying options available to the County for financing the cost of construction, operation, and maintenance of stormwater management facilities.

The report, released in February 1987, analyzed selected portions of Alligator and Phillippi Creeks. The analysis of these two basins included identifying problem areas, describing alternative solutions, and recommending actions. This information was extrapolated to the 14 remaining basins within the study area to provide cost estimates for stormwater improvements that could be implemented in these watersheds.

The County began the Basin Master Planning Program in 1991 when the Board of County Commissioners authorized the preparation of detailed basin master plans for Phillippi Creek and Hudson Bayou. The planning process include developing runoff hydrographs and water surface profiles for existing and future (2010) land uses for 2-year, 5-year, 10-year, 25-year, and 100-year/24-hour storm events for each basin. Each Basin Master Plan also identifies improvements needed to the County drainage systems to meet the adopted level-of-service (LOS) standards within the basin.

As of December 2004, the following studies have been completed or are under contract (Figure 6-2):

1. Whitaker Bayou – approved December 2003
2. Hudson Bayou – approved September 1994
   Business District – approved March 2002
3. Phillippi Creek – approved December 1994
4. Matheny Creek – approved September 1994
5. Elligraw Bayou – approved August 1994
   Holliday Bayou – approved August 1997
   Clower Creek – approved March 1994
6. Catfish Creek – approved July 2001
7. North Creek – approved April 1999
8. South Creek – approved June 2001
9. Shakett Creek – approved October 2001
   Fox Creek – approved June 1999
   Cow Pen Slough – approved October 2001
10. Curry Creek – approved July 2001
11. Hatchett Creek – approved July 2001
12. Alligator Creek – approved March 1987
13. Woodmere Creek – approved January 1999
14. Forked Creek – approved March 1996
15. Gottfried Creek – approved March 1996
16. Ainger Creek – approved July 1999
17. Braden River – under contract
18. Lower Myakka River – approved February 2004
    Upper Myakka River – under contract
19. Deer Prairie Slough – under contract
20. Big Slough – under contract

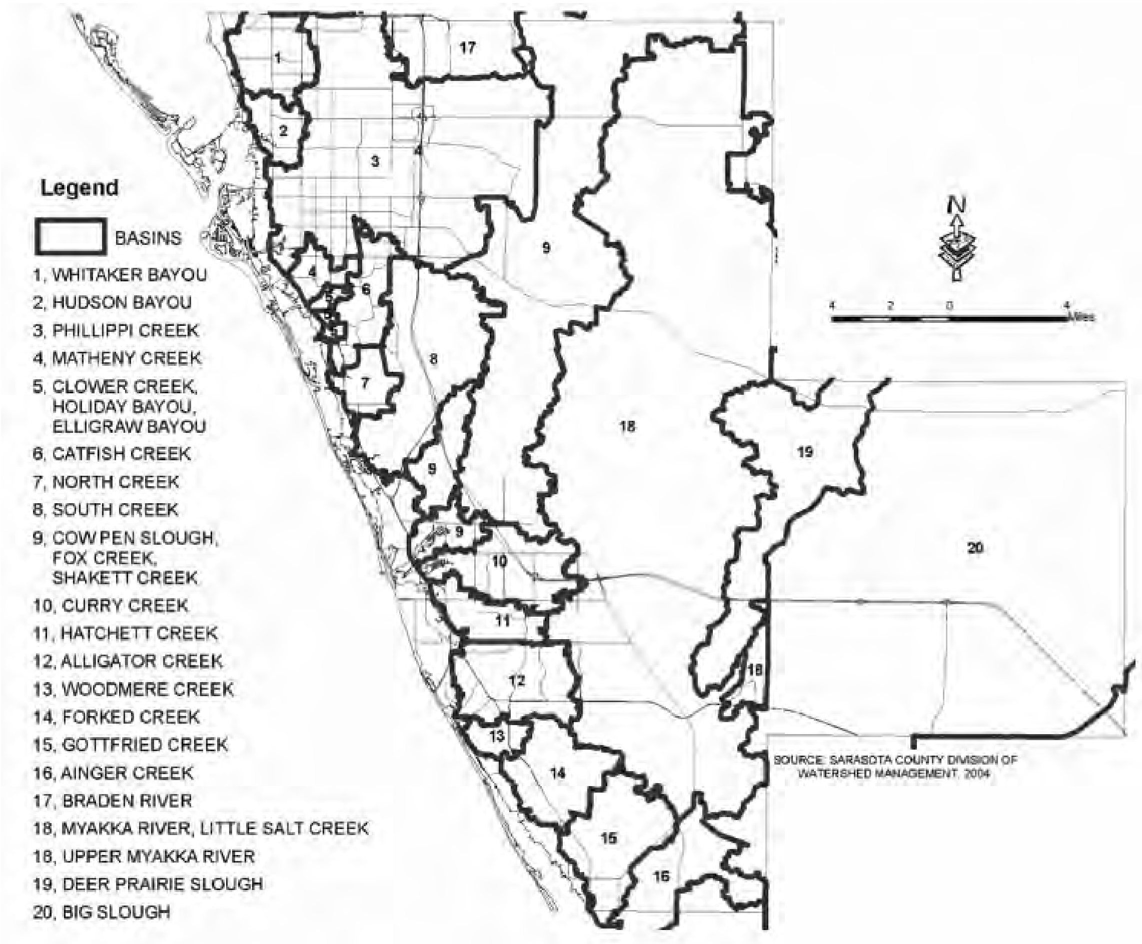

Figure 6-2 Sarasota County Drainage Basins
(Sarasota County Comprehensive Plan Figure 4-4)

Figure 6-3 presents an important product of the basin master plan effort: the horizontal limits of the riverine, 100-year floodplain. Much of the county riverine floodplain map to be used for local stormwater management planning has been completed. These maps and the detailed flood prediction models must, however, be kept up to date to reflect changes occurring in the watershed, such as land development and stormwater projects, or they will become obsolete.

Figure 6-3 Areas of Special Flood Hazard
(Sarasota County Comprehensive Plan Figure 4-5)

6.3 WATERSHED MASTER PLANNING

Numerous hydrologic studies dating back to the late 1950s have been completed throughout Sarasota County. The Alligator Creek (March 1987), Woodmere Creek (May 2000), Forked Creek (March 1996), Gottfried Creek (March 1996), and Ainger Creek (July 1999) Basin Master Plans were based on a detailed analysis of these studies, the existing and projected land uses, existing drainage facilities, and projected stormwater management needs. This information was used to develop hydrologic and hydraulic models to simulate runoff, conveyance, and flooding conditions for these Lemon Bay subbasins. Model results were used to identify the location and magnitude of existing flooding problems in the basins, to recommend a water quantity level of service, and to evaluate best management practices (BMPs) that could be developed into recommend Capital Improvement Projects to bring stormwater conveyance systems within the basins into compliance with the recommended FPLOS criteria.

6.3.1 Flood Protection Level of Service (FPLOS)

The stormwater quantity FPLOS requires that stormwater management systems, public and private, provide adequate control of stormwater runoff. The Stormwater Quantity or FPLOS and Design Criteria used throughout the Basin Master Plan program are defined in the Sarasota County Comprehensive Plan and LDR (Table 6-1).

Table 6-1 Stormwater Quantity Level of Service Design Criteria

Category		Flooding Reference	Level of Service (flood interval, years)
I.	Buildings	Emergency shelters and essential services	>100
		Habitable	100
		Employment/Service centers	100
II.	Roads Access	Evacuation	>100
		Arterials	100
		Collectors	25
		Neighborhood	10
III.	Sites	Urban (>1 unit/acre)	5
		Rural	2

*The above FPLOS criteria can be adjusted to allow greater amounts of flooding of roads and sites if the flooding is provided for in a Basin Master Plan or as part of a Stormwater Management system design. Increased flooding should not adversely impact public health and safety, natural resources, or property.

The highest goal of these criteria is to prevent flooding of emergency shelters and structures providing essential services from storms equal to or exceeding the 100-year event (10 inches in 24 hours). The FPLOS goal for habitable structures and employment/service centers is no flooding from storms up to and including the 100-year storm. Flooding of garages, barns, sheds, and other out-buildings is not considered structure flooding. The FPLOS established for roadways varies depending on the classification of the street or roadway. The objective of these criteria is to prevent flooding of evacuation routes and major arterial roadways during storms up to and including the 100-year event. Flooding of agricultural land, developed open or green space, and undeveloped lands designated for future development is acceptable in storms greater than 5-year events (7 inches in 24 hours) for urban areas (>1 unit/acre) and storms greater than the 2-year event (5 inches in 24 hours) in rural areas. This does not include flowways, floodplain, or flood storage areas.

Acceptable flooding for a 100-year storm is shown in Figure 6-4. FPLOS deficiencies consist of flooded homes and businesses as well as flooded streets. To date, the primary focus of the County's stormwater improvement program has been to address flooded homes and businesses, with a secondary focus on severe street flooding.

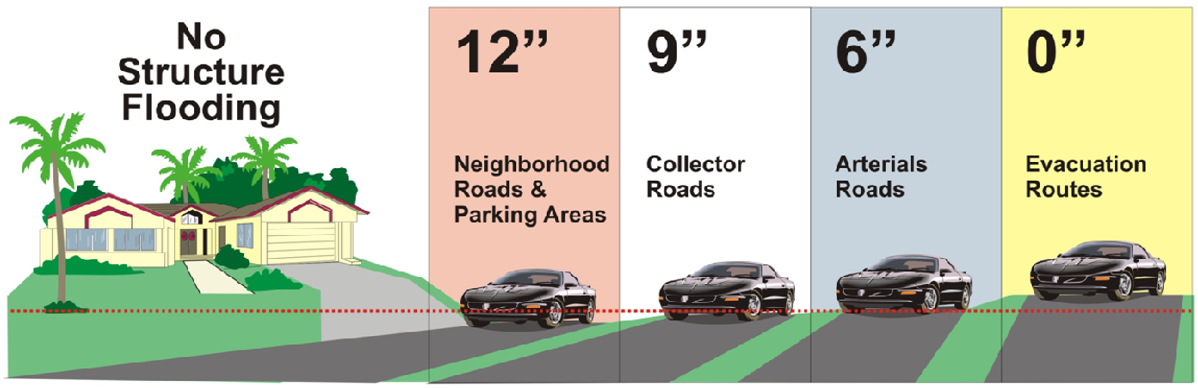

Figure 6-4 Acceptable Flooding for a 100-Year Storm

6.3.2 Watershed Modeling and Map Modernization

The County uses and maintains hydrological and hydraulic watershed specific models for most of the county. These models are used for development and CIP purposes to ensure no adverse impact offsite due to additional impervious area, per the LDR. Over time, land development, stormwater projects, erosion, and natural forces change water flow and drainage patterns. The risk of flooding in certain areas changes along with these factors. The detailed flood prediction models and county floodplain maps must therefore be updated regularly to be used for local stormwater management planning.

As with the County maps, the FEMA maps, which were created in the 1970s, also need to be updated. Sarasota County is partnering with SWFWMD to provide model and flood map updates. SWFWMD became a Cooperative Technical Partner with FEMA in 2001 to:

- Digitize the current paper flood maps, which were most recently updated in 1992.
- Input up-to-date flood data from more current Flood Study Updates for the County's 28 watershed basins.

The digital maps will reflect current flood risks, including areas of recent growth, replacing older paper maps produced many years ago. New digital mapping techniques provide more detailed, reliable, and current data on flood hazards. The new digital maps will provide up-to-date, reliable information on a property-by-property basis electronically. Once the models and digital maps are completed, they will be used to produce new Digital Flood Insurance Rate Maps (DFIRMs). After an adoption period, the maps will become the effective flood information for the National Flood Insurance Rate Program (NFIP). The County will also continue to update the floodplain maps and models for local stormwater management planning needs.

The map modernization process is a concurrent work effort with this WMP and will bring Alligator Creek basin floodplain mapping up to 2007 LiDAR standards.

6.3.3 Capital Improvement Projects

CIPs address water quantity FPLOS deficiencies for structures and roadways. The SEU started its first capital improvement projects in 1994 to address structure flooding and severe street flooding. Stormwater Improvement Assessments were initiated in 1995. A revolving 5-year plan of CIPs, as required by the Comprehensive Plan, was then established to prioritize the initiation and implementation of the projects. CIP projects in the Lemon Bay Watershed are presented in Figure 6-5 and Table 6-2.

6.4 CONCLUSION

Sarasota County has flood-protection-related policies and programs in place to minimize flood risk to protect human safety and property in existing developed areas while protecting natural and beneficial functions of the remaining floodplain. In addition, the County LDR provides regulations that guide new development as it pertains to the force of flowing water and drainage of runoff. Several capital improvement projects, such as stormwater control structures, retrofit projects, and retention and detention ponds, are currently occurring throughout the watershed. Chapter 8 of this WMP includes proposed projects and recommendations to further mitigate flooding, such as increased buffers around water courses for future development, rain gardens aimed at restoring some of the isolated wetland loss functions of attenuation, and LID to reduce freshwater discharges.

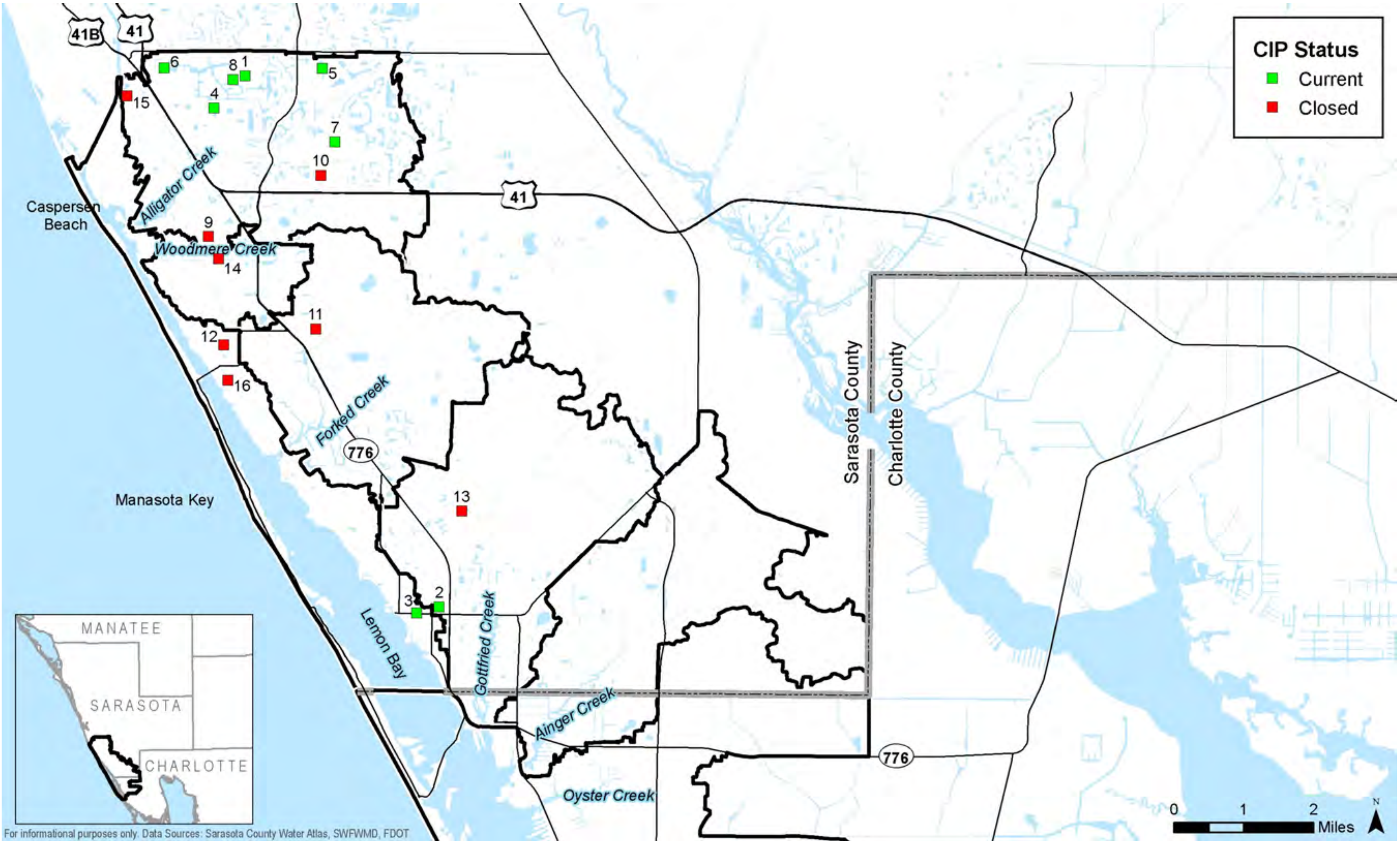

Figure 6-5 Lemon Bay Watershed 2009 CIP Projects

Table 6-2 Lemon Bay Watershed CIP Projects				
Map ID	Project ID	Project Title	Project Description	Project Status
1	85872	Bal Harbour Dr	This project will provide Banyan Drive culvert replacements and ROW storage, Briarwood area conveyance improvements, Bal Harbour/ Shamrock Blvd. drainage improvements, and Quail Lake control structure modifications. The project also expands and conve*	Current
2	75828	Coconut Avenue/Elsie Quirk	This project will secure easements and construct an outfall control structure in the lake between Coconut Avenue and Perry Lane to improve the conveyance of water into Gottfried Creek. Currently updating the model to better define the floodplain.	Current
3	Englewood	Englewood CRA Stormwater Treatment	*	Current
4	85872	General Neighborhood Briarwood	This project will provide Banyan Drive culvert replacements and ROW storage, Briarwood area conveyance improvements, Bal Harbour/ Shamrock Blvd. drainage improvements, and Quail Lake control structure modifications. The project also expands and conve*	Current
5	85872	Quail Lake Pond Area	This project will provide Banyan Drive culvert replacements and ROW storage, Briarwood area conveyance improvements, Bal Harbour/ Shamrock Blvd. drainage improvements, and Quail Lake control structure modifications. The project also expands and conve*	Current
6	85872	Shamrock and Banyan Intersection	This project will provide Banyan Drive culvert replacements and ROW storage, Briarwood area conveyance improvements, Bal Harbour/ Shamrock Blvd. drainage improvements, and Quail Lake control structure modifications. The project also expands and conve*	Current
8	85872	Venice East Blvd – Gulf Breeze Blvd	This project will provide Banyan Drive culvert replacements and ROW storage, Briarwood area conveyance improvements, Bal Harbour/ Shamrock Blvd. drainage improvements, and Quail Lake control structure modifications. The project also expands and conve*	Current
9	Venice Gard	Venice Gardens Stormwater Infrastructure	*	Current

Table 6-2 Lemon Bay Watershed CIP Projects				
Map ID	Project ID	Project Title	Project Description	Project Status
10	85874	Golf Club Lane	This project was identified in the Sarasota County Stormwater Master Plan. The area experiences frequent roadway and structure flooding due to insufficient channel capacity downstream of Lake Marlin and Dolphin Lake. Maintenance of the existing chann*	Closed
11	85878	Gulf View Estates Outfall	This project, located in the Venice East area, involves an existing canal along Golf Club Lane requiring redesign to reduce erosion and encroachment onto private property.	Closed
12	Manasota	Manasota Gardens	The project consists of widening and improving conveyance within the Forked Creek channel including replacement of two wooden bridges with box culverts, and some ditch work in the area.	Closed
13	75802	North Englewood Lateral	*	Closed
14	75819	Northern Branch	The proposed improvements have been identified in the Gottfried Creek Basin Study. Phase I improvements, replacing existing pipes under SR776 with a triple barrel box culvert, have already been completed. Phase II improvements include ditch widening, c*	Closed
15	Scenic Drive	Scenic Drive Stormwater Improvements	Woodmere Drainage Improvements project proposes to replace the existing culverts under Heron Road, Kent Road, Pompano Road, and Florida Road with 8-foot x 12-foot box culverts for a total length of 289 feet. Also, this project includes water quality enhancement*	Closed
16	75801	South Manasota Beach Road		Closed

* Information provided by Sarasota County. Please contact the County office for additional details.

Chapter 7

Stormwater Management Facility Maintenance

August 2010

Sarasota County

Southwest Florida Water Management District

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7.0 STORMWATER MANAGEMENT FACILITY MAINTENANCE

7.1 INTRODUCTION

Comprehensive, regular maintenance of stormwater management systems is essential to ensure the efficient function of existing stormwater conveyances and for new stormwater facilities to function within their original design parameters following construction. Maintenance is also required for preventing water quality degradation, controlling exotic plant species, preserving aesthetics, and maintaining public safety.

The Stormwater Environmental Utility (SEU) was established in 1989 "to provide a dedicated source of funding for the operation, maintenance, planning, and improvement of the public stormwater system." The SEU developed a *Strategic Maintenance Plan* adopted in 1999 that established level-of-service (LOS) goals for maintenance activities for the Field Services Group (fka Drainage Operations). The plan identifies maintenance practices and classifies practices into *Routine*, *Extraordinary*, and *Support* activities in which the staff engages for maintenance repairs, improvement, management, and operation of the public stormwater system.

Reorganization within the County grouped facilities maintenance into a single entity now called Field Services. The recently created divisions within Field Services are Water Systems and Road Right-of-Way Systems. Figure 7-1 shows the organizational groups within Field Services. Each group provides inspection and maintenance for their respective areas of responsibility. Funding for stormwater maintenance is derived from the Stormwater Environmental Utility Service Assessment.

Jones Edmunds analyzed current maintenance policies and procedures as part of the Roberts Bay North and Lemon Bay Watershed Management Plans (WMPs) including:

- Evaluating current maintenance practices.
- Identifying additional improvements to stormwater maintenance practices.
- Analyzing best management practices (BMPs) for nutrient reduction efficiency and estimating removal costs.
- Analyzing vegetative growth for flood conveyance impairment.

Identifying maintenance practices to improve water quality without compromising flood control allows maintenance to contribute to meeting the County's environmental goals.

The evaluation found that water quality should receive added considerations in maintenance practices; thus, this section of the WMP focuses on identifying maintenance practices for water quality improvement purposes without compromising the flood control LOS. The practices identified are applicable to all the County's watersheds.

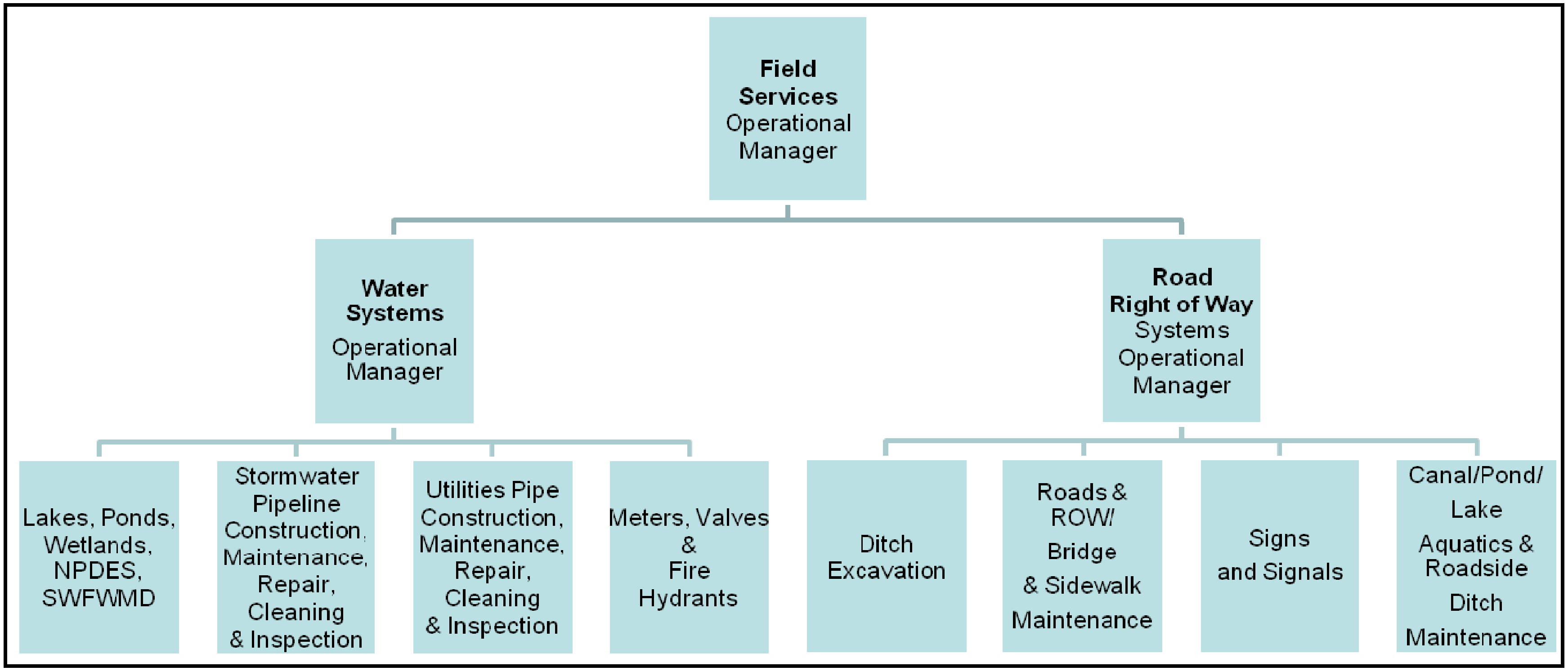

Figure 7-1 Sarasota County Operations and Maintenance Services Organizational Chart

7.2 FACILITIES AND RELATED PROGRAMS

7.2.1 Facilities

The Field Services group is responsible for maintaining a system of canals, lakes, and subdivision retention/detention ponds deeded to the County. Sarasota County has approximately 600 miles of canals, of which 375 miles are maintained by the County. The group also maintains the following types of public stormwater utilities:

- Storm sewers, culverts, pipes, and inlets.
- Water control structures, weirs, and pumps.
- Permitted wetland mitigation sites.
- Roadside ditches.

The *Strategic Maintenance Plan* provides a scoring/scheduling framework to establish priorities for routine system maintenance. The scoring is based on land use, flooding history, and facility type and determines if a facility should be maintained every year, every 2 years, or every 3 years. The total maintenance effort required is calculated; if maintenance demand exceeds the working capacity of the staff, priorities are re-evaluated to balance the demand on the staff to meet their working capacity.

A system inspection schedule is not explicitly outlined in the *Strategic Maintenance Plan* but is referenced as routine inspection programs and internally generated inspection reports.

7.2.2 Related Programs

7.2.2.1 FEMA CRS Program

The Federal Emergency Management Agency (FEMA) offers an incentive program for communities participating in the Community Rating System (CRS) program. Participation is voluntary, and the County chooses to participate to provide lower flood insurance premiums to its residents. The purpose of the program is to recognize and encourage community floodplain management activities that exceed the minimum requirements of the National Flood Insurance Program (NFIP). Premium discounts are provided for the entire County based on a rating system tied to creditable activities within the following categories:

- Public Information.
- Mapping and Regulations.
- Flood Damage Reductions.
- Flood Preparedness.

Within the County's CRS program *Activity 540, Drainage System Maintenance*, is the responsibility of the County's Field Services group, which participates in the following activities:

- Inspecting the stormwater management system.
- Responding to Customer Service Requests.
- Monitoring recurrent problem areas.
- Documenting above activities.

7.2.2.2 NPDES and County MS4 Permit

Sarasota County is a Municipal Separate Storm Sewer System (MS4) operator and holds a National Pollutant Discharge Elimination System (NPDES) permit (Number FLS000004) from the Florida Department of Environmental Protection (FDEP). To maintain the permit, the County has developed a stormwater management program that includes BMPs with measurable goals to effectively implement eight minimum control measures outlined in the 2006 Comprehensive Plan:

1. Maintenance of Structural Controls: Inspect and maintain structural controls. Maintain an internal record keeping system.

2. Development Planning: Adopt stormwater treatment ordinances requirement treatment of the first one inch of runoff. Complete Basin Master Plans. Implement Land Development Practices to reduce impervious surfaces.

3. Roadway Maintenance: Control litter along roads. Sweep Streets. Maintain catch basins, grates and roadside ditches. Properly dispose of wastes. Use Best Management Practices (BMPs) to reduce polluted runoff from road repairs, equipment yards and maintenance shops.

4. Municipal Facilities: Use BMPs to reduce polluted discharges from solid waste transfer lift stations, maintenance and storage yards for waste transportation fleets, and sludge sites.

5. Pesticides, Herbicides, and Fertilizers: Encourage the public to reduce use of pesticides, herbicides, and fertilizers. Train and certify employees handling pesticides, herbicides, and fertilizers. Minimize the use and properly store and mix pesticides, herbicides and fertilizers.

6. Illicit Discharges and Improper Disposal: Inspections, Ordinances, and Enforcement: List non-stormwater discharges allowed into MS4. Inspect and prohibit illicit connections and illegal dumping into the MS4. Use Sarasota

County's Hazardous Materials Emergency Plan to mitigate potential pollutant discharges to surface waters. Support and promote oil recycling, collection of household hazardous wastes. Support and promote marking of storm sewer inlets that discharge into surface waters.

7. Industrial and High Risk Runoff: Prioritize an inventory of all high-risk facilities discharging into the MS4, including outfall and receiving water. Inspect facilities. Monitor high-risk facilities.

8. Construction Site Planning and Inspection and Enforcement: Regulate erosion control through requirement of Erosion Control plans for earth moving activities. Document BMP installation, maintenance and effectiveness. Train inspectors. Use an inspection checklist. Require compliance with stormwater ordinance and local permits. Conduct an annual NPDES workshop for design professionals, land developers, inspectors and contractors.

From the 2000 *Stormwater Environmental Utility Strategic Plan*, the Stormwater Environmental Utility is responsible for several elements of the permit: basin master planning, capital improvement program, stormwater management system inspection, inspection/maintenance of the public drainage system, proper disposal of sediments and other materials, and proper storage and use of herbicides. Field Services provides critical support for four of the measures within the SEU areas of responsibility: Maintenance of Structural Controls; Roadway Maintenance; Pesticides, Herbicides, and Fertilizers; and Illicit Discharge Detection and Improper Disposal. Field Services works with the rest of the County staff to meet the overall goal of the NPDES permit, which is to reduce or prevent impairment of the local waterbodies.

7.3 WATER QUALITY MAINTENANCE PRACTICES AND CONSIDERATIONS

Current stormwater maintenance activities are directed primarily at maintaining the stormwater conveyance function as well as the safety and aesthetic features of the system. The water quality improvement features of the stormwater management facilities should receive equal emphasis. In some cases, this increased focus on water quality can be successful with minor changes to existing routine practices.

Modification of routine maintenance practices may reduce the pollutant load to County waterways. Below is a discussion of several pollutant sources and their impacts to the pollutant load followed by BMP removal efficiencies of these pollutants and a cost/benefit analysis for the removal of pollutants of concern.

7.3.1 Current Practices

Field Services performs activities classified as routine, extraordinary, and support maintenance practices. Generally, routine practices are performed as scheduled or programmed, although recurrent problems are addressed on a relatively consistent schedule and could be called preventive maintenance. As-needed routine maintenance includes:

- Erosion repair.
- Bank stabilization.
- Structure and pipe repair.
- Herbicide spraying.
- Hand clearing.
- Channel dredging for drainage purposes.
- Lake, pond, and mitigation area maintenance and monitoring.
- Vegetative mowing.
- Mechanical system servicing.

Extraordinary maintenance is usually unexpected and generally a response an emergency. The *Stormwater Environmental Utility Strategic Plan* (2000) notes that it is possible to schedule some extraordinary maintenance when deterioration has been observed and documented.

Jones Edmunds held several meetings and conference calls with Field Services to determine the policies and procedures implemented in the field. The topics covered in the meetings with respect to maintenance practices included the following:

- Removing excess vegetation.
- Applying herbicides or growth inhibitors.
- Altering flowpaths.
- Installing check dams or weirs.
- Sodding and seeding.
- Mowing practices.

During meetings with the County, the maintenance staff expressed concern regarding the amount of vegetation in several of the channels and the impact increased vegetation has on flood capacity. Staff regularly denudes the channel banks to restore flood capacity and requested guidance as to a minimal level of vegetation that could remain and not impact flood conveyance or control. This guidance is discussed later in this chapter.

7.3.2 Field Observations of Maintenance Practices

Maintenance practices that could be improved have been noted by County staff as well as during field visits by Jones Edmunds. During the initial meeting with County staff, several examples of undesirable maintenance practices were discussed and photographs shown:

- Woodmere Creek appeared to have had vegetation cut mechanically. The channel and slopes were then denuded, either mechanically or with herbicides. Possibly as a result, there was an approximately 14-inch deep buildup of silt and muck in the channel. Dead vegetation was washed downstream, partially clogging the conveyance. Water quality sampling showed an increase in turbidity and total nitrogen soon after vegetation removal, although this could have been a coincidence.

- Philippi Creek—Channel "Main B" appeared to have fill placed at the bottom of the channel slopes, possibly to remediate slope erosion. The slopes had no vegetation, and there was no vegetation in the channel bottom. A turbidity curtain had been placed in the channel during fill placement but did not appear to be effective. As a result, flowing water was very turbid, a thick layer of muck was observed in the bottom of the channel, and silt had built up in the downstream structures.

- Photographs of Cow Pen Slough showed thick vegetation build-up below the south weir. The County regularly sprays the vegetation but does not remove the decaying plant material from the watercourse.

The negative impacts of these practices on water quality are increased nutrients, increased turbidity, and decreased benthic habitat value.

Sediment management and natural systems tasks in the WMP included site visits and field investigations, during which Jones Edmunds noted current maintenance practices. The following are some examples of maintenance activities observed in the watersheds.

On October 22, 2008 in the Forked Creek subwatershed, on the south side of Overbrook Rd east of Fairview Drive Bridge, we observed improper mowing practices in a drainage swale that drains directly into Forked Creek. The drainage swale had been mowed within the last several days. Dry grass clippings were lying on the side slopes of the swale as well as on a drop inlet directly connected to the creek (Photograph 1). Grass clipping debris was in the bottom of the drop box.

Photograph 1 Grass Clippings Lining Drainage Swale

On October 23, 2008 in the Alligator Creek subwatershed we identified two sites—upstream of the US 41 bridge and the creek adjacent to Dorchester Drive—where maintenance practices were inconsistent with the County's goal of BMPs in the waterways. Herbicides were applied to in-stream vegetation and vegetation on the banks. The location upstream of the US 41 bridge contained approximately 2,000 square feet of water lettuce that had been sprayed and left in the waterway. The rotting vegetation blocked the flow of water and emitted a foul odor (Photograph 2). Additionally, herbicides had been sprayed on vegetation outside of the flowpath, and the vegetation was left to decompose and fall into the waterway. Adjacent to Dorchester Drive, water lettuce was sprayed and left in the waterway and vegetation outside the waterway was sprayed and left to decompose into the waterway.

Photograph 2 Decomposing Water Lettuce Blocking the Flowpath

On October 23, 2008, Jones Edmunds staff visited another site in the Alligator Creek subwatershed at the east end of East Baffin Road. The drainage swales had been completely denuded by an excavator and had not been reseeded (Photograph 3). Sediment was able to flow freely from the downstream end of drainage swales into the tributary of Alligator Creek (Photograph 4).

Photograph 3 Excavated Roadside Drainage Swale

Photograph 4 Erosion at Outfall Pipe

7.3.3 Considerations for Vegetation Removal

Excess vegetation in channels and ditches impacts the flood control capacity of the waterway, so the excess vegetation must be removed to maintain the conveyance capacity of the channel for public safety. However, the current practices of excess vegetation removal by the maintenance staff may result in significant pollutant loading that could potentially be prevented in lieu of other potentially more expensive pollutant reduction measures.

Aquatic and terrestrial vegetation remove nutrients from runoff. When these plants decay, nutrients are released back into the water and environment. Terrestrial vegetation contributes to bank stabilization; removal of the plant and root systems reduces soil moisture capacity and cohesiveness, leading to erosion and excess sedimentation. Both types of vegetation also provide habitat value.

7.3.3.1 Water Quality

A number of attempts have been made to quantify the nutrient (nitrogen and phosphorus) content of wetland plants. Kadlec and Knight (1996) evaluated the ranges of mineral composition of typical plants used in wetland treatment systems. They reported the average nitrogen content to be 2.26% with a range of 1.46 to 3.95% of the dry weight and the average phosphorus to be 0.25% with a range of 0.08 to 0.63% of the dry weight of plant material. Mitsch and Gosselink (1993) report an optimal N:P ratio of wetland plants to be 8:1, concluding nitrogen and phosphorus uptakes by the plant are not independent of each other. They also reported more nitrogen and phosphorus is retained in above-ground plants, with a nitrogen range of 3 g/m^2 to 29 g/m^2. Several studies in Brevard County have quantified the leaching of nutrients into stormwater when the organic constituents are submerged to help facilitate the selection of BMPs. The nutrient leaching cited in these studies was used to estimate the cost per pound of removal of Total Kjeldahl Nitrogen (TKN) and total phosphorus (TP) for several maintenance practices.

One study from Brevard County (Strynchuk et al., 2004) focused on the leaching of nutrients from grass clippings and leaf litter if the solids are trapped in a wet environment BMP. The peak of the leaching process of TKN and P from the organic solid debris into the stormwater system occurs during the first day of submergence. An approximately 11% decrease in the TKN and 54% decrease in the P from the original solids mass corresponds to a 44% increase of TKN and a 746% increase of P in the liquid control volume during that time. The implication from this study is that landscape debris entering the system within hours of cutting or falling will increase the nutrient load in the water. Increased nutrient loads can stimulate excessive algae growth, decrease water clarity, and account for habitat loss. While the study focused on leaf litter and grass clippings, applying herbicides to aquatic plants within the flowpath will have the same outcome and contribute organic nutrients and debris to the system when vegetation is left to decay in the waterway.

A second study in Brevard County (England, 2008) measured the decrease in nutrient content from the drying process in fertilized and unfertilized grass clippings. After 30 days of drying, the reduction in TKN from the samples ranged from 58 to 96%. The drying process resulted in a 23 to 49% reduction in TP. The implication for maintenance is that removing vegetation to a location outside of the channel that allows for drying has a nutrient-load-reduction benefit compared to leaving the material in the channel.

7.3.3.2 Flood Control Capacities

Denuding channel banks is regularly practiced to maintain the flood capacity of the drainage channel. The increased roughness and drag associated with the density and dimensions of plant growth may inhibit the conveyance capacity of the channel, but the removal of all vegetation leads to increased bank instability and erosion and ultimately the sediment is transported and deposited downstream, with potentially adverse impacts. Maintenance crews regularly practice complete removal (denuding) when clearing roadside ditches and swales. Resodding or seeding is completed within 14 days of the excavation. This practice is consistent with the Florida Erosion and Sediment Control Manual direction that "Disturbed areas which are to be stabilized with permanent vegetation must be sodded or planted within 15 days after final grade is reached unless temporary stabilization is applied."

Maintenance practices may be altered to mow or trim vegetation to a level that will have minimal impact on the conveyance capacity of the channel and prevent destabilization and erosion of the channel banks. Note that when mowing or trimming, grass and vegetative clippings need to be removed from the channel banks to avoid decomposing in the waterway and increasing the nutrient load to the water and bottom sediments.

Vegetation increases the roughness of channels; therefore, increased vegetation results in increased flood stages. Yet because of the many beneficial aspects of increased vegetation such as erosion control and water quality improvement, vegetation in swales and channels is desirable.

Relative vegetation effects on flood stage were calculated by setting Manning's equation equal for the different roughness conditions and solving for depth. Typical roughness values were taken from the FDOT Drainage Manual (FDOT, 1986). The graphs illustrate the relative effect of vegetation on flood stage for a typical swale (Figure 7-2) and a typical channel (Figure 7-3) and show that in two equivalent channels, one maintained and the other vegetated, flood stages for the same flow will be higher in the vegetated channel. These increases range from significant to modest. For example, in Figure 7-3 if water is flowing at a 4-foot depth in a maintained channel, this same flow would increase by over 3 feet (above 7 feet deep) in a heavily vegetated channel but would expect only modest increases (around 0.6 feet) in a "low" vegetated channel.

Short-standing vegetation has minimal impact to channel conveyance capacity.

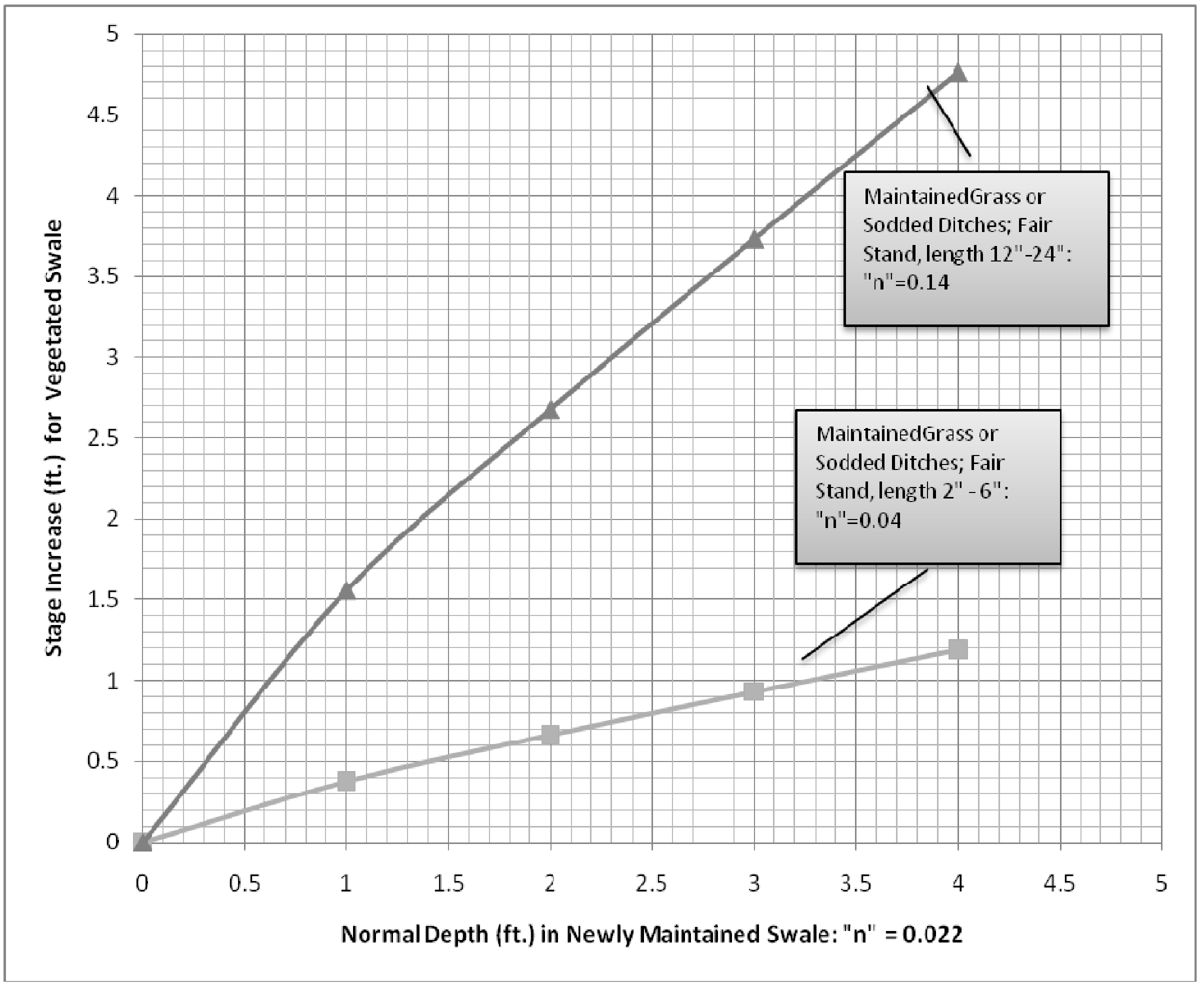

Figure 7-2 Stage Increase for Typical Swale

Source: Jones Edmunds & Associates, Inc. (2009); FDOT Drainage Manual, Volume 2, 1986

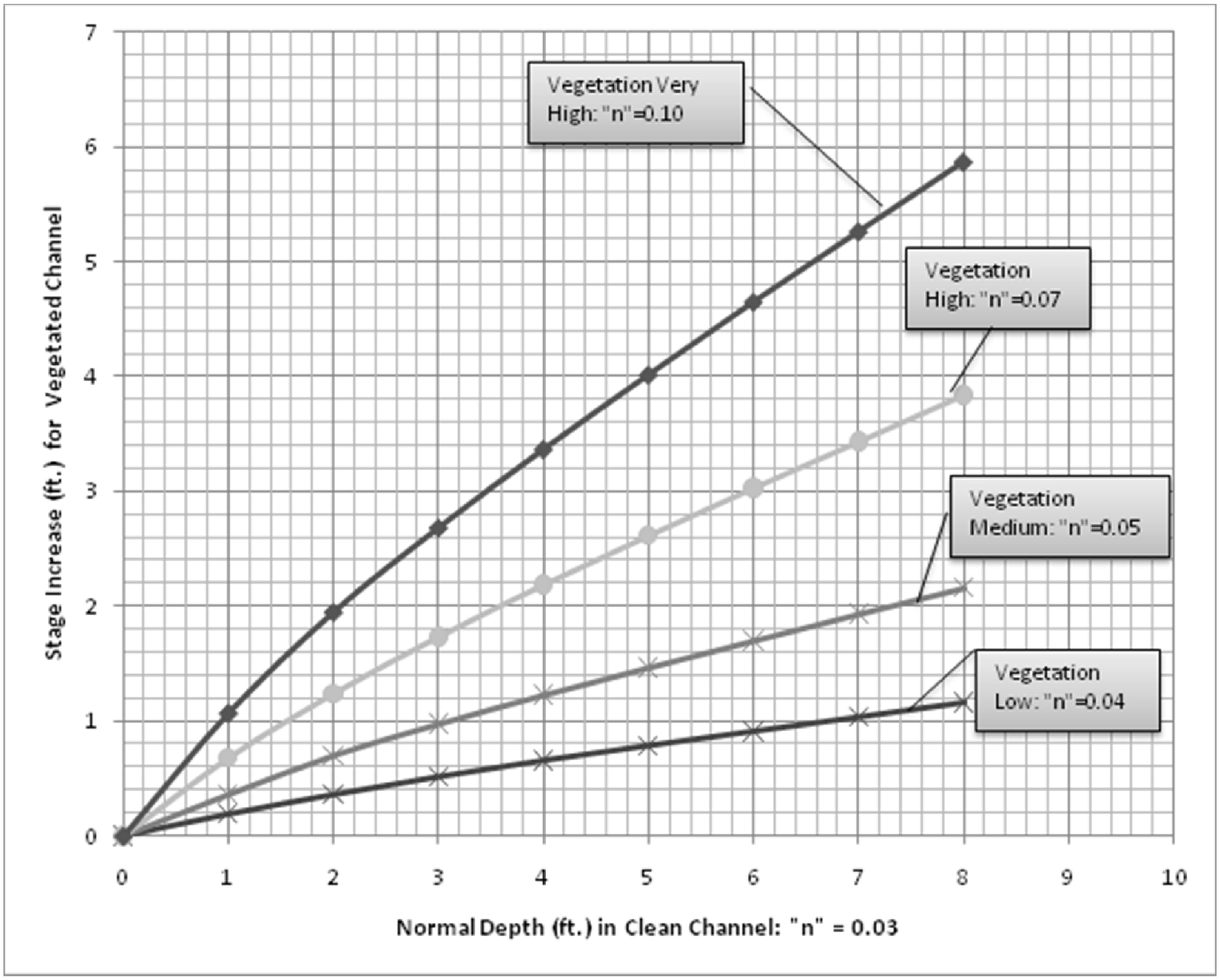

Figure 7-3 Stage Increase for Typical Channel

Source: Jones Edmunds & Associates, Inc. (2009); FDOT Drainage Manual, Volume 2, 1986

The approximate stage increases shown on these graphs are a rough approximation intended to provide basic, relative information. To determine the actual effect of vegetation on flood stage, hydraulic modeling would be needed to incorporate roughness changes. The model will not be limited by the simplifying assumptions used to develop these graphs—namely steady, normal flow.

Since it is clear that different maintenance practices will have varying levels of impact on flood levels, it may be important to understand two other data elements. The first element is the actual design roughness for each channel reach. If higher roughness values were used, then it may be possible to be less aggressive with vegetation removal and still provide desired levels of service for flood protection. Unfortunately, the design calculations for many of the channels and swales are not available due to the age of the system. Additionally, the channel geometries may no longer be representative of the original design conditions due to erosion, sedimentation, or other changes. The second element is how much the roughness (i.e., the maintenance practice) could deviate from the original design condition or the condition currently used in the County's models without creating a reduction in the desired flood protection LOS. This element of data would require extensive analysis and likely result in reach-specific maintenance requirements.

7.4 BEST MANAGEMENT PRACTICES

In stormwater management, BMPs refer to controls and techniques used to mitigate impacts from stormwater runoff due to land development. Stormwater BMPs, structural and non-structural, are intended to improve stormwater runoff quality and many provide hydrologic restoration benefits as well. Source control, a subset of non-structural BMPs, addresses pollution prevention through "good housekeeping" practices. These non-structural BMPs are designed to improve stormwater runoff quality, and a select few of them provide hydrologic restoration benefits.

Some structural BMPs function in part to attenuate flow and provide a specified level of flood protection. They also function to reduce stormwater pollution. Structural BMPs are generally stormwater ponds (wet and dry), constructed wetlands, grassed swales or ditches, bioretention systems, filtration systems, and sediment removal devices. The ability of a structural BMP to remove constituents of concern partially depends on maintenance.

Non-structural BMPs are a combination of practices that focus on preservation of natural systems and pollution reduction. Low-impact-development (LID) practices such as disconnecting stormwater drains, protecting buffers, and reducing impervious areas as well as public education are part of the suite of non-structural BMPs that do not require traditional stormwater maintenance. Source control is a subset of non-structural BMPs that requires maintenance effort. Source control BMPs discussed here are street sweeping, storm drain cleanout, herbicides, fertilizer management, and harvesters.

In 2003 the U.S. Environmental Protection Agency (EPA) identified approximately 130 individual BMPs associated with NPDES regulation categories and requirements. Examples of BMP options are provided in Table 7-1.

Table 7-1 EPA's NPDES BMP Options

Structural BMPs	Non-Structural BMPs	Source Control
Dry detention ponds	Buffer zones	Parking lot and street cleaning
Wet ponds	Conservation easements	Storm drain system cleanout
Infiltration basins	LID Practices	Herbicide management
Porous pavement	Public Education	Fertilizer management
Bioretention	BMP inspection and maintenance	Harvesters
Stormwater wetlands	Source Control	
Grassed swales		
Sediment Removal Devices		

Source: EPA: The Use of Best Management Practices in Urban Watersheds (2005)

7.4.1 Structural BMPs

7.4.1.1 Wet Pond

Wet ponds are popular BMPs in the urban Florida landscape. They provide flood protection, erosion control, and pollutant removal for stormwater runoff in developed areas. A network of drainage devices, typically swales and culverts, direct runoff from a developed area to a drainage basin. A control structure regulates the release of water downstream into receiving waters through orifices, notches, and grates.

Urbanization and the associated increase in impervious area cause an increase in peak runoff. By attenuating runoff and controlling the discharge of the stormwater, flooding and erosion risks downstream can be reduced. The vegetation in littoral zones and on the banks improves water quality.

Maintenance of these ponds consists of as-needed mowing, structure inspection and clean-out, and aquatic plant control.

7.4.1.2 Dry Pond

Dry ponds are designed to capture and treat stormwater runoff by allowing water to infiltrate through soil media into the shallow groundwater aquifer (SWFWMD, 2008). Grass usually covers the side slopes and bottom of the pond. Under normal circumstances, these ponds do not discharge to a downstream stormwater conveyance system.

Maintenance of these ponds consists of as-needed mowing and litter and debris removal as well as excess sediment removal.

7.4.1.3 Infiltration Systems

For the purposes of this discussion, infiltration systems are dry, constructed ponds with underdrain systems to allow runoff to discharge to a downstream stormwater conveyance system. The underdrain system has sand or soil media that act as a filter. Replacement of the media is necessary to maintain the design function of the pond.

Maintenance of these ponds consists of as-needed mowing, litter and debris removal, and replacement of the sand filter.

7.4.1.4 Permeable Pavement

The use of permeable pavement is generally considered part of a suite of LID practices to reduce non-point source stormwater runoff but is treated as a structural BMP herein because it requires maintenance. Permeable pavement allows some infiltration of stormwater through voids in the paving material or "gapped" installation where traditional paving materials do not have the capacity for any percolation or infiltration of runoff.

Newer products such as porous asphalt, pervious concrete, etc. minimize runoff from small storms and allow some stormwater to infiltrate into the soil media below, reducing runoff and pollutant loads to receiving waters. The paving material is underlain with an aggregate sub-base and geotextile. Water is stored in the voids in the aggregate and will eventually evaporate or infiltrate. Using care is necessary when choosing sites for porous pavement, and maintenance is required three to four times per year.

Pervious pavement systems must be maintained by removing clogging material from the surface to maintain optimum surface infiltration rates. Vacuuming systems on vehicles are often used for large pervious pavement areas where the vehicles' movement is not limited. The surface must not be pressure washed to remove clogging material since pressure washing can force clogging material deeper into the pervious pavement system where it is more difficult to extract, thus permanently reducing infiltration rates. Alternative methods (such as industrial vacuum cleaners) for removing clogging material from less-accessible installations, such as walking, cycling, and cart paths or driveways, may be permissible as long as surface infiltration rates are improved and are greater than the threshold 1.5 inches per hour. Follow-up infiltration rate measurements, to ensure that the infiltration rate exceeds 1.5 inches per hour, are required. Any surface shifting or cracking should be promptly repaired. Filter material removed during vacuum sweeping should be replenished with material that meets the specifications of the original filter material. Please see the Sarasota County Low-Impact Development Manual for additional information.

7.4.1.5 Bioretention

Bioretention areas are shallow depressions used as structural stormwater controls to capture, treat, and infiltrate stormwater runoff and are part of a suite of LID practices. Within the bioretention area, nutrient adsorption media, soils, mulch, and planted vegetation facilitate treatment and remove pollutants from the runoff. Multiple bioretention areas are often distributed throughout a larger catchment, providing numerous treatment and water storage areas. Although any one treatment area may be small, the cumulative effect can be significant. This distributed approach also better mimics predevelopment hydrologic conditions by promoting stormwater infiltration, thereby reducing runoff and recharging groundwater.

To facilitate maintenance of the underdrain system, capped and sealed inspection and cleanout ports that extend to the surface of the ground should be provided at the beginning and end of each run of pipe and at every 50 feet or every bend greater than 45 degrees, whichever is shorter.

The following maintenance procedures are recommended:

- Prune and weed to maintain appearance and keep any structures clear as needed.
- Maintain/mow the pretreatment vegetative filter or swale at least twice during the growing season and remove clippings from the flow path.
- Replace mulch where needed when erosion is evident.
- Remove trash and debris as needed.
- Replace mulch over the entire area every 2 to 3 years.
- Remove sediment from inflow system and outflow system as needed.
- Stabilize any upstream erosion as needed.
- Remove and replace any dead or severely damaged vegetation.

7.4.1.6 Constructed Stormwater Wetlands

Constructed stormwater wetlands are designed primarily for pollutant removal, erosion control, and flood protection but also provide wildlife habitat and aesthetic value. Generally, stormwater influent is stored in shallow pools that allow the settling of particulates, biological uptake by plants, and filtration by the soil media. The shallow pools and small channels associated with constructed wetlands create a suitable environment for submerged and emergent vegetation. As with natural wetlands, the constructed wetland must be able to maintain a permanent pool in the dry season but tend to have less biodiversity. Constructed wetlands are designed to effectively remove sediment, nitrogen, phosphorus, and heavy metals from runoff.

7.4.1.7 Grassed Swales

Grassed swales are linear, vegetated, open-channel BMPs used for stormwater treatment and conveyance and are often associated with roadway drainage. The design allows the water to be absorbed quickly. Swales will normally hold water after storm events but are generally dry features.

7.4.1.8 Sediment Removal Devices

Sediment removal devices (CDS Units, baffle boxes, water quality inlets) are designed to retain coarse-grained sediment from an urban landscape with fine-grained sediment usually passing through. The removal efficiency of the unit depends on many factors, including the size of the sump and the amount of sediment and debris collected in the sump. As the sump fills, the efficiency of sediment removal starts to decrease; sediment captured in the sump will start to become re-suspended in the water column as the sump is filled and collected debris will be flushed downstream. With ongoing semi-annual cleaning, maintenance staff can gauge which units need more frequent cleanout to maintain higher water quality removal efficiencies.

7.4.2 Non-Structural BMPs

7.4.2.1 Maintenance Buffer Zones

Buffer zones along watercourses provide important benefits, including water quality improvement, flood protection, bank stabilization, and habitat protection. While most research has focused on forested buffers, similar benefits may be realized in an urban setting. A buffer in an urban area is typically an area of vegetation consisting of trees, shrubs, and grass designed to:

- Trap sediment and remove pollutants.
- Protect stream banks from erosion by providing hearty root systems to increase the cohesiveness of the soil matrix and reduce the velocity of overland flow.

Buffers facilitate pollutant removal through plant uptake of nutrients and removal of surface runoff particulates. Recommended minimum buffer widths for specific watershed objectives listed in the Chesapeake Bay Riparian Handbook are shown in Table 7-2.

Table 7-2 Minimum Buffer Widths

Objective	Buffer Width (ft)
Bank stabilization	< 25
Water temperature	15-25
Nitrogen removal	35-90
Sediment removal	50-100
Flood mitigation	50-200
Wildlife habitat	> 100

7.4.2.2 Conservation Easements

"A conservation easement is a voluntary, legally binding agreement between a landowner and a government agency or non-government conservation organization that keeps land in natural habitat, agricultural and/or open space uses. The agreement is customized to meet the landowner's and conservation entity's objectives and, in most cases, is perpetual." (http://edis.ifas.ufl.edu/fr149, 2010). The easement agreements limit the amount of development on a property, are usually perpetual, and provide a tax benefit to the landowner. Each conservation easement agreement is unique and should be handled on a case-by-case basis.

7.4.2.3 BMP Inspection and Maintenance

Once designed and constructed, structural BMPs will function appropriately for a time but inspection and maintenance is a necessary part of successfully managing a stormwater system. Deferred maintenance and declining infrastructure can lead to increased costs and flooding risks as well as ecological degradation of the system downstream.

Regularly scheduled maintenance practices help to ensure the proper functioning of flood control facilities. These maintenance practices also affect the amount of sediment, debris, and pollutants reaching County waterways. Included in these activities are cleaning out baffle boxes; removing excess vegetation and sediment from swales and roadside ditches; replacing damaged infrastructure; and maintaining control structures, weirs, and pumps.

In the County's MS4 Permit, the stormwater management program requirements are to reduce the discharge of pollutants to the maximum extent practical. Table 7-3 lists the inspection and maintenance frequency required by the permit.

Table 7-3 MS4 Permit: Inspection and Maintenance Schedule for Structural Controls and Roadways

Structural Control	Required Frequency of Inspection	2008 Permit Requirements for Maintenance Activities
Stormwater Treatment Ponds - Wet	1.5 - 2 years	As Needed
Stormwater Treatment Ponds - Dry	1.5 - 2 years	As Needed
Stormwater Treatment Ponds - Dry w/Infiltration	1.5 - 2 years	2 x/year
Exfiltration Trench	2 x/year	2 x/year
Stormwater Pump Stations	2 x/year	As Needed
Canals (miles)	1 x/year	As Needed
Channel control structures	4 x/year	As Needed
Pollution control boxes	4 x/year (2008) 1 x/year (2009)	As Needed
Grassed Swales (miles)	1 x/year	As Needed
Inlets/catch basins/grates	1 x/year	As Needed

Wet and dry pond maintenance activities include mowing, removing debris and litter, removing accumulated sediment, stabilizing eroded banks, fertilizing, applying herbicides, and cleaning out infrastructure. These activities occur multiple times per year as needed. Wet ponds require aquatic plant management and harvesting as needed. Infiltration ponds and exfiltration trenches require additional maintenance of sand filtration systems. The annual or biannual complete removal and replacement of the geotextile, filter sand, and gravel are normally recommended. Bar screens in a stormwater pump station need to be cleared and sediments and debris removed frequently for the system to operate as designed. Canals, channels, and swales all require mowing, debris removal, and sediment removal. Stormwater structures require debris and sediment removal and structural repairs to remain in good working condition.

Drainage area conditions at a specific BMP may dictate more frequent maintenance (i.e., heavy vehicular traffic, construction, invasive-exotic vegetation). Excess debris, sediment, and vegetation may impede the flood protection capabilities of a system as well as hinder the pollutant removal functions. In developing a proactive maintenance plan, maintenance crews need to make note of large amounts of debris, sediment, or vegetation to mark these structures or areas for more frequent maintenance.

Current stormwater system maintenance is primarily a flood control function; however, routine BMP maintenance can improve the overall efficiency and removal rate of pollutants. For water quality considerations sediment and debris cleanout may need to be more frequent than maintenance for flood protection. Table 7-4 shows the recommended frequency of cleanout for sediment and debris removal in common structural BMPs to maintain the design water quality improvement levels.

Table 7-4 Recommended BMP Cleanout Frequency for Water Quality Improvement

BMP Type	Annual Frequency of Cleanout
Wet Detention Pond	1
Dry Retention Pond	1-2
Infiltration System	2
Permeable Pavement	3-4
Bioretention	1
Stormwater Wetlands	1
Grassed Swales	1
Stormwater Structures	2-18

7.4.3 Source Control

7.4.3.1 Street Sweeping

New technology incorporated into street sweepers has brought about a re-evaluation of the benefits and effectiveness of street sweeping. Vacuum-assisted and regenerative-air sweepers are now able to pick up fine-grained sediments that carry a large portion of the pollutant load. Two distinctive but not mutually exclusive removal rates are cited in the literature: the removal of sediment load and the removal of nutrients associated with the sediment load due to stormwater runoff.

The amount of sediment removed by street sweeping depends on several factors. The intensity of a rainfall event, the length of time between sweeping events, particle size, land use, and the location of the impervious surface (up-gradient or down-gradient) all contribute to determining the amount of sediment available for sweeping, the efficiency of removal, and the quantity of sediment removed from the potential sediment load to stormwater runoff. The frequency of sweeping in wet and dry seasons impacts the overall removal rates, and the U.S. Geological Survey (Breault et al., 2005) reports that only a small fraction of the total load is removed unless intensive sweeping programs are implemented. Total sediment load reduction by street sweeping is cited in the literature as 15 to 90% of the potential sediment load to the stormwater system.

The Federal Highway Administration (www.fhwa.dot.gov/environment) reports vacuum-assisted sweeper removal efficiencies of 74% for total phosphorus, 77% for total nitrogen, and 93% for total solids. The expected reduction of pollutants from street sweeping varies with the frequency of sweeping. Comparing monthly to weekly frequencies of sweeping, researchers found reductions in total solids ranging from 42 to 60%, in total phosphorus ranging from 15 to 30%, and in total nitrogen ranging from 20 to 45%. A report assessing maintenance practices in Florida issued through the University of Florida cites the average total nitrogen (TN) at approximately 500 mg/kg and TP at approximately 300 mg/kg in sediment samples removed through street sweeping.

7.4.3.2 Drain Clean-out

A small number of monitoring studies evaluate the pollutant reduction resulting from storm drain or catch basin cleanouts and the optimal frequencies for cleanouts at a catchment scale. These studies indicate catchment cleanouts can reduce pollutants by 5 to 25% depending on catchment conditions, cleaning frequency, and type of pollutant. The pollutant-removal capability of catch basins is fundamentally constrained by the design that retains coarse-grained sediments but pass finer grained sediment that typically contains higher concentrations of nutrients and metals (Law et al., 2008).

7.4.3.3 Herbicides

The tropical climate in Sarasota County provides an ideal setting for aquatic invasive/exotic plant species to flourish. The undesirable vegetation, if left unchecked, may eradicate native plant species, cause public health risks, and impede flood conveyance.

Using herbicides to manage aquatic plant growth has been a common practice in the United States since the late 1800s. Occasionally the use of these chemicals has resulted in human health and environmental problems. Herbicides are now regulated by the EPA and FDEP with only 11 herbicides approved for use in plant management in Florida waters.

Maintenance staff is responsible for choosing the herbicide and application method appropriate to the aquatic vegetation. Education and training are essential to balancing the environmental risk with the chemicals and the potential degradation of an ecosystem when the invasive plants prosper.

7.4.3.4 Fertilizer Management

Nitrogen and phosphorus are common nutrients found in fertilizer. The misuse of fertilizer products may create undesirable environmental and recreational conditions. Excess nutrients accelerate algae growth particularly when coupled with the tropical temperatures in Sarasota County, leading to red tide blooms, impaired flood conveyance, public health risks, and eutrophication of aquatic systems.

Sarasota County adopted Ordinance Number 2007-062 governing fertilizer and landscape management. Specific sections of the ordinance address:

- Application.
- Nutrient content.
- Impervious surface.
- Buffer zones.
- Grass clippings.
- Training and licensing.
- Enforcement.

The Ordinance requires the use of BMPs to minimize the negative and cumulative impacts of fertilizer misuse on the County’s natural systems and waterways, citing these as critical to the environmental, recreational, cultural, and economic well-being of Sarasota County residents and the health of the public.

7.4.3.5 Harvesters

Aquatic vegetation plays an integral role in marine systems, but often non-native, invasive plants are found in the waters of Sarasota County. Hydrilla, water lettuce, and water hyacinth are undesirable types of vegetation commonly found in County waterways. These species tend to block out sunlight necessary to maintain a healthy benthic environment by creating a canopy on the water surface and hindering oxygen circulation by keeping the water stagnant. Additionally, non-native plants often impede recreational water use, increase flooding risks, and eradicate native species.

Mechanical harvesters offer an alternative to herbicides in controlling aquatic vegetation. Harvesting is perceived by the public as being environmentally neutral and does not suffer the negative public perception that herbicides do. Harvesters are large machines that cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. Harvested weeds may have a beneficial reuse as compost. Harvesters can cut and collect several acres per day depending on weed type, plant density, and storage capacity of the equipment. Harvesting speeds for typical machines range from 0.5 to 1.5 acres per hour.

Photograph 5: Aquatic Weed Harvester

Transportation and disposal of the vegetation biomass after harvesting is an important financial consideration in harvester use. A large degree of variation is found in the biomass of the "crop"; water hyacinth can weigh 200 to 300 tons per acre and hydrilla can weigh 10 tons or less per acre (Gettys et al., 2009). With the removal of the biomass, all of the nutrients that would contribute to the system during plant decomposition are now removed.

Routine mechanical maintenance of the harvester is necessary monthly, with some done quarterly. Cleaning the machine thoroughly when it is being moved from one waterbody to another ensures undesirable plants and microbes will not infest another waterbody. Table 7-5 lists some of the advantages and disadvantages to using harvesters.

Table 7-5 Advantages and Disadvantages of Aquatic Harvesting

Advantages	Disadvantages
Opens waterway conveyance immediately	Repetitive maintenance practice
Removes nitrogen and phosphorus from the system	Machinery is difficult to maneuver
Removes organic material and reduces the amount of particulates in the conveyance if harvested before the end of the life cycle of the plant	Small fish and turtles may be caught and harvested in plant material
Targets specific areas	Capital expenditure and maintenance costs are significant
Oxygen remains in the water when decomposing plant material is removed	Machines generally clear only several acres per day
	Disposal of vegetation may be costly
	Short-term increase in turbidity

Plant Management in Florida Waters, a website created and maintained by the University of Florida's Institute of Food and Agricultural Sciences, concludes that even with the disadvantages associated with harvesters, the machines are suitable for many Florida waterways. Evaluation of plant species, disposal of wastes, uses, and physical characteristics of the waterbody play an important role in choosing to use a harvester.

7.4.4 BMP Efficiencies

BMPs and maintenance practices impact the removal of solids, heavy metals, nutrients, and organics found in stormwater systems. The three primary constituents found in runoff and evaluated for removal efficiencies in this WMP are suspended solids, nitrogen, and phosphorus.

Suspended solids are primarily a function of land use; an increase in the amount of impervious area found in urban development is associated with an increase in suspended solids in stormwater runoff. If suspended solids remain suspended, the particulates reduce water clarity and limit the amount of sunlight reaching marine life; suspended solids that settle in a stream system adversely impact benthic habitats and the flood control capacity of the system.

Nitrogen and phosphorus are nutrients found in soils naturally; increased erosion usually associated with urban development adds not just solids to the stream system but nutrients as well. Fertilizer contributes to the nutrient load in runoff when lawns are unable to assimilate the amount of fertilizer applied. Excess nutrients combined with the tropical temperatures in Sarasota County can lead to excessive algae growth impacting not only the recreational aspects of the waterways but also creating an oxygen deficit impacting the marine life and aquatic habitats.

BMPs function to limit pollutants from reaching primary conveyance systems (i.e., channels, streams, canals, ditches) and eventually the bays of Sarasota County. There is considerable variability in the effectiveness of BMPs to achieve pollutant removal. Rainfall variability makes efficiencies hard to predict, but the regular inspection and maintenance of BMPs and consistent maintenance practices can facilitate better functioning of a stormwater system for flood control and water quality improvements.

Regular inspection and maintenance of can facilitate better functioning of a stormwater system for flood control and water quality improvements.

In June 2007, the FDEP issued a report titled *Evaluation of Current Stormwater Design Criteria within the State of Florida.* Summarized in the text are the performance efficiencies of stormwater management retention and detention system ponds to remove pollutant loads found in stormwater runoff from studies specific to Florida. In stormwater ponds, removal efficiency is related to the retention volume, residence time, littoral zone size, scheduled maintenance, and mowing frequency. Removal efficiencies in infiltration and bioretention systems are affected by the number of storms where first flush occurs and the frequency of media replacement. Table 7-6 cites the range of removal efficiencies of total suspended solids loads associated with stormwater runoff by BMP from these Florida studies.

Table 7-6 TSS Removal Efficiencies in Common BMPs

BMP Type	# of Studies	Efficiency Range
Dry Retention Pond	2	80-99%
Wet Detention Pond	10	55-94%
Dry Retention with Filtration	2	77-98%
Offline Systems	2	89-95%

A literature search revealed a great deal of variability in the range of removal efficiencies of structural and source control BMPs. The geographic location, climate, degree of urbanization, and study limitations all impact the variance found in removal efficiencies. Table 7-7 shows the range of removal efficiencies within individual studies as well as across technical documentation from public and private sources.

Table 7-7 Range of Removal Efficiencies (%) of Structural and Source Control BMPs

Study	Year	Dry Retention			Wet Detention			Dry Retention w Filtration			Offline Systems/ Constructed Wetlands			Porous Pavement			Grassed Swales			Bioretention			Other Filtration			Buffer Zones			Street Sweeping			Catch Basin/Baffle Box		
		TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN
Evaluation of Current Stormwater Design Criteria within the State of Florida	2007	80-99	61-99	80-99	55-94	20-91	4-63	77-98	0-92	0-80	89-95	76-92	30-85	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
The Cost and Effectiveness of Stormwater Management Practices	2005	—	15-45	—	—	30-65	—	—	50-80	—	—	15-45	—	—	30-65	—	—	15-45	—	—	—	—	—	30-80	—	—	—	—	—	—	—	—	—	—
Technical Memorandum: The Runoff Reduction Method	2008	—	—	—	—	50-75	30-40	—	25	15	—	50-75	25-55	—	25	25	—	15	20	—	20-40	40-60	—	60-65	30-45	50-85	—	—	—	—	—	—	—	—
Urban Pollutant Loads and General BMP Cost Analysis	2005	50	30	—	90	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Effective Use of BMPs in Stormwater Management	2005	61	19	21	58-78	48-62	21-43	75	60-70	55-60	36-96	21-89	19-48	82-95	65	80-85	7-69	14-37	14-55	80	65-87	49	—	—	—	—	—	—	37-50	9-28	—	10-25	—	—
Permeable Pavement Summary Fact Sheet	2005	—	—	—	—	—	—	—	—	—	—	62	88	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 7-7 Range of Removal Efficiencies (%) of Structural and Source Control BMPs

Study	Year	Dry Retention			Wet Detention			Dry Retention w Filtration			Offline Systems/ Constructed Wetlands			Porous Pavement			Grassed Swales			Bioretention			Other Filtration			Buffer Zones			Street Sweeping			Catch Basin/Baffle Box		
		TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN
Stormwater Pollutant Removal Criteria	2004	40-60	20	20	50-90	50	30	—	—	—	90	50	30	0-80	60	50	—	—	—	90	60	30	60-80	30-50	30-35	—	30	30	—	—	—	—	—	—
Stormwater Management Program for Nutrient Control	2004	—	—	—	—	40	25	—	—	—	—	35	40	—	—	—	—	20	20	—	35	40	—	45	35	—	—	—	—	—	—	—	—	—
Riparian Forest Buffer Practice and Riparian Grass Buffer Practice	2007	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	45-65	65-85	—	—	—	—	—	—
Final Report of the Statewide Task Force on Riparian Forest Buffers	2000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37-99	6-97	7-95	—	—	—	—	—	—
Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping	2008	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18-72	10-30	15-45	39-75	3-6	14-27
Potential Effects of Structural Controls and Street Sweeping on Stormwater Loads to the Lower Charles River, Massachusetts	2002	62	46	—	62	46	—	78	56	—	—	—	—	—	—	—	—	—	—	45	32	—	—	—	—	—	—	—	25-95	5-90	—	—	—	—
Residential Street Dirt	2004	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20-92	—	—	—	—	—

Table 7-7 Range of Removal Efficiencies (%) of Structural and Source Control BMPs

Study	Year	Dry Retention			Wet Detention			Dry Retention w Filtration			Offline Systems/ Constructed Wetlands			Porous Pavement			Grassed Swales			Bioretention			Other Filtration			Buffer Zones			Street Sweeping			Catch Basin/Baffle Box		
		TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN
Accumulation Rates and Chemical Composition and Removal Efficiencies																																		
New Developments in Street Sweeper Technology Article 121	2002	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	45-65	30-55	—	—	—	—
Stormwater Best Management Practices in an Ultra Urban Setting: Selection and Monitoring	2006	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55-93	40-74	42-77	—	—	—

Complete references provided in Appendix F.

7.4.5 Cost/Benefit Analysis

FDEP evaluated 31 projects across the state that were funded by 319 grants for TP and TN removal and costs—17 projects were wet detention ponds, 3 were dry retention ponds, and 11 were other treatment options. The cost per pound of removal of TN annually was approximately $5,000 for the "average" wet detention pond and was approximately $4,000 for the "average" dry retention pond; the cost per pound of removal for TP annually was approximately $17,000 for the "average" wet detention pond and was approximately $21,000 for the "average" dry retention pond.

Jones Edmunds performed a cost/benefit analysis to evaluate the cost of pollutant removal by common BMPs and maintenance practices. For the purposes of this analysis, BMPs are those practices with an associated initial capital cost as well as labor costs, and maintenance practices were labor costs only. The three constituents evaluated are solids, nitrogen, and phosphorus.

7.4.5.1 BMPs

For wet retention, dry detention ponds, and street sweeping, literature values for pollutant removal efficiencies are generally reported as TN and TP. The pollutant constituents in stormwater runoff are generally land development based; therefore, the cost per pound of removal for nutrients in Table 7-8 reflects TN and TP removal.

The equation developed and used to calculate the dollars per pound removal values of BMPs has four variables: annualized BMP cost, estimated pollutant load, constituent of interest percentage of total estimated pollutant load, and BMP efficiency. The following criteria and assumptions were used for the BMP evaluation:

1. Annualized BMP cost
   - ❖ Capital costs for land purchase is included in the pond values. An FDEP 319h grant study provided land costs from around the state; these costs were averaged and divided over the life span of the BMP.
   - ❖ Harvester and street sweeper costs include the capital cost for the equipment divided over the life span of the BMP.
   - ❖ The interest rate for the capital expense was held constant at 6.5% across the lifespan of the BMP.
   - ❖ The lifespan of the BMPs are assumed to be:
     - Wet Ponds—40 years
     - Dry Ponds—40 years
     - Stormwater structure—50 years
     - Street Sweeper—10 years
     - Harvester—15 years

- All dollars per pound reported include the annual cost of maintenance. The maintenance costs are based on contractual values or labor costs of $15/hour.

2. Estimated load
   - For wet ponds, dry ponds, and sediment-removal devices, the total load averages in lb/ac/yr from the SIMPLE model were weighted based on area. The weighted average of lb/ac/yr was applied to a reasonable drainage area for the BMP and then used as the estimated load value (pounds) for a BMP.
   - Street sweeping services for Sarasota County are contracted to a private entity. Information from the 2009 NPDES Annual Report Form for street sweeping was used in the evaluation: total street miles swept was 4,300 (16.5 miles/day on a 5 day work week) and 735 tons of material collected (5,650 lb/day on a 5 day work week).
   - The estimated load of the harvester is based on the literature values discussed in Section 7.4.3.5.

3. Pollutant % of estimated load
   - The constituent percent of the average load from the SIMPLE Model results determined the percent of the pollutant within the load. This was applied to wet ponds, dry ponds, sediment removal devices, and street sweeping. The constituent percents are 8.5% TSS, 0.1 % TP, and 0.5% TN.
   - For the harvester, from Section 7.3.1.1, the TKN is assumed to be 2.26% of the dry weight and the TP is assumed to be 0.25% of the dry weight of plant material (Kadlec and Knight, 1996).

4. BMP efficiency
   - Table 7-8 shows the removal efficiencies of wet ponds, dry ponds, sediment removal devices, and street sweeping for total suspended solids, total nitrogen, and total phosphorus. Minimum and maximum efficiency values were used to establish a range of costs for constituent removal.
   - Harvesters do not remove any suspended solids from the system; therefore, the efficiency is 0%; the TKN and TP removal is estimated between 75% and 100%, taking into account some vegetation being left in the water course.

To calculate $/lb removed by pollutant, the following formula was applied:

$/lb = Annualized BMP Cost ÷ (Estimated Load (lb) * Pollutant % of Estimated Load * BMP Efficiency)

Each BMP has a range of removal efficiency; therefore, the $/lb pollutant removal also has a range of values. In Table 7-8, the lower dollar value represents the maximum possible efficiency of a BMP while the higher dollar value represents the minimum efficiency.

Table 7-8 Annual BMP Cost per Pound of Nutrient Removal[1]

BMP	TSS $/lb	TP $/lb	TN $/lb
Wet Retention Pond	$50 - $100	$3,500 - $15,000	$1,000 - $20,000
Dry Detention Pond	$100 - $150	$6,500 - $10,000	$1,500 - $2,500
Sediment Removal Devices	$2 - $5	$10,000 - $20,000	$500 - $1,000
Street Sweeping	$10 - $30	$200 - $500	$20 - $50
Harvester	$0 - $0	$200 - $600	$30 - $70

1. Transportation and disposal fees for sediment and vegetation are NOT included.

Ponds and sediment removal devices are stationary BMPs with fixed drainage areas; the intent is to not only provide treatment of runoff but for ponds, attenuation, and flood control as well. Once installed, operation and maintenance costs are minimal.

Street sweepers and harvesters are both source-control practices that have the ability to affect large areas of the County. Operation and maintenance costs are generally much higher than that of stationary BMPs. The intent of these mechanical BMPs is to prevent pollutants from reaching the downstream system across a large geographic area, although both do have flood-control components. If a mechanical BMP were purchased and limited to use in a single subbasin, the cost would far outweigh the benefit, but by using the mechanical BMP throughout the County the cost per pound of removal is reduced.

For example, if both BMPs have equal pollutant loads and equal drainage areas (3 acres), the cost per pound of pollutant removal of the street sweeping is approximately 10 times more than the sediment removal device. The reality is the sediment-removal device has a fixed removal cost based on location, but the street sweeper has the ability to increase its service area and decrease the cost. If the street sweeper is used in a larger drainage area (as an example 30 acres instead of 3 acres), the costs per pound of pollutant removal are now equal. By increasing the coverage of the street sweeper even more, the cost per pound of removal is now less than that of the sediment-removal device.

7.4.5.2 Maintenance Practices

Maintenance duties often involve the management of grasses, aquatic plants, and other vegetation that impede the stormwater system. Section 7.3.3.1 presented information on the nutrient content of vegetation; this information was evaluated to establish average values of TKN and TP for grasses, leaves, and aquatic plants.

For the purposes of the evaluation, the benefit is expressed in pounds of nutrient removed. TKN, which is a laboratory measurement of organic nitrogen (N), ammonia (NH_3) and ammonium (NH_4+), was included because it provided a common denominator for a large portion of the data sets that are lacking a measurement of TN.

To evaluate maintenance practices as cost per pound of pollutant removal, a similar equation was developed. To calculate $/lb removed by pollutant, the following formula was applied:

$/lb = Annualized Labor Cost ÷ (Estimated Load (lb) * Pollutant % of Estimated Load * Estimated Maintenance Practice Efficiency)

The general baseline criteria and assumptions used to equate $/lb removal are based on cost information provided by Sarasota County's Maintenance Department. Table 7-9 shows the removal costs for common maintenance practices.

Table 7-9 Maintenance Practices Cost per Pound of Nutrient Removal[1]

Maintenance Activity	TSS $/lb	TP $/lb	TKN $/lb
Herbicide	$0 - $0	$0 - $0	$0 - $0
Hand Clearing	$2 - $20	$30 - $90	$20 - $80
Ditch/Channel Cleanout	$20 - $200	$1,100 - $3,000	$200 - $750
Sediment Removal	$15 - $45	$6,600 - $13,000	$600 - $1,200
Mowing	$2 - $20	$30 - $80	$15 - $70

1. Transportation and disposal fees for sediment and vegetation are NOT included.

7.5 RECOMMENDATIONS

As described in the preceding sections, the stormwater maintenance staff has two important responsibilities: inspection and permit compliance and facility maintenance. Both tasks are vital to maintaining public safety, reducing flood risks, and the improving the health of the aquatic environment. The *Strategic Maintenance Plan* provides a baseline to build and implement a more robust approach to maintenance to meet the County's maintenance needs.

Jones Edmunds recommends the following approach to expand and enhance the stormwater maintenance process to include water quality in addition to flood protection as part of the focus:

- *Implement the 1999 Strategic Maintenance Plan.*
- *Achieve the inspection and maintenance frequency required in the MS4 Permit.*
- *Update the Strategic Maintenance Plan.*
- *Adopt practices listed below when fiscally feasible.*

Updating the *Strategic Maintenance Plan* and adopting several non-structural BMPs and source control practices may provide the best opportunities for increased awareness and implementation of mechanisms to improve the quality of stormwater runoff to the bays and estuaries throughout the County.

With the County's water quality goals in mind, Jones Edmunds recommends the following modifications, additions, or removal of maintenance practices to progress toward meeting those goals.

7.5.1 Inspection and Permit Compliance

7.5.1.1 NPDES Inspection

A system inspection schedule is not explicitly outlined in the *Strategic Maintenance Plan* but is referenced as routine inspection programs and internally generated inspection reports. The current NPDES permit requires inspecting all stormwater facilities ranging from quarterly to every 2 years.

The inspection schedule in this program should be adopted by reference into the Strategic Maintenance Plan.

7.5.1.2 Asset Management

Maximo is an asset-management system implemented by the County that tracks inspections and maintenance work orders. Additionally, the spatial component of the stormwater system is being inventoried and mapped by the GIS department. Functionality between the two systems is somewhat difficult. Implementing a work flow process for maintenance, tracking inspections, assisting in resource allocation for CIP projects, and providing good customer service to residents will be achieved when the two systems are integrated.

7.5.1.3 FEMA Community Rating System

The County participates in a Community Rating System (CRS) through FEMA to reduce hazard damages.

> *Incorporating the documentation for required annual inspections and debris removal into the Maximo system would help track long-term issues that may require a CIP or help identify smaller local-scale projects that may improve drainage and water quality.*

7.5.2 Facility Maintenance and BMPs

7.5.2.1 Facilities: Scheduling

The *Strategic Maintenance Plan* details for maintenance of drainage canals, structures, ponds, and lakes based on a 1-, 2-, or 3-year cycle.

> *Revising the matrix for maintenance and decreasing the maximum cycle to 2 years will help reduce flooding concerns and decrease the organic debris and nutrients in the system.*
>
> *For the most effective removal of nutrients, baffle boxes should be cleaned at least monthly during the wet season and quarterly during the dry season to remove sediment and vegetation.*

7.5.2.2 Facilities: Denuding Conveyance Features

As a regular maintenance practice, County staff excavates and denudes roadside swales and other conveyance features to eliminate vegetation and remove possible sediment accumulation. The current practice for County maintenance crews is to seed or sod the denuded swales within 2 weeks after the excavation. This practice leaves the channel vulnerable to erosion until ground cover is reestablished.

Jones Edmunds recommends replacing the practice of denuding with mowing/removal practices that keep vegetation and root systems in place to reduce sediment load. To reduce nutrient leaching and sediment loading, grass clippings need to be removed from the swale. In cases where denuding is necessary to ensure public safety or reduce flooding risks, the practice should be limited to the dry season to minimize the chance for erosion to occur. Additionally, where denuding is necessary, we recommend placing sod within 2 days.

7.5.2.3 Non-Structural BMPs: Buffer Zones

Buffer zones provide aesthetic value as well as functional value to uplands adjacent to the watercourse.

Jones Edmunds recommends implementing buffer zones on County-owned uplands to:

- *Minimize maintenance.*
- *Reduce pollutant loads found in urbanized overland flow.*

A general practice by County staff and homeowners is mowing beyond the top of bank within the stream banks or to the waterline. Grass clippings and vegetation debris are often left within the banks or adjacent to the watercourse. As discussed in Section 7.3.3.1, removing the organic debris is a source control for minimizing additional nitrogen and phosphorus entering the waterway. Researchers found a benefit to landowners in reduced mowing and maintenance costs when these areas are managed as vegetated buffers rather than turf grasses (University of South Carolina, 2000).

A "no-mow buffer" reduces the probability that organic debris will reach the waterway. Jones Edmunds recommends adding buffer zones to major waterways to prevent landscape debris from blowing into the surface water system. Additionally, public education on the benefits of buffer zones for private property along the watercourse will result in increased awareness of water quality issues.

General maintenance guidelines for the buffer zone include leaving native vegetation and leaf litter undisturbed, restricting pesticide and herbicide use, and removing non-native vegetation.

7.5.2.4 Non-Structural BMPs: Low-Impact-Development

LID is a stormwater management approach that uses a suite of hydrologic controls (structural and non-structural) distributed throughout the site and integrated as a treatment train (i.e., in series) to replicate the natural hydrologic functioning of the predevelopment landscape.

> *Jones Edmunds recommends that when a drainage project is sent to a staff engineer for design and permitting considerations, the project should be evaluated and if feasible incorporate LID design standards.*

7.5.2.5 Source Control: Street Sweeping

In 1983 the EPA reported that street sweeping was not effective in reducing pollutant loads in stormwater runoff. Recent innovations in technology have improved the abilities of street sweepers to more effectively pick up fine-grain sediments that tend to carry a large part of the pollutant load in runoff. The new technology incorporates an air-filtrated vacuum sweeper with a mechanical sweeper to remove particles adhering to the pavement. For industrial and densely-populated areas where space for additional stormwater BMPs is not available, street sweeping removes sediment and pollutants before either reaches the stormwater system.

Although there are challenges to funding the program,

> *Jones Edmunds recommends weekly street sweeping in the wet season to maximize removal of sediment and pollutants between rain events and bi-monthly street sweeping during the dry season.*

Initially, the program should focus on neighborhoods, communities, and industrial areas that do not have stormwater BMPs. In areas with limited stormwater BMPs, adding street sweeping can be part of a treatment train approach to improving water quality. Building partnerships with other stakeholders for funding street sweeping in highly urbanized areas with large traffic corridors would benefit the County's waterways.

7.5.2.6 Source Control: Herbicides

A normal practice by the County maintenance staff is to use herbicides within a watercourse or on adjacent banks.

> *To facilitate achieving TMDL levels set within Sarasota County and improving water quality in impaired water bodies, the practice of herbiciding and leaving decaying vegetation in the watercourse should be replaced with vegetation removal.*

Vegetation removal by mechanical harvesting, bagged mowing, or hand clearing provides more effective removal of nutrients from the system. Removing exotic-invasive species during routine maintenance creates a more natural system. However, the removal process must not destabilize the stream banks. This activity would be best suited to maintenance performed during the dry season. Ideally, soil amendment using compost materials and re-introducing native species will decrease maintenance requirements.

The release of nitrogen and phosphorus from vegetation to the water is highest during the 24 hours following cutting/falling/treating than the cumulative effect of all the subsequent time the plant matter stays in the waterway. The removal mechanism of the vegetation is site specific. For example, in Photo 2 Alligator Creek of Section 7.3.2 mechanical harvesting would be the preferred mechanism because of the depth of water in the creek, whereas the preferred mechanism in Photo 1 showing a roadside swale in Forked Creek would be bagged mowing.

7.5.2.7 Source Control: Fertilizer Management

The County fertilizer ordinance states: "In no case shall grass clippings, vegetative material, and/or vegetative debris either intentionally or accidentally be washed, swept, or blown off into stormwater drains, ditches, conveyances, water bodies, or roadways." This statement is not explicit in the Sarasota County Stormwater Maintenance: Canal and Drainage System Maintenance Bid Contract.

> *Jones Edmunds recommends adding this statement as a working condition to all outside vendor bid contracts involving stormwater system maintenance and referencing the fertilizer ordinance as guidance when updating the Strategic Maintenance Plan.*

Many County residents take pride in their homes and landscaping.

> *As the wet season approaches, informing residents through stepped-up public education and awareness to reduce or eliminate fertilizer application during this critical time will help reduce nutrients from reaching the waterways.*
>
> *Continued training and licensing of landscape professionals and consistent code enforcement are explicit in the County ordinance and should continue.*

The grass and vegetative clippings retained from maintenance could be composted for other beneficial uses as long as pesticides and herbicides have not been applied.

7.5.2.8 Source Control: Harvesters

Applying herbicide to aquatic vegetation and leaving the decaying organic debris in place are detrimental to the County's efforts to improve water quality. With the vast channel system throughout the County, removal of the decaying vegetation is somewhat prohibitive with a limited maintenance staff. Aquatic harvesters mechanize the process and reduce the time required for maintenance crews to perform this task. Eliminating herbicides in the waterways also eliminates the chemicals in herbicides from entering the environment and provides composting material to use in soil amendment for bank stabilization. Harvesters also can remove organic debris associated with algae blooms, water lettuce, and hydrilla that impact the aesthetics and health of County waterways.

> *Jones Edmunds recommends adding an aquatic harvester to the suite of maintenance practices to help the County achieve its water quality goals.*

7.5.3 Other

7.5.3.1 Composting Pilot Study

> *Jones Edmunds recommends a pilot study on the beneficial reuse of grass clipping and vegetation debris.*

Maintenance staff and contracted vendors will bag grass clippings during the mowing specifically along waterways and transport the debris to a designated composting facility. The compost would then be used by maintenance staff on stream banks that need to be stabilized or vegetated. The maintenance staff would transport the compost to the site and amend the compost into the on-site soils. Composting the organic debris offers several benefits:

- Removing products before decay will reduce the potential for nitrogen and phosphorus to enter the waterways.
- Using compost material as a soil amendment on eroding banks will provide structure and moisture capacity to the soil matrix.
- Improving the soil matrix may result in better vegetation root growth and ultimately more stable systems.

Stormwater maintenance has traditionally played an active role in maintaining the flood capacity of the stormwater system throughout the County. By creating an even more robust maintenance program by implementing these recommendations, maintenance activities will play a bigger role in improving the quality of the runoff reaching the estuaries and bays of Sarasota County.

Chapter 8

Project Analysis

August 2010

Sarasota County

Southwest Florida Water Management District

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8.0 PROJECT ANALYSIS

8.1 INTRODUCTION

The purpose of this chapter is to integrate the project and program recommendations made in previous chapters of this report into a final set of prioritized recommendations that are consistent with and support the County's established levels of service and other goals. The recommendations cover four categories: flood control, water quality, natural systems, and water supply. This four-category grouping mirrors the State's Water Management Districts' four "Areas of Responsibility." Project recommendations include capital improvement projects as well as programmatic projects. The inclusion of proposed projects in this plan does not confer any special status, approval, permitting, standing, or funding from Southwest Florida Water Management District (SWFWMD). All proposed projects are subject to regulatory review and permitting. Requests for funding assistance will have to meet the requirements of funding programs and be subject to the District's Governing and Basin Boards appropriating funds.

Project prioritization typically includes an evaluation of costs, benefits, and other measures such as permitability. Comparing benefits that achieve distinctly disparate goals makes comparing projects over multiple areas of responsibility a challenge. For instance, how comparable are the benefits of a project that provides flood protection to two homes to those of a project that reduces total nitrogen loading by 500 pounds per year? In other management plans, qualitative scoring systems are often developed to overcome the difficulty of equating benefits between different project categories. For instance, projects may accumulate relative benefit scores on a fixed scale (e.g., 0 to 10) in multiple categories, with a weighted or unweighted total determining their overall relative benefit. Although this method is easier to implement and understand, it tends to compress the actual scale of benefits and make costs a greater determining factor in the recommendations.

The approach applied in this chapter uses a quantitative evaluation of benefits in combination with benefit values to provide a more equivalent comparison of costs and benefits for each recommended project. To implement this type of approach, it was necessary to use a common metric for benefits and remove two items from consideration. The two items that were removed from consideration are minor benefits and other subjective measurements such as permitability. An example of a minor benefit is a small reduction in flood stage (e.g., 0.1 foot) that is the result of an erosion-control project and that does not contribute to a change in the flood protection level of service. Although these types of benefits may have some level of importance, they are generally very small compared to major benefits. Subjective measurements, such as permitability, were not considered because these factors are already applied at the project evaluation stage within each chapter. For instance, an erosion-control project that would be difficult to permit because it would increase flood stages is very unlikely to be a recommended project.

8.2 MEASURES OF BENEFITS

Based on the discussion above, this analysis focuses on measures of major benefits for each recommendation. The metric that allows the best comparison of major benefits to costs across multiple areas of responsibility is dollars. Therefore, it was necessary to determine the major benefits to measure, how they would be measured, and the dollar value associated with each measure. The following measures of major benefits were determined the most significant and appropriate for this project:

- ❖ Natural Systems—Functional gain using Uniform Mitigation Assessment Methodology (UMAM).
- ❖ Water Quality—Pounds per year of total nitrogen reduction provided by the project. This measure could be changed or expanded to include other water quality measurements as TMDLs within the stream segments change.
- ❖ Water Supply—Total acre-feet per year of alternative water supply beneficially used/supplied by a project.
- ❖ Flood Control—Number of road segments and number of homes in which an improved flood protection level of service is provided by the project. Also, the total cubic yards of sedimentation removed at sediment sumps or erosion prevented by a project.

8.3 BENEFIT VALUE

The following total benefit value for the measures above were determined from published information concerning the dollar value per unit of benefit as follows:

- ❖ Natural Systems—The benefit value of wetland creation or preservation is $55,000 per credit for herbaceous wetlands and $80,000 per credit for forested wetlands based on costs of credits at nearby wetland mitigation banks.
- ❖ Water Quality—The benefit value of $3,700 per pound of total nitrogen removed per year is based on average nitrogen removal costs reported in Florida Department of Environmental Protection (FDEP) grant projects. In this case, the benefit may be thought of as the cost avoided by not having to implement another or different project.
- ❖ Water Supply—The benefit value for water supply is $815 per acre-foot of water per year based on a typical alternative water supply cost of $2.50 per 1,000 gallons in Sarasota County from the District's Regional Water Supply Plan.

- Flood Control—The value of benefits for flood control projects is based primarily on using the Sarasota County's Stormwater Environmental Utility's Cost-Effective Analysis for Stormwater Projects. Typical or average values were used for each category. Benefits for erosion prevention and sediment removal at sump locations are based on avoided removal costs along channel reaches. The flood control benefit values are as follows:

  - Improved home flooding level of service—$300,000 per home.
  - Improved evacuation route flooding level of service—$275,000 per segment.
  - Improved arterial route flooding level of service–$225,000 per segment.
  - Improved collector route flooding level of service—$125,000 per segment.
  - Improved neighborhood route flooding level of service—$45,000 per segment.
  - Erosion prevention and sediment removal—$10 per cubic yard, with sediment removal at sump locations being an annual occurrence and the total benefit being over the useful life of the project.

8.4 PROJECT BENEFITS

Project benefits were calculated for each of the recommended projects in the manner described above. Table 8-1 summarizes the benefits and costs. Costs include capital and operation and maintenance costs. The projects in Table 8-1 are sorted based on the benefit-to-cost ratio. The locations of the recommended capital improvement projects are shown in Figure 8-1.

Additionally the projects were evaluated for other criteria used by the County when determining project feasibility and prioritization. The evaluated criteria are:

- Public Property—The project was marked with a Y if it is located on public property and is marked with an N if it will require coordination with a private property owner or is located on private property.

- Intangibles—Some projects have benefits that are difficult to quantify but are important to the health of the watershed. Each project was marked with a Y in the related column if it was determined to improve or restore natural systems, restore historical hydrologic regime, or provide water quality benefits. An N indicates the project does not provide that intangible benefit.

A project sheet and opinion of probable cost for each recommended project are included at the end of this chapter. The project sheets summarize Site Evaluation, Project Elements, Project Benefits, Estimated Pollutant Removal or UMAM Credits, and Opinion of Probable Cost. More detailed information for each project can be found in the Chapters 3, 4, or 5 or Appendix C. The project name will indicate the reference chapter. The first two letters in the project name refer to the watershed (i.e., LB=Lemon Bay). The following letters indicate the area of responsibility benefited by the project and the associated chapter where the project was analyzed (i.e., NS=Natural Systems – Chapter 3, WQ=Water Quality – Chapter 4, WS=Water Supply – Chapter 5, S=Sediment – Appendix C). The numbers indicate the project number assigned during the analysis.

Table 8-1 Project Analysis

		Flood Protection	Water Quality	Natural Systems		Water Supply								Owner	Intangibles		
Project ID	Project Description	Cubic Yards of Erosion Prevention and Sediment Control	Annual Pounds of Total Nitrogen Removal	UMAM Credits of Herbaceous Wetlands	UMAM Credits of Forested Wetlands	Annual Acre-feet of Beneficially Used Water	Estimated Value of Major Benefits	Opinion of Probable Cost	Average Annual O&M Cost	BMP Lifespan	Present Value of O&M	Present Value of Costs	Benefits / Costs	Public Property	Improve/Restore Natural Systems	Restore Historic Hydrologic Regime	Provide Water Quality Benefits
LBWQ01	Alligator Creek Historic Stream Restoration	0	130	0.0	0.0	0	$ 481,000	$ 142,000	$ 100	25	$ 1,000	$ 143,000	$3.36	Y	Y	Y	Y
LBWS06	Heritage Christian Academy	0	113	0.0	0.0	30	$ 418,100	$ 342,000	$ 800	20	$ 9,000	$ 351,000	$1.19	N	N	Y	Y
LBWS26	Myakka Pines Golf Course	0	526	0.0	0.0	107	$ 1,946,200	$ 1,793,600	$ 2,000	20	$ 22,000	$ 1,815,600	$1.07	N	N	Y	Y
LBWQ16	Court St -Langsner ST	20	20	0.0	0.0	0	$ 75,400	$ 62,000	$ 1,000	40	$ 14,000	$ 76,000	$0.99	Y	Y	N	Y
LBWQ12	Cortes Dr	0	20	0.0	0.0	0	$ 74,000	$ 43,000	$ 2,500	40	$ 35,000	$ 78,000	$0.95	Y	N	N	Y
LBWQ04	Waterford Drive	0	125	0.0	0.0	0	$ 462,500	$ 468,000	$ 1,500	50	$ 22,000	$ 490,000	$0.94	Y	N	N	Y
LBWS27	Boca Royale Golf and CC	0	344	0.0	0.0	70	$ 1,272,800	$ 1,544,000	$ 2,000	20	$ 22,000	$ 1,566,000	$0.81	N	N	Y	Y
LBWQ15	Magnolia Ave	0	20	0.0	0.0	0	$ 74,000	$ 56,000	$ 2,500	40	$ 35,000	$ 91,000	$0.81	Y	N	N	Y
LBWS13	Englewood Sports Complex	0	299	0.0	0.0	92	$ 1,106,300	$ 1,657,000	$ 2,000	20	$ 22,000	$ 1,679,000	$0.66	Y	N	Y	Y
LBS16	Forked Creek @ US 41	250	100	0.0	0.0	0	$ 387,500	$ 577,000	$ 2,500	40	$ 35,000	$ 612,000	$0.63	Y	Y	N	Y
LBNS01	Englewood McCall Road Site	0	0	0.0	1.0	0	$ 80,000	$ 158,000	$ 3,000	50	$ 44,000	$ 202,000	$0.40	Y	Y	Y	N
LBWQ06	Overbrook Drive	0	35	0.0	0.0	0	$ 129,500	$ 334,000	$ 100	40	$ 1,000	$ 335,000	$0.39	Y	N	N	Y
LBNS02	Alligator Creek CA - Woodmere Park	0	0	0.0	3.8	0	$ 304,000	$ 284,000	$ 37,000	50	$ 547,000	$ 831,000	$0.37	Y	Y	N	N
LBWS23	South Venice Park	0	20	0.0	0.0	9	$ 74,000	$ 214,000	$ 800	20	$ 9,000	$ 223,000	$0.33	Y	N	Y	Y
LBS06	Woodmere Park Library	650	45	0.0	0.0	0	$ 212,000	$ 470,000	$ 13,000	25	$ 143,000	$ 613,000	$0.35	Y	Y	N	Y
LBNS05	South Venice Lemon Bay Preserve - North	0	0	1.0	0.0	0	$ 55,000	$ 182,000	$ 500	50	$ 7,000	$ 189,000	$0.29	Y	Y	Y	N
LBWS04	Elsie Quirk Library	0	15	0.0	0.0	5	$ 55,500	$ 212,000	$ 800	20	$ 9,000	$ 221,000	$0.25	Y	N	Y	Y
LBNS03	Englewood Sports Complex	0	0	0.9	0.0	0	$ 49,500	$ 118,000	$ 5,500	50	$ 81,000	$ 199,000	$0.25	Y	Y	N	N
LBNS04	South Venice Lemon Bay Preserve - South	0	0	0.3	0.0	0	$ 16,500	$ 95,000	$ 1,300	50	$ 19,000	$ 114,000	$0.14	Y	Y	N	N
LBS07	Venice Gardens WRF	2700	35	0.0	0.0	0	$ 318,500	$ 2,630,000	$ -	25	$ -	$ 2,630,000	$0.12	Y	Y	N	Y
LBS02	Siesta Drive South	1800	10	0.0	0.0	0	$ 163,000	$ 1,830,000	$ 10,000	25	$ 110,000	$ 1,940,000	$0.08	Y	Y	N	Y
LBS05	Briarwood Rd to Alligator Creek	3500	25	0.0	0.0	0	$ 337,500	$ 8,380,000	$ -	25	$ -	$ 8,380,000	$0.04	Y	Y	N	Y
LBS01	Siesta Ditch North	1200	30	0.0	0.0	0	$ 195,000	$ 6,410,000	$ 5,000	25	$ 55,000	$ 6,465,000	$0.03	Y	N	N	Y

* Zero values indicate a neglegible benefit

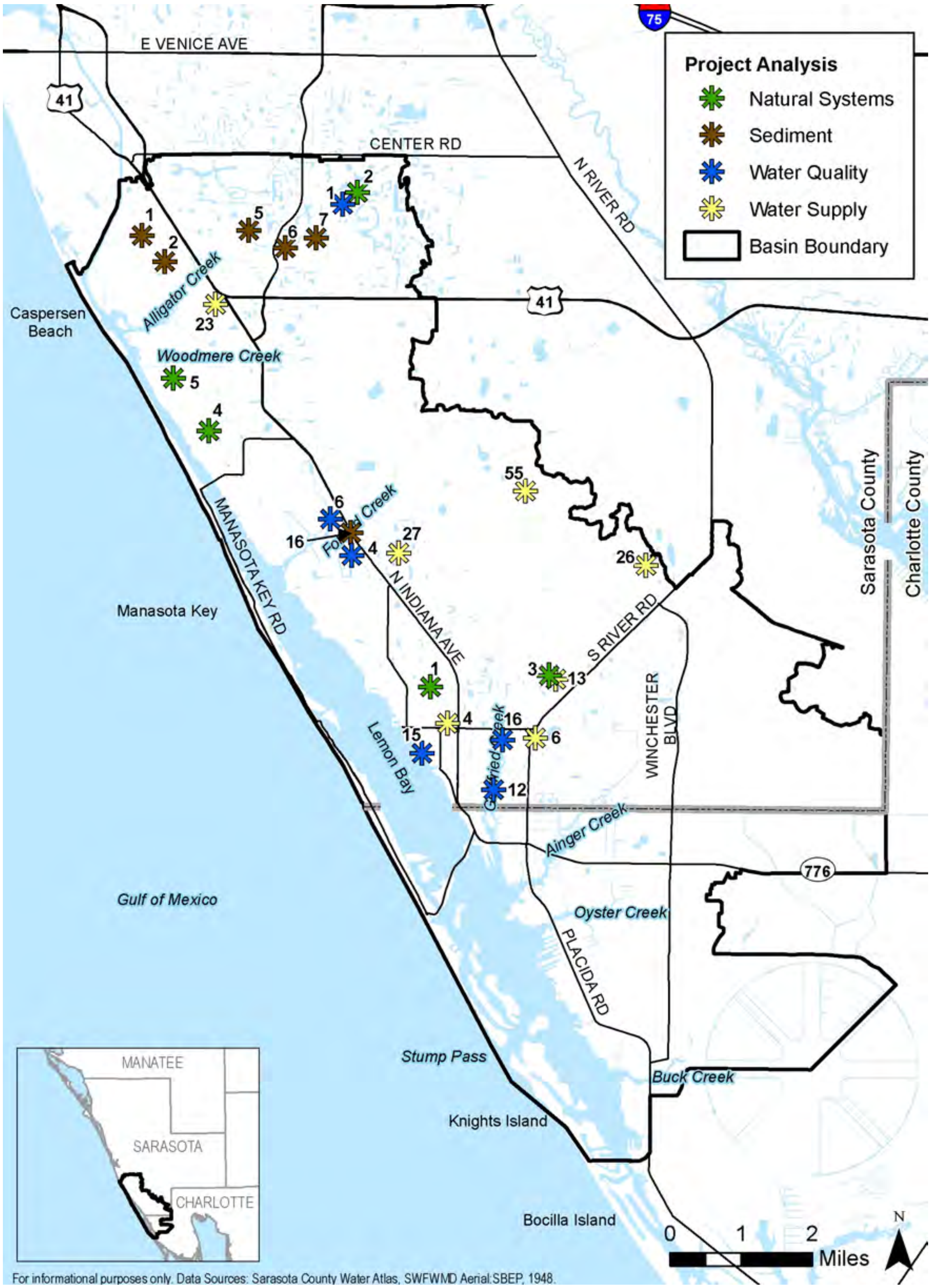


Figure 8-1 Location of Recommended Capital Improvement Projects

8.5 STATUS OF PROJECTS FROM PREVIOUS PLANS

Previous plans and studies were reviewed within the Lemon Bay WMP framework. Although not evaluated as part of the WMP, the projects are important to the County's goals of preserving, protecting, and restoring natural systems and water quality in Lemon Bay ecosystems; supporting a sustainable water supply; and providing flood protection.

Table 8-2 lists projects from these plans that are under contract for design or have been completed between the time of the previous plan and this WMP.

Table 8-3 lists projects previously recommended but not yet initiated; please see the specific plan for additional details. The projects were originally identified as having flood protection or water quality benefits, an analysis of the project descriptions identified additional benefits included in the projects, and these are listed in the Area of Responsibility column. Further design and analysis are necessary for these projects.

Table 8-2 Completed or In-Progress Basin Master Plan Projects

Basin Master Plan	Area of Responsibility	General Project Recommendation	Status
Alligator Creek Flood Protection Improvement Plan	Flood Protection	Scenic Drive- Outfall to Intracoastal Waterway.	Complete
Alligator Creek Flood Protection Improvement Plan	Flood Protection	Quail Lake/Venice East Boulevard Heron and Liesl Lake overflow.	Complete
Forked Creek BMP	Flood Protection	Construct drainage ditch along Manasota Beach Road and improve existing culverts.	Complete
Gottfried Creek BMP	Flood Protection	Remove existing culvert and improve existing ditch upstream of Viridian Street. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Flood Protection	Replace existing culvert across Elm Street . Eliminate culvert located about 50 ft east of Elm Street crossing. Restore ditch cross section. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Flood Protection	Coordinate with FDOT to replace culverts on the north SR 776 crossing downstream from the Viridian Street pond . Replace existing culverts across the Florida Power easement. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Flood Protection	Clear and snag existing ditch in the Artist Avenue area. Maintain existing culvert. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Flood Protection	Remove erosion deposits and provide erosion protection in creek channel. Regrade banks. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Flood Protection	Replace culverts across Florida Power easement with double 72 inch pipes. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Flood Protection	Maintain culvert across River Road. (South River Road Improvement)	Complete
Woodmere Creek BMP	Flood Protection	Hourglass Lakes and Circlewood Condos: Replace Florida Rd culverts	Complete
Woodmere Creek BMP	Flood Protection	Hourglass Lakes and Circlewood Condos: Replace Englewood Rd culverts.	Complete
Woodmere Creek BMP	Flood Protection	Hourglass Lakes and Circlewood Condos: Regrade channel from Englewood Rd to pond outfall and excavate lower pond banks for two ponds in Hourglass Lakes and Circlewood Condos	Complete
Ainger Creek BMP	Flood Protection	Obtain public access and drainage easements for the Englewood Farm Acres and Wellington Acres subdivisions to all routine maintenance	In Progress

Table 8-2 Completed or In-Progress Basin Master Plan Projects

Basin Master Plan	Area of Responsibility	General Project Recommendation	Status
Gottfried Creek BMP	Flood Protection	Elsie Quirk Library - Coconut Ave. Provide positive outfall for Coconut Ave pond with connection to SR 776	Under Contract for Design
Alligator Creek Flood Protection Improvement Plan	Flood Protection	Culverts under Banyan Drive and storage in ROW.	Under Contract for Design
Alligator Creek Flood Protection Improvement Plan	Flood Protection	Briarwood Area conveyance improvements.	Under Contract for Design
Forked Creek BMP	Flood Protection	Provide bank erosion control in secondary channel that runs along the south side of Almeda Isles subdivision.	Under Contract for Design
Gottfried Creek BMP	Water Quality	Regional water quality facility. Clear, snag, and remove existing spoil berms along the creek banks between the confluence of the main branch with the Englewood lateral and the Park Forest bridge. Place diversion structures to route flows through adjacent wetlands for water quality treatment. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Water Quality	Regional detention facility north of an existing Englewood lateral weir structure. (Englewood Lateral Improvement)	Complete
Gottfried Creek BMP	Water Quality	Englewood CRA / West Dearborn St. Low Impact Development Project	Under Contract for Design

Table 8-3 Basin Master Plan Projects

Basin Master Plan	Area of Responsibility	General Project Recommendation
Ainger Creek BMP	Flood Protection	Construct an overflow swale along the side of Englewood Hospital to tie into the improved outfall for Medical Center Blvd to address the flooding in Wellington Acres
Ainger Creek BMP	Flood Protection	Construct a swale along the north side and along the east side in Englewood Farm Acres to connect to the existing ditch network to the south
Ainger Creek BMP	Flood Protection	Re-establish the north-south drainage ditch along the North Port city limits to Ainger Creek Main
Ainger Creek BMP	Flood Protection/ Water Quality	Mitigate the future development impacts of Morris Industrial Park
Ainger Creek BMP	Flood Protection/ Water Quality	Mitigate the future development impacts of Interstate Industrial Park.
Ainger Creek BMP	Flood Protection	Manage floodplain functions adjacent to Ainger Creek Main by setting aside a preservation or conservation area
Ainger Creek BMP	Flood Protection/ Water Supply	Construct a regional stormwater facility
Forked Creek BMP	Flood Protection	Improve facilities to prevent localized flooding in the area around Franklin Street (various localized projects).
Forked Creek BMP	Flood Protection	Acquire easements and clear and snag existing channels from Manasota Beach Road to Overbrook Road.
Forked Creek BMP	Flood Protection	Install culverts at the inflow of the Overbrook Road pond. Add an additional culvert at the outflow.
Forked Creek BMP	Flood Protection	Clear and snag the creek channel downstream from wetland area.
Forked Creek BMP	Flood Protection	Clear and snag the creek channel immediately upstream from Dale Lake (SR 776 crossing).
Forked Creek BMP	Flood Protection	Clear and snag the channel downstream from the Keyway Road culvert. Remove spoil berms where feasible.
Forked Creek BMP	Flood Protection	Clear and snag channel. Provide erosion protection on the creek banks.
Forked Creek BMP	Flood Protection	Provide erosion protection of the creek channel along the Brook to Bay Trailer Ranch.
Forked Creek BMP	Flood Protection	Provide bank erosion control in main channel downstream from the Dale Lake outfall.
Gottfried Creek BMP	Flood Protection	Replace existing culvert. (South River Road Improvement)

Table 8-3 Basin Master Plan Projects

Basin Master Plan	Area of Responsibility	General Project Recommendation
Woodmere Creek BMP	Flood Protection	Olivia Rd Flooding: Replace Heron Rd culvert
Woodmere Creek BMP	Flood Protection	Olivia Rd Flooding: Replace Kent Rd culvert
Woodmere Creek BMP	Flood Protection	Olivia Rd Flooding: Replace Pompano Rd culverts
Woodmere Creek BMP	Flood Protection	Japanese Gardens Mobile Home Park: Replace Heron Rd culvert
Woodmere Creek BMP	Flood Protection	Japanese Gardens Mobile Home Park: Replace Colonial Rd culvert
Woodmere Creek BMP	Flood Protection	Japanese Gardens Mobile Home Park: Replace Japanese Gardens culverts and provide storm sewer outfalls to channel with new endwalls
Woodmere Creek BMP	Flood Protection	Gulfview Estates: Replace Osceola Rd culvert and regrade upstream channel
Woodmere Creek BMP	Flood Protection	Gulfview Estates: Add new culvert at private road crossing and provide new headwalls
Woodmere Creek BMP	Flood Protection	Gulview Estates: Replace Englewood Rd culvert
Woodmere Creek BMP	Flood Protection	Gulview Estates: Replace Gulview Estates pond outfalls and replace pond interconnections
Ainger Creek BMP	Water Quality	Maintain good water quality
Ainger Creek BMP	Water Quality	Construct a regional stormwater facility to addrress potential future impacts caused by development
Forked Creek BMP	Water Quality	Construct a channel to connect the existing wetland systems
Forked Creek BMP	Water Quality	Improve channel and clear and snag the creek segment from Manasota Beach Road to existing driveway.
Forked Creek BMP	Water Quality	Acquire and improve existing wetland.
Forked Creek BMP	Water Quality	Clear and snag the channel adjacent to wetland area downstream.
Forked Creek BMP	Water Quality/ Flood Protection	Reconstruct channel upstream from SR 776 crossing. Provide for erosion control along the creek.
Forked Creek BMP	Water Quality/ Flood Protection	Improve channel in the Whispering Pines area by reshaping the creek banks. Stabilize creek banks in areas where existing structures are located.
Forked Creek BMP	Water Quality/ Water Supply/ Flood Protection	Implement a Regional Stormwater Management Facility (RSMF) in the Forked Creek basin with its outfall located approximately 1,300 ft north of Keyway Road crossing on the creek's eastern branch.
Gottfried Creek BMP	Water Quality/ Water Supply/ Flood Protection	Construct stormwater detention facility approximately 1,300 ft downstream from the existing WENG Radio culvert in the Ainger Creek basin. (South River Road Improvement)

8.6 PROGRAM RECOMMENDATIONS

Sustainability and conservation programs were discussed throughout the previous chapters. Several key programs were identified in the WMP; some have direct nutrient reduction impacts while others have less quantifiable impacts but are important to improving environmental quality throughout the County. Table 8-4 shows those programs with measurable nutrient reductions followed by a discussion of additional program recommendations.

The following criteria, methods, and assumptions were used to calculate the nutrient reduction for the measurable programs.

- LBP11—Stormwater Harvesting: Assume 80% harvesting efficiency of future residential land use. See Chapter 5 for more detailed information.

- LBP25—Aquatic Harvester: From removal rates calculated in Chapter 7, 9% of the total load. See Chapter 7 for more detailed information

- LBP20—Fertilizer Ordinance: Assume 5% reduction of nitrogen loading in commercial, residential, and golf course land uses in the watershed. See Chapter 7 for more detailed information

- LBP24—Buffer Zones: Assume a 50-ft to 100-ft buffer along the undeveloped property identified in the watershed with a removal efficiency between 65% and 85%. See Chapter 3 for more detailed information

- LBP18—Street Sweeping: From the 2009 NPDES Annual Report, 735 tons of sediment was removed from paved surfaces, of which 0.5% of the weight is nitrogen. See Chapter 7 for more detailed information

- LBP28—Public Outreach and Education: Assume 10% of residents see material and take action, which yields a 5% reduction in nitrogen loading. See Chapter 3 for more detailed information

- LBP10—Cisterns: Assume 10% of residential land use will participate in the rain water harvesting. See Chapter 5 for more detailed information

- LBP14—Septic pump out regulation: Calculated from Pollutant Loading Model data with an expected 5% reduction in failure rate. See Chapter 4 for more detailed information

- LBP03—School Programs: Assume on-site instructional programs will lead to implementation and will reduce nitrogen loading on ¼ of the campus by 2%.

Table 8-4 Program Analysis

		Flood Protection		Water Quality	Natural Systems		Water Supply							
Project ID	Project Description	County Flood Control Benefits	Cubic Yards of Erosion Prevention and Sediment Control	Annual Pounds of Total Nitrogen Removal	UMAM Credits of Herbaceous Wetlands	UMAM Credits of Forested Wetlands	Annual Acre-feet of Beneficially Used Water	Estimated Value of Major Benefits	Opinion of Probable Cost	Average Annual O&M Cost	BMP Lifespan	Present Value of O&M	Present Value of Costs	Benefits / Costs
LBP11	Encourage stormwater harvesting (water supply)	0	0	40000	0	0	0	$148,000,000	$0	$10,000	25 yr	$110,000	$110,000	$1,350
LBP25	Implement a aquatic harvester for stormwater maintenance	0	0	3000	0	0	0	$11,100,000	$5,900	$1,300	10 yr	$9,000	$15,000	$740
LBP20	Enforce fertilizer ordinance	0	0	3000	0	0	0	$11,100,000	$0	$5,000	10 yr	$36,000	$36,000	$310
LBP24	Implement buffer zones	0	0	3700	0	0	0	$13,690,000	$0	$5,000	25 yr	$55,000	$55,000	$250
LBP18	Update street sweeping	0	0	750	0	0	0	$2,775,000	$7,700	$4,900	10 yr	$35,000	$43,000	$60
LBP28	Public Outreach and Education	0	0	300	0	0	0	$1,110,000	$15,000	$5,000	10 yr	$36,000	$51,000	$20
LBP10	Participate in rainwater harvesting (cisterns)	0	0	300	0	0	0	$1,110,000	$0	$9,600	25 yr	$106,000	$106,000	$10
LBP14	Septic tank pump out regulation	0	0	40	0	0	0	$148,000	$0	$3,000	10 yr	$22,000	$22,000	$10
LBP03	Sarasota County Schools teacher training and campus environmental activities	0	0	4	0	0	0	$15,000	$0	$5,000	10 yr	$36,000	$36,000	$0

While the programs listed in Table 8-4 are measurable, not all programs have a quantitative value but are important to improving environmental quality throughout the County. The following discussions are recommendations for continuing, revising, and implementing programs to engage residents and help the County achieve its sustainability goals.

8.6.1 LBP01: Public Outreach and Education

Sarasota County has developed a program for Neighborhood Environmental Stewardship Teams (NEST). NEST is a voluntary association of county residents (neighbors, civic groups, student organizations and others) who want to better understand and improve the environmental conditions in the watershed. The public purpose is two-fold: to provide constructive and meaningful activities to help residents improve the environmental quality of the watershed and their neighborhoods and to develop an education of and advocacy for watershed improvement policies and management strategies. NEST's activities address issues such as water quality, natural system preservation, neighborhood drainage, landscaping, and other water-related issues. NEST activities may include water quality or biological monitoring, volunteer restoration, research, and planning input. NEST provides individual and community awareness of appropriate fertilizer usage, implementing buffer zones, incorporating Low Impact Development (LID) practices, and conservation awareness. Additionally public outreach includes developing web/email campaigns and educational materials.

8.6.2 LBP12: National Pollutant Discharge Elimination System (NPDES)

Sarasota County is a Municipal Separate Storm Sewer System (MS4) operator and holds a National Pollutant Discharge Elimination System (NPDES) permit (Number FLS000004) from the Florida Department of Environmental Protection (FDEP). To maintain the permit, the County has developed a stormwater management program that includes BMPs with measurable goals to effectively implement eight minimum control measures outlined in the 2006 Comprehensive Plan. See Chapter 7 for a detailed discussion of the NPDES program and MS4 permit. Field Services must continue to work with the rest of the County staff to meet the overall goals of the NPDES permit, which is to reduce or prevent impairment of the local waterbodies.

8.6.3 LBP15: Facilitating Agricultural Resource Management Systems

The Florida Department of Agriculture and Consumer Services and SWFWMD have developed the Facilitating Agricultural Resource Management Systems (FARMS) program. FARMS is an agricultural best management practices (BMP), cost-share reimbursement program and is intended to expedite implementation of production-scale agricultural BMPs that will help agriculturalists reduce groundwater use from the Upper Floridan aquifer, improve water quality, and restore and augment the area's water. See Chapter 5 for additional information. The program is specific to the Upper Myakka watershed but may be used as a template for agricultural BMPs throughout the County.

8.6.4 LBP16: Preservation Areas

Sarasota County incorporates natural resource protection requirements in its Land Development Regulations (LDRs). One of these requirements is a 30% open space requirement for developments that prioritize natural communities such as wetlands, mesic hammocks, and coastal hammocks. Additional requirements include 30-foot wetland buffers, 33% littoral shelf for stormwater treatment ponds, and a 50-foot buffer around all water courses (Section 3.1.4). Most of these preservation and littoral shelf areas are scattered throughout the County. Chapter 3 discusses the work completed in the WMP to digitize some of the preservation information, but complete digital files will help County staff keep an inventory of preservation areas in the County, make more informed decisions regarding developments adjacent to these protected areas, and identify additional areas for preservation where acquiring land may be most beneficial.

8.6.5 LBP32: Septic Replacement Program

Septic systems that are not properly installed or maintained can increase fecal coliform counts in Lemon Bay and its tributaries. The South County Wastewater Improvement Program (SCWIP) evaluated whether existing wastewater treatment practices affect water quality in the project area and recommended that Sarasota County provide central sewers for those sub-areas with average acreage sizes less than 0.5 acres. The SCWIP recommendation to replace septic systems in certain areas is based on their analysis of the design, construction, installation, utilization, operation, maintenance, and repair of septic tank systems. The SCWIP found that only 24% of all developed parcels have been permitted post-1983 and meet current code separation requirements. Fecal coliforms may pose a special health risk for infants, young children, and people with severely compromised immune systems (epa.gov). Septic systems that are not properly installed or maintained can increase fecal coliform counts in the bay and its tributaries. The continued replacement of septic systems reduces human health risk for exposure to fecal coliforms and may improve water quality; both are beneficial to the residents of Sarasota County and the environment. See Chapter 4 for additional information.

8.6.6 LBP35: Septic to Cistern

In June 2009 the County Health Department implemented a procedure for converting abandoned septic tanks into cisterns based on 64E-6.011 FAC. This conversion allows a single-family residence to convert an abandoned septic tank to a cistern by permit within 90 days of connecting the building plumbing to sanitary sewer. Local-scale harvesting would be more cost-effective and provide a beneficial use for the large number of septic tanks that are no longer needed because of the septic tank phase-out program in this watershed. Active public outreach and education could assist homeowners in the permitting and testing phases of the process. See Chapter 5 for additional discussion.

8.6.7 LBP19: Strategic Maintenance Manual

Stormwater maintenance has traditionally played an active role in maintaining the flood capacity of the stormwater system throughout the County. A more robust maintenance program incorporating the recommendations described below will play a larger role in improving the quality of the runoff reaching the estuaries and bays of Sarasota County. The following approach is intended to expand and enhance the stormwater maintenance process to include water quality in addition to flood protection as part of the focus:

- Implement the 1999 *Strategic Maintenance Plan*.
- Achieve the inspection and maintenance frequency required in the MS4 Permit.
- Update the *Strategic Maintenance Plan*.
- Adopt practices listed below when fiscally feasible.

Updating the *Strategic Maintenance Plan* and adopting several non-structural BMPs and source control practices may provide the best opportunities for increased awareness and implementation of maintenance improvements aimed at improving water quality. With the County's water quality goals in mind, the modifications, additions, or removal of maintenance practices detailed in Section 7.5 will help progress toward meeting those goals. A summary list of topics recommended in Section 7.5 is provided here.

- Inspection and Permit Compliance
  - NPDES Inspection
  - Asset Management
- FEMA Community Rating System
- Facility Maintenance and BMPs
  - Facilities: Scheduling
  - Facilities: Denuding Conveyance Features
  - Non-Structural BMPs: Buffer Zones
  - Non-Structural BMPs: Low-Impact-Development
  - Source Control: Street Sweeping
  - Source Control: Herbicides
  - Source Control: Fertilizer Management
  - Source Control: Harvesters

8.6.8 LBP08: Stormwater Manual

The Stormwater Manual describes the review process and standards for capital improvement projects and land development projects. The manual is designed to assist the applicant with the submittal process and is consistent with the most current (2001) LDRs. Many developers follow the formatting and use the manual as a reference. Adoption of the manual would provide a formal template for consistency.

8.6.9 LBP26: Composting Pilot Study

Composting for beneficial reuse of grass clipping and vegetation debris offers several benefits:

- Removing products before decay will reduce the potential for nitrogen and phosphorus to enter the waterways.
- Using compost material as a soil amendment on eroding banks will provide structure and moisture capacity to the soil matrix.

Maintenance staff and contracted vendors can bag grass clippings during the mowing specifically along waterways and transport the debris to a designated composting facility. The compost would then be worked into the soil by maintenance staff on stream banks that need to be stabilized or vegetated.

8.6.10 LBP31: Low Impact Development (LID)

LID is a stormwater management approach that uses a suite of hydrologic controls (structural and non-structural) distributed throughout the site and integrated as a treatment train (i.e., in series) to replicate the natural hydrologic function of the landscape. A County manual to assist in incorporating LID projects into new development and infrastructure retrofit projects is in development. Consistently implementing LID concepts, design, and practice will improve the overall effectiveness and efficiency of stormwater management relative to conventional systems, reducing runoff and improving water quality.

8.6.11 LBP17: Exotic Species Management Program

The tropical climate in Sarasota County provides an ideal setting for aquatic invasive/exotic plant species to flourish. The undesirable vegetation, if left unchecked, may out-compete native plant species, cause public health risks, and impede flood conveyance. Only 11 herbicides are approved for use in plant management in Florida waters. Education and training are essential to balancing the environmental risk associated with chemicals versus the potential degradation of an ecosystem where invasive plants prosper. The NEST program provides an opportunity to expand education for individuals and the community on the benefits of using native plant species in landscaping and identifying and removing nuisance species.

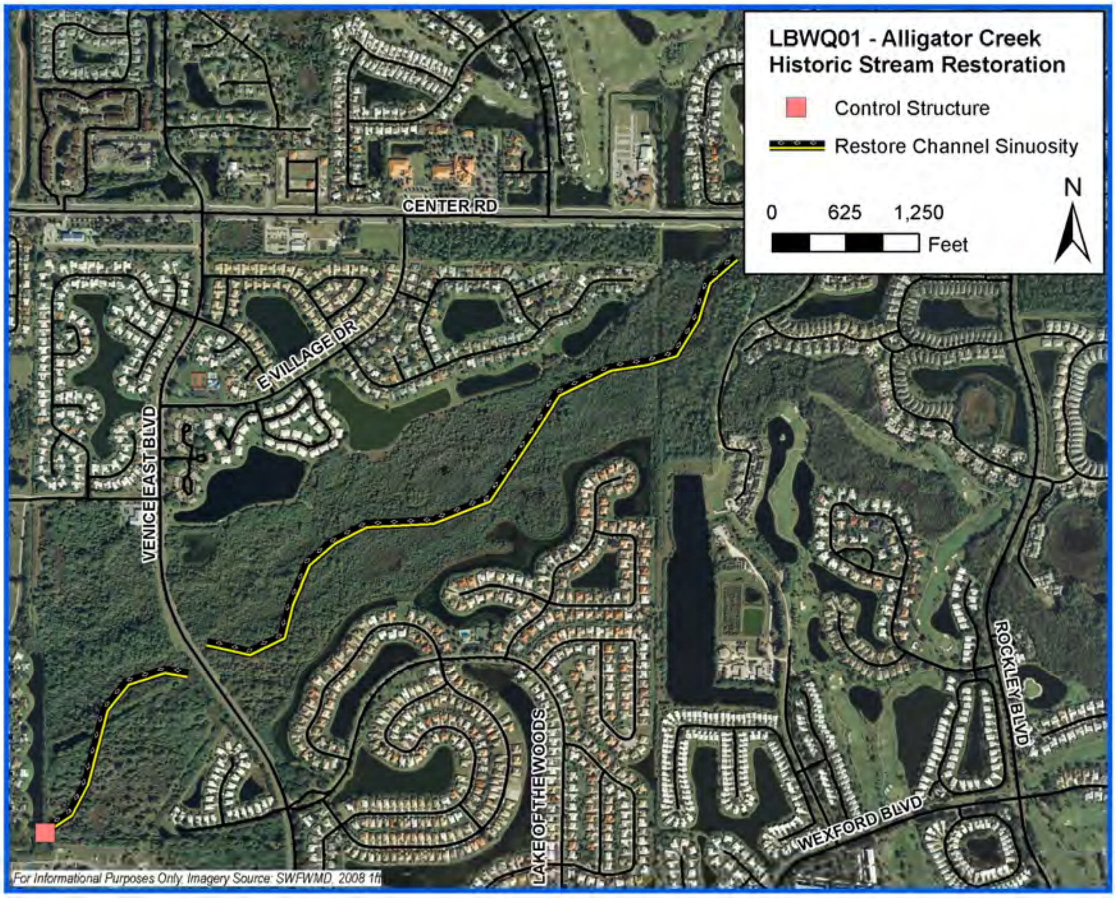
8.7 CONCEPTUAL LEVEL PROJECT SHEETS AND COST ESTIMATES

Sarasota County

Lemon Bay Watershed Management Plan
Water Quality Improvements

Jones Edmunds

Janicki Environmental, Inc.



Site Evaluation

Historical aerials show the flowpath of Alligator Creek previous to 1950 was more sinuous adjacent to Venice East Blvd. Restoring the historical flow regime will reduce velocities thus encouraging nutrient uptake and settling.

Proposed Project Elements

- Recreate the historical flowpath of Alligator Creek by installing strategic blocks to reroute water employing low-impact construction techniques involving minimal earthwork and clearing

Benefits

A sinuous channel will reduce flow velocities through the system thus providing a higher level of riparian treatment.

Pollutant Removal Estimate

TSS (lb/yr): 600 - 6900
TP (lb/yr): 0 - 5
TN (lb/yr): 50 - 210

Opinion of Probable Cost

$142,000

PROJECT TITLE: **Lemon Bay Water Quality Improvements**				
LBWQ01: Alligator Creek Historic Stream Restoration		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-015-03 Task 4110**		CHECKED BY: **CAM** DATE: **8/21/2010**		
ESTIMATE TYPE: ROM		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 2,475.00	$ 2,475
Control Structure	EA	1	$ 60,000.00	$ 60,000
Wet Excavation	CY	1500	$ 15.00	$ 22,500
Materials Subtotal				**$ 82,500**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 8,250
Subtotal				$ 90,750
CONTINGENCY		20%		$ 18,150
Construction Subtotal				**$ 108,900**
Survey				$ 4,050
Geotechnical Investigation				$ 4,050
Design and Permitting				$ 25,000
Engineering Services Subtotal				**$ 33,100**
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 142,000**
General Maintenance	LS	1	$100	$100
MAINTENANCE (First Yr Annual Cost)				**$100**

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Water Supply

Site Evaluation

This project involves converting the existing wet detention pond east of the academy into a stormwater harvesting pond to supply irrigation water for the academy. The contributing area is 18 acres.

Proposed Project Elements

- Install an end suction pump, filtration system, irrigation screen and a backflow preventer
- Install piping

Benefits

Pollutant removal, water supply source, reduce freshwater peak flow to estuary

- Approximate Average Volume (ac-ft/yr): 30
- Pollutant Removal Estimate: TN (lb/yr): 113

Opinion of Probable Cost

$342,000

JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

PROJECT TITLE: Lemon Bay Harvesting Revised Cost Estimate				
LBWS04: Elsie Quirk Library		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-016-03**		CHECKED BY: **BAC** DATE: **8/22/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE): **Conceptual Plan Cost Estimate**		CONSTRUCTION OR PROJECT ESTIMATE: **PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 3,694.57	$ 3,695
Excavation	CY	500	$ 15.00	$ 7,500
Silt Fence	LF	2000	$ 2.00	$ 4,000
Turbidity Barrier Floating (Multiple Use)	LF	2000	$ 12.00	$ 24,000
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
End Suction Pump (250 gpm)	EA	1	$ 4,320.00	$ 4,320
Pipe (sch 40 PVC 2.5 inch)	LF	710	$ 2.44	$ 1,732
Irrigation Basket Screen	EA	1	$ 300.00	$ 300
Filtration System	EA	1	$ 14,400.00	$ 14,400
Backflow Preventer	EA	1	$ 6,000.00	$ 6,000
Pipe (sch 40 PVC 4 inch)	LF	1600	$ 36.00	$ 57,600
Subtotal				$ 127,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 12,700
Subtotal				$ 139,700
CONTINGENCY		20%		$ 27,940
Survey		5%		$ 6,985
Geotechnical Investigation		5%		$ 6,985
Design and Permitting		20%		$ 30,000
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 212,000**
Pump Maintenance	EA	1	$ 250.00	$ 250
Filter Maintenannce	EA	1	$ 500.00	$ 500
MAINTENANCE (First Yr Annual Cost)				**$ 800**

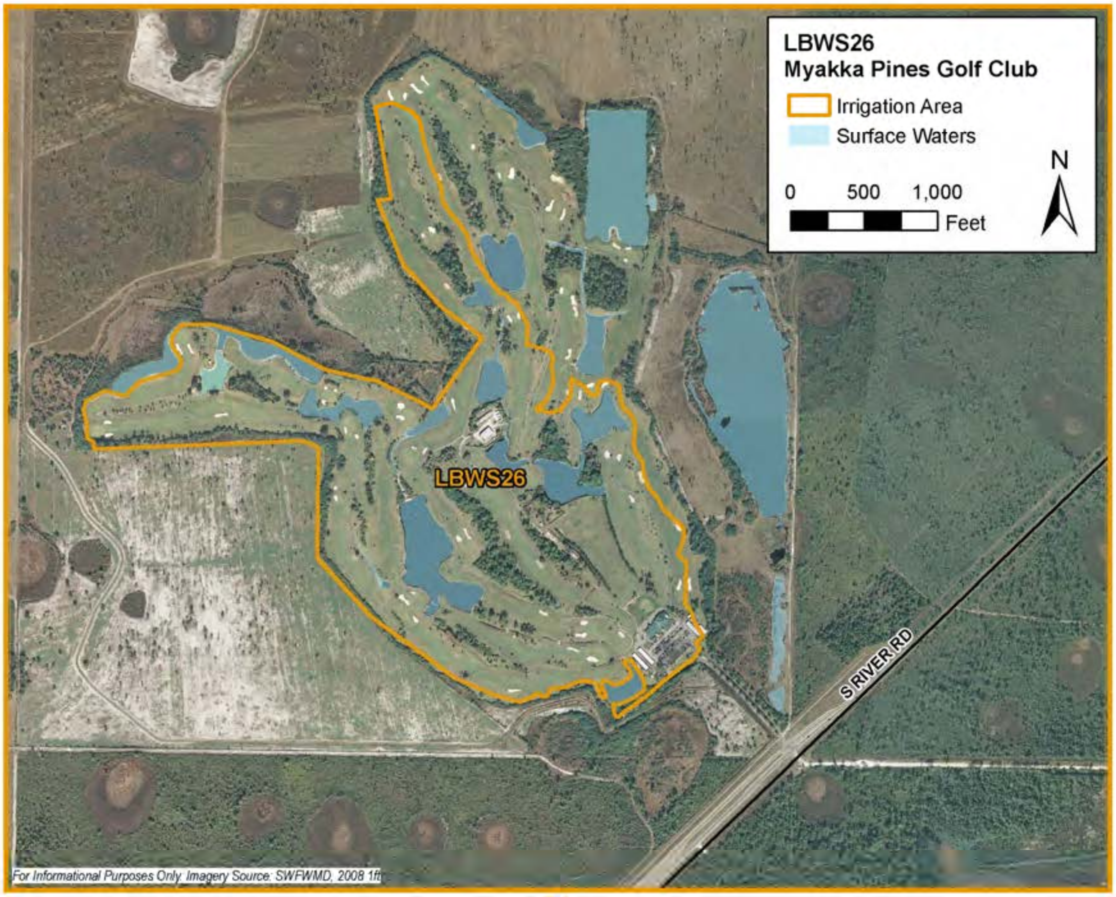
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
Note 2: It is assumed that minimal distribution additions are required.

Sarasota County

Lemon Bay Watershed Management Plan
Water Supply

JONES EDMUNDS

Janicki Environmental, Inc.



Site Evaluation

This project involves converting the existing wet detention ponds into stormwater harvesting ponds to supply irrigation water for the golf club. The contributing area is 143 acres within the Lemon Bay watershed. Additional golf club property exists outside of the Lemon Bay watershed.

Proposed Project Elements

- Install 3 end suction pumps, filtration systems, irrigation screens and backflow preventers
- Install piping

Benefits

Pollutant removal, water supply source, reduce freshwater peak flow to estuary

- Approximate Average Volume (ac-ft/yr): 107
- Pollutant Removal Estimate: TN (lb/yr): 526

Opinion of Probable Cost

$1,793,600

JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

PROJECT TITLE: Lemon Bay Harvesting Revised Cost Estimate				
LBWS26		ESTIMATED BY:	**JRM**	
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY:	**BAC**	
19006-016-03		DATE:	**8/22/2009**	
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 31,665.30	$ 31,665
Excavation	CY	10000	$ 15.00	$ 150,000
Silt Fence	LF	10000	$ 2.00	$ 20,000
Turbidity Barrier Floating (Multiple Use)	LF	10000	$ 12.00	$ 120,000
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
End Suction Pump (250 gpm)	EA	3	$ 4,320.00	$ 12,960
Pipe (sch 40 PVC 2.5 inch)	LF	15,500	$ 22.50	$ 348,750
Irrigation Basket Screen	EA	3	$ 300.00	$ 900
Filtration System	EA	3	$ 14,400.00	$ 43,200
Backflow Preventer	EA	3	$ 6,000.00	$ 18,000
Pipe (sch 40 PVC 4 inch)	LF	9400	$ 36.00	$ 338,400
Subtotal				$ 1,087,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 108,700
Subtotal				$ 1,195,700
CONTINGENCY		20%		$ 239,140
Survey		5%		$ 59,785
Geotechnical Investigation		5%		$ 59,785
Design and Permitting		20%		$ 239,140
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 1,793,600**
Pump Maintenance	EA	3	$ 250.00	$ 750
Filter Maintenannce	EA	3	$ 500.00	$ 1,500
MAINTENANCE (First Yr Annual Cost-ROUNDED)				**$ 2,000**

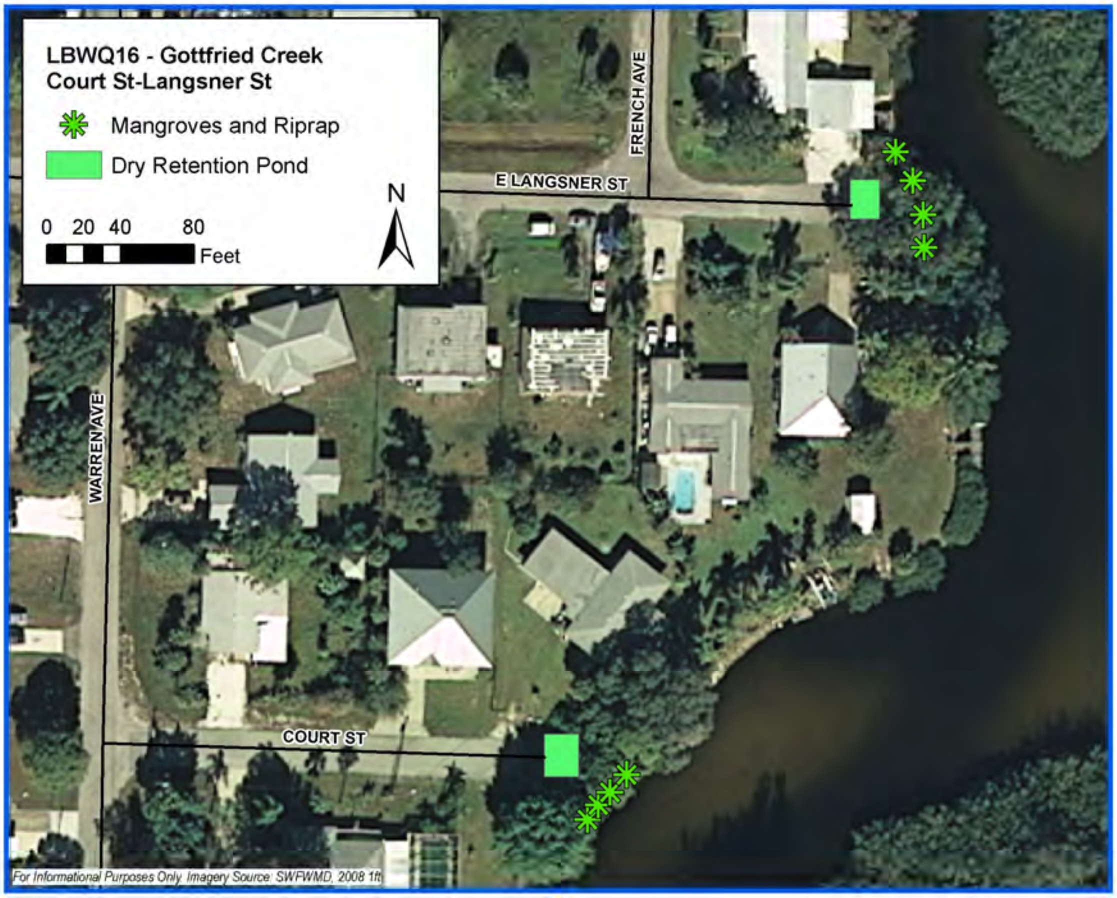
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
Note 2: It is assumed that minimal distribution additions are required.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Water Quality Improvements



Site Evaluation

Court and Langsner Streets are roadways that end within 100 feet of Gottfried Creek. The roadways are in poor repair and have excess gravel and fine sediment accumulated on the surface. The roadways are sloped to direct stormwater runoff directly to the creek without any treatment.

Proposed Project Elements

- Add dry retention ponds at the end of the roadways to provide treatment
- Add mangroves and riprap to the shoreline to provide additional stability

Benefits

The small stormwater pond will capture roadway runoff and reduce pollutants from reaching the canal system. Mangroves will provide additional bank stabilization.

Pollutant Removal Estimate

TSS (lb/yr): 300 - 400
TP (lb/yr): 2 - 3
TN (lb/yr): 15 - 20

Sediment Abatement/Removal Estimate

- Stabilization (CY): 20

Opinion of Probable Cost

$62,000

PROJECT TITLE: **Lemon Bay Water Quality Improvements**				
LBWQ16: Gottfried Creek - Court St/Langsner St.		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-016-03**		CHECKED BY: **CAM** DATE: **8/21/2010**		
ESTIMATE TYPE: ROM		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
		PROJECT ESTIMATE		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 759.02	$ 759.02
Excavation	CY	160	$ 15.00	$ 2,400.00
Riprap	CY	40	$ 451.02	$ 18,040.80
Mangrove (seedlings)	EA	30	$ 10.00	$ 300.00
Silt Fence	LF	330	$ 2.00	$ 660.00
Turbidity Barrier Floating (Multiple Use)	LF	50	$ 12.00	$ 600
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Materials Subtotal				**$ 26,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 2,600
Subtotal				$ 28,600
CONTINGENCY		20%		$ 5,720
Construction Subtotal				**$ 34,320**
Survey				$ 1,300
Geotechnical Investigation				$ 1,300
Design and Permitting				$ 25,000
Engineering Services Subtotal				**$ 28,000**
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 62,000**
Sediment Removal	CY	20	$ 50.00	$ 1,000
MAINTENANCE (First Yr Annual Cost)				**$ 1,000**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

Lemon Bay Watershed Management Plan
Water Quality Improvements

Site Evaluation

This site is located at the end of Cortes Drive off of South Oxford Drive. A drop inlet with a pipe discharging directly to the tidally-influenced creek is located between the end of the cul-de-sac and the mangroves. The roadway is in poor condition with accumulated sediment and gravel on the surface and along the edge of pavement. Much of the sediment on the roadway is crumbling roadway material.

Proposed Project Elements

- Add a dry retention pond at the end of the roadway to provide treatment to stormwater runoff
- Add bioretention swales to provide attenuation and treatment
- Replace damaged discharge structure

Benefits

The stormwater pond will capture roadway runoff and reduce pollutants from reaching the canal system.

Pollutant Removal Estimate

TSS (lb/yr): 300 - 500
TP (lb/yr): 0 - 5
TN (lb/yr): 15 - 25

Opinion of Probable Cost

$43,000

PROJECT TITLE: **Lemon Bay Water Quality Improvements**				
LBWQ12: Gottfried Creek - Cortes Dr.		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY: **CAM**		
19006-016-03		DATE: **8/21/2010**		
ESTIMATE TYPE: ROM		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 345.96	$ 345.96
Wet Excavation	CY	100	$ 50.00	$ 5,000.00
Dewatering (pond)	DAY	1	$ 780.00	$ 780.00
Grading	SF	400	$ 0.03	$ 12.00
24" RCP	LF	20	$ 59.00	$ 1,180.00
Silt Fence	LF	600	$ 2.00	$ 1,200.00
Turbidity Barrier Floating (Multiple Use)	LF	5	$ 12.00	$ 60.00
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300.00
Materials Subtotal				**$ 11,878**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 1,188
Subtotal				$ 13,066
CONTINGENCY		20%		$ 2,613
Construction Subtotal				**$ 15,679**
Survey				$ 1,200
Geotechnical Investigation				$ 1,200
Design and Permitting				$ 25,000
Engineering Services Subtotal				**$ 27,000**
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 43,000**
Clean out Bioretention	LF	1	$ 1,500.00	$ 1,500
SW Pond		1	$ 1,000.00	$ 1,000
MAINTENANCE (First Yr Annual Cost)				**$ 2,500**

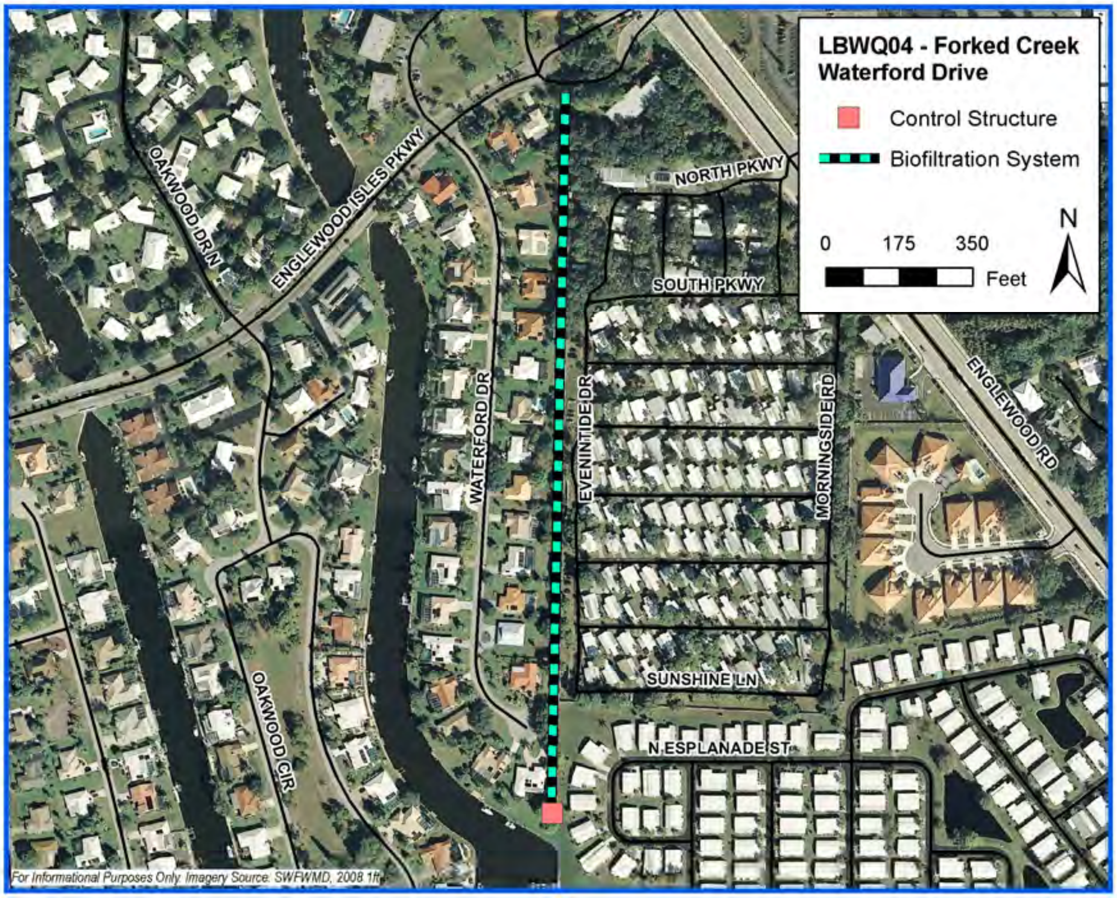
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

Lemon Bay Watershed Management Plan
Water Quality Improvements

JONES EDMUNDS

Janicki Environmental, Inc.



Site Evaluation

A 1700 ft channel discharges to a Forked Creek tributary through a 15-inch culvert at this location. The channel segment carries runoff from approximately 30 acres of a medium-density residential area with the swale as the only water quality treatment BMP.

Proposed Project Elements

- Replace drainage swale with a biofiltration system
- Install a control structure at the outfall

Benefits

The benefits of biofiltration include decreased surface runoff, increased groundwater recharge, and increased pollutant removal.

Pollutant Removal Estimate

TSS (lb/yr): 2500 - 4100
TP (lb/yr): 0 - 0
TN (lb/yr): 100 - 150

Opinion of Probable Cost

$468,000

PROJECT TITLE: **Lemon Bay Water Quality Improvements**				
LBWQ04: Waterford Dr.		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-015-03 Task 4110**		CHECKED BY: **CAM** DATE: **8/21/2010**		
ESTIMATE TYPE: ROM		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 8,408.67	$ 8,409
Grading	SF	12000	$ 0.03	$ 360
Control Structure	EA	1	$ 60,000.00	$ 60,000
Organic Mulch	SY	1850	$ 2.48	$ 4,588
Planting Soil Filter Bed	0	1850	$ -	$ -
Sand Filter Bed	CY	600	$ 35.91	$ 21,546
Filter Fabric	SY	1850	$ 1.42	$ 2,627
Gravel Media	CY	600	$ 90.00	$ 54,000
Perforated Underdrain Pipe	LF	1700	$ 47.04	$ 79,968
Excavation	CY	3100	$ 15.00	$ 46,500
Silt Fence	LF	3,400	$ 2.00	$ 6,800
Turbidity Barrier Floating (Multiple Use)	LF	50	$ 12.00	$ 600
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Materials Subtotal				**$ 289,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 28,900
Subtotal				$ 317,900
CONTINGENCY		20%		$ 63,580
Construction Subtotal				**$ 381,000**
Survey				$ 14,450
Geotechnical Investigation				$ 14,450
Design and Permitting				$ 57,800
Engineering Services Subtotal				**$ 87,000**
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 468,000**
Structure cleanout	CY	1	$ 30.00	$ 30
Clean out bioretention	EA	1	$ 1,500.00	$ 1,500
MAINTENANCE (First Yr Annual Cost)				**$ 1,530**

**Distance and Fuel Costs may cause this cost to change.

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Lemon Bay Watershed Management Plan
Water Supply

Site Evaluation

This project involves converting the existing wet detention ponds into stormwater harvesting ponds to supply irrigation water for the club. The contributing area is 94 acres.

Proposed Project Elements

- Install 2 end suction pumps, filtration systems, irrigation screens and backflow preventers
- Install piping

Benefits

Pollutant removal, water supply source, reduce freshwater peak flow to estuary

- Approximate Average Volume (ac-ft/yr): 70
- Pollutant Removal Estimate: TN (lb/yr): 344

Opinion of Probable Cost

$1,544,000

PROJECT TITLE: Lemon Bay Harvesting Revised Cost Estimate				
LBWS27: Boca Royale Golf and CC		ESTIMATED BY:	**JRM**	
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY:	**BAC**	
19006-016-03		DATE:	**8/22/2009**	
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 27,259.20	$ 27,259
Excavation	CY	10000	$ 15.00	$ 150,000
Silt Fence	LF	12000	$ 2.00	$ 24,000
Turbidity Barrier Floating (Multiple Use)	LF	12000	$ 12.00	$ 144,000
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
End Suction Pump (250 gpm)	EA	2	$ 4,320.00	$ 8,640
Pipe (sch 40 PVC 2.5 inch)	LF	10,600	$ 22.50	$ 238,500
Irrigation Basket Screen	EA	2	$ 300.00	$ 600
Filtration System	EA	2	$ 14,400.00	$ 28,800
Backflow Preventer	EA	2	$ 6,000.00	$ 12,000
Pipe (sch 40 PVC 4 inch)	LF	8300	$ 36.00	$ 298,800
Subtotal				$ 936,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 93,600
Subtotal				$ 1,029,600
CONTINGENCY		20%		$ 205,920
Survey		5%		$ 51,480
Geotechnical Investigation		5%		$ 51,480
Design and Permitting		20%		$ 205,920
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 1,544,000**
Pump Maintenance	EA	2	$ 250.00	$ 500
Filter Maintenannce	EA	2	$ 500.00	$ 1,000
MAINTENANCE (First Yr Annual Cost)				**$ 2,000**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
Note 2: It is assumed that minimal distribution additions are required.

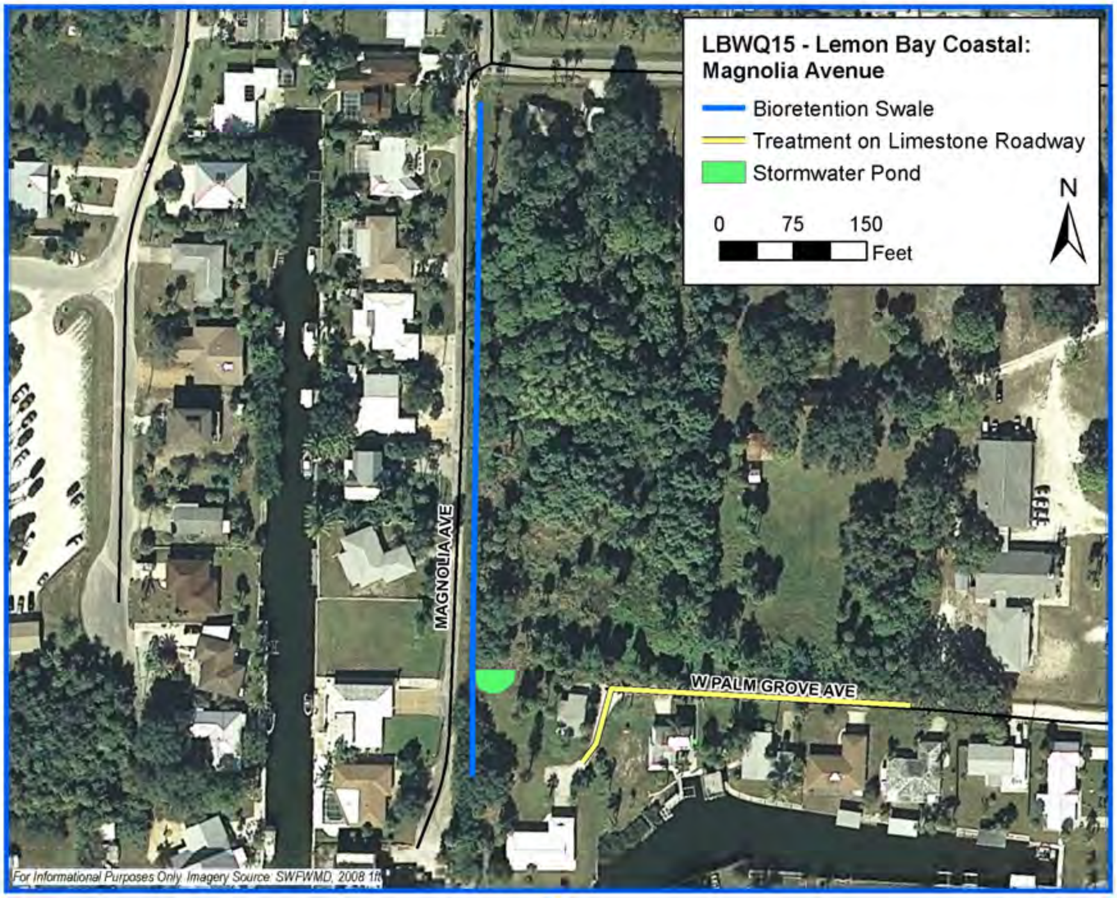
Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

Lemon Bay Watershed Management Plan
Water Quality Improvements



Site Evaluation

A large wetland, located to the east of Magnolia Avenue, provides some treatment for stormwater runoff.

Proposed Project Elements

- Treat limestone on West Palm Grove Avenue
- Construct a stromwater pond
- Create a bioswale on the east side of Magnolia Avenue for additional treatment of stormwater runoff

Benefits

The small stormwater pond will capture roadway runoff and reduce pollutants from reaching the canal system. Bioswales serve to remove sediment and nutrients in runoff by slowing overland flow.

Pollutant Removal Estimate

TSS (lb/yr): 200 - 600
TP (lb/yr): 0 - 5
TN (lb/yr): 15 - 25

Opinion of Probable Cost

$56,000

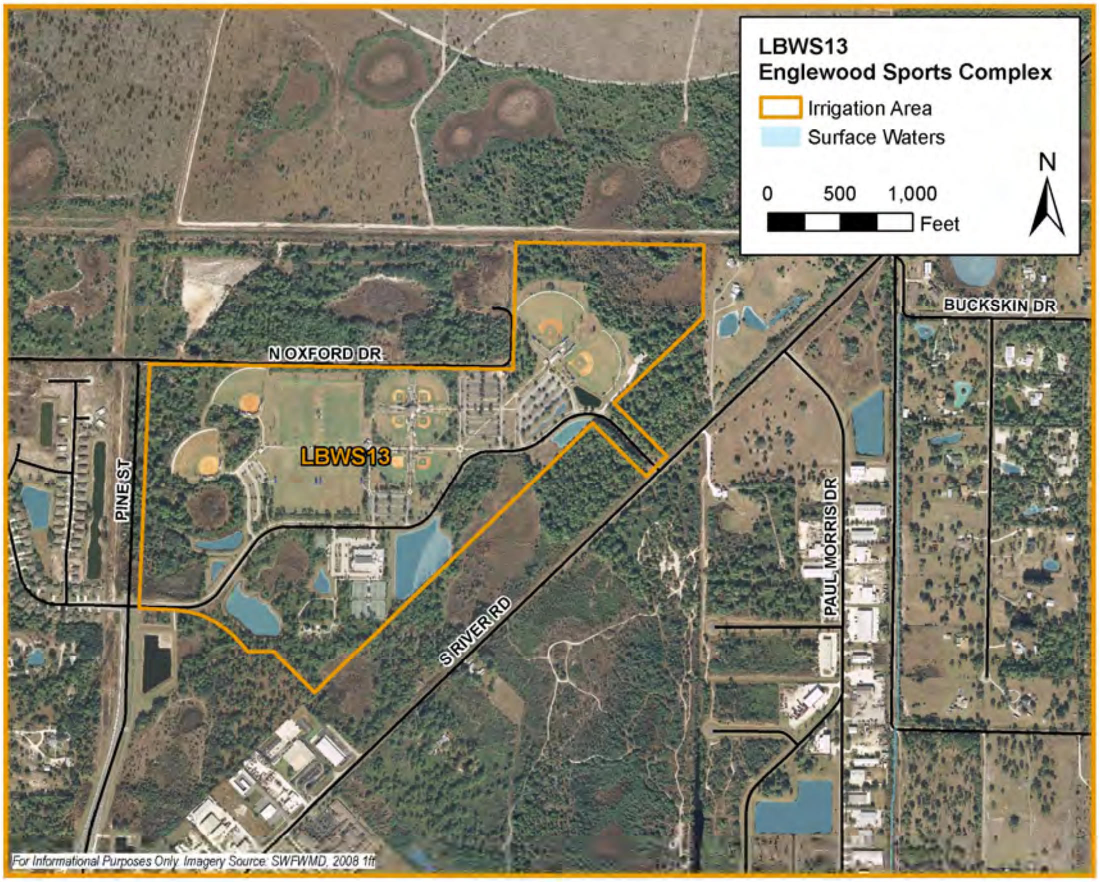
PROJECT TITLE: **Lemon Bay Water Quality Improvements**				
LBWQ15: Lemon Bay Coastal - Magnolia Avenue		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY: **CAM**		
19006-016-03		DATE: **8/21/2010**		
ESTIMATE TYPE: ROM		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
		PROJECT ESTIMATE		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 642.48	$ 642
Treatment on Limestone Road	SF	4000	$ 1.08	$ 4,316
Excavation	CY	500	$ 15.00	$ 7,500
Silt Fence	LF	3000	$ 2.00	$ 6,000
Grading	SF	6000	$ 0.03	$ 180
Turbidity Barrier Floating (Multiple Use)	LF	10	$ 12.00	$ 120
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 22,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 2,200
Subtotal				$ 24,200
CONTINGENCY		20%		$ 4,840
Construction Subtotal				**$ 29,040**
Survey				$ 1,200
Geotechnical Investigation				$ 1,200
Design and Permitting				$ 25,000
Engineering Services Subtotal				**$ 27,000**
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 56,000**
Sediment Removal	CY	20	$ 50.00	$ 1,000
Bioretention	EA	1	$ 1,500.00	$ 1,500
MAINTENANCE (First Yr Annual Cost)				**$ 2,500**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

Lemon Bay Watershed Management Plan
Water Supply

JONES EDMUNDS
Janicki Environmental, Inc.



Site Evaluation

This project involves converting the existing wet detention ponds into stormwater harvesting ponds to supply irrigation water for the park. The contributing area is 137 acres.

Proposed Project Elements

- Install 3 end suction pumps, filtration systems, irrigation screens and backflow preventers
- Install piping

Benefits

Pollutant removal, water supply source, reduce freshwater peak flow to estuary

- Approximate Average Volume (ac-ft/yr): 92
- Pollutant Removal Estimate: TN (lb/yr): 299

Opinion of Probable Cost

$1,657,000

JONES EDMUNDS ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

PROJECT TITLE: Lemon Bay Harvesting Revised Cost Estimate				
LBWS13: Englewood Sports Complex	ESTIMATED BY:	**JRM**		
JONES EDMUNDS PROJECT NUMBER:	CHECKED BY:	**BAC**		
19006-016-03	DATE:	**8/22/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:			
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**			

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 29,253.30	$ 29,253
Excavation	CY	10000	$ 15.00	$ 150,000
Silt Fence	LF	13000	$ 2.00	$ 26,000
Turbidity Barrier Floating (Multiple Use)	LF	13000	$ 12.00	$ 156,000
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
End Suction Pump (250 gpm)	EA	3	$ 4,320.00	$ 12,960
Pipe (sch 40 PVC 2.5 inch)	LF	15,500	$ 22.50	$ 348,750
Irrigation Basket Screen	EA	3	$ 300.00	$ 900
Filtration System	EA	3	$ 14,400.00	$ 43,200
Backflow Preventer	EA	3	$ 6,000.00	$ 18,000
Pipe (sch 40 PVC 4 inch)	LF	6000	$ 36.00	$ 216,000
Subtotal				$ 1,004,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 100,400
Subtotal				$ 1,104,400
CONTINGENCY		20%		$ 220,880
Survey		5%		$ 55,220
Geotechnical Investigation		5%		$ 55,220
Design and Permitting		20%		$ 220,880
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 1,657,000**
Pump Maintenance	EA	3	$ 250.00	$ 750
Filter Maintenannce	EA	3	$ 500.00	$ 1,500
MAINTENANCE (First Yr Annual Cost)				**$ 2,000**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
Note 2: It is assumed that minimal distribution additions are required.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Sediment Management Plan

Site Evaluation

A mobile home community is adjacent to the creek on the upstream side and residents report the creek is un-navigable due to accumulated sediment. The southern bank has a seawall while the northern bank is mangroves. The system is tidally influence and the bottom sediment appears mucky. On the downstream side of the 41 bridge, the south bank was hardened with a seawall from the bridge to about 300 feet downstream. Residents reported the channel had been dredged to remove excess sediment that interfered with recreational boat traffic. The north bank has mangroves for approximately 200 feet and then is hardened by seawalls.

Proposed Project Elements

- Add a dry retention pond
- Add mangroves and riprap at outfall
- Regrade and revegetating banks
- Add riprap at outfalls
- Remove an obstruction in the channel
- Add a riparian maintenance buffer
- Create a bioretention swale to capture and treat runoff from the entrance

Benefits

Creating a maintenance buffer of vegetation along channel bank to reduce the impact of mowing. Maintenance buffers also serve to dissipate energy by slowing overland flow and remove nutrients in the runoff. Re-introduction of native vegetation will reduce maintenance requirements.

Pollutant Removal Estimate

TSS (lb/yr): 1300 - 2100
TP (lb/yr): 10 - 15
TN (lb/yr): 90 - 110

Sediment Abatement/Removal Estimate

- Stabilization (CY): 250

Opinion of Probable Cost

$577,000

PROJECT TITLE: **Lemon Bay Sediment**				
LBS16: Forked Creek at US 41		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY: **KBC**		
19006-016-03		DATE: **08.24.2010**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 10,369.85	$ 10,370
Excavation	CY	2000	$ 50.00	$ 100,000
Planting	AC	0.5	$ 5,000.00	$ 2,515.61
Revegetation Mat	SY	800	$ 7.95	$ 6,360.00
Native Plants for Bank Stabilization	EA	50	$ 1.51	$ 75.50
Grading	SF	16000	$ 0.03	$ 480
Mangroves	EA	35	$ 10.00	$ 350.00
Riprap	CY	20	$ 451.02	$ 9,020.40
Silt Fence	LF	7400	$ 30.00	$ 222,000
Turbidity Barrier Floating (Multiple Use)	LF	130	$ 12.00	$ 1,560
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 356,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 35,600
Subtotal				$ 391,600
CONTINGENCY		20%		$ 78,320
Survey				$ 17,800
Geotechnical Investigation				$ 17,800
Design and Permitting				$ 71,200
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 577,000**
Bioretention Maintenance	Ea	1	$ 1,500.00	$ 1,500
Stormwater Pond Maintenance	Ea	1	$ 1,000.00	$ 1,000
MAINTENANCE (First Yr Annual Cost)				**$ 2,500**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Natural Systems & Habitat Improvements

Site Evaluation

The Englewood McCall Road site is an approximately 18-acre County-owned property bound on the west by North Elm Street and the east by North McCall Road. An approximately 6-acre medium-quality Mixed Wetland Hardwood habitat is located in the central portion of the site. Exotic and invasive species are scattered throughout the wetland. A channelized ditch runs from the southeast corner through this wetland to a stormwater pond in the northwest corner of the property. Much pepper vine was encroaching into the wetland, which may indicate that this ditch is affecting the hydrology. Local residents north of the site discussed flooding and high water problems in this area along their back yards during the summer.

Proposed Project Elements

- Remove exotic species
- Construct ditch block
- Install geofabric and rip rap on both sides of ditch block

Benefits

Exotic species removal and hydrologic enhancement at this site will increase the habitat quality. Installing a ditch block will help to rehydrate the wetlands, improve water quality and may also reduce flooding.

- 1 UMAM Credit

Opinion of Probable Cost

$158,000

OWNER:	ESTIMATED BY:
Sarasota County	**JRM**
CLIENT:	CHECKED BY:
Sarasota County	**BJ**
PROJECT TITLE:	APPROVED BY:
McCall Road Habitat Improvement	
JONES EDMUNDS PROJECT NUMBER:	DATE:
19006-015-04 Task 4320	**6/12/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	0.5	$ 13,600.67	$ 6,800
Rubber Mats	EA	70	$ 80.00	$ 5,600
Earthen Ditch Block	CY**	13	$ 390.00	$ 5,200
Sod	SF	180	$ 30.55	$ 5,499
Riprap	SY	7	$ 120.90	$ 806
Geofabric	SY	7	$ 3.50	$ 23
Silt Fence	LF	84	$ 1.20	$ 100
Turbidity Barrier Floating (Multiple Use)	LF	40	$ 12.00	$ 480
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Maintenance of Exotic Species (4 Years)	ACRE	6	$ 500.00	$ 12,000
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 25,000.00	$ 25,000
Subtotal				$ 119,809
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 11,981
Subtotal				$ 131,790
CONTINGENCY		20%		$ 26,358
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 158,000**
MAINTENANCE (First Yr Annual Cost)				**$ 3,000**

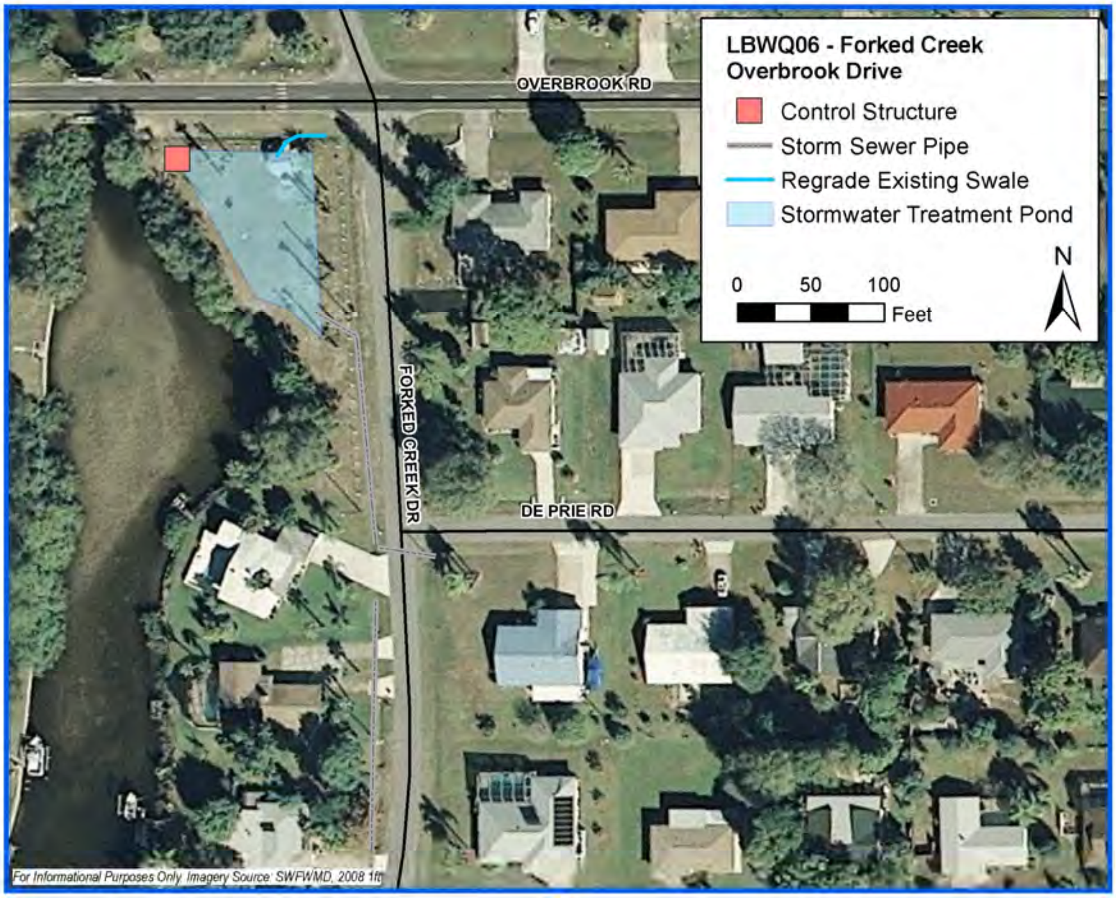
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

**Distance and Fuel Costs may cause this cost to change.

Sarasota County

Lemon Bay Watershed Management Plan
Water Quality Improvements

Jones Edmunds
Janicki Environmental, Inc.



Site Evaluation

The bridge west of Forked Creek Drive on Overbrook Road was replaced in 2008. Accumulated sediment south of the bridge is visible in 2007 aerial photographs. Stormwater runoff flows directly to the channel through a driveway culvert/roadside swale system. Overbrook Road is in good repair but several of the local neighborhood roads are pitted and graveled with accumulated sediment on the pavement and at the edge of the pavement.

Proposed Project Elements

- Construct a stormwater treatment pond
- Build supporting infrastructure

Benefits

- The retention pond will capture roadway runoff and reduce the sediment and pollutant loads reaching the canal system.

Pollutant Removal Estimate

TSS (lb/yr): 1400 - 2500
TP (lb/yr): 5 - 20
TN (lb/yr): 0 - 70

Opinion of Probable Cost

$334,000

PROJECT TITLE: **Lemon Bay Water Quality Improvements**				
LBWQ06: Forked Creek - Overbrook Drive		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-016-03**		CHECKED BY: **KBC**		
		DATE: **08.20.2009**		
ESTIMATE TYPE: ROM		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 6,003.60	$ 6,004
Wet Excavation	CY	2000	$ 50.00	$ 100,000
Dewatering (Pond)	DAY	1	$ 780.00	$ 780
24" RCP	LF	500	$ 59.00	$ 29,500
Grading	SF	10000	$ 0.03	$ 300
Silt Fence	LF	3000	$ 2.00	$ 6,000
Control Structure	EA	1	$ 60,000.00	$ 60,000
Turbidity Barrier Floating (Multiple Use)	LF	20	$ 12.00	$ 240
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Materials Subtotal				**$ 206,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 20,600
Subtotal				$ 226,600
CONTINGENCY		20%		$ 45,320
Construction Subtotal				**$ 271,920**
Survey				$ 10,300
Geotechnical Investigation				$ 10,300
Design and Permitting				$ 41,200
Engineering Services Subtotal				**$ 62,000**
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 334,000**
MAINTENANCE (First Yr Annual Cost)				**$ 100**

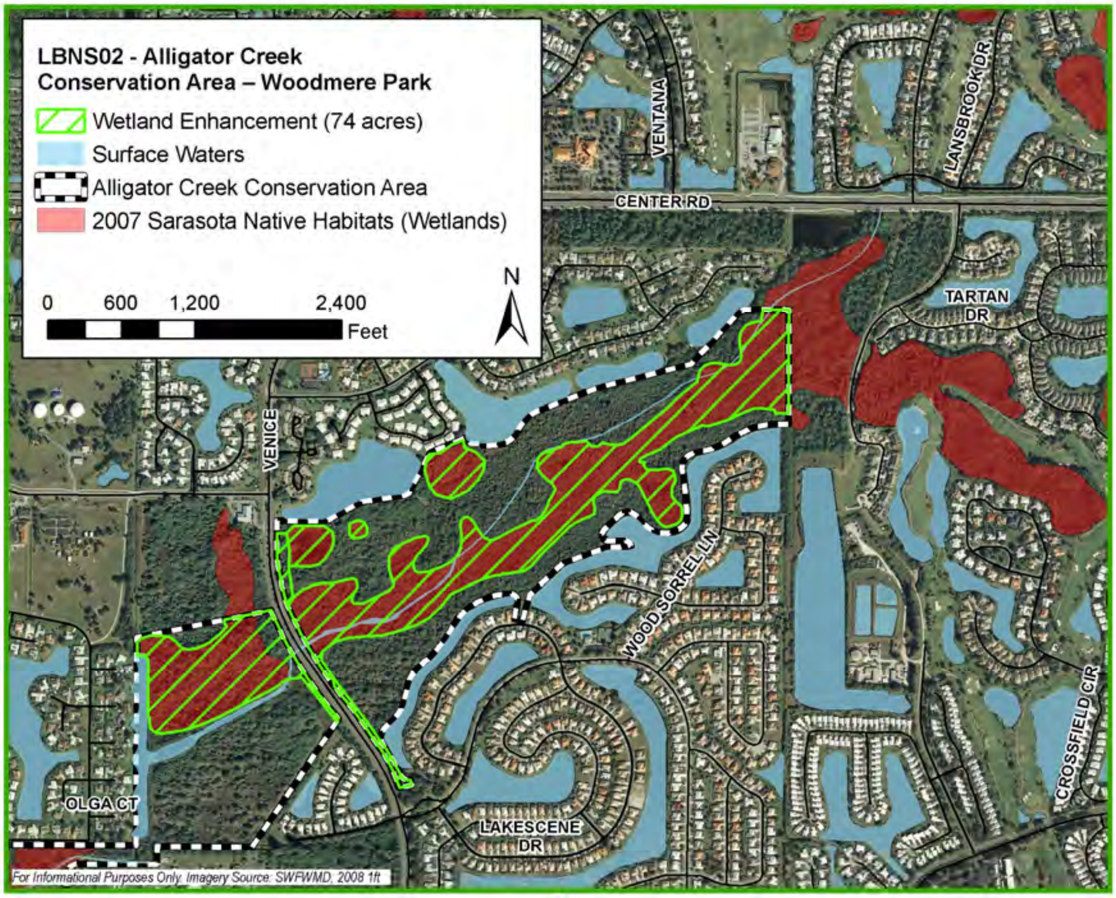
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Natural Systems & Habitat Improvements



Site Evaluation

Alligator Creek downstream of Center Road is a channelized system with dense Brazilian pepper along the banks. Areas adjacent to the creek are characterized as Mixed Wetland Hardwoods. These wetlands are dominated by exotic and invasive species.

Proposed Project Elements

- Remove exotic species.

Benefits

Removing exotic species will increase the habitat quality of the on-site wetland and reduce the further encroachment of these species. The project will provide wetland enhancement for approximately 74 acres of wetlands.

- 3.8 UMAM Credits

Opinion of Probable Cost

$284,000

OWNER:	ESTIMATED BY:
Sarasota County	**JRM**
CLIENT:	CHECKED BY:
Sarasota County	**BJ**
PROJECT TITLE:	APPROVED BY:
Alligator Creek Preservation Area Habitat Improvement	
JONES EDMUNDS PROJECT NUMBER:	DATE:
19006-015-04 Task 4320	**6/12/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Maintenance of Exotic Species (4 Years)	ACRE	74	$ 500.00	$ 148,000
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 12,000.00	$ 12,000
Subtotal				$ 215,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 21,500
Subtotal				$ 236,500
CONTINGENCY		20%		$ 47,300
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 284,000**
MAINTENANCE (First Yr Annual Cost)				**$ 3,000**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

Lemon Bay Watershed Management Plan
Water Supply

Jones Edmunds
Janicki Environmental, Inc.

Site Evaluation

This project involves converting the existing wet detention pond into a stormwater harvesting pond to supply irrigation water for the park. The contributing area is 9 acres.

Proposed Project Elements

- Install an end suction pump, filtration system, irrigation screen and a backflow preventer
- Install piping

Benefits

Pollutant removal, water supply source, reduce freshwater peak flow to estuary

- Approximate Average Volume (ac-ft/yr): 9
- Pollutant Removal Estimate: TN (lb/yr): 20

Opinion of Probable Cost

$214,000

PROJECT TITLE: Lemon Bay Harvesting Revised Cost Estimate				
LBWS23: South Venice Park		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY: **BAC**		
19006-016-03		DATE: **8/22/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 3,752.10	$ 3,752
Excavation	CY	700	$ 15.00	$ 10,500
Silt Fence	LF	2400	$ 2.00	$ 4,800
Turbidity Barrier Floating (Multiple Use)	LF	2400	$ 12.00	$ 28,800
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
End Suction Pump (250 gpm)	EA	1	$ 4,320.00	$ 4,320
Pipe (sch 40 PVC 2.5 inch)	LF	900	$ 22.50	$ 20,250
Irrigation Basket Screen	EA	1	$ 300.00	$ 300
Filtration System	EA	1	$ 14,400.00	$ 14,400
Backflow Preventer	EA	1	$ 6,000.00	$ 6,000
Pipe (sch 40 PVC 4 inch)	LF	900	$ 36.00	$ 32,400
Subtotal				$ 129,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 12,900
Subtotal				$ 141,900
CONTINGENCY		20%		$ 28,380
Survey		5%		$ 7,095
Geotechnical Investigation		5%		$ 7,095
Design and Permitting		20%		$ 30,000
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 214,000**
Pump Maintenance	EA	1	$ 250.00	$ 250
Filter Maintenannce	EA	1	$ 500.00	$ 500
MAINTENANCE (First Yr Annual Cost)				**$ 800**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
Note 2: It is assumed that minimal distribution additions are required.

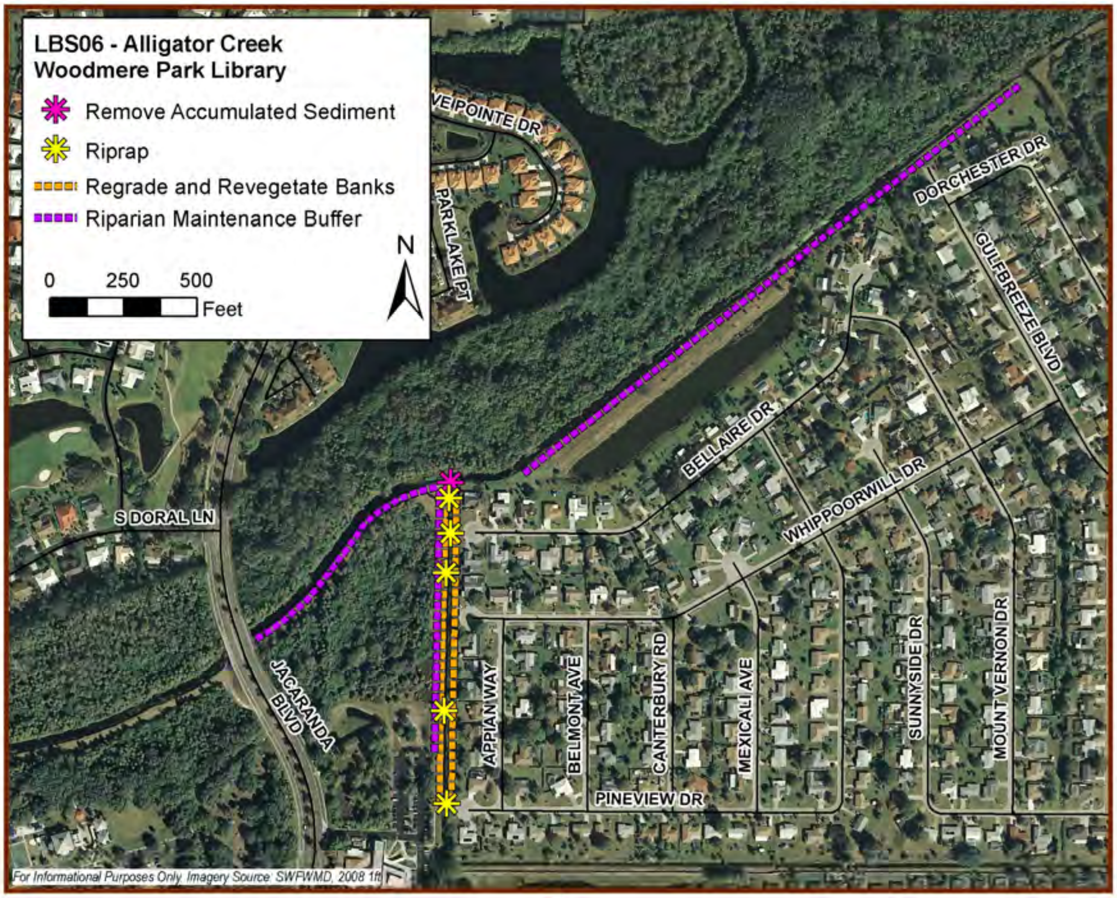
Sarasota County

Jones Edmunds

Janicki Environmental, Inc.

Southwest Florida Water Management District

Lemon Bay Watershed Management Plan
Sediment Management Plan



Site Evaluation

This channel segment starts at the Woodmere Park Library and extends 1300 feet to Alligator Creek. The banks are steep, less than 3:1 (H:V) and show signs of eroding, sloughing, and undercutting. Primrose was pervasive along the entire eastern bank. Manicured lawns extend to the top of bank on the east side with evidence of grass clippings in the channel. The channel bottom had several sand bars toward the upstream end.

Proposed Project Elements

- Add a riparian buffer zone
- Amend soil to improve moisture holding capacity and revegetation with native species
- Add riprap at outfalls
- Remove accumulated sediment

Benefits

Soil amendment and revegetation with native plants will improve the quality of the waterway. Maintenance buffers serve to dissipate energy by slowing overland flow, thereby reducing erosion at the top of bank removing pollutants in the runoff.

Pollutant Removal Estimate

TSS (lb/yr): 600 - 1400
TP (lb/yr): 0 - 10
TN (lb/yr): 40 - 50

Sediment Abatement/Removal Estimate

- Stabilization (CY): 600
- Sediment Removal (CY): 50

Opinion of Probable Cost

$470,000

PROJECT TITLE: **Lemon Bay Sediment**				
LBS06: Alligator Creek - Woodmere Park Library		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY: **KBC**		
19006-016-03		DATE: **08.24.2010**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 8,408.79	$ 8,409
Excavation	CY	3200	$ 50.00	$ 160,000
Grading	SF	5800	$ 0.03	$ 174
Revegetation Mat	SY	6100	$ 7.95	$ 48,495
Native Plants for Bank Stabilization	EA	110	$ 1.51	$ 166
Planting	AC	2	$ 5,000.00	$ 11,661
Riprap	CY	85	$ 451.02	$ 38,337
Silt Fence	LF	8600	$ 2.00	$ 17,200
Turbidity Barrier Floating (Multiple Use)	LF	80	$ 12.00	$ 960
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 289,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 28,900
Subtotal				$ 317,900
CONTINGENCY		20%		$ 63,580
Survey				$ 14,450
Geotechnical Investigation				$ 14,450
Design and Permitting				$ 57,800
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 470,000**
Remove Accumulated Sediment	CY	250	$ 50.00	$ 12,500
MAINTENANCE (First Yr Annual Cost)				**$ 13,000**

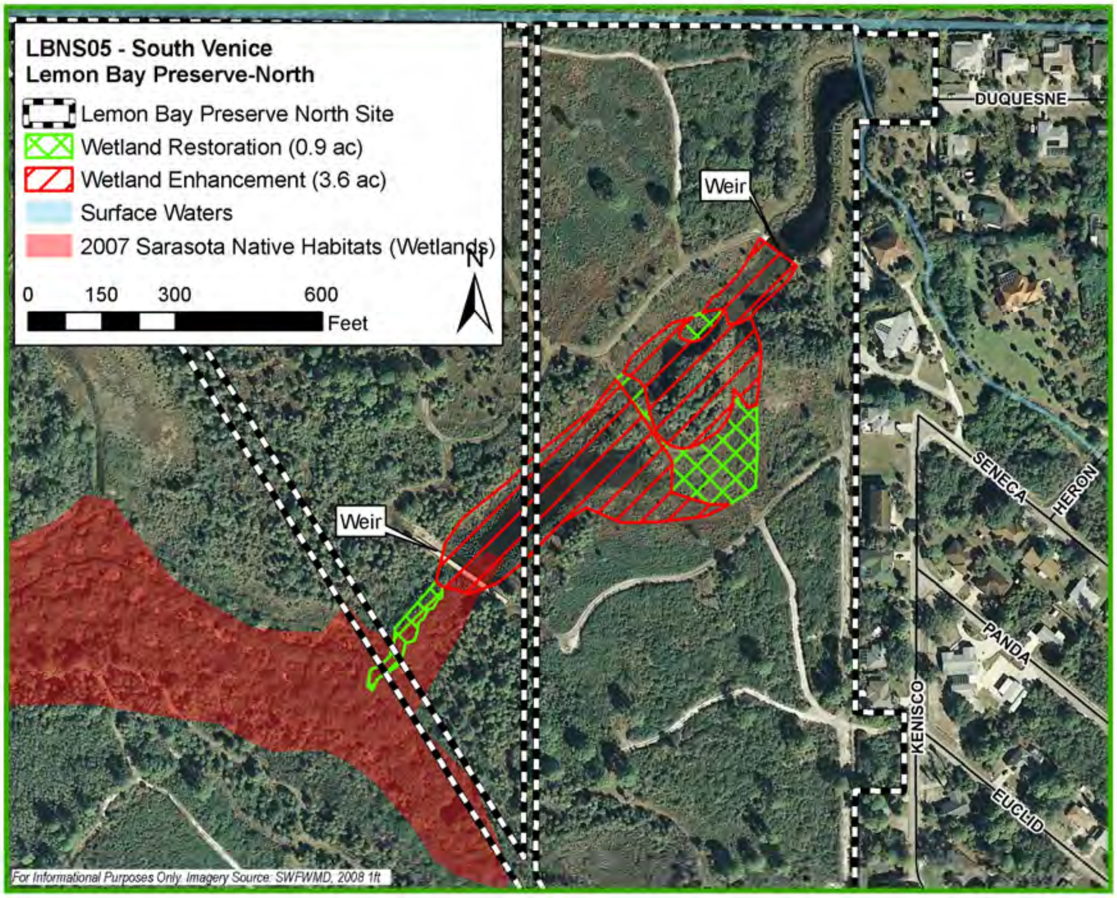
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Natural Systems & Habitat Improvements



Site Evaluation

Sarasota County recently completed a restoration project at this park which entailed regrading areas and installing a weir near Woodmere Creek South Branch. However, some areas were not graded down to wetland grade and thus they are not sufficiently hydrated and are impounding water upstream of these areas.

Proposed Project Elements

- Regrade
- Install native herbaceous wetland plan species

Benefits

Approximately 4 acres of wetlands will be enhanced hydrologically by grading down the high areas. This project will restore the hydroperiod to downstream and upstream wetlands. Planting native, herbaceous wetland vegetation will restore additional wetland areas.

- 1 UMAM Credits

Opinion of Probable Cost

$182,000

PROJECT TITLE:				
South Venice Lemon Bay Preserve Habitat Improvement (North)		ESTIMATED BY **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-015-05**		CHECKED BY: **BJB** DATE: **6/25/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Excavation	CY	1,452	$ 22.96	$ 33,338
Silt Fence	LF	4,000	$ 1.50	$ 6,000
Turbidity Barrier	LF	200	$ 12.00	$ 2,400
Equipment Matting	EA	250	$ 80.00	$ 20,000
Planting	LS		$ 7,000.00	$ 7,000
Subtotal				**$ 68,738**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 6,874
Subtotal				$ 75,612
CONTINGENCY		20%		$ 15,122
Survey				$ 3,437
Geotechnical Investigation				$ 3,437
Design and Permitting				$ 25,000
Monitoring (Baseline and 3 Years)				$ 55,000
Maintenance of Exotic Species (4 Years)	ACRE	1	$500	$ 4,000
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 182,000**
MAINTENANCE (First Yr Annual Cost)				**$ 500**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Water Supply

Site Evaluation

This project involves converting the existing wet detention pond north of the library into a stormwater harvesting pond to supply irrigation water for the library. The contributing area is 3 acres.

Proposed Project Elements

- Install an end suction pump, filtration system, irrigation screen and a backflow preventer
- Install piping

Benefits

Pollutant removal, water supply source, reduce freshwater peak flow to estuary

- Approximate Average Volume (ac-ft/yr): 5
- Pollutant Removal Estimate: TN (lb/yr): 15

Opinion of Probable Cost

$212,000

PROJECT TITLE: Lemon Bay Harvesting Revised Cost Estimate				
LBWS04: Elsie Quirk Library		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-016-03**		CHECKED BY: **BAC** DATE: **8/22/2009**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE): **Conceptual Plan Cost Estimate**		CONSTRUCTION OR PROJECT ESTIMATE: **PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 3,694.57	$ 3,695
Excavation	CY	500	$ 15.00	$ 7,500
Silt Fence	LF	2000	$ 2.00	$ 4,000
Turbidity Barrier Floating (Multiple Use)	LF	2000	$ 12.00	$ 24,000
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
End Suction Pump (250 gpm)	EA	1	$ 4,320.00	$ 4,320
Pipe (sch 40 PVC 2.5 inch)	LF	710	$ 2.44	$ 1,732
Irrigation Basket Screen	EA	1	$ 300.00	$ 300
Filtration System	EA	1	$ 14,400.00	$ 14,400
Backflow Preventer	EA	1	$ 6,000.00	$ 6,000
Pipe (sch 40 PVC 4 inch)	LF	1600	$ 36.00	$ 57,600
Subtotal				$ 127,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 12,700
Subtotal				$ 139,700
CONTINGENCY		20%		$ 27,940
Survey		5%		$ 6,985
Geotechnical Investigation		5%		$ 6,985
Design and Permitting		20%		$ 30,000
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 212,000**
Pump Maintenance	EA	1	$ 250.00	$ 250
Filter Maintenannce	EA	1	$ 500.00	$ 500
MAINTENANCE (First Yr Annual Cost)				**$ 800**

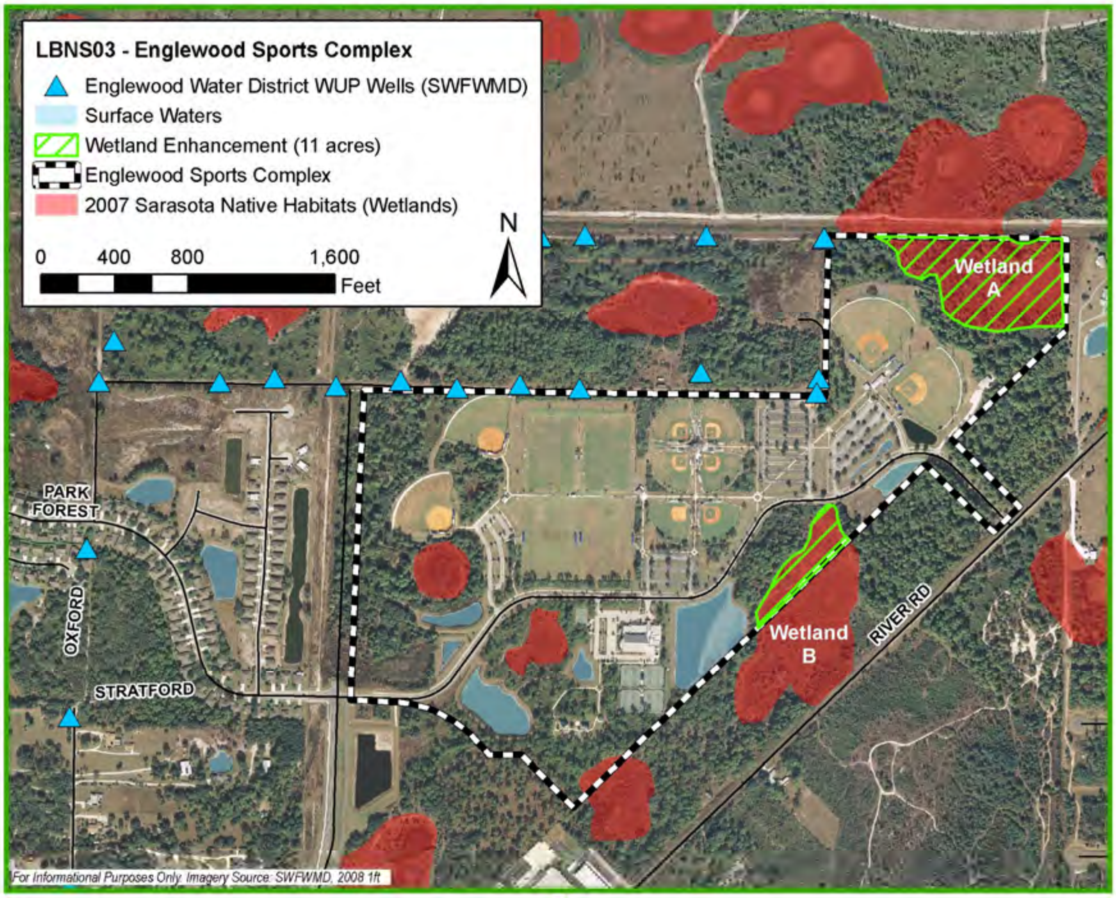
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
Note 2: It is assumed that minimal distribution additions are required.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Natural Systems & Habitat Improvements



Site Evaluation

This 137-acre site contains four main on-site wetlands. Wetlands A and B are characterized as a high-quality wet prairies and are dominated by exotic and invasive species. Wetland A is extremely dry, possibly due to the numerous wells immediately to the west.

Proposed Project Elements

- Remove exotic species

Benefits

Removing the exotic species in Wetlands A and B will increase habitat quality of the on-site wetlands and reduce further encroachment of these species.

- 0.9 UMAM Credits

Opinion of Probable Cost

$118,000

OWNER:	ESTIMATED BY:
Sarasota County	**JRM**
CLIENT:	CHECKED BY:
Sarasota County	**BJ**
PROJECT TITLE:	APPROVED BY:
Englewood Sports Complex Habitat Improvement	
JONES EDMUNDS PROJECT NUMBER:	DATE:
19006-015-04 Task 4320	**6/12/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**

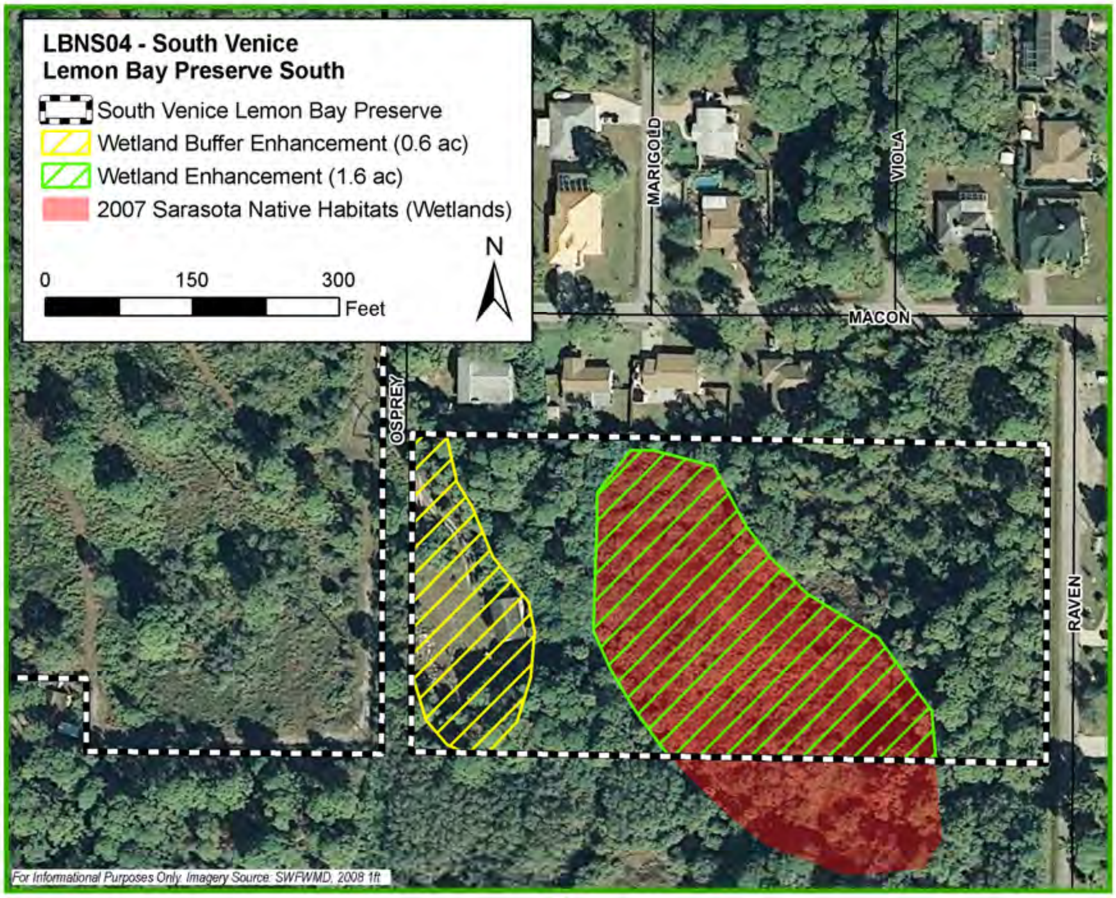
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Maintenance of Exotic Species (4 Years)	ACRE	11	$ 500.00	$ 22,000
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 12,000.00	$ 12,000
Subtotal				$ 89,000
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 8,900
Subtotal				$ 97,900
CONTINGENCY		20%		$ 19,580
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 117,500**
MAINTENANCE (First Yr Annual Cost)				**$ 5,500**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

Lemon Bay Watershed Management Plan
Natural Systems & Habitat Improvements

Jones Edmunds
Janicki Environmental, Inc.



Site Evaluation

An approximately 5-acre portion of the preserve located at the end of Osprey Road and fronts Raven Road on its east side. This site was a former homestead and the County recently demolished the home. An open, grassed area along the west side of the property was the former maintained yard of the residence. This property contains an isolated, approximately 2-acre wetland characterized as Willow and Elderberry. Exotic species are scattered throughout the wetland.

Proposed Project Elements

- Remove exotic species in buffer and wetland

Benefits

Removing the exotic species will increase habitat quality of the on-site wetlands and reduce the further encroachment of these species. Enhancing the wetland buffer will improve the habitat quality and provide greater cover for wetland- and upland-dependent wildlife species. The enhanced buffer will also create a naturally vegetated corridor to the remaining portions of the park to the west.

Opinion of Probable Cost

$95,000

OWNER:	ESTIMATED BY:
Sarasota County	**JRM**
CLIENT:	CHECKED BY:
Sarasota County	**BJ**
PROJECT TITLE:	APPROVED BY:
South Venice Lemon Bay Preserve Habitat Improvement (South)	
JONES EDMUNDS PROJECT NUMBER:	DATE:
19006-015-04 Task 4320	**6/2/2009**
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):	CONSTRUCTION OR PROJECT ESTIMATE:
Conceptual Plan Cost Estimate	**PROJECT ESTIMATE**

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Maintenance of Exotic Species (4 Years)	ACRE	2.6	$ 500.00	$ 5,200
Monitoring (Baseline and 3 Years)	LS	1		$ 55,000
Design and Permitting	LS	1	$ 12,000.00	$ 12,000
Subtotal				$ 72,200
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 7,220
Subtotal				$ 79,420
CONTINGENCY		20%		$ 15,884
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 95,000**
MAINTENANCE (First Yr Annual Cost)				**$ 1,300**

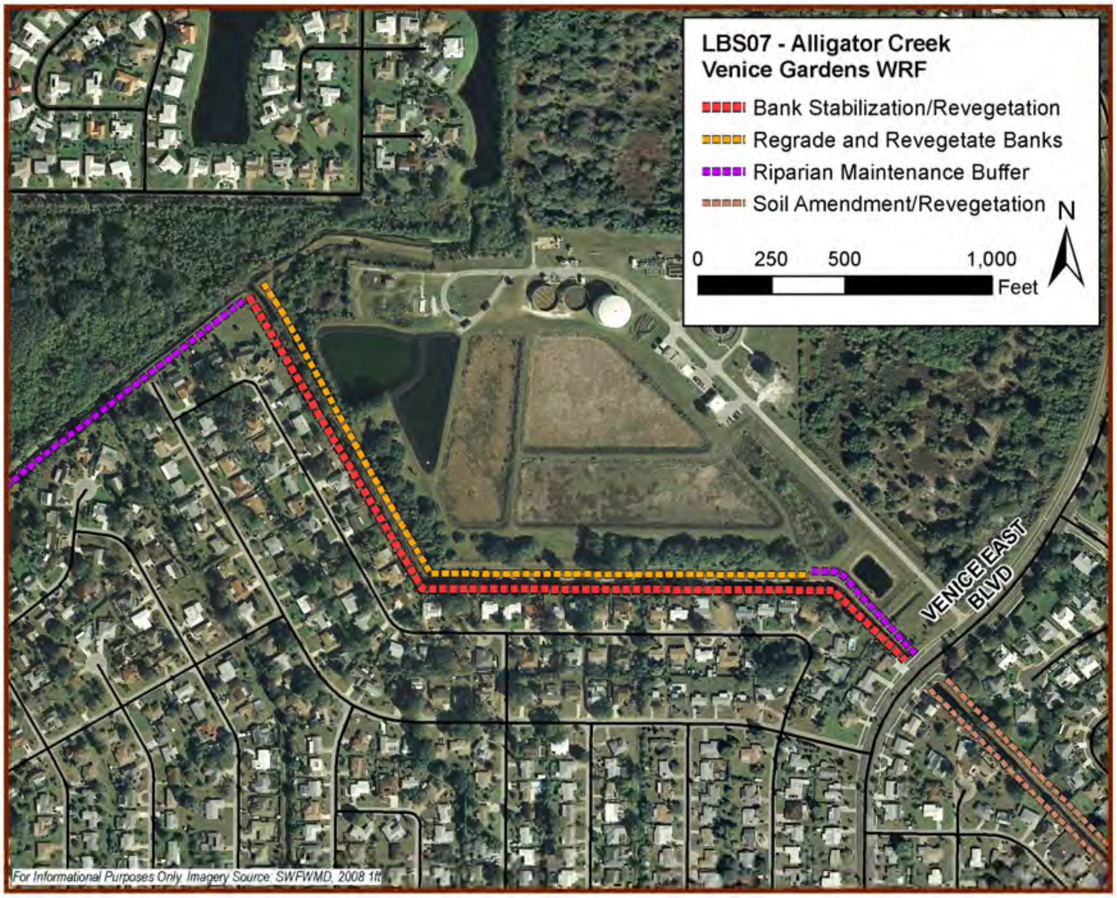
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Sediment Management Plan



Site Evaluation

The upstream segment, southeast of Venice East Boulevard is characterized by very loose, sandy soils and sloughing of the banks with a proliferation of nuisance vegetation that does not add cohesiveness to the soil matrix. The banks on the downstream portion of the channel segment show signs of erosion and undercutting.

Proposed Project Elements

- Add a riparian buffer zone
- Regrade and revegetate banks
- Stabilize banks using geoweb and geofabric
- Amend soil to improve moisture holding capacity

Benefits

Maintenance buffers serve to dissipate energy by slowing overland flow, thereby reducing erosion at the top of bank, removing pollutants in the runoff. Bank stabilization will reduce erosion and retain sediment thereby improving flood control conditions. Soil amendment and revegetation with native plants will improve the quality of the waterway.

Pollutant Removal Estimate

TSS (lb/yr): 400 - 1000
TP (lb/yr): 5 - 10
TN (lb/yr): 30 - 40

Sediment Abatement/Removal Estimate

- Stabilization (CY): 2700

Opinion of Probable Cost

$2,630,000

JONES EDMUNDS
ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

LBS05: Alligator Creek - Briarwood Rd to Alligator Creek		ESTIMATED BY:	**JRM**	
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY:	**KBC**	
19006-016-03		DATE:	**08.24.2010**	
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 150,654.76	$ 150,655
Excavation	CY	20300	$ 15.00	$ 304,500
Grading	SY	40700	$ 0.03	$ 1,221
Riprap	CY	320	$ 451.02	$ 144,326
Revegetation Mat	SY	55000	$ 7.95	$ 437,250
Soil Amendment	SF	60000	$ 53.50	$ 3,210,000
Geoweb	SF	60000	$ 3.00	$ 180,000
Geofabric	SY	6700	$ 3.50	$ 23,450
Gravel	CY	6700	$ 90.00	$ 603,000
Disconnect Roofdrains	EA	60	$ 75.00	$ 4,500
Silt Fence	LF	46300	$ 2.00	$ 92,600
Planting	AC	3	$ 5,000.00	$ 15,278
Turbidity Barrier Floating (Multiple Use)	LF	200	$ 12.00	$ 2,400
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 5,172,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 517,200
Subtotal				$ 5,689,200
CONTINGENCY		20%		$ 1,137,840
Survey				$ 258,600
Geotechnical Investigation				$ 258,600
Design and Permitting				$ 1,034,400
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 8,380,000**
MAINTENANCE (First Yr Annual Cost)				**$ -**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

Lemon Bay Watershed Management Plan
Sediment Management Plan

Jones Edmunds

Janicki Environmental, Inc.

Site Evaluation

This channel segment flows parallel to Siesta Drive. The adjacent roadways are drained by a small roadside swale system, but Siesta Drive discharges stormwater runoff directly to the channel. The banks are loose, non-cohesive sand that does not have good moisture retaining characteristics. The nuisance vegetation does not have deep root systems to help create a cohesive soil matrix. The banks slopes are steep, approximately 2:1 (H:V).

Proposed Project Elements

- Monitor water quality
- Incorporate a sidewalk, bioswale, trees and vegetation along the top of bank
- Amend soil to improve moisture holding capacity
- Remove nuisance vegetation
- Plant native vegetation on the banks to stabilize slopes and in the flowpath to improve water quality
- Install a low-flow sedimentation weir
- Add riprap

Benefits

Re-introduction of native vegetation will reduce maintenance requirements. Bank stabilization will reduce erosion and retain sediment thereby improving flood control conditions. Constructing small swales at the top of bank will aid in providing retention and treatment of roadway runoff, dissipate energy of the overland flow and reduce the erosion along the top of bank of the channel.

Pollutant Removal Estimate

TSS (lb/yr): 0 - 100
TP (lb/yr): 0 - 5
TN (lb/yr): 5 - 10

Sediment Abatement/Removal Estimate

- Stabilization (CY): 1800

Opinion of Probable Cost

$1,830,000

PROJECT TITLE: **Lemon Bay Sediment**				
LBS02: Alligator Creek - Siesta Ditch South		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-016-03**		CHECKED BY: **KBC** DATE: **08.24.2010**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE): **Conceptual Plan Cost Estimate**		CONSTRUCTION OR PROJECT ESTIMATE: **PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 32,820.30	$ 32,820
Grading	SF	101500	$ 0.03	$ 3,045
Planting Trees and Shrubs	EA	200	$ 20.00	$ 4,000
Riprap	CY	400	$ 451.02	$ 180,408
Soil Amendment	SF	3750	$ 53.50	$ 200,625
Geoweb	SF	3750	$ 3.00	$ 11,250
Geofabric	SY	400	$ 3.50	$ 1,400
Gravel	CY	200	$ 90.00	$ 18,000
Revegetation Mat	SY	400	$ 7.95	$ 3,180
Native Plants for Bank Stabilization	EA	200	$ 1.51	$ 302
Excavation	CY	44000	$ 15.00	$ 660,000
Silt Fence	LF	4100	$ 2.00	$ 8,200
Turbidity Barrier Floating (Multiple Use)	LF	25	$ 12.00	$ 300
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 1,127,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 112,700
Subtotal				$ 1,239,700
CONTINGENCY		20%		$ 247,940
Survey				$ 56,350
Geotechnical Investigation				$ 56,350
Design and Permitting				$ 225,400
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 1,830,000**
Water Quality Monitoring	EA	2	$ 2,500.00	$ 5,000
Bioretention Cleanout	EA	3	$ 1,500.00	$ 4,500
Bi-annual sediment cleanout	CY	20	$ 30.00	$ 600
MAINTENANCE (First Yr Annual Cost)				**$ 10,000**

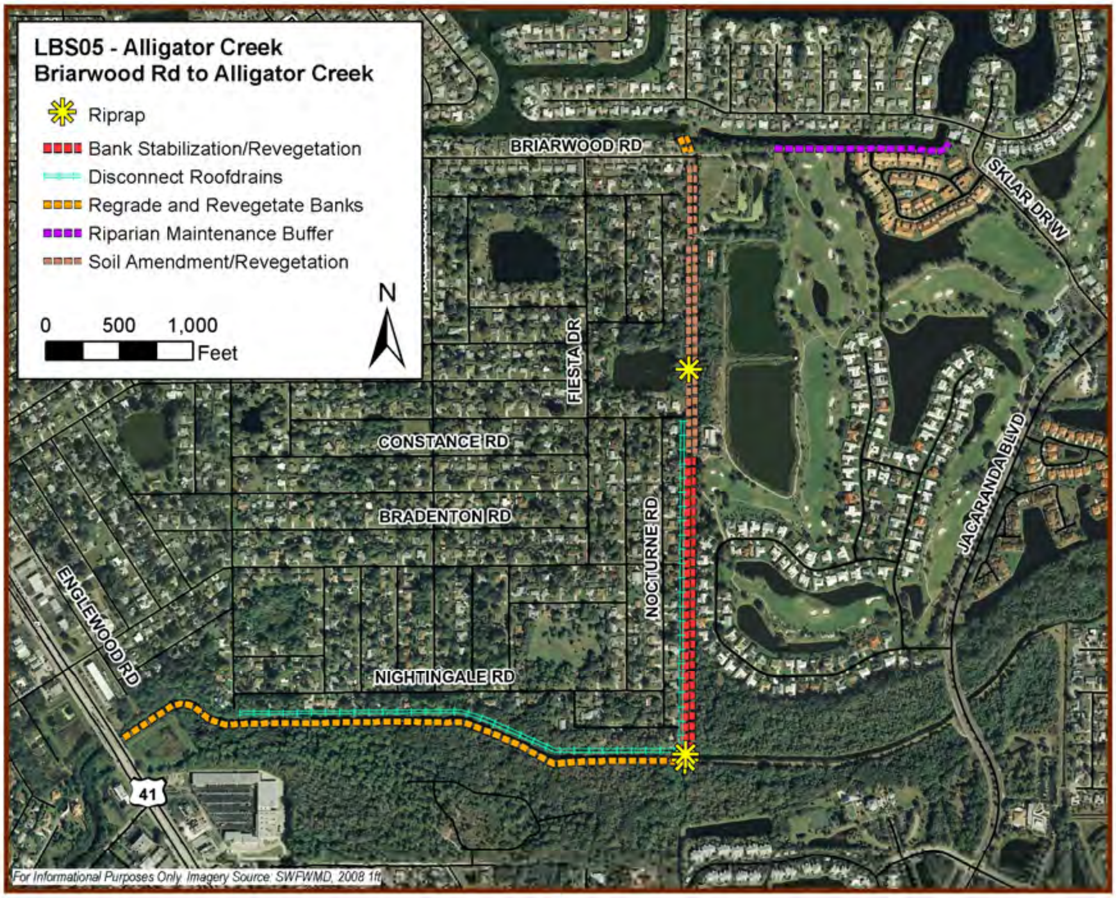
Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.
**Distance and Fuel Costs may cause this cost to change.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Sediment Management Plan



Site Evaluation

This site is at the end of Briarwood Road at the entrance to a decommissioned WWTP. The channel segment on the north side of Briarwood Road is densely vegetated. Erosion was pronounced on the eastern slope of the downstream segment although the bank slope is relatively gentle at approximately 4:1 (H:V). The vegetation in the channel showed evidence of being sprayed with herbicide and the decaying vegetation left in the channel. The south bank was covered with nuisance vegetation but the soil matrix was very loose and signs of erosion were present.

Proposed Project Elements

- Add riparian maintenance buffer
- Regrade and revegetating banks
- Amend soil to improve moisture holding capacity
- Stabilize banks with geoweb and geofabric
- Disconnect roof drains

Benefits

Maintenance buffers serve to dissipate energy by slowing overland flow, thereby reducing erosion at the top of bank and removing pollutants in the runoff. Soil amendment and revegetation with native plants will improve the quality of the waterway. Bank stabilization will reduce erosion and retain sediment thereby improving flood control conditions.

Pollutant Removal Estimate

TSS (lb/yr): 200 - 400
TP (lb/yr): 0 - 5
TN (lb/yr): 20 - 30

Sediment Abatement/Removal Estimate

- Stabilization (CY): 3500

Opinion of Probable Cost

$8,380,000

JONES EDMUNDS ENGINEERS | ARCHITECTS | SCIENTISTS

Sarasota County

LBS05: Alligator Creek - Briarwood Rd to Alligator Creek		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER: **19006-016-03**		CHECKED BY: **KBC** DATE: **08.24.2010**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 150,654.76	$ 150,655
Excavation	CY	20300	$ 15.00	$ 304,500
Grading	SY	40700	$ 0.03	$ 1,221
Riprap	CY	320	$ 451.02	$ 144,326
Revegetation Mat	SY	55000	$ 7.95	$ 437,250
Soil Amendment	SF	60000	$ 53.50	$ 3,210,000
Geoweb	SF	60000	$ 3.00	$ 180,000
Geofabric	SY	6700	$ 3.50	$ 23,450
Gravel	CY	6700	$ 90.00	$ 603,000
Disconnect Roofdrains	EA	60	$ 75.00	$ 4,500
Silt Fence	LF	46300	$ 2.00	$ 92,600
Planting	AC	3	$ 5,000.00	$ 15,278
Turbidity Barrier Floating (Multiple Use)	LF	200	$ 12.00	$ 2,400
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 5,172,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 517,200
Subtotal				$ 5,689,200
CONTINGENCY		20%		$ 1,137,840
Survey				$ 258,600
Geotechnical Investigation				$ 258,600
Design and Permitting				$ 1,034,400
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 8,380,000**
MAINTENANCE (First Yr Annual Cost)				**$ -**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Sarasota County

JONES EDMUNDS

Janicki Environmental, Inc.

Lemon Bay Watershed Management Plan
Sediment Management Plan

Site Evaluation

This channel segment runs parallel to Quincy Road for approximately ½ mile. The area is drained by a small roadside swale system. The banks are sparsely vegetated with nuisance vegetation and the soil is non-cohesive and sandy. The water surface is covered with hydrilla.

Proposed Project Elements

- Add a sediment removal structure at the upstream discharges
- Amend soil, hydroseed, and plant adjacent to Quincy Road
- Disconnect roof drains
- Add riprap to outfalls
- Add a sediment sump downstream
- Regrade top of bank adjacent to Quincy Road
- Add trees and shrubs to the top of bank adjacent to Siesta Drive

Benefits

The addition of a sediment sump will reduce flow velocities and promote settling of sediment. Soil amendment and planting will enhance the environmental quality of the channel segment.

Pollutant Removal Estimate

TSS (lb/yr): 1400 - 3400
TP (lb/yr): 0 - 5
TN (lb/yr): 20 - 40

Sediment Abatement/Removal Estimate

- Stabilization (CY): 850
- Sediment Sump (CY): 350

Opinion of Probable Cost

$6,410,000

PROJECT TITLE: **Lemon Bay Sediment**				
LBS01: Alligator Creek - Siesta Ditch North		ESTIMATED BY: **JRM**		
JONES EDMUNDS PROJECT NUMBER:		CHECKED BY: **KBC**		
19006-016-03		DATE: **08.24.2010**		
ESTIMATE TYPE (ROM, BUDGET, DEFINITIVE):		CONSTRUCTION OR PROJECT ESTIMATE:		
Conceptual Plan Cost Estimate		**PROJECT ESTIMATE**		
DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Clearing and Grubbing	LS	1	$ 115,255.01	$ 115,255
Excavation	CY	850	$ 15.00	$ 12,750
Sediment Sump Construction	CF	10000	$ 50.00	$ 500,000
Dewatering (Sump)	CY	1300	$ 13.50	$ 17,550
Sediment Removal Baffle Box	EA	1	$ 70,000.00	$ 70,000
Grading	SF	8700	$ 0.03	$ 261
Soil Amendment	SF	56700	$ 53.50	$ 3,033,450
Revegetation Mat	SY	6300	$ 7.95	$ 50,085
Planting	AC	1.5	$ 5,000.00	$ 7,500
Trees and Shrubbs	EA	80	$ 20.00	$ 1,600
Geoweb	SF	4800	$ 3.00	$ 14,400
Geofabric	SY	550	$ 3.50	$ 1,925
Gravel	CY	550	$ 90.00	$ 49,500
Silt Fence	LF	12100	$ 1.50	$ 18,150
Riprap	CY	130	$ 451.02	$ 58,633
Disconnect Roof Drains	EA	30	$ 75.00	$ 2,250
Turbidity Barrier Floating (Multiple Use)	LF	40	$ 12.00	$ 480
Soil Tracking Prevention Device	EA	1	$ 3,300.00	$ 3,300
Subtotal				**$ 3,957,000**
MOBILIZATION AND GENERAL CONDITIONS		10%		$ 395,700
Subtotal				$ 4,352,700
CONTINGENCY		20%		$ 870,540
Survey				$ 197,850
Geotechnical Investigation				$ 197,850
Design and Permitting				$ 791,400
OPINION OF PROBABLE CONSTRUCTION COST (ROUNDED)				**$ 6,410,000**
Bi-annual sump cleanout	EA	2	$ 1,000.00	$ 2,000
Bi-annual sediment removal structure cleanout	CY	20	$ 150.00	$ 3,000
MAINTENANCE (First Yr Annual Cost)				**$ 5,000**

Note 1: The unit costs for this estimate were derived using 2009 RS Means Data and 2009 FDOT Unit Costs.

Chapter 9

Monitoring and Implementation

August 2010

Sarasota County

Southwest Florida Water Management District

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LIST OF FIGURES

9.0 MONITORING AND IMPLEMENTATION

This section presents the following:

- ❖ A summary of the recommendations for monitoring environmental conditions in Lemon Bay and its watershed.
- ❖ A watershed report card used to present information regarding the status and trends in the water quality of Lemon Bay and its watershed.
- ❖ A summary of the recommendations for monitoring the management actions that comprise the watershed plan.
- ❖ A recommended methodology for tracking progress in implementing the Lemon Bay Watershed Plan.

9.1 ENVIRONMENTAL MONITORING

The Sarasota County Environmental Services Business Center conducts extensive monitoring of natural systems in Lemon Bay including:

- ❖ Estuarine and tributary water quality.
- ❖ Stage, flow, and rainfall.
- ❖ A biannual oyster bed health survey.
- ❖ An annual synoptic tidal creek index sampling.
- ❖ A volunteer-assisted seagrass characterization and validation survey.
- ❖ An annual parcel-level assessment of mangroves within the watershed.

Together these monitoring programs represent a concerted effort on the part of Sarasota County to provide proper stewardship of the natural resources of the Lemon Bay watershed.

In addition, the Charlotte Harbor National Estuary Program (CHNEP) cooperatively sponsors water quality monitoring in the Charlotte County portion of Lemon Bay and the Charlotte Harbor Aquatic Preserve conducts monthly sampling at fixed stations throughout Lemon Bay.

The development of this watershed management plan included three workshops to gather input from local environmental professionals on the critical aspects of the watershed management plan and to develop the critical questions that guided the plan's development. The majority of time during these workshops was spent considering the types of monitoring and reporting tools that could be best used to routinely evaluate the health of the valued natural resources of Lemon Bay and developing appropriate metrics. Outcomes of these discussions became tasks that were then completed as part of the watershed management plan for Lemon Bay. These tasks included:

- ❖ Reviewing current routine monitoring efforts.

- ❖ Evaluating the current routine monitoring programs for gaps and redundancies.
- ❖ Evaluating the overall monitoring program for providing information necessary to develop a reporting tool for the watershed.
- ❖ Recommending how the monitoring and reporting elements of the watershed management plan can be optimized to protect the valued natural resources of Lemon Bay.
- ❖ Developing a reporting tool to summarize and convey pertinent information to aid in watershed management decision making.

The County's overall strategic monitoring plan was reviewed in detail as part of the watershed management plan development for Lemon Bay (Janicki Environmental, 2009). This review document provided a detailed account of the routine monitoring elements currently conducted by Sarasota County Environmental Services Water Quality Division and an evaluation of how the monitoring programs may be optimized to provide the highest return on the resources invested. The review found that the current monitoring design was sufficient to track changes in many aspects of ecosystem health over time and report in a timely fashion for the development of a watershed reporting tool. Data gaps were identified with respect to the evaluation of some key elements in evaluating ecosystem health and minor improvements in the overall design for several aspects of the overall program were recommended:

The following summarizes the recommendations in the document:

- ❖ Estuarine Water Quality
  - Current sampling intensity is sufficient for regulatory-based inference and watershed management planning activities in Lemon Bay. The County should continue the current level of spatial and temporal sampling intensity.
- ❖ Watershed Water Quality
  - Routine watershed water quality sampling began in 2006 in tributaries throughout the County, and at the time the management plan was developed only approximately 15 samples were available for analysis, which was too few for statistical optimization of the design of the watershed water quality sampling program. It was recommended that once data are collected through December 2009 and available for analysis (~36 samples per station), a statistical analysis should be performed to assess the spatial correlation of sampling points within each water body to determine if redundancies exist in the sampling design that would allow for reducing the sampling effort at that time.
- ❖ Oyster Monitoring
  - The County should continue with its current oyster monitoring program.
  - As budgetary constraints allow, a mapping effort should be undertaken to document the extent of oyster habitat. Quantifying the extent of oyster

habitat and ensuring that an adequate representation of the available oyster habitat is maintained in the monitoring effort will be an important addition to the current program and assist in any oyster reef restoration efforts in the estuary.

- As more data are collected, time series trends for individual oyster reefs should be reported as part of the routine reporting for this program.

❖ Tidal Creek Condition Index (TCCI)
- The review supported the eventual use of the TCCI as part of the overall strategic monitoring plan for Sarasota County. As more years of data are collected, the variability in TCCI scores can be used to develop an appropriate mechanism for including this information for reporting on changes in this index over time.

❖ Seagrasses
- The County should continue supporting State-sponsored seagrass monitoring activities in Sarasota County waters.
- The County should also continue its own validation efforts using volunteers to validate localized inferences regarding the areal extent of seagrass with County waters.
- As the volunteer monitoring program evolves, a more statistically rigorous sampling design should be developed to allow validation to be generalized to the sample space with more confidence.

❖ Benthos
- A one-time synoptic benthic sampling effort should be conducted to characterize the benthos in Sarasota County's open bays as funding permits. Specifically, it was recommended that the sampling design follow that established by the United States Environmental Protection Agency's Coastal 2000 Inshore Marine Monitoring and Assessment Program, which uses a rigorous statistical sampling design to assess coastal estuarine waters throughout the United States. This effort will characterize spatial differences in sediments and benthos rather than tracking temporal changes in indicators over time. This spatial focus is needed in Sarasota County's estuarine waters to identify areas where the benthic integrity may be compromised and to estimate the areal extent of a community composition or pollutant-intolerant taxa value less than some pre-determined threshold value.

❖ Fish
- The CHNEP is currently negotiating with the Florida Fish and Wildlife Conservation Commission to perform a synoptic study of Lemon Bay to determine species composition and spatial and temporal variation in community structure. The County should use the results of the 1-year study documenting the temporal variability in fisheries catch in the Lemon Bay estuary to explore the efficacy of developing an index to use for

incorporating a fisheries score into a report card. The index should include a baitfish species complex and a sportfish species complex sampled during an index period (i.e., summer) as an economical way to evaluate these important indicators of fisheries production.

- ❖ Mangroves
  - Lemon Bay was designated an aquatic preserve with the primary purpose of preserving the biological resources of endangered fringing mangroves and mangrove islands with clam beds, oyster bars, salt marsh, and other habitat (FDNR, 1992). The designation of Lemon Bay submerged lands as an aquatic preserve, along with the Bay's designation as an Outstanding Florida Waters (OFW) and Class II and Class III waterbodies, restricts the types of activities permitted in the watershed and estuary. While these designations are designed to protect and preserve conditions in the estuary, natural resource monitoring and management activities are required to ensure that natural systems such as the extent of mangroves in Lemon Bay are protected. A cost-effective means of evaluating changes in the aerial extent would be to use GIS technology and the biennial aerial seagrass monitoring data collected by SWFWMD. Ideally, synoptic mangrove health assessments could also be conducted and include estimates of elevation of mangrove base soils monitored providing information of changes in elevation relative to changes in coastal sea level rise.
- ❖ Special Studies
  - The recommendations above are generally long-term monitoring recommendations. In addition to the long-term monitoring, there may also be a need for special monitoring studies to understand a single issue, such as the influence of a particular practice. This type of monitoring does not need to be performed for the long term. Rather, it will be used to understand a single issue. Once the issue is understood, there will be no need for additional monitoring of the issue.

Sarasota County has been progressive in its efforts to track environmental conditions in watersheds in a quantitative manner that can be used to evaluate not only ecosystem health but also evaluate the effects of management actions on key indicators within the watershed and receiving estuary.

9.2 WATERSHED REPORT CARD

The successful management of coastal ecosystems requires accurate quantitative tools for managers, scientists, and the public at the local and regional levels to easily understand and apply basic principles of ecosystem management. Our current scientific knowledge allows us to understand the complexity and variability found in the marine environment. Considerable amounts of money and time are spent on environmental monitoring programs, but they often fail to provide the accurate information needed to understand the condition of the marine environment or to assess those human impacts (Mulvihill, 1990). Taking the data and applying them to management practices can be difficult based on the wide range of audiences to whom information must be conveyed. Monitoring programs are also often ineffective because the translation of data through analysis and subsequent conveyance to decision makers and the public are inadequate or confusing (Mulvihill, 1990). Most importantly, many monitoring programs extend over many years although data must regularly be analyzed and disseminated to the public so that management decisions can be made or monitoring can be changed to understand or reflect environmental change.

The following provides a review of two very successful monitoring programs used to assess water quality in San Francisco and Chesapeake Bay.

The San Francisco Estuary demonstrates many of the management issues faced by estuaries worldwide, including aquatic resource degradation, wetlands loss, decline of wildlife species, altered flow regimes, introduced species, increased pollution, and lack of integrated planning and management (EPA, 1999). The San Francisco Estuary Regional Monitoring Program (RMP) has monitored water quality since 1993. Through 2001, monitoring was conducted at 21 sites throughout the Bay. In 2002, the RMP implemented a new monitoring design to provide more spatial coverage and to include shallow and deep channels (Conner et al., 2007). The new design included 33 stations, 28 of which were randomly selected and located within the major hydrographic regions of the estuary. Additional stations are found in the deltas of Sacramento and San Joaquin rivers, upstream from the Lower South Bay, and outside the Golden Gate (Conner et al., 2007). In addition to water quality monitoring, the RMP has produced an extensive dataset on estuarine toxic contamination. Monitoring performed in the RMP determines spatial patterns and long-term trends in contamination through sampling of water, sediment, bivalves, and fish and also evaluates toxic effects on sensitive organisms and chemical loading to the Bay. The program combines RMP data with data from other sources to provide for comprehensive assessment of chemical contamination in the Bay. Monitoring at each station includes mercury, PCBs, selenium, copper, and perfluorinated chemicals (SFEI, 2006).

The RMP produces an Annual Monitoring Report called *Pulse of the Estuary* that summarizes the current state of the estuary with regard to contamination. The Pulse documents the extensive efforts made each year to manage and monitor water quality and estuarine conditions in the estuary and disseminate information at the public level detailing the state of San Francisco Estuary. Additionally, technical reports and journal publications document specific studies and RMP results. In this estuary the combination of the data-collection system along with the regular report of trends and status facilitate effective policy-making and management decisions, thus meeting the criteria previously established for a “successful” estuary recovery program.

Chesapeake Bay provides another example of a successful estuary recovery effort. Chesapeake Bay is the largest estuary in the United States and its watershed encompasses parts of six surrounding states, making effective management difficult. In 1984, state and federal agencies initiated a coordinated monitoring program in Chesapeake Bay for the mainstem and its tributaries. Integrated into the Bay Monitoring Program are routine measurements at over 165 stations in the tidal waters of the Bay and its tributaries (Boesch, 2000). Additionally, data are incorporated from a citizens monitoring program initiated in 1995. Progress towards a healthy bay is tracked with 13 indicators grouped into three priority areas that represent major components of the Bay ecosystem. The Bay Monitoring Program measures nutrients (nitrogen and phosphorus), chlorophyll a, suspended sediments, toxicants in water and sediment, water temperature, salinity, water circulation, fresh water inflows, dissolved oxygen, submersed aquatic vegetation, plankton, benthos, and fish and shellfish including blue crabs, striped bass, shad, menhaden, and oysters.

Yearly reports are published, including The State of the Chesapeake Bay (1984-2004) and Chesapeake Bay Health and Restoration Assessment (2005-2007), in which clear quantitative restoration goals have been set and a chart provided for each indicator to show the percent goal, current status, and history of progress towards achieving the goal. In addition to assessing ecosystem health the report also has three other chapters which address factors impacting the Bay, including population, land use, river flow, and pollution loads (CBF, 2008). Chapter 3 focuses on restoration efforts based on 20 indicators grouped into five priority areas and the quantitative goals set for each priority area. Chapter 4 focuses on the health of freshwater streams and rivers as set by Federal 305b/303d reporting requirements.

The following discussion describes the approach followed to establish a watershed report card that will provide information regarding the status and trends in the quality of Lemon Bay. The audience for the report card is the general public and the County Commission (and other decision-makers). The indicators and methodology for scoring are also defined as is a suggested format for hard-copy and digital versions.

To establish the watershed report card, three workshops were held to solicit input from County staff and other interested scientific professionals primarily on the content of the report card and the methodology for quantifying the scores for each indicator and the overall watershed score. Concurrent to these workshops was consideration of the County's current monitoring program and definition of a strategic monitoring program designed to meet the objectives defined by the workshop participants. This approach allowed additional justification for inclusion of particular indicators in the strategic monitoring program design that were identified as critical to the proposed report card.

In addition to the input from the technical audience, input from the County's public information/education staff on the format of the report card was also solicited.

Several key considerations regarding the report card were also expressed:

- The watershed report card will be based on key data provided by the County's Strategic Monitoring Program as well as on other data/information sources.
- The report card, while simple in its presentation and interpretation, will have a sound technical basis.
- The watershed report card will be updated annually. Data availability will determine the completeness of each annual report.
- The watershed report card will be disseminated in a hard-copy format and on the County's Water Atlas.
- The watershed report card will be complemented by two additional documents:
  - A County-wide report card that compares the status and trends in the quality of all major watersheds in the County.
  - A third document that explains:
    - The measurements used in the report cards.
    - The choice of indicators.
    - Why the indicators are important.
    - How the indicators are measured.
    - How the indicators are scored.

The following details the proposed report card contents, the justification for selected indicators, and the methodology for scoring.

The watershed report card will include:

- A description of the watershed characteristics that do not vary significantly between years but are important influences on watershed and receiving waterbody quality:
  - Land use/cover
  - Percent of Impervious Surface
  - Population
- A temporal context for assessing the status and trends in watershed and receiving waterbody quality:
  - Annual rainfall and comparison to the long-term record
  - Annual and monthly flows and comparison to long-term record (if possible)
  - Unusual events such as red tide blooms, accidental spills, etc.

The major elements of the watershed report card scoring will be:

❖ Chlorophyll *a*—Chlorophyll a is a pigment used in photosynthesis which serves as a measure of biomass (abundance) of phytoplankton in estuaries. Planktonic algae provide a food source for filter-feeding bivalves (oysters, mussels, scallops, clams) and zooplankton (including the larvae of crustaceans and finfish). Chlorophyll *a* concentrations can also be used as measure of overall ecosystem health. High amounts of chlorophyll *a* in estuarine waters are a primary indicator of nutrient pollution because excess nutrients fuel the growth of algae. High chlorophyll *a* values can have adverse impacts on aquatic life and human recreation.

❖ Water Clarity—Water Clarity is a measure of the amount of sunlight that can penetrate through the water. Water clarity is measured using two methods. With a device called a *Secchi disk*, the *Secchi depth*, is the measure of water clarity and the depth at which sunlight is able to penetrate through the water. Higher Secchi disc depths indicate increased water clarity. With a transmissometer, the amount of light that reaches a particular depth is compared to that reaching the water surface. The light extinction coefficient (referred to as K_d) is calculated based on this comparison. Higher K^d values indicate reduced water clarity. Clear waters indicate a healthy estuary, although many factors impact water clarity. Excess suspended sediments from runoff and rainfall can negatively impact water clarity. Nutrients, mainly nitrogen and phosphorus, can fuel the growth of photosynthesizing algae. High chlorophyll *a* concentrations associated with high algal biomass can decrease light penetration, decreasing water clarity. Decreased water clarity can negatively impact the estuary in many ways. Reduced light transmission can decrease seagrass abundance, which can impact the entire food web. Decreases in seagrass abundance reduce habitat for the hundreds of species which depend on the seagrass.

❖ Dissolved Oxygen—Dissolved Oxygen (DO) is a very important limiting factor impacting estuarine systems. DO can be used as an indicator of the health of the ecosystem. Cultural eutrophication (nutrient excess leading to overproduction of microalage and associated trophic imbalances) is common in estuaries near human population centers. Under conditions of eutrophication DO can exhibit extreme diel cycles. Photosynthesis via algae elevates DO levels in the water during the day but at night when respiration is high, the DO can drop dangerously low. Eutrophication can lead to periodic or long-term hypoxia (water column oxygen concentrations <2 mg O_2 l^{-1}) and anoxia in estuarine ecosystems. Fishes, crabs, and shrimp will attempt to move away from oxygen concentration of less than 2 mg O_2 l^{-1} and few marine animals survive in prolonged exposure to hypoxic conditions. DO levels are often quite variable in estuarine system due to fluctuations in temperature, salinity, basin morphology, and overall productivity.

- Pollutant Loading—Excess nutrients, mainly nitrogen and phosphorus, can also be considered pollutants. Nutrient inputs from watersheds adjacent to coastal and estuarine waters have significant impacts on estuarine function. Excess nitrogen and phosphorus in estuarine ecosystems lead to increased rates of primary production (termed *eutrophication*), reduced biodiversity, habitat alteration, and shifts in ecosystems. The total nitrogen (TN) loading is particularly critical to estuarine health and will be assessed in the report card.

- Seagrass—Seagrasses serve significant functions. They help maintain water clarity by trapping fine sediments and particles with their leaves and they stabilize the estuarine sediments with their roots. Seagrasses are very effective at removing dissolved nutrients from water that can enter from runoff from land. Removing sediment and nutrients helps improve water clarity, thereby improving overall ecosystem health. Seagrasses provide habitats for fish, crustaceans, and shellfish, providing a nursery ground for many recreationally and commercially valuable species. They are also food for organisms that inhabit them and marine mammals such as manatees and waterfowl such as ducks and geese. Human activities can harm seagrasses by degrading estuarine water quality and promoting physical disturbances and algal blooms. Reductions in light availability associated with nutrient inputs and sediments can damage or eliminate seagrass habitat.

- Oysters—Oysters are filter feeders able to filter out sediments which decrease water quality. They also help reduce nutrients and plankton from the water and keep the delicate food web in balance. One healthy oyster reef can be home to over 300 different organisms, including adult and juvenile fish, shrimp, crabs, and clams. Oysters are used as an indicator species in many of our nation’s estuaries, meaning that if oysters are doing well many other species will also be doing well.

9.2.1 Report Card Scoring

Based on input from the workshop participants and County staff it was agreed that the scoring of each major element will depend on:

- A target or baseline value.
- A measure of deviation from the target.
- A measure of persistence of the deviation from the target.

For example, a score will be computed for any indicator given a defined target for that indicator, a defined measure of deviation from the target, and a defined measure of persistence of the deviation from the target. This approach recognizes that relatively chronic conditions (i.e., relatively small exceedances from the target for a relatively long period) can be as or even more undesirable than relatively acute conditions (i.e., relatively large exceedances from the target for a short period). If a water quality standard exists, e.g., DO, then the proposed scoring should mimic currently accepted methods used to identify impaired waters.

The proposed scoring for chlorophyll *a*, water clarity, and TN loading will be computed by comparing the mean annual value for the variable in question to the target value. If the annual mean is greater than the target value, the magnitude of the difference is compared to the standard deviation of the observed annual mean chlorophyll *a*, water clarity, and TN loading If the difference is less than or equal to the standard deviation, the difference is defined as a "small" magnitude difference (Figure 9-1). If the difference is greater than one standard deviation the difference is defined as a "large" magnitude difference (Figure 9-1). If the observed differences occur for at least 2 consecutive years but less than 4 consecutive years, the duration is defined as "short" (Figure 9-1). If the observed differences occur for at least 4 consecutive years, the duration is defined as "long" (Figure 9-1). Otherwise, for example if the exceedance is for only one year, the duration of the difference is not significant.

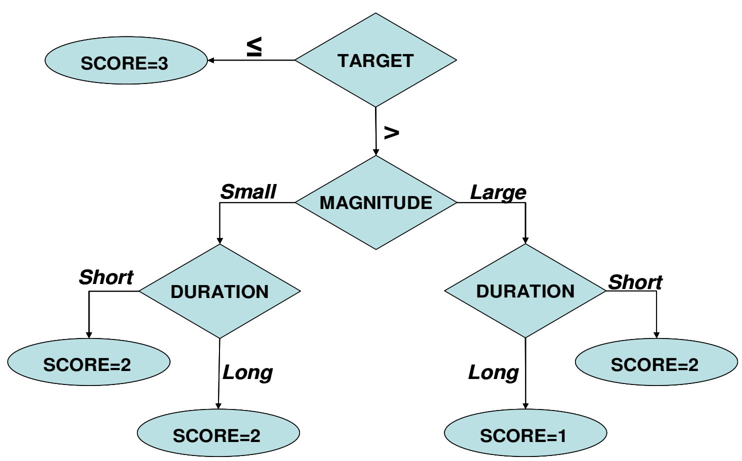

Figure 9-1 Proposed Scoring Methodology for the Chlorophyll *a*, Water Clarity, and TN Loading Indicators

The Charlotte Harbor National Estuary Program is currently working toward the development of numeric nutrient criteria for Lemon Bay and the other harbor segments within the program's area. A critical element of this work is definition of chlorophyll a thresholds. The Technical Advisory Committee will be reviewing this work in October 2010 and make recommendations to the Management and Policy committees. Proposed numeric nutrient criteria will be provided to the U.S. Environmental Protection Agency in December.

The following targets and standard deviations (for chlorophyll *a*, K_d, DO, and TN loading) are used to calculate the scores for chlorophyll *a*, water clarity, DO, and TN loading:

- ❖ Chlorophyll *a* concentration – 7.8 µg/L and 2.2 µg/L;
- ❖ K_d – 1.07 (m^1) and 0.1 (m^1);
- ❖ DO – 4 mg/L
- ❖ TN loading – 95 tons/year and 53 tons/year.

The proposed scoring for DO will be computed by tallying the number of excursions from the target DO of 4 mg/L (the State DO standard):

- ❖ If % excursions below 4 mg/L is greater than 10% the score is 1.
- ❖ If % excursions below 4 mg/L is 5-10% the score is 2.
- ❖ If % excursions below 4 mg/L is <5% the score is 3.

The sum of the chlorophyll *a*, water clarity, DO, and TN loading indicator scores is defined as *the Water Quality Score*.

The proposed scoring for seagrass is based upon the CHNEP seagrass targets for Upper and Lower Lemon Bays (Janicki Environmental, 2009). The seagrass targets for Lemon Bay are:

- ❖ Upper Lemon Bay
  - Protection Target – 1,009 aces
  - Total Target – 1,009 acres
- ❖ Lower Lemon Bay
  - Protection Target – 2,502 acres
  - Restoration Target – 380 acres
  - Total Target – 2,882 acres
- ❖ Total Lemon Bay
  - Protection Target – 3,511 acres
  - Restoration Target – 380 acres
  - Total Target – 3,891 acres

The assessment of the status of the seagrass cover relative to this target should take into account the natural variability in seagrass cover. To estimate this variability, the standard deviation of the biannual seagrass cover surveys was calculated. This value was 95 acres for Upper Lemon Bay, 75 acres for Lower Lemon Bay, and 100 acres for the total Lemon Bay estimates.

Both the seagrass target and the estimates of variability will be used to compute the seagrass score for Lemon Bay. The seagrass scoring rules are:

- ❖ Upper Lemon Bay
  - If the current year seagrass cover is greater than 1,103 acres then the score is 3;

- If the current year seagrass cover is between 914 and 1,104 acres then the score is 2;
- If the current year seagrass cover is less than 914 acres then the score is 1.

❖ Lower Lemon Bay
- If the current year seagrass cover is greater than 2,957 acres then the score is 3;
- If the current year seagrass cover is between 2,807 and 2,957 acres then the score is 2;
- If the current year seagrass cover is less than 2,807 acres then the score is 1.

❖ Total Lemon Bay
- If the current year seagrass cover is greater than 3,991 acres then the score is 3;
- If the current year seagrass cover is between 3,791 and 3,991 acres then the score is 2;
- If the current year seagrass cover is less than 3,791 acres then the score is 1.

This method allows for assessments to be completed for either Upper or Lower Lemon Bay as well as the total Lemon Bay.

The proposed scoring for oysters will be computed as follows:

❖ If oyster index (% alive) is <50%, the score is 1.
❖ If oyster index (% alive) is 50-75%, the score is 2.
❖ If oyster index (% alive) is >75%, the score is 3.

The sum of the seagrass and oyster indicator scores is defined as t*he Bay Quality Score*.

The overall Watershed Quality Score is proposed to be the sum of the Water Quality and Bay Quality scores. The maximum possible score is 18 and the minimum is 6. Scores that range from 15-18 are defined as “Better than Target”; scores that range from 9-15 are defined as “Meeting Target”; and scores that are less than 9 are defined as “Worse than Target.”

Based on input from the workshop participants and County staff it was generally agreed that the overall and individual indicator scores will be presented in graphical form. Year-to-year trends in these scores will also be presented.

Appendix D presents a draft watershed report card format.

9.3 MONITORING OF RECOMMENDED PROJECTS AND PROGRAMS

We do not propose any additional monitoring for recommended projects or programs at this point. The recommended monitoring discussed in this chapter should provide adequate evidence of project and program implementation benefits at the watershed scale. Additionally, most of the recommended capital improvement projects use technology that is either understood reasonably well in terms of its effectiveness under various design conditions or is essentially self-monitored (e.g., stormwater harvesting projects would have flow meters that monitor the volume of flow that is reused).

9.4 ACTION PLAN DATABASE: TRACKING PROGRESS

The watershed plan presented above identifies management actions that could be taken to meet goals and priorities for protecting, preserving, and restoring critical resources and habitats. Of paramount importance is the linkage of management actions to these goals. One method of accomplishing this linkage is to develop an Action Plan Database. We recommend developing an Action Plan Database to help track progress towards the goals and objectives set forth in this Watershed Management Plan. The Action Plan Database provides a way to link expected results of management actions to goals and is a convenient and efficient way to track actions and progress towards goals. Specific project plans should include sufficient information to assign habitat and load-reduction projects to specific areas of the study area to allow tracking of expected plan results by basin and jurisdictional entity. As plans are implemented, additional information related to realized results can be used to refine the project effects with respect to habitat and/or load-reduction benefits.

Action plans for the Action Plan Database will include information that allows calculation of project habitat protection, preservation, and restoration areas by habitat type, as well as information to allow calculation of pollutant-load reductions due to land use change, change in land management practices, and directed load-reduction projects.

Another important aspect of the projects in the Action Plan Database will be the effective date of the project. Including planned and actual completion dates for projects allows management decisions to be made for selected time periods with complete information regarding when specific projects will be in place.

The database would be developed and maintained as a Microsoft Access database, allowing for efficient compiling and reporting of projects developed for specific action plans (i.e., habitat restoration, nutrient-load reduction) or for specific areas or responsible entities. Some key elements of the database include:

- The front page of the database would allow users to add projects and view compilations of project information based on certain criteria (i.e., location in the watershed, completion date). An example front page is shown in Figure 9-2.

- The project entry page provides for inclusion of project-specific information, including attachment of additional documentation in the form of electronic files (Word or Adobe documents, spreadsheets, text files) to support estimation of habitat acreages and/or nutrient-load reductions expected. The relevant information also includes location, cost, and schedule for the project. An example front page is shown in Figure 9-3.

Figure 9-2 Example Front Page for the Lemon Bay Action Plan Database

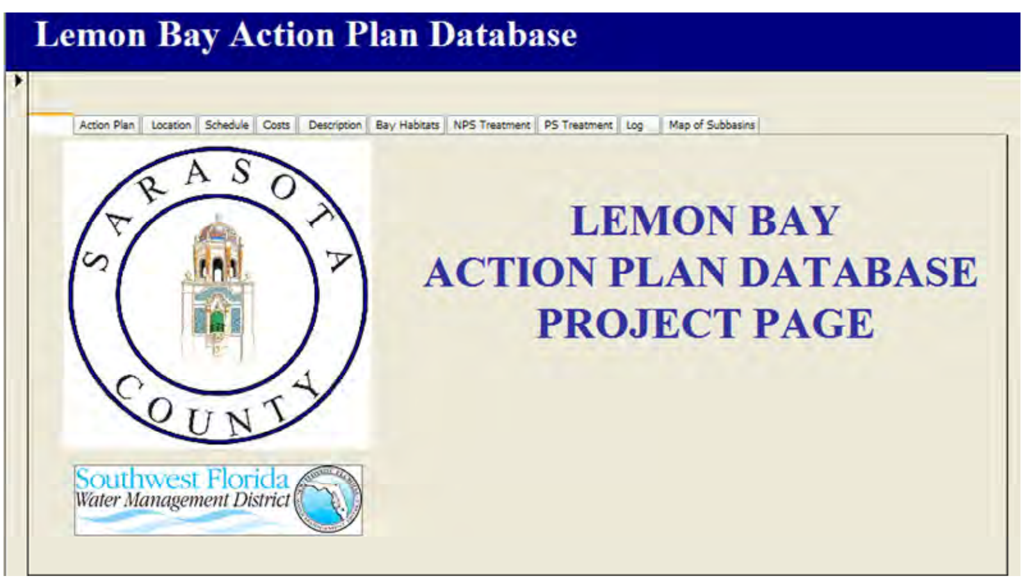

Figure 9-3 Example Project Entry Page for the Lemon Bay Action Plan Database

Appendix A

Existing Management Programs

August 2010

Sarasota County

Southwest Florida Water Management District

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Natural Systems

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Sarasota County Comprehensive Plan	2006	Sarasota County Planning Department	Protect, maintain and, where deemed necessary in the public interest, restore the barrier island, beach, and estuarine systems of Sarasota County. (Chapter 2, Environmental Goal 1)	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.
			Protect and enhance wherever possible, the quality of the estuarine environment throughout Sarasota County. (Chapter 2, Environmental Goal 2)		
			It shall be the goal of Sarasota County, as a member of the Sarasota Bay and Charlotte Harbor National Estuary Programs to support the implementation of their regional Comprehensive Conservation and Management Plans (CCMP) to restore and improve the natural estuarine systems and related coastal components. (Chapter 2, Environmental Goal 3)		
			Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County. (Chapter 2, Environmental Goal 4)		
			Lessen the impact of a destructive storm on human life, public facilities, private structures, infrastructure, and coastal natural resources in Sarasota County. (Chapter 2, Environmental Goal 5)		
			Preserve, protect, and restore the integrity of the natural environment, historic and archeological resources, neighborhoods, and preserve agricultural uses consistent with resource protection (Chapter 9, FLU Goal 1)		
			Sarasota County shall provide programs which enhance, protect, and conserve the hydrologic and ecological functions of natural systems including estuaries, freshwater, and groundwater systems. (Chapter 4, Water Goal 2)		
Land Management Plan for the Alligator Creek Conservation Area	2005	Sarasota County Natural Resources	To manage the Conservation area's upland communities to improve habitat value for wildlife and habitat function.	Nuisance exotic species control.	Quarterly evaluation of nuisance exotic plant species populations should be conducted to assess the success of treatment as well as the need for additional control.
				Understory vegetation reduction.	Where deemed appropriate, areas of mesic flatwoods shall be managed by periodic rollerchopping, brown tree cutting, or other similar methods to reduce the height and density of understory vegetation.
				Community coordination.	The Conservation area boundaries will be clearly identified and signage will be positioned so that all interested parties can contact the County with inquiries related to the Conservation area.
					Adjacent land owners that are encroaching on the Conservation area shall be notified once boundaries are clearly identified and encroachment activities (e.g., discarding yard waste) are positively identified.
					Sarasota County staff will involve local homeowner's associations and nearby residents to solicit input on any major land management activities or recreational amenities proposed.

LEMON BAY WATERSHED MANAGEMENT PLAN
Existing Goals, Objectives, and Recommendations

Natural Systems

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Southern Coastal Comprehensive Watershed Management Plan	2000	Southwest Florida Water Management District	To protect, preserve, and restore natural Florida ecosystems and to establish minimum water levels and flows necessary to maintain these natural systems.	Strategy: Continue ongoing efforts focused on protecting and restoring wetlands in the Southern Coastal Watershed.	Through the SWIM Trust Fund, and the District's Cooperative Funding Program, continue ongoing efforts to enhance, restore, and create wetlands throughout the Southern Coastal Watershed.
					Provide proactive, cooperative consultation to the private and public sectors on development proposals and regulatory issues that impact wetlands.
				Strategy: Protect natural systems within the Southern Coastal Watershed through land acquisition (fee simple) and other land conservation methods (e.g., conservation easements).	Identify and prioritize conservation lands within the watershed using the Florida Game and Freshwater Fish Commission's "Closing the Gaps" reports, as well as recent efforts by local governments and the District's SOR/P2000 Program.
					Coordinate land acquisition and other conservation efforts among federal, state, regional, and local governments.
					Educate land owners of significant undeveloped areas (e.g., ranchers in eastern Sarasota County) about protection and management of listed species habitats.
Charlotte Harbor Surface Water Improvement and Management (SWIM) Plan	2000	Southwest Florida Water Management District	Improve the environmental integrity of the Charlotte Harbor study area.	Where practical, identify and remove areas of heavy invasive exotic vegetation from the Charlotte Harbor NEP study area.	Implement restoration master plan for Alligator Creek
					Restore Amberjack Slough.
					Restore Lemon Bay Park.
					Continue various other restoration projects.
				Enhance fish and wildlife habitat along shorelines, including canals, lakes, riverine systems, and artificial water bodies	Develop a water and nutrient budget for Lake Hancock for water quality improvement.
					Implement restoration Plan for Alligator Creek.
					Restore Amberjack Slough.
					Restore Lemon Bay Park.
					Continue various other restoration projects.
			Preserve, restore, and enhance seagrass beds, coastal wetlands, barrier beaches, and functionally related uplands.	Restore freshwater and estuarine wetland areas, especially those adversely impacted by ditching	Implement restoration Plan for Alligator Creek.
					Restore Amberjack Slough.
					Restore Lemon Bay Park.
					Continue various other restoration projects.
				Bring environmentally sensitive land under protection through ownership and/or management, and expand conservation areas, reserves, and preserves	Continue ongoing land acquisition/conservation easement activities.
				Acquire lands to increase wildlife habitat currently privately held within large, undeveloped, platted areas	Continue ongoing land acquisition/conservation easement activities.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Natural Systems

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay	2004	Southwest Florida Water Management District	To reduce nonpoint source loadings from the Lemon Bay watershed to Lemon Bay.	Implement Hydrologic Restoration Program to restore freshwater systems that have been altered through manmade drainage activities to restore freshwater flows to estuary systems, enhance floodplain storage, and improve surface water quality through increased residence time in restored freshwater systems.	Alligator Creek Restoration.
					Forked Creek Western Branch Restoration Site.
					Forked Creek Eastern Branch Restoration Site.
					Manasota Key Restoration Site.
					Gottfried Creek Restoration Site.
					River Road Wetland Restoration Site.
					Ainger Creek Restoration.
Comprehensive Conservation and Management Plan (CCMP)	2007	Charlotte Harbor National Estuary Program	Improve the environmental integrity of the Charlotte Harbor study area.	FW-1: Meet the stated objectives for the target extent, location, and quality of the following habitats in the CHNEP study area: submerged aquatic vegetation (SAV), submerged and intertidal unvegetated habitats, mangroves, saltwater marsh, freshwater wetland systems, oyster bars, native upland communities, and water column.	FW-A: Develop methods to enhance seagrass recovery from prop scarring.
			Preserve, restore, and enhance sea grass beds, coastal wetlands, barrier beaches, and functionally related uplands.		FW-B: Ensure navigation programs protect the CHNEP study area habitat resources.
			Reduce the severity, extent, duration, and frequency of harmful algal blooms (HABs), including red tide.		FW-C: Restore freshwater and estuarine wetland areas, especially those adversely impacted by ditching, using the following methods: backfilling of ditches, removal of spoil piles, elimination of exotic vegetation and other techniques.
			Conserve and preserve sensitive lands to protect habitat.		FW-D: Enhance fish and wildlife habitat along shorelines, including canals, lakes, riverine systems, and artificial waterways.
			Stop new infestations of exotic pest plants and exotic nuisance animals and bring current infestations to manageable levels.		FW-E: Assess the impacts of canal/lake management activities on fish and wildlife.
			Address fish and wildlife habitat loss, such as degradation and elimination of headwater streams and other habitats caused by development, conversion of natural shorelines, cumulative impacts of docks and boats, invasion of exotic species, and cumulative and future impacts.		FW-F: Restore and protect a balance of native plant and animal communities.
					FW-G: Provide additional support for environmental compliance and enforcement on land and water. Ensure uniform compliance and enforcement of environmental regulations and permitting criteria.
					FW-O: Provide multifaceted environmentally responsible boater education programs.
					FW-P: Support public involvement programs in habitat and wildlife issues.
				FW-2: By 2025, achieve a 100 percent increase in conservation, preservation, and stewardship lands within the boundaries of the CHNEP study area. The increase will be based upon 1998 acreage of existing conservation, preservation, and stewardship lands.	FW-H: Bring environmentally sensitive land under protection through ownership and/or management and expand conservation areas, reserves and preserves, including undeveloped platted lots.
					FW-I: Advocate land acquisition and conservation easement programs.
					FW-J: Provide information on the economic, social, and environmental benefits of protected land.
					FW-K: Acquire as much of Babcock Ranch as possible for public stewardship and promote conservation management of the entire ranch.
					FW-P: Support public involvement programs in habitat and wildlife issues.
				FW-3: By 2020, on conservation, preservation, stewardship and other public lands achieve controllable levels of invasive exotic plants, as defined by the Florida Exotic Pest Plant Council, and exotic nuisance animals, as defined by the Florida Fish and Wildlife Conservation Commission.	FW-L: Where practical, identify and remove areas of heavy invasive exotic vegetation and exotic nuisance animals.
					FW-M: Promote local programs to research and eliminate nuisance exotic animal species.
					FW-N: Provide education programs on the impacts of invasive exotic plants and exotic nuisance animals.
			Address hydrologic alterations, which cause adverse changes to amounts, locations, and timing of freshwater flows, the hydrologic function of floodplain systems, and natural river flows.	HA-1: By 2015, identify, establish, and maintain a more natural seasonal variation (annual hydrograph) in freshwater flows for Caloosahatchee River, Peace River and its tributaries, Myakka River with special attention to Flatford Swamp and Tatum Sawgrass, Estero Bay and its tributaries.	HA-A: Develop a historic and current estuarine mixing model, focusing on salinity, indicator species that are sensitive to salinity changes, and better evaluate proposed capital and operations projects.
					HA-C: Protect headwater tributaries from elimination and restore these tributary courses and their floodplains where opportunities exist.
					HA-D: Set and achieve minimum aquifer levels. Reduce the rate of saltwater intrusion of the Floridan aquifer.
					HA-E: Establish minimum flows and levels (MFLs).
					HA-F: Participate in Everglades restoration and the Southwest Florida Feasibility Study.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation, and water use.
				HA-2: By 2020, restore, enhance, and improve, where practical, historic watershed boundaries and natural hydrology for watersheds within the CHNEP study area, with special attention to Outstanding Florida Waters and Class I water bodies.	HA-F: Participate in Everglades restoration and the Southwest Florida Feasibility Study.
					HA-G: Reestablish hydrologic watersheds to contribute flows to their historic receiving water bodies.
					HA-H: Identify natural, existing, and target water budgets for each watershed.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation, and water use.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Natural Systems

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Comprehensive Conservation and Management Plan (CCMP)	2007	Charlotte Harbor National Estuary Program	Address hydrologic alterations, which cause adverse changes to amounts, locations, and timing of freshwater flows, the hydrologic function of floodplain systems, and natural river flows.	HA-3: By 2020, enhance and improve to more natural hydrologic conditions water bodies affected by artificially created structures throughout the CHNEP study area. Reduce negative hydrologic effects of artificially created structures such as weirs, causeways, dams, clay settling areas, and new reservoirs.	HA-F: Participate in Everglades restoration and the Southwest Florida Feasibility Study.
					HA-I: Evaluate the impacts of man-made barriers to historic flows.
					HA-J: Build and restore water conveyances to have shallow, broad, vegetated and serpentine components that also restore floodplains.
					HA-K: Identify the hydrologic and environmental impacts of surface water reservoirs on estuaries within the watershed.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation and water use.
				HA-4: By 2010, for each watershed, identify the linkages between local, water management district, state and federal government development permitting, and capital programs affecting water storage, flood control, and water quality. By 2012, identify and recommend reforms through tools such	HA-L: Encourage the use of low-impact techniques in new and old developments.
					HA-N: Implement watershed initiative projects to address hydrologic alterations, loss of water storage, changed hydroperiod and improve water quality.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation and water use.
Tidal Creek Condition Index for Coastal Streams in Sarasota County, Florida	2006	Mote Marine Laboratory	Develop an index for use by county government in tracking the biological health of tidal creeks.		A refined index should be field tested in the 2007 dry season. The index should conserve all of the metrics tested in 2006, for both intertidal and subtidal settings. The density (O.D.) crustaceans and mollusks from coarsely sieved benthic samples should be added as a new metric.
					The effects of sample size and replication should be determined for metrics of interest.
					Improvements in site selection should be sought. While most sites are representative, some could be relocated to avoid problems encountered in 2006. A decision is needed regarding the use of bay sites for highly altered or unsafe creeks.
					The 2007 report will produce consistent, robust data set that should be thoroughly analyzed with respect to alternative methods of rectification, aggregation, and index normalization. Then, creek index scores should be compared to as many independent systems of watershed and creek conditions as may be available.
					A workshop should be held to address: (1) Whether, or how, the creek index can be incorporated into a watershed or stream "report card" by which the county can track overall environmental conditions along the coast, and (2) The question of other season sampling needs to be resolved. The behavior of the index during a wet season is presently unknown, and whether it should be evaluated in 2007 will depend on Sarasota County expectations for the index's future use. For example, an index based on periodic dry-season sampling may not be useful as an immediate response to a catastrophic pollution event during a wet season.
Lemon Bay Interagency Comprehensive Watershed Management Plan	2004	Lemon Bay League	To enhance, protect, and conserve the hydrologic and ecologic functions of natural systems including estuaries, freshwater, and groundwater systems.	Determine and restore more natural hydrologic regimes to our natural water systems.	Development of watershed budgets.
					Aquifer storage and recovery feasibility study.
					Hydrologic restoration program.
					Stormwater conservation and reuse program.
					Conversion of wastewater treatment plants to stormwater treatment plants.
				Protect and restore ecological habitat.	Hydrologic restoration program.
					Conservation of effluent ponds to stormwater management systems.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Water Quality					
Plan	**Year**	**Agency**	**Goal**	**Objective / Strategy**	**Recommendations**
Sarasota County Comprehensive Plan	2006	Sarasota County Planning Department	Sanitary sewer service shall be provided to Sarasota County residents through the continual evolution of a centralized regional wastewater collection and treatment system, and shall be provided in a safe, clean, efficient, economical, and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 1)	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.
			Sarasota County shall provide programs which enhance water quality where appropriate (Chapter 4, Water Goal 2)		
Forked Creek Basin Master Plan	1996	Sarasota County Stormwater Environmental Utility	Meet water quality goals as stated in the Sarasota County Comprehensive Plan.	Implement projects to address both the flood control and water quality LOS.	F-2: Construct an approximately 400 ft channel, 12 ft wide with 3:1 side slopes along 5th Street to connect the existing wetland systems
					F-6: Improve channel and clear and snag 1,200 ft long creek segment from Manasota Beach Road to existing driveway. Design improvements as a longitudinal wetland/slough with 3:1 side slopes to obtain water quality benefits.
					F-7: Acquire and improve existing 3 acre wetland.
					F-8: Clear and snag about 700 ft of channel from previous location to an existing 0.25 acre adjacent wetland area downstream.
					F-10: Reconstruct about 300 ft of creek channel upstream from a private driveway located approximately 500 ft upstream from SR 776 crossing. Design the system as a longitudinal wetland/slough with 3:1 side slopes to obtain water quality benefits. Provide for erosion control at selected locations along the creek. Sides with slopes steeper than 3:1 should be protected with erosion control materials.
					F-13: Improve about 1,500 ft of creek channel in the Whispering Pines area by reshaping the creek banks to a 3:1 slope or a 2:1 slope with protected side slopes. Stabilize creek banks in areas where existing structures are located. Design project as a longitudinal wetland/slough to obtain water quality benefits.
					Implement a Regional Stormwater Management Facility (RSMF) in the Forked Creek basin with its outfall located approximately 1,300 ft north of Keyway Road crossing on the creek's eastern branch.
Ainger Creek Comprehensive Basin Master Plan	1997	Sarasota County Stormwater Environmental Utility	To identify existing and future Level of Service deficiencies with respect to water quality.	Implement alternatives to address water quality LOS deficiencies.	Coordinate with landowner and Sarasota County's Environmentally Sensitive Lands Program to protect the Ainger Creek floodplain.
					Restore water level control structure located just within North Port city limits on SWFWMD property.
					Construct a minimum 50 acre regional stormwater facility.
					Maintain existing systems.
Gottfried Creek Basin Master Plan	1996	Sarasota County Stormwater Environmental Utility	To evaluate the existing and future water quality LOS and identify the best management practices required to control stormwater pollution.	Implement projects to address water quality LOS deficiencies.	G-7: Regional water quality facility. Clear, snag, and remove existing spoil berms along the creek banks between the confluence of the main branch with the Englewood lateral and the Park Forest bridge. Place diversion structures to route flows through adjacent wetlands for water quality treatment. (Englewood Lateral Improvement)
					G-9: Proposed future regional detention facility: It will cover about 60 acres of currently undeveloped land north of an existing Englewood lateral weir structure. (Englewood Lateral Improvement)
					G-12: Construct stormwater detention facility approximately 1,300 ft downstream from the existing WENG Radio culvert in the Ainger Creek basin. (South River Road Improvement)

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Water Quality

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay	2004	Southwest Florida Water Management District	To reduce nonpoint source loadings from the Lemon Bay watershed to Lemon Bay.	Implement Hydrologic Restoration Program to restore freshwater systems that have been altered through manmade drainage activities to restore freshwater flows to estuary systems, enhance floodplain storage, and improve surface water quality through increased residence time in restored freshwater systems.	Alligator Creek Restoration.
					Forked Creek Western Branch Restoration Site
					Forked Creek Eastern Branch Restoration Site
					Manasota Key Restoration Site
					Gottfried Creek Restoration Site
					River Road Wetland Restoration Site
					Ainger Creek Restoration
				Conversion of effluent ponds to stormwater management systems to eliminate wastewater discharge and improve stormwater quality.	Florida Pines MHP
					Japanese Gardens MHP
					Polynesian Village MHP
					Englewood Utility
				Conversion of wastewater treatment plants to stormwater treatment plants to reduce stormwater pollutant loads and excess volumes to bays and also to provide beneficial irrigation uses.	Venice Gardens WRF
					Plantation
Southern Coastal Comprehensive Watershed Management Plan	2000	Southwest Florida Water Management District	To protect water quality by preventing further degradation of the water resource and enhancing water quality where appropriate.	Strategy: Continue ongoing monitoring and data management activities in Sarasota and Manatee Counties.	Through the District's cooperative funding program, determine those water quality monitoring programs in need of support and/or enhancement though the use of District staff and/or funding.
					Through the District's cooperative funding program, continue to support efforts focused on determining the status and trends (if any) in water quality.
				Strategy: Expand ongoing monitoring and data management activities into Charlotte County.	Through the District's cooperative funding program, and in coordination with the Charlotte Harbor NEP, develop a coordinated water quality monitoring program for Lemon Bay and Gasparilla Sound.
				Strategy: Determine the potential ecological consequences associated with further development of the Lemon Bay watershed.	In coordination with the Charlotte Harbor NEP and the SWIM Program, develop a detailed pollutant loading model for Lemon Bay, with special attention paid to generating potential scenarios associated with increased nitrogen loads into Lemon Bay.
				Strategy: Better understand the ecological impacts of present-day flood control practices in Cow Pen Slough, and determine the potential for utilizing high flows as a supplement to potable and/or non-potable water supplies in Sarasota County.	Through the District's cooperative funding program, and in coordination with the Charlotte Harbor NEP and the SWIM Program, develop a detailed hydrologic model of Cow Pen Slough, Shakett Creek, and Dona and Roberts Bays to better understand the ecological impacts of present-day flood control practices.
				Strategy: Reduce wastewater-related point and non-point source pollutant loads to the freshwater and estuarine waters of the Southern Coastal Watershed.	Support local governments in their efforts to require wastewater treatment policies consistent with either nutrient removal technology, or advanced secondary treatment with effective reuse.
					Develop a multi-county wastewater reclamation program to minimize the discharge of treated wastewater to the freshwater and estuarine waters of the Southern Coastal Watershed.
				Strategy: Reduce stormwater-related non-point source pollutant loads to the freshwater and estuarine waters of the Southern Coastal Watershed.	Promote pollution prevention through improved landscape design and maintenance of residential areas.
					Continue ongoing efforts to implement the Sarasota Bay NEP's "Florida Yards and Neighborhoods Program."
					Develop and implement stormwater management master plans for tributaries identified as "hot spots" for toxic and/or sediment loadings.
					Continue ongoing efforts to maintain stormwater management and treatment systems for maximum efficiency in reducing pollutant loads.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Water Quality

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Charlotte Harbor Surface Water Improvement and Management (SWIM) Plan	2000	Southwest Florida Water Management District	Reduce point and non-point sources of pollution to attain desired use of the estuary.	Identify gaps in water quality data needed to calibrate the appropriate models used to determine Total Maximum Daily Load (TMDL) limits; coordinate monitoring programs; and implement programs to fill data gaps for TMDLs.	Develop a linked nutrient budget and water quality model for Lemon Bay.
					Develop a resource-based pollutant load reduction goal for Charlotte Harbor "Proper."
					Continue the existing short-term water quality monitoring program.
					Implement the long-term water quality monitoring program.
					Continue seagrass mapping efforts.
				Install or retrofit best management practices (BMPs) to maintain or improve water quality.	Develop a linked nutrient budget and water quality model for Lemon Bay.
					Develop a resource-based pollutant load reduction goal for Charlotte Harbor "Proper."
					Implement the Canal Water Quality Enhancement Project.
					Develop and implement water quality improvement projects, as appropriate.
			Provide the proper fresh water inflow to the estuary to ensure a balanced and productive ecosystem.	Establish and implement minimum flows for tributaries as detailed within the draft CCMP. Determine maximum cumulative withdrawals.	Establish minimum flows for the Upper Peace River by 2001.
					Establish minimum flows for the Middle and Lower Peace River (including Shell, Horse, and Joshua Creeks) between 2002 and 2005.
					Establish minimum flows for the Myakka River between 2011 and 2015.
					Continue efforts to reduce excessive dry season flows in the Upper Myakka River.
					Assess the potential for hydrologic restoration of Cow Pen Slough.
				Reestablish, where practical, surface flows from sub-basins that do not currently contribute to their historic hydrologic connections.	Assess the potential for hydrologic restoration of identified sub-basins.
				Where possible, and practical, restore groundwater levels to historic seasonal mean levels.	Establish minimum flows for the Upper Peace River by 2001.
					Establish minimum flows for the Middle and Lower Peace River (including Shell, Horse and, Joshua Creeks) between 2002 and 2005.
				Evaluate potential alternatives to modification and/or removal of the structure at the southern end of Lake Hancock.	Establish minimum flows for the Upper Peace River by 2001.
					Develop a water and nutrient budget for Lake Hancock for water quality improvement.
Comprehensive Conservation and Management Plan (CCMP)	2007	Charlotte Harbor National Estuary Program	Reduce point and non-point sources of pollution to attain desired uses of the estuary.	WQ-1: Maintain or improve water quality from year 2000 levels. By 2011, bring all impaired water bodies into a watershed management program such as Reasonable Assurance or Basin Management Action Plan. Remove at least two water bodies from the impaired list by improving water quality by 2015.	WQ-A: Participate in 303(d) Total Maximum Daily Load (TMDL), Reasonable Assurance and Basin Management Action Plan (BMAP) development and implementation.
					WQ-B: Identify gaps in water quality data needed to calibrate the appropriate models used to assess impairments, determine total maximum daily load (TMDL) limits and develop basin management action plans (BMAP). Coordinate monitoring programs and implement programs to fill data gaps for impairment assessments, TMDLs, and BMAPs.
			Address water quality degradation, including but not limited to pollution from agricultural and urban runoff, point source discharges, septic tank system loadings, atmospheric deposition, and groundwater.		WQ-C: Develop integrated ground and surface water quality and pollutant loading models.
					WQ-D: Reduce nonpoint-source pollutants associated with stormwater runoff. Install or retrofit best management practices (BMP) to maintain or improve water quality and flows.
					WQ-E: Implement projects to restore or protect water quality to offset anthropogenic impacts.
					WQ-F: Promote conservation, stormwater and intergovernmental coordination within local comprehensive plans to prevent the impacts of increasing levels of impervious surface and fill to achieve either a neutral impact on water quality and loss of groundwater and surface water storage, or achieve restoration, based upon the condition of the receiving waters.
					WQ-K: Implement the Florida Yards and Neighborhoods program and similar Florida-friendly plant programs throughout the CHNEP study area.
					WQ-L: Increase the use of personal and home best management practices by consumers throughout the watershed to reduce nonpoint-source pollution.
					WQ-M: Support public involvement programs addressing water quality issues.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Water Quality

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Comprehensive Conservation and Management Plan (CCMP)	2007	Charlotte Harbor National Estuary Program	Address water quality degradation, including but not limited to pollution from agricultural and urban runoff, point source discharges, septic tank system loadings, atmospheric deposition, and groundwater.	WQ-2: By 2015, develop and meet site-specific alternative criteria that are protective of living resources for dissolved oxygen, chlorophyll a, turbidity/total suspended solids, salinity and pesticides.	WQ-G: Develop site-specific criteria for dissolved oxygen, chlorophyll a, turbidity/total suspended solids, salinity and pesticides as applicable.
					WQ-H: Assess the bacteria, nutrient load, and base flow impacts of septic tank systems, wastewater treatment plants, and reuse water. Recommend effective corrective action.
					WQ-M: Support public involvement programs addressing water quality issues.
				WQ-3: By 2025, reduce severity, extent, duration, and frequency of harmful algal blooms (HABs), including macro-algae, phytoplankton, and periphyton, through the identification and reduction of anthropogenic influences.	WQ-I: Determine the relationship between macro and micronutrients and phytoplankton/algal blooms.
					WQ-M: Support public involvement programs addressing water quality issues.
				WQ-4: By 2025, meet shellfish harvesting standards year round for the Myakka River conditionally restricted area and the conditionally approved areas of Lemon Bay, Gasparilla Sound, Myakka River, Pine Island Sound Western Section, and Pine Island Sound eastern section.	WQ-J: Provide central sanitary sewers to developed areas within 900 feet of waters such as estuarine shorelines, rivers, creeks, canals, and lakes.
					WQ-H: Assess the bacteria, nutrient load and base flow impacts of septic tank systems, wastewater treatment plants, and reuse water. Recommend effective corrective action.
					WQ-M: Support public involvement programs addressing water quality issues.
			Address hydrologic alterations, which cause adverse changes to amounts, locations, and timing of freshwater flows, the hydrologic function of floodplain systems, and natural river flows.	HA-1: By 2015, identify, establish, and maintain a more natural seasonal variation (annual hydrograph) in freshwater flows for Caloosahatchee River, Peace River and its tributaries, Myakka River with special attention to Flatford Swamp and Tatum Sawgrass, Estero Bay and its tributaries.	HA-A: Develop a historic and current estuarine mixing model, focusing on salinity, indicator species that are sensitive to salinity changes, and better evaluate proposed capital and operations projects.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation, and water use.
				HA-2: By 2020, restore, enhance, and improve where practical historic watershed boundaries and natural hydrology for watersheds within the CHNEP study area, with special attention to Outstanding Florida Waters and Class I water bodies.	HA-G: Reestablish hydrologic watersheds to contribute flows to their historic receiving water bodies.
					HA-H: Identify natural, existing, and target water budgets for each watershed.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation, and water use.
				HA-3: By 2020, enhance and improve to more natural hydrologic conditions water bodies affected by artificially created structures throughout the CHNEP study area. Reduce negative hydrologic effects of artificially created structures such as weirs, causeways, dams, clay settling areas, and new reservoirs.	HA-J: Build and restore water conveyances to have shallow, broad, vegetated, and serpentine components that also restore floodplains.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation and water use.
				HA-4: By 2010, for each watershed, identify the linkages between local, water management district, state and federal government development permitting, and capital programs affecting water storage, flood control, and water quality. By 2012, identify and recommend reforms through tools such as comprehensive watershed management plans. By 2015, implement the reforms.	HA-L: Encourage the use of low-impact techniques in new and old developments.
					HA-M: Limit big-pulsed release events.
					HA-N: Implement watershed initiative projects to address hydrologic alterations, loss of water storage, changed hydroperiod and improve water quality.
					HA-O: Encourage, expand and develop incentives for the reuse of waters that are protective of water quality and natural hydrology.
					HA-P: Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation and water use.
Lemon Bay Interagency Comprehensive Watershed Management Plan	2004	Lemon Bay League	To protect water quality by preventing further degradation of the water resource and enhancing water quality where appropriate.	Protect and improve surface water quality.	Water quality sampling of creek systems.
					Biological characterization of tidal creek systems.
					Hydrologic restoration program.
					Sediment management program.
					Stormwater conservation and reuse program.
					Conservation of effluent ponds to stormwater management systems.
					Conversion of wastewater treatment plants to stormwater treatment plants.
					Biosolids handling initiative.
					Lemon Bay water quality monitoring.
				Protect groundwater quality.	Intermediate aquifer monitoring program.

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Existing Goals, Objectives, and Recommendations

Water Supply

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Sarasota County Comprehensive Plan	2006	Sarasota County Planning Department	Potable water service shall be provided to Sarasota County residents through the continual evolution of a centralized regional supply, treatment, and distribution system, and shall be provided in a safe, efficient, economical, sustainable and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 3)	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.
			Sarasota County shall provide programs to ensure safe, efficient, economical, and sustainable water supplies that provides customers the appropriate water quality for the intended use. (Chapter 4, Water Goal 2)	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.	See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.
Southern Coastal Comprehensive Watershed Management Plan	2000	Southwest Florida Water Management District	To ensure an adequate supply of the water resource for all reasonable and beneficial uses, now and in the future, while protecting and maintaining the water and related resources of the District.	Strategy: Seek inclusion of water resource/land use planning as a consistency requirement for Local Government Comprehensive Plans.	Use the District's Needs and Sources report as the source document for water supply availability.
					Include land use and water resource planning consistency as part of the District's 1999 legislative agenda.
					Seek opportunities to enhance linkages between the District and local governments as they relate to water resources and land use planning.
				Strategy: Improve coordination between land and water planners	Increase District involvement with the Tampa Bay and Southwest Florida Regional Planning Councils and local government planning departments.
					Develop an annual report summarizing the status of water supply, water resources, and new regulations for distribution to local land use planners and others.
					Develop procedures with local governments so that District input becomes part of government decisions on land use planning.
					Coordinate five-year planning documents, such as Comprehensive Plan updates and Basin Plans, on the same time frame.
				Strategy: Promote conservation and reuse.	Continue existing conservation programs and reuse system expansion.
					Continue interconnection and regionalization of reuse systems, where cost-effective, to improve efficiency and increase reclaimed water utilization.
					Investigate opportunities to develop reuse systems in new areas.
					Continue current funding levels and the associated programs and regulatory requirements for conservation and reuse.
					Investigate financial incentives to offset the costs of industrial and commercial reuse and conservation programs.
					Recognize and reward industries and other entities who have strong conservation and/or reuse programs.
					Develop pilot projects for stormwater reuse.
					Increase public awareness of the environmental costs of water use.
				Strategy: Improve compliance with water shortage restrictions and year-round conservation measures.	Educate the public on how year-round water conservation measures and water shortage restrictions affect them.
					When noticing adjacent property owners regarding water use permits, mention any water shortage restrictions included in the permit. For example, in noticing nearby homeowners when golf courses are issued water use permits, homeowners could be informed regarding the allowable golf course irrigation schedules and could assist in ensuring their compliance with water shortage restrictions.
					Coordinate with local governments to identify means of enforcing watering restrictions.
				Strategy: Develop alternative water sources.	Continue New Water Sources Initiative and Cooperative Funding Program to assist local governments in developing alternative supplies. Include alternative sources as a primary component of water supply plans.
					Continue regulatory requirements/incentives for alternative water sources.
					Optimize use of aquifer storage and recovery for reclaimed and surface water sources.
				Strategy: Adopt aquifer levels for the intermediate aquifer to establish limits on withdrawals that will not cause significant harm to the water resources or the ecology of the area.	Collect and evaluate hydrologic and ecological information necessary to establish minimum levels ground water for the Intermediate aquifer.
					Adopt minimum ground water levels for the Intermediate aquifer.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Water Supply

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
SWUCA Recovery Strategy	2006	Southwest Florida Water Management District	Reduce the rate of saltwater intrusion in coastal Hillsborough, Manatee and Sarasota counties by achieving the proposed minimum aquifer level for saltwater intrusion by 2025; once achieved, future efforts should seek further reductions in the rate of saltwater intrusion and the ultimate stabilization of the saltwater-freshwater interface		Resource monitoring, reporting and cumulative impact analysis
			Ensure that there are sufficient water supplies for all existing and projected reasonable beneficial uses.		Development and implementation of water resource development projects that will restore historically last lake and floodplain storage
					Provide financial incentives to encourage conservation and development of alternative supplies to ensure consistency with the Recovery Strategy
					Enhancements to existing rules
					Use of existing rules to effectively contribute to the Recovery Strategy
					Development of a regional water supply plan to achieve effective water management
Comprehensive Conservation and Management Plan (CCMP)	2008	Charlotte Harbor National Estuary Program	Address hydrologic alterations, which cause adverse changes to amounts, locations, and timing of freshwater flows, the hydrologic function of floodplain systems, and natural river flows.	By 2015, identify, establish and maintain a more natural seasonal variation (annual hydrograph) in freshwater flows for Caloosahatchee River, Peace River and its tributaries, Myakka River with special attention to Flatford Swamp and Tatum Sawgrass, Estero Bay and its tributaries.	Identify gaps in flow data based on ecosystem needs and projected needs for water withdrawals due to population growth, development, agriculture, and mining. Implement data collection to address these gaps.
					Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation, and water use.
				By 2010, for each watershed, identify the linkages between local, water management district, state and federal government development permitting and capital programs affecting water storage, flood control and water quality. By 2012, identify and recommend reforms through tools such as comprehensive watershed management plans. By 2015,	Encourage, expand, and develop incentives for the reuse of waters that are protective of water quality and natural hydrology.
					Support public involvement programs addressing watershed management issues of hydrology, water resource issues, water conservation, and water use.
Lemon Bay Interagency Comprehensive Watershed Management Plan	2004	Lemon Bay League	To ensure safe, efficient, economical, and sustainable water supplies that provide customers the appropriate water quality for the intended use	Evaluate future water needs and the capacity of existing supplies.	
				Identify and evaluate future water supply options.	Aquifer storage and recovery feasibility study.
					Stormwater conservation and reuse program.
					Conversion of wastewater treatment plants to stormwater treatment plants.
				Optimize water use efficiency and supply sustainability.	Aquifer storage and recovery feasibility study.
					Intermediate aquifer monitoring program.
					Stormwater conservation and reuse program.
					Conversion of wastewater treatment plants to stormwater treatment plants.
				Establish sound business practices to optimize the financial sustainability of water.	Conservation of effluent ponds to stormwater management systems.
					Conversion of wastewater treatment plants to stormwater treatment plants.
					Biosolids handling initiative.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Flooding

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Sarasota County Comprehensive Plan	2006	Sarasota County Planning Department	Sarasota County shall provide programs which prevent and mitigate the losses, cost, and human suffering caused by flooding; protect natural and beneficial functions of the floodplain (Chapter 4, Water Goal 2)		See Sarasota County Comprehensive Plan Summary following watershed Areas of Responsibility Summarys of Previous Goals and Objectives.
Alligator Creek Flood Protection Improvement Plan	2002	Sarasota County Stormwater Environmental Utility	To provide Sarasota County Stormwater with a tool to help determine and prioritize the flood protection capital improvements.	Implement projects that meet the LOS criteria in a cost effective manner.	2.1: Scenic Drive- Outfall to Intracoastal Waterway.
					3.1: Culverts under Banyan Drive and storage in 150' ROW.
					4.2: Briarwood Area conveyance improvements.
					5.3: Bal Harbour/Shamrock Boulevard drainage improvements.
					7.3: Quail Lake/Venice East Boulevard interconnect culvert.
					8.1: Venice East Boulevard 5.5'x9.0' box culvert.
Gottfried Creek Basin Master Plan	1996	Sarasota County Stormwater Environmental Utility	To evaluate the existing and future flood control LOS in the basin and identify stormwater drainage improvements required to meet the existing and projected LOS.	Implement projects to address water quality LOS deficiencies.	G-1: Remove existing culvert and improve approximately 300 ft of existing ditch upstream of Viridian Street. (Englewood Lateral Improvement)
					G-2: Replace existing culvert across Elm Street with double 54 inch culverts. Eliminate culvert located about 50 ft east of Elm Street crossing. Restore about 250 ft of ditch cross section. (Englewood Lateral Improvement)
					G-3: Coordinate with FDOT to replace culverts on the north SR 776 crossing downstream from the Viridian Street pond with triple 60 inch RCPs. Replace existing culverts across the Florida Power easement with double 54 inch pipes. (Englewood Lateral Improvement)
					G-4: Clear and sang approximately 250 ft of existing ditch in the Artist Avenue area. Maintain existing culvert. (Englewood Lateral Improvement)
					G-6: Remove erosion deposits and provide erosion protection in about 700 ft of creek channel. Regrade banks to a 3:1 slope. (Englewood Lateral Improvement)
					G-8: Replace culverts across Florida Power easement with double 72 inch pipes. (Englewood Lateral Improvement)
					G-10: Maintain culvert across River Road. (South River Road Improvement)
					G-11: Replace about 300 linear ft of existing 29"x45" culvert. (South River Road Improvement)
Ainger Creek Comprehensive Basin Master Plan	1997	Sarasota County Stormwater Environmental Utility	To identify existing and future Level of Service deficiencies with respect to flood protection and establish a Stormwater Improvement Program and/or basin specific design criteria.	Implement alternatives to address water quality LOS deficiencies.	Improve outfall from Englewood Hospital to Ainger Creek Main by replacing twin 24"x38" ERCP culverts with twin 38"x60" ERCP culverts.
					Acquire additional real property rights to secure drainage maintenance for Englewood Hospital outfall.
					Coordinate with property owners in unplatted subdivision, located just east of North Port and just north of Charlotte County, and SWFWMD to restore north/south drainage ditch to Ainger Creek Main.
					Coordinate with landowner and Sarasota County's Environmentally Sensitive Lands Program to protect the Ainger Creek floodplain.
					Construct an overflow swale from Morningside Drive along the east side of Englewood Hospital.
					Acquire additional real property rights for overflow swale.
					Replace 24" CMP culvert at Morningside Drive with twin 29"x45" ERCP culverts.
					Replace 30"x54" CMPA culvert at Morningside Drive with twin 42" RCP culverts.
					Acquire real property rights for downstream segments of Englewood Farm Acres Lateral(s).
					Construct a swale in the existing public drainage easement located along the north side of Lots 1 through 5 and the east side of Lots 5 through 7 in Englewood Farms Acres subdivision. Construct culvert under Buckskin Court and tie into existing drainage system to the south.
					Construct a minimum 50 acre regional stormwater facility.
					Implement Ordinance No. 93-059.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Flooding

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Forked Creek Basin Master Plan	1996	Sarasota County Stormwater Environmental Utility	To meet goals as stated in the Sarasota County Comprehensive Plan.	Implement projects to address both the flood control and water quality LOS.	F-1: Improve facilities to prevent localized flooding in the area around Franklin Street (various localized projects).
					F-3: Acquire easements and clear and snag 2,400 ft of existing channels from Manasota Beach Road to Overbrook Road.
					F-4: Install double 30 inch culverts at the inflow of the Overbrook Road pond. Add an additional 30 inch culvert at the outflow.
					F-5: Construct 1,500 ft drainage ditch along Manasota Beach Road and improve existing culverts to double 24 ft RCP.
					F-9: Clear and snag approximately 800 ft of creek channel downstream from wetland area.
					F-11: Clear and snag approximately 500 ft of creek channel immediately upstream from Dale Lake (SR 776 crossing).
					F-12: Clear and snag about 1,000 ft of channel downstream from the Keyway Road culvert. Remove spoil berms where feasible.
					F-14: Clear and snag about 300 ft of channel. Provide erosion protection on the creek banks.
					F-15: Provide erosion protection on the 800 ft segment of the creek channel along the Brook to Bay Trailer Ranch.
					F-16: Provide bank erosion control in secondary channel that runs along the south side of Almeda Isles subdivision.
					F-17: Provide bank erosion control in main channel downstream from the Dale Lake outfall.
Woodmere Creek Basin Master Plan	1999	Sarasota County Stormwater Environmental Utility	To identify existing and future flood protection Level of Service (LOS) deficiencies throughout the Woodmere Creek basin.	Implement projects to address flood control	Area 1 Olivia Rd Flooding: Replace Heron Rd 60" RCP culvert with 8' x 12' box culvert
			To develop and evaluate stormwater improvements required to address the existing and projected LOS deficiencies.		Area 1 Olivia Rd Flooding: Replace Kent Rd 72" RCP with 8' x 12' box culvert
					Area 1 Olivia Rd Flooding: Replace Pompano Rd 2-60" RCP culverts with 8' x 12' box culvert
					Area 2 Hourglass Lakes and Circlewood Condos: Replace Florida Rd 2-48" RCP with 6' x 12' box culvert
					Area 2 Hourglass Lakes and Circlewood Condos: Replace Englewood Rd 236" RCP with 2-60" RCP
					Area 2 Hourglass Lakes and Circlewood Condos: Regrade 1200' of channel from Englewood Rd to pond outfall and excavate lower pond banks for two ponds in Hourglass Lakes and Circlewood Condos
					Area 3 Japanese Gardens Mobile Home Park: Replace Heron Rd 60" RCP with 6' x 12' box culvert
					Area 3 Japanese Gardens Mobile Home Park: Replace Colonial Rd 54" RCP with 5' x 12' box culvert
					Area 3 Japanese Gardens Mobile Home Park: Replace Japanese Gardens 22" x 36" CMP outfall with a 34" x 54" ERCP and provide storm sewer outfalls to channel with new endwalls
					Area 4 Gulfview Estates: Replace Osceola Rd 24" x 38" ERCP with 54" RCP and regrade upstream channel
					Area 4 Gulfview Estates: Add new 42" RCP to existing 42" RCP at private road crossing and provide new headwalls
					Area 4 Gulview Estates: Replace Englewood Rd 30" RCP with 2-42" RCP
					Area 4 Gulview Estates: Replace Gulview Estates 2-18" RCP pond outfalls with 42" RCP and replace 2-18" RCP pond interconnections with 2-36" RCP

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Flooding

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Nonpoint Source Model Development and Basin Management Strategies for Lemon Bay	2004	Southwest Florida Water Management District	To reduce nonpoint source loadings from the Lemon Bay watershed to Lemon Bay.	Implement Hydrologic Restoration Program to restore freshwater systems that have been altered through manmade drainage activities to restore freshwater flows to estuary systems, enhance floodplain storage, and improve surface water quality through increased residence time in restored freshwater systems.	Alligator Creek Restoration.
					Forked Creek Western Branch Restoration Site.
					Forked Creek Eastern Branch Restoration Site.
					Manasota Key Restoration Site.
					Gottfried Creek Restoration Site.
					River Road Wetland Restoration Site.
					Ainger Creek Restoration.
Southern Coastal Comprehensive Watershed Management Plan	2004	Southwest Florida Water Management District	Minimize potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood prone areas. The District shall give preference wherever possible to nonstructural surface water management methods.	Strategy: Enhance flood protection data collection and management.	Develop a data management system with appropriate standards to provide the information required to define the flood prone areas.
					Provide the requirements necessary, in an ARC/INFO based GIS format, to allow the transfer and formulation of input and output data from numerical models to a GIS. This will support further data development for other predictive models (i.e., water quantity, water quality, ground water, natural systems). It will also provide access to the data and modeling results for regulation within the watershed.
					Encourage the development of data transfer tools by the developers of stormwater management software. The goal is to have software with the capability to transfer the input data and output results to SWFWMD standards or to translate the information to data formats used by other stormwater management software and GIS.
					Use of data management tools to update the database through the regulatory process by requiring Environmental Resource Permit (ERP) submittals to include the data in the District's data standards.
					Perform aerial mapping with contour information (paper and digital formats) for areas in the watershed that have no such information or outdated information.
					Promote cooperative agreements to build data collection responsibilities based on need and the capabilities of the agency (FEMA, SWFWMD, Counties, Cities).
					Levels of Service (LOS) objectives should be set within project areas. These LOSs could be based on 25-year or 100-year, 24-hour events, and the number of homes affected, and length and classification of impacted roads, etc. could be used to develop a decision support matrix to evaluate the merits of multiple projects.
				Strategy: Obtain additional floodplain information.	Perform flood studies on unstudied areas.
					Set priorities based on current development pressures.
					Set priorities based on historic flooding problems.
				Strategy: Address increased runoff volume due to development.	Require modeling of current tailwater conditions and impacts of upstream volumes and timing on a site proposed stormwater management system and the proposed systems receiving water for stormwater management system permits.
					Permit applications should require "critical event" analysis.
					Promote the reuse of stormwater for non-potable water uses to increase storage in flood prone areas in stormwater management system applications.
				Strategy: Effective regulation and management of floodplain functions.	Ensure that regulations are enforced. That is, lands necessary for the provision of compensatory storage should be available when needed, systems should be designed to accommodate flooding during extreme events, and such systems should not increase the level of flood waters either upstream or downstream of the site.
					Regulations should require conservative estimates of seasonal high groundwater elevations when determining the amount of compensating storage for encroachment into the floodplain.
					During permitting, consider cumulative impacts of increased runoff volume in the watershed.
					Include inspection of stormwater management systems for integrity of impoundments, embankments, and other components of the system in current enforcement and inspection programs.

LEMON BAY WATERSHED MANAGEMENT PLAN
Existing Goals, Objectives, and Recommendations

Flooding					
Plan	**Year**	**Agency**	**Goal**	**Objective / Strategy**	**Recommendations**
Southern Coastal Comprehensive Watershed Management Plan	2004	Southwest Florida Water Management District	Minimize potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood prone areas. The District shall give preference wherever possible to nonstructural surface water management methods.	Strategy: Link water resource planning and land use planning.	Encourage local governments to establish levels of service for current (present) and targeted (build-out) conditions for the watershed's stormwater management infrastructure facilities for flood protection using methods developed by the Stormwater Level of Service (LOS) Conventions Committee.
					Assist local governments in using LOS criteria in their comprehensive plans to measure the watershed's current flood management capacity. Cooperate with FOOT and local governments on the design of roads. The roads should be designed to meet LOS. Signage programs, including flood elevation levels, could be developed to warn drivers of flooding conditions.
					Back legislation to require deeds or other documents for real estate to indicate if land is in a floodplain.
					Determine and establish appropriate setbacks from riparian systems for any structure (i.e., landward of 100-year flood plain) or some distance from 10-year flood plain or wetland boundaries.
					Coordinate with local and county governments to limit densities in floodplains.
					Encourage current open land uses (i.e., agricultural, recreational corridors) in floodplain to remain instead of land uses that allow alterations to the floodplain.
					Encourage conservation easements, green ways, and the efficient use of the required stormwater management storage, and placement of mitigation areas within existing flood prone areas.
					Promote clustering of development outside the floodplain.
					Encourage the use of density credits to cluster development outside flood plains, incentive-based regulation.
				Strategy: Adequately plan for future flood protection efforts.	Convince local governments that the entire watershed should be examined using a flood prone area analysis.
					Encourage local governments to inventory existing drainage systems.
					Encourage local governments to set goals for flood protection based on a consistent LOS policy.
					Incorporate other planning elements in the Stormwater Management Plan method, i.e., transportation, major developments of regional significance, greenway/wildlife corridors, recreation/parks, agricultural development, water supply, and environmental management.
					The Districts requirements for Stormwater Management Plans should develop a consistent framework for management throughout the watershed.
					Pursue special development codes for building construction in floodplains (i.e., no fill for house pads in floodplains, signage required for depth of flooding, etc.).
				Strategy: Determine ownership, operation and maintenance responsibilities for flood management systems.	Determine the ownership of identified stormwater management systems.
					Determine the responsible entity for operation and maintenance of identified stormwater management systems.
					Develop operation and maintenance plans for the flood management systems within the watershed. This includes developing strategies for maintaining and operating the systems, obtaining easements or ingress and egress agreements with property owners, and naming the governments or other responsible parties to complete the work.
				Strategy: Seek consistent source(s) of funding for flood management systems.	Alternatives to general revenue sources should be considered for funding of stormwater projects.
					Encourage the establishment of stormwater management utility fees.
					Encourage the establishment of special assessment districts
					Encourage contributions to regional facilities developed based on a Stormwater Management Master Plan.
					Develop an educational program implemented by the District for county and local governments that illustrate the available funding.
					Encourage cooperative projects or piggyback scenarios where many agencies contribute to a project developed through a watershed-wide study. Possibly provide credits for developers, roadway improvements (FDOT, Counties, Cities) who tie into regional projects that provide efficient stormwater quality and quantity storage, wetland mitigation, and protection of the floodplain and its function. Provide mechanisms for maintenance and operation funding.

LEMON BAY WATERSHED MANAGEMENT PLAN

Existing Goals, Objectives, and Recommendations

Flooding

Plan	Year	Agency	Goal	Objective / Strategy	Recommendations
Southern Coastal Comprehensive Watershed Management Plan	2004	Southwest Florida Water Management District	Minimize potential for damage from floods by protecting and restoring the natural water storage and conveyance functions of flood prone areas. The District shall give preference wherever possible to nonstructural surface water management methods.	Strategy: Facilitate public education and understanding of flood protection are necessary in order to build support for stormwater management projects or programs that protect the natural floodplain and its function.	Educate public and elected officials that developments are often designed to flood relatively frequently (based on a probability of occurrence of a storm event), based on the level of service provided.
					Educate the public on the hydrologic cycle and its interaction with the water resource and the impacts on water use.
					Educate the public and elected officials that restricting development in the flood plain may result in significant monetary savings and enhance natural systems in the future.
					Clarify District flood protection responsibilities.
					Clarify the role of FEMA and their responsibilities and contribution to flood protection.
					Promote cooperation between the responsible jurisdictions on flood protection issues.
					Provide educational talks to technical groups.
Lemon Bay Interagency Comprehensive Watershed Management Plan	2004	Lemon Bay League	To prevent and mitigate the losses, cost, and human suffering caused by flooding; and to protect natural and beneficial functions of the floodplain.	Determine the depth and extent of area susceptible to riverine flooding.	Development of watershed budgets.
					Complete flood studies.
					Continuously update flood studies.
					Flood reporting program.
				Protect existing and future residents from flood damage.	Development of watershed budgets.
					Complete flood studies.
					Continuously update flood studies.
					Implementation of stormwater improvement program.
					Development of local flood mitigation program.
					Primary drainage system maintenance program.
					Secondary drainage system maintenance program.
					Use cost effective analysis to monitor stormwater improvement program.
					Develop strategies to address future development in the floodplain.
					Flood reporting program.
				Develop and implement cost effective management strategies to protect the natural functions of the floodplain.	Complete flood studies.
					Continuously update flood studies.
					Development of local flood mitigation program.
					Hydrologic restoration program.
					Develop strategies to address future development in the floodplain.
					Flood reporting program.

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Natural Systems		
Goal	**Objective**	**Policy**
Protect, maintain and, where deemed necessary in the public interest, restore the barrier island, beach, and estuarine systems of Sarasota County. (Chapter 2, Environmental Goal 1)	Construction activities on or off the shore of the barrier islands shall not detrimentally impact the barrier island system. (Environmental Objective 1.1)	Enforce Sarasota County Ordinances pertaining to construction seaward of the County's Gulf Beach Setback Line and Barrier Island Pass Hazard Line. (ENV Policy 1.1.1)
		Hardening of Gulf beaches or passes shall be prohibited unless such hardening has been found to be in the public interest. A hardening project that is determined to be in the public interest shall not impact lateral public pedestrian access, and shall minimize adverse impacts to coastal processes and resources, neighboring properties, and the values and functions of beaches and dune systems, and provide mitigation where determined by the Board of County Commissioners to be appropriate. Permanent disruptions to natural coastal processes and long-term erosion impacts shall be considered in deliberations. (ENV Policy 1.1.2)
		The County shall discourage offshore petroleum development activities and will not favorably consider rezoning or other governmental actions to provide ancillary support facilities onshore. (ENV Policy 1.1.3)
		In order to restore barrier island coastal processes and beach habitat, existing derelict shore protection structures located seaward of a beach nourishment project's Erosion Control Line (ECL) shall be removed where practicable. (ENV Policy 1.1.4)
		Notwithstanding any other policies or principles for evaluating development proposals that would conflict with the construction of a County Coastal Restoration Project, the Board of County Commissioners may approve and construct a County Coastal Restoration Project, provided the Coastal Restoration Project satisfies the following criteria: (1) Impacts to environmental resources shall be minimized and mitigated in accordance with County, state and federal permitting requirements (where these requirements conflict, the more stringent requirements shall be followed); (2) Impacts to lower quality habitats and resources shall be considered and used in the project before impacts to higher quality habitats and resources are considered and used. For purposes of this policy, a County Coastal Restoration Project shall be a County-initiated and managed: inlet restoration, spoil island restoration, waterways maintenance, beach nourishment, or dune restoration project. (ENV Policy 1.1.5)
	Exceed the current acreage of public beaches and dunes through the year 2020 in accordance with policies established in the Parks and Recreation Plan. (ENV Objective 1.2)	Fund the County's beach/dune protection and restoration program applicable to all County owned Gulf shoreline properties.(ENV Policy 1.2.1)
		Protect beaches, dunes and coastal vegetation from vehicular traffic and pedestrian traffic by providing vehicular parking, dune walkovers and by encouraging bicycle use through the provision of bicycle paths and storage racks. (ENV Policy 1.2.2)
		By 2009, develop a Beach and Inlet Management strategy with a monitoring program for Sarasota County, incorporating regional coordination and interaction, to: assess the nature and extent of coastal erosion; monitor the effectiveness of beach restoration programs determine the effect of storm events on sand movement; identify dominant coastal processes which would aid in evaluating permit applications and coastal decision making; incorporate the long-term effects of sea level rise within the management policies; identify the impacts of modified inlets on historic erosion rates; identify beach segments with common erosion/accretion histories; recommend beach management strategies for each segment, including maintenance; identify potential impacts to existing environmental conditions; identify and assess impacts to marine habitats and wildlife; ensure beach management strategies are environmentally sound; and develop a long term strategy for areas of chronic erosion. (ENV Policy 1.2.3)
	Maintain existing access to Gulf and bay waters for a variety of water dependent activities and if necessary, provide for additional access where feasible. (ENV Objective 1.3)	Extend every effort to increase the number of public beach access points and parking spaces. (ENV Policy 1.3.1)
		When coastal development is proposed, provision will be made for lateral public beach access to the wet sand beach where beach hardening practices are proposed. (ENV Policy 1.3.2)
		The County will identify areas suitable for water-dependent/water-related uses and develop and implement techniques to encourage development and expansion of such uses in these areas provided such uses will not degrade environmental resources. The County will discourage any conversion of water-dependent uses to non water-dependent uses, and shall prohibit conversion when land use changes reduce or eliminate public accessibility and recreation on waterways. The County will develop incentives for water dependent/water-related businesses to maintain their current use. (ENV Policy 1.3.3)
		Encourage the construction of dry dock storage as compared to wet slip docking facilities and encourage this storage upland of the Gulf and bay shorelines. (ENV Policy 1.3.4)
		The expansion of existing boating facilities in suitable areas shall be permitted preferentially to the construction of new facilities. New and expanded motorized boating facilities shall not be located in or adjacent to areas of significant manatee habitat and travelway as defined by the Manatee Protection Plan Implementation Code (MPPIC). No new motorized boating facilities shall be allowed within the Pansy Bayou and the Warm Mineral Springs and Creek. (ENV Policy 1.3.5)
		New construction and expansion of marine facilities of five slips or greater, shall be as defined in the Boat Facility Siting Plan (BFSP) contained within Sarasota County's Manatee Protection Plan and existing county code. Construction or expansion of boat ramps shall also be as defined by the BFSP. Amendments to the Boat Facility Siting Plan, shall be implemented by action of the Board of County Commissioners. (ENV Policy 1.3.6)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Natural Systems		
Goal	**Objective**	**Policy**
Protect and enhance wherever possible, the quality of the estuarine environment throughout Sarasota County. (Chapter 2, Environmental Goal 2)	Improve surface water quality including estuarine, freshwater, coastal streams, rivers, and bays, including the Myakka River and its tributaries. (ENV Objective 2.1)	Conduct a baseline assessment of water quality in County coastal streams, bays, and estuaries including the Myakka River and its tributaries. The County shall review waterways as per their designated use as outlined in Rule 62-302.400, F.A.C, identify impaired water bodies in the County, and develop restoration plans for those waters by 2009. (ENV Policy 2.1.1)
		Prohibit dredge and fill activities in the Gulf of Mexico, bays, rivers, and streams of the County except to maintain previously dredged and existing drainage canals. All new environmentally sound navigation channels and beach nourishment projects require approval by the Board of County Commissioners and must be determined to be in the public interest. The dredging of new navigation channels other than those just described shall be prohibited. (ENV Policy 2.1.2)
		Orient boating activities to suitable areas away from sensitive habitats, and restrict boat access in areas of marginal navigability in order to prevent bottom scour or damage to sensitive habitats. (ENV Policy 2.1.3)
		Sewage pump out facilities shall be required for new marinas and existing marinas whenever slips are added if they are served by central sewer. Marinas which sell petroleum and other such products shall provide adequate fuel spill containment devices in accordance with state and federal regulations. The County shall require all new marinas and, where feasible, existing marinas proposing expansion to obtain a Florida Clean Marina designation from the Florida Department of Environmental Protection. (ENV Policy 2.1.4)
		Monitoring surface water quality during the development activities of projects of significant impact as determined by Water Resources. This program, in conjunction with the NPDES permit program, will facilitate the monitoring of cumulative impacts of development on stormwater runoff and water quality. (ENV Policy 2.1.5)
	Increase the area and improve the habitat quality of coastal wetlands and marine resources. (ENV Objective 2.2)	Maintain a program of water quantity and quality data collection and analysis for estuarine areas. Coordinate with existing programs that perform biological and water quality data collection and analyses in Sarasota County and evaluate results to determine what further study is necessary. (ENV Policy 2.2.1)
		Develop and implement spoil island restoration plans in cooperation with state and regional agencies. (ENV Policy 2.2.2)
		Restore coastal wetlands and habitat including submerged aquatic vegetation through revegetation projects, shoreline softening, and management of mosquito-ditched mangroves. Where necessary, appropriate native coastal habitat restoration planting and enhancement projects shall be required in development orders authorizing shoreline hardening. (ENV Policy 2.2.3)
		Utilize the County's regulatory authority to restore damaged wetlands to their natural state. (ENV Policy 2.2.4)
		The County should participate in the Gulf of Mexico Alliance discussions on the health and restoration of the Gulf, especially the eastern portions. The County shall cooperate in advancing the understanding of system dynamics and the Board of County Commissioners shall consider relevant initiatives for support. (ENV Policy 2.2.5)
		Maintain a program of coastal systems data collection and analysis to assist in the protection of natural systems and in long-range, post-disaster planning. Coordinate with existing programs to ensure appropriate ecological data is available for required data analyses. (ENV Policy 2.2.6)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Natural Systems		
Goal	**Objective**	**Policy**
It shall be the Goal of Sarasota County, as a member of the Sarasota Bay and Charlotte Harbor National Estuary Programs to support the implementation of their regional Comprehensive Conservation and Management Plans (CCMP) to restore and improve the natural estuarine systems and related coastal components. (Chapter 2, Environmental Goal 3)	Participate in intergovernmental processes designed to pursue the goals and objectives of the Sarasota Bay and Charlotte Harbor Management Plans. (ENV Objective 3.1)	Participate in local, state, or federal scientific modeling of Sarasota Bay and Charlotte Harbor to determine the cumulative impact of development on the water resources of the harbor, bay, springs and Myakka River. (ENV Policy 3.1.1)
		Support the implementation of the Florida Department of Environmental Protection Lemon Bay Aquatic Preserve Management Plan. (ENV Policy 3.1.2)
Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County. (Chapter 2, Environmental Goal 4)	Identify, manage, and protect all ecological communities, habitat corridors and wildlife, especially critical habitats and endangered, threatened, and species of special concern identified in official federal, state, or international treaty lists. (ENV Objective 4.4)	Review all development proposals for consistency with the "Principles for Evaluating Development Proposals in Native Habitats" as required by the Land Development Regulations (Ordinance No. 81-12, as amended). (ENV Policy 4.4.1)
		Development and infrastructure shall be configured or designed to optimize habitat connectivity, minimize habitat fragmentation, and minimize barriers to wildlife movement. Where deemed necessary by the County, configuration shall include artificial corridor components. (ENV Policy 4.4.2)
		By 2009, Sarasota County shall complete an updated native habitat land cover map and risk assessment study for each native habitat identified within the Comprehensive Plan. Current standards for native habitat impacts contained within "Principles for Evaluating Development Proposals in Native Habitats" shall be evaluated against this assessment for their validity. Remnant native habitats contained within urban areas shall be included within this analysis along with alternatives to the use of regulatory powers to encourage restoration and protection of native habitats that are threatened due to current land use practices. (ENV Policy 4.4.3)
		The County shall coordinate with state and federal agencies and shall support implementation of protection guidelines relating to listed species. Unless precluded by state or federal laws, the County may adopt more stringent regulations where deemed appropriate. The County will encourage effective communication between federal, state agencies, local organizations and the public regarding protected species and the ecological implications of projects proposed within the County. (ENV Policy 4.4.4)
		Require development order applicants to consult with the appropriate agencies, to use recognized sampling techniques to identify listed species, and to provide documentation of such coordination and compliance prior to County approval to conduct any activities that could disturb listed species or the habitat. (ENV Policy 4.4.5)
		Special measures shall be taken to protect sea turtles. (ENV Policy 4.4.6)
		The County shall coordinate with the West Coast Inland Navigation District (WCIND) and other state and federal agencies to ensure that areas of critical manatee habitat, including the Myakka River, are posted and maintained as manatee protection zones pursuant to state law. (ENV Policy 4.4.7)
		Development shall not adversely impact the manatee. (ENV Policy 4.4.8)
		Sarasota County shall complete a Habitat Conservation Plan (HCP) for the Florida Scrub-jay. Upon completion of the HCP, the County will apply for an Incidental Take Permit (ITP) under the Endangered Species Act from the United States Fish and Wildlife Service. Upon acceptance of an ITP by the Board of County Commissioners, Scrub habitats and Scrub-jay areas shall be protected to establish a Scrub-jay preserve as designed within the HCP and to comply with any stipulations set forth in the permit. Development orders covered by the HCP shall be consistent with the HCP and shall preserve Scrub habitats and Scrub species. (ENV Policy 4.4.9)
		By 2007, the County shall evaluate the effects of pre-clearing of native habitats, characterize the problem, and develop a strategy, which may include new regulations, to avoid the loss of native habitat function and value. (ENV Policy 4.4.10)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Natural Systems		
Goal	**Objective**	**Policy**
Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County. (Chapter 2, Environmental Goal 4)	Preserve a network of habitat connectivity across the landscape that ensures adequate representation of native habitats suitable to support the functions and values of all ecological communities. (ENV Objective 4.5)	When land development involves the conversion of native habitats, the County's open space requirements shall be fulfilled first with habitats required to be preserved, then with habitats that should be conserved, then with other allowable types of open space. Open space shall be determined by applying the "Principles for Evaluating Development Proposals in Native Habitats," and shall focus on maintaining a network of connectivity throughout the landscape, favoring higher functioning habitat areas. Planted and maintained littoral zones may be credited toward the open space requirement as permitted by the County zoning regulations. The County may consider alternatives to conserved habitats or other allowable open space that clearly demonstrate, through planned development designs and environmental management plans, greater native habitat function and value and connectivity. (ENV Policy 4.5.1)
		Sarasota County shall implement the Land Management Master Plan and develop site-specific management plans for protected environmental lands within the County. (ENV Policy 4.5.2)
		Lands purchased for primarily environmental reasons shall be managed consistent with Sarasota County's Land Management Master Plan and individual site plans for specific sites. (ENV Policy 4.5.3)
		The County shall develop a strategy to ensure open space, as required through development review, contributes effectively to other environmental greenway programs. Selection of open space acreage shall favor factors such as onsite and adjacent off-site habitat connectivity. (ENV Policy 4.5.4)
		The County shall evaluate the ecological implications of future infrastructure improvement projects early in the planning process to ensure adequate protection of habitat connectivity, hydrological impacts, and wildlife and to allow for modification or abandonment of environmentally poor alignments. The County will assess the cumulative effects of proposed infrastructure projects to ensure that significant ecological linkage areas are protected and that pubic interest is adequately addressed. The County will give priority to social, historic, and environmental issues over engineering issues to ensure an environmentally sound transportation system. (ENV Policy 4.5.5)
		The County shall evaluate open space and native habitat protection strategies and, by 2007, adopt an amendment to the Land Development Regulations that achieves compliance with environmental goals. Particular focus shall be placed on the establishment or maintenance of a network of habitat connectivity, favoring higher functioning habitat areas. (ENV Policy 4.5.6)
		The Future Land Use Map Series shall be maintained to show the location of areas of high ecological value as identified by staff and approved by the Board of County Commissioners. (ENV Policy 4.5.7)
		Develop mechanisms to acquire and physically link natural areas into a contiguous system or otherwise protect environmentally significant lands through a voluntary program (Environmentally Sensitive Lands Protection Program). Coordinate County resources with state programs and with groups such as The Nature Conservancy and the Trust for Public Lands. Priority should be given to acquiring and otherwise protecting properties which are adjacent to or in close proximity to existing preservation and conservation areas and public resource lands, with emphasis on maintaining opportunities for a regional greenways system that may include a mix of flow ways, areas subject to flooding, native habitats, recreational trails, and wildlife corridors. (ENV Policy 4.5.8)
		The County shall develop mechanisms to acquire and physically link natural areas into a contiguous system, or otherwise protect and enhance urban green space through a voluntary program and coordinate County resources with State programs and groups focused on similar community outcomes. Priority should be given to acquiring and otherwise protecting properties which are adjacent to or in close proximity to existing preservation areas, with emphasis on maintaining opportunities for a regional greenways system that may include a mix of flow ways, areas subject to flooding, native habitats, recreational trails, and wildlife corridors. (ENV Policy 4.5.9)
		Sarasota County shall continue establishing incentive programs for landowners to protect the naturally beneficial features of the lands identified as having high ecological value, pursuant to Policy 4.5.2., rather than emphasizing reliance upon regulatory police power authority. These additional incentives shall utilize a full range of techniques as appropriate (including, but not limited to, tax incentives and provisions for variable lot sizes in rural areas) without increasing densities. (ENV Policy 4.5.10)
		The development review process shall require the identification of potential conservation and preservation area habitats in those areas which have the potential of becoming incorporated into an overall natural areas network through the voluntary incentive program. (ENV Policy 4.5.11)
		The clustering of residential developments or the implementation of other measures to first avoid, then minimize, and then mitigate adverse environmental impacts, shall be required whenever areas of significant native habitats are involved. (ENV Policy 4.5.12)
		Encourage the use of cluster and planned development that preserves and protects habitats in open space, and encourage development forms that provide enhanced open space preservation and protection of habitats in all zoning districts. (ENV Policy 4.5.13)
		The County shall implement and update, where necessary, guidelines in the Land Development Regulations (LDR), Zoning Ordinance, and/or other existing regulations which regulate development and specify the necessary design standards to protect environmentally significant/sensitive areas (for example, barrier islands, floodplains, watersheds, and water recharge areas) and on properties adjacent to Public Conservation/Preservation Lands. (ENV Policy 4.5.14)
		The County shall protect mangroves to the fullest extent allowed by County and State law. (ENV Policy 4.5.15)
		Maintain and promote rural and natural resource land management practices, such as prescribed burning, including a requirement that all new development in the rural areas or areas adjacent to Public Conservation/Preservation Lands shall, as part of the development review process, recognize and protect existing rural and natural resource land management practices. (ENV Policy 4.5.16)
		Protect the natural diversity, processes, and functions of natural communities in the public resource lands including Myakka River and Oscar Scherer State Parks, and Myakka State Forest. Coordinate with other government agencies to maintain and enhance soils, groundwater, surface and subsurface waters, shorelines, vegetative communities, and wildlife habitats within these management areas. (ENV Policy 4.5.17)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Natural Systems

Goal	Objective	Policy
Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County. (Chapter 2, Environmental Goal 4)	Preserve a network of habitat connectivity across the landscape that ensures adequate representation of native habitats suitable to support the functions and values of all ecological communities. (ENV Objective 4.5)	Native habitats set aside in preservation and conservation areas shall be managed in accordance with resource management plans, which are subject to review and approval by the County through the development review process, to ensure maintenance and, if necessary, enhancement of the functions and values of these native habitats in perpetuity. The County shall encourage and provide incentives for the maintenance and enhancement of privately-owned preservation and conservation areas set aside prior to the County's requirement to provide a resource management plan. (ENV Policy 4.5.18)
		The amount of wetland mitigation required will be based upon the most current state-approved methodology. (ENV Policy 4.5.19)
		Policy 2.1.2. of the Future Land Use Chapter shall include Figure 2-10: Sites of High Ecological Value, and Figure 2-9: Ecological Strategy Map, in Unincorporated Sarasota County as part of the Future Land Use Map Series. (ENV Policy 4.5.20)
	Coordinate future land uses and provision of urban services with the protection of environmental resources. (ENV Objective 4.8)	Land uses and land and water development shall be consistent with and governed by the environmental values and functions of Sarasota County's native habitats in accordance with the "Principles for Evaluating Development Proposals in Native Habitats." (ENV Policy 4.8.1)
		The County shall continue to require planted littoral zones to provide water quality treatment for surface waters and wildlife habitat. (ENV Policy 4.8.2)
Sarasota County shall provide programs which enhance, protect and conserve the hydrologic and ecological functions of natural systems including estuaries, freshwater and groundwater systems (Chapter 4, Water Goal 2)	Address the maintenance of existing facility capacity and ensure the adequacy of facilities to meet future needs. (Water Objective 2.1)	As the County develops stormwater management facilities, all facilities shall be developed with consideration for aesthetics and the possibility of incorporation into the County park system. (Water Policy 2.1.6)
		The County shall support creation of Watershed Management Plans, including the Lemon Bay Watershed, that include holistic management practices of the watershed to protect the health of the surface waters. (Water Policy 2.1.7)
Potable water service shall be provided to Sarasota County residents through the continual evolution of a centralized regional supply, treatment, and distribution system, and shall be provided in a safe, efficient, economical, sustainable, and environmentally sound manner concurrent with urban development. (Chapter 4, Water Goal 3)	Protect the functions of natural groundwater recharge areas and natural drainage features. Water Objective 3.4)	Sarasota County will protect its potable water supply system, contributing recharge areas, and related open space benefits through implementation of its Wellhead Protection Ordinance which shall identify inappropriate land uses and facilities including, but not limited to, underground fuel storage tanks, landfills, hazardous materials storage, and certain commercial and industrial uses. The County's Wellhead Protection Ordinance will be amended, as needed, for consistency with the Florida Department of Environmental Protection's rule governing wellhead protection adopted in May 1995. The protection effort may include requests to the Southwest Florida Water Management District for cooperative funding or technical assistance to further identify zones of protection and cones of influence around individual wellheads or well fields. (Water Policy 3.4.1)
		Usage and maintenance of potable water resources on the T. Mabry Carlton, Jr. Memorial Reserve shall be in accordance with the Environment Plan and monitoring requirements contained in the Southwest Florida Water Management District Water Use Permit for the well field, which requires that the County continue to monitor and assess any variations in the hydro period of wetlands, various aquifers, and flora and fauna. (Water Policy 3.4.2)
Preserve, protect and restore the integrity of the natural environment, historic and archeological resources, neighborhoods and preserve agricultural uses consistent with resource protection (Chapter 9, FLU Goal 1)	Protect environmentally sensitive lands, conserve natural resources, protect floodplains, maintain or improve water quality, and open space, and conserve and protect historic and archeological resources. (FLU Objective 1.1)	All development proposals must conform to the appropriate portions of the Environment Chapter's Primary Components and Guiding Principles before such proposals can be considered to be consistent with the Future Land Use Plan. (FLU Policy 1.1.1)
		Sarasota County will coordinate efforts to acquire public lands for conservation, preservation, and open space. (FLU Policy 1.1.8)
		Any new Public Conservation and Preservation Area, preserved /acquired pursuant to Policy 4.5.2. and 4.5.3. of the Environment Chapter, shall have all buffering and land use compatibility strategies incorporated to the extent feasible and finalized prior to the closing. (FLU Policy 1.1.10)
		Normal management practices associated with maintaining and restoring native habitats such as controlled burning within public and private Conservation/Preservation areas shall be permitted. (FLU Policy 1.1.11)
		Preserve and protect agricultural lands. (FLU Objective 1.3)
Coordinate future land uses with environmental characteristics and the availability of facilities, and ensure that sufficient acreage is designated for urban uses to accommodate the projected population growth. (Chapter 9, FLU Goal 2)	Coordinate land use designations with soil and topographic characteristics, the protection of historical and natural resources, existing land uses, forms of development, and the availability of public facilities. (FLU Objective 2.1)	The preparation of the Future Land Use Map shall take into consideration the projects included in the Five Year Schedule of Capital Improvements and Future Capital Improvements – 2025. (FLU Policy 2.1.1)

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Sarasota County Planning Department

Water Quality

Goal	Objective	Policy
Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County. (Chapter 2, Environmental Goal 4)	Protect the quality and quantity of all jurisdictional waters, recognize the ongoing study efforts, and ensure that the current water quality in the County be improved through the year 2010. (ENV Objective 4.2)	Utilize the County's regulatory authority to encourage shoreline softening rather than shoreline hardening practices. Where practical, shoreline planting and enhancement projects shall be required during development orders proposing shoreline hardening in accordance with Policy 2.2.3. Require effective vegetative buffer zones for all new construction adjacent to watercourses, wetlands, and bays. (ENV Policy 4.2.1)
		Support the efforts and consider recommendations from intergovernmental organizations concerning Sarasota's bays, the Myakka River watershed, and the Braden River watershed. (ENV Policy 4.2.2)
		Enforce the Myakka River Protection Zone regulations and all other County regulations designed to protect the Myakka River and the wild and scenic nature of the River. (ENV Policy 4.2.3)
		Mining activities (as defined by County Ordinance) are not permitted or permissible under the County zoning regulations within designated areas of special environmental significance and/or sensitivity. The watersheds of Cow Pen Slough and the Myakka River, including the tributaries of the Myakka River, are designated areas of special environmental significance. (ENV Policy 4.2.4)
		The County shall monitor and assess any variations in the hydroperiod of wetlands, various aquifers, and flora and fauna located on the T. Mabry Carlton Jr., Memorial Reserve in accordance with the provisions of Ordinance No. 82-94. (ENV Policy 4.2.5)
		Require Best Management Practices, as provided in the County's Earthmoving Ordinance, for conversion of native habitat to agricultural land uses, consistent with state and federal recommended standards, to reduce pesticides, fertilizer, and soil erosion. (ENV Policy 4.2.6)
Sanitary sewer service shall be provided to Sarasota County residents through the continual evolution of a centralized regional wastewater collection and treatment system, and shall be provided in a safe, clean, efficient, economical, and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 1)	Continue to correct existing wastewater facility deficiencies, and coordinate the acquisition, extension, and construction of, or increase in the capacity of, facilities to meet future needs. (Water Objective 1.1.)	A list of all wastewater treatment plants, both public and private, shall be maintained which includes, but is not limited to, the following: entity having operational responsibility, current rated plant capacity, existing treatment status (number and type of hookups), and all future committed capacity (number and type of hookups). (Water Policy 1.1.1)
		The Utilities Department shall continue to identify existing Sarasota County Utilities System facility deficiencies, as well as address implementation activities for establishing priorities for replacement and correction of existing facility deficiencies. (Water Policy 1.1.2)
		Consistent with the requirements in the Capital Improvements Plan, projects needed to correct existing deficiencies within the Sarasota County Utilities System shall be given priority in the formulation and implementation of the annual work schedules or programs of the Sarasota County Utilities Department. (Water Policy 1.1.3)
		The County shall continue implementation of the Franchise Acquisition, Consolidation, Implementation Plan – Wastewater Collection, Treatment, and Reuse Master Plan Wastewater Management Plan, which provides an engineered master plan for providing wastewater service to the unincorporated areas of Sarasota County concurrent with urban development and land use planning. (Water Policy 1.1.4)
		The Wastewater Management Plan shall be updated as acquisition and consolidation efforts warrant and as continuing engineering activities progress. (Water Policy 1.1.5)
		The County shall continue its on-going planning and engineering activities for providing central wastewater systems or alternative onsite systems to critical areas in the Urban Service Area currently served by onsite wastewater treatment and disposal systems. (Water Policy 1.1.6)
		The County shall prohibit the installation of onsite wastewater treatment and disposal systems in the areas designated Urban Service Area and Barrier Island on the Future Land Use Map Series, unless the installation and use shall not adversely affect the the quality of groundwater or surface water or adversely affect the natural function of floodplains as required by the provisions of the County Land Development Regulations (Ordinance No. 81 12, as amended); Ordinance No. 83-83 and Chapter 10D-6 F.A.C, regulating design, construction, installation, utilization, operation, maintenance, and repair of individual onsite wastewater treatment and disposal systems, as amended; and any more stringent regulations applicable. Further, the County shall require that all buildings served by onsite wastewater treatment and disposal systems, except approved onsite greywater systems, connect to a publicly-owned or investor-owned sewerage system within one year of notification by the County that such a system is available as defined in Chapter 10D - Section 6.042, Florida Administrative Code.
		As the County consolidates wastewater treatment plants, all facilities shall be developed with consideration for aesthetics and the possibility of incorporation into the County park system. (Water Policy 1.1.6)
	Maximize the use of existing and available central wastewater facilities and new facilities when they are constructed, and discourage urban sprawl. (Water Objective 1.2)	The County shall continue to require new development to connect to central wastewater systems consistent with the requirements contained in the Land Development Regulations based on the size of the development and distance to the existing system, the available capacity in the system, and the utility's rules allowing connection to the system. (Water Policy 1.2.1)

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Sarasota County Planning Department

Water Quality

Goal	Objective	Policy
Sanitary sewer service shall be provided to Sarasota County residents through the continual evolution of a centralized regional wastewater collection and treatment system, and shall be provided in a safe, clean, efficient, economical, and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 1)	Continue to explore and use alternative and supplemental water resources to conserve and replace the use of traditional potable water supplies. (Water Objective 1.3)	The County shall continue implementation of the reuse policies in the Wastewater Management Plan in order to reduce the demand on potable water supplies and withdrawals from ground water aquifers. (Water Policy 1.3.1)
		The County shall reclaim treated wastewater for irrigation purposes as its primary method of disposal for treated wastewater. The use of deep well injection or surface water discharge shall be used only when opportunities to use reclaimed water for irrigation is not available. (Water Policy 1.3.2)
	Protect the functions of natural ground water recharge areas, natural drainage features, and surface water bodies. (Water Objective 1.4)	The wastewater treatment plant inspection and compliance monitoring program shall continue. All wastewater treatment plants shall be monitored as outlined in the DEP Specific Operating Agreement. (Water Policy 1.4.1)
		The County shall continue to provide a program to ensure that septage and sludge are received and disposed of in an environmentally sound manner. (Water Policy 1.4.2)
		All sludge disposal sites and facilities shall be authorized, specifically identified, monitored, and routinely inspected for compliance with State and County regulations. (Water Policy 1.4.3)
		Sarasota County regulations for the disposal and use of septage and sludge shall provide for their efficient and beneficial use and prevent adverse environmental impacts. Land spreading and disposal of sludge shall be allowed only in areas that will not adversely impact groundwater resources and watersheds that drain into surface water supplies (which are used to meet potable water supply needs), recharge areas of a public water system, and/or Outstanding Florida Waters. The land spreading of septage shall be prohibited within the County. (Water Policy 1.4.4)
	Ensure that the issuance of development permits shall be conditioned upon adequate sanitary sewer service capacity. (Water Objective 1.5)	No construction permit shall be issued for new development which will result in an increase in demand upon deficient wastewater treatment facilities prior to the completion of improvements needed to bring the facility up to adopted level of service standards, unless provided for by existing State and County laws. (Water Policy 1.5.1)
		Issuance of development orders for any site proposing to utilize an onsite wastewater treatment and disposal system shall be contingent upon demonstration of compliance with applicable federal, State, and local permit requirements. Soil surveys shall be required for onsite wastewater treatment and disposal system permits. No individual onsite systems shall be permitted where soil conditions indicate that the system would not function without degrading water quality or where land alterations necessary to accommodate the system would interfere with drainage or floodplain functions. (Water Policy 1.5.2)
		Sanitary Sewer Level of Service: (1) Minimum average daily flow to be treated from domestic units shall be 200 gallons per Equivalent Dwelling Unit per day; and (2) Wastewater effluent shall meet standards defined by state law, permit requirements of the Florida Department of Environmental Protection, and County Ordinance when discharged to groundwater or surface water in the County. (Water Policy 1.5.3)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Water Quality

Goal	Objective	Policy
Sarasota County shall provide programs which enhance water quality where appropriate (Chapter 4, Water Goal 2)	Address the maintenance of existing facility capacity, and ensure the adequacy of facilities to meet future needs. (Water Objective 2.1)	The County shall continue to operate a Stormwater Environmental Utility to provide for monitoring, maintenance, and improvement of the County's stormwater management system. The Utility shall continue cooperation with the municipalities, other appropriate governmental agencies, and public and/or private utilities, which will implement the CWM Plan. Replacement and correction of existing facility deficiencies as well as providing for future facility requirements shall be identified and prioritized for inclusion in the County's Capital Improvement Program. (Water Policy 2.1.1)
		The County and private developments shall monitor and maintain stormwater management and conveyance facilities to ensure that the stormwater facilities are adequately maintained and functioning in compliance with design requirements. (Water Policy 2.1.2)
		The County shall continue to fund the continuous maintenance of watershed maps and models for each drainage basin in the County through the Basin Master Planning Program to provide a basis of review for new development and other watershed alteration proposals as well as assure that stormwater management facilities are developed to attain the adopted level of service. Implementation of all detailed master plans shall be completed by 2001. Each detailed master plan shall be developed, in accordance with the Basin Master Plan Schedule, as a Sarasota County inter-department effort to ensure consideration of natural drainage functions. Basin master plans shall be developed in cooperation with the municipalities and adjacent Counties to address stormwater quality and quantity problems in basins crossing more than one political boundary. Each plan shall be designed to protect downstream and estuarine water from degradation by stormwater runoff. Each basin plan shall define the level of service and develop a cost-effective capital improvements program. As each basin plan is completed, the comprehensive plan, including the Capital Improvements Plan, shall be amended to incorporate and reflect the stormwater management facility improvements identified in the basin plan. (Water Policy 2.1.3)
		The County shall pursue providing regional stormwater management facilities, including those that could take the place of site-specific attenuation facilities. These regional facilities should be developed by the County and, when appropriate, funded by development in lieu of construction of onsite, private attenuation facilities. Water quality treatment facilities should be located onsite to promote source control of pollutants before they enter the County stormwater system. (Water Policy 2.1.5)
	Protect the functions of natural groundwater recharge areas and natural drainage features by providing for the maintenance of existing, and where feasible the restoration of the pre-development, water budgets to historical watercourses (as identified by the original United States General Land Office Township Plats from the Mid to Late 1800's). (Water Objective 2.2)	The County shall implement its Watershed Management Plan consistent with the National Pollutant Discharge Elimination System (NPDES) permit issued to the County by FDEP. The Comprehensive Stormwater Quality Program shall provide for management and control of stormwater runoff to reduce pollution at the source and discharge of pollutants into receiving waters from the County's stormwater system to the maximum extent possible. (Water Policy 2.2.1)
		The County shall require that the treatment of stormwater discharge meet standards which will ensure that there will not be adverse impacts on the quality of natural surface waters. (Water Policy 2.2.2)
		New development in the 100-year floodplains shall be consistent with all other Goals, Objectives, and Policies of the Sarasota County Comprehensive Plan. (Water Policy 2.2.3)
	Ensure that development and redevelopment provides for adequate stormwater management. (Water Objective 2.3)	No permit shall be issued for new development which will result in an increase in demand upon deficient stormwater facilities prior to the completion of improvements needed to bring the facility up to adopted level of service standards. (Water Policy 2.3.1)
		Stormwater Level Of Service: Stormwater Quality: no discharge from any stormwater facility shall cause or contribute to a violation of water quality standards in waters of the State as provided for in County Ordinances, Federal Laws and State Statutes. Water quality levels of service shall be set consistent with the protection of public health, safety and welfare; and natural resources functions and values. To protect water quality and maintain stormwater quality level of service standards. (Water Policy 2.3.2)
		Consistent with the National Pollutant Discharge Elimination System (NPDES) permit, the County's Watershed Management Plan shall establish water quality design criteria for each drainage basin. In establishing these criteria, the County shall consider recommendations from the Sarasota Bay and Charlotte Harbor National Estuary Programs. Drainage basin pollutant load reduction goals are to be established by the Southwest Florida Water Management District and the State Surface Water Ambient Monitoring Program. (WATER Policy 2.3.3)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Water Quality		
Goal	**Objective**	**Policy**
Potable water service shall be provided to Sarasota County residents through the continual evolution of a centralized regional supply, treatment, and distribution system, and shall be provided in a safe, efficient, economical, sustainable and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 3)	Protect the functions of natural groundwater recharge areas and natural drainage features. Water Objective 3.4)	Sarasota County will protect its potable water supply system, contributing recharge areas, and related open space benefits through implementation of its Wellhead Protection Ordinance which shall identify inappropriate land uses and facilities including, but not limited to, underground fuel storage tanks, landfills, hazardous materials storage, and certain commercial and industrial uses. The County's Wellhead Protection Ordinance will be amended, as needed, for consistency with the Florida Department of Environmental Protection's rule governing wellhead protection adopted in May 1995. The protection effort may include requests to the Southwest Florida Water Management District for cooperative funding or technical assistance to further identify zones of protection and cones of influence around individual wellheads or well fields. (Water Policy 3.4.1)
		Usage and maintenance of potable water resources on the T. Mabry Carlton, Jr. Memorial Reserve shall be in accordance with the Environment Plan and monitoring requirements contained in the Southwest Florida Water Management District Water Use Permit for the well field, which requires that the County continue to monitor and assess any variations in the hydroperiod of wetlands, various aquifers, and flora and fauna. (Water Policy 3.4.2)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Water Supply		
Goal	**Objective**	**Policy**
Protect, maintain, and, where necessary, restore the natural resources of Sarasota County to ensure their continued high quality and critical value to the quality of life in the County. (Chapter 2, Environmental Goal 4)	Protect and conserve surface and groundwater resources. (ENV Objective 4.3)	Land use development activities in important groundwater recharge areas shall be consistent with water resources protection. (ENV Policy 4.3.1)
		Sarasota County will coordinate with other governmental and private entities to protect water resources. (ENV Policy 4.3.2)
		The County shall work with the Southwest Florida Water Management District, local municipalities, and other entities to protect the quality of Warm Mineral Springs, Little Salt Spring, their aquifers, and the creek system. The County will work with the State of Florida to secure matching funding for the acquisition of Warm Mineral Springs and Little Salt Spring or work with the owners to create a conservation easement over the springs and their tributaries. (ENV Policy 4.3.3)
		The County shall enforce ordinances that regulate borrow pits and other excavations, stockpiling, hauling and land fillings throughout Sarasota County including mitigation and restoration measures as necessary. (ENV Policy 4.3.4)
Potable water service shall be provided to Sarasota County residents through the continual evolution of a centralized regional supply, treatment, and distribution system, and shall be provided in a safe, efficient, economical, sustainable, and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 3)	Continue to correct existing potable water facility deficiencies and coordinate the acquisition, extension, and construction of, or increase in the capacity of, facilities to meet future needs. (Water Objective 3.1)	Sarasota County Utilities shall maintain up to date inventories indicating the available capacity and present demand for potable water facilities in the Sarasota County Utilities System service area. (Water Policy 3.1.1)
		Sarasota County Utilities shall continue to identify existing Sarasota County Utilities System facility deficiencies, as well as address implementation activities for establishing priorities for replacement and correction of existing facility deficiencies. This shall be an ongoing effort for the continual setting of capital improvement priorities. Efforts to correct these deficiencies shall be made on the basis of maximizing the use of existing facilities as well as economic feasibility under the Sarasota County Utilities preventive maintenance practices. (Water Policy 3.1.2)
		Consistent with the requirements in the Capital Improvements Plan, projects needed to correct existing deficiencies within the Sarasota County Utilities System shall be given priority in the formulation and implementation of the annual work schedules or programs of Sarasota County Utilities. (Water Policy 3.1.3)
		Potable water master plans and modeling of the Sarasota County Utilities System shall be updated as continued engineering and construction activities progress. (Water Policy 3.1.4)
		Continue to extend water lines to those portions of unincorporated Sarasota County developed with private wells utilizing the County's Line Extension Policy through the Sarasota County Utilities Capital Improvement Program and utilizing other mechanisms such as Municipal Service Benefit Unit non-ad valorem assessments. (Water Policy 3.1.5)
		Sarasota County will continue to explore sustainable alternative water resources in cooperation with state, regional, and local agencies and other local governments. County water supply planning will be coordinated with the Southwest Florida Water Management District's Regional Water Supply Plan. Additional water supply sources will need to be identified and developed to supplement existing sources. (Water Policy 3.1.6)
		As the County consolidates and develops potable water facilities, all facilities shall be developed with consideration for aesthetics and the possibility of incorporation into the County park system. (Water Policy 3.1.7)
	Maximize the use of existing and available central potable water facilities and new facilities when they are constructed, and discourage urban sprawl. (Water Objective 3.2)	Until such time as the Sarasota County Utilities System can expand its distribution system to provide centralized potable water service, individually owned platted lots of record located within the designated Urban Service Area, as adopted pursuant to Sarasota County Ordinance No. 81-30, may be provided potable water with a private well provided all other legislative and regulatory requirements are met. (Water Policy 3.2.1)
		The County shall mandate hookup to a centralized potable water system, where available, in accordance with State and County laws. (Water Policy 3.2.2)
		The County shall continue to require new development to connect to central water systems consistent with the requirements contained in the Land Development Regulations, based on the size of the development and distance to the existing system, if the capacity is available in the system, and the Utility's rules allow connection to the system. (Water Policy 3.2.3)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Water Supply

Goal	Objective	Policy
Potable water service shall be provided to Sarasota County residents through the continual evolution of a centralized regional supply, treatment, and distribution system, and shall be provided in a safe, efficient, economical, sustainable, and environmentally sound manner, concurrent with urban development. (Chapter 4, Water Goal 3)	Continue to implement programs to conserve potable water resources. (Water Objective 3.3)	Sarasota County shall continue its efforts to implement water conservation programs, including such initiatives as the existing inverted water rate structure, low flow toilet rebates and showerhead exchange, and outreach educational programs. Water conservation programs shall operate in cooperation with the Southwest Florida Water Management District, Manasota Basin Board, and other appropriate entities, both public and private. (Water Policy 3.3.1)
		The County will continue to abide by the Southwest Florida Water Management District's (SWFWMD) emergency water shortage plan, and when necessary, the County may implement more restrictive water conservation measures, as may be required to protect and maintain the utility system. (Water Policy 3.3.2)
		The County will continue, in partnership with the Southwest Florida Water Management District (SWFWMD) to ensure through a variety of educational and enforcement activities, the proper abandonment of unused water wells. SWFWMD Quality of Water Improvement (QWIP) incentive funding will be utilized to the greatest extent possible to realize the goal of measurable aquifer water quality upgrading. (Water Policy 3.3.3)
		New development shall prioritize meeting irrigation needs through (1) demand management strategies, (2) reclaimed water, if available, (3) rain water or stormwater, and finally, (4) community ground water wells. (Water Policy 3.3.4)
	Ensure that the issuance of development permits shall be conditioned upon adequate potable water capacity. (Water Objective 3.5)	No permit shall be issued for new development which will result in an increase in demand upon deficient central potable water facilities prior to the completion of improvements needed to bring the facility up to adopted level of service standards, unless provided for by existing State and County laws. (Water Policy 3.5.1)
		The County Public Health Unit shall enforce potable water quality standards in accordance with the Federal Safe Drinking Water Act, Chapter 403, Part VI, Florida Statutes, "Florida Safe Drinking Water Act", and Chapter 62- 550, 62-551, 62-555, 62-560, or 10D-4, Florida Administrative Code, and as prescribed by the U.S. Environmental Protection Agency. However, the County may adopt more stringent standards if it deems necessary. (Water Policy 3.5.2)
		Issuance of development orders will be contingent upon demonstration of compliance with applicable federal, State, and local permit requirements for onsite potable water systems. (Water Policy 3.5.3)
		Potable Water Level of Service: (1) System capacity shall be based on 250 gallons per Equivalent Dwelling Unit per day based on peak flow plus the maintenance of minimum fire flow standards. (2) Minimum potable water quality shall be as defined by the U.S. Environmental Protection Agency, except where the State, or County may impose stricter standards. (Water Policy 3.5.4)
Preserve, protect and restore the integrity of the natural environment, historic and archeological resources, neighborhoods and preserve agricultural uses consistent with resource protection (Chapter 9, FLU Goal 1)	Protect environmentally sensitive lands, conserve natural resources, protect floodplains, maintain or improve water quality, and open space, and conserve and protect historic and archeological resources. (FLU Objective 1.1)	Development proposals within the watershed of an existing public potable surface water supply shall provide reasonable assurance, prior to the approval of such development, that the development will not degrade the quality of such water supply for potable use. In the development and application of necessary regulations and mitigation measures to protect public potable surface water supplies, Sarasota County shall coordinate with jurisdictions whose public potable surface water supplies could be affected. (FLU Policy 1.1.5)

SARASOTA COUNTY COMPREHENSIVE PLAN

Sarasota County Planning Department

Flood Protection		
Goal	**Objective**	**Policy**
Sarasota County shall provide programs which prevent and mitigate the losses, cost, and human suffering caused by flooding, and protect natural and beneficial functions of the floodplain (Chapter 4, Water Goal 2)	Address the maintenance of existing facility capacity, and ensure the adequacy of facilities to meet future needs. (Water Objective 2.1)	The County and private developments shall monitor and maintain stormwater management and conveyance facilities to ensure that the stormwater facilities are adequately maintained and functioning in compliance with design requirements. (Water Policy 2.1.2)
		The County shall continue to fund the continuous maintenance of watershed maps and models for each drainage basin in the County through the Basin Master Planning Program to provide a basis of review for new development and other watershed alteration proposals as well as assure that stormwater management facilities are developed to attain the adopted level of service. Implementation of all detailed master plans shall be completed by 2001. Each detailed master plan shall be developed, in accordance with the Basin Master Plan Schedule, as a Sarasota County inter-department effort to ensure consideration of natural drainage functions. Basin master plans shall be developed in cooperation with the municipalities and adjacent Counties to address stormwater quality and quantity problems in basins crossing more than one political boundary. Each plan shall be designed to protect downstream and estuarine water from degradation by stormwater runoff. Each basin plan shall define the level of service and a cost- effective capital improvements program shall be developed. As each basin plan is completed, the comprehensive plan, including the Capital Improvements Plan, shall be amended to incorporate and reflect the stormwater management facility improvements identified in the basin plan. (Water Policy 2.1.3)
		As part of the Basin Master Planning Program, the County shall identify: (1) the extent of the existing 100-year floodplain, (2) all drainage facilities which fall below adopted level of service standards, (3) costs associated with improving such facilities to meet minimum drainage level of service standards, and (4) funding sources for those improvements. Where the improvements of drainage facilities are not feasible or desirable, alternative methods may be employed including, but not limited to, off-line reservoirs, parks designed for flooding, and floodways. If the completion of improvements to provide the adopted minimum level of service standards for existing development or existing roadways would result in un-acceptable adverse economic or social impacts to specific areas, a level of service less than the adopted minimum may be accepted for the specific area. (Water Policy 2.1.4)
	Protect the functions of natural groundwater recharge areas and natural drainage features by providing for the maintenance of existing, and where feasible the restoration of the pre-development, water budgets to historical watercourses (as identified by the original United States General Land Office Township Plats from the Mid to Late 1800's). (Water Objective 2.2)	New development in the 100-year floodplains shall be consistent with all other Goals, Objectives, and Policies of the Sarasota County Comprehensive Plan. (Water Policy 2.2.3)
	Ensure that development and redevelopment provides for adequate stormwater management. (Water Objective 2.3)	No permit shall be issued for new development which will result in an increase in demand upon deficient stormwater facilities prior to the completion of improvements needed to bring the facility up to adopted level of service standards. (Water Policy 2.3.1)
		Stormwater Level of Service - Stormwater Quantity: Stormwater management systems shall provide for adequate control of stormwater runoff. See Design Criteria, page 4-83 of the Sarasota County Comprehensive Plan. (Water Policy 2.3.2)
		The County shall work with the Southwest Florida Water Management District (SWFWMD) in an effort to coordinate approaches to planning and permitting of stormwater management and shall specifically request SWFWMD comment on a volume based approach to regulating stormwater management in addition to the common peak discharge rate approach. (Water Policy 2.3.4)
		Development shall provide for easy maintenance of outfalls for discharge of drainage. (Water Policy 2.3.5)
Preserve, protect and restore the integrity of the natural environment, historic and archeological resources, neighborhoods and preserve agricultural uses consistent with resource protection (Chapter 9, FLU Goal 1)	Protect environmentally sensitive lands, conserve natural resources, protect floodplains, maintain or improve water quality, and open space, and conserve and protect historic and archeological resources. (FLU Objective 1.1)	No development order shall be issued which would permit development in 100 year floodplains, as designated on Federal Emergency Management Agency Flood Insurance Rate Maps or adopted County flood studies, or on floodplain associated soils, defined as Soils of Coastal Islands, Soils of the Hammocks, Soils of Depressions and Sloughs, and Soils of the Floodplains and shown in Figure 2-2, that would adversely affect the function of the floodplains or that would degrade the water quality of water bodies associated with said floodplains in violation of any local, State, or federal regulation, including water quality regulations. (FLU Policy 1.1.6)

Appendix B

Pollutant Load Results

August 2010

Sarasota County

Southwest Florida Water Management District

HISTORICAL

BASIN	V (AC-FT/AC/YR)	BOD (LB/AC/YR)	TSS (LB/AC/YR)	TP (LB/AC/YR)	N (LB/AC/YR)	FECAL COLIFORM (LB/AC/YR)
AINGER CREEK	1.43	11.47	36.63	0.40	4.54	1.65
ALLIGATOR CREEK	1.37	9.57	36.28	0.54	4.27	2.11
FORKED CREEK	1.23	9.13	31.69	0.36	3.79	1.57
GOTTFRIED CREEK	1.25	9.17	33.14	0.36	3.83	1.60
LEMON BAY COASTAL	2.15	4.19	15.42	2.67	3.84	0.92
WOODMERE CREEK	1.14	8.20	28.03	0.34	3.46	1.52
LEMON BAY WATERSHED	1.45	8.74	30.85	0.80	4.02	1.59

CURRENT

BASIN	V (AC-FT/AC/YR)	BOD (LB/AC/YR)	TSS (LB/AC/YR)	TP (LB/AC/YR)	N (LB/AC/YR)	FECAL COLIFORM (LB/AC/YR)
AINGER CREEK	1.48	10.49	46.78	0.50	4.33	21.96
ALLIGATOR CREEK	2.05	25.91	140.77	1.45	7.33	147.39
FORKED CREEK	1.49	15.34	107.44	0.96	5.70	67.97
GOTTFRIED CREEK	1.51	14.66	102.84	0.88	5.45	58.76
LEMON BAY COASTAL	2.44	11.30	53.37	3.08	5.36	79.12
WOODMERE CREEK	1.78	22.87	84.95	1.28	6.31	143.46
LEMON BAY WATERSHED	1.79	16.23	92.66	1.35	5.72	80.13

FUTURE

BASIN	V (AC-FT/AC/YR)	BOD (LB/AC/YR)	TSS (LB/AC/YR)	TP (LB/AC/YR)	N (LB/AC/YR)	FECAL COLIFORM (LB/AC/YR)
AINGER CREEK	2.09	26.52	112.95	1.26	7.68	203.43
ALLIGATOR CREEK	2.18	31.09	150.07	1.61	8.31	185.43
FORKED CREEK	1.88	24.93	124.85	1.26	7.12	189.75
GOTTFRIED CREEK	1.94	25.89	135.84	1.32	7.42	195.14
LEMON BAY COASTAL	2.51	13.23	61.50	1.47	5.17	99.97
WOODMERE CREEK	1.91	29.69	107.18	1.56	7.83	191.82
LEMON BAY WATERSHED	2.10	24.91	118.77	1.40	7.23	176.97

Appendix C

Sediment Management Plan

August 2010

Sarasota County

Southwest Florida Water Management District

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1.0 INTRODUCTION

1.1 TASK OBJECTIVES

This Sediment Management Plan (SMP) is an element of the comprehensive watershed management plan for Lemon Bay. This element of the plan includes an analysis of the primary stream systems in Lemon Bay and their associated tributary areas to determine watershed-based loading of sediment and other associated pollutants, identify other sediment sources, and determine potential remedial and preventative erosion and sedimentation measures. Tasks for the SMP included field sampling, modeling, assessing methods for reducing erosion and sedimentation in the watershed, and evaluating and prioritizing projects proposed to reduce and prevent sedimentation.

1.2 EFFECT OF URBANIZATION ON SEDIMENTATION CYCLE

Sediment production is a natural watershed process, but urbanization and other land-use changes can impact the processes associated with the sedimentation cycle: erosion, transport, and deposition. Anthropogenic causes of sediment production that lead to erosion are increased impervious surface associated with urbanization, construction, soil compaction, streambed alteration, and vegetation removal.

Within an urban setting, sediment production has two primary sources. The first is wash-off from the terrestrial watershed surface. The second is in-stream channel erosion—typically following the pattern of degradation (down-cutting), loss of toe stability, and then bank sloughing. Another lesser source includes sediment load draining directly into the stream down the channel banks. Bank steepness, degree of concentration (runoff velocity), and stability (e.g., vegetation) influence the quantity of this portion of the sediment load.

In urban watersheds, the greatest contributor to increased wash-off is impervious surfaces. Impervious surfaces increase runoff volume and peak-flow rates, which carry a significant sediment load to the waterways. In addition to increasing runoff, urbanization decreases the magnitude of baseflow by limiting infiltration and increases the frequency of runoff events. Both can affect the physical character of the channel and the overall environmental condition of the stream. A study on the effect of imperviousness on sedimentation showed that significant degradation to stream stability, habitat, and water quality occurs at even minimal levels of imperviousness on the order of 10 to 15% (Fischenich, 2001).

An open channel is dynamic and will naturally adjust slope, sinuosity, width, and depth to maintain equilibrium in the system. The equilibrium is dominated by the flow through the system and the sediment load. The natural process of stream channel erosion is typically accelerated and heightened through urbanization in the watershed. Streams adjust to these changes within the physical constraints of bridges, bank stabilization measures, and other hardened surfaces to establish a new equilibrium condition that is often different than their previous “natural” state.

Impacts associated with the “new” equilibrium include the following:

- Greater and more frequent peak storm flows capable of eroding channel beds and banks.
- Enlargement of the channel through incision and widening processes or constriction of channels through sediment deposition.
- Decreased recharge of shallow- and medium-depth aquifers that sustain base and low flows.
- Higher nutrient and contaminant loading.
- Alteration of the channel substrate.
- Reduction of stream system function.

Erosion and sedimentation can contribute to water quality and water quantity problems. Nutrients, pesticides, and heavy metals are adsorbed to sediment originating in the upstream subbasins. The sediments are transported from the upstream areas of the watershed to the bay and estuaries by the interconnected creek and canal systems throughout Lemon Bay. The suspension and transport of these sediments in receiving waters directly affects the water quality (e.g., clarity and light penetration) that is important to preserve or improve the health of the bay. Water quantity impacts can include loss of flood conveyance and navigability through sedimentation or production of snags as well as property or structure damage through channel widening. Managing activities and upstream sources that increase sediment and flow within the Lemon Bay tributaries is a key component in managing the health of Lemon Bay.

1.3 SEDIMENT MANAGEMENT

Managing sedimentation in an urban setting requires a multi-pronged approach. Three management strategies will reduce unwanted sediment in the system:

- Providing source control to reduce or remove solids in upland areas.
- Implementing maintenance practices designed to reduce sedimentation.
- Improving eroding and sloughing banks for long-term stability.

These strategies lead to reduced turbidity, increased clarity, and reduced nutrient and sediment load. The end result is the improved health of the estuaries and Lemon Bay.

Providing source control to reduce or remove total suspended solids in the uplands keep pollutants from running off in stormwater and getting to the receiving waters of the channel and ditch system and ultimately Lemon Bay. Source control activities include low-impact development projects, street sweeping, and construction-area silt fencing.

Regularly scheduled maintenance practices ensure the proper functioning of flood control facilities. These practices also affect the amount of sediment, debris, and pollutants reaching County waterways. Included in these activities are cleaning out baffle boxes; removing excess vegetation from swales and roadside ditches; replacing damaged infrastructure; and maintaining control structures, weirs, and pumps.

Bank stabilization in an urban setting is challenging. Stream banks throughout the County exhibit the following characteristics that lead to erosion and sloughing:

- Steep slopes due to lack of available easement space.
- Loose soil matrix on steep slopes without hearty root systems or moisture-holding capacity.
- Direct runoff washing out the top of banks.
- Lack of proper reinforcement for outfalls.

For stabilization to be effective in the long term, remediation and restoration should not be limited to a single point in the stream but will be more effective when conducted as multiple projects along a channel system.

Constraints of an urban system require management practices to limit the potentially harmful effects of erosion and sedimentation, which include reduced flood control and increased pollution. Performing the activities listed above will improve the health of the system by increasing flood control and improving several water quality components by reducing turbidity, increasing clarity, and reducing nutrient and sediment load. The end result is the improved health of both the estuaries and Lemon Bay.

This sediment management plan summarizes:

- Existing studies in the watershed.
- Investigation sites from this scope of work.
- Pollutant loading from upland areas.
- Best Management Practices' efficiencies.
- Potential projects from previous and current work efforts.

Section 6 evaluates potential sediment load reduction projects within the watershed and Section 7 prioritizes and recommends the projects.

2.0 EXISTING DATA

Between 1992 and 2008, 26 studies focusing on sediment and erosion have been conducted with components in the Lemon Bay watershed. The types of studies are discussed below; the recommendations from the studies are included in Section 5 Potential Projects.

Table 2-1 summarizes the data collected for the various types of studies. Study locations across the watershed are shown in Figure 2-1. More detailed descriptions, locations, and recommendations for the previous studies are in Section 5 Potential Projects.

2.1 SEDIMENT ABATEMENT STUDIES

Nineteen Sediment Abatement Studies throughout the County have been completed by Greenman-Pederson, Inc., Southeast (formerly Berryman & Henigar) for the County's Navigable Waterways Program; three of the studies were on the Lemon Bay watershed. The studies were used to assess potential locations to reduce land-based sediment accumulation in County waterways. These studies are typically for areas of a few square miles. No sampling was included, only an inspection of shorelines and coastal areas to identify problem sites, such as drainage outfalls and steep eroding banks. Estimates of pollutant loading from land-use-based sediment load and recommendations for reducing erosion and sediment deposition in the waterways are included. Of the three studies in Lemon Bay, two were in the Forked Creek subbasin and one in Lemon Bay Coastal subbasin.

2.2 COUNTY-WIDE WEIR STUDY

A 2003 Post, Buckley, Schuh & Jernigan County-wide Weir Study (Weir Study) surmised that a portion of the fine-grained sediments that contain elevated concentrations of nitrogen and metals are blocked by the weirs, preventing the pollutants from being transported downstream and into the Bay segments.

Two sites studied were in Alligator Creek and two in Forked Creek, with results reported for the two sites in Alligator Creek and one site in Forked Creek. None of these sites was used in the comparison of core samples upstream and downstream of the weirs. None of the three sites evaluated in Lemon Bay were ranked as a high priority for cleanup or removal of contaminated sediments. The Weir Study provides a matrix that ranks sites based on exceedance of Effects Levels and Target Cleanup Levels of heavy metal concentrations as determined by Florida Department of Environmental Protection (FDEP).

2.3 ALLIGATOR CREEK SEDIMENT MANAGEMENT PLAN

In April 2006, Berryman & Henigar completed a Sediment Management Plan for the Alligator Creek subbasin within the Lemon Bay watershed. The investigation divided Alligator Creek into six systems and found the banks of each system showed signs of moderate to severe erosion attributed to steep slopes and non-cohesive, sandy soils. The recommendations are conceptual-level bank treatments for the reduction and management of sediment to Alligator Creek.

Table 2-1 Existing Sediment Management Studies and Sampling Programs for the Lemon Bay Watershed

Lemon Bay Study	Author	Year	Study Location	No. Sample Location	Information Obtained					
					Sediment Volume	Grain Size Analysis	Sediment Quality			
							Nutrients	Metals	Organics	Other
Special Purpose Study										
Sediment Quality at Weirs	Post, Buckley, Schuh & Jernigan	2003	Sarasot a County	3	no	yes	yes	yes	yes	no
Management Plan										
Alligator Creek Sediment Management Plan	Berryman & Henigar, Inc	2006	Alligator Creek	0	Estimated Loading	no	no	no	no	no
Sediment Abatement Studies										
Forked Creek Neptune SAS	Berryman & Henigar, Inc	2006	Forked Creek	0	Estimated Loading	no	no	no	no	no
Brucewood Bayou SAS	Greenman-Pederson, Inc.	2007	Lemon Bay Coastal	0	Estimated Loading	no	no	no	no	no
Dale Lakes SAS	Greenman-Pederson, Inc.	2007	Forked Creek	0	Estimated Loading	no	no	no	no	no

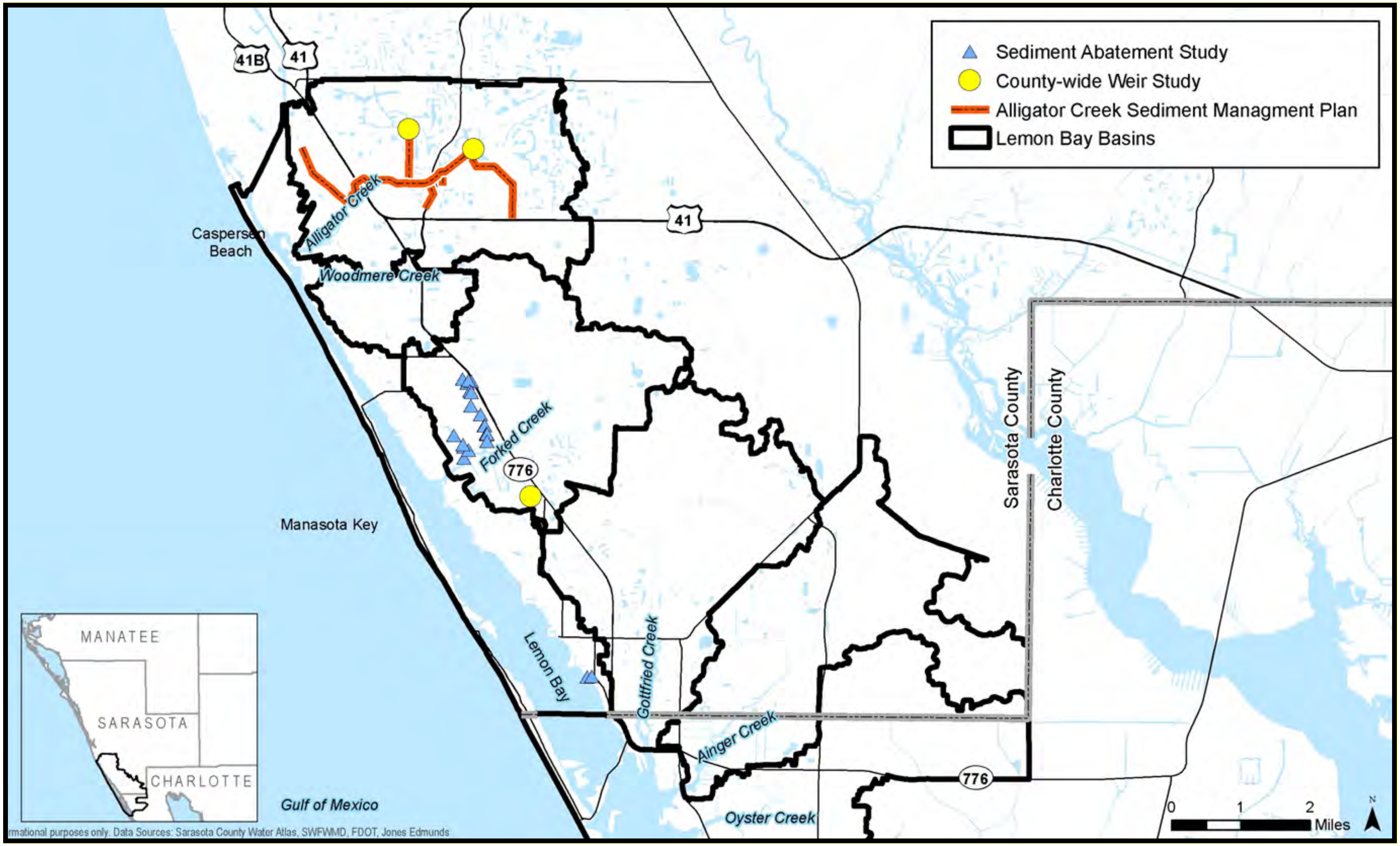


Figure 2-1 Previous Study Locations in Lemon Bay

3.0 FIELD INVESTIGATION

3.1 SAMPLING LOCATION CRITERIA

Jones Edmunds conducted sediment sampling as part of this Watershed Management Plan (WMP) work effort in order to identify areas of recent sediment erosion and accretion that were not identified in previous studies. Sample locations from previous studies are shown in Figure 2-1. Jones Edmunds evaluated existing information to identify additional sampling sites. Sites visited between March 2007 and May 2009 are shown in Figure 3-1. The sites were selected based on the following parameters:

- Accessibility.
- No previous sampling.
- Representative of system.
- Observed erosion/scoring or sediment accumulation.
- Observations made during a field reconnaissance conducted in May 2008.
- County staff input.

The sites include locations in six subbasins:

- Alligator Creek.
- Woodmere Creek.
- Forked Creek.
- Gottfried Creek.
- Ainger Creek.
- Lemon Bay Coastal.

The mainstems and the tributaries are represented. Laboratory testing was not part of this sampling.

3.2 SAMPLING AND ANALYSIS PROCEDURES

The sediment testing consisted of two elements: unconsolidated sediment depth and general physical characteristics. The upstream sites will assess the potential load from relatively undeveloped land in the basin headwaters. The downstream sites will provide data on potential erosion and deposition from urban areas.

1. Depth of sediment—The sediment depth at each site was measured using a stiff metal rod. The probe was manually pushed down into the sediment until refusal and the depth was measured. Three depth probes were taken at each sampling site—one near each toe and one near the middle of the channel bottom. The depth of standing or flowing water in the channel was also measured. In addition, general site conditions were recorded. The channel cross-section width was

measured at water level, a GPS location point was recorded at each cross section, and photographs were taken in the upstream and downstream directions at each location (included in the next subsection). A GIS feature class was also created containing the field measurements (Figure 3-2).

2. General Physical Characteristics—Unconsolidated sediment samples were examined in the field for general physical features, including qualitative descriptions of composition (organic, sand, clay, etc.), and relative percent of large organic matter/detritus.

3.3 SAMPLING SITE DESCRIPTIONS

Sites investigated for this study focused on bank stability and sediment accumulation from in-stream processes. The observations include these focus issues but also noted are any applicable upland contributing factors to sedimentation. The in-stream processes of bank erosion and sedimentation are part of the natural system but are accelerated by urbanization and anthropogenic activities in surrounding areas. Additionally, several sites were visited to help form a proactive plan to alleviate future sediment loading and accumulation to the waterways with future development. The site visits and potential projects are presented within the following areas of interest:

- Alligator Creek.
- Woodmere Creek.
- Forked Creek.
- Gottfried Creek.
- Ainger Creek.
- Lemon Bay Coastal.

Table 3-1 shows characteristics of soil groups found at the sites. The soil groups throughout the watershed range from somewhat poorly drained to very poorly drained; have an average depth to water table of less than 18 inches; and originate from sandy, loamy marine deposits. Loose, sandy soils do not aggregate or hold water well and by nature are more erodible—particularly on steep slopes.

Jones Edmunds conducted the site investigations between May 2008 and June 2009. Jones Edmunds, County, Southwest Florida Water Management, and Wolf Enterprises staff investigated five sites in March 2008. Jones Edmunds evaluated sites and/or measured sediment depth at 55 sites in Lemon Bay in between October 2008 and June 2009. Details concerning these site visits are provided in the following subsections arranged by basin, beginning with Alligator Creek.

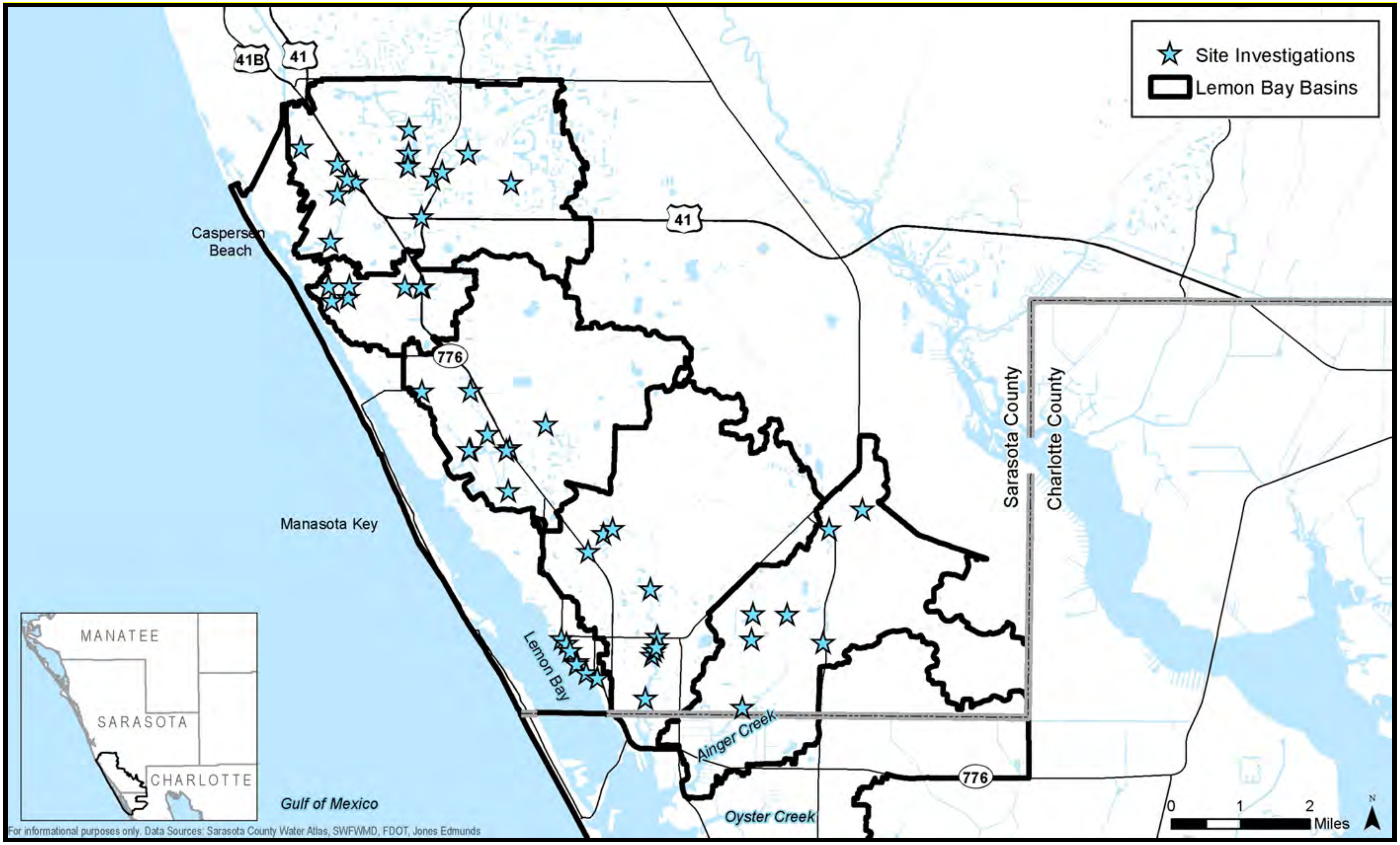


Figure 3-1 Location of Site Investigations

Table 3-1 NRCS Soil Descriptions					
Soil Name	Landform	Parent Material	Slope	Drainage Class	Depth to Water Table (DTWT)
Bradenton fine sands	Flats on marine terraces, rises on marine terraces	Sandy & loamy marine deposits	0 to 2%	Poorly drained	About 0 to 12 inches
Cassia fine sands	Ridges on marine terraces, rises on marine terraces	Sandy marine deposits	0 to 2%	Somewhat poorly drained	About 18 to 42 inches
EauGallie & Myakka fine sands	Flatwoods on marine terraces	Sandy & loamy marine deposits	0 to 2%	Poorly drained	About 6 to 18 inches
Felda fine sands	Drainage ways on marine terraces	Sandy & loamy marine deposits	0 to 2%	Poorly drained	About 0 to 6 inches
Felda fine sands (depressional)	Depressions on marine terraces	Sandy & loamy marine deposits	0 to2%	Very poorly drained	About 0 inches
Felda & Pompano fine sands	Floodplains on marine terraces	Sandy & loamy marine deposits	0 to 2%	Poorly drained	About 0 to 6 inches
Floridana mucky fine sands	Drainage ways on marine terraces, flats on marine terraces	Sandy & loamy marine deposits	0 to 2%	Very poorly drained	About 0 to 6 inches
Floridana & Gator fine sands (depressional)	Depression on marine terraces	Sandy & loamy marine deposits	0 to 2%	Very poorly drained	About 0 inches
Holopaw fine sands (depressional)	Depressions on marine terraces	Sandy & loamy marine deposits	0 to 2%	Very poorly drained	About 0 inches
Pineda fine sands	Drainage ways on marine terraces	Sandy & loamy marine deposits	0 to 2%	Poorly drained	About 0 to 12 inches
Symrna fine sands	Flats on marine terraces	Sandy marine deposits	0 to 2%	Poorly drained	About 6 to 18 inches

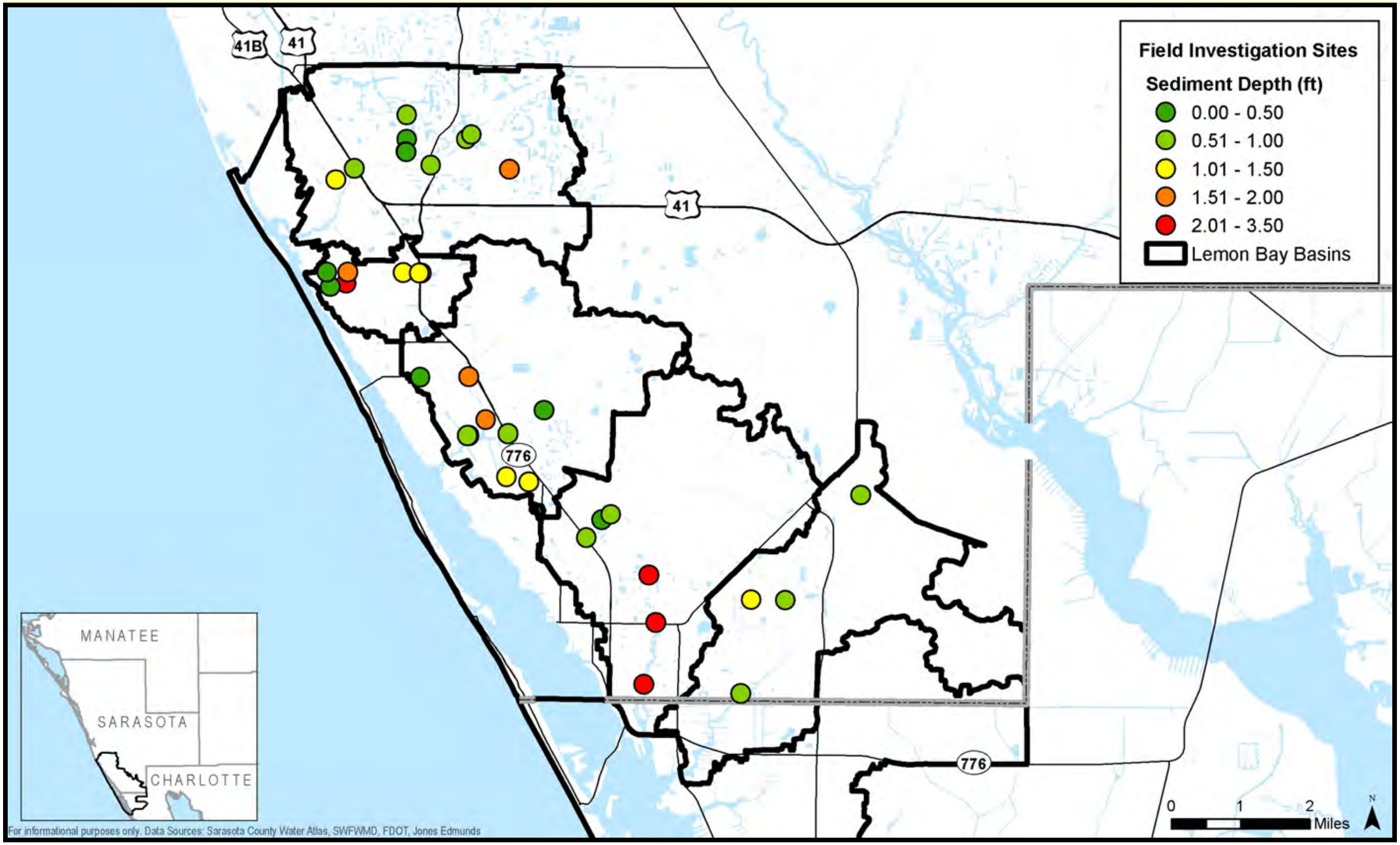


Figure 3-2 Sediment Depth Measurements from County-wide Weir Study and Jones Edmunds Field Investigations

3.3.1 Alligator Creek

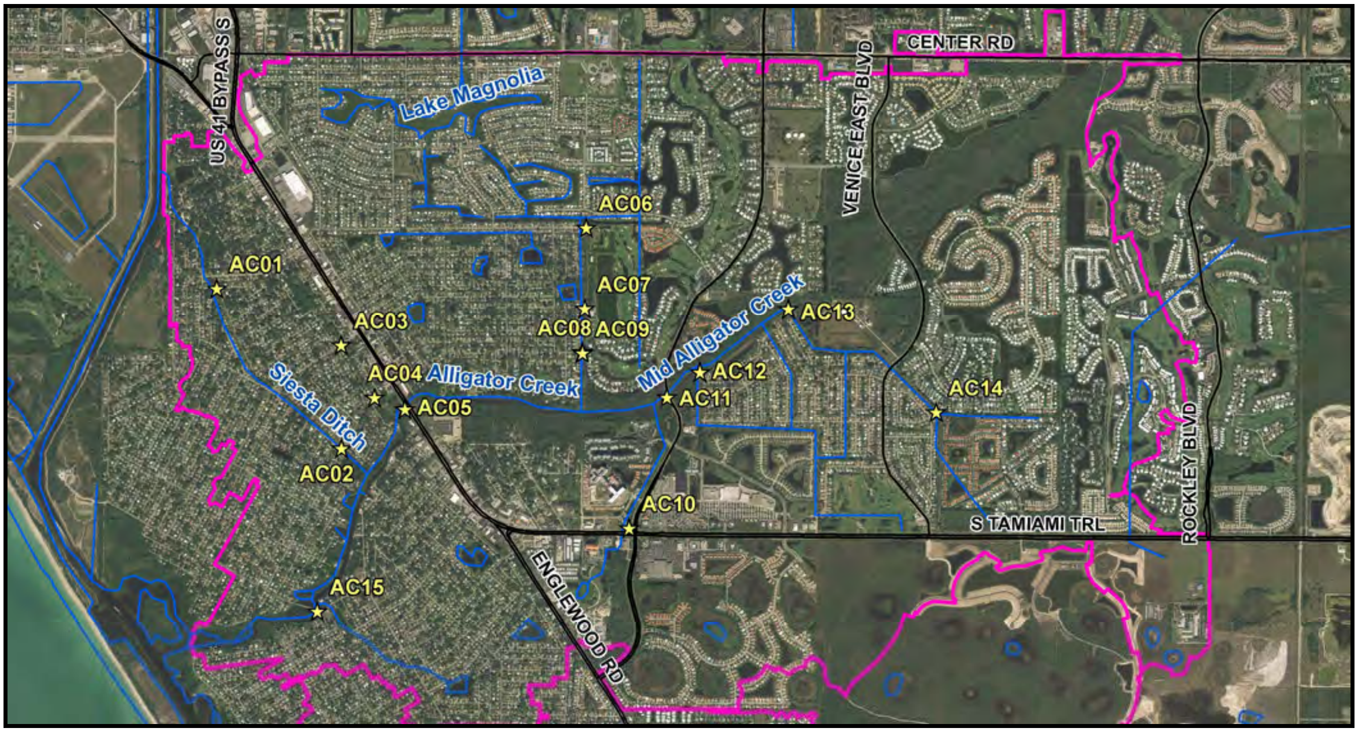


Figure 3-3 Alligator Creek Site Visit Locations (2007 Aerial Photograph, SWFWMD)

AC01: Siesta Ditch North

The upstream end of this channel segment is at the intersection of Thistle Road and Quincy Road. The channel segment runs parallel to Quincy Road for approximately half a mile. The area is drained by a small roadside swale system to two culverts that discharge to the channel. The banks are sparsely vegetated with nuisance vegetation and the soil is non-cohesive, sandy soils. The water surface was covered with hydrilla.

The downstream end of the segment opens slightly and a swale system from the west merges into the primary ditch. The nuisance vegetation through the downstream segment is very dense.

The area is medium-density residential land use. The NRCS native soils are primarily Holopaw fine sand, Pineda fine sand, and Eau Gallie/Myakka fine sands. The photos below show the general bank conditions found throughout the channel segment. Sediment depth was not measured at the site.

Photo: AC01: Looking South

Photo: AC01: General Bank Condition

AC02: Siesta Ditch South

The channel segment is located west of Tamiami Trail and flows parallel to Siesta Drive. The adjacent roadways are drained by a small roadside swale system but Siesta Drive discharges stormwater runoff directly to the channel. The banks are loose, non-cohesive sand that does not have good moisture-retaining characteristics. The nuisance vegetation does not have deep root systems to help create a cohesive soil matrix. The banks slopes are very steep, approximately 2:1 (H:V). The area is medium-density residential land use; backyard fences are at the edge of the sloughing top of bank. The channel segment is a remnant of an agricultural drainage system and provides effective flood control. The NRCS native soils are primarily Pineda fine sand and Eau Gallie/Myakka fine sands. Sediment depth measured in October 2008 averaged 1.8 feet. The streambed is sandy and contained little vegetation, but had collected urban debris.

Photo: Siesta Ditch AC02-upstream (Looking North)

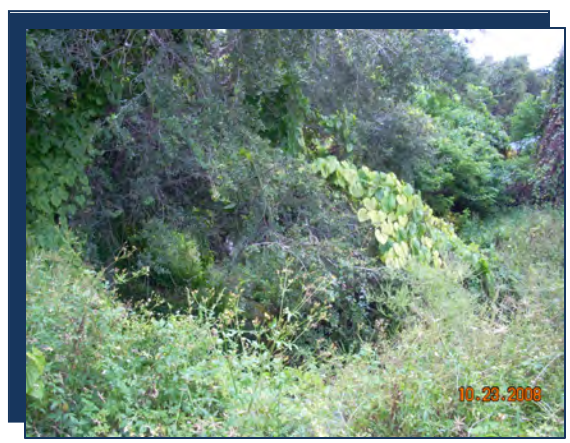


Photo: Siesta Ditch AC02-downstream (Looking South)

AC03 and AC04: Datura Ditch

This ditch segment, located between Seminole Drive and Baffin Drive, has private homes on both the east and west banks. The slopes are steep (less than 2:1 (H:V)) along the entire segment with backyard fences and electrical poles at the top of the sloughing banks. Nuisance vegetation is prevalent on the very loose, sandy soils on the banks and does not provide any cohesiveness to the soil matrix. The vegetation was dense and could interfere with the flood control function of the waterway. The ditch is surrounded by medium-density residential land use with commercial/industrial only one block away on US41. The NRCS native soils are primarily Pineda fine sand and Eau Gallie/Myakka fine sands. Sediment depth was not measured at this site.

Photo: AC03 Upstream (Looking North)

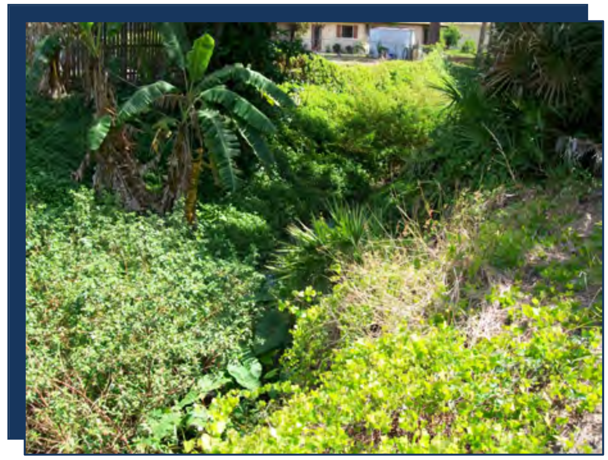


Photo: AC03 Downstream (Looking South)

<u>AC05: Alligator Creek at US41</u>

The channel segment is from US-41 extending eastward approximately 1 mile upstream. The channel banks are steep, less than 2:1 (H:V), and show evidence of undercutting and top of bank erosion caused by overland flow entering the channel. Surrounding land use is medium-density residential and commercial. The NRCS soil type in the upland areas is Eau Gallie/Myakka fine sand. Mangroves line a portion of the north bank. Sediment depth measured 0.8 feet in October 2008.

The County is in the process of designing a recreational trail from Jacaranda Blvd to US-41 along this channel segment.

Photo: AC05 Upstream (Looking West)

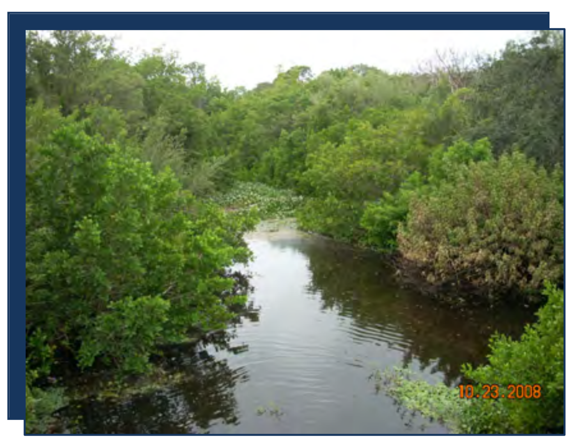


Photo: AC05 Downstream (Looking East)

<u>AC06: Briarwood Road</u>

This site is at the end of Briarwood Road at the entrance to the decommissioned WWTP. The channel segment on the north side of Briarwood Road is densely vegetated. The channel had standing water but did not reach the invert of the 3-CMPs installed to convey flow from the upstream lake system to channel to Alligator Creek. Erosion was pronounced on the eastern slope of the downstream segment although the bank slope is relatively gentle at approximately 4:1 (H:V). The vegetation in the channel showed evidence of being sprayed with herbicide and the decaying vegetation left in the channel. The south bank was covered with nuisance vegetation but the soil matrix was very loose and signs of erosion were present. The site has varied land use: medium-density residential, recreational (golf course), and a decommissioned utility. The NRCS predominant native soil type is Eau Gallie/Myakka fine sands. Sediment depth was not measured at the site.

Photo: AC06 Culverts

Photo: AC06 General Bank Condition

Photo: AC06 Downstream (Looking South)

AC07: Darwin Road

The site is adjacent to large reclaimed water storage ponds. The banks are steep, less than 3:1 (H:V), and characterized by sloughing and erosion on the east bank with a proliferation of nuisance vegetation on the west bank. The soil matrix is non-cohesive. Surrounding land use classifications are medium-density residential, recreational (golf course), and utilities. Greater than 90% of the NRCS native soil is Eau Gallie/Myakka fine sands. The bottom sediments were sandy and mucky and flow was stagnant. Sediment depth measured at the site was 0.4 feet in October 2008.

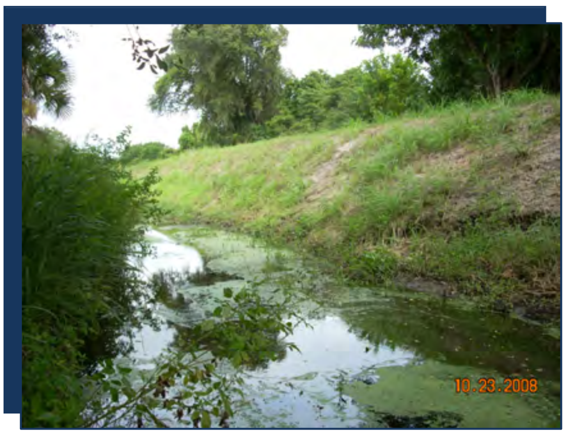


Photo: AC07 Upstream (Looking North)

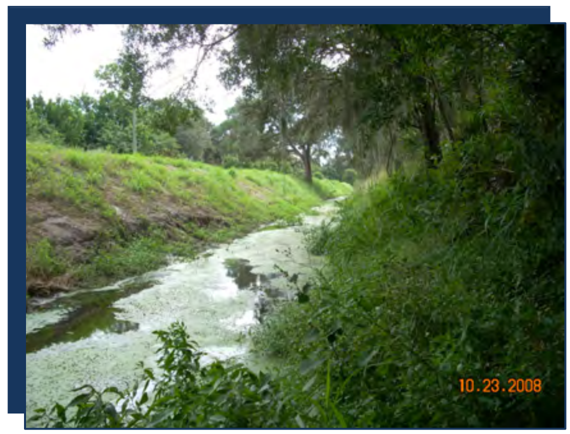


Photo: AC07 Downstream (Looking South)

AC08 and AC09: East Baffin Drive

The sites are at the east end of East Baffin Road adjacent to the channel. The swale on the north side of the road flows directly into the channel and the flow on the south side reaches the channel through a culvert. The outfall locations were densely vegetated. County maintenance crews had recently denuded the swales along the roadway. Erosion and loose sediment were evident throughout the system.

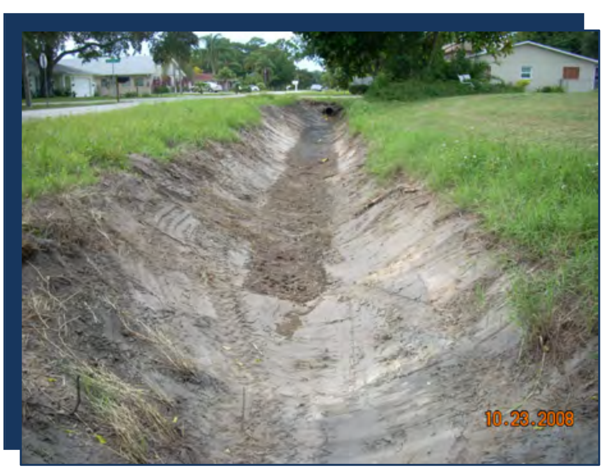


Photo: AC08 Denuded Swale (Looking West)

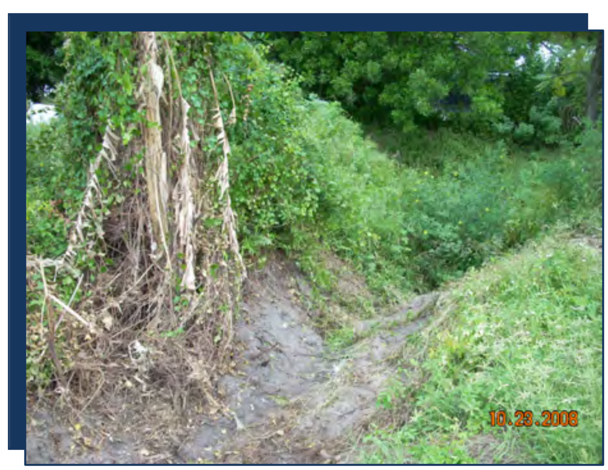


Photo: AC08 Swale Outfall (Looking East)

Photo: AC09 Culvert Outfall

AC10: Jacaranda at US41

The site, located at the corner of Jacaranda Blvd and Tamiami Trail, is surrounded by commercial/industrial land use and a large transportation corridor. The banks of the ditch are approximately 4:1 (H:V) and fully sodded and maintained. Sediment accumulation is apparent along the channel segment. The site is a confluence of several storm sewer systems from the east and south. It was not readily apparent which of the systems was transporting the sediment load observed in the ditch. Sediment depth was not measured at the site.

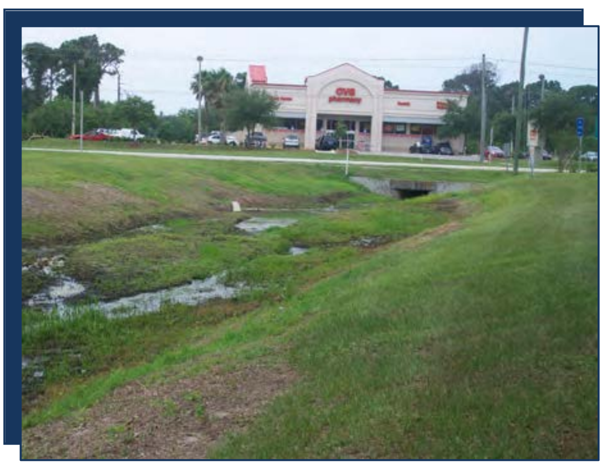


Photo: AC10 Upstream (Looking South)

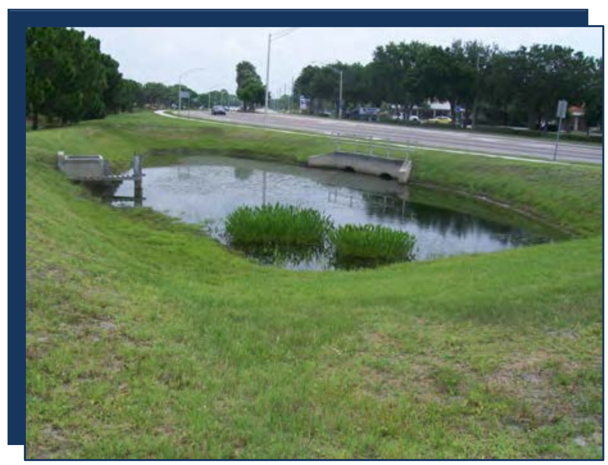


Photo: AC10 Adjacent Detention Pond

Photo: AC10 Downstream (Looking North)

AC11: Alligator Creek at Jacaranda Bridge

The channel segment is upstream and downstream of the Jacaranda Bridge at Alligator Creek. The banks are steep and show evidence of erosion and top of bank erosion caused by overland flow entering the channel. The south bank is sodded and maintained; the north bank is vegetated with native and nuisance vegetation. The south bank has loose, sandy soils. The surrounding land-use classifications are high-density residential and commercial/industrial. Greater than 90% of the NRCS native soil is Eau Gallie/Myakka fine sands with the channel bottom being Delray fine depressional sands. Sediment depth measured at the site was 1.0 feet in October 2008.

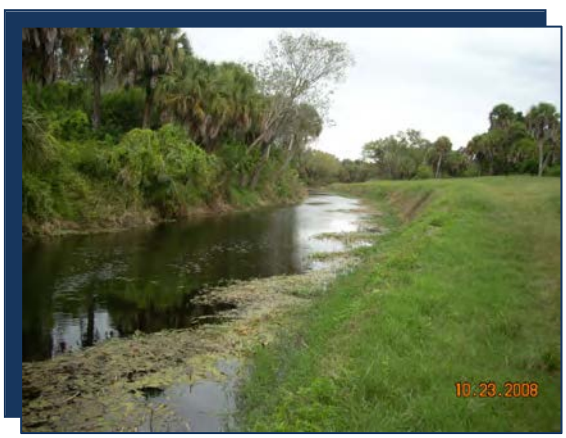


Photo: AC11 Upstream (Looking Northeast)

Photo: AC11 Downstream (Looking Southwest)

AC12: Woodmere Park Library

The channel segment starts at the Woodmere Park Library and extends 1300 feet to Alligator Creek. The banks are steep, less than 3:1 (H:V), and show signs of eroding, sloughing, and undercutting. Primrose was pervasive along the entire eastern bank. Manicured lawns extend to the top of bank on the east side with evidence of grass clippings in the channel. The channel bottom had several sandbars toward the upstream end. The surrounding land-use classifications are high-density residential and commercial/industrial. Greater than 90% of the NRCS native soil is Eau Gallie/Myakka fine sands with the channel bottom being Delray fine depressional sands. Sediment depth was not measured at the site. The area on the west bank of the channel segment is County-owned property.

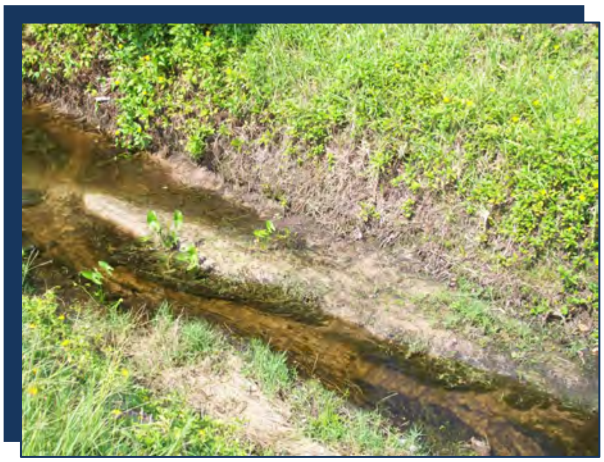


Photo: AC12 Sediment Deposits and Undercutting

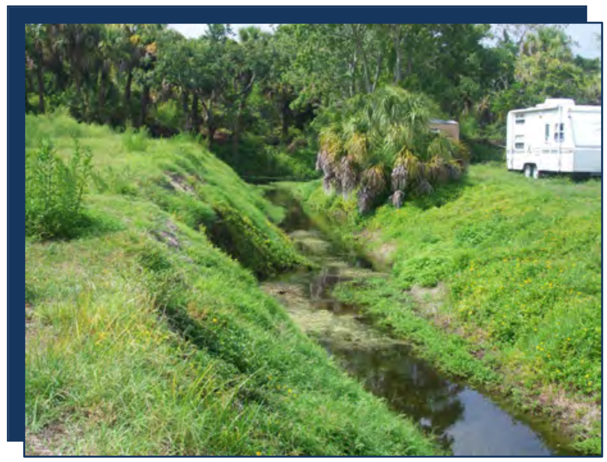


Photo: AC12 Downstream (Looking North)

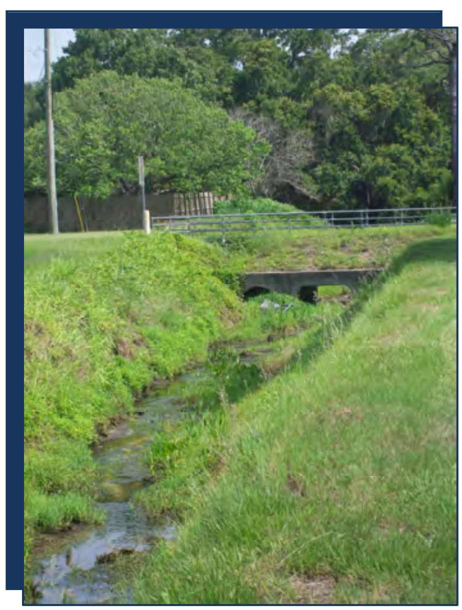


Photo AC12 Upstream (Looking South)

AC13 and AC14: Venice Gardens WRF

The channel segment is approximately 1 mile long. The upstream segment is characterized by very loose, sandy soils and sloughing of the banks with a proliferation of nuisance vegetation that does not add cohesiveness to the soil matrix. The banks on the downstream portion of the channel segment show signs of erosion and undercutting. Decaying vegetation from herbiciding was in Alligator Creek during the field investigation in October 2008.

The surrounding land use is high-density residential and utilities. The easement is 40 feet wide along the length of the channel with the top of bank generally extending beyond the easement boundary. Greater than 90% of the NRCS soil type is EauGallie/Myakka fine sands with the downstream portion of the channel being Manatee loamy sand. Sediment depth measured at the upstream end of the segment was 1.9 feet and 1.0 foot in the downstream segment in October 2008.

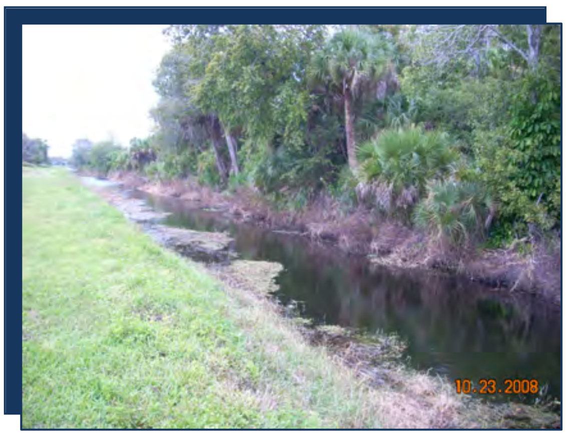


Photo: AC13 Downstream (Looking Southwest)

Photo: AC13 Small stream intersecting at Dorchester

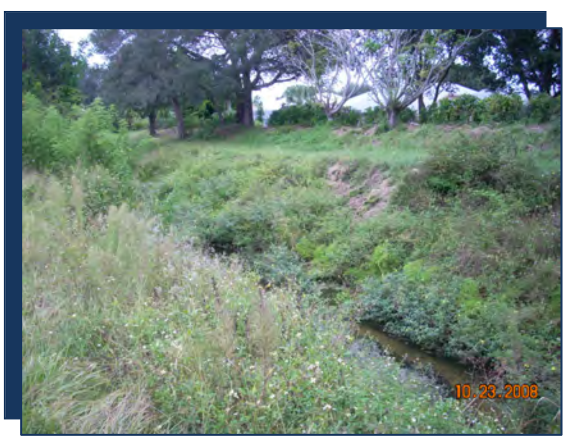


Photo: AC14 Upstream (Looking Southeast)

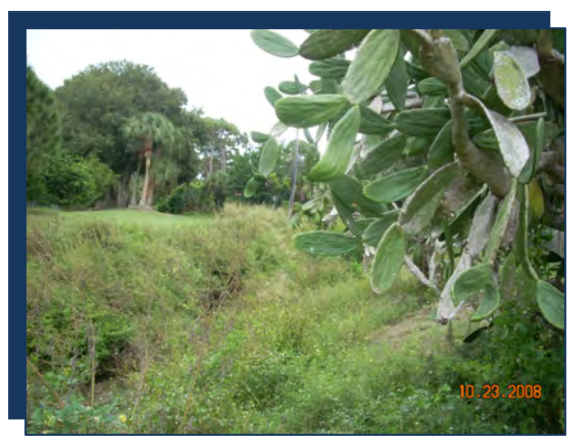


Photo: AC14 Downstream (Looking Northwest)

<u>*AC15: Alligator Creek Downstream at Shamrock Drive*</u>

The site was inaccessible for sediment depth measurements and is entirely a tidally-driven area, approximately 3500 feet east of the Intracoastal Waterway. The creek narrows to 65 feet to flow through the Shamrock Drive Bridge. Mangroves line most of the bank although seawalls are present. The creek is surrounded by medium-density residential land use. Sedimentation is visible in aerial photographs.

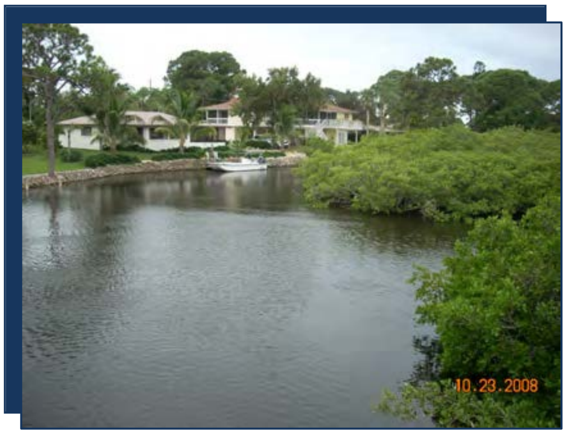


Photo: AC15 Upstream (Looking West)

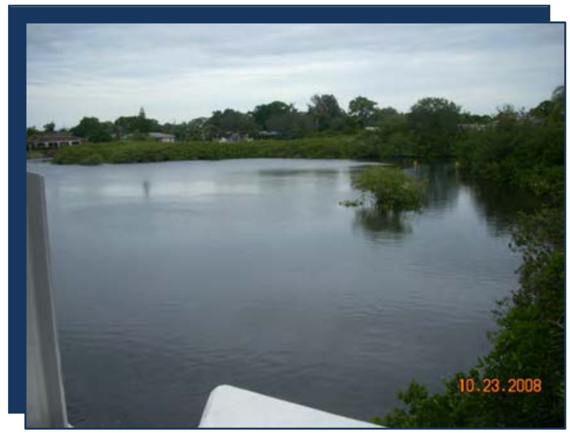


Photo: AC15 Downstream (Looking West)

3.3.2 Woodmere Creek

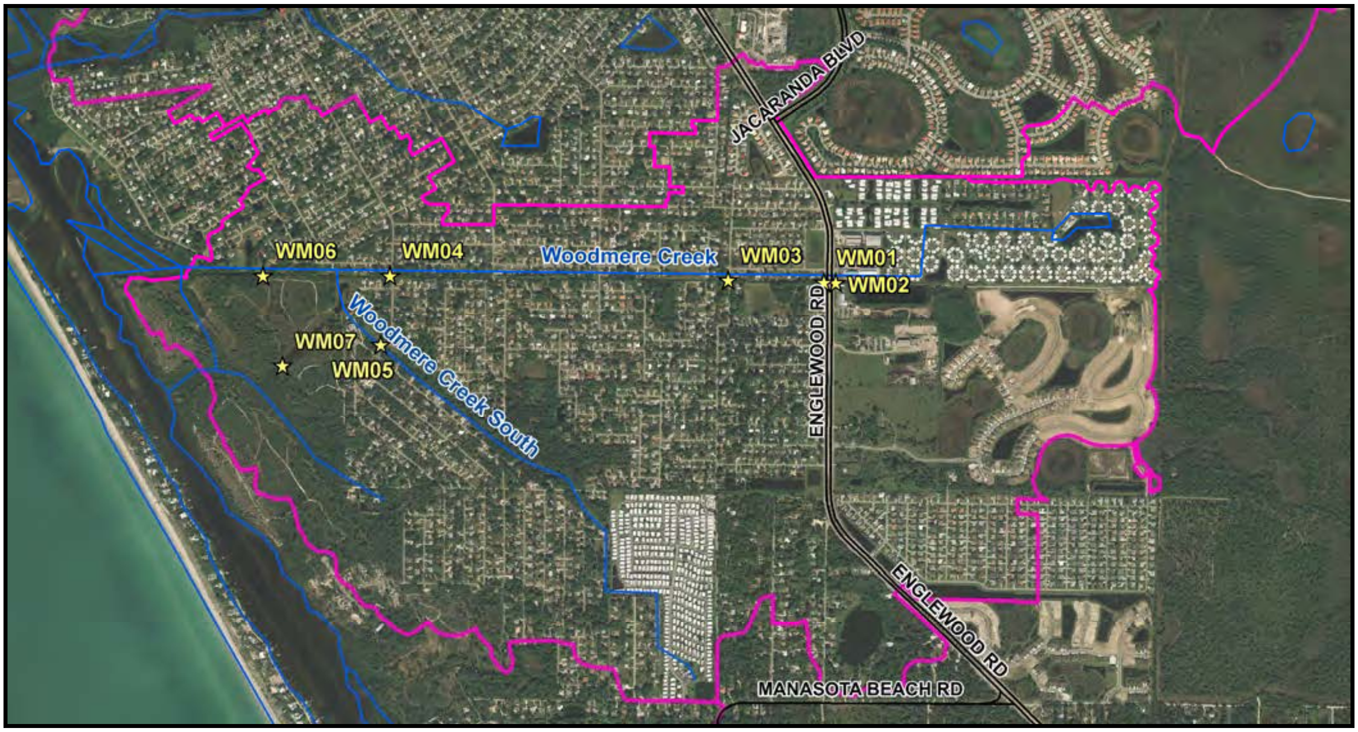


Figure 3-4 Woodmere Creek Site Visit Locations (2007 Aerial Photograph, SWFWMD)

WM01 and WM02: Woodmere Creek at US41

The site is where Woodmere Creek crosses US41. The upstream side is adjacent to a nursery and a flea market. The banks are heavily vegetated with nuisance species. The slope is approximately 4:1 (H:V). The streambed has aquatic vegetation and is mucky. Sediment depth measured 1.9 feet in October 2008.

The downstream channel segment is heavily vegetated and County maintenance staff denude the banks to maintain the flood capacity of the channel. Natural recruitment is allowed to take place; nuisance vegetation has filled in the banks. The process of denuding has contributed to the erosion and sloughing of the banks found through the channel segments. The soil matrix is loose, sandy soils without any cohesiveness. Sediment depth measured in October 2008 was 1.3 feet.

Photo: WM01 Upstream (East of US41 March 2008)

Photo: WM01 Upstream (East of US41 October 2008)

Photo: WM02 Downstream culverts (West of US41)

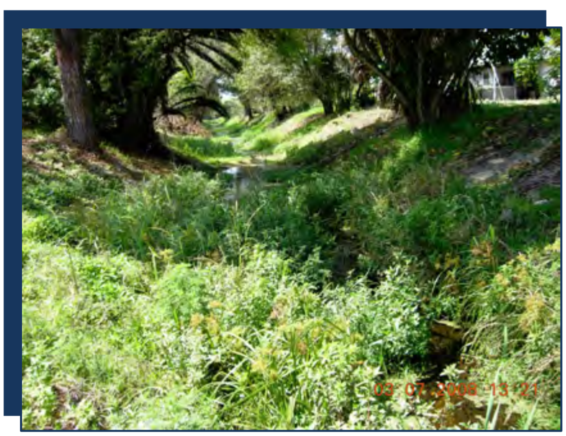


Photo: WM02 Downstream (West of US41 March 2008)

Photo: WM02 Downstream (West of US41 October 2008)

WM03: Florida Road

The site is west of Florida Road approximately 140 feet south of Rutgers Road in Woodmere Creek. The banks are heavily vegetated. County maintenance staff denude the banks to maintain the flood capacity of the channel. Natural recruitment is allowed to take place; nuisance vegetation has filled in the banks. The process of denuding has contributed to the erosion and sloughing of the banks found through the upstream and downstream segments adjacent to the site. The sediment depth measured in October 2008 was 1.4 feet.

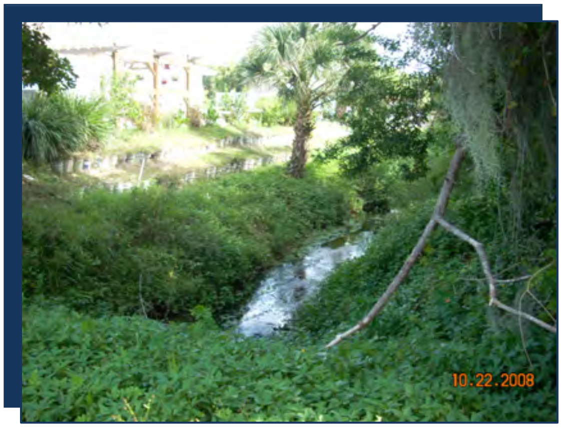


Photo: Woodmere Creek WM03-upstream

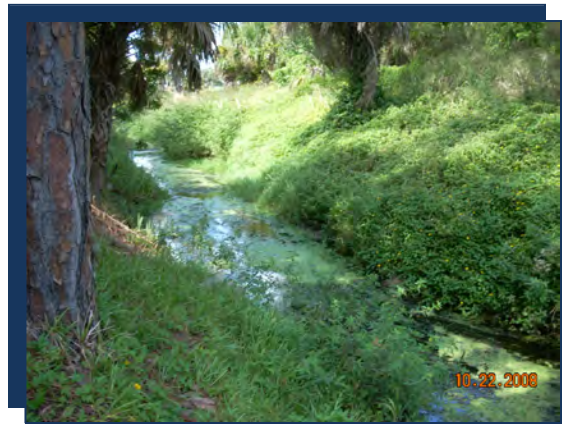


Photo: Woodmere Creek WM03-downstream

Photo: Woodmere Creek WM03-downstream culvert

WM04: Heron Road Bridge

The slope of the banks in the upstream and downstream channel segments are less than 3:1 (H:V). The streambed is mucky with some aquatic vegetation. Hydrilla was evident on the water surface and the flow was stagnant. The easement is 50 feet wide. The segment ends adjacent to the Lemon Bay Preserve. The surrounding area is medium-density residential land use with little stormwater treatment prior to runoff reaching the channel. The predominant NRCS soil groups are Pomello fine sand and Eau Gallie/Myakka fine sands. Sediment depth measured 1.8 feet in October 2008.

Photo: WM04 Upstream (Looking East)

Photo: WM04 Downstream (Looking West)

WM05: Heron Road and Seneca Road

The site is the channel segment along Woodmere Creek South 140 feet northeast of the intersection of Seneca Drive and Heron Road. The downstream segment flows approximately 900 feet to the Lemon Bay Preserve. The streambed has dense aquatic vegetation and the sediment is mucky. The banks are gently sloped but dense with nuisance vegetation. The surrounding land use is medium-density residential. The predominant NRCS soil types are Holopaw fine sand and Eau Gallie/Myakka fine sand. Sediment depth measured 2.2 feet in October 2008.

Photo: WM05 Upstream (Looking Southeast)

Photo: WM05 Downstream (Looking Northwest)

WM06 and WM07: Preservation Area

Woodmere Creek travels through the Lemon Bay Preserve and out to Lemon Bay. The channel is tidally influenced at the site. Mangroves line the south bank; manicured yards are adjacent to the north bank. The adjacent land uses are medium-density residential, hardwood conifers, and wetland forested mixed. The predominant NRCS soil groups are Eau Gallie/Myakka fine sands and Holopaw fine sand. Approximately 1600 feet west of Heron Road the sediment depth measured 0.5 feet in October 2008.

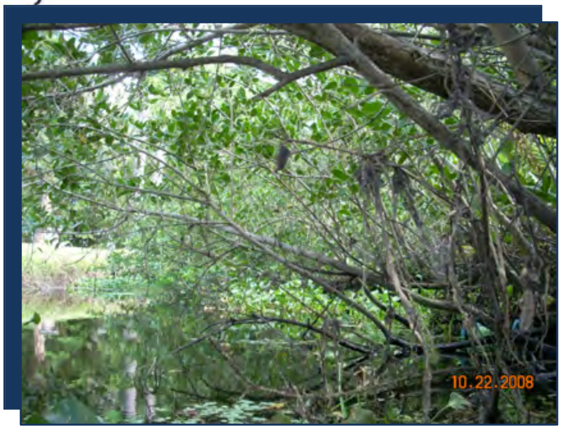


Photo: WM06 Upstream (Looking East)

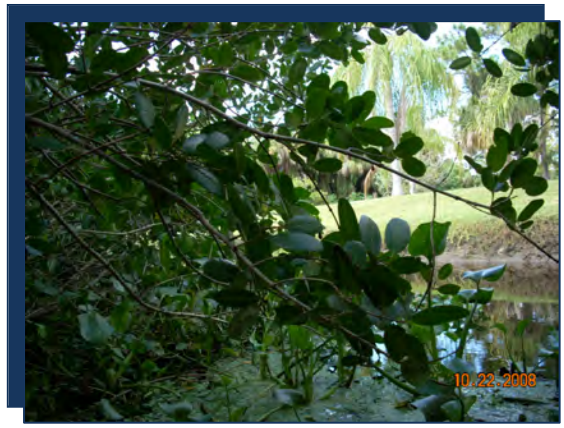


Photo: WM06 Downstream (Looking West)

Photo: WM07 Preservation Area Weir

3.3.3 Forked Creek

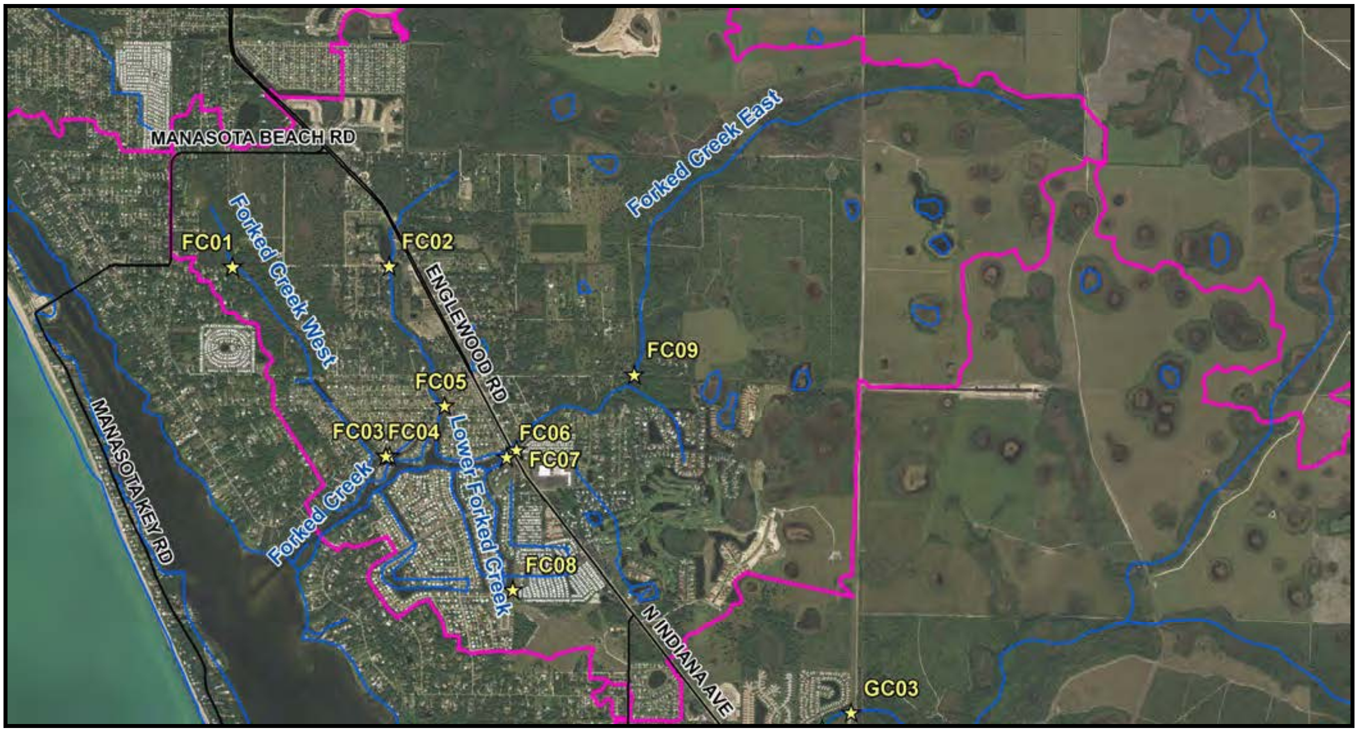


Figure 3-5 Forked Creek Site Visit Locations (2007 Aerial Photograph, SWFWMD)

FC01: West 5th Street

The site was a dry stream bed adjacent to West 5th Street, a limestone roadway. The flowpath was not discernable during the site visit.

Photo: FC01 Upstream

Photo: FC01 Downstream

FC02: 5th Street

The outfall from Dale Lake is a small channel at the south end of the lake at the east end of 5th Street. A 400 feet swale from Englewood Road to the lake discharges at the outfall as well as a roadside swale from the west. The channel segment is densely vegetated at the outfall point with nuisance and exotic vegetation. Over 90 percent of the surrounding land use is medium-density residential. NRCS soil types are Eau Gallie /Myakka fine sands and Boca and Hallandale soils. Sediment depth measured 1.6 feet in October 2008.

Photo: Forked Creek FC02-downstream

FC03 and FC04: San Remo Drive

The sites are within the canal system tributary to Forked Creek. Stormwater discharge into the canal is untreated. The banks are selectively hardened with some mangroves present. Homeowners reported mangroves being cut down by County maintenance workers. The bottom is sandy and does not have any aquatic vegetation. Sediment depth measured at the sites was 1.1 feet and 1.0 foot respectively in October 2008.

Photo: FC03 Mangroves

FC05: Overbrook Road

The bridge west of Forked Creek Drive on Overbrook Road was replaced in 2008. Accumulated sediment south of the bridge is visible in 2007 aerial photographs. The site is surrounded by high-density residential land use. Stormwater runoff flows directly to the channel through a driveway culvert/roadside swale system. Overbrook Road is in good repair but several of the local neighborhood roads are pitted and graveled with accumulated sediment on the pavement and at the edge of the pavement. NRCS soil types are primarily Pomello and Cassia fines sands. Sediment depth measured in October 2008 was 1.6 feet.

Photo: FC05 Bridge

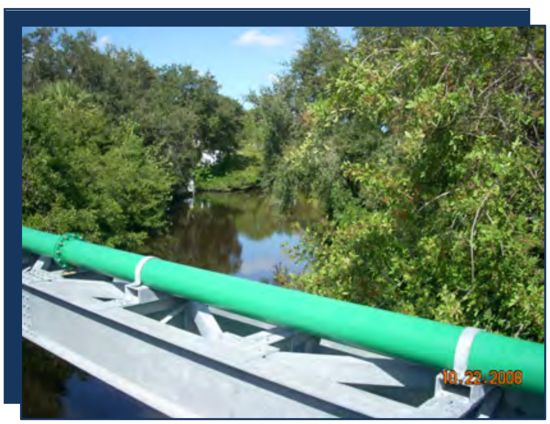


Photo: FC05 Upstream (Looking North)

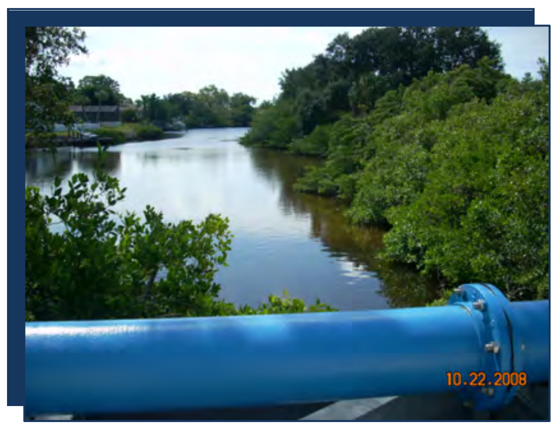


Photo: FC05 Downstream (Looking South)

FC06 and FC07: Forked Creek at US41

The site is in a highly-urbanized portion of the Forked Creek basin. A mobile home community is adjacent to the creek on the upstream side and residents report the creek to be unnavigable due to the accumulated sediment. The southern bank has a seawall while the northern bank is mangroves. The system is tidally influenced and the bottom sediment appears mucky. Sediment depth measured 1.0 ft in October 2008.

On the downstream side of the bridge, the south bank was hardened with a seawall from the bridge to about 300 feet downstream. Residents reported the channel had been dredged to remove excess sediment that interfered with recreational boat traffic. The north bank had mangroves for approximately 200 feet and then was hardened by seawalls. Several culverts discharge to Forked Creek adjacent to the bridge.

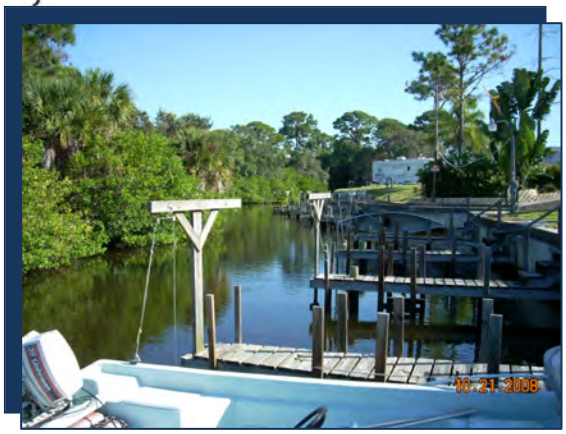


Photo: FC06 Upstream (Looking East)

Photo: FC06 Downstream (Looking West)

Photo: FC07 Upstream (Looking East)

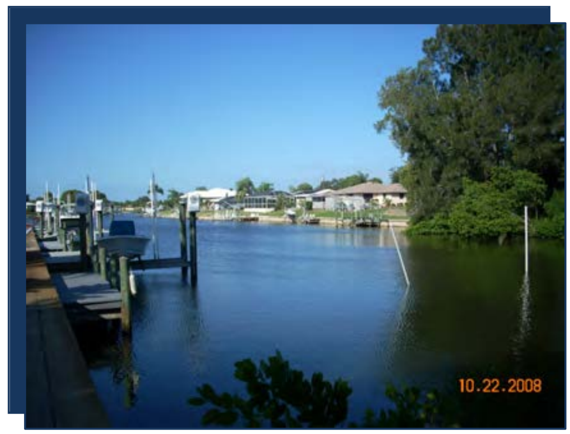


Photo: FC07 Downstream (Looking West)

FC08: Buchan Airport

The site is located on the Buchan Airport property owned by the County. The stream outfalls into a canal connected to Forked Creek. The stream has several stepped weirs to keep the water level in the stream elevated upstream to US 41. The stepped system has kept the water stagnant and covered with duckweed. Residents in the adjacent subdivisions have expressed concern about the amount of sediment being transported down the stream and into the canal. The outfall is approximately 3 feet above the high tide water line. The sediment at the seawall was measured at greater than 1.5 feet in October 2008.

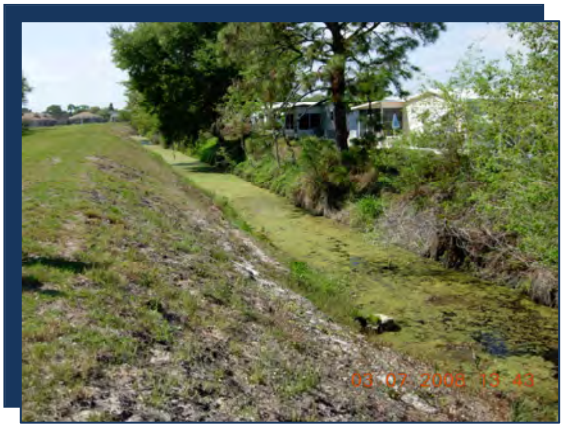


Photo: FC08 Upstream (Looking East)

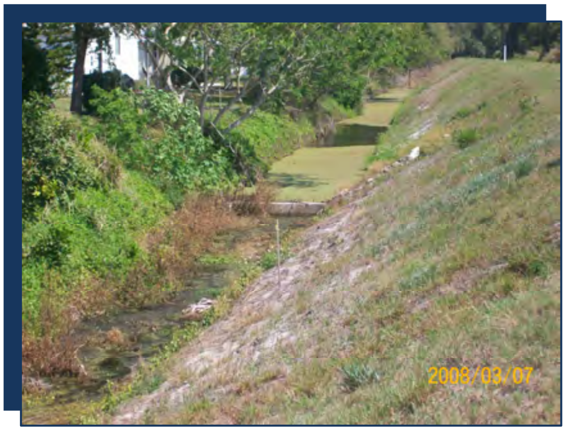


Photo: FC08 Downstream (Looking West)

Photo: FC08 Step Weir

Photo: FC08 Outfall

Photo: FC08 Outfall

FC09: Keyway Road

The site is at the end of a limestone road on private property. The surrounding land use is low-density residential, pasture and cropland, and pine flatwoods. NRCS soil types are Pineda fine sand, Holopaw fine sand and Eau Gallie/Myakka fine sands. Access was limited but the system appeared natural with 0.4 feet of sediment accumulation measured in October 2008.

Photo: FC09 Upstream

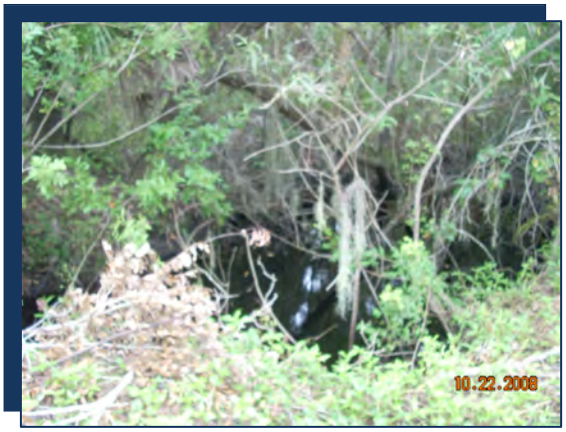


Photo: FC09 Downstream

3.3.4 Gottfried Creek

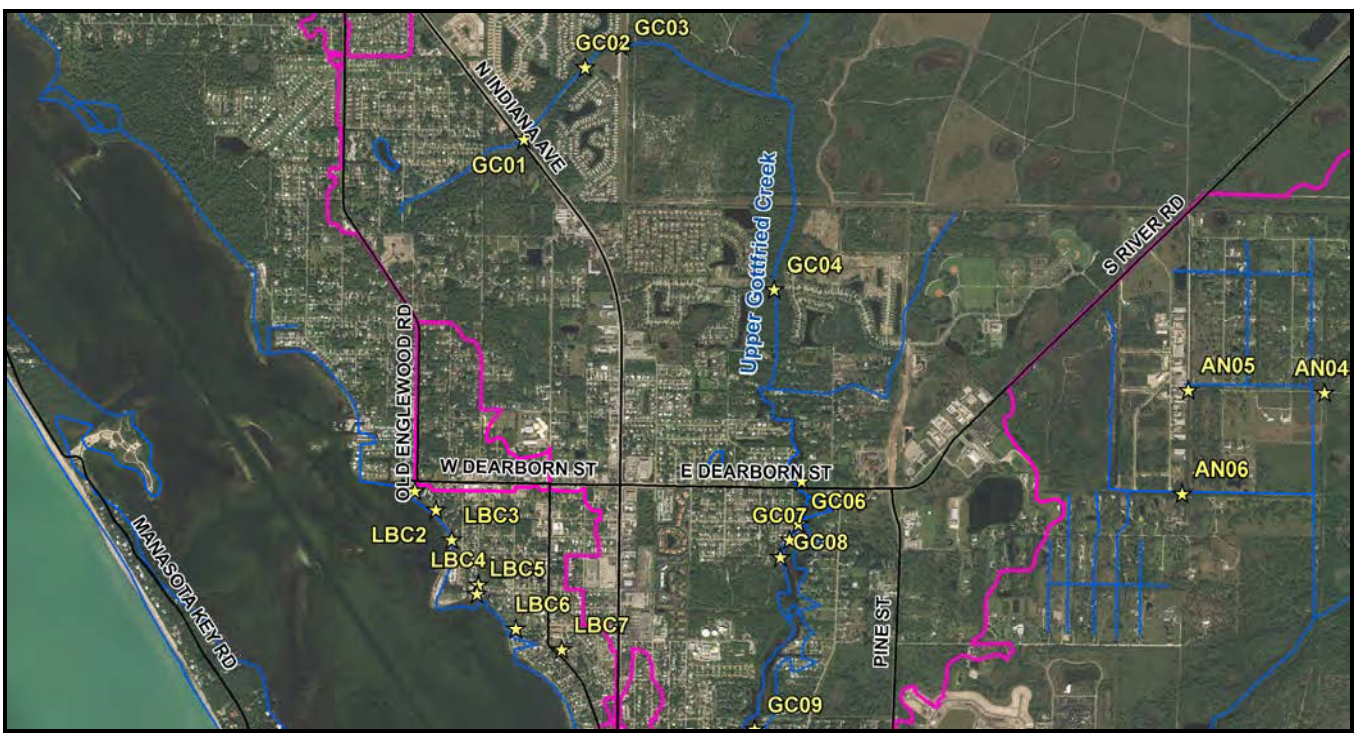


Figure 3-6 Gottfried Creek Site Visit Locations (2007 Aerial Photograph, SWFWMD)

GC01: Bridge on Indiana Avenue

The site is downstream (east) of Indiana Ave between Yosemite Drive and Tangerine Woods Boulevard. between two FDOT ponds. Upstream of the site is a nursery discharging directly to the channel. The channel bed was sandy with a significant amount of organics. NRCS soil types are Eau Gallie/Myakka fine sands, Manatee loamy sands, and Holopaw fine sands. The sediment depth measured in October 2008 was 0.8 feet.

GC02 and GC03: Tangerine Woods Blvd to FPL Easement

The gently sloping channel segment flows from Tangerine Woods Boulevard east to the power easement on the east side of the subdivision. The water surface was covered with hydrilla and other aquatic vegetation along the 650 feet segment. No erosion, sloughing, or undercutting was apparent. Surrounding land use is high-density residential, hardwood conifer mix, open land and utilities. NRCS soil types are Holopaw fine sands and Eau Gallie/Myakka fine sands. Sediment depths measured in October 2008 were 0.1 feet and 0.7 feet upstream and downstream, respectively.

Photo: GC02 Upstream

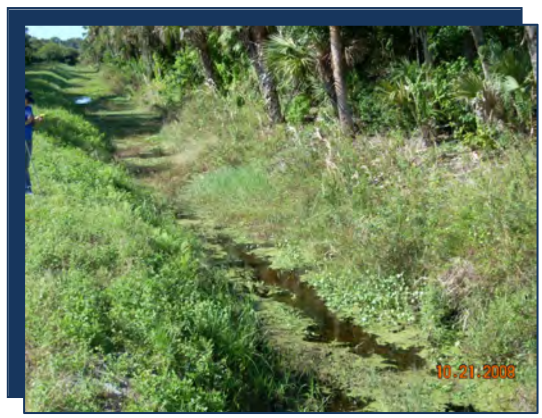


Photo: GC02 Downstream

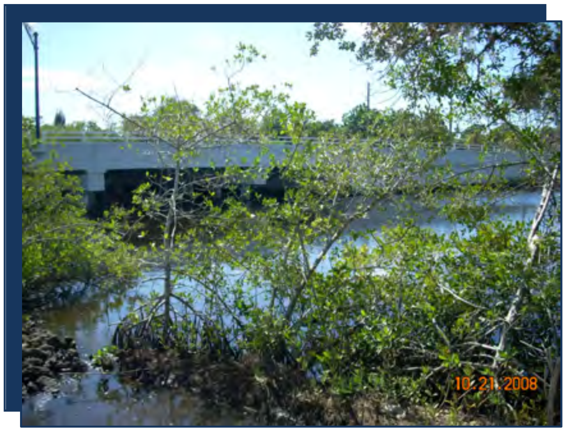


Photo: GC02 Downstream Culvert

Photo: GC03 Upstream

Photo: GC03 Downstream

GC04: Park Forest

The site is in the Park Forest subdivision and is a relatively natural stream system. A small oxbow has formed but does not affect the flood capacity of the stream. The banks show some evidence of undercutting. The bottom sediments are mucky and devoid of aquatic vegetation. The site is surrounded by medium-density residential land use that receives stormwater treatment prior to entering the natural stream system. NRCS soil groups are Boca and Hallandale soils. Sediment depth measured 3.3 feet in October 2008.

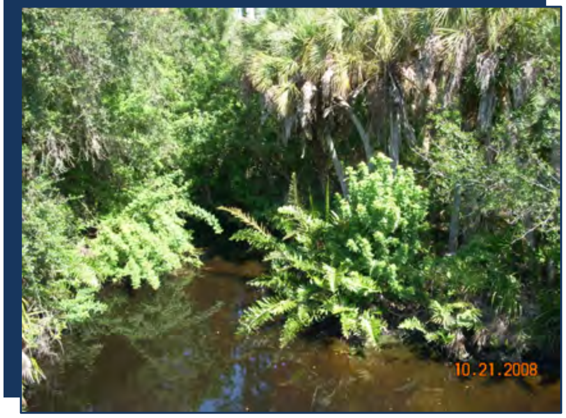


Photo: GC04 Upstream (Looking South)

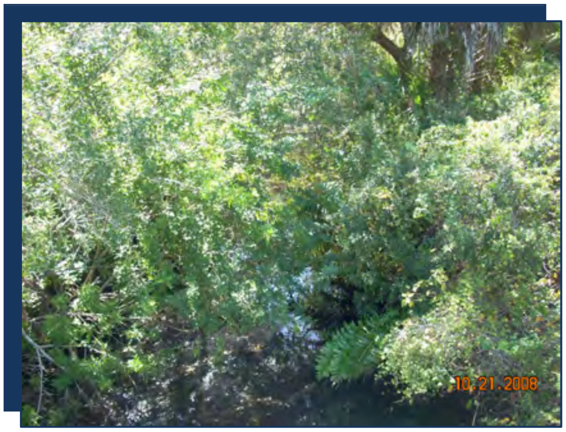


Photo: GC04 Downstream (Looking North)

GC05: Dearborn Street Bridge

The site is upstream of the Dearborn Street Bridge. The channel is surrounded by low- and medium-density residential land use. NRCS soil types are Boca and Hallandale soils in the uplands and Kesson and Wulfert mucks adjacent to the channel. The system is tidally influenced with a mucky bottom and the banks were generally hardened by seawalls. Sediment depth measured 2.4 feet in October 2008.

Photo: GC05 Basin Area

GC06, GC0, and GC087: Local Roadways

The sites are at the east ends of Langsner, Court, and Cowles Streets respectively. For Langsner and Court Streets, the roadways are graded for stormwater runoff to flow directly into the creek. The end of the pavement is between 50 and 75 feet from the top of bank of the creek. The land surface appears to be several feet higher than the water surface elevation (the site visit was after several days of heavy rainfall in June 2009).

For the site at the end of Cowles Street, the land surface was 10 feet above the water surface. A nearby homeowner reported never seeing water from the creek come close to the top of bank and did not observe runoff from any of the adjacent roadways. The small depressional area at the top of the bank had large—70 to 80 feet tall—Australian pines.

The surrounding land use types are low- and medium-density residential. NRCS soil types are Cassia fine sand and Eau Gallie/Myakka fine sands.

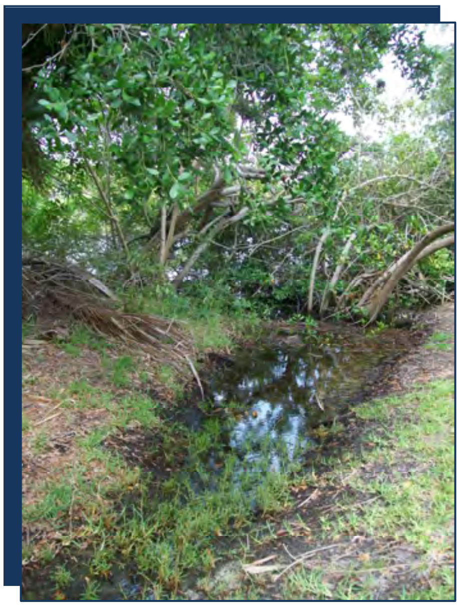


Photo: GC07 Looking East at Gottfried Creek

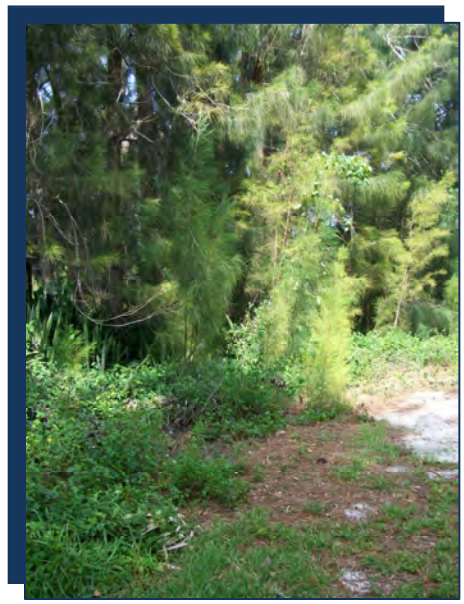


Photo: GC08 Looking East at Gottfried Creek

GC09: Cortes Drive

The site is at the end of Cortes Drive off of South Oxford Drive. Between the end of the cul de sac and the mangroves is a drop inlet with a pipe that discharges directly to the tidally-influenced creek. The roadway is in poor condition with accumulated sediment and gravel on the surface and along the edge of pavement. Much of the sediment on the roadway is crumbling roadway material. Sediment depth measured at the pipe outfall was 3.5 feet in October 2008.

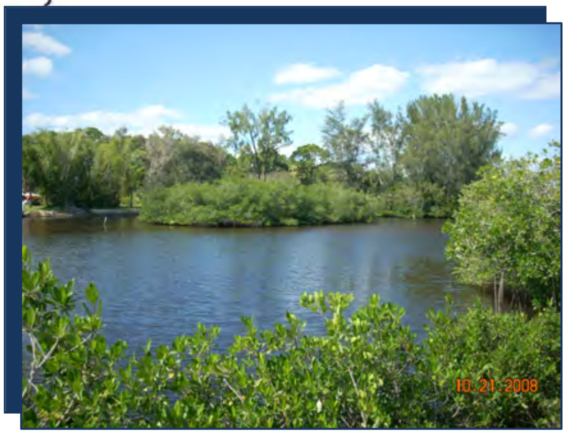


Photo: GC09 Upstream (Looking North)

Photo: GC09 Downstream (Looking South)

Photo: GC09 Upland

Photo: GC09 Outlet

3.3.5 Ainger Creek

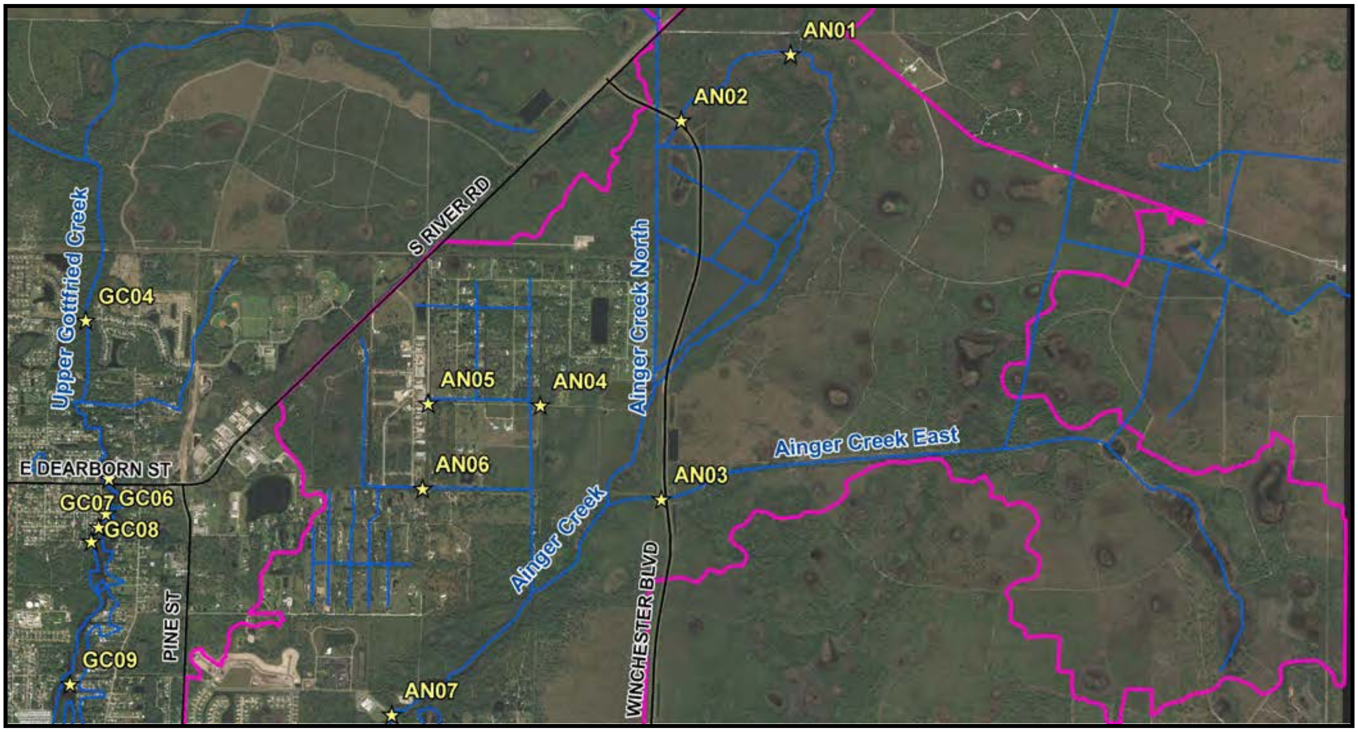


Figure 3-7 Ainger Creek Site Visit Locations (2007 Aerial Photograph, SWFWMD)

AN01: Myakka State Forest

The site is in the state park approximately 3000 feet east of the park entrance. During our visit the flow was stagnant and the river bottom was covered with vegetation. The muck smelled like sulphur. The surrounding land use is fresh water marshes and open rural land. The primary NRCS soil groups are Pople fine sand, Holopaw fine sand, and Delray depressional sand. Sediment depth measured 0.6 feet in October 2008.

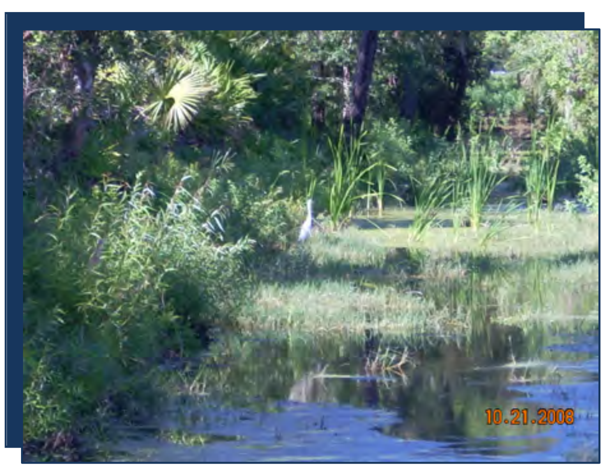


Photo: AN01 Wetland

AN02 and AN03: Winchester Road

The stormwater system along Winchester Road is extensive, consisting of treatment ponds, wetlands, and culverts. Unfortunately, the stormwater system was inaccessible. The surrounding area is undeveloped and primarily natural ecosystems. No erosion or sediment accumulation was evident.

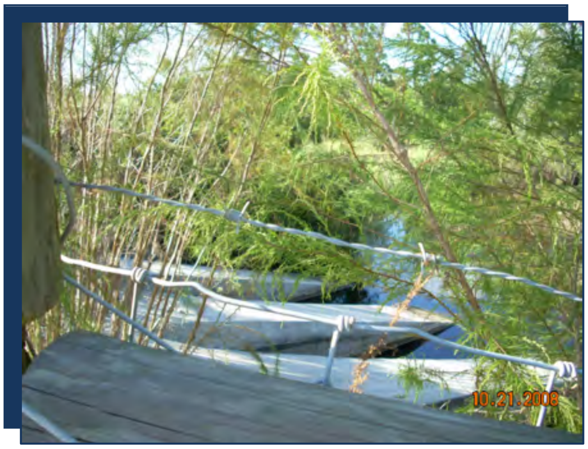


Photo: AN03 SW Treatment System

Photo: AN03 SW Treatment System

AN04: East Melody Lane

The site is at the end of a limestone road and channel is a former agricultural drainage ditch. The banks are stable, vegetated, and show no signs of erosion. The surrounding land use is low-density residential and agriculture. The NRCS soil type is Eau Gallie/Myakka fine sands. The water surface was covered with duck weed and the channel bottom consisted of a mixture of sand and muck with aquatic vegetation. Sediment depth measured 0.9 feet in October 2008.

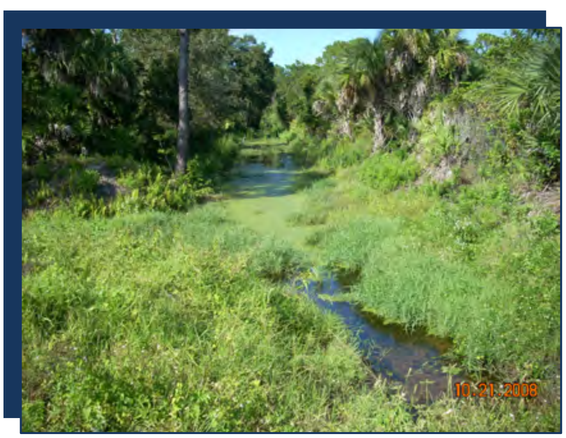


Photo: AN04 Upstream (Looking North)

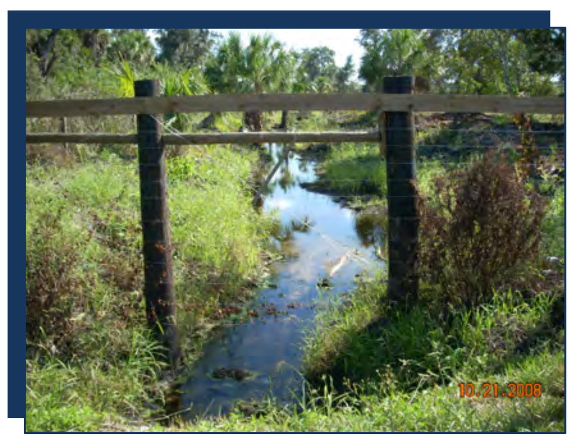


Photo: AN04 Downstream (Looking South)

AN05: Melody Lane

The site is a half a mile west of AN04 and the discharge point of approximately 136 acres through 2 42-inch culverts. The downstream channel segment is severely degraded. The bottom sediment is mucky and smells of sulphur. An industrial complex is adjacent to but not discharging to the channel segment. The upstream area that discharges to the channel is low-density residential and agriculture. The predominant NRCS soil is Eau Gallie/Myakka fine sands. The sediment measured in the stream bed was approximately 1.5 feet.

Photo: AN05 Upstream (Looking North)

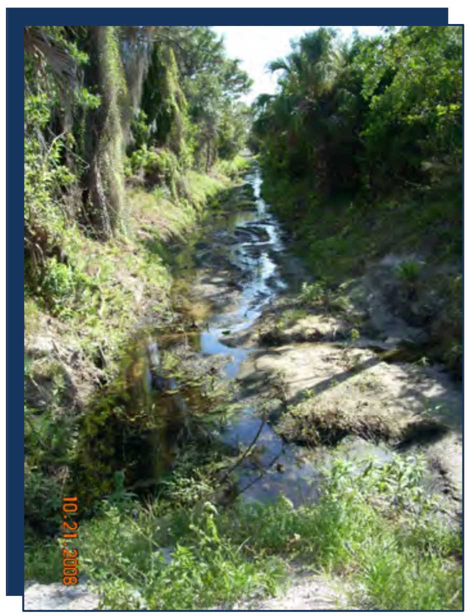


Photo: AN05 Downstream (Looking South)

AN06: Paul Morris Drive

The site is adjacent to the outfall end of AN05. Melody Lane and was inaccessible for measurements.

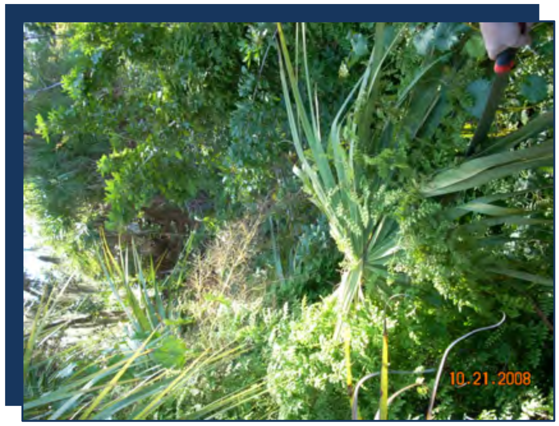


Photo: AN06 Downstream (Looking East)

<u>AN07: YMCA</u>

The site is at the back of the YMCA property at the east end of Medical Blvd. The YMCA site and adjacent development to the north and west have stormwater treatment systems. The area to the east is predominantly a natural system. No erosion or undercutting was visible on the banks. The NRCS soil types are Eau Gallie/Myakka fine sands, Holopaw fine sand, and Pople fine sand.

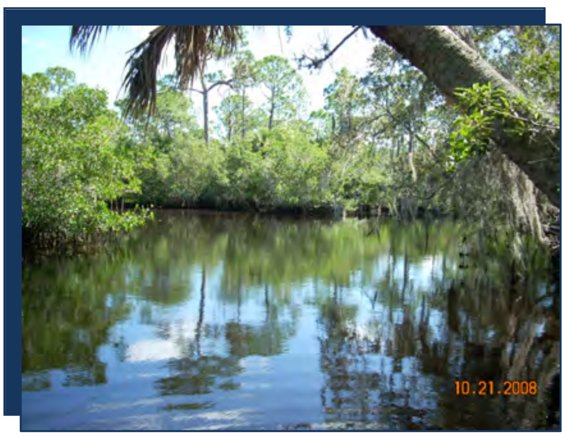


Photo: AN07 Upstream (Looking West)

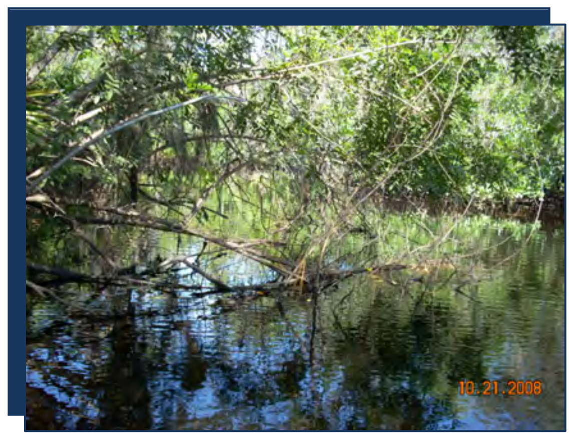


Photo: AN07 Downstream (Looking East)

3.3.6 Lemon Bay Coastal

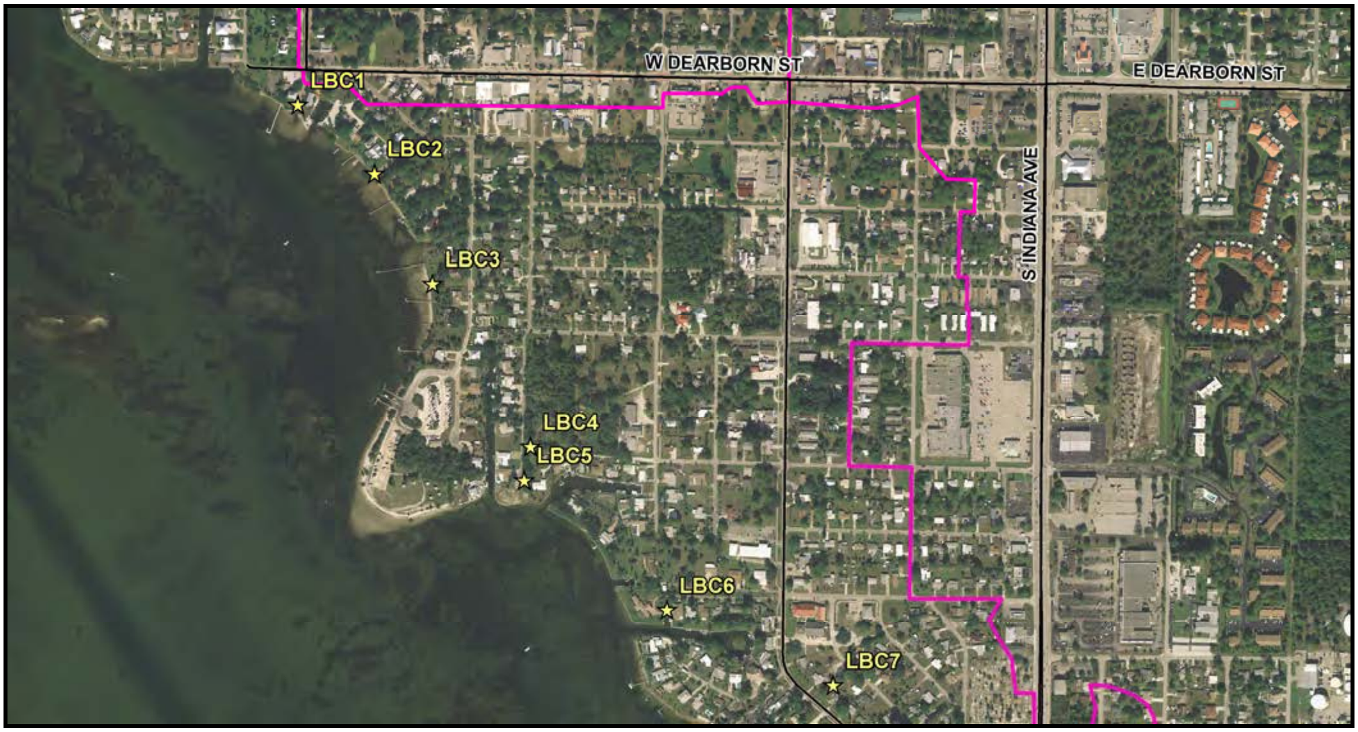


Figure 3-8 Lemon Bay Coastal Site Visit Locations (2007 Aerial Photograph, SWFWMD)

Jones Edmunds visited seven sites in the coastal area adjacent to Gottfried Creek. Sediment accumulation is visible at the outfalls to Lemon Bay in the aerial photographs. During high tides, the outfalls are often inaccessible and salt water flows into the stormwater culverts and swales restricting outflow of runoff. Deposition of sand in the stormwater system is common as the tide recedes. Sediment depth measurements were not taken at these sites.

The largest outfall (LBC1) is a box culvert structure with a grate on the top that is the discharge for the storm sewer system along the refurbished Dearborn Street. The bottom of the box is filled with sand. The upstream end of the box culvert is a ditch-bottom inlet (DBI) with 3 culverts conveying flow in and one conveying flow to the outfall. Approximately 4 inches of accumulated sediment was measured in the bottom of the DBI in March 2009.

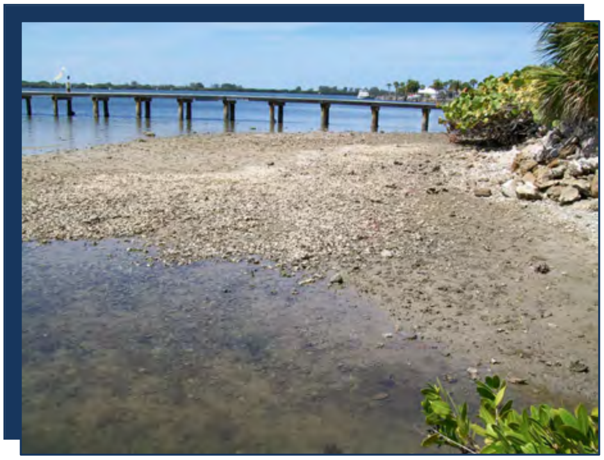


Photo: LBC1 Pier adjacent to outfall March 2009

Photo: LBC1 Pier adjacent to outfall June 2009

Photo: LBC1 Outfall (Looking North)

A small area (LBC2) at the end of Cherokee Drive provides minimal treatment of roadway runoff as flow travels overland to the bay.

Photo: LBC2 (Looking West)

Sites LBC4 and LBC5 are adjacent to Magnolia Drive. The swale parallel to the roadway is dense with nuisance vegetation. West Palm Grove Avenue to the east is limestone. Further upstream is a 3.5 acre area of hardwood conifers. During high tides, the salt water reaches more than 200 feet upstream into the swale. Easement area is available for a local-scale stormwater retention pond.

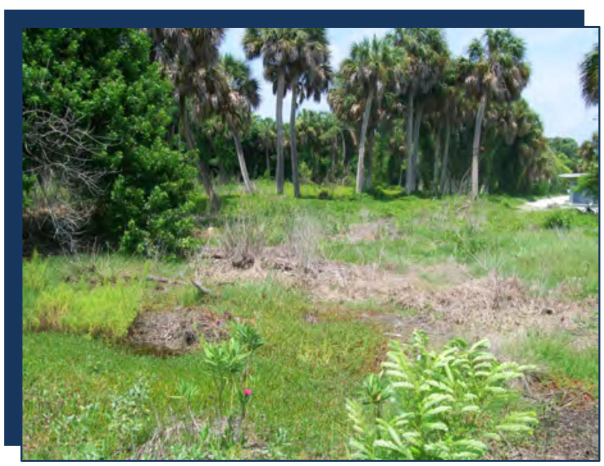


Photo: LBC4 and LBC5 (Looking East)

LBC6 is adjacent to Brucewood Bayou and was included as a site visit to evaluate the recommendations from the Sediment Abatement Study (2007).

LBC7 is a large stormwater vault. The site visit was to evaluate the potential for any further opportunities for sediment removal.

4.0 SPATIALLY INTEGRATED MODEL FOR POLLUTANT LOADING ESTIMATES

Jones Edmunds developed a County-wide pollutant-loading model within a GIS framework for Sarasota County. The model is referred to as the *Spatially Integrated Model for Pollutant Loading Estimates* (SIMPLE) and uses computational methods from the Watershed Management Model (WMM) and the Harvey Harper Method (Harper, 2004) as well as additional methods to predict either monthly, seasonal, and annual loads from a variety of point sources, non-point sources (e.g., direct runoff and base flow), and septic tanks.

For this modeling effort, Jones Edmunds used NEXRAD rainfall data from February 2004 through April 2008. After the hydrology module of the model was run, the pollutant-loading portion of the model was split into six modules: direct runoff, base flow, wet/dryfall, irrigation, point-source, and septic tank. These modules estimated the load of various pollutant indicators such as biochemical oxygen demand (BOD), total suspended solids (TSS), nitrogen, phosphorus, and heavy metals by subbasin. For this study, the subbasins generally corresponded to the Groups defined in the County's ICPR stormwater models and associated GIS geodatabases.

Total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP) are three primary constituents found in runoff and evaluated for removal efficiencies in this plan.

Suspended solids loading is primarily a function of land use. An increase in the amount of impervious area found in urban areas is associated with an increase in suspended solids in stormwater runoff. If suspended solids remain suspended, the particulates reduce water clarity, and limit the amount of sunlight reaching marine life. Suspended solids that settle in a stream system can adversely impact benthic habitats and the flood control capacity of the system.

Nitrogen and phosphorus are nutrients found in soils naturally but are elevated due to anthropogenic activities. Increased erosion, usually associated with urban development, can add nutrients as well as solids to the stream system. Fertilizer contributes to the nutrient load in runoff when lawns are unable to assimilate the amount of fertilizer applied. Excess nutrients combined with the tropical temperatures found in Sarasota County can lead to excessive algae growth impacting the recreational aspects of the waterways and creating an oxygen deficit which affects the marine life and aquatic habitats.

Figure 4-1, Figure 4-2, and Figure 4-3 show the spatial variation of these components in stormwater runoff in pounds per acre per year.

The data shown in Table 4-1 represents the average pounds per acre per year loading from January 1995 through December 2007, for TSS, TP, and TN in each subbasin.

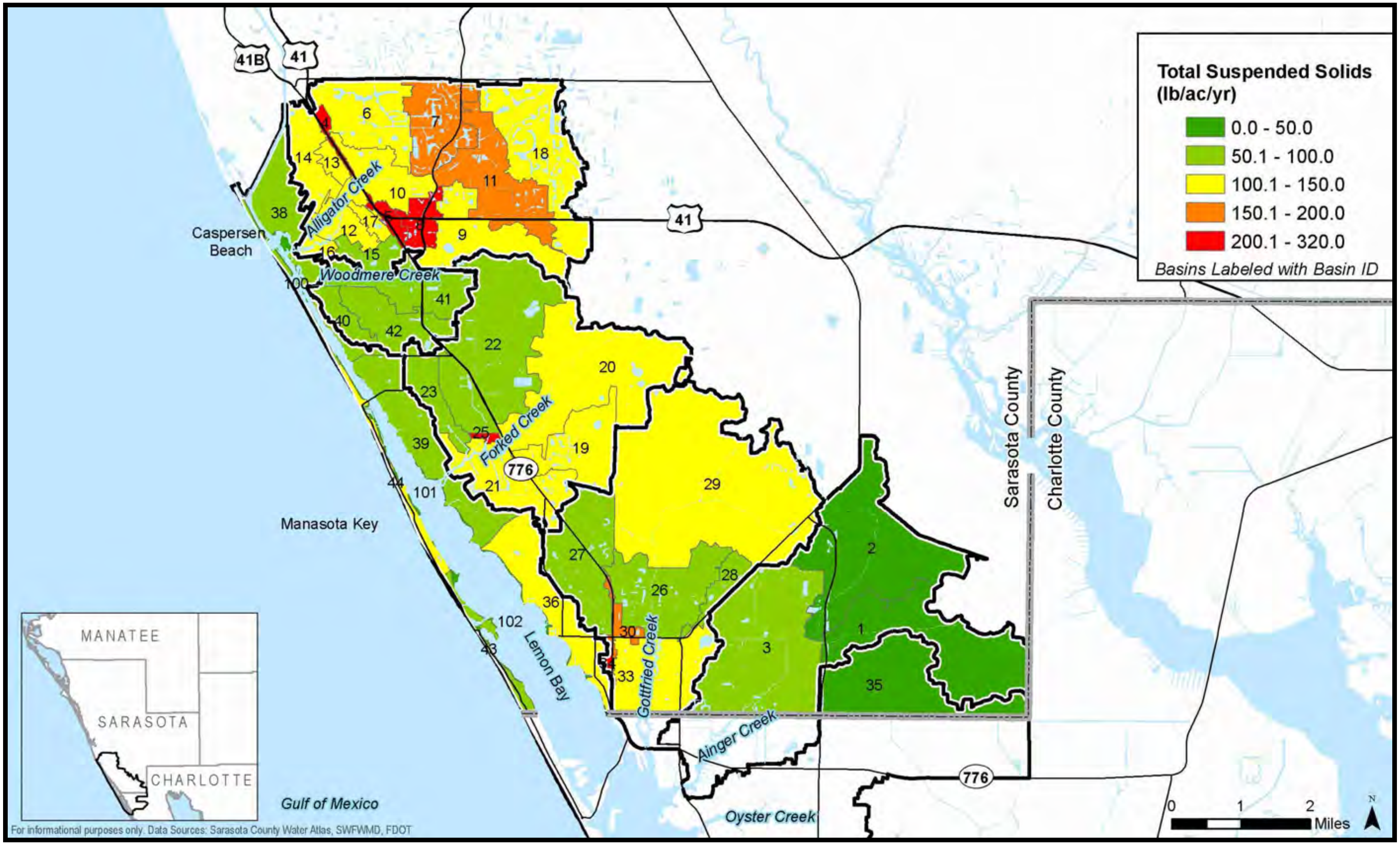


Figure 4-1 Total Suspended Solids Loading to Lemon Bay

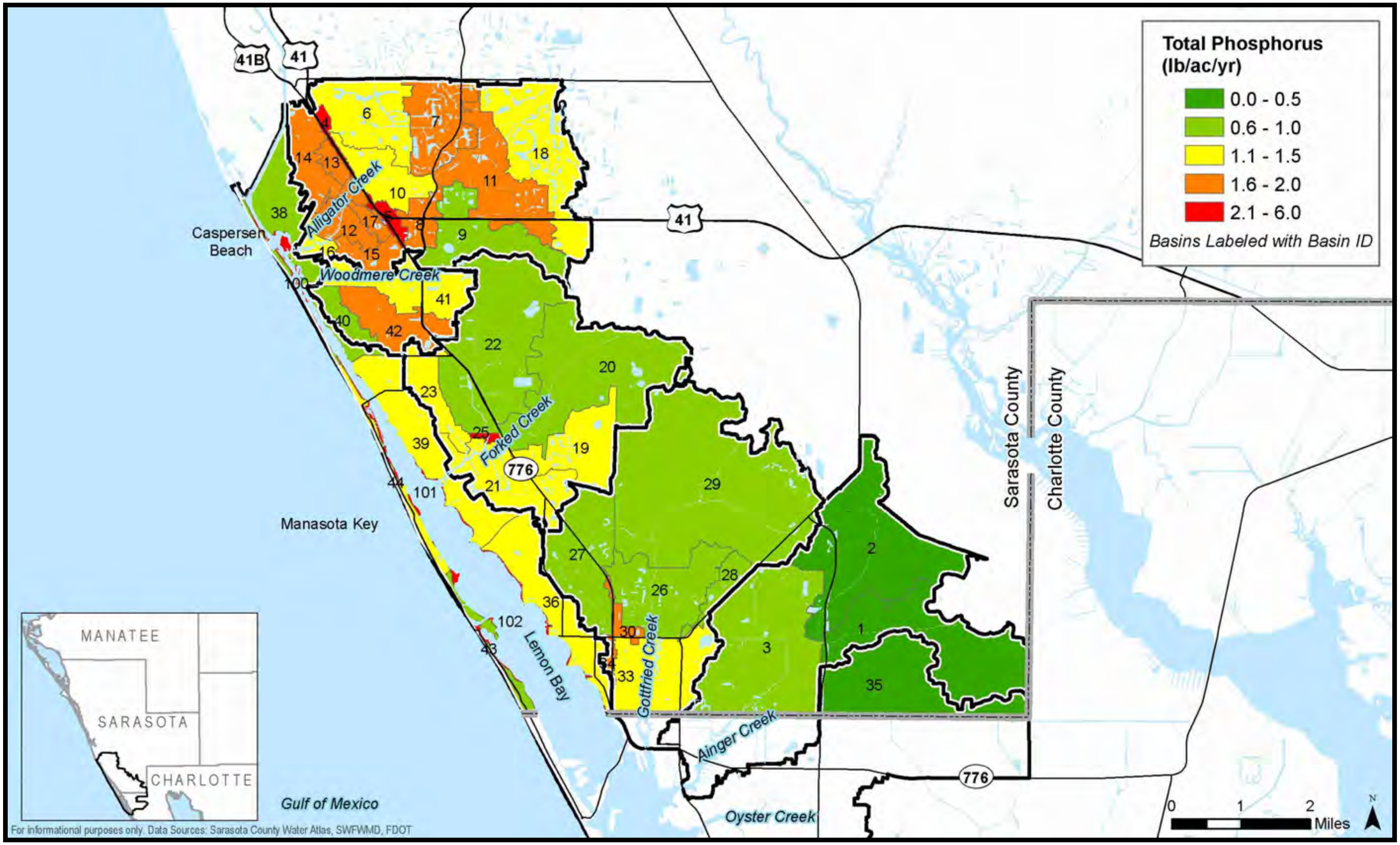


Figure 4-2 Total Phosphorus Loading to Lemon Bay

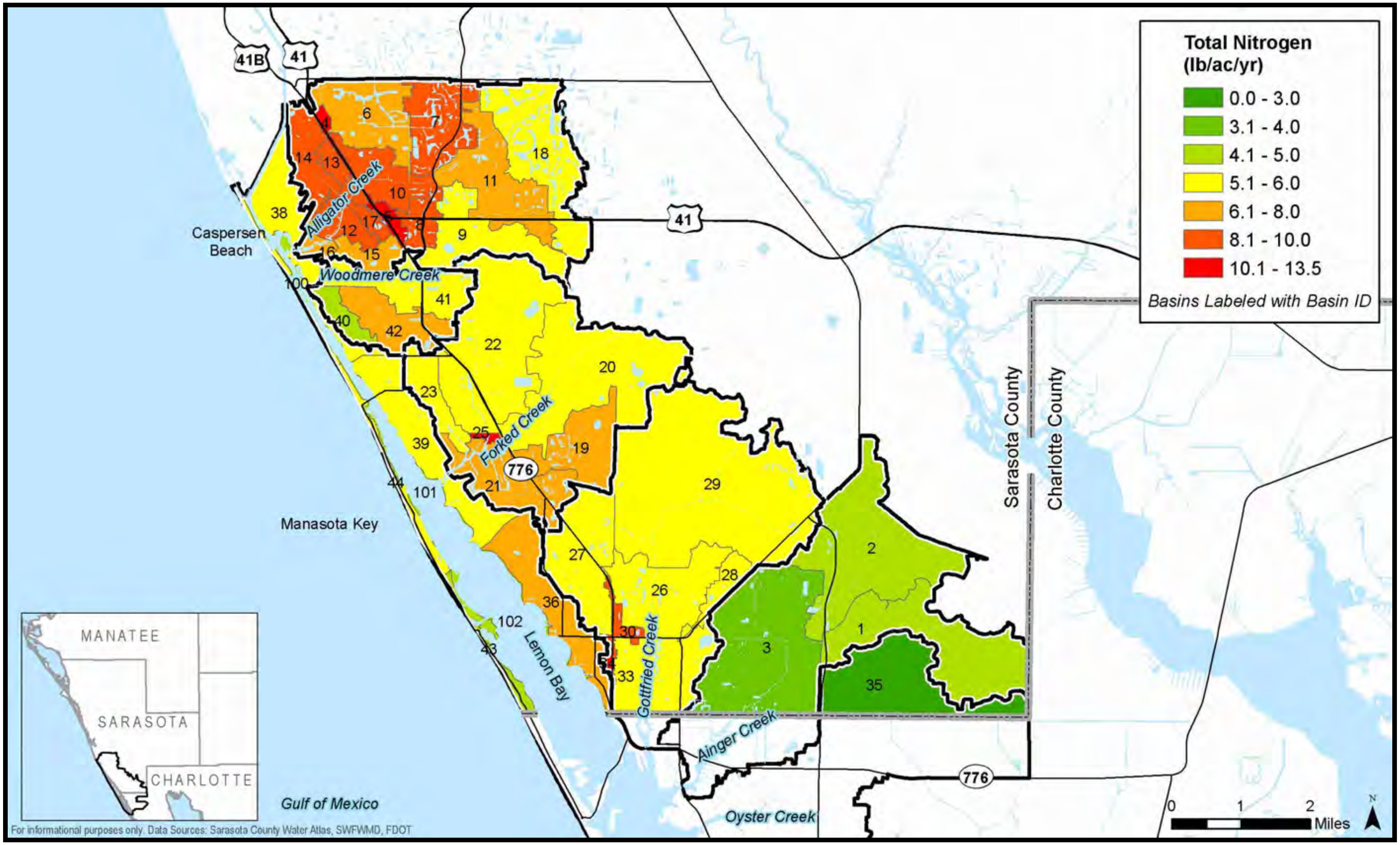


Figure 4-3 Total Nitrogen Loading to Lemon Bay

Table 4-1 Annual Average Pollutant Loads (lb/ac/yr) and Rank

Subbasin ID	Basin Name	ICPR Group	Area (ac)	TSS (lb/ac/yr)	TSS Rank	TP (lb/ac/yr)	TP Rank	TN (lb/ac/yr)	TN Rank
1	Ainger Creek	AIC-EAST	1548.33	42.19	39	0.43	39	4.78	36
2	Ainger Creek	AIC-NRTH	1958.70	44.33	38	0.44	38	4.41	38
3	Ainger Creek	AIC-STH	2052.44	52.58	36	0.62	37	3.92	39
4	Alligator Creek	AC-41NW	73.18	319.98	1	2.24	2	13.34	1
5	Alligator Creek	AC-41SE	113.51	277.32	2	2.20	3	12.22	2
6	Alligator Creek	AC-BRIAR	815.10	102.96	23	1.44	16	7.18	17
7	Alligator Creek	AC-JAC	721.57	162.03	8	1.72	8	8.24	12
8	Alligator Creek	AC-LAT1	243.22	228.95	5	1.54	13	9.19	5
9	Alligator Creek	AC-LAT2	799.60	105.68	21	0.87	29	5.32	31
10	Alligator Creek	AC-LOW	457.47	128.81	14	1.38	17	8.29	11
11	Alligator Creek	AC-MID	948.17	198.82	6	1.73	7	7.82	14
12	Alligator Creek	AC-SVMD	323.12	134.66	11	1.59	11	8.37	10
13	Alligator Creek	AC-SVNE	101.81	127.60	15	1.85	5	9.11	6
14	Alligator Creek	AC-SVNW	446.02	114.39	17	1.72	9	8.44	9
15	Alligator Creek	AC-SVSE	235.42	96.77	25	1.58	12	8.00	13
16	Alligator Creek	AC-SVSW	138.56	130.08	13	1.46	15	7.61	15
17	Alligator Creek	AC-TRPN	88.53	142.18	9	1.78	6	8.85	8
18	Alligator Creek	AC-UP	1293.83	118.10	16	1.13	22	5.32	30
19	Forked Creek	FC-BOCA	719.31	130.14	12	1.19	19	6.10	20
20	Forked Creek	FC-EAST	1952.02	101.54	24	0.82	31	5.59	26
21	Forked Creek	FC-LOWER	813.19	140.45	10	1.35	18	6.34	18
22	Forked Creek	FC-MID	1966.30	92.27	28	0.81	32	5.28	33
23	Forked Creek	FC-WEST	382.66	90.89	29	1.08	23	5.95	21
25	Forked Creek	LBP-FC	29.12	262.44	3	2.46	1	10.11	4
26	Gottfried Creek	GC-MID	942.70	71.19	35	0.86	30	5.29	32
27	Gottfried Creek	GC-NOLAT	1007.38	87.79	32	0.99	27	5.65	24
28	Gottfried Creek	GC-RIVER	213.49	88.70	30	0.70	36	5.51	28
29	Gottfried Creek	GC-UPPER	3758.43	109.70	19	0.81	33	5.25	34
30	Gottfried Creek	GC-776	148.63	182.90	7	1.54	14	8.87	7

Table 4-1 Annual Average Pollutant Loads (lb/ac/yr) and Rank

Subbasin ID	Basin Name	ICPR Group	Area (ac)	TSS (lb/ac/yr)	TSS Rank	TP (lb/ac/yr)	TP Rank	TN (lb/ac/yr)	TN Rank
33	Gottfried Creek	GC-LOWER	941.71	109.83	18	1.00	26	5.48	29
34	Gottfried Creek	GC-LOWER	25.80	247.30	4	1.86	4	10.56	3
36	Lemon Bay Coastal	LBC-LOWER	886.92	109.15	20	1.14	21	6.28	19
38	Lemon Bay Coastal	LBC-UPPER	895.18	95.54	26	0.96	28	5.64	25
39	Lemon Bay Coastal	LBC-MID	977.88	71.73	34	1.02	25	5.56	27
40	Woodmere Creek	LBP-WC	220.86	50.86	37	0.72	35	4.85	35
41	Woodmere Creek	WC-NORTH	696.78	88.13	31	1.16	20	5.93	22
42	Woodmere Creek	WC-SOUTH	557.05	94.50	27	1.65	10	7.37	16
43	Lemon Bay Coastal	LBC-LOWER	219.60	71.96	33	0.79	34	4.73	37
44	Lemon Bay Coastal	LBC-MID	278.78	104.77	22	1.04	24	5.78	23

4.1 POLLUTANT REDUCTION EFFICIENCIES IN BEST MANAGEMENT PRACTICES

Structural BMPs provide treatment for stormwater runoff. Structural BMPs are generally stormwater ponds (wet and dry), constructed wetlands, grassed swales or ditches, bioretention systems, and filtration systems. Non-structural BMPs include LID practices, public education, source control, BMP inspection and maintenance, conservation easements, and buffer zones. A complete discussion of BMPs is provided in Chapter 7, Section 4.

The SIMPLE model calculates removal of pollutants from runoff for BMPs in a given subbasin. Existing BMP pollutant removal is included in the total pounds per acre per year loading. The model uses the following removal efficiencies in the runoff loading calculations:

Table 4-2 Modeled Removal Efficiencies

SIMPLE Model	Removal Efficiency (%)		
BMP Type	TSS	TP	TN
Dry Retention	90	90	27
Wet Detention	90	70	90
Dry Retention with Filtration	90	50	90

4.1.1 Source Control

Source control is a part of non-structural best management practices that reduces sedimentation and improves water quality before runoff reaches the County's waterways.

Street Sweeping

New technology incorporated into street sweepers has brought about a re-evaluation of the benefits and effectiveness of street sweeping. Vacuum-assisted and regenerative-air sweepers are now able to pick up the fine-grained sediments that carry a large portion of the pollutant load. Two distinctive but not mutually exclusive removal rates are cited in the literature: the removal of sediment load and the removal of nutrients associated with the sediment load due to stormwater runoff.

The amount of sediment removed by street sweeping depends on several factors. The intensity of a rainfall event, the length of time between events, particle size, land use, and the location of the impervious surface (up gradient or down gradient) all contribute to determining the efficiency of removal and the quantity of sediment removed from the potential sediment load to stormwater runoff. The frequency of sweeping in wet and dry seasons impacts the overall removal rates and the US Geological Survey reports that only a small fraction of the total load is removed unless intensive sweeping programs are implemented. Total sediment load reduction by street sweeping is cited in the literature as 15 to 90% of the potential sediment load to the stormwater system.

Sedimentation Devices

Sedimentation devices (e.g., CDS Units, baffle boxes) are designed to retain coarse-grained sediment with fine-grained sediment usually passing through. The removal efficiency of the unit depends on the size of the sump and the amount of sediment and debris collected in the sump. As the sump fills, the efficiency of sediment removal starts to decrease; sediment captured in the sump will start to become re-suspended in the water column as the sump is filled and collected debris will be flushed downstream.

Maintenance Buffer

Buffer zones along watercourses provide important benefits, including water quality improvement, flood protection, bank stabilization, and habitat protection. While most research has focused on forested buffers, the same benefits may be realized in an urban setting. A buffer in an urban setting is typically an area of vegetation consisting of trees, shrubs, and grass designed to:

- ❖ Trap and remove sediment, phosphorus, nitrogen and other nutrients.
- ❖ Protect stream banks from erosion by providing hearty root systems to increase the cohesiveness of the soil matrix and reduce the velocity of overland flow.

Width, slope, and sediment size impact removal efficiency of a buffer zone. Previous studies recommend a 15-ft minimum buffer.

Table 4-3 shows the range of removal efficiencies of structural, nonstructural, and source control BMPs found in technical publications.

Table 4-3 Range of Pollutant Removal Efficiencies (%) of Common BMPs

Study	Year	Dry Retention			Wet Detention			Dry Retention w Filtration			Offline Systems/ Constructed Wetlands			Porous Pavement			Grassed Swales			Bioretention			Other Filtration			Buffer Zones			Street Sweeping			Catch Basin/Baffle Box		
		TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN	TSS	TP	TN
Evaluation of Current Stormwater Design Criteria within the State of Florida	2007	80-99	61-99	80-99	55-94	20-91	4-63	77-98	0-92	0-80	89-95	76-92	30-85	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
The Cost and Effectiveness of Stormwater Management Practices	2005	—	15-45	—	—	30-65	—	—	50-80	—	—	15-45	—	—	30-65	—	—	15-45	—	—	—	—	—	30-80	—	—	—	—	—	—	—	—	—	—
Technical Memorandum: The Runoff Reduction Method	2008	—	—	—	—	50-75	30-40	—	25	15	—	50-75	25-55	—	25	25	—	15	20	—	20-40	40-60	—	60-65	30-45	50-85	—	—	—	—	—	—	—	—
Urban Pollutant Loads and General BMP Cost Analysis	2005	50	30	—	90	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Effective Use of BMPs in Stormwater Management	2005	61	19	21	58-78	48-62	21-43	75	60-70	55-60	36-96	21-89	19-48	82-95	65	80-85	7-69	14-37	14-55	80	65-87	49	—	—	—	—	—	—	37-50	9-28	—	10-25	—	—
Permeable Pavement Summary Fact Sheet	2005	—	—	—	—	—	—	—	—	—	—	62	88	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stormwater Pollutant Removal Criteria	2004	40-60	20	20	50-90	50	30	—	—	—	90	50	30	0-80	60	50	—	—	—	90	60	30	60-80	30-50	30-35	—	30	30	—	—	—	—	—	—
Stormwater Management Program for Nutrient Control	2004	—	—	—	—	40	25	—	—	—	—	35	40	—	—	—	—	20	20	—	35	40	—	45	35	—	—	—	—	—	—	—	—	—
Riparian Forest Buffer Practice and Riparian Grass Buffer Practice	2007	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	45-65	65-85	—	—	—	—	—	—
Final Report of the Statewide Task Force on Riparian Forest Buffers	2000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	37-99	6-97	7-95	—	—	—	—	—	—
Deriving Reliable Pollutant Removal Rates for Municipal Street Sweeping	2008	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18-72	10-30	15-45	39-75	3-6	14-27
Potential Effects of Structural Controls and Street Sweeping on Stormwater Loads to the Lower Charles River, Massachusetts	2002	62	46	—	62	46	—	78	56	—	—	—	—	—	—	—	—	—	—	45	32	—	—	—	—	—	—	—	25-95	5-90	—	—	—	—
Residential Street Dirt Accumulation Rates and Chemical Composition and Removal Efficiencies	2004	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20-92	—	—	—	—	—
New Developments in Street Sweeper Technology Article 121	2002	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	45-65	30-55	—	—	—	—
Stormwater Best Management Practices in an Ultra Urban Setting: Selection and Monitoring	2006	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55-93	40-74	42-77	—	—	—

Complete references provided in Appendix G.

5.0 POTENTIAL PROJECTS

Using the results of field investigations and previous studies, Jones Edmunds prepared 24 conceptual plans (Table 5-1) for potential erosion- and sedimentation-control projects within the Lemon Bay Watershed. The projects originate from two sources: field investigations and previous studies. The first type is conceptual plans developed under this study for the more severe in-stream erosion and sedimentation problems identified by County maintenance staff and during Jones Edmunds' field investigations for areas that were not analyzed under previous studies. The second type of project comes from the recommendations included in previous sediment abatement studies and other special-interest studies.

In the discussions on the second type of projects, suggested modifications to the original recommendations are included where applicable and included in the conceptual plans. The revisions are based on current site evaluations and recommendations formed within the framework of this study. The Sediment Abatement Studies were evaluated as overall projects, not as the individual sites.

Evaluation and prioritization of the projects are summarized in Section 6.

5.1 CONCEPTUAL PLAN DESCRIPTIONS AND FIGURES

Sarasota County streams present several challenging elements for restoring and managing sediment that are common in many urban settings:

- Steep channel side slopes.
- Unconsolidated sand side slopes causing unstable conditions.
- Narrow channel corridors resulting from limited drainage easements and rights-of-way.
- Need for continuing channel maintenance.

County staff identified several locations for potential improvement. The field investigations described in Section 3 identified additional sites. Additionally, Jones Edmunds reviewed recommendations from previous studies and revised some of the recommendations based on current conditions. While the improvements are intended to relieve persistent sediment accumulation and erosion problems, the long-term effect is the reduction of the sediment load to the stream or creek and ultimately to Lemon Bay. As part of the SMP, Jones Edmunds prepared conceptual plans for 24 of the sites as these locations represent the most severe problems identified.

Table 5-1 shows the conceptual plans grouped by subbasin area and Figure 5-1 shows the location of each proposed project within the watershed.

Table 5-1 Conceptual Plan Identification		
Plan ID	Subbasin	Project Name
LBS01	Alligator Creek	Siesta Ditch North
LBS02	Alligator Creek	Siesta Ditch South
LBS03	Alligator Creek	Datura Ditch
LBS04	Alligator Creek	Lake Magnolia
LBS05	Alligator Creek	Briarwood Rd to Alligator Creek
LBS06	Alligator Creek	Woodmere Park Library
LBS07	Alligator Creek	Venice Gardens WRF
LBS08	Alligator Creek	Alligator Creek at US 41 Bridge
LBS09	Alligator Creek	General
LBS26	Alligator Creek	Venice East Low-Impact-Development Demonstration Project
LBS10	Woodmere Creek	Woodmere Creek at US 41
LBS11	Woodmere Creek	Heron Rd and Seneca Rd
LBS12	Forked Creek	5th Street
LBS13	Forked Creek	Overbrook Drive
LBS14	Forked Creek	Fairview Dr
LBS15	Forked Creek	Bridge St
LBS16	Forked Creek	Forked Creek at US 41
LBS17	Forked Creek	Buchan Airport
LBS18	Forked Creek	General
LBS19	Gottfried Creek	Court St-Langsner St
LBS20	Gottfried Creek	Cortes Dr
LBS21	Gottfried Creek	General
LBS22	Ainger Creek	Melody Rd
LBS23	LB Coastal	Cherokee St
LBS24	LB Coastal	Magnolia Ave
LBS25	LB Coastal	Dearborn Street Low-Impact-Development Pilot Project

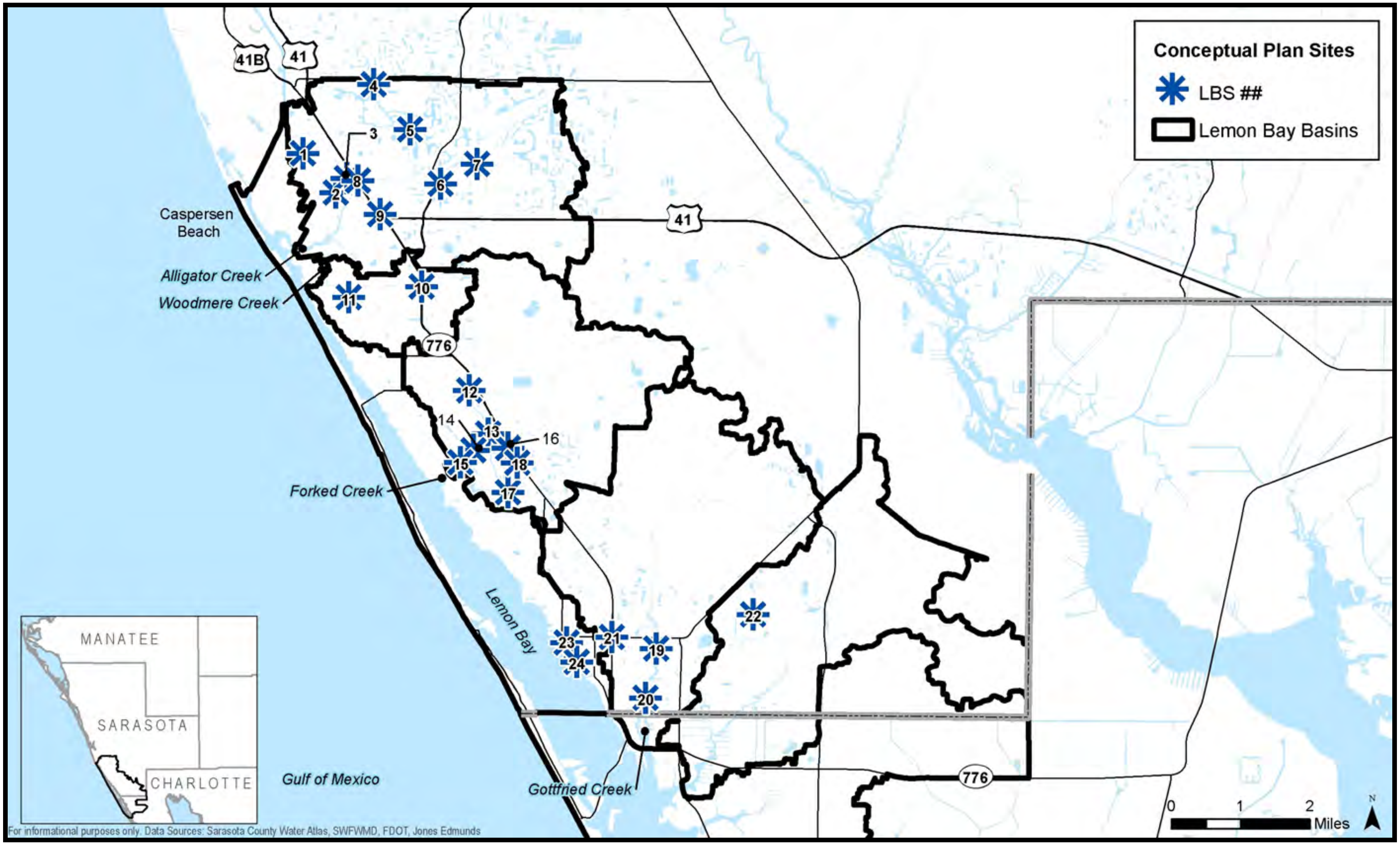


Figure 5-1 Conceptual Plan Site Locations

5.1.1 Alligator Creek Basin

5.1.1.1 LBS01: Siesta Ditch North

The 2006 Alligator Creek SMP characterizes the banks as highly eroded with severe sloughing and considerable sediment deposition along the channel bottom. Conceptual-level bank treatment recommendations from the study are to stabilize the banks via gabions, revegetate the banks with desirable herbaceous species, and schedule regular maintenance.

Quincy Road runs parallel to the north segment of Siesta Ditch for approximately half a mile. Quincy Road, as well as the adjacent roadways, do not have a curb and gutter system and are in poor condition with accumulated sediment and gravel on the surface and along the edge of pavement. Much of the sediment on the roadway is crumbling roadway material that moves to the channel segment when runoff commences. Four culverts discharge into the upstream end of the channel segment from residential areas that do not have any stormwater treatment. Two corrugated pipes project into the channel without any erosion control visible. Figure 5-2 shows the following recommended sediment control improvements at the site:

- ❖ Adding a sediment removal structure at the upstream discharges.
- ❖ Amending soil, hydroseeding, and planting adjacent to Quincy Road.
- ❖ Disconnecting roof drains.
- ❖ Adding riprap to outfalls.
- ❖ Adding a sediment sump downstream.
- ❖ Regrading top of bank adjacent to Quincy Road.
- ❖ Add trees and shrubs to the top of bank adjacent to Siesta Drive.

5.1.1.2 LBS02: Siesta Ditch South

The 2006 Alligator Creek SMP characterizes the banks as sloughing due to direct runoff from Siesta Drive. Conceptual-level bank treatment recommendations from the study are to construct a curb along Siesta Drive to divert stormwater away from the system, stabilize the banks via gabions, revegetate the banks with desirable herbaceous species, and schedule regular maintenance.

The site is located at the intersection of Siesta Drive and West Baffin Road. The soil quality along the top of bank and adjacent to the roadway is poor, as is the soil matrix of the side slopes. The steep banks are characterized by erosion and sloughing. Sediment depth upstream of the culvert under West Baffin Road was measured at 1.5 feet on the toe of slopes and 0.6 feet at the stream centerline. The homes in the surrounding residential area are on septic systems. Recommended sediment control improvements at the site are:

- ❖ Monitoring water quality.
- ❖ Incorporating a sidewalk, bioswale, trees, and vegetation along the top of bank.

- Amending soil to improve moisture-holding capacity.
- Removing nuisance vegetation.
- Adding native vegetation on the banks to stabilize slopes and in the flowpath to improve water quality.
- Installing a low-flow sedimentation weir.
- Adding riprap.

5.1.1.3 LBS03: Datura Ditch

The channel extends between the backyards of the homes on Datura Road and Virginia Avenue and the drainage easement is only 20 feet wide leaving little space for channel improvements. Bank stabilization with geoweb and geofabric may be a first alternative and if unsuccessful, the problem may require hardening the steep banks with gabions.

5.1.1.4 LBS04: Lake Magnolia

Several FDEP 319 grant projects are currently being proposed for the lake system. These projects have not been finalized as of this submittal date and are not included in the analysis of the site.

Based on the County's ICPR model, a 30-acre catchment including over 1 linear mile of Center Road drains to Lake Magnolia. The lake is plagued with several water-quality issues and adding a sediment removal structure to the upstream end would help to alleviate much of the sediment load reaching the lake from Center Road. Additionally, street-sweeping would provide source control to reduce the amount of sediment being carried in stormwater runoff to the lake. Figure 5-4 shows the recommended sediment control improvements at the site:

- Adding a sediment removal structure.
- Sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.

5.1.1.5 LBS05: Briarwood Road to Alligator Creek

The County-wide Weir Study scored the site with 3 points based on an exceedance of SCTL-R of arsenic; the target is 0.8 mg/kg and the measured concentration was 1.5 mg/kg. No recommendations were made in the study for the site.

The 2006 Alligator Creek SMP characterizes the banks as highly eroded with sloughing slopes and sediment deposition apparent in the channel bottom. The banks show overgrowth of nuisance and exotic vegetation. Conceptual-level bank treatment recommendations from the study are to reduce the slopes from 2:1 to 4:1, widen the bottom along the eastern bank, remove nuisance and exotic vegetation, stabilize the bank via erosion control blankets, revegetate banks with desirable herbaceous species, and schedule regular maintenance.

The channel shows signs of erosion, sloughing, and undercutting. Urban debris was found along the entire segment. Homes along the southern portion of the channel have roof drains discharging directly to the channel. Denuding of the roadside swales that discharge to the channel is common practice that adds to the heavy sedimentation observed through the segment. Figure 5-6 shows the recommended sediment control improvements at the site:

- ❖ Adding a maintenance buffer.
- ❖ Regrading and revegetating banks.
- ❖ Amending soil to improve moisture-holding capacity.
- ❖ Stabilizing banks with geoweb and geofabric.
- ❖ Disconnecting roof drains.

5.1.1.6 LBS06: Woodmere Park Library

The 2006 Alligator Creek SMP characterizes the channel segments as relatively shallow with minimal signs of erosion and contributing less sediment to Alligator Creek than other segments. Conceptual-level bank treatment recommendations from the study are to widen the ditch bottom along the western bank, reduce the slopes from 2:1 to 4:1, stabilize the banks via erosion control blankets, revegetate the banks with desirable herbaceous species, and schedule regular maintenance.

The steep banks show signs of sloughing, erosion, and undercutting at the flow line. The channel segment is within a County-owned easement. Regrading the banks, amending the soil, and planting native plants with hearty root systems is recommended. Figure 5-7 shows the recommended sediment control improvements at the site:

- ❖ Adding a buffer zone.
- ❖ Amending soil to improve moisture-holding capacity.
- ❖ Adding riprap at outfalls.
- ❖ Removing accumulated sediment.

5.1.1.7 LBS07: Venice Gardens WRF

The 2006 Alligator Creek SMP characterized the channel segment as showing minimal erosion at the downstream outfall to Alligator Creek with bank erosion increasing in severity at the upstream end near Tamiami Trail. Conceptual-level bank treatment recommendations from the study are to widen the bottom along the eastern bank, reduce the slopes from 2:1 to 4:1, stabilize the banks via erosion control blankets, revegetate the banks with herbaceous species, and schedule regular maintenance.

The segment is characterized by steep sandy banks with nuisance vegetation. The easement available for remediation varies in width along the segment and the recommendations vary accordingly. Figure 5-8 shows the recommended sediment control improvements at the site:

- Adding a buffer zone.
- Regrading and revegetating banks.
- Stabilizing banks using geoweb and geofabric.
- Amending soil to improve moisture-holding capacity.

5.1.1.8 LBS08: Alligator Creek at US 41 Bridge

The ACSMP characterizes the erosion in the channel from minimal to severe. The southern banks of the system have steep, sandy slopes and show signs of sloughing and undercutting. Recommendations from the study include reducing the slopes from 2:1 to 4:1, stabilizing the banks via erosion control blankets, revegetating the banks with herbaceous species, scheduling regular maintenance, removing Brazilian Pepper with herbicide application, restoring mangroves, and installing a culvert.

This site is located upstream of the US 41 bridge at Alligator Creek. The stream reach is tidally influenced. The north bank is lined with mangroves and residential properties. The south bank is very steep and shows signs of erosion and instability. No vegetation is found on the slope into the watercourse on the south bank. During field reconnaissance, several acres of water lettuce and terrestrial plants had herbicide applied and were left to decompose in the watercourse. Although this is common practice, the plant matter settles to the bottom and creates organic "soup" that is detrimental to the health of the ecosystem. Figure 5-9 shows the following recommended sediment control improvements at the site:

- Stabilizing the top of bank and toe of slope with geoweb and geofabric.
- Removing excess nuisance vegetation from the north bank and restoring the mangroves.
- Disconnecting the roof drains.
- Avoid impacts to mangroves on the north bank.
- Adding a recreational trail.

5.1.1.9 LBS09: Alligator Creek General

Results from the SIMPLE model show US41 through Alligator Creek ranked Number 1 in pounds per acre per year for TSS in the watershed. Sediment source control recommended for the site (Figure 5-10) is sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.

5.1.1.10 LBS25: Venice East Low-Impact-Development Demonstration Project

Sarasota County in partnership with the Southwest Florida Water Management District (SWFWMD) has finished a draft of a Low Impact Development (LID) Manual for the Sarasota County area. The manual covers four LID techniques including:

- Greenroofs with cisterns.
- Pervious paving.
- Stormwater harvesting.
- Detention with biofiltration.

Biofiltration/bioretention techniques raised numerous questions with the committee that helped develop the manual. Among the questions were concerns about the effect of high seasonal high water tables on the efficiency of treatment techniques that are dependant on infiltration of stormwater. Additionally, there were questions about how bioretention differed from retention that is currently permitted by SWFWMD. Sarasota County believes that the addition of a broader palette of plants as well as possibly "engineered soils" has the potential to improve the efficiency of these systems.

Venice East Blvd is between Center Road and US41 and is surrounded by medium-density residential on the north end, commercial development on the south end, and Alligator Creek in the center. The location for the demonstration project was chosen because of the diversity of the terrain and close proximity to the Creek. The proposed project intends to demonstrate the effectiveness of bioretention areas with a focus on:

- Planting a wide vegetative palette.

- Engineering soil amendments with products such as "Bold and Gold" with a goal of encouraging denitrification of stormwater pollutants that infiltrate through the system.

- Developing soil amendments similar to "Bold and Gold" that are formulated using Sarasota County waste products such as compost and mulch from the Solid Waste handling facility and harvested/dried aquatic vegetation that are specifically formulated to assist with the denitrification process.

- Demonstrating techniques that can be used to retrofit existing neighborhood streets that currently have no stormwater treatment.

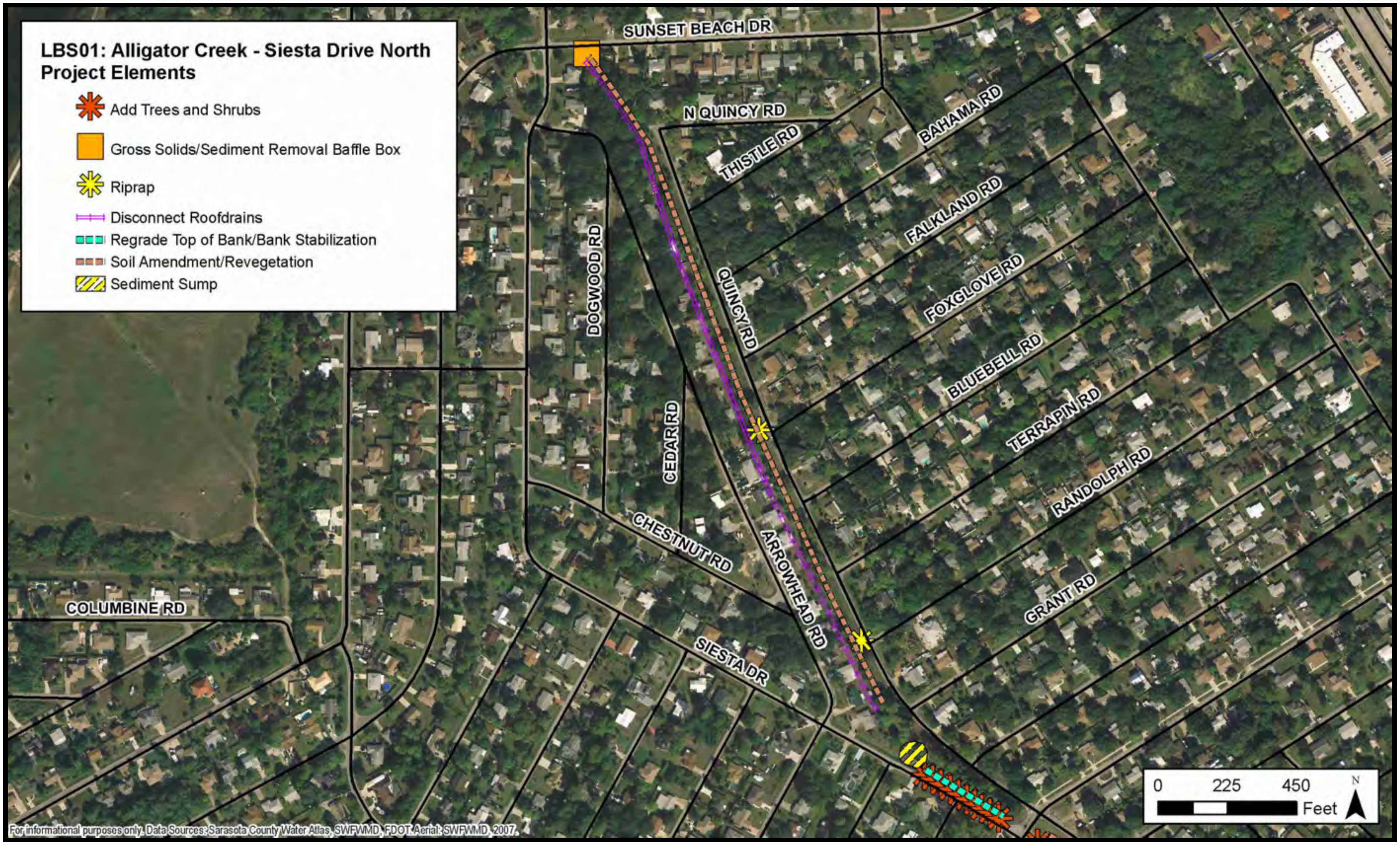


Figure 5-2 LBS01: Alligator Creek: Siesta Ditch North

Figure 5-3 LBS02: Alligator Creek: Siesta Ditch South

Figure 5-4 LBS03: Alligator Creek: Datura Ditch

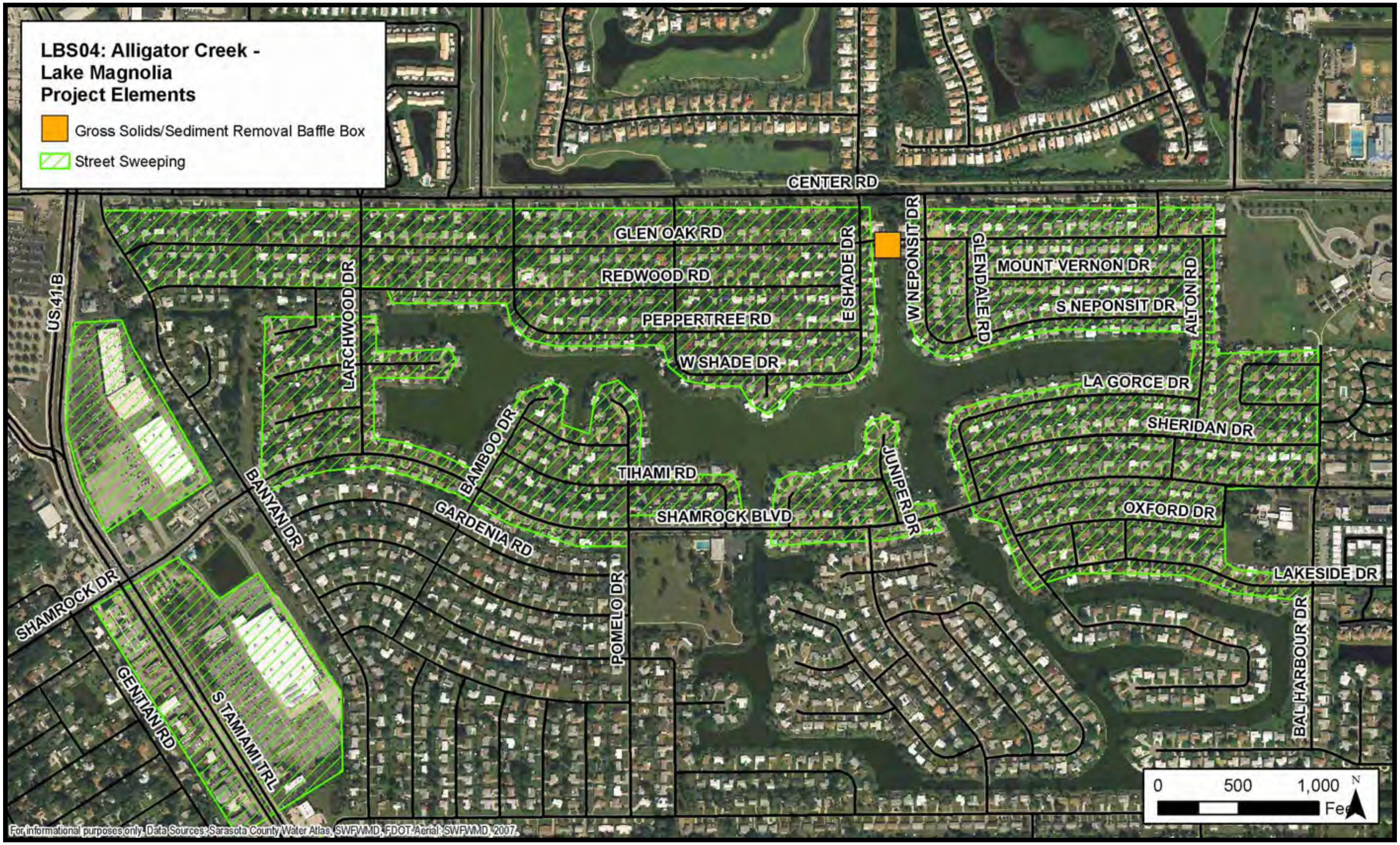


Figure 5-5 LBS04: Alligator Creek: Lake Magnolia

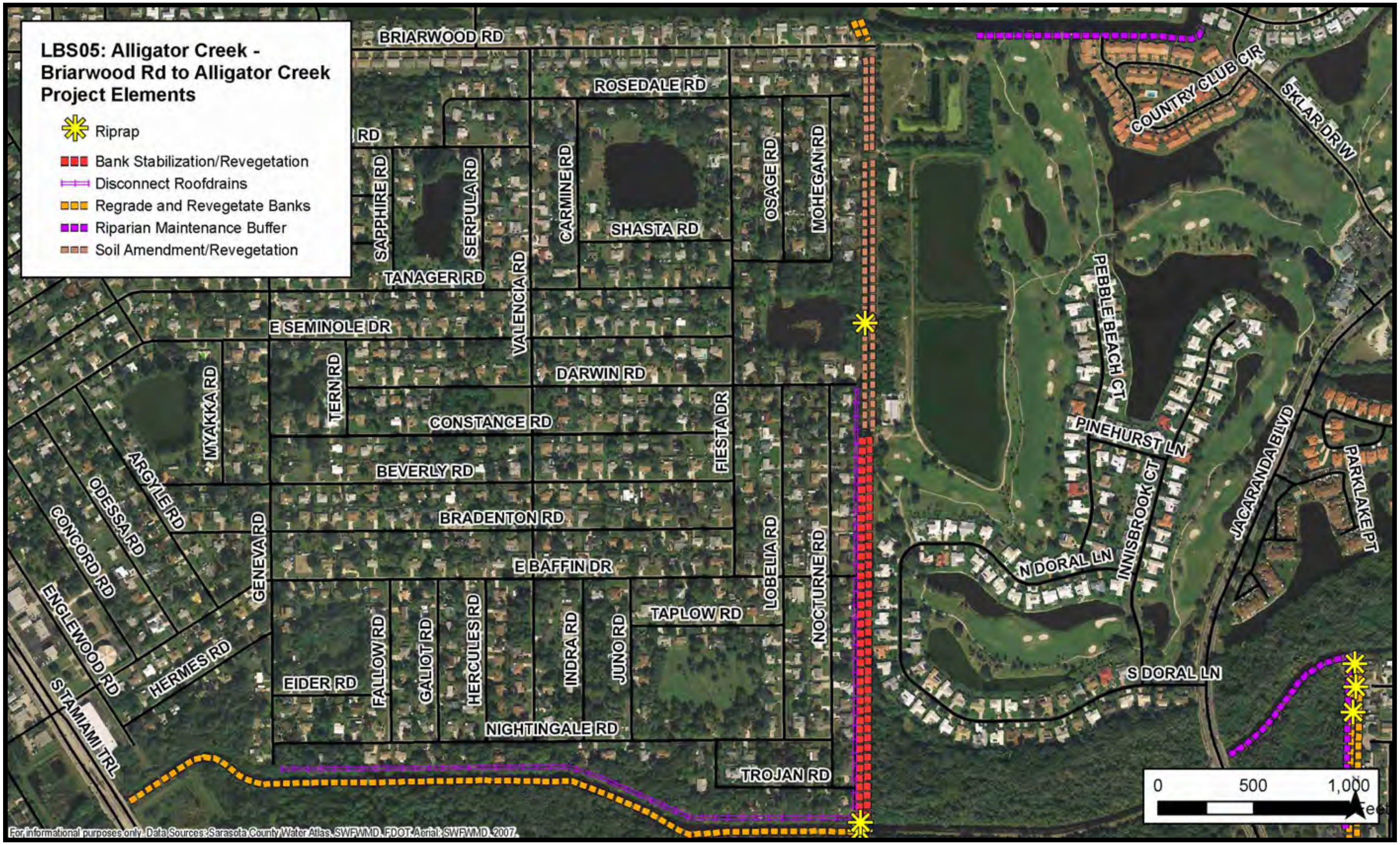


Figure 5-6 LBS05: Alligator Creek: Briarwood Road to Alligator Creek

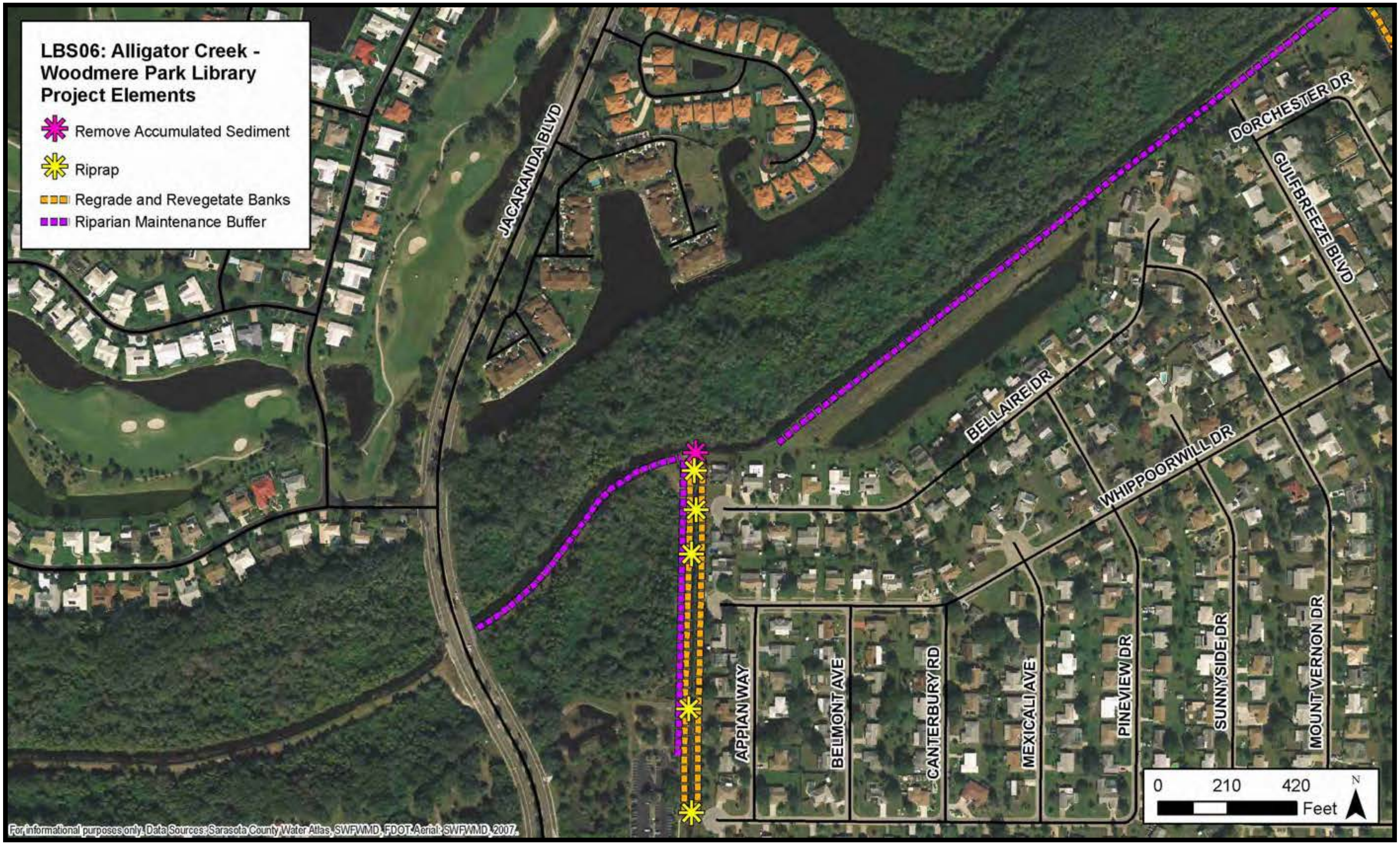


Figure 5-7 LBS06: Alligator Creek: Woodmere Park Library

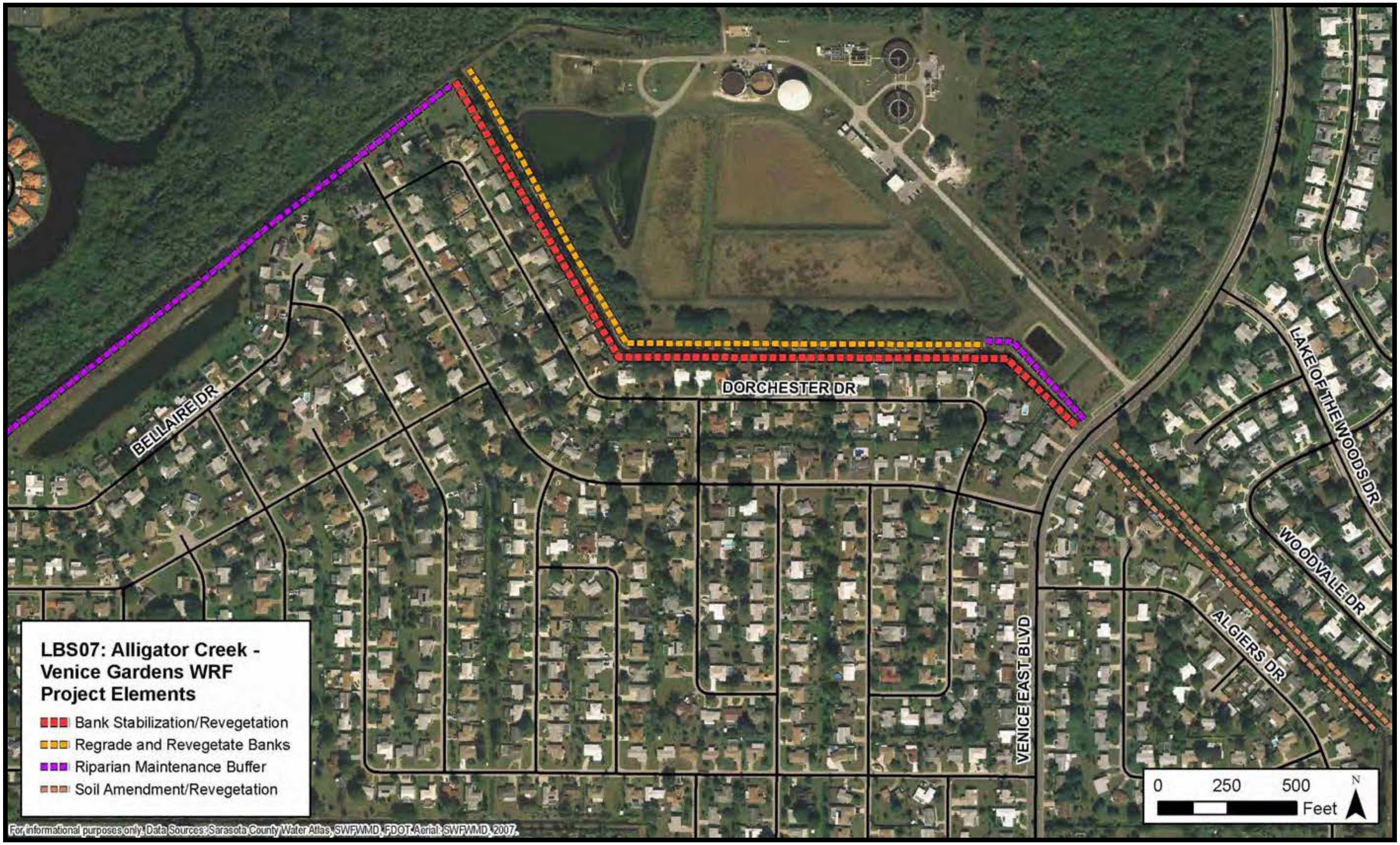


Figure 5-8 LBS07: Alligator Creek: Venice Gardens WRF

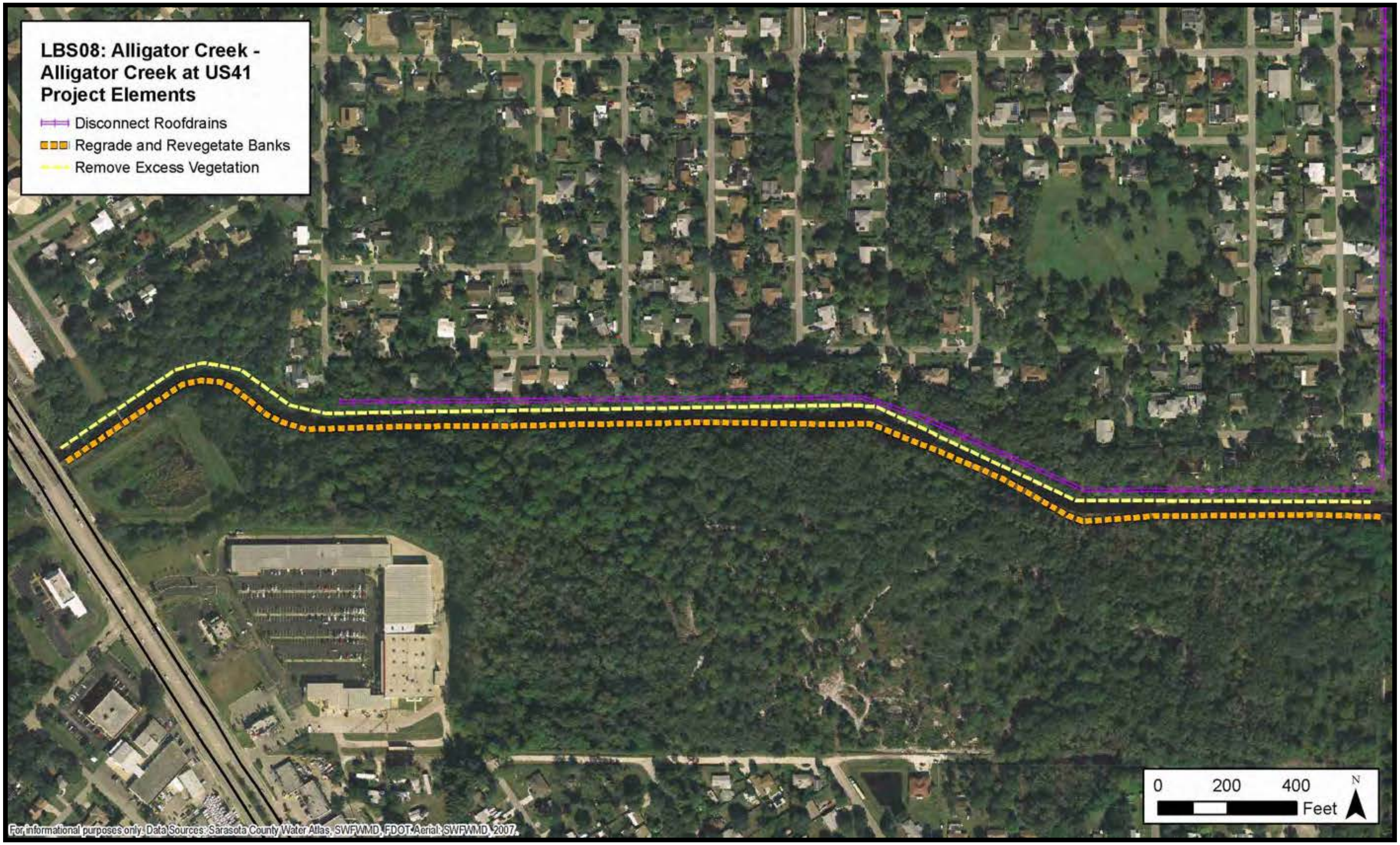


Figure 5-9 LBS08: Alligator Creek: Alligator Creek at US 41 Bridge

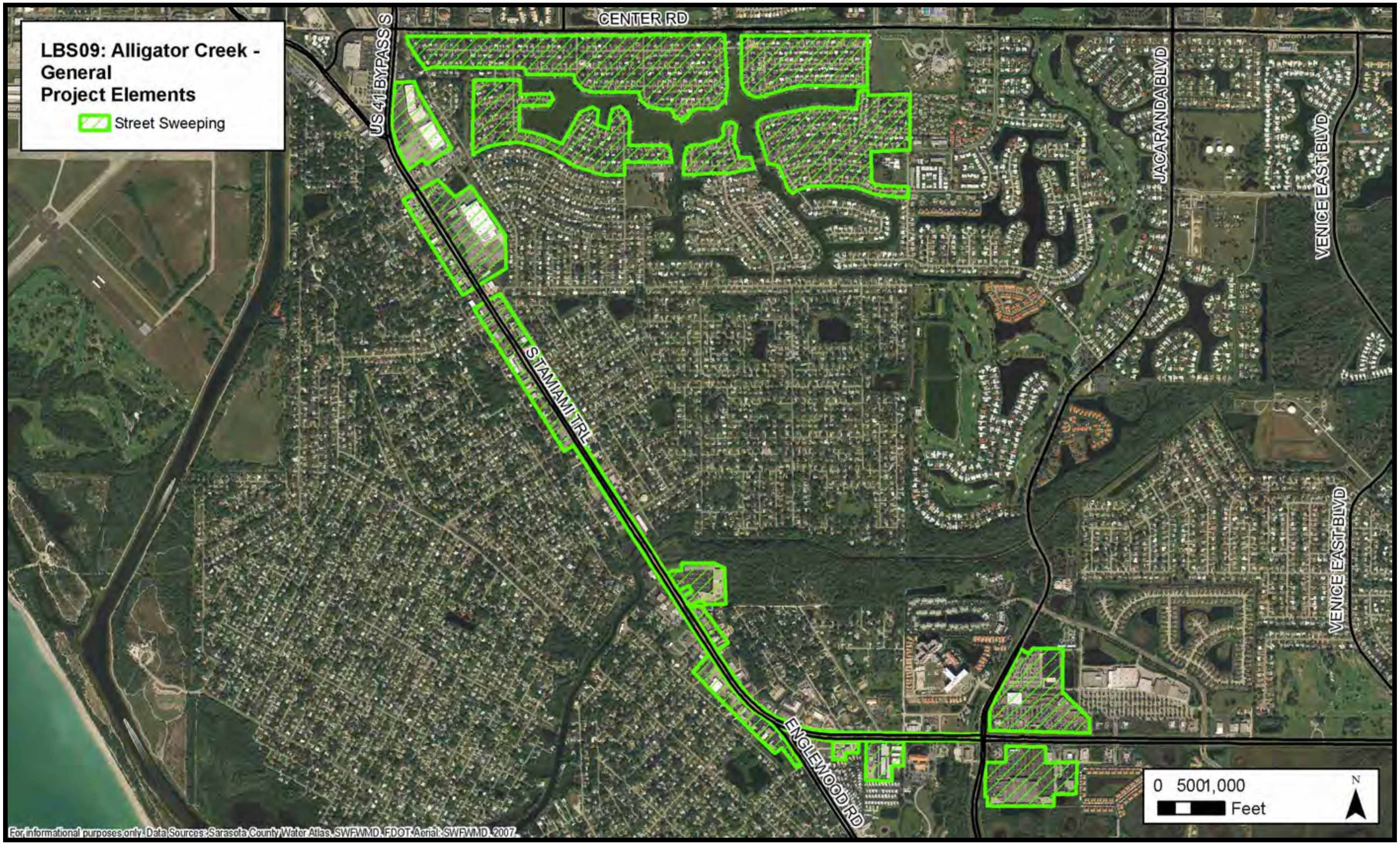


Figure 5-10 LBS09: Alligator Creek: General

5.1.2 Woodmere Creek

5.1.2.1 LBS10: Woodmere Creek at US 41

The site is on the west side of US 41 where Woodmere Creek flows under US 41. Thick, heavy, and exotic nuisance vegetation covers the banks. This site had been denuded by County maintenance crews late in 2007 and contributed heavy sediment loads downstream prior to the re-emergence of the vegetation. Sediment accumulation was observed at the downstream end of the culverts. Sediment depth is 1.3 feet at the outfall. Figure 5-11 shows the following recommended sediment control improvements at the site:

- Removing nuisance vegetation by mechanical means without denuding the banks.
- Monitoring water quality of the runoff from the nursery adjacent to the flea market.
- Adding cisterns for beneficial stormwater runoff use in residential areas.
- Adding riprap to outfalls for erosion control.
- Adding a sediment removal structure.
- Stabilizing banks using geoweb and geofabric.
- Adding a maintenance buffer.

5.1.2.2 LBS11: Heron Road and Seneca Road

The channel is tributary to the Lemon Bay Preserve and on private property. The nuisance vegetation is dense upstream and downstream of the bridge. Figure 5-12 shows the following recommended sediment control improvements at the site:

- Removing nuisance vegetation by mechanical means without denuding the banks.
- Removing accumulated sediment.
- Adding riprap at outfall.

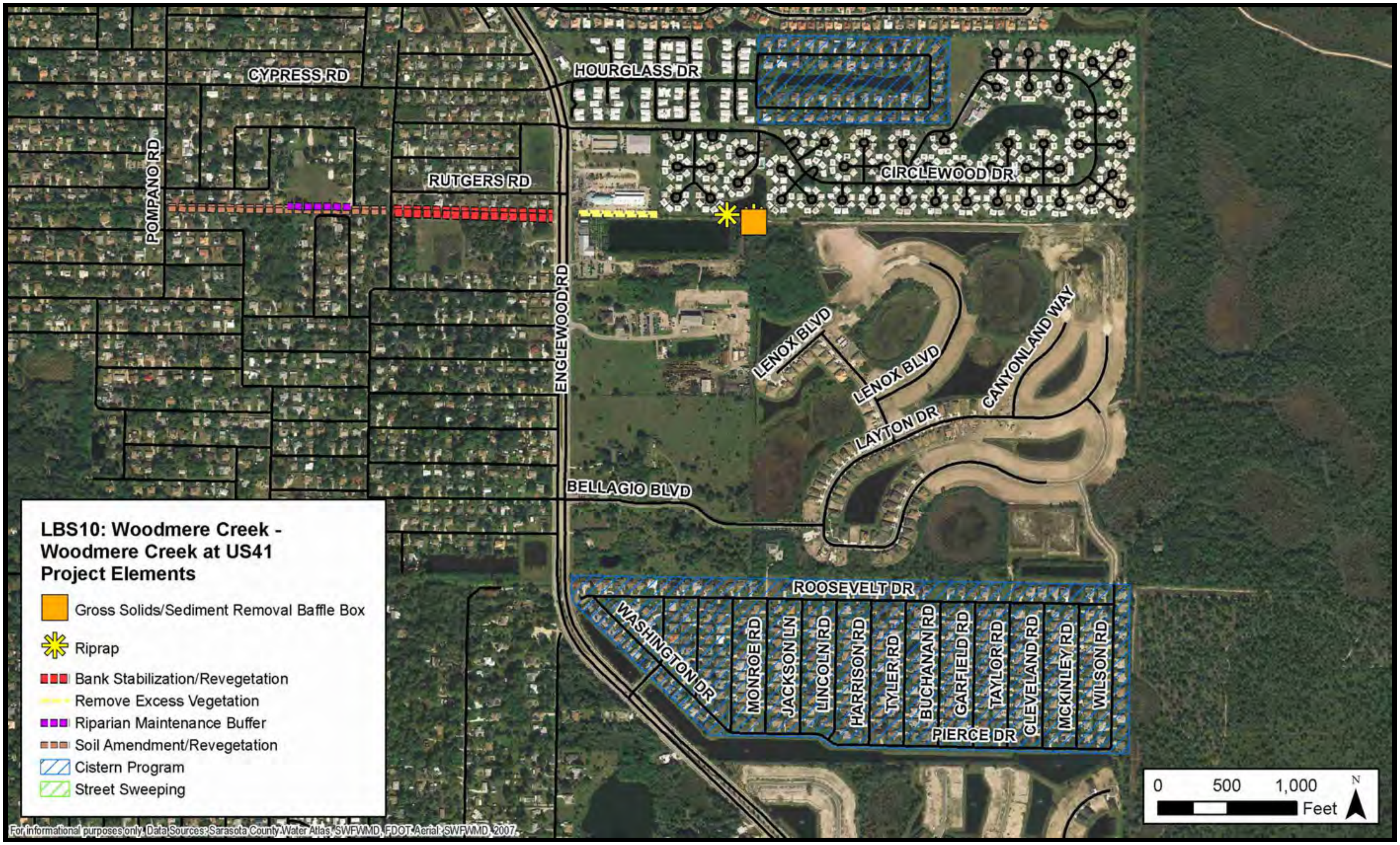


Figure 5-11 LBS10: Woodmere Creek: Woodmere Creek at US41

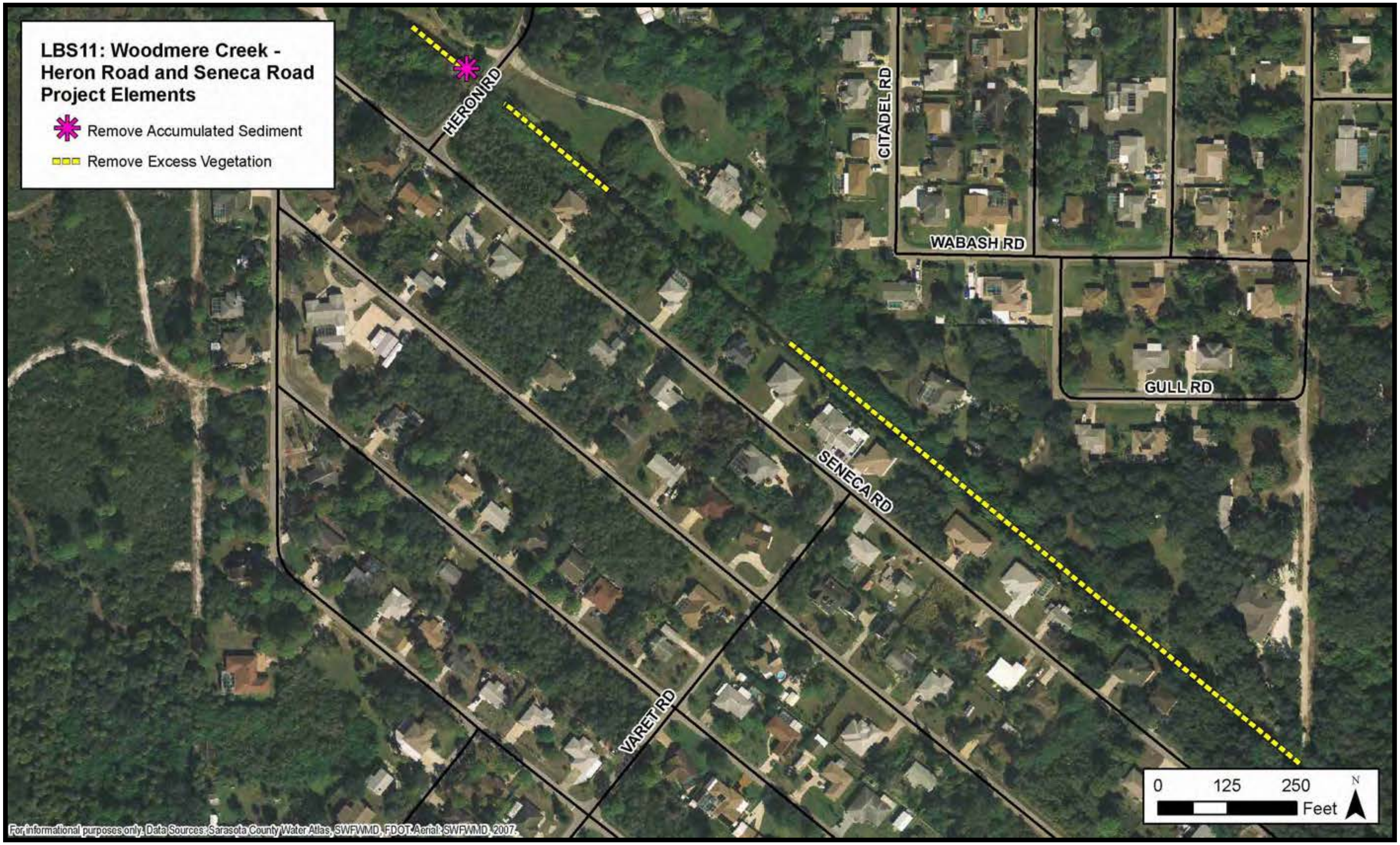


Figure 5-12 LBS11: Woodmere Creek: Heron Road and Seneca Road

5.1.3 Forked Creek

5.1.3.1 LBS12: 5th Street

West of Englewood Road between Shane Road and 5th Street is Dale Lake, an approximately 5-acre stormwater pond. At the south is a channel outfall 1 mile north of Forked Creek. A Sediment Abatement Study identified 14 basins as contributing to the sediment and pollutant load along this tributary to Forked Creek. Maintenance and updating of the culvert-swale system at Keyway Road and East Crest Drive was recommended in the study.

Several opportunities for sediment control were found at the channel outfall from Dale Lake during the field visit. A 400-foot ditch conveys flow from Englewood Road to the lake without any treatment. The ditch outfall is adjacent to the channel outfall from the lake so the residence time for the runoff is minimal. A limestone roadway and parking lot are adjacent to the stormwater system and add to the pollutant load to the lake. Figure 5-13 shows the following recommended sediment control improvements at the site:

- Regrading and revegetating banks
- Adding erosion control and riprap.
- Applying limestone treatment on roadway to reduce dust and particles from washing into the adjacent waterways.
- Adding a bioretention swale to convey flow from Englewood Road to the channel.
- Adding a maintenance buffer.
- Adding a sediment removal structure.

5.1.3.2 LBS13: Overbrook Drive

From the Sediment Abatement Study at Neptune Drive, five basins were identified as contributing to the sediment and pollutant load along this tributary to Forked Creek. No new BMPs were recommended for this reach from the study.

The SIMPLE model results show that this catchment has the third highest TSS load in lb/ac/yr for all of Lemon Bay. On the southwest corner of Overbrook Drive and Forked Creek Drive is an oddly-shaped empty lot. The lot could be utilized as a wet detention pond. Stormwater currently travels through a culvert-swale system to Forked Creek without any attenuation. Supporting infrastructure is necessary to convey the stormwater from Englewood Road and the adjacent neighborhood to the pond. The stormwater pond would function to not only treat runoff but reduce the sediment load currently being conveyed to the creek. Figure 5-14 shows the following recommended sediment-control improvements at the site:

- Adding a stormwater treatment pond
- Building supporting infrastructure.

5.1.3.3 LBS14: Fairview Drive

Fairview Drive ends in a small roundabout less than 40 feet from Forked Creek. The street is entirely built out and the small area between the roundabout and the creek provides a local-scale opportunity for stormwater treatment. The contributing area is 1.2 acres and a dry pond would retain the roadway runoff from small rain events. Figure 5-15 show the following recommended sediment control improvements at the site:

- Adding a dry retention pond at the end of the roadway to provide treatment to stormwater runoff.
- Adding bioretention swales for attenuation and treatment.

5.1.3.4 LBS15: Bridge Street

Bridge Street ends less than 100 feet from the creek. The flow travels down the slope of the roadway directly to the creek. Within the 100 feet that is currently overland flow, a small dry retention pond would retain the roadway runoff from small rain events reducing the amount of sediment being carried directly to the creek. Figure 5-16 shows the following recommended sediment control improvements at the site:

- Adding a dry retention pond at the end of the roadway to provide treatment to stormwater runoff.
- Adding bioretention swales to attenuation and treatment.
- Adding mangroves and riprap to the shoreline to provide additional stability.

5.1.3.5 LBS16: Forked Creek at US 41

During field reconnaissance, residents reported excessive sedimentation on the upstream side of the bridge. Figure 5-17 shows the following recommended sediment control improvements at the site:

- Adding a dry retention pond.
- Adding mangroves and riprap.
- Regrading and revegetating banks.
- Adding riprap.
- Removing an obstruction in the channel.
- Adding a maintenance buffer
- Creating a bioretention swale to capture and treat runoff from the entrance.

5.1.3.6 LBS17: Buchan Airport

The County-wide Weir Study collected samples upstream and downstream of a weir. The sampling indicated a TEL exceedance of cadmium, the target is 0.596 mg/kg and the upstream measurement showed a concentration of 1.2 mg/kg and the downstream showed 1.4 mg/kg. No recommendations were made for the site in this study.

Immediately upstream of the airport fence line is a widening in the creek. On the south side is the end of the airport property and on the north side is a drainage easement behind the Alameda Gardens. This section of airport property is used for RC airplane enthusiasts. By increasing this slightly widened area and lowering the elevation, a treatment wetland could be created, improving the quality of the water entering the canal. A small sediment sump should be at the upstream end of the treatment wetland to catch the sediment moving down the stream bed and causing the sedimentation problem in the canal.

Figure 5-18 shows the following recommended sediment control improvements at the site:

- Adding aquatic plants in flowpath.
- Cutting v-notches in concrete weirs to facilitate flow.
- Adding a maintenance buffer.
- Creating a flow-through wetland.
- Removing accumulated sediment from behind stepped weirs bi-annually.
- Add riprap to discharge structures from Alameda Gardens.

5.1.3.7 LBS18: Forked Creek General

From the SIMPLE model, the TSS in stormwater runoff for the catchments in Forked Creek range from 90.89 lb/ac/yr to 262.44 lb/ac/yr. Several areas have pavement that is pitted and graveled and generally in poor condition. Additionally, sand is blown in from the coastal areas. Recommended sediment-control improvements for areas with degraded pavement are sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.

Figure 5-13 LBS12: Forked Creek: 5th Street

Figure 5-14 LBS13: Forked Creek: Overbrook Drive

Figure 5-15 LBS14: Forked Creek: Fairview Drive

Figure 5-16 LBS15: Forked Creek: Bridge Street

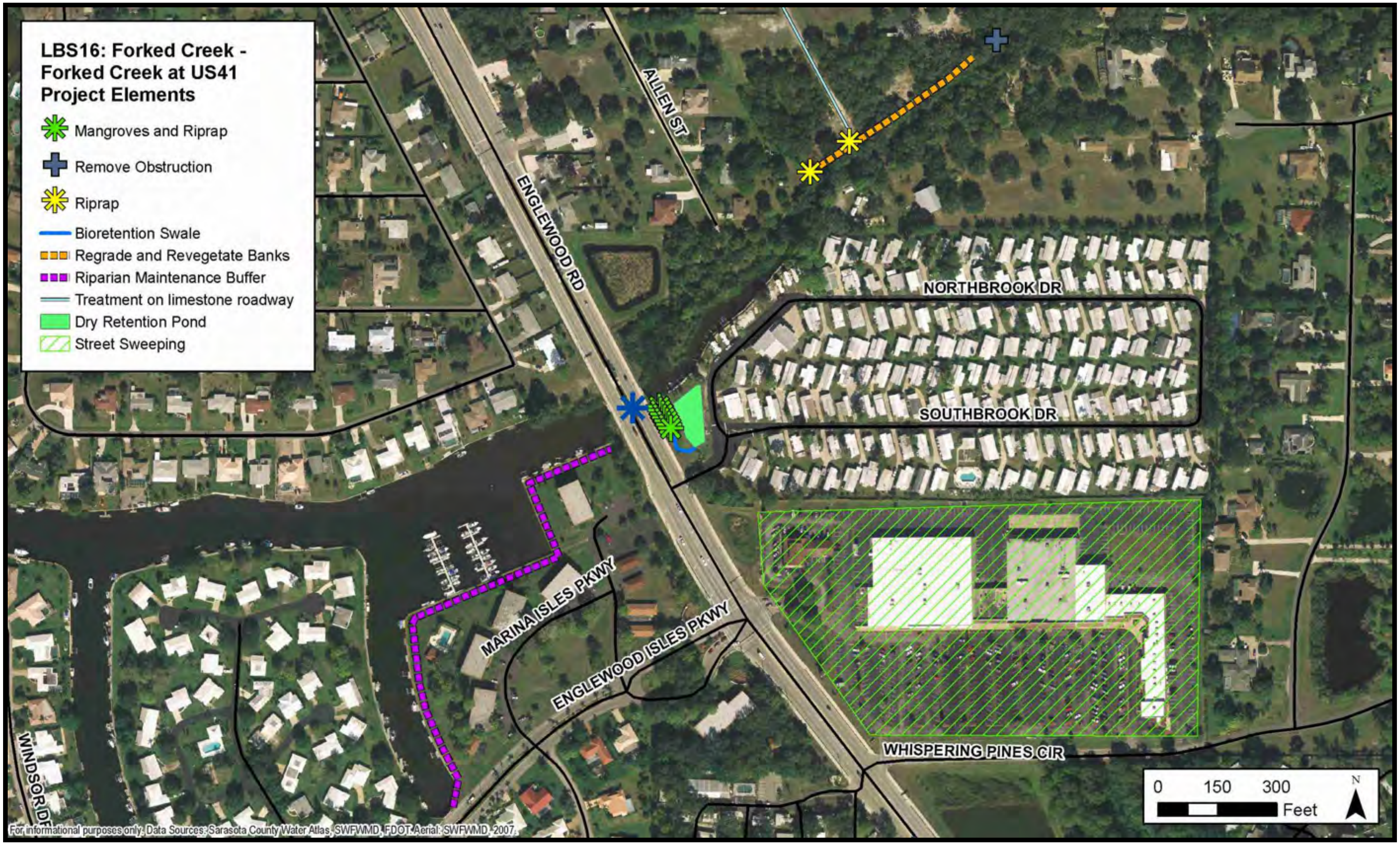


Figure 5-17 LBS16: Forked Creek: Forked Creek at US 41 Bridge

Figure 5-18 LBS17: Forked Creek: Buchnan Airport

Figure 5-19 LBS18: Forked Creek: General

5.1.4 Gottfried Creek

5.1.4.1 LBS19: Court Street-Langsner Street

Court and Langsner Streets are roadways that end within 100 feet of Gottfried Creek. The roadways are not in good repair and have excess gravel and fine sediment accumulated on the surface. The roadways are sloped for stormwater runoff to flow directly to the creek without any attenuation or treatment. A local-scale dry retention pond at the end of each roadway will capture and retain sediment from small rainfall events. Figure 5-20 shows the following recommended sediment control improvements at the site:

- ❖ Adding dry retention ponds at the end of the roadway to provide treatment to stormwater runoff.
- ❖ Adding mangroves and riprap to the shoreline to provide additional stability.

5.1.4.2 LBS20: Cortes Drive

Cortes Drive is a 900 ft roadway flowing toward Gottfried Creek. The existing small depressional area at the end of the cul de sac may allow for some treatment, but additional planting and small scale excavation of a dry retention pond will allow for greater treatment of the roadway runoff in storm events. The following are recommended sediment-control improvements for the site:

- ❖ Adding a dry retention pond at the end of the roadway to provide treatment to stormwater runoff.
- ❖ Adding bioretention swales to attenuation and treatment.
- ❖ Replacing damaged discharge structure.

5.1.4.3 LBS21: Gottfried Creek General

The catchments adjacent to South Indiana Avenue (SR 776) are ranked Numbers 4 and 7 in TSS load lb/ac/yr from the SIMPLE model results. Recommended sediment management through this area is bi-monthly street sweeping because of TSS load.

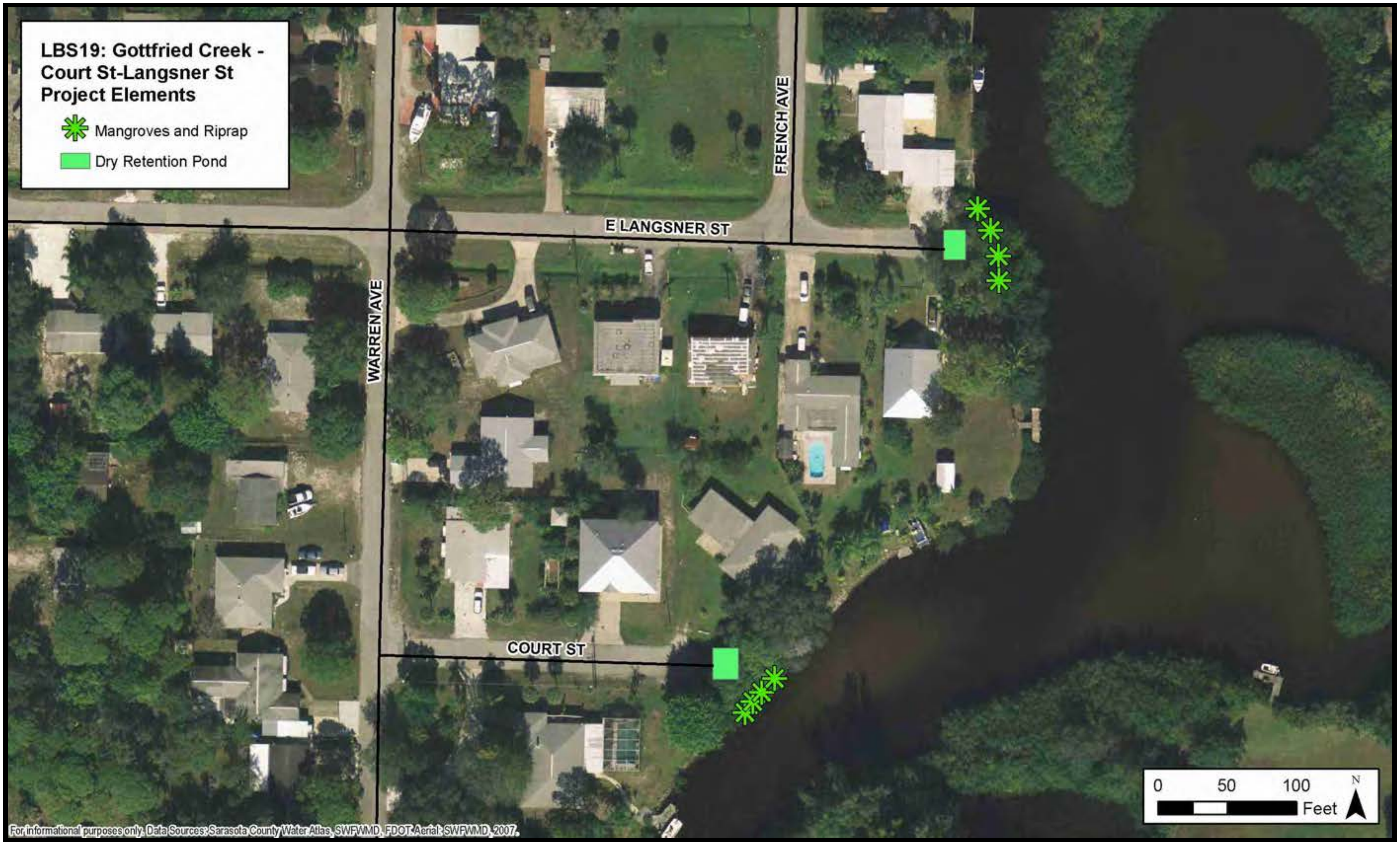


Figure 5-20 LBS19: Gottfried Creek: Court Street and Langsner Street

Figure 5-21 LBS20: Gottfried Creek: Cortes Drive

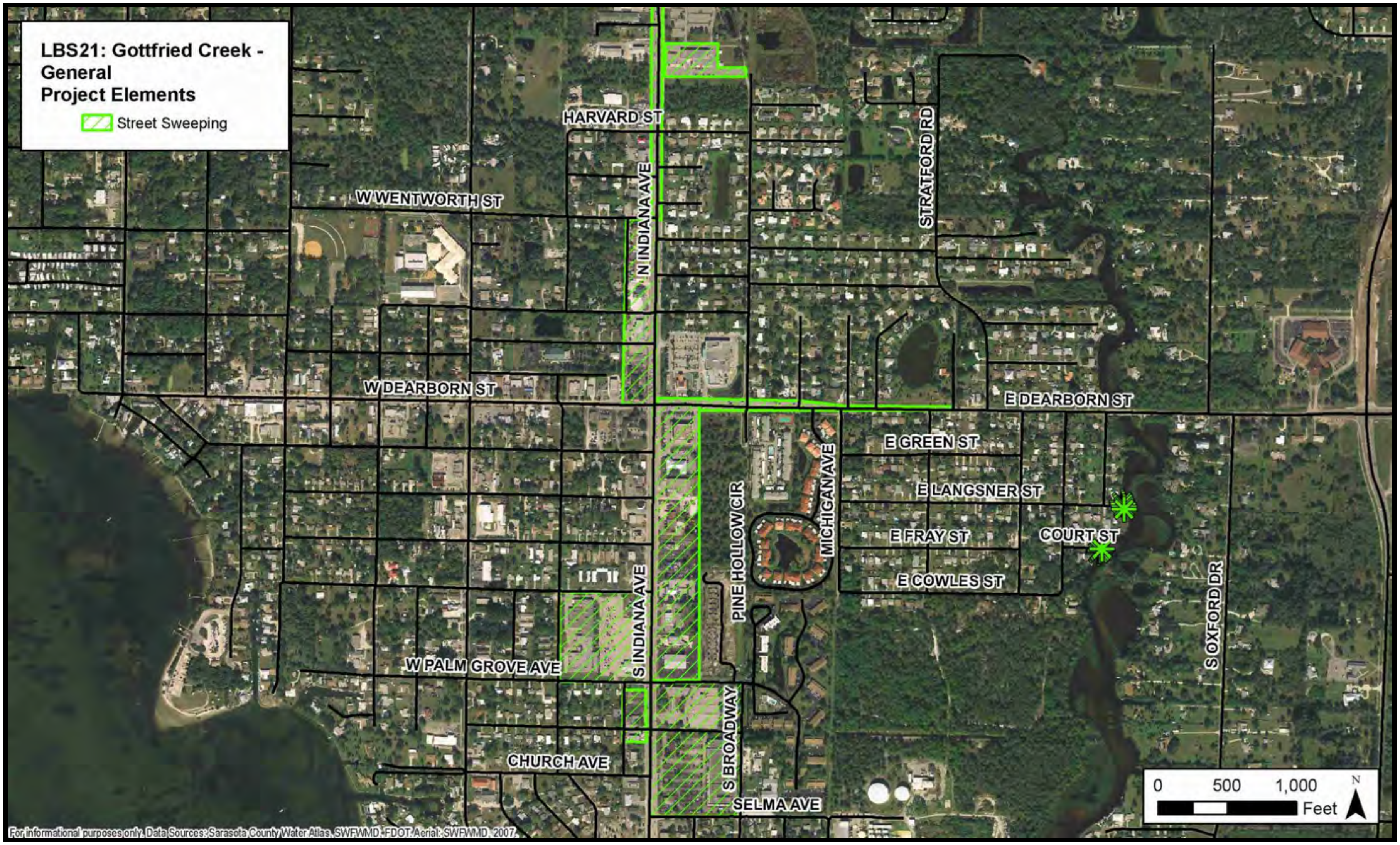


Figure 5-22 LBS21: Gottfried Creek: General

5.1.5 Ainger Creek

5.1.5.1 LBS22: Melody Road

In Ainger Creek, the site is off South River Road on Melody Lane before the ninety degree bend in the road. The ditch system in this area appears to have served as an agricultural drainage system in the past. The flow from this system enters the upstream portion of Ainger Creek. The upstream basin area of the stream is an industrial area along a limestone road. The stream bed is filled with organics and muck and had a foul odor.

Dredging sediment and planting native vegetation will restore this previously ditched channel to a functional stream. A sediment sumps at the upstream end of the restored stream will minimize sediments from the adjacent industrial area and limestone roadways from entering the receiving water which drain to Ainger Creek

Figure 5-23 shows the following recommended sediment control improvements at the site:

- Removing accumulated sediment.
- Adding riprap to the outfall.
- Constructing a sediment sump.
- Creating a 2000-foot bioretention area.
- Treating limestone on Melody Lane.
- Street sweeping through adjacent industrial area.

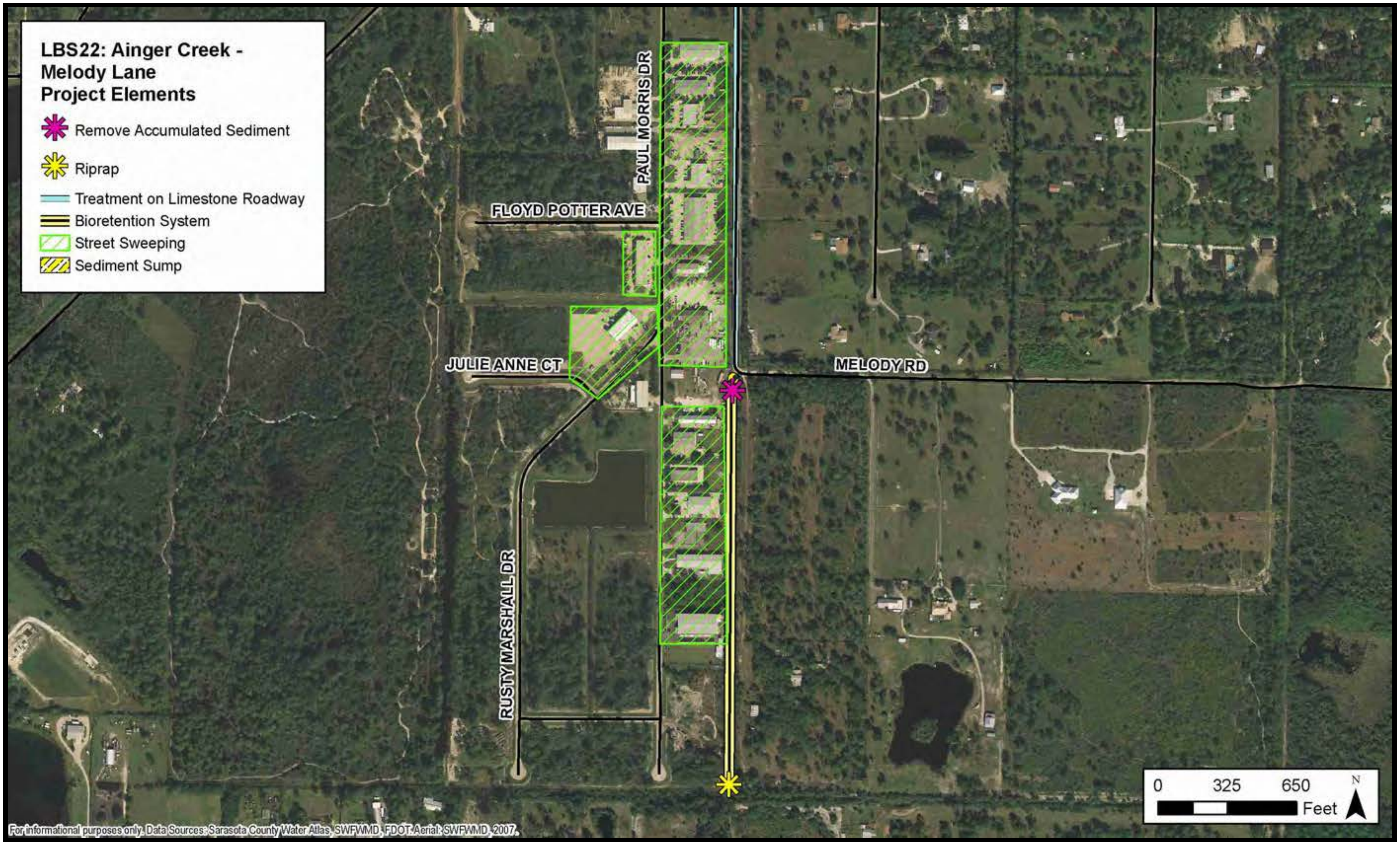


Figure 5-23 LBS22: Ainger Creek: Melody Lane

5.1.6 Lemon Bay Coastal

5.1.6.1 LBS23: Cherokee Street

Stormwater runoff from the sloped roadway flows directly to Lemon Bay. Swales with driveway culverts are on both sides of the road and discharge directly to the bay as well. Figure 5-25 shows the following recommended sediment control improvements at the site:

- Constructing a dry retention pond.
- Adding riprap and erosion control along the shoreline.
- Regrading roadside swales.

5.1.6.2 LBS24: Magnolia Avenue

From the Sediment Abatement Study of Brucewood Bayou, the two outfalls reviewed discharge to navigable canals in a residential area adjacent to the Intercoastal Waterway. The study recommended proper maintenance of the swale system upstream of the discharge to provide adequate treatment and sediment removal. For the discharge under South McCall Road, the construction of an enhanced nutrient separating baffle box was recommended.

To the east of Magnolia Avenue is a large wetland. The wetland provides some treatment for stormwater runoff but the addition of a dry retention pond would reduce the amount of sediment transported into the bay. Figure 5-26 shows the following recommended sediment control improvements at the site:

- Treating limestone on West Palm Grove Avenue.
- Constructing a dry retention pond.
- Creating a bioswale on the east side of Magnolia Avenue for additional treatment of stormwater runoff.

With this work effort, a review of recommendations from previous studies was completed. Table 5-2 summarizes the recommendations from the current work assignment and previous studies. Recommendations from several projects were revised based on current conditions in the watershed; these are also included in the summary table. The projects are grouped by subbasin area. Several recommendations are generalized and common to multiple projects. The following section discusses the generalized elements in the proposed projects.

5.1.6.3 LBS26: Dearborn Street Low-Impact-Development Pilot Project

The area parallel to West Dearborn Street from CR 776 west to Lemon Bay bound by Cocoanut Avenue on the north and Green Street on the south has been designated as the Englewood Community Redevelopment Area. Stormwater runoff receives minimal treatment before discharging to Lemon Bay. As part of the redevelopment, the County is moving forward with the

Dearborn Street Low-Impact-Development Pilot Project to provide stormwater treatment through this area within the right-of-way and County owned parcels. The project encompasses approximately 50 acres.

The proposed project intent is to capture the runoff as close to the source as possible in bioretention areas. The bioretention areas will replace the existing ditch system. The proposed system consists of vegetated swales, engineered soils, and perforated pipe all surrounded by an impermeable liner. Additional elements to the proposed project are cistern use, stormwater harvesting, and pervious pavement. Figure 5-24 shows the proposed project limits.

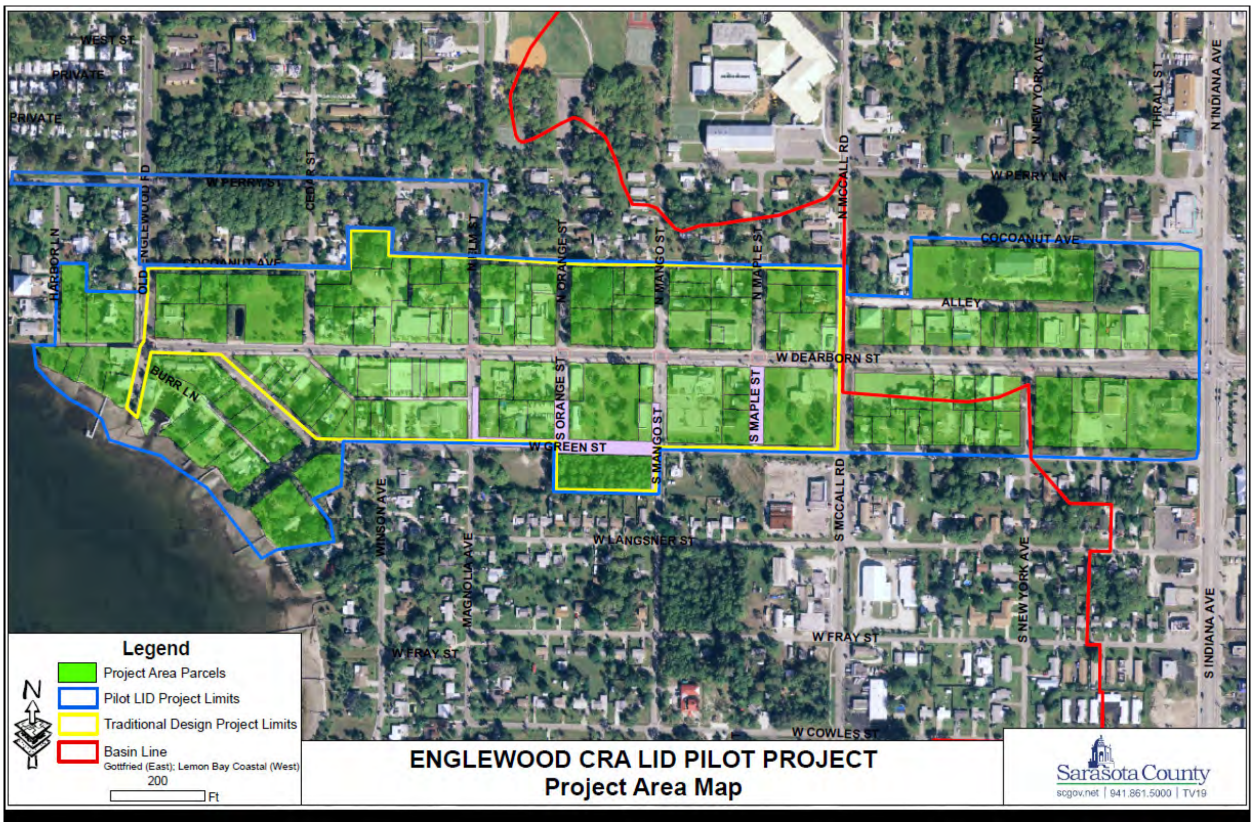


Figure 5-24 Englewood Community Redevelopment Area

(Source: Sarasota County GIS-Stormwater Environmental Utility)

Figure 5-25 LBS23: Lemon Bay Coastal: Cherokee Drive

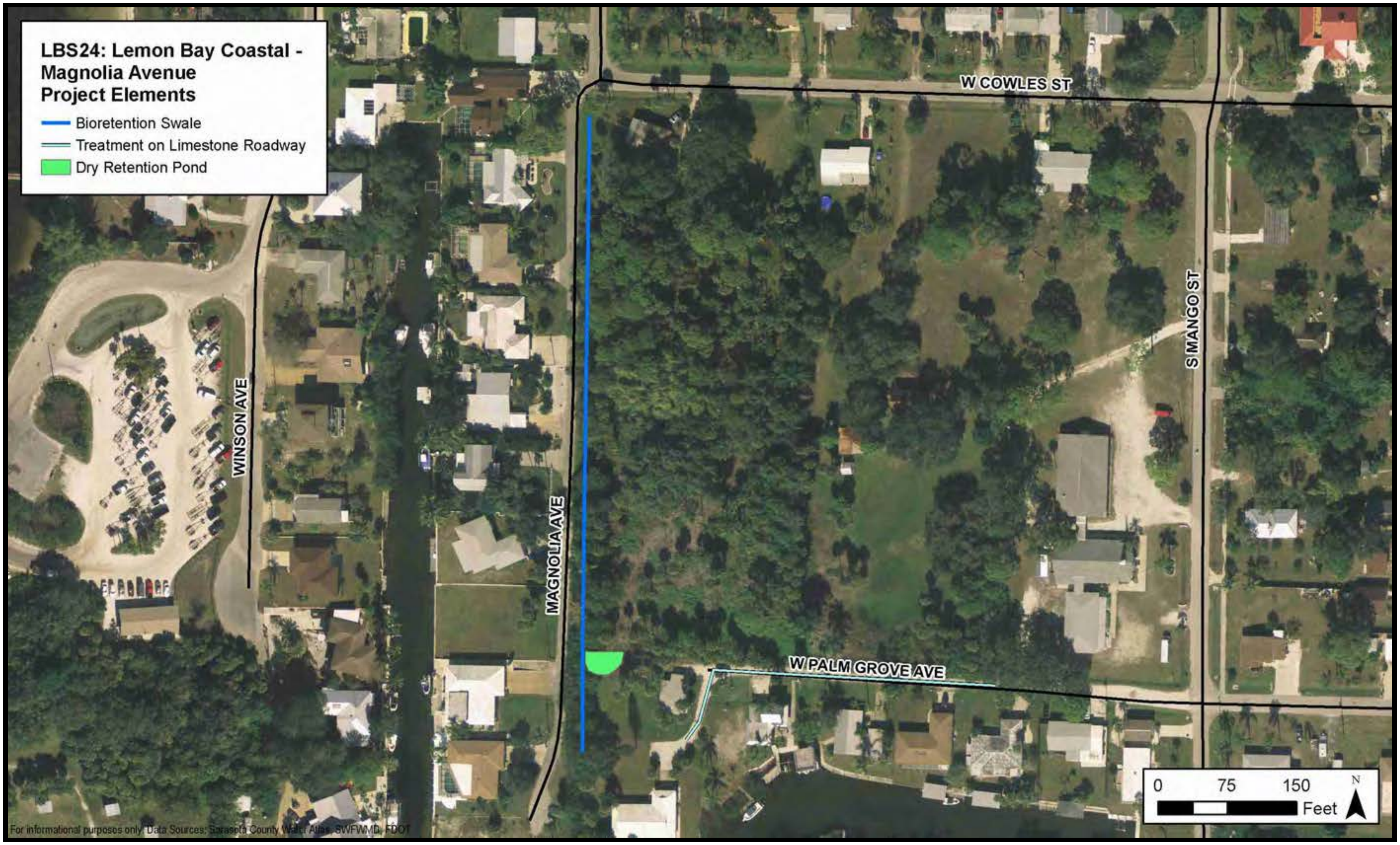


Figure 5-26 LBS24: Lemon Bay Coastal: Magnolia Avenue

Table 5-2 Summary of Recommendations						
Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
Alligator Creek	ACSMP	System 5			Stabilizing the banks via gabions. Revegetating the banks with desirable herbaceous species. Scheduling regular maintenance.	See Conceptual Plan LBS01.
Alligator Creek	Jones Edmunds	AC01	Siesta Ditch North	LBS01	Adding a sediment removal structure. Amending soil and planting adjacent to Quincy Road. Disconnecting roof drains. Adding riprap. Adding a sediment sump. Regrading top of bank adjacent to Siesta Drive. Add trees and shrubs to the top of bank adjacent to Siesta Drive.	No changes to original recommendations.
Alligator Creek	ACSMP	System 5			Constructing a curb along Siesta Drive to divert stormwater away from the system. Stabilizing the banks via gabions. Revegetating the banks with desirable herbaceous species. Scheduling regular maintenance.	See Conceptual Plan LBS02.
Alligator Creek	Jones Edmunds	AC02	Siesta Ditch South	LBS02	Monitoring water quality. Incorporating a sidewalk, bioswale, trees and vegetation along the top of bank. Amending soil to improve moisture holding capacity. Removing nuisance vegetation. Adding native vegetation on the banks to stabilize slopes and in the flowpath to improve water quality. Installing a low-flow sedimentation weir. Adding riprap.	No changes to original recommendations.

Table 5-2 Summary of Recommendations						
Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
Alligator Creek	Jones Edmunds	AC03/04	Datura Ditch	LBS03	Hardening steep banks with gabions.	No changes to original recommendations.
Alligator Creek	Jones Edmunds		Lake Magnolia	LBS04	Adding a sediment removal structure. Sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.	
Alligator Creek	ACSMP	System 1			Reducing the slopes from 2:1 to 4:1. Widening the bottom along the eastern bank. Removing nuisance and exotic vegetation. Stabilizing the bank via erosion control blankets. Revegetating banks with desirable herbaceous species. Scheduling regular maintenance.	See Conceptual Plan LBS05
Alligator Creek	Weir Study	W28-07T	Briarwood Rd		No recommendations for this site	No changes to original recommendations.
Alligator Creek	Jones Edmunds	A C06	Briarwood Rd to Alligator Creek	LBS05	Adding a maintenance buffer. Regrading and revegetating banks. Amending soil to improve moisture holding capacity. Stabilizing banks with geoweb and geofabric.	No changes to original recommendations.
Alligator Creek	ACSMP	System 2	Jacaranda at Tamiami		Removing nuisance and exotic species. Realigning stream bank. Revegetating with native herbaceous, shrub, and tree species. Scheduling regular maintenance. Widening the channel bottom along the eastern bank.	No recommendations at this time.

Table 5-2 Summary of Recommendations

Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
					Stabilizing the bank via erosion control blankets.	
Alligator Creek	ACSMP	System 3	Woodmere Park		Widening ditch bottom along the western bank. Reducing the slopes from 2:1 to 4:1. Stabilizing banks via erosion control blankets. Revegetating banks with desirable herbaceous species. Scheduling regular maintenance.	See Conceptual Plan LBS06.
Alligator Creek	Jones Edmunds	AC12	Woodmere Park Library	LBS06	Adding a buffer zone. Amending soil to improve moisture holding capacity. Adding riprap at outfalls. Removing accumulated sediment.	No changes to original recommendations.
Alligator Creek	ACSMP	System 4			Widening the bottom along the eastern bank. Reducing the slopes from 2:1 to 4:1. Stabilizing the banks via erosion control blankets. Revegetating the banks with herbaceous species. Scheduling regular maintenance.	See Conceptual Plan LBS07.
Alligator Creek	Weir Study	W28-04	Liesl Dr		No recommendations from the study.	Monitor site for constituents of concern
Alligator Creek	Jones Edmunds	AC13	Venice Gardens WRF	LBS07	Adding a buffer zone. Regrading and revegetating banks. Stabilizing banks using geoweb and geofabric. Amending soil to improve moisture holding capacity.	No changes to original recommendations.

Table 5-2 Summary of Recommendations

Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
Alligator Creek	ACSMP	System 6	Alligator Creek		Reducing the slopes from 2:1 to 4:1. Stabilizing banks via erosion control blankets. Revegetating banks with desirable herbaceous species. Scheduling regular maintenance. Removing Brazilian Pepper by herbicide application. Restoring mangroves. Installing a culvert.	See Conceptual Plan LBS08.
Alligator Creek	Jones Edmunds	AC05	Alligator Creek at US41 Bridge	LBS08	Stabilizing the top of bank and toe of slope with geoweb and geofabric. Removing excess nuisance vegetation from the north bank and restoring the mangroves. Disconnecting the roof drains.	No changes to original recommendations.
Alligator Creek	Jones Edmunds		General	LBS09	Sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.	No changes to original recommendations.
Woodmere Creek	Jones Edmunds	WM01/02	Woodmere Creek at US41	LBS10	Removing nuisance vegetation by mechanical means without denuding the banks. Monitoring water quality of the runoff from the nursery adjacent to the flea market. Adding cisterns for beneficial stormwater runoff use in residential areas. Adding riprap to outfalls for erosion control. Adding a sediment removal structure. Stabilizing banks using geoweb and geofabric. Adding a maintenance buffer.	No changes to original recommendations.

Table 5-2 Summary of Recommendations						
Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
Woodmere Creek	Jones Edmunds	WM05	Heron Rd and Seneca Rd	LBS11	Removing nuisance vegetation by mechanical means without denuding the banks. Removing accumulated sediment. Adding riprap at outfall.	No changes to original recommendations.
Forked Creek	Jones Edmunds	FC02	5th Street	LBS12	Regrading and revegetating banks. Adding erosion control and riprap. Applying limestone treatment on roadway to reduce dust and particles from washing into the adjacent waterways. Adding a bioretention swale to convey flow from Englewood Rd to the channel. Adding a maintenance buffer. Adding a sediment removal structure.	No changes to original recommendations.
Forked Creek	Jones Edmunds	FC05	Overbrook Dr	LBS13	Adding a stormwater treatment pond and supporting infrastructure.	No changes to original recommendations.
Forked Creek	GPI SAS	FC05	Dale Lakes		No new BMPs recommended.	See Conceptual Plan LBS14
Forked Creek	Jones Edmunds	FC03/04	Fairview Dr	LBS14	Adding a dry retention pond at the end of the roadway to provide treatment to stormwater runoff. Adding bioretention swales to attenuation and treatment.	No changes to original recommendations.
Forked Creek	Jones Edmunds		Bridge St	LBS15	Adding a dry retention pond at the end of the roadway to provide treatment to stormwater runoff. Adding bioretention swales to attenuation and treatment.	No changes to original recommendations.

Table 5-2 Summary of Recommendations						
Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
					Adding mangroves and riprap to the shoreline to provide additional stability.	
Forked Creek	Jones Edmunds	FC06/07	Forked Creek at US41	LBS16	Adding a dry retention pond. Adding mangroves and riprap. Regrading and revegetating banks. Adding riprap. Removing an obstruction in the channel. Adding a maintenance buffer. Creating a bioretention swale to capture and treat runoff from the entrance.	No changes to original recommendations.
Forked Creek	Weir Study	W35-02	Buchnan Airport		No recommendations from the study.	No changes to original recommendations.
Forked Creek	Jones Edmunds	FC08	Buchnan Airport	LBS17	Adding aquatic plants in flowpath. Cutting v-notches in concrete weirs to facilitate flow. Adding a maintenance buffer. Creating a flow-through wetland. Removing accumulated sediment from behind stepped weirs bi-annually. Add riprap to discharge structures from Alameda Gardens.	No changes to original recommendations.
Forked Creek	GPI SAS	FC03/04	Neptune Dr		No new BMPs recommended.	No changes to original recommendations.
Forked Creek	Jones Edmunds		General	LBS18	Sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.	No changes to original recommendations.

Table 5-2 Summary of Recommendations						
Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
Gottfried Creek	Jones Edmunds	GC06/07	Court St-Langsner St	LBS19	Adding dry retention ponds at the end of the roadway to provide treatment to stormwater runoff. Adding mangroves and riprap to the shoreline to provide additional stability.	No changes to original recommendations.
Gottfried Creek	Jones Edmunds	GC09	Cortes Dr	LBS20	Adding a dry retention pond at the end of the roadway to provide treatment to stormwater runoff. Adding bioretention swales to attenuation and treatment. Replacing damaged discharge structure.	No changes to original recommendations.
Gottfried Creek	Jones Edmunds		General	LBS21	Sweeping the streets bi-monthly to remove loose gravel and sediment from the roadways.	No changes to original recommendations.
Ainger Creek	Jones Edmunds	AN05	Melody Lane	LBS22	Removing accumulated sediment. Adding riprap to the outfall. Constructing a sediment sump. Creating a 2000-LF bioretention area. Treating limestone on Melody Lane. Street sweeping through adjacent industrial area.	No changes to original recommendations.
LB Coastal	Jones Edmunds	LBC2	Cherokee St	LBS23	Constructing a dry retention pond. Adding riprap and erosion control along the shoreline. Regrading roadside swales.	No changes to original recommendations.
LB Coastal	Jones Edmunds	LBC6	Magnolia Avenue	LBS24	Treating limestone on West Palm Grove Avenue. Constructing a dry retention pond.	No changes to original recommendations.

Table 5-2 Summary of Recommendations

Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Original Recommendation	Changes to Original Recommendations From Other Studies
					Creating a bioswale on the east side of Magnolia Avenue for additional treatment of stormwater runoff.	
LB Coastal	GPI SAS	LBC6	Brucewood Bayou		Maintaining swale and culvert system. Installing a nutrient separating baffle box.	See Conceptual Plan LBS24

Projects LBS25: Venice East Blvd LID Demonstration Project and LBS26: Dearborn Street LID Pilot Project were reviewed by others and not included in this task.

5.2 GENERAL DESIGN CONSIDERATIONS

The projects presented above are conceptual and, as such, a detailed engineering evaluation of site conditions including survey and geotechnical information was not included in the conceptual design. The final design of any project to reduce sediment in the channels and ditches should include a professional geotechnical evaluation and survey of the site.

Several recommendations are common to the potential projects:

- Adding geofabrics and geoweb for bank stabilization.
- Amending soils.
- Planting native vegetation or revegetation.
- Constructing sediment sumps.
- Monitoring sites for constituents of concern.
- Adding riprap.
- Sweeping streets.

5.2.1 Geofabrics

Geosynthetic fabrics or geofabrics are used to enhance the subgrade and prevent soil erosion without hardening the channel bank. Erosion-control fabrics are available with long and short life spans and permanent, partial, or complete erodibility. The fabric is generally straw or mulch with non-biodegradable netting. The straw or mulch is designed to degrade over time as vegetation develops hearty root systems. Steeper slopes (less than 3:1 (H:V)) may require an additional element for stabilization, a geoweb. A geoweb averages 6 inches deep and contains pockets for soil media to be held in place, which aid revegetation of the bank and prevent sloughing. Either product can be used individually, but on steep banks using both a geofabic and a geoweb will generally provide a longer-term solution.

5.2.2 Soil Amendment

Soil amendment is aimed at improving water retention, permeability, infiltration, drainage, and structure of the soil and providing a better environment for root systems. For amendment to be successful, the amendment media needs to be thoroughly mixed into the soil and not just buried. Soil amendment products are organic or inorganic. Common organic amendments are sawdust, wood chips, compost, manure, sphagnum moss, and biosolids. Common inorganic amendments are tire chunks, perlite, and vermiculite. Choosing a soil amendment is site specific; factors to consider are: longevity, pH, testure, and salinity of the soil. Soil amendment does not depend on installing geofabric and may be done independently.

5.2.3 Vegetation

Planting and recruiting of native vegetation with adequate root systems is a common practice in bank stabilization. Vegetation protects the soil against erosion by building soil structure. The plants create a more cohesive soil matrix and filter pollutants commonly found in stormwater runoff.

Native species of plants will provide longer-term erosion control and bank protection. The appropriate selection of plants during the design phase is essential as fast-growing plants with abundant foliage may impede the flow and reduce the overall flood capacity of the system. Suggested plantings of upland and wetland plant species for stream/ditch bank stabilization are listed in Table 5-3 and wetland plants are listed in Table 5-4. These are general recommendations for plantings; for successful recruitment of vegetation, plantings should be evaluated during the design phase.

Table 5-3 Proposed Species for Stream/Ditch Stabilization

Common Name	Scientific Name	Location	Size
Yaupon holly	*Ilex vomitoria*	Upper side slopes	1 gallon
Dwarf palmetto	*Sabal minor*	Upper side slopes	1 gallon
Knotgrass	*Paspalum vaginatum*	Upper side slopes	1 gallon
Sand cordgrass	*Spartina bakerii*	Upper side slopes	4" liner
Cinnamon fern	*Osmunda cinnamomea*	Lower side slopes	1 gallon
Bacopa	*Bacopa spp.*	Lower side slopes	Bare root
Lizards tail	*Saururus cernuss*	Lower side slopes	Bare root

Table 5-4 Proposed Wetland Plant Species for Stormwater Ponds

Common Name	Scientific Name	Location
Soft rush	*Juncus effuses*	Side slopes
Sand cordgrass	*Spartina bakerii*	Side slopes
Yellow canna	*Canna* sp.	Side slopes
Giant bulrush	*Scirpus californicus*	Pond basin
Pickerelweed	*Pontedaria cordata*	Pond basin
Cow lily	*Nuphar luteum*	Pond basin
Water lily	*Nymphae odorata*	Pond basin

5.2.4 Sediment Sumps

Sediment sumps allow coarse-grained suspended solids to settle out of the flow, reducing the sediment load carried downstream. When the sumps are designed in conjunction with a low-flow weir for small storm events, a fraction of the finer-grained sediment will also settle out of the water behind the weir. Properly designed sediment sumps allow suspended sediment to settle out of the flow in a desirable location—one that will not adversely impact the natural system. Detailed design studies of flow rate, particle characteristics, and settling rates will provide optimal location and size of the sump. The design should consider soil type, drainage area, desired removal efficiency, flow rate, and accessibility for maintenance and sediment removal. When a sump is filled to 40 to 50% of the original capacity, accumulated sediment should be removed to maintain the design removal efficiency of the BMP.

5.2.5 Monitoring for Constituents of Concern

Monitoring for constituents of concern is recommended at multiple sites. The Florida Department of Environmental Protection has developed two levels of guidance to address heavy metal contaminant concentrations in sediment: Effects Levels and Target Cleanup Levels.

Threshold Effect Level (TEL) and Probable Effect Level (PEL) address lower and upper limits for adverse biological effects on aquatic organisms. The TEL represents the upper limit of the range of sediment contaminant concentrations in which no adverse effects on aquatic organisms have been shown through testing and sampling. Within this range, concentrations of sediment-associated contaminants are not considered to represent significant hazards to aquatic organisms (FDEP, Chapter 5, p. 37). The PEL represents the lower limit of the range of contaminant concentrations that are usually or always associated with adverse biological effect. The concentrations of sediment-associated contaminants are considered to represent significant and immediate hazards to aquatic organisms. Within this range of concentrations, adverse biological effects are possible, but it is difficult to predict the occurrence, nature, and severity of the effects.

Additionally, FDEP has developed Soil Cleanup Target Levels (SCTL) to help protect human health by direct exposure to anthropogenically contaminated soils in residential and commercial settings. Table 5-5 reflects the current FDEP guidelines.

Table 5-5 FDEP Guidelines

Metal	SCTL (residential)	SCTL (commercial)	TEL	PEL
	Sediment Contamination (mg/kg)			
Aluminum (Al)	80000	n/a	n/a	n/a
Antimony (Sb)	27	370	n/a	n/a
Arsenic (As)	2.1	12	7.24	41.6
Barium (Ba)	120	130000	n/a	n/a
Beryllium (Be)	120	1400	n/a	n/a
Cadmium (Cd)	82	1700	0.676	4.21
Chromium Cr)	210	470	52.3	160
Copper (Cu)	150	89000	18.7	108
Lead (Pb)	400	1400	30.2	112
Nickel (Ni)	340	35000	15.9	42.8
Selenium (Se)	440	11000	n/a	n/a
Silver (Ag)	410	8200	0.733	1.77
Thallium (Tl)	6.1	150	n/a	n/a
Zinc (Zn)	26000	630000	124	271
Mercury (Hg)	3	17	0.13	0.696

5.2.6 Maintenance Activities

Adding riprap and sweeping streets are maintenance activities that contribute to the improved health of the system through consistent practice. With urbanized stormwater systems, outfalls will continue to flow to the waterways. The potential for erosion and channel degradation is greater without any reinforcement at outfalls to dissipate energy.

5.3 CONCEPTUAL LEVEL ESTIMATE OF PROBABLE COST

The projects presented in Section 5 are conceptual. Table 5-6 summarizes the conceptual level estimates of probable cost for the project recommendations. The generalized estimates were based on the extents of and current site conditions in the project areas. The project estimates include the estimated annual maintenance cost where applicable. The project cost includes estimated materials, labor, and engineering design services. Maintenance costs are summarized in the table below.

Table 5-6 Conceptual Level Estimates of Probable Cost

Project ID	Area of Interest	Project Name	Total Project Cost+	Construction Cost	Engineering Design Services*	Maintenance Cost
LBS01	Alligator Creek	Siesta Ditch North	$3,190,000	$2,599,000	$591,000	$5,000
LBS02	Alligator Creek	Siesta Ditch South	$1,500,000	$1,221,000	$278,000	$10,000
LBS03	Alligator Creek	Datura Ditch	$1,350,000	$1,104,000	$251,000	$0
LBS04	Alligator Creek	Lake Magnolia	$124,000	$92,000	$32,000	$6,000
LBS05	Alligator Creek	Briarwood Rd to Alligator Creek	$3,010,000	$2,454,000	$558,000	$0
LBS06	Alligator Creek	Woodmere Park Library	$460,000	$375,000	$85,000	$13,000
LBS07	Alligator Creek	Venice Gardens WRF	$2,440,000	$1,987,000	$452,000	$0
LBS08	Alligator Creek	Alligator Creek at US 41 Bridge	$680,000	$550,000	$125,000	$0
LBS09	Alligator Creek	General	$0	$0	$0	$8,000
LBS10	Woodmere Creek	Woodmere Creek at US 41	$1,824,000	$1,486,000	$338,000	$6,000
LBS11	Woodmere Creek	Heron Rd and Seneca Rd	$72,000	$49,000	$23,000	$3,000
LBS12	Forked Creek	5th Street	$363,000	$296,000	$67,000	$2,000
LBS13	Forked Creek	Overbrook Drive	$329,000	$268,000	$61,000	$0
LBS14	Forked Creek	Fairview Drive	$26,000	$15,000	$9,000	$2,000
LBS15	Forked Creek	Bridge Street	$59,000	$40,000	$19,000	$2,000
LBS16	Forked Creek	Forked Creek at US 41	$572,000	$466,000	$106,000	$0
LBS17	Forked Creek	Buchnan Airport	$788,000	$642,000	$146,000	$5,000
LBS18	Forked Creek	General	$0	$0	$0	$4,000
LBS19	Gottfried Creek	Court St / Langsner St.	$51,000	$34,000	$16,000	$1,000
LBS20	Gottfried Creek	Cortes Dr	$24,000	$15,000	$9,000	$2,000
LBS21	Gottfried Creek	General	$0	$0	$0	$6,000
LBS22	Ainger Creek	Melody Rd	$1,116,000	$909,000	$207,000	$7,000
LBS23	Lemon Bay Coastal	Cherokee St / Dearborne St	$63,000	$43,000	$20,000	$1,000
LBS24	Lemon Bay Coastal	Magnolia Ave	$43,000	$29,000	$14,000	$1,000

+Total Project Cost includes Mobilization and Contingency costs along with Construction costs and Engineering Design Services

*Design services include Survey, Geotechnical Investigation, Engineering Design and Permitting

6.0 EVALUATION MATRIX

The projects discussed in the section above vary considerably in terms of size, cost, benefits, and other factors. To evaluate the projects in a consistent manner, Jones Edmunds created a qualitative evaluation matrix that considers the following criteria:

- Severity of problem—Problems that are the most extensive in area/length/volume or that have the potential to cause damage to buildings or infrastructure were given the highest ranking.
- Feasibility—Available BMP space, ownership, and constructability were all considered in feasibility.
- Cost—This criterion considered two costs: construction and operation/maintenance.
- Benefits—Four benefits were considered under this criterion: erosion control/stabilization, sediment removal, flood control, and water quality. Natural systems and water supply benefits were not used as part of the evaluation of the projects.

Each criterion for the site was scored on a scale of 1 to 5. A value of 1 represents the least favorable score or an evaluation category without actionable recommendations. For example, a value of 1 represents a problem with very low severity, insufficient space for the solution, minimal benefits, or a high cost. A value of 5 represents the most favorable score.

In the evaluation of each category, the following scoring system was used for consistency as cited below:

- Severity: For sites discussed in the County-wide Weir Study—for sites receiving 4 points in the original study, severity was scored with 3 points in the matrix and received a comment to continue to monitor the site for constituents of concern; for sites receiving 0 or 3 point in the original study, severity was scored with 1 point in the matrix. Additionally, if sediment depth from field measurements indicated a sediment accumulation of greater than 1 foot, the site was scored as a 4 or 5.

- BMP Space Available: Scores range from 3 to 5 based on the general location of the available space.

- County-owned Land: Scores range from 1 to 5 based on the ownership of the parcel. A higher score was awarded for land that was partially or fully within County drainage easements.

- Constructability: Scores ranged from 2 to 5 based on the relative ease of permittability of the overall project.

- Maintenance Effort: Sites without any original or revised recommendations score a 1. For sites requiring monitoring or cleaning out of structures, the score is 2. Sites requiring bank stabilization or riprap with no maintenance requirements score a 4 or 5.

- Construction Costs: The score was based on the Project Cost from the cost estimates provided in Section 5.4.

- Erosion Control/Stabilization: Sites requiring riprap or bank stabilization score a 5. Sites without any requirements score a 2.

- Sediment Removal: Projects specifically removing sediment from the system or reducing erosion on the stream bank score a 5. Catch basins/baffle boxes score a 4 for removal efficiencies. Sites with no recommendations or monitoring score a 1.

- Flood Control: Most projects are flood control neutral and score a 2; several projects will have flood control benefits and score between 3 and 5.

- Water Quality: Most projects are water quality neutral and score a 2; some projects had nutrient-removal values (Section 6.3) associated with them and were scored accordingly; some projects will remove contaminated sediment and score a 5.

Results and rankings for all the project evaluations discussed in the previous section are presented in Table 6-1. Scores for each criterion are computed as arithmetic averages of values within the criterion and total scores for each project are calculated as the total point value of the criteria scores. Table 6-2 shows each site ranked within the basin areas.

Table 6-1 Ranking of Potential Projects

Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Severity	Feasibility	Cost	Benefits	Score	Rank
Forked Creek	Jones Edmunds	FC08	Buchnan Airport	LBS17	5	5.00	3	4.75	17.75	1
Alligator Creek	Jones Edmunds	AC01	Siesta Ditch North	LBS01	5	4.67	2	4.5	16.17	2
Alligator Creek	Jones Edmunds	AC12	Woodmere Park Library	LBS06	4	4.67	3.5	4	16.17	3
Alligator Creek	Jones Edmunds	-	General	LBS09	5	5.00	2.5	3.5	16.00	4
Forked Creek	Jones Edmunds	FC06/07	Forked Creek at US41	LBS16	5	3.67	3	4.25	15.92	5
Alligator Creek	Jones Edmunds	AC02	Siesta Ditch South	LBS02	5	4.67	2	4	15.67	6
Alligator Creek	Jones Edmunds	AC13	Venice Gardens WRF	LBS07	4	4.67	3	4	15.67	7
Forked Creek	Jones Edmunds	-	General	LBS18	4	5.00	3	3.5	15.50	8
Gottfried Creek	Jones Edmunds	-	General	LBS21	4	5.00	3	3.5	15.50	9
Alligator Creek	Jones Edmunds	AC06	Briarwood Rd to Alligator Creek	LBS05	5	4.00	2.5	3.75	15.25	10
Forked Creek	Jones Edmunds	N/A	Bridge St	LBS15	3	4.67	3.5	3.75	14.92	11
Forked Creek	Jones Edmunds	FC05	Overbrook Dr	LBS13	3	4.33	3.5	4	14.83	12
Alligator Creek	Jones Edmunds	N/A	Lake Magnolia	LBS04	3	4.67	3.5	3.5	14.67	13
Forked Creek	Jones Edmunds	FC02	5th Street	LBS12	4	4.67	2.5	3.5	14.67	14
Woodmere Creek	Jones Edmunds	WM01/02	Woodmere Creek at US41	LBS10	5	3.33	2	4.25	14.58	15
Alligator Creek	ACSMP	System 5	Siesta Ditch South		5	4.00	2	3.5	14.50	16
Ainger Creek	Jones Edmunds	AN05	Melody Lane	LBS22	3	4.00	3	4.5	14.50	17
Alligator Creek	ACSMP	System 1	Briarwood		5	4.33	2	3	14.33	18
Alligator Creek	ACSMP	System 3	Woodmere Park		4	4.33	3	3	14.33	19
Gottfried Creek	Jones Edmunds	GC09	Cortes Dr	LBS20	3	4.67	3.5	3	14.17	20
Woodmere Creek	Jones Edmunds	WM05	Heron Rd and Seneca Rd	LBS11	4	3.33	3.5	3.25	14.08	21
Alligator Creek	ACSMP	System 5	Siesta Ditch North		5	4.00	2	3	14.00	22
Forked Creek	Jones Edmunds	FC03/04	Fairview Dr	LBS14	3	4.33	3.5	3	13.83	23
Gottfried Creek	Jones Edmunds	GC06/07	Court St-Langsner St	LBS19	3	4.33	3.5	3	13.83	24
Alligator Creek	Jones Edmunds	AC03/04	Datura Ditch	LBS03	5	3.00	2.5	3.25	13.75	25
Alligator Creek	Jones Edmunds	AC05	Alligator Creek at US41 Bridge	LBS08	4	3.00	3	3.75	13.75	26
LB Coastal	Jones Edmunds	LBC2	Cherokee St-Dearborne St	LBS23	3	4.33	3.5	2.75	13.58	27
Alligator Creek	ACSMP	System 2	Jacaranda and Tamiami		4	4.00	2	3.25	13.25	28
Alligator Creek	ACSMP	System 4	Venice Gardens WRF		4	4.00	2	3.25	13.25	29
LB Coastal	Jones Edmunds	LBC6	Magnolia Avenue	LBS24	3	3.67	3.5	3	13.17	30
Alligator Creek	ACSMP	System 6	Alligator Creek		4	3.33	2	3	12.33	31
LB Coastal	GPI SAS	LBC6	Brucewood Bayou		3	3.67	3	2.25	11.92	32
Alligator Creek	Weir Study	W28-07T	Briarwood Rd		1	1.00	2	1.75	5.75	33
Alligator Creek	Weir Study	W28-04	Liesl Dr		1	1.00	2	1.75	5.75	34
Forked Creek	Weir Study	W35-02	Buchnan Airport		1	1.00	1	1.25	4.25	35
Forked Creek	GPI SAS	FC05	Dale Lakes		1	1.00	1	1	4.00	36
Forked Creek	GPI SAS	FC03/04	Neptune Dr		1	1.00	1	1	4.00	37

Projects LBS25: Venice East Blvd LID Demonstration Project and LBS26: Dearborn Street LID Pilot Project were analyzed by others and are not included in the evaluation.

Table 6-2 Potential Project Ranking by Basin

Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Severity	Feasibility	Cost	Benefits	Score	Basin Rank
Ainger Creek	Jones Edmunds	AN05	Melody Lane	LBS22	3	4.00	3	4.5	14.50	1
Alligator Creek	Jones Edmunds	AC01	Siesta Ditch North	LBS01	5	4.67	2	4.5	16.17	1
Alligator Creek	Jones Edmunds	AC12	Woodmere Park Library	LBS06	4	4.67	3.5	4	16.17	2
Alligator Creek	Jones Edmunds	-	General	LBS09	5	5.00	2.5	3.5	16.00	3
Alligator Creek	Jones Edmunds	AC02	Siesta Ditch South	LBS02	5	4.67	2	4	15.67	4
Alligator Creek	Jones Edmunds	AC13	Venice Gardens WRF	LBS07	4	4.67	3	4	15.67	5
Alligator Creek	Jones Edmunds	AC06	Briarwood Rd to Alligator Creek	LBS05	5	4.00	2.5	3.75	15.25	6
Alligator Creek	Jones Edmunds	N/A	Lake Magnolia	LBS04	3	4.67	3.5	3.5	14.67	7
Alligator Creek	ACSMP	System 5	Siesta Ditch South		5	4.00	2	3.5	14.50	8
Alligator Creek	ACSMP	System 1	Briarwood		5	4.33	2	3	14.33	9
Alligator Creek	ACSMP	System 3	Woodmere Park		4	4.33	3	3	14.33	10
Alligator Creek	ACSMP	System 5	Siesta Ditch North		5	4.00	2	3	14.00	11
Alligator Creek	Jones Edmunds	AC03/04	Datura Ditch	LBS03	5	3.00	2.5	3.25	13.75	12
Alligator Creek	Jones Edmunds	AC05	Alligator Creek at US41 Bridge	LBS08	4	3.00	3	3.75	13.75	13
Alligator Creek	ACSMP	System 2	Jacaranda and Tamiami		4	4.00	2	3.25	13.25	14
Alligator Creek	ACSMP	System 4	Venice Gardens WRF		4	4.00	2	3.25	13.25	15
Alligator Creek	ACSMP	System 6	Alligator Creek		4	3.33	2	3	12.33	16
Alligator Creek	Weir Study	W28-07T	Briarwood Rd		1	1.00	2	1.75	5.75	17
Alligator Creek	Weir Study	W28-04	Liesl Dr		1	1.00	2	1.75	5.75	18
Forked Creek	Jones Edmunds	FC08	Buchnan Airport	LBS17	5	5.00	3	4.75	17.75	1
Forked Creek	Jones Edmunds	FC06/07	Forked Creek at US41	LBS16	5	3.67	3	4.25	15.92	2
Forked Creek	Jones Edmunds	-	General	LBS18	4	5.00	3	3.5	15.50	3
Forked Creek	Jones Edmunds	N/A	Bridge St	LBS15	3	4.67	3.5	3.75	14.92	4
Forked Creek	Jones Edmunds	FC05	Overbrook Dr	LBS13	3	4.33	3.5	4	14.83	5
Forked Creek	Jones Edmunds	FC02	5th Street	LBS12	4	4.67	2.5	3.5	14.67	6
Forked Creek	Jones Edmunds	FC03	Fairview Dr	LBS14	3	4.33	3.5	3	13.83	7
Forked Creek	Weir Study	W35-02	Buchnan Airport		1	1.00	1	1.25	4.25	8
Forked Creek	GPI SAS	FC05	Dale Lakes		1	1.00	1	1	4.00	9
Forked Creek	GPI SAS	FC03/04	Neptune Dr		1	1.00	1	1	4.00	10
Gottfried Creek	Jones Edmunds	-	General	LBS21	4	5.00	3	3.5	15.50	1
Gottfried Creek	Jones Edmunds	GC09	Cortes Dr	LBS20	3	4.67	3.5	3	14.17	2
Gottfried Creek	Jones Edmunds	GC06/07	Court St-Langsner St	LBS19	3	4.33	3.5	3	13.83	3
LB Coastal	Jones Edmunds	LBC2	Cherokee St-Dearborne St	LBS23	3	4.33	3.5	2.75	13.58	1
LB Coastal	Jones Edmunds	LBC6	Magnolia Avenue	LBS24	3	3.67	3.5	3	13.17	2
LB Coastal	GPI SAS	LBC6	Brucewood Bayou		3	3.67	3	2.25	11.92	3

Table 6-2 Potential Project Ranking by Basin

Area of Interest	Study	Project ID	Location	Conceptual Plan Number	Severity	Feasibility	Cost	Benefits	Score	Basin Rank
Woodmere Creek	Jones Edmunds	WM01/02	Woodmere Creek at US41	LBS10	5	3.33	2	4.25	14.58	1
Woodmere Creek	Jones Edmunds	WM05	Heron Rd and Seneca Rd	LBS11	4	3.33	3.5	3.25	14.08	2

6.1 PROPOSED PROJECTS' POLLUTANT REMOVAL VALUES

Sediment removal is the primary focus of the BMPs proposed in the conceptual plans but several of the BMPs have water quality improvement components. TSS, TN and TP are the only pollutant constituents quantified in this evaluation although some BMPs are effective in removing other constituents of concern.

Twenty-one proposed projects contain BMPs with associated removal efficiencies for TSS, TP, and TN. Table 6-3 shows the estimated range of pounds per year of pollutant removed by the proposed BMP. If a project did not include specific BMPs to further treat stormwater runoff (i.e., bank stabilization), it is not listed in the table.

The results of the SIMPLE model were used to calculate normalized pounds per acre per year value by catchment area. To calculate the range of pollutant removal by BMP, the normalized results by catchment from the SIMPLE model were multiplied by the contributing area to create a pounds-per-year value. The pounds-per-year values were multiplied by the minimum and maximum reported efficiencies for the BMP to give a range of potential pounds per year of pollutant removed from stormwater runoff.

Table 6-3 Estimated Pollutant Removal by Proposed BMP

Project ID	Basin	Project Name	BMP Type	Estimated Drainage Area	Estimated Pollutant Removal (lb/yr) (rounded)		
					Total Suspended Solids	Total Phosphorus	Total Nitrogen
LBS01	Alligator Creek	Siesta Dr North	Sediment Removal Structure	16.0	700 - 1400	0 - 5	20 - 40
			Sediment Sump	25.0	700 - 2000	0	0
		Total			1400 - 3400	0 - 5	20 - 40
LBS02	Alligator Creek	Siesta Dr South	Bioswale	1.5	0 - 100	0 - 5	5 - 10
		Total			0 - 100	0 - 5	5 - 10
LBS04	Alligator Creek	Lake Magnolia	Sediment Removal Structure	30.0	1200 - 2300	0 - 5	30 - 60
			Street Sweeping	223.0	6900 - 14000	40 - 80	400 - 800
		Total			8100 - 16000	40 - 90	400 - 860
LBS05	Alligator Creek	Briarwood Rd to Alligator Creek	Maintenance Buffer	5.0	200 - 400	0 - 5	20 - 30
		Total			200 - 400	0 - 5	20 - 30
LBS06	Alligator Creek	Woodmere Park Library	Maintenance Buffer	8.0	600 - 1400	0 - 10	40 - 50
		Total			600 - 1400	0 - 10	40 - 50
LBS07	Alligator Creek	Venice Gardens WRF	Maintenance Buffer	6.0	400 - 1000	5 - 10	30 - 40
		Total			400 - 1000	5 - 10	30 - 40
LBS09	Alligator Creek	General	Street Sweeping	190.0	15700 - 31000	50 - 100	500 - 1100
		Total			15700 - 31000	50 - 100	500 - 1100

Table 6-3 Estimated Pollutant Removal by Proposed BMP							
Project ID	Basin	Project Name	BMP Type	Estimated Drainage Area	Estimated Pollutant Removal (lb/yr) (rounded)		
					Total Suspended Solids	Total Phosphorus	Total Nitrogen
LBS10	Woodmere Creek	Woodmere Creek at US41	Sediment Removal Structure	18.0	600 - 1200	0 - 5	15 - 30
			Cisterns	20.0	500 - 1000	0 - 5	30 - 60
			Maintenance Buffer	4.0	100 - 300	0 - 5	15 - 20
		Total			1300 - 2500	0 - 15	60 - 110
LBS12	Forked Creek	5th Street	Bioswale	2.3	0 - 200	0 - 5	0 - 10
			Maintenance Buffer	2.5	100 - 200	0 - 5	0 - 10
			Sediment Removal Structure	2.3	100 - 200	0	0 - 5
			Limestone Roadway Treatment	0.6	10 - 30	0	0
		Total			200 - 600	0 - 5	15 - 20
LBS13	Forked Creek	Overbrook Dr	Stormwater Treatment Pond	10.0	1400 - 2500	5 - 20	0 - 70
		Total			1400 - 2500	5 - 20	0 - 70
LBS14	Forked Creek	Fariview Dr	Dry Retention Pond	1.2	100 - 200	0 - 10	0 - 10
		Total			100 - 200	0 - 10	0 - 10
LBS15	Forked Creek	Bridge St	Dry Retention Pond	1.0	100 - 100	0 - 5	0 - 10
		Total			100 - 100	0 - 5	0 - 10
LBS16	Forked Creek	Forked Creek at US41	Dry Retention Pond	12.0	1000 - 1200	0 - 10	50 - 70
			Maintenance Buffer	8.5	300 - 700	0 - 5	30 - 40

Table 6-3 Estimated Pollutant Removal by Proposed BMP

Project ID	Basin	Project Name	BMP Type	Estimated Drainage Area	Estimated Pollutant Removal (lb/yr) (rounded)		
					Total Suspended Solids	Total Phosphorus	Total Nitrogen
			Bioswale	1.5	0 - 100	0 - 5	0 - 5
		Total			1300 - 2100	10 - 15	90 - 110
LBS17	Forked Creek	Buchnan Airport	Treatment Wetland	40.0	4300 - 5500	10 - 50	50 - 120
		Total			4300 - 5500	10 - 50	50 - 120
LBS18	Forked Creek	General	Street Sweeping	25.0	1000 - 1900	0 - 10	35 - 80
		Total			1000 - 1900	0 - 10	35 - 80
LBS19	Gottfried Creek	Court St-Langsner St	Dry Retention Pond	3.5	300 - 400	0 - 3	15 - 20
		Total			300 - 400	2 - 3	15 - 20
LBS20	Gottfried Creek	Cortes Dr	Dry Retention Pond	2.5	200 - 300	0 - 5	10 - 14
			Bioswale	2.5	100 - 200	0 - 5	5 - 10
		Total			300 - 500	0 - 5	15 - 25
LBS21	Gottfried Creek	General	Street Sweeping	56.0	3100 - 6000	10 - 20	110 - 250
		Total			3100 - 6000	10 - 20	110 - 250
LBS22	Ainger Creek	Melody Ln	Bioretention Area	45.0	500 - 1900	15 - 25	70 - 110
			Sediment Sump	35.0	500 - 1300	0	0
			Street Sweeping	21.0	300 - 700	0 - 5	20 - 40
			Limestorne Roadway Treatment	1.3	10 - 30	0	0

Table 6-3 Estimated Pollutant Removal by Proposed BMP

Project ID	Basin	Project Name	BMP Type	Estimated Drainage Area	Estimated Pollutant Removal (lb/yr) (rounded)		
					Total Suspended Solids	Total Phosphorus	Total Nitrogen
		Total			1300 - 3900	15 - 30	90 - 150
LBS23	LB Coastal	Cherokee St-Dearborne St	Dry Retention Pond	0.5	0 - 100	0 - 5	0 - 5
		Total			0 - 100	0 - 5	0 - 5
LBS24	LB Coastal	Magnolia Ave	Dry Retention Pond	0.7	100 - 100	0 - 5	0 - 5
			Bioswale	5.0	100 - 400	0 - 5	10 - 20
			Limestone Treatment	0.7	10 - 40	0	0
		Total			200 - 600	0 - 5	15 - 25

Projects LBS25: Venice East Blvd LID Demonstration Project and LBS26: Dearborn Street LID Pilot Project were evaluated by others.

In reviewing the ten subbasins discharging the most total suspended solids in pound per acre per year, six of the subbasins are in Alligator Creek, two are in Forked Creek, and two are in Gottfried Creek. Three of the subbasins represent major transportation corridors—Tamiami Trail (US41) in Alligator Creek and Indiana Avenue (CR 776) in Gottfried Creek.

Table 6-4 Top TSS Producing Subbasins

Subbasin ID	Basin Name	ICPR Group	Area (ac)	TSS (lb/ac/yr)	TSS Rank
4	Alligator Creek	AC-41NW	73.18	319.98	1
5	Alligator Creek	AC-41SE	113.51	277.32	2
8	Alligator Creek	AC-LAT1	243.22	228.95	5
11	Alligator Creek	AC-MID	948.17	198.82	6
7	Alligator Creek	AC-JAC	721.57	162.03	8
17	Alligator Creek	AC-TRPN	88.53	142.18	9
25	Forked Creek	LBP-FC	29.12	262.44	3
21	Forked Creek	FC-LOWER	813.19	140.45	10
34	Gottfried Creek	GC-LOWER	25.80	247.30	4
30	Gottfried Creek	GC-776	148.63	182.90	7

After reviewing the project components and pollutant removal estimates, several projects were reclassified as Water Quality conceptual projects. The projects are LBS04, LBS09, LBS13, LBS14, LBS15, LBS17, LBS18, LBS19, LBS20, LBS21, LBS23, LBS24, LBS25, and LBS26. The focus of each of these projects was not sediment removal due to erosion or sediment abatement with bank stabilization. These projects focused on TSS removal through source control or the BMP proposed has the primary mechanism of water quality improvement. Chapter 8 Project Analysis contains the recommendations for these projects.

7.0 RECOMMENDATIONS AND PRIORITIZATION

The diversity of Lemon Bay presents challenges to sediment management. Alligator Creek, Woodmere Creek and the coastal area are heavily urbanized and offer remediation opportunities primarily in the form of stabilizing banks, amending soil to increase cohesiveness, and removing nuisance and exotic vegetation. Forked Creek is moderately developed. Seven projects ranging from local-scale to regional-scale are proposed to cover the diversity of sedimentation sources observed in the basin. Gottfried Creek and Ainger Creek are relatively rural and would most benefit from implementing and enforcing guidelines for urban growth and development.

7.1 ALLIGATOR CREEK

The single largest opportunity to reduce sediment migrating to Lemon Bay is source control of the TSS in stormwater runoff from the US41 transportation corridor in Alligator Creek. Persistent street sweeping along the Tamiami Trail and adjacent commercial properties will reduce the amount of sediment available for transport to Lemon Bay.

The banks along the tributaries to Alligator Creek are generally characterized by loose, sandy, non-cohesive soils. Soil amendment will increase the moisture-holding capacity of the soil matrix making it more desirable for native plants. Through some of the segments, the easement is not wide enough to allow for slope reduction; geoweb and geofabric will provide stability on the steeper slopes and combined with soil amendment will allow native vegetation with hearty root systems to flourish.

7.2 WOODMERE CREEK

Implementation of buffer zones will reduce sediment and urban debris as well as improve water quality by reducing the organic debris load flowing into the Woodmere Creek. The practice of denuding channel banks, while effective at increasing flood capacity quickly and efficiently, is detrimental to the health of the system and Jones Edmunds recommends the maintenance practice be eliminated except in cases of public safety due to flooding.

Cistern usage in select subdivisions would reduce the rooftop debris captured in stormwater runoff and provide residents with a beneficial reuse option.

7.3 FORKED CREEK

Seven conceptual projects were presented in the basin. Several are local-scale projects designed to be implemented and evaluated as pilot projects for pollutant-load removal efficiencies. The projects are small dry ponds at the end of a sloped roadway to capture and treat runoff from small events. The conceptual designs are basic enough to be translated to other sites and may prove a cost effective way to reduce the sediment load and improve the water quality of runoff discharging directly to the creek. Evaluation of the pond effectiveness is measurable as the bulk weight of the sediment removed by County maintenance staff.

Buchnan Airport provides an opportunity to build a stormwater treatment system for areas east of Englewood Road that drain through the airport site as well as capture the sediment that is missed in urban development and construction. As a somewhat regional treatment system, the project can be viewed as sediment reduction and water quality protective measures for the future. This project ranked Number 1 in scoring the sediment management plan prioritization matrix.

7.4 GOTTFRIED CREEK

The Indiana Avenue transportation corridor has the third largest TSS runoff in the watershed. The roadway is less than 1 mile from the bay, persistent street-sweeping as a source control will reduce the amount of sediment available to be transported to Lemon Bay. Sediment build-up is visible at the coastal outfalls in aerial photographs.

7.5 AINGER CREEK

Urban development has not impacted Ainger Creek to the same degree as the rest of the watershed. One project has been proposed in the basin adjacent to an industrial area. As urban development proceeds into the basin, the County has the opportunity to incorporate buffer zones, soil amendment, and LID practices as well as inspection and enforcement other sedimentation preventative measures during public and private construction projects.

7.6 LEMON BAY COASTAL

Two local-scale projects are proposed in the coastal area adjacent to Gottfried Creek to minimize sediment being transported from the uplands to Lemon Bay.

7.7 ADDITIONAL RECOMMENDATIONS

Restoration and rehabilitation are necessary to alleviate anthropogenic sediment accumulation that impedes flow regimes and navigability of waterways and disrupts natural systems. Proactive maintenance practices will help the County achieve long-term goals and achieve sustainability for the waterways and natural systems.

As a parallel task in this WMP, Jones Edmunds evaluated County-wide maintenance practices. Several of the practices are specific to sediment accumulation and erosion and are discussed below.

Maintaining the hundreds of miles of channels in the County is a massive work effort. The County has several mechanisms for monitoring, reporting, and correcting activities that may lead to increased sediment deposition in the County's stormwater system and waterways, such as:

- The County's Environmental Services Department has a Strategic Maintenance Plan for the Drainage Operations Division that outlines maintenance schedules and routine maintenance practices.

- The maintenance staff is proactive in monitoring and reporting sediment issues as part of their routine duties.

- The County's MS4 Permit summarizes prevention and enforcement tasks associated with minimizing erosion due to construction.

Additionally, an asset-management system is being implemented throughout the County that will improve the tracking of maintenance requests and regularly scheduled maintenance.

Recommendations from the maintenance evaluation to reduce sediment loads are as follows:

- For the most effective removal of nutrients, baffle boxes should be cleaned at least monthly during the wet season and quarterly during the dry season to remove sediment and vegetation.

- Sediment sump cleanout should be scheduled bi-annually. If during regular maintenance, County staff observe sediment buildup that exceeds 50% of the sump volume, regular maintenance should be scheduled more frequently.

- A normal practice by the County maintenance staff is to use herbicides within a watercourse or on adjacent banks. To facilitate achieving TMDL levels set for Lemon Bay and prevent muck buildup in the channel, decaying vegetation should not be left in the watercourse.

- As a regular maintenance practice, County staff excavates and denudes roadside swales to eliminate vegetation and remove possible sediment accumulation. Within the 2 weeks after the excavation, County staff will re-sod the bare soil. Denuding should be replaced with mechanized removal of vegetation to a minimum length leaving root systems in place.

- Removing exotic-invasive species during routine maintenance creates a more natural system. However, the removal process must not destabilize the stream banks. This activity would be best suited to maintenance during the dry season. Ideally, re-introducing native species will decrease maintenance requirements.

- For industrial and densely-populated areas, where space for additional stormwater BMPs is not available, bi-monthly street sweeping removes sediment and pollutants before either reaches the stormwater system.

- Public outreach is recommended for educating homeowners, landscapers, and lawn-maintenance workers on proper maintenance along streams and ditches.

Appendix D

Report Card

August 2010

Sarasota County

Southwest Florida Water Management District

2 0 0 9

WHAT CAN YOU DO TO PROTECT THE LEMON BAY NORTH WATERSHED?

- Start a Neighborhood Environmental Stewardship Team (NEST) in your neighborhood to improve the health of the watershed.
- Don't fertilize June 1 - September 30 (rainy season) to reduce nutrients (nitrogen).
- Create a living shoreline along your property by planting mangroves instead of hardening the shoreline with seawalls.
- Install a rain garden in your yard to capture stormwater.

The data and information used in the Lemon Bay Report Card were provided by the following monitoring programs:

- Sarasota Environmental Aquatics Team
- Sarasota County Monitoring Program
- SWFWMD Seagrass Monitoring

Sarasota County

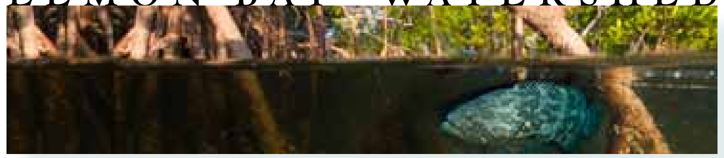
2 0 0 9

REPORT CARD

LEMON BAY WATERSHED

Sarasota County

2009 REPORT CARD
LEMON BAY WATERSHED



2009 IMPROVEMENTS

- Lower average rainfall led to lower pollutants entering the bay. As a result, chlorophyll and water clarity were exceptionally good.
- Aerial survey results showed an increase in seagrass coverage.
- Scallop abundance has increased over the previous years.
- Sarasota County began design on sediment abatement projects within the Lemon Bay watershed.
- Sarasota County has begun a water quality improvement project designed to enhance water quality entering Alligator creek upstream of U.S. Highway 41.
- 11 Neighborhood Environmental Stewardship Teams (NEST) were established to improve the watershed.

WETLANDS

About 50% of the pre-development wetland area remains in the Lemon Bay watershed.

SHORELINE

The Sarasota County 2007-2008 mangrove survey indicated:

- Over half (57 percent) of the parcels surveyed had mangroves present along more than 30 percent of the parcel's shoreline.
- Of those parcels containing mangroves, 67 percent were untrimmed, showing compliance with trimming limits is high.
- 99 percent of trimming performed was within limits established by law.

FAST FACTS

The Lemon Bay Watershed is approximately 74 square miles in area. 68 percent of the watershed is in Sarasota County and the rest is in Charlotte County. Seven drainage basins drain into Lemon Bay. Five of these are either entirely or mainly in Sarasota County and two basins are primarily or entirely in Charlotte County.

- Alligator Creek
- Ainger Creek
- Forked Creek
- Gottfied Creek
- Woodmere Creek
- Oyster Creek (Charlotte County)
- Buck Creek (Charlotte County)

In 1986 Lemon Bay was designated an Aquatic Preserve. The data used for this report card does not include data from Oyster Creek or Buck Creek basins.

OTHER WATERSHED HEALTH INDICATORS

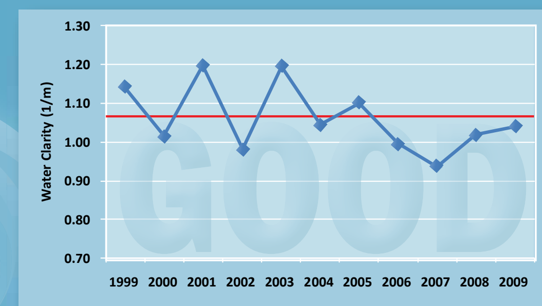
- Half of the watershed is still undeveloped.
- There is a conditionally approved shellfish harvesting area on the western section of Lemon Bay, north of Stump Pass.
- A Florida Department of Environmental Protection assessment showed water quality impairments for nutrients in upper Lemon Bay.

2009 WATERSHED SCORE = GOOD

range: good, fair, poor *

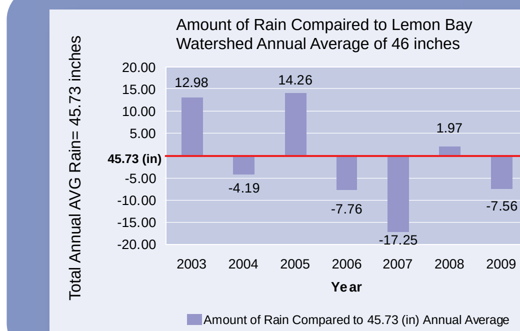
Water Quality Index Indicators Below the red line is good

WATER CLARITY – a measure of the amount of light that reaches the bottom; depends upon the amount of chlorophyll, turbidity, water color, and suspended sediments. Affects seagrass growth and reproduction.



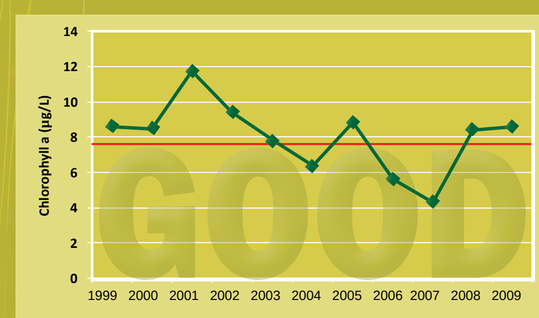
NITROGEN LOADING – an estimate of the amount of nitrogen flowing off the watershed to the bay; influenced by rainfall, runoff from fertilizer, pet waste, and other sources. Affects water quality, especially chlorophyll.

RAINWATER – driver for water quality. More rain brings more stormwater runoff, which carryies pollutants and nutrients to the bay. Here is the deviation from the average annual rainfall of 46 inches in the Lemon Bay Watershed.



* Rainfall values obtained from data collected by Sarasota County automated data collection sites within the watershed.

CHLOROPHYLL – a measure of algae in the water; influenced by levels of nutrient loading and water circulation. Affects water clarity.



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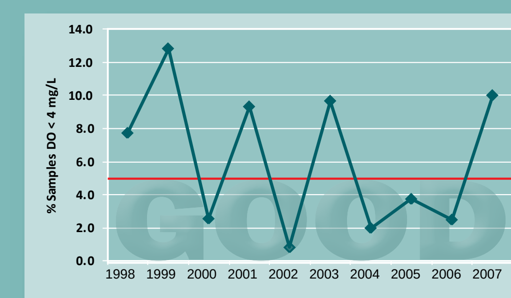

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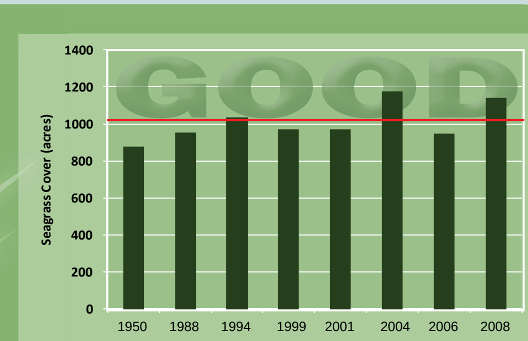

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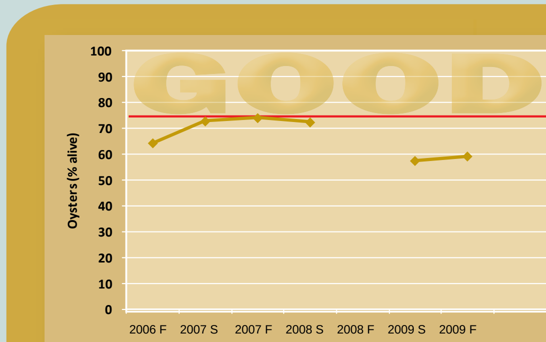

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Sponsored by a grant from the Manasota Basin Board of the Southwest Florida Water Management District
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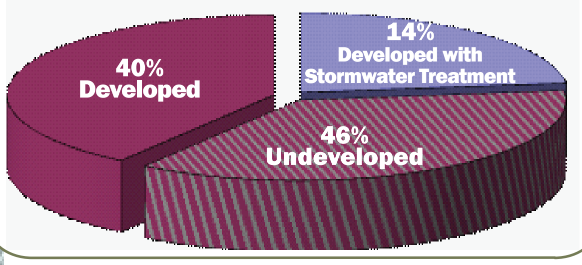
Lemon Bay percentage of Land Developed, Undeveloped and Developed with stormwater BMPs



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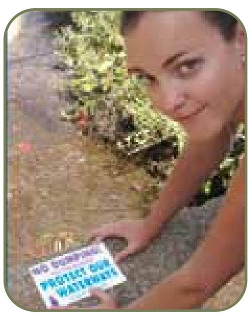
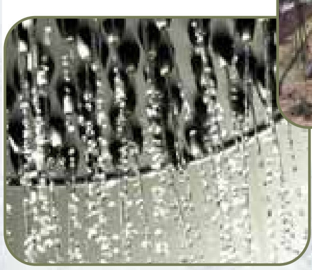

Storm drain markers


Cistern collecting rainwater for watering plants


Rain garden (foreground) Cistern (background)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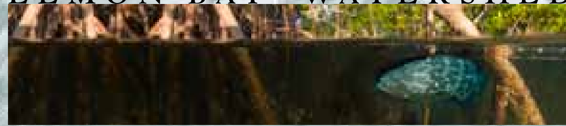
Sarasota County

2009

REPORT CARD

LEMON BAY WATERSHED



How we measure up

Habitat

Mangroves provide many benefits to people and the environment:

- Roots and trunks resist and prevent shoreline erosion
- Food and habitat is provided for the marine food chain, including fish we like to consume
- Stormwater is filtered as it runs off the land helping to maintain the quality of our coastal waters
- Homes are protected from severe wind damage

Our goal is to increase mangroves along shorelines so they can provide even greater benefits to a larger area of our coastline.

Mangrove habitat has remained relatively stable in Lemon Bay. Maintaining existing mangrove areas is important and encouraging mangroves to grow is a less expensive and more effective way of preventing both erosion and property damage from tropical storms.

Fresh Water Wetlands provide many valuable services for the watershed, including flood control, recreation, water quality improvement, and habitat for plants and animals. Approximately 50% of the pre-development freshwater wetlands remain in the Lemon Bay watershed. Continued wetland protection through minimizing impacts and restoring wetland function where possible will help ensure the future health of the watershed.

Tree Canopy is important for the watershed because it intercepts rainfall and helps reduce stormwater runoff.

22% of the Lemon Bay watershed remains covered by tree canopy. Much of that canopy exists in undeveloped areas in the eastern portion of the watershed. Our goal is to work to preserve natural areas and increase tree canopy, where appropriate, to help reduce stormwater runoff and bank erosion as well as to provide habitat.

Tidal Creeks are unique ecosystems that provide habitat for marine and plant life and function as a link between the watershed and the bay by delivering freshwater and nutrients. The Tidal Creek Condition Index (TCCI) is an ecologically-based tool that measures the biological health of county tidal creeks.

The Lemon Bay Watershed is comprised of five tidal creeks that drain the associated basins: Alligator Creek (10.71 sq. miles), Woodmere Creek (2.30 sq. miles), Forked Creek (9.12 sq. miles), Gottfried Creek (11.3 sq. miles), and Ainger Creek (10.37 sq miles). On our TCCI measurement scale of 1-3, the Lemon Bay Watershed score is a 2 which is categorized as FAIR.

Water Use (conservation)

How much water do we use in our homes and on our landscaping? Our county goal is to use no more than 86-gallons of water per person, per day. In 2009, Sarasota County met that goal by only using 83-gallons of water per person, per day. What about reusing our treated waste water? Our goal is to use 75% of treated waste water for irrigation, however, during 2009 we used only 66%. Sarasota County began selling rain barrels to the public in 2009 to help reduce potable water use outdoors. 91 rain barrels were sold county-wide with six rain barrels in the Lemon Bay watershed.

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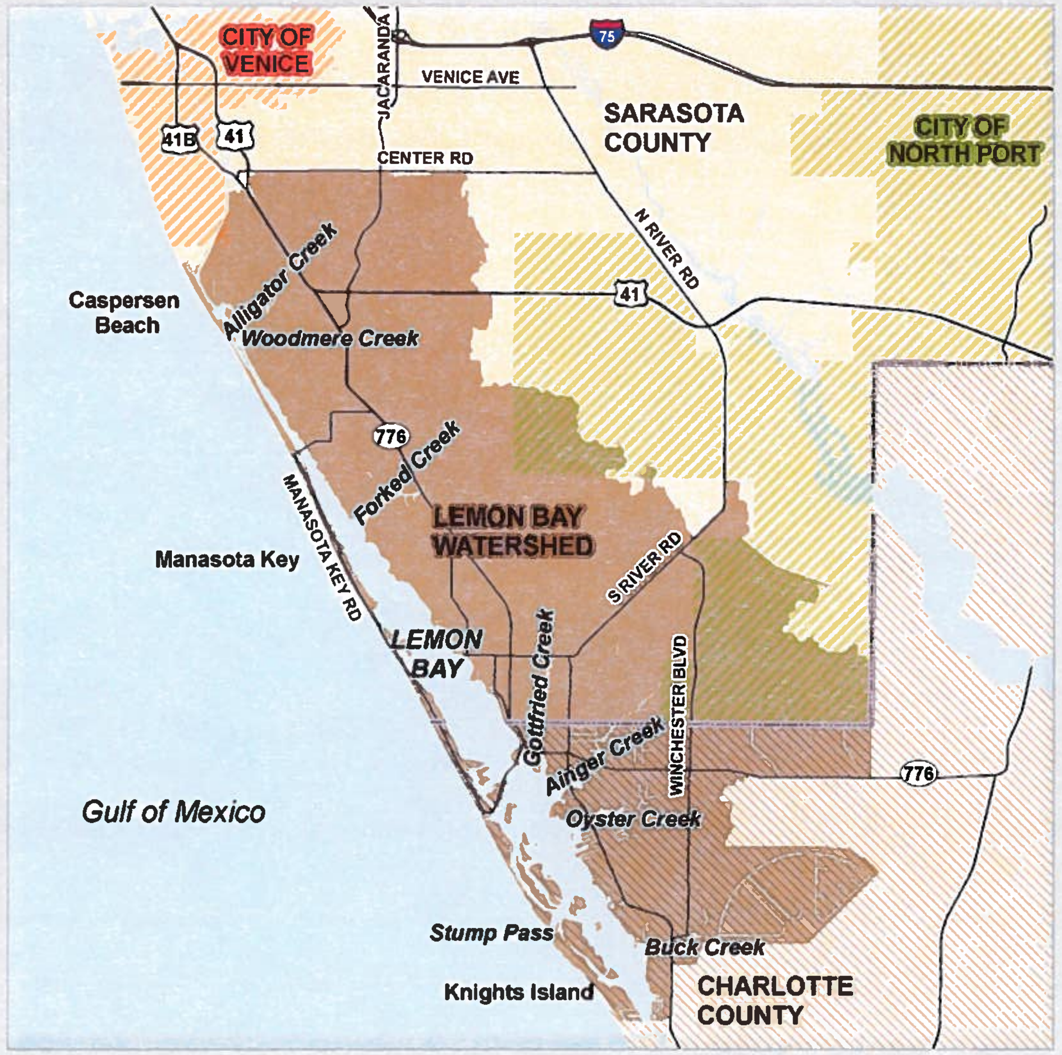


WHAT CAN YOU DO TO PROTECT THE LEMON BAY NORTH WATERSHED?

- Call 861-5000 to start a Neighborhood Environmental Stewardship Team (NEST) in your neighborhood to improve the health of the watershed.
- Don't fertilize June 1 - September 30 (rainy season) to reduce nutrients (nitrogen).
- Create a living shoreline along your property by planting mangroves instead of hardening the shoreline with seawalls.
- Install a rain garden in your yard to capture stomwater.

The data and information used in the Lemon Bay Report Card were provided by the following monitoring programs:

- Sarasota Environmental Aquatics Team
- Sarasota County Monitoring Program
- SWFWMD Seagrass Monitoring

Sarasota County

2 0 1 0

REPORT CARD

LEMON BAY WATERSHED

Sarasota County

2 0 1 0

REPORT CARD

LEMON BAY WATERSHED

2010 WATERSHED SCORE = GOOD

range: good. fair. poor *

2010 IMPROVEMENTS

- Aerial survey results showed an increase in seagrass coverage.
- Sarasota County began design on sediment abatement projects within the Lemon Bay watershed.
- Sarasota County has begun a water quality improvement project designed to enhance water quality entering Alligator creek upstream of U.S. Highway 41.
- Ten Neighborhood Environmental Stewardship Teams (NEST) were established to improve the watershed.

WETLANDS

About 50% of the pre-development wetland area remains in the Lemon Bay watershed.

FAST FACTS

The Lemon Bay Watershed is approximately 74 square miles in area. 68 percent of the watershed is in Sarasota County and the rest is in Charlotte County. Seven drainage basins drain into Lemon Bay. Five of these are either entirely or mainly in Sarasota County and two basins are primarily or entirely in Charlotte County.

- Alligator Creek
- Ainger Creek
- Forked Creek
- Gottfied Creek
- Woodmere Creek
- Oyster Creek (Charlotte County)
- Buck Creek (Charlotte County)

In 1986 Lemon Bay was designated an Aquatic Preserve. The data used for this report card does not include data from Oyster Creek or Buck Creek basins.

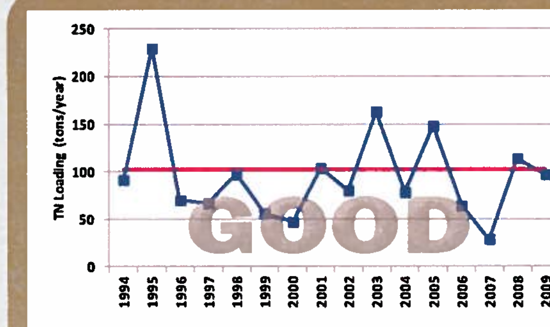
OTHER WATERSHED HEALTH INDICATORS

- Half of the watershed is still undeveloped.
- There is a conditionally approved shellfish harvesting area on the western section of Lemon Bay, north of Stump Pass.
- 11 scallops were found in the bay.
- A Florida Department of Environmental Protection assessment showed water quality impairments for nutrients in upper Lemon Bay.
- Red tide cell counts below detection.

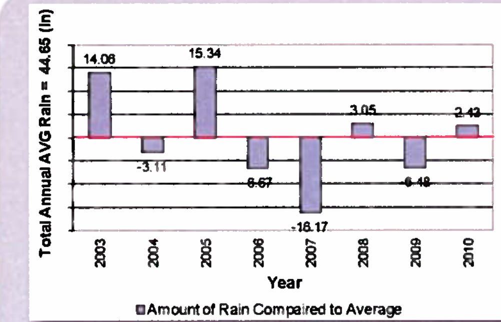
Water Quality Index Indicators

CHLOROPHYLL – a measure of algae in the water; influenced by levels of nutrient loading and water circulation. Affects water clarity.

NITROGEN LOADING – an estimate of the amount of nitrogen flowing off the watershed to the bay; influenced by rainfall, runoff from fertilizer, pet waste, and other sources. Affects water quality, especially chlorophyll.



RAINWATER – driver for water quality. More rain brings more stormwater runoff, which carries pollutants and nutrients to the bay. Here is the deviation from the average annual rainfall of 45 inches in the Lemon Bay watershed.



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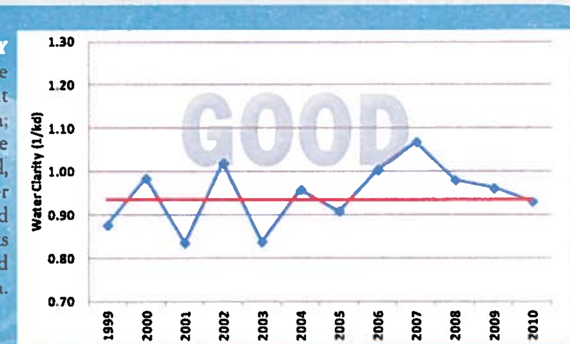
WATER CLARITY – a measure of the amount of light that reaches the bottom; depends upon the amount of chlorophyll, turbidity, water color, and suspended sediments. Affects seagrass growth and reproduction.



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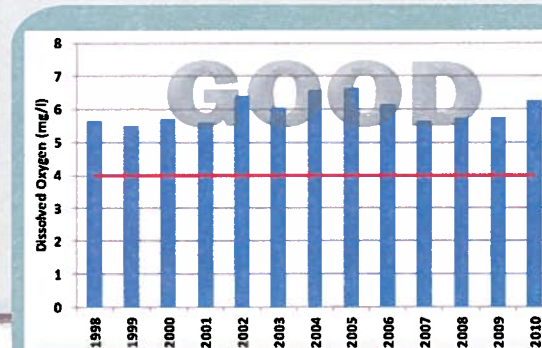

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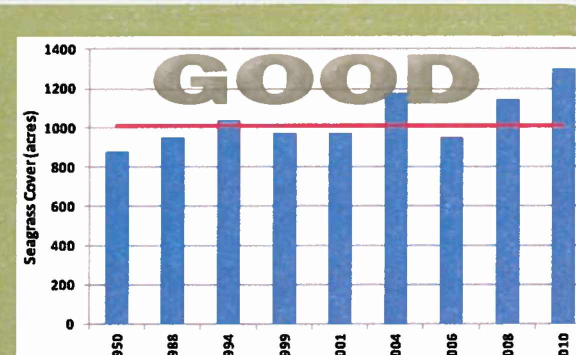

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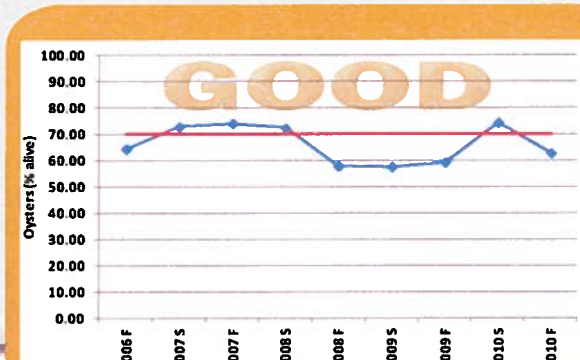

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Sarasota County

Southwest Florida Water Management District

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2 0 1 0

REPORT CARD

LEMON BAY WATERSHED

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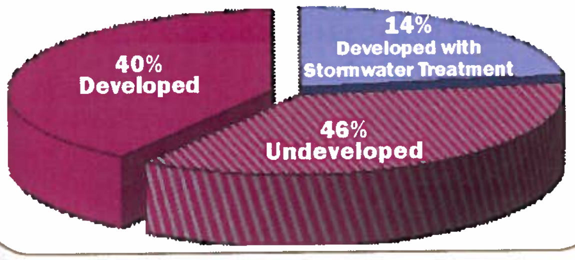

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Sarasota County

Appendix E

Water Budget Data

August 2010

Sarasota County

Southwest Florida Water Management District

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1.0 LEMON BAY WATERSHED

1.1 CURRENT CONDITIONS

Table 1-1 Monthly Rainfall for Lemon Bay Watershed (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	3.29	2.25	1.29	2.85	0.58	21.02	16.40	8.04	9.04	10.37	0.85	1.30	77.29
1996	1949	2016	3.34	1.16	3.97	1.94	4.83	3.82	3.46	5.96	4.67	6.25	0.34	0.80	40.54
1997	1950	2017	1.69	0.32	1.26	5.52	1.40	3.02	3.55	3.48	8.77	2.21	3.86	5.91	40.99
1998	1951	2018	5.31	4.92	4.43	0.19	1.71	2.39	6.60	4.92	7.59	0.84	3.93	0.56	43.40
1999	1952	2019	2.24	0.06	1.66	0.34	0.96	6.14	5.02	7.44	7.62	2.52	0.56	1.66	36.23
2000	1953	2020	1.09	0.45	0.82	1.87	0.60	5.01	4.72	7.00	5.55	0.22	0.76	0.59	28.69
2001	1954	2021	0.22	0.01	6.83	0.35	0.33	6.42	12.22	5.43	10.46	1.56	0.21	0.31	44.36
2002	1955	2022	0.54	4.28	0.23	1.56	2.77	6.61	3.44	11.20	3.51	0.95	4.90	4.47	44.47
2003	1956	2023	0.04	0.80	1.94	3.11	3.78	15.43	4.65	12.25	11.85	0.57	0.51	3.67	58.61
2004	1957	2024	1.56	3.87	0.79	3.52	1.12	5.70	7.13	7.32	4.69	3.04	2.04	2.98	43.78
2005	1958	2025	1.60	2.84	4.34	2.25	4.96	16.40	8.63	5.06	3.63	9.07	3.19	0.28	62.25
2006	1959	2026	0.44	2.75	0.31	0.05	1.72	5.22	10.49	7.21	5.21	1.15	0.46	2.47	37.48
2007	1960	2027	1.35	1.46	0.31	2.25	0.64	4.48	4.37	3.60	4.75	4.11	0.59	0.84	28.76
		Average	**1.75**	**1.94**	**2.17**	**1.98**	**1.96**	**7.82**	**6.98**	**6.84**	**6.72**	**3.30**	**1.71**	**1.99**	**45.14**

Table 1-2 Current Total Volume for Lemon Bay Watershed (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	3,539.4	2,306.6	1,742.3	1,898.0	851.0	35,309.8	29,326.9	13,416.5	17,818.0	19,201.3	3,560.6	2,499.0	131,469.4
1996	4,480.3	1,975.1	3,457.5	2,082.9	5,047.1	2,612.6	2,627.0	5,751.3	4,361.3	9,414.6	1,935.9	1,700.4	45,446.0
1997	2,130.6	846.0	1,380.4	4,223.8	942.3	1,733.3	1,731.4	1,789.1	10,029.3	2,369.8	4,623.8	8,158.4	39,958.3
1998	10,686.2	8,768.3	8,329.1	1,912.6	2,099.2	1,984.8	5,733.4	3,831.5	8,018.9	2,875.3	6,272.5	1,429.9	61,941.6
1999	2,106.1	767.1	1,297.1	635.4	637.0	2,909.7	3,854.3	5,980.1	9,647.2	4,721.1	2,106.2	2,528.2	37,189.6
2000	1,645.9	944.3	911.2	1,468.7	691.1	2,044.9	2,395.5	8,283.0	6,041.8	1,714.5	1,430.8	1,143.0	28,714.7
2001	815.4	599.3	6,618.6	680.2	558.3	3,967.2	15,440.6	9,760.3	16,565.4	3,703.5	1,950.9	1,456.3	62,115.9
2002	1,212.5	4,793.7	836.8	1,179.6	1,953.9	3,818.4	2,194.6	11,285.1	5,403.0	2,502.9	8,788.9	5,298.0	49,267.5
2003	1,918.5	1,481.2	1,779.1	3,881.8	3,735.8	22,106.4	5,598.5	20,085.3	24,152.6	3,411.1	2,064.4	4,936.1	95,150.6
2004	1,872.8	4,855.4	1,454.4	3,395.4	1,060.7	3,441.9	5,106.4	8,443.9	6,519.8	5,899.2	3,234.8	4,332.2	49,617.1
2005	2,679.1	4,216.3	5,807.1	1,809.9	5,028.0	22,018.3	14,617.3	5,829.8	4,655.2	14,978.5	5,289.8	2,133.9	89,063.3
2006	1,505.3	2,998.7	994.9	730.2	1,101.3	2,514.9	9,175.4	8,334.8	6,741.8	3,153.0	1,744.9	2,817.5	41,812.6
2007	1,560.6	1,290.3	719.5	1,680.0	645.8	2,020.1	1,907.5	1,745.8	2,537.6	3,162.6	1,269.2	1,129.1	19,668.1
Average	**2,781.0**	**2,757.1**	**2,717.5**	**1,967.6**	**1,873.2**	**8,190.9**	**7,669.9**	**8,041.3**	**9,422.5**	**5,931.3**	**3,405.6**	**3,043.2**	**57,801.1**

Table 1-3 Current Direct Runoff for Lemon Bay Watershed (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1,445.2	545.3	241.4	394.9	43.6	28,995.1	22,352.2	7,271.9	11,081.3	11,872.2	110.1	214.0	84,567.2
1996	1,697.6	303.0	1,410.3	597.8	3,272.1	1,105.1	998.9	3,127.5	1,876.7	5,242.3	15.2	115.1	19,761.6
1997	715.9	13.1	421.8	2,556.8	144.0	815.9	785.5	652.3	7,934.9	905.3	2,851.2	4,931.1	22,727.8
1998	6,550.7	4,426.3	4,674.1	4.0	311.4	498.7	3,345.4	1,528.4	4,100.7	108.3	3,796.6	67.8	29,412.5
1999	691.6	0.1	289.7	27.4	93.8	1,332.3	2,192.0	3,123.2	5,275.2	1,052.1	78.2	792.7	14,948.1
2000	375.1	32.1	57.5	514.9	95.3	884.3	1,104.5	5,875.8	3,108.5	16.3	88.6	83.9	12,236.8
2001	9.2	0.0	4,674.6	26.5	13.2	2,430.7	10,950.6	4,742.3	10,659.0	263.0	18.6	8.9	33,796.9
2002	28.4	3,117.3	23.7	337.7	1,001.3	2,101.2	723.6	7,904.7	1,371.9	210.3	6,284.3	2,375.1	25,479.4
2003	0.0	69.7	336.4	2,457.2	2,221.3	17,204.6	1,665.5	13,247.1	17,326.2	80.6	26.5	2,765.5	57,400.6
2004	432.1	3,183.4	215.0	1,921.9	157.7	1,858.7	2,738.8	4,495.6	2,437.6	2,907.3	1,295.4	2,510.0	24,153.4
2005	1,164.9	2,788.6	3,885.8	424.7	3,033.7	15,701.4	8,239.2	1,517.4	1,223.9	10,341.7	1,873.2	3.0	50,197.5
2006	17.3	1,411.6	45.6	0.4	180.5	1,124.8	6,040.9	4,236.7	2,340.5	531.0	42.8	1,039.8	17,012.0
2007	295.9	250.4	23.0	709.2	53.5	736.2	679.8	446.5	989.1	1,270.5	91.1	129.1	5,674.2
Average	**1,032.6**	**1,241.6**	**1,253.8**	**767.2**	**817.0**	**5,753.0**	**4,755.1**	**4,474.6**	**5,363.5**	**2,677.0**	**1,274.8**	**1,156.6**	**30,566.8**

Table 1-4 Summary of Annual Current Total Volume Inputs for Lemon Bay Watershed (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	30,688.4	84,567.2	437.9	66.0	586.5	15,123.4
1996	16,781.6	19,761.6	444.3	66.0	592.3	7,800.2
1997	9,066.7	22,727.8	443.2	66.0	598.3	7,056.3
1998	22,875.5	29,412.5	448.8	65.9	603.0	8,535.8
1999	14,258.5	14,948.1	450.8	32.6	610.3	6,889.3
2000	10,351.8	12,236.8	455.8	59.3	615.9	4,995.2
2001	18,676.5	33,796.9	460.4	46.0	621.9	8,514.2
2002	14,608.5	25,479.4	463.4	51.2	629.9	8,035.1
2003	25,997.7	57,400.6	466.4	57.6	637.1	10,591.2
2004	16,371.6	24,153.4	471.3	23.5	644.1	7,953.2
2005	25,409.0	50,197.5	471.3	21.0	649.1	12,315.3
2006	16,827.3	17,012.0	471.3	21.2	649.1	6,831.8
2007	6,848.4	5,674.2	471.3	16.8	649.1	6,008.3
Average	**17,597.0**	**30,566.8**	**458.2**	**45.6**	**622.1**	**8,511.5**

Table 1-5 Annual Total Volume to Rainfall Coefficients for Lemon Bay Watershed

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1995	48.83	77.29	0.63
1996	16.88	40.54	0.42
1997	14.84	40.99	0.36
1998	23.01	43.40	0.53
1999	13.81	36.23	0.38
2000	10.67	28.69	0.37
2001	23.07	44.36	0.52
2002	18.30	44.47	0.41
2003	35.34	58.61	0.60
2004	18.43	43.78	0.42
2005	33.08	62.25	0.53
2006	15.53	37.48	0.41
2007	7.31	28.76	0.25
Average	**21.47**	**45.14**	**0.45**

Table 1-6 Average Monthly Rainfall to Total Volume Coefficients for Lemon Bay Watershed

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.03	1.75	0.59
Feb	1.02	1.94	0.53
Mar	1.01	2.17	0.47
Apr	0.73	1.98	0.37
May	0.70	1.96	0.36
Jun	3.04	7.82	0.39
Jul	2.85	6.98	0.41
Aug	2.99	6.84	0.44
Sep	3.50	6.72	0.52
Oct	2.20	3.30	0.67
Nov	1.26	1.71	0.74
Dec	1.13	1.99	0.57

Table 1-7 Wet Season Total Volume to Rainfall Coefficients for Lemon Bay Watershed

	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	42.74	64.87	0.66
1996	9.20	24.16	0.38
1997	6.56	21.03	0.31
1998	8.34	22.35	0.37
1999	10.07	28.74	0.35
2000	7.61	22.50	0.34
2001	18.36	36.10	0.51
2002	9.36	25.72	0.36
2003	27.99	44.75	0.63
2004	10.92	27.89	0.39
2005	23.06	42.79	0.54
2006	11.11	29.28	0.38
2007	4.22	21.31	0.20
Average	**14.58**	**31.65**	**0.42**

Table 1-8 Dry Season Total Volume to Rainfall Coefficients for Lemon Bay Watershed			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	6.09	12.42	0.49
1996	7.68	16.38	0.47
1997	8.28	19.96	0.42
1998	14.67	21.05	0.70
1999	3.74	7.49	0.50
2000	3.06	6.19	0.49
2001	4.71	8.26	0.57
2002	8.94	18.76	0.48
2003	7.35	13.86	0.53
2004	7.50	15.89	0.47
2005	10.02	19.46	0.51
2006	4.42	8.20	0.54
2007	3.08	7.45	0.41
Average	**6.89**	**13.49**	**0.51**

Table 1-9 Annual Direct Runoff to Rainfall Coefficients for Lemon Bay Watershed			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	31.41	77.29	0.41
1996	7.34	40.54	0.18
1997	8.44	40.99	0.21
1998	10.92	43.40	0.25
1999	5.55	36.23	0.15
2000	4.55	28.69	0.16
2001	12.55	44.36	0.28
2002	9.46	44.47	0.21
2003	21.32	58.61	0.36
2004	8.97	43.78	0.20
2005	18.64	62.25	0.30
2006	6.32	37.48	0.17
2007	2.11	28.76	0.07
Average	**11.35**	**45.14**	**0.23**

Table 1-10 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.38	1.75	0.22
Feb	0.46	1.94	0.24
Mar	0.47	2.17	0.21
Apr	0.28	1.98	0.14
May	0.30	1.96	0.16
Jun	2.14	7.82	0.27
Jul	1.77	6.98	0.25
Aug	1.66	6.84	0.24
Sep	1.99	6.72	0.30
Oct	0.99	3.30	0.30
Nov	0.47	1.71	0.28
Dec	0.43	1.99	0.22

Table 1-11 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	30.30	64.87	0.47
1996	4.59	24.16	0.19
1997	4.12	21.03	0.20
1998	3.56	22.35	0.16
1999	4.82	28.74	0.17
2000	4.08	22.50	0.18
2001	10.79	36.10	0.30
2002	4.57	25.72	0.18
2003	18.39	44.75	0.41
2004	5.36	27.89	0.19
2005	13.75	42.79	0.32
2006	5.30	29.28	0.18
2007	1.53	21.31	0.07
Average	**8.55**	**31.65**	**0.23**

Table 1-12 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	1.11	12.42	0.09
1996	2.75	16.38	0.17
1997	4.32	19.96	0.22
1998	7.37	21.05	0.35
1999	0.73	7.49	0.10
2000	0.46	6.19	0.07
2001	1.76	8.26	0.21
2002	4.89	18.76	0.26
2003	2.93	13.86	0.21
2004	3.61	15.89	0.23
2005	4.89	19.46	0.25
2006	1.02	8.20	0.12
2007	0.58	7.45	0.08
Average	**2.80**	**13.49**	**0.18**

1.2 HISTORICAL CONDITIONS

Table 1-13 Historical Total Volume for Lemon Bay Watershed (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	2,594.4	1,565.6	1,015.5	1,218.3	581.0	33,643.9	27,219.1	10,608.7	14,582.7	16,044.7	1,972.8	1,445.7	112,492.4
1949	3,292.0	1,244.8	2,547.4	1,497.9	4,329.6	1,927.7	1,692.6	4,099.3	3,102.4	7,440.8	1,121.8	1,124.7	33,420.9
1950	1,669.0	645.6	1,085.7	3,618.1	717.8	1,455.0	1,342.9	1,353.5	8,614.2	1,533.8	3,879.4	7,019.2	32,934.2
1951	9,301.2	7,657.0	6,249.0	1,140.9	1,447.5	1,500.5	5,343.9	3,139.8	6,769.0	1,619.2	4,985.7	992.0	50,145.9
1952	1,598.8	616.1	978.7	548.2	517.1	2,293.0	3,628.2	4,756.9	7,846.8	2,897.7	1,213.7	1,751.2	28,646.4
1953	1,237.8	734.9	736.9	1,160.3	541.7	1,451.1	1,876.4	7,247.5	4,863.3	1,090.4	1,013.6	837.3	22,791.2
1954	649.0	489.0	5,585.9	631.3	530.1	3,683.2	15,571.7	8,058.1	14,065.2	2,004.0	1,126.8	975.2	53,369.4
1955	890.9	4,520.2	667.6	896.6	1,427.7	3,655.0	1,724.9	10,152.8	3,587.1	1,411.2	7,564.3	4,517.7	41,016.1
1956	1,354.6	1,140.6	1,430.7	3,713.5	3,543.3	21,845.5	3,644.5	16,967.9	21,305.4	1,639.0	1,134.6	3,924.1	81,643.9
1957	1,334.3	3,754.7	1,059.3	2,899.6	877.8	2,635.0	4,345.7	6,763.4	4,774.1	4,096.2	2,205.0	3,702.8	38,448.0
1958	1,910.6	3,494.5	4,718.1	1,148.5	3,726.8	20,046.8	11,504.7	3,460.0	2,645.0	12,601.4	3,715.5	1,250.9	70,222.8
1959	1,035.6	2,286.9	745.0	601.7	835.2	1,897.5	8,603.2	6,629.2	4,528.5	1,678.4	1,042.3	2,152.5	32,036.0
1960	1,248.6	934.3	558.9	1,183.3	530.7	1,399.6	1,337.3	1,322.5	1,731.7	2,146.2	706.1	680.4	13,779.7
Average	**2,162.8**	**2,237.2**	**2,106.1**	**1,558.3**	**1,508.2**	**7,494.9**	**6,756.5**	**6,504.6**	**7,570.4**	**4,323.3**	**2,437.0**	**2,336.5**	**46,995.9**

Table 1-14 Historical Direct Runoff for Lemon Bay Watershed (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	1,065.31	325.35	31.98	41.10	2.21	27,849.93	22,053.65	6,993.26	10,373.77	11,432.10	51.65	21.87	80,242.19
1949	1,394.31	70.64	839.11	334.91	2,796.13	680.45	443.85	2,163.43	1,465.15	4,632.70	0.25	16.98	14,837.92
1950	553.59	0.04	264.87	2,054.75	8.67	601.75	473.65	347.12	6,758.52	419.09	2,504.88	4,592.54	18,579.47
1951	6,265.14	4,708.28	3,818.17	0.06	143.72	325.12	3,198.74	1,191.27	3,800.47	22.54	3,162.03	1.05	26,636.60
1952	409.08	0.00	67.75	0.24	15.49	744.31	2,071.42	2,360.10	4,655.13	769.09	2.36	489.95	11,584.92
1953	253.70	0.10	4.13	291.44	5.88	335.11	641.36	5,148.06	2,671.39	3.92	25.78	12.93	9,393.82
1954	0.01	0.00	3,723.41	9.94	2.58	2,155.94	11,545.37	4,897.94	10,229.03	136.43	1.39	0.00	32,702.02
1955	0.03	3,038.03	13.87	159.32	546.22	2,020.22	433.12	7,282.83	1,101.63	61.07	5,588.77	2,265.17	22,510.30
1956	0.00	0.55	142.91	2,377.48	2,071.81	17,522.31	1,251.35	12,704.02	16,895.95	6.06	0.11	2,296.01	55,268.56
1957	208.61	2,333.76	73.37	1,580.04	72.08	1,123.29	2,333.62	4,035.62	2,229.75	2,266.66	930.18	2,298.31	19,485.29
1958	753.32	2,301.93	3,155.58	96.86	2,097.52	15,199.82	7,764.65	1,011.30	706.31	9,410.39	1,477.46	2.30	43,977.45
1959	0.04	1,010.69	0.38	0.00	4.74	570.03	5,801.22	3,655.66	1,921.58	267.88	1.99	792.32	14,026.54
1960	252.12	90.46	0.10	302.26	0.58	165.56	163.45	144.96	421.05	766.77	29.20	17.46	2,353.97
Average	**858.10**	**1,067.68**	**933.51**	**557.57**	**597.51**	**5,330.30**	**4,475.04**	**3,995.04**	**4,863.82**	**2,322.67**	**1,059.70**	**985.15**	**27,046.08**

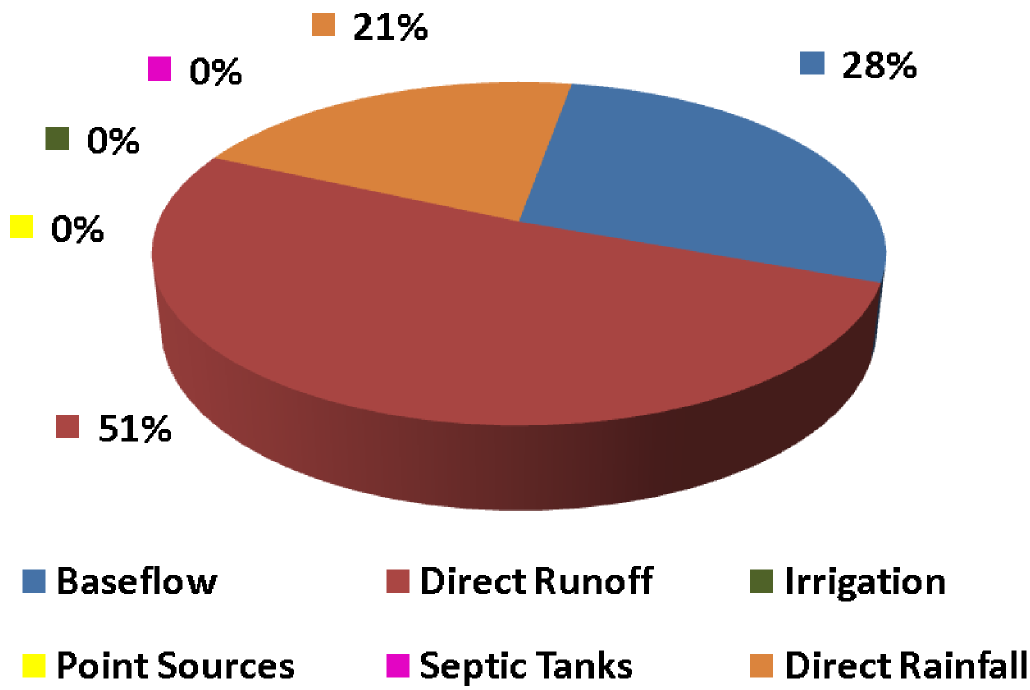

Figure 1-1 Lemon Bay Watershed Historical Total Volume Water Budget

Table 1-15 Summary of Annual Historical Total Volume Inputs for Lemon Bay Watershed (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	17,126.8	80,242.2	0.0	0.0	0.0	15,123.4
1949	10,782.7	14,837.9	0.0	0.0	0.0	7,800.2
1950	7,298.3	18,579.5	0.0	0.0	0.0	7,056.3
1951	14,973.3	26,636.6	0.0	0.0	0.0	8,535.8
1952	10,172.0	11,584.9	0.0	0.0	0.0	6,889.3
1953	8,402.1	9,393.8	0.0	0.0	0.0	4,995.2
1954	12,153.0	32,702.0	0.0	0.0	0.0	8,514.2
1955	10,470.6	22,510.3	0.0	0.0	0.0	8,035.1
1956	15,784.1	55,268.6	0.0	0.0	0.0	10,591.2
1957	11,009.4	19,485.3	0.0	0.0	0.0	7,953.2
1958	13,930.0	43,977.4	0.0	0.0	0.0	12,315.3
1959	11,177.5	14,026.5	0.0	0.0	0.0	6,831.8
1960	5,417.3	2,354.0	0.0	0.0	0.0	6,008.3
Average	**11,438.2**	**27,046.1**	**0.0**	**0.0**	**0.0**	**8,511.5**

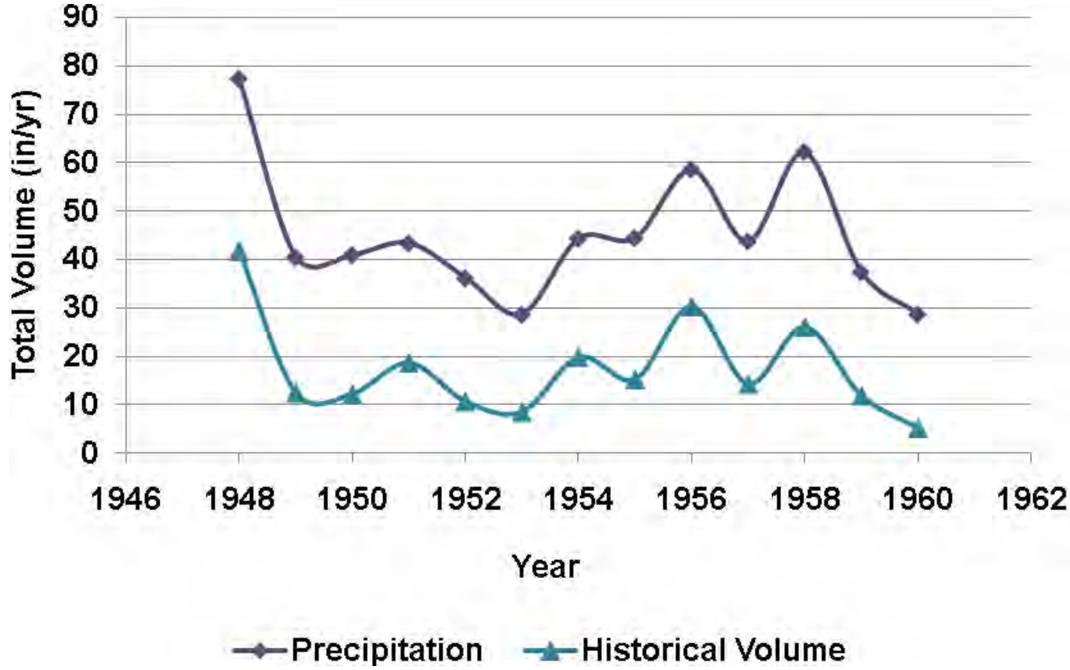

Figure 1-2 Annual Variability of Precipitation and Total Volume for the Lemon Bay Watershed

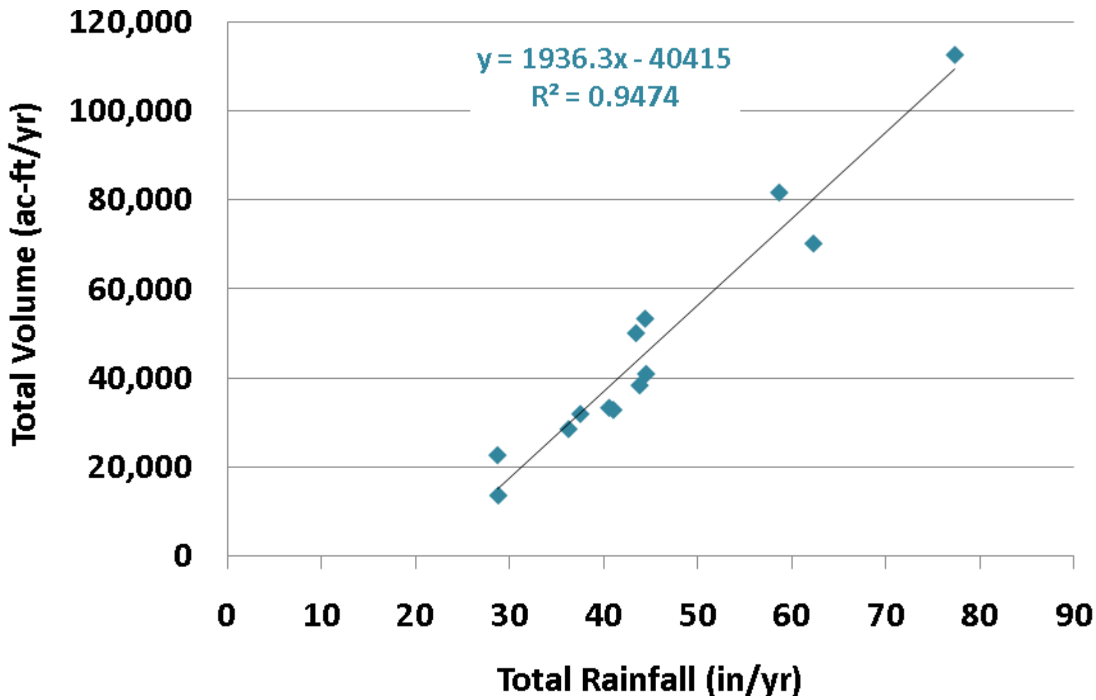

Figure 1-3 Correlation of Annual Total Volume to Rainfall for the Lemon Bay Watershed

Table 1-16 Annual Total Volume to Rainfall Coefficients for Lemon Bay Watershed			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	41.78	77.29	0.54
1949	12.41	40.54	0.31
1950	12.23	40.99	0.30
1951	18.63	43.40	0.43
1952	10.64	36.23	0.29
1953	8.47	28.69	0.30
1954	19.82	44.36	0.45
1955	15.23	44.47	0.34
1956	30.32	58.61	0.52
1957	14.28	43.78	0.33
1958	26.08	62.25	0.42
1959	11.90	37.48	0.32
1960	5.12	28.76	0.18
Average	**17.46**	**45.14**	**0.36**

Figure 1-4 Variability of Average Monthly Total Volume in the Lemon Bay Watershed

Table 1-17 Average Monthly Rainfall to Total Volume Coefficients for Lemon Bay Watershed

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.80	1.75	0.46
Feb	0.83	1.94	0.43
Mar	0.78	2.17	0.36
Apr	0.58	1.98	0.29
May	0.56	1.96	0.29
Jun	2.78	7.82	0.36
Jul	2.51	6.98	0.36
Aug	2.42	6.84	0.35
Sep	2.81	6.72	0.42
Oct	1.61	3.30	0.49
Nov	0.91	1.71	0.53
Dec	0.87	1.99	0.44

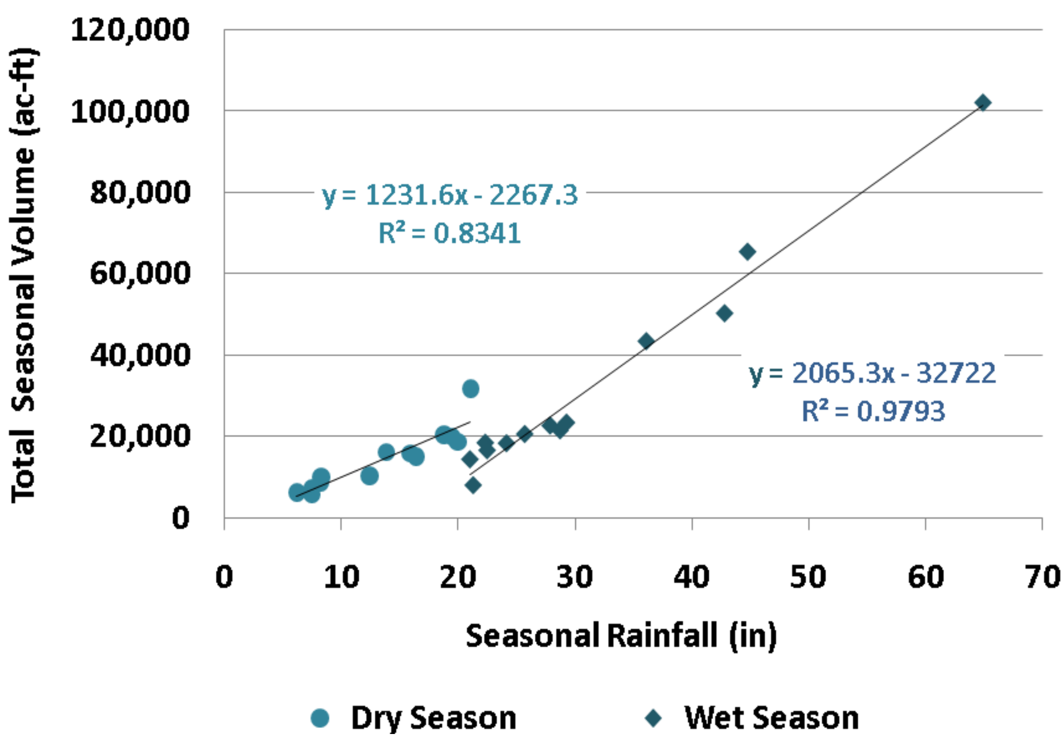

Figure 1-5 Correlation of Seasonal Total Volume to Rainfall for the Lemon Bay Watershed

Table 1-18 Wet Season Total Volume to Rainfall Coefficients for Lemon Bay Watershed

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	37.92	64.87	0.58
1949	6.78	24.16	0.28
1950	5.31	21.03	0.25
1951	6.82	22.35	0.31
1952	7.96	28.74	0.28
1953	6.14	22.50	0.27
1954	16.11	36.10	0.45
1955	7.63	25.72	0.30
1956	24.29	44.75	0.54
1957	8.40	27.89	0.30
1958	18.67	42.79	0.44
1959	8.67	29.28	0.30
1960	2.95	21.31	0.14
Average	**12.13**	**31.65**	**0.34**

Table 1-19 Dry Season Total Volume to Rainfall Coefficients for Lemon Bay Watershed

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	3.86	12.42	0.31
1949	5.63	16.38	0.34
1950	6.92	19.96	0.35
1951	11.80	21.05	0.56
1952	2.68	7.49	0.36
1953	2.33	6.19	0.38
1954	3.71	8.26	0.45
1955	7.61	18.76	0.41
1956	6.03	13.86	0.44
1957	5.88	15.89	0.37
1958	7.42	19.46	0.38
1959	3.23	8.20	0.39
1960	2.17	7.45	0.29
Average	**5.33**	**13.49**	**0.39**

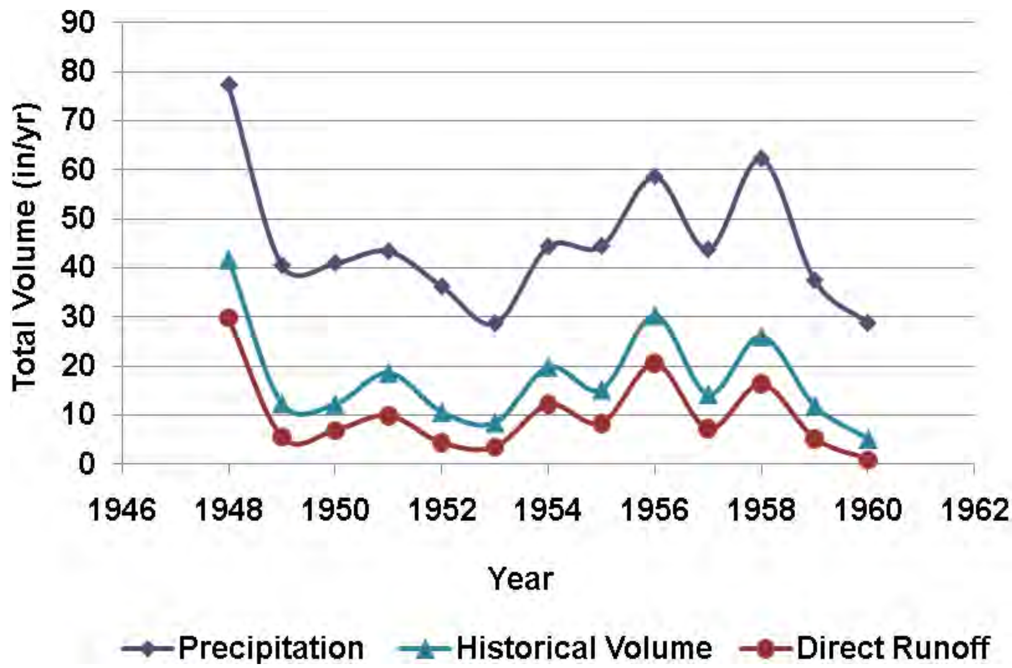

Figure 1-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for the Lemon Bay Watershed

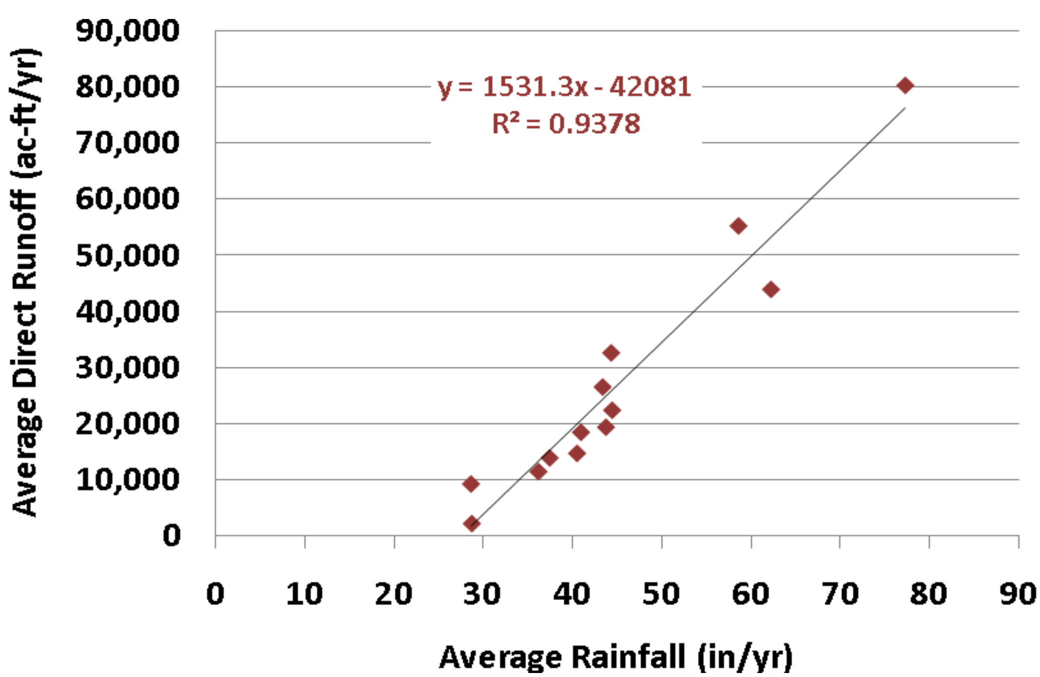

Figure 1-7 Correlation of Average Annual Direct Runoff to Rainfall for the Lemon Bay Watershed

Table 1-20 Annual Direct Runoff to Rainfall Coefficients for Lemon Bay Watershed

	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	29.80	77.29	0.39
1949	5.51	40.54	0.14
1950	6.90	40.99	0.17
1951	9.89	43.40	0.23
1952	4.30	36.23	0.12
1953	3.49	28.69	0.12
1954	12.15	44.36	0.27
1955	8.36	44.47	0.19
1956	20.53	58.61	0.35
1957	7.24	43.78	0.17
1958	16.33	62.25	0.26
1959	5.21	37.48	0.14
1960	0.87	28.76	0.03
Average	**10.05**	**45.14**	**0.20**

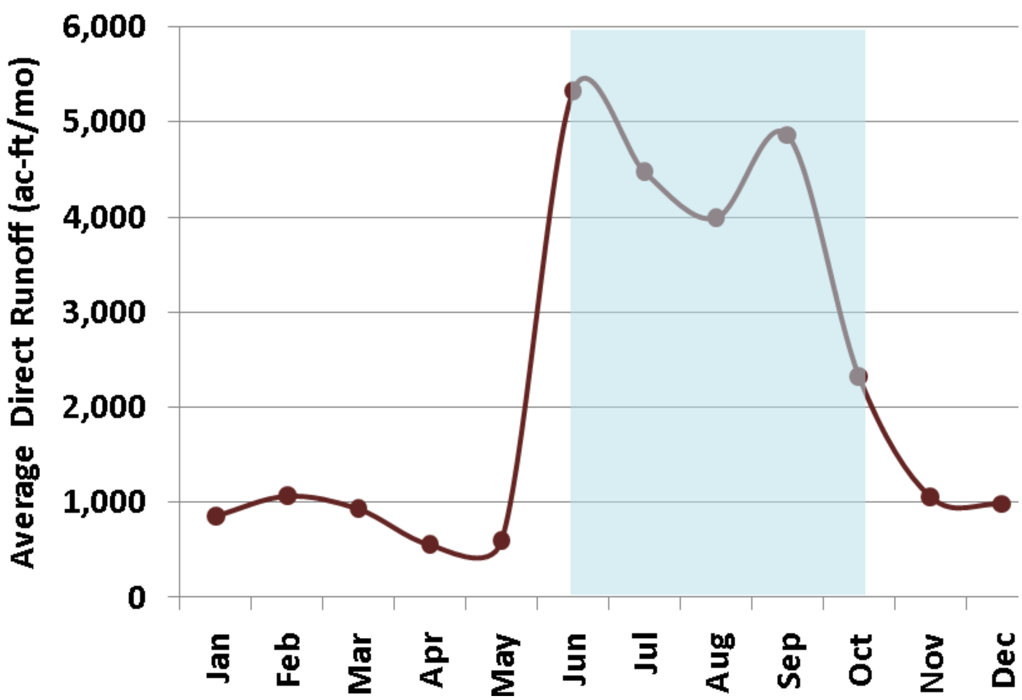

Figure 1-8 Variability of Average Monthly Direct Runoff to the Lemon Bay Watershed

Table 1-21 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.32	1.75	0.18
Feb	0.40	1.94	0.20
Mar	0.35	2.17	0.16
Apr	0.21	1.98	0.10
May	0.22	1.96	0.11
Jun	1.98	7.82	0.25
Jul	1.66	6.98	0.24
Aug	1.48	6.84	0.22
Sep	1.81	6.72	0.27
Oct	0.86	3.30	0.26
Nov	0.39	1.71	0.23
Dec	0.37	1.99	0.18

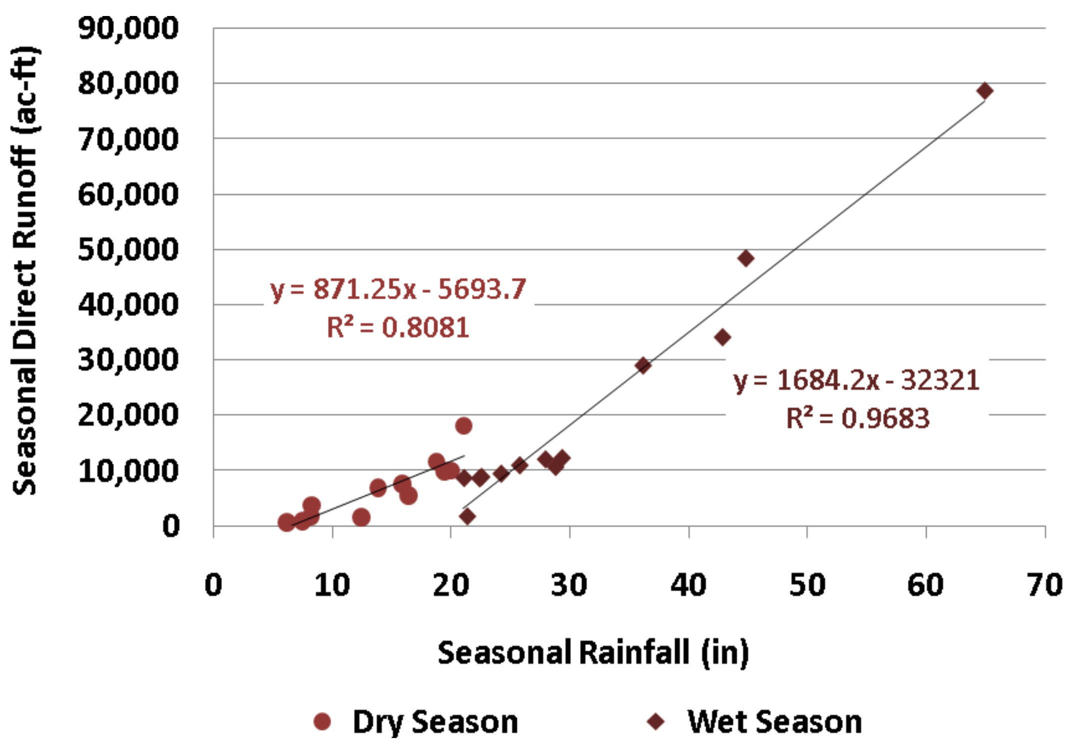

Figure 1-9 Correlation of Seasonal Direct Runoff to Rainfall for the Lemon Bay Watershed

Table 1-22 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	29.23	64.87	0.45
1949	3.49	24.16	0.14
1950	3.19	21.03	0.15
1951	3.17	22.35	0.14
1952	3.94	28.74	0.14
1953	3.27	22.50	0.15
1954	10.76	36.10	0.30
1955	4.05	25.72	0.16
1956	17.97	44.75	0.40
1957	4.45	27.89	0.16
1958	12.66	42.79	0.30
1959	4.54	29.28	0.15
1960	0.62	21.31	0.03
Average	**7.79**	**31.65**	**0.21**

Table 1-23 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.57	12.42	0.05
1949	2.03	16.38	0.12
1950	3.71	19.96	0.19
1951	6.72	21.05	0.32
1952	0.37	7.49	0.05
1953	0.22	6.19	0.04
1954	1.39	8.26	0.17
1955	4.31	18.76	0.23
1956	2.56	13.86	0.18
1957	2.78	15.89	0.18
1958	3.67	19.46	0.19
1959	0.67	8.20	0.08
1960	0.26	7.45	0.03
Average	**2.25**	**13.49**	**0.14**

1.3 FUTURE CONDITIONS

Table 1-24 Future Total Volume for Lemon Bay Watershed (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	4,463.2	3,019.7	2,283.8	2,345.3	991.5	36,966.9	32,343.8	16,929.2	21,375.0	22,676.6	5,094.0	3,412.9	151,902.0
2016	5,642.6	2,477.2	4,107.2	2,315.8	5,516.5	3,314.3	3,492.8	7,172.3	5,781.6	11,565.5	2,757.7	2,198.2	56,341.7
2017	2,354.5	960.4	1,444.6	4,209.1	1,030.3	1,933.7	1,939.6	2,086.6	11,389.2	3,130.3	5,495.8	9,379.4	45,353.5
2018	11,527.5	9,871.1	10,182.9	2,680.9	2,626.7	2,362.8	6,304.4	4,740.8	9,889.2	4,319.7	7,578.5	1,809.8	73,894.3
2019	2,481.0	825.1	1,420.1	637.1	679.4	3,311.6	4,144.5	7,086.3	11,630.9	6,251.3	2,851.4	3,107.8	44,426.6
2020	1,826.6	1,034.7	981.0	1,543.4	704.6	2,382.9	2,651.1	8,970.6	7,454.0	2,289.5	1,737.2	1,326.0	32,901.6
2021	886.2	618.1	7,540.6	611.4	478.6	4,049.1	15,522.5	11,266.2	19,588.2	5,497.3	2,709.9	1,852.1	70,620.3
2022	1,438.0	4,673.8	902.7	1,375.3	2,318.0	4,265.8	2,460.8	12,666.0	7,220.4	3,553.2	9,923.8	6,283.3	57,081.2
2023	2,293.2	1,652.2	1,893.4	3,602.8	3,522.9	22,736.4	7,606.0	24,332.9	26,820.9	5,111.4	2,936.6	5,749.6	108,258.2
2024	2,278.5	5,604.1	1,642.5	3,462.1	1,100.2	3,765.1	6,119.7	10,253.5	8,671.0	7,571.6	4,181.4	5,108.9	59,758.6
2025	3,141.0	4,480.3	6,634.8	2,235.4	6,040.1	24,767.5	17,983.5	8,527.2	6,881.4	17,662.5	6,890.5	2,929.5	108,173.6
2026	1,853.7	3,599.8	1,097.0	750.9	1,206.1	2,797.6	9,960.8	10,199.4	9,087.2	4,552.8	2,404.8	3,258.9	50,769.0
2027	1,882.4	1,483.2	778.2	1,942.1	674.7	2,407.8	2,258.7	1,981.8	3,018.4	3,931.4	1,624.2	1,338.2	23,321.0
Average	**3,236.0**	**3,100.0**	**3,146.8**	**2,131.6**	**2,068.4**	**8,850.9**	**8,676.0**	**9,708.7**	**11,446.7**	**7,547.2**	**4,322.0**	**3,673.4**	**67,907.8**

Table 1-25 Future Direct Runoff for Lemon Bay Watershed (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	1,901.7	818.6	384.1	639.0	83.0	30,168.1	23,295.7	7,961.4	11,983.1	12,519.1	156.3	324.7	90,234.9
2016	2,131.4	446.2	1,888.5	723.7	3,628.8	1,550.1	1,440.1	3,925.9	2,475.4	6,030.3	39.0	181.0	24,460.3
2017	712.4	23.7	433.2	2,527.5	244.5	1,045.9	1,029.1	933.4	9,091.2	1,266.8	3,345.4	5,434.6	26,087.8
2018	6,319.5	4,062.9	5,292.6	9.4	386.9	616.0	3,772.7	2,059.6	4,798.4	196.4	4,405.8	97.8	32,018.1
2019	902.0	0.1	404.2	50.0	173.5	1,778.7	2,527.6	3,946.3	6,228.6	1,214.6	132.0	1,008.3	18,365.9
2020	377.9	49.6	105.1	597.6	136.1	1,261.4	1,406.5	6,396.8	3,862.6	40.8	123.0	120.7	14,478.1
2021	14.0	0.0	5,607.2	57.8	38.6	2,615.6	10,799.0	4,493.9	11,554.8	426.1	30.3	17.2	35,654.5
2022	54.9	2,903.5	35.3	526.4	1,383.4	2,581.5	958.8	8,722.4	1,530.3	268.4	6,931.8	2,856.1	28,753.0
2023	0.0	115.7	432.8	2,222.5	2,086.0	17,293.2	1,962.6	14,791.4	17,594.1	124.7	44.9	3,102.9	59,770.8
2024	603.7	3,811.8	333.4	1,987.9	237.7	2,241.5	3,577.8	4,991.7	2,809.9	3,369.5	1,601.1	2,931.6	28,497.6
2025	1,407.1	2,945.1	4,480.5	643.9	3,851.0	17,032.4	8,953.6	2,166.7	1,722.9	11,471.3	2,278.0	4.6	56,957.0
2026	29.9	1,820.1	59.0	0.5	295.9	1,436.8	6,581.7	4,868.6	2,878.6	705.8	67.1	1,109.8	19,853.6
2027	418.2	349.1	38.2	965.6	98.1	1,151.2	1,066.8	705.1	1,390.3	1,721.2	146.6	178.0	8,228.5
Average	**1,144.1**	**1,334.3**	**1,499.5**	**842.5**	**972.6**	**6,213.3**	**5,182.5**	**5,074.1**	**5,993.9**	**3,027.3**	**1,484.7**	**1,335.9**	**34,104.6**

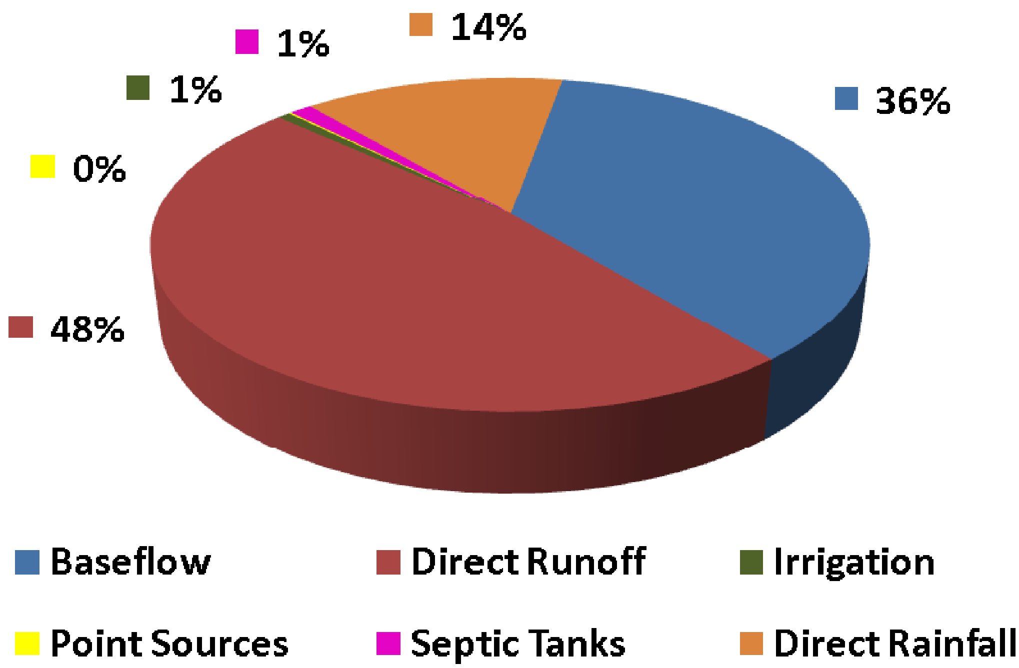

Figure 1-10 Lemon Bay Watershed Future Total Volume Water Budget

Table 1-26 Summary of Annual Future Total Volume Inputs for Lemon Bay Watershed (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	45,428.4	90,234.9	369.7	101.9	643.7	15,123.4
2016	22,965.8	24,460.3	369.7	101.9	643.7	7,800.2
2017	11,094.1	26,087.8	369.7	101.9	643.7	7,056.3
2018	32,218.7	32,018.1	369.7	108.3	643.7	8,535.8
2019	18,058.7	18,365.9	369.7	99.3	643.7	6,889.3
2020	12,324.7	14,478.1	369.7	90.1	643.7	4,995.2
2021	25,367.2	35,654.5	369.7	70.8	643.7	8,514.2
2022	19,200.5	28,753.0	369.7	79.2	643.7	8,035.1
2023	36,788.7	59,770.8	369.7	94.0	643.7	10,591.2
2024	22,257.9	28,497.6	369.7	36.4	643.7	7,953.2
2025	37,856.1	56,957.0	369.7	31.8	643.7	12,315.3
2026	23,042.8	19,853.6	369.7	27.4	643.7	6,831.8
2027	8,044.3	8,228.5	369.7	26.4	643.7	6,008.3
Average	**24,203.7**	**34,104.6**	**369.7**	**74.6**	**643.7**	**8,511.5**

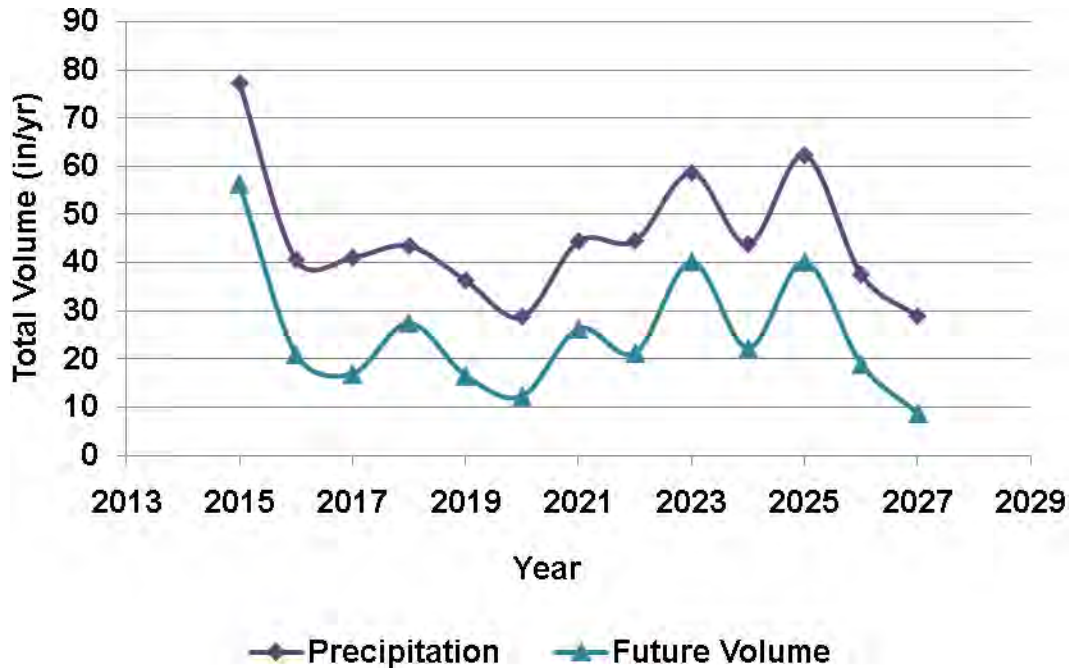

Figure 1-11 Annual Variability of Precipitation and Total Volume for the Lemon Bay Watershed

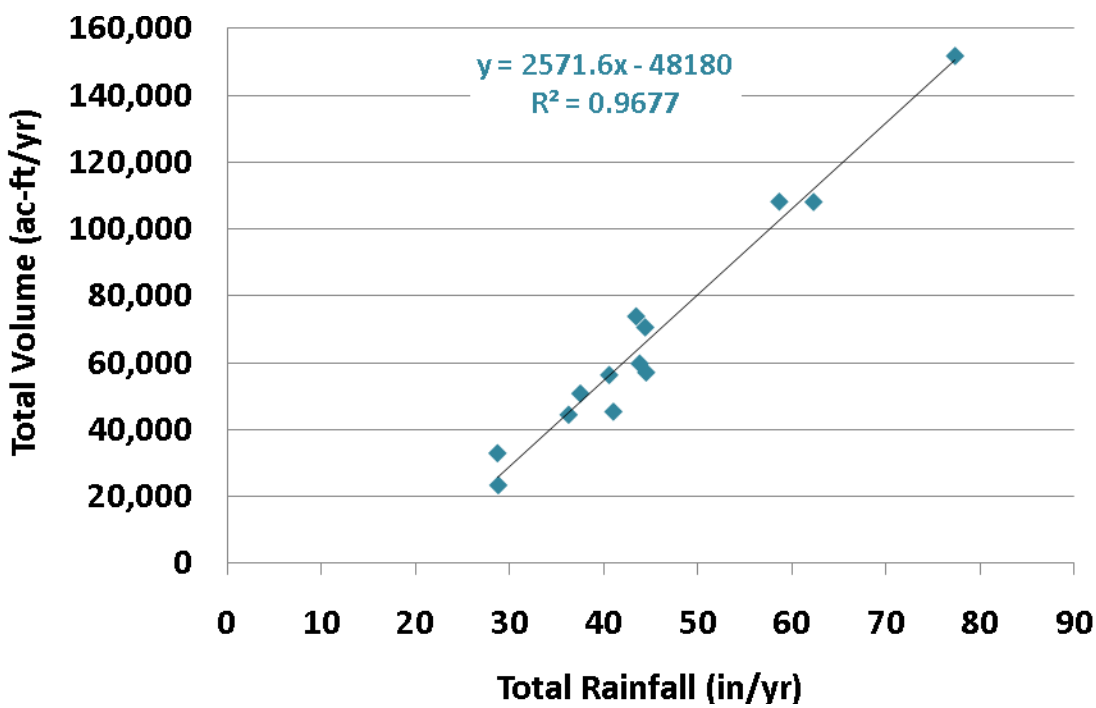

Figure 1-12 Correlation of Annual Total Volume to Rainfall for the Lemon Bay Watershed

Table 1-27 Annual Total Volume to Rainfall Coefficients for Lemon Bay Watershed			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	56.42	77.29	0.73
2016	20.93	40.54	0.52
2017	16.85	40.99	0.41
2018	27.45	43.40	0.63
2019	16.50	36.23	0.46
2020	12.22	28.69	0.43
2021	26.23	44.36	0.59
2022	21.20	44.47	0.48
2023	40.21	58.61	0.69
2024	22.20	43.78	0.51
2025	40.18	62.25	0.65
2026	18.86	37.48	0.50
2027	8.66	28.76	0.30
Average	**25.22**	**45.14**	**0.53**

Figure 1-13 Variability of Average Monthly Total Volume in the Lemon Bay Watershed

Table 1-28 Average Monthly Rainfall to Total Volume Coefficients for Lemon Bay Watershed

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.20	1.75	0.69
Feb	1.15	1.94	0.59
Mar	1.17	2.17	0.54
Apr	0.79	1.98	0.40
May	0.77	1.96	0.39
Jun	3.29	7.82	0.42
Jul	3.22	6.98	0.46
Aug	3.61	6.84	0.53
Sep	4.25	6.72	0.63
Oct	2.80	3.30	0.85
Nov	1.61	1.71	0.94
Dec	1.36	1.99	0.69

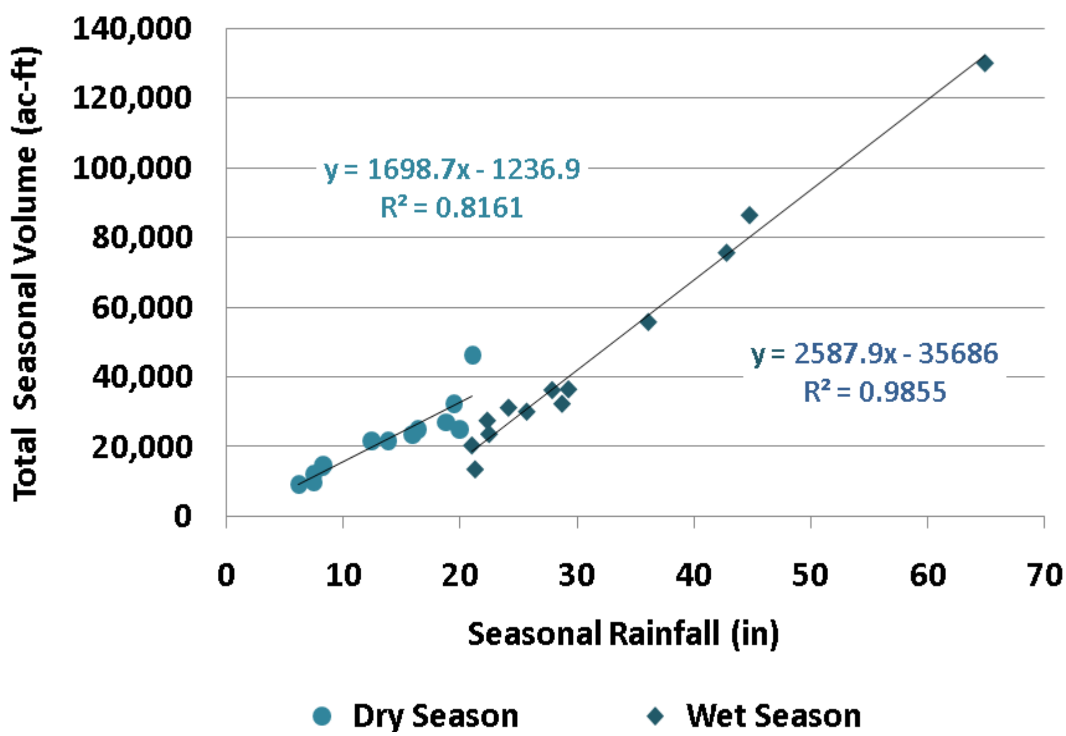

Figure 1-14 Correlation of Seasonal Total Volume to Rainfall for the Lemon Bay Watershed

Table 1-29 Wet Season Total Volume to Rainfall Coefficients for Lemon Bay Watershed			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	48.39	64.87	0.75
2016	11.64	24.16	0.48
2017	7.61	21.03	0.36
2018	10.26	22.35	0.46
2019	12.04	28.74	0.42
2020	8.82	22.50	0.39
2021	20.77	36.10	0.58
2022	11.20	25.72	0.44
2023	32.17	44.75	0.72
2024	13.51	27.89	0.48
2025	28.16	42.79	0.66
2026	13.59	29.28	0.46
2027	5.05	21.31	0.24
Average	**17.17**	**31.65**	**0.49**

Table 1-30 Dry Season Total Volume to Rainfall Coefficients for Lemon Bay Watershed			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	8.03	12.42	0.65
2016	9.29	16.38	0.57
2017	9.24	19.96	0.46
2018	17.19	21.05	0.82
2019	4.46	7.49	0.60
2020	3.40	6.19	0.55
2021	5.46	8.26	0.66
2022	10.00	18.76	0.53
2023	8.04	13.86	0.58
2024	8.68	15.89	0.55
2025	12.02	19.46	0.62
2026	5.26	8.20	0.64
2027	3.61	7.45	0.48
Average	**8.05**	**13.49**	**0.59**

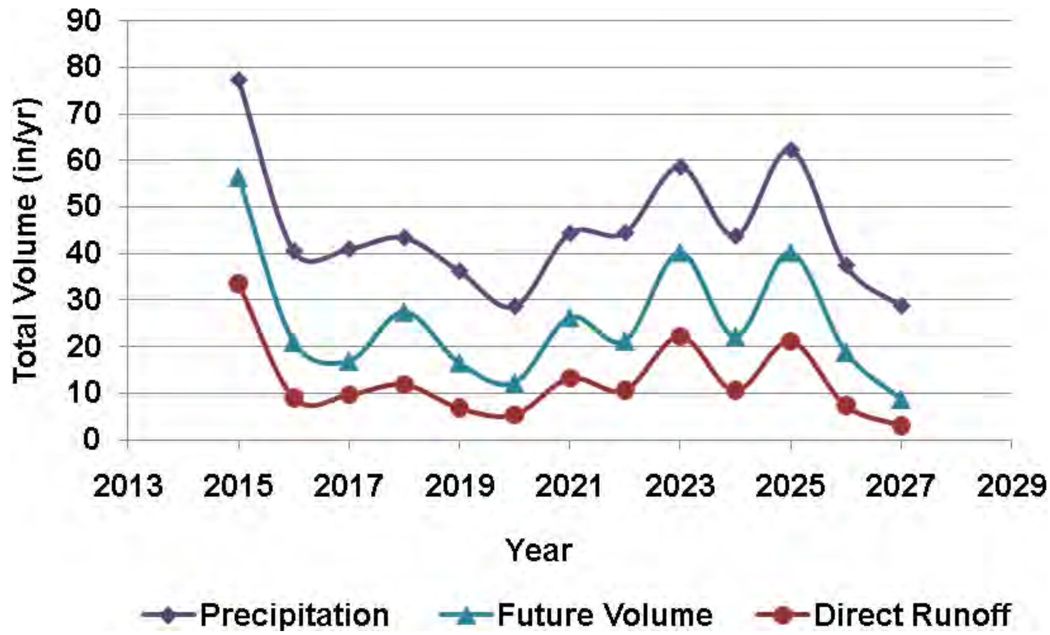

Figure 1-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for the Lemon Bay Watershed

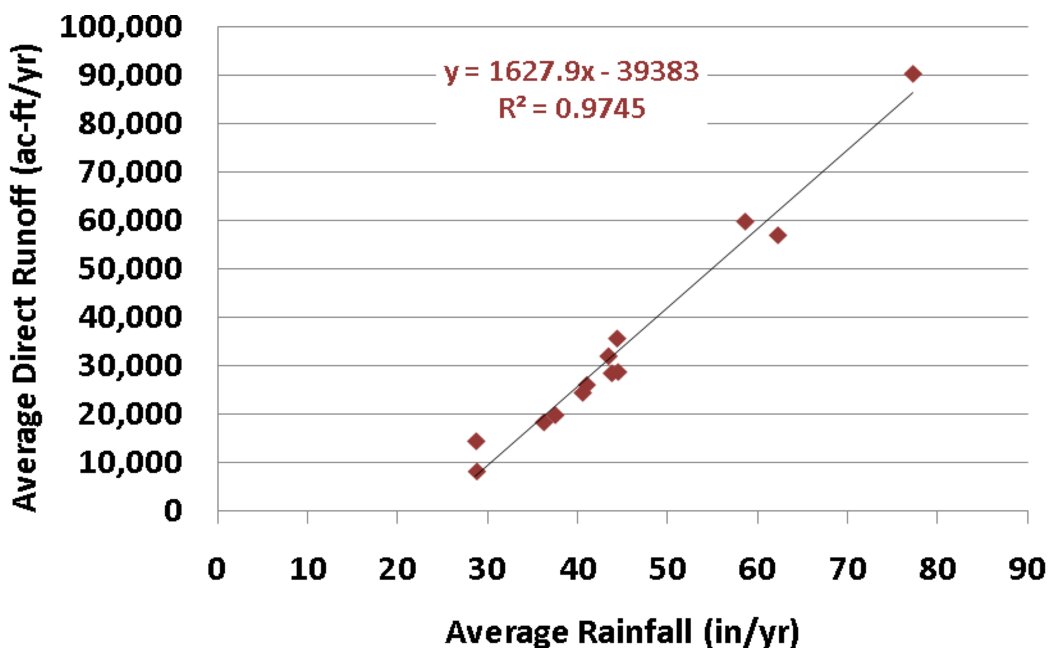

Figure 1-16 Correlation of Average Annual Direct Runoff to Rainfall for the Lemon Bay Watershed

Table 1-31 Annual Direct Runoff to Rainfall Coefficients for Lemon Bay Watershed			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	33.52	77.29	0.43
2016	9.09	40.54	0.22
2017	9.69	40.99	0.24
2018	11.89	43.40	0.27
2019	6.82	36.23	0.19
2020	5.38	28.69	0.19
2021	13.24	44.36	0.30
2022	10.68	44.47	0.24
2023	22.20	58.61	0.38
2024	10.58	43.78	0.24
2025	21.16	62.25	0.34
2026	7.37	37.48	0.20
2027	3.06	28.76	0.11
Average	**12.67**	**45.14**	**0.26**

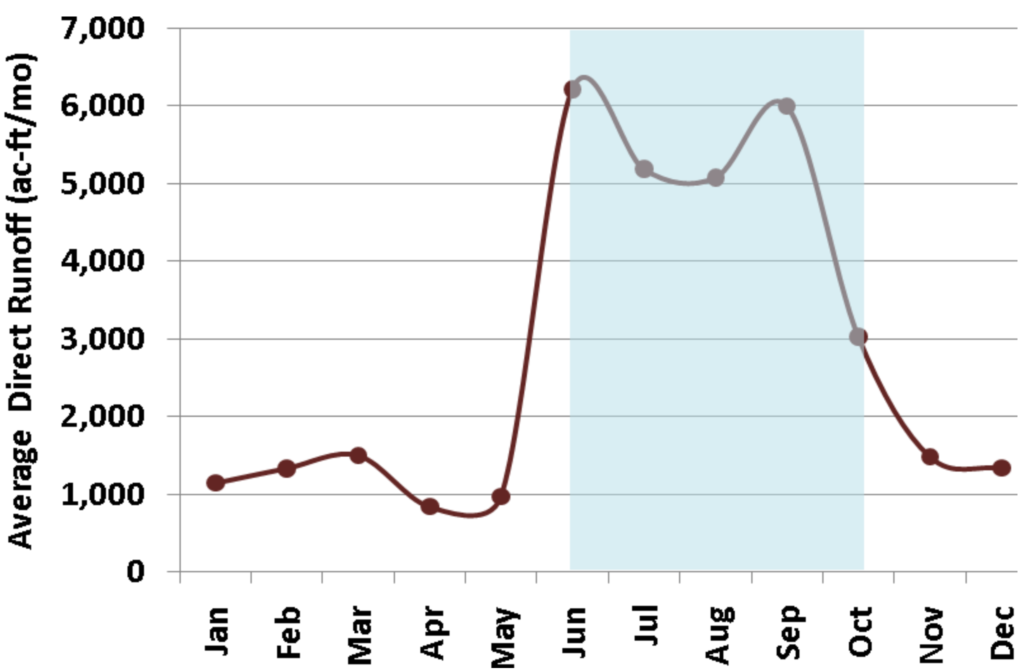

Figure 1-17 Variability of Average Monthly Direct Runoff to the Lemon Bay Watershed

Table 1-32 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.42	1.75	0.24
Feb	0.50	1.94	0.26
Mar	0.56	2.17	0.26
Apr	0.31	1.98	0.16
May	0.36	1.96	0.18
Jun	2.31	7.82	0.30
Jul	1.92	6.98	0.28
Aug	1.88	6.84	0.28
Sep	2.23	6.72	0.33
Oct	1.12	3.30	0.34
Nov	0.55	1.71	0.32
Dec	0.50	1.99	0.25

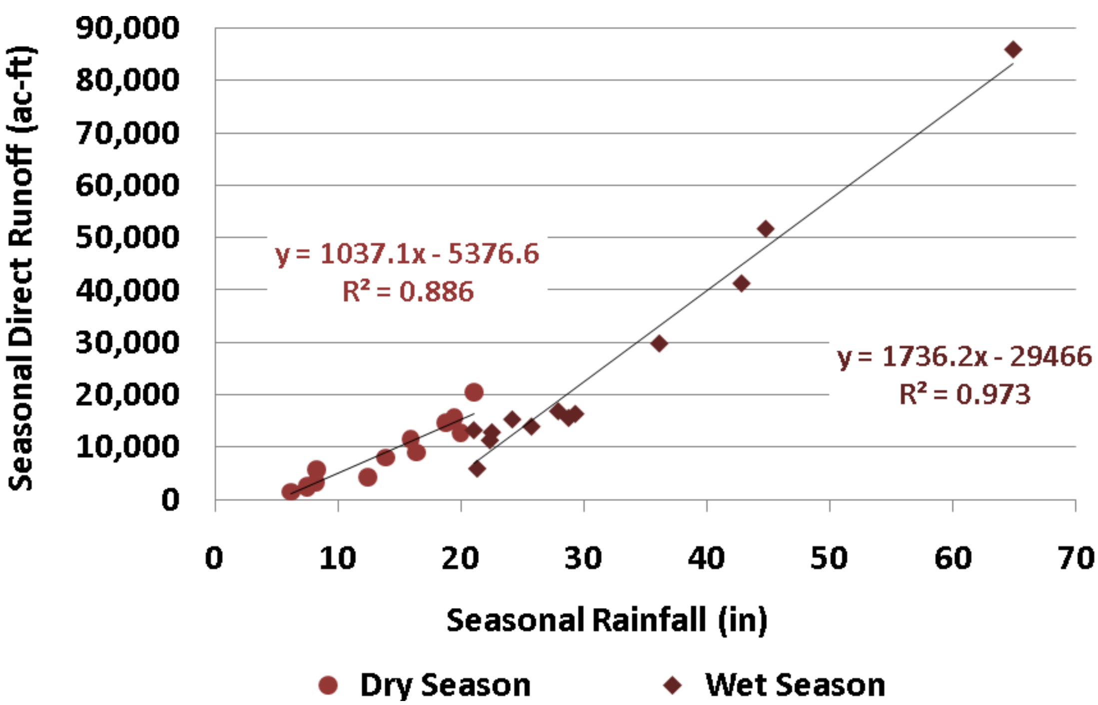

Figure 1-18 Correlation of Seasonal Direct Runoff to Rainfall for the Lemon Bay Watershed

Table 1-33 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	31.92	64.87	0.49
2016	5.73	24.16	0.24
2017	4.96	21.03	0.24
2018	4.25	22.35	0.19
2019	5.83	28.74	0.20
2020	4.82	22.50	0.21
2021	11.10	36.10	0.31
2022	5.22	25.72	0.20
2023	19.23	44.75	0.43
2024	6.31	27.89	0.23
2025	15.36	42.79	0.36
2026	6.12	29.28	0.21
2027	2.24	21.31	0.11
Average	**9.47**	**31.65**	**0.26**

Table 1-34 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	1.60	12.42	0.13
2016	3.36	16.38	0.20
2017	4.72	19.96	0.24
2018	7.64	21.05	0.36
2019	0.99	7.49	0.13
2020	0.56	6.19	0.09
2021	2.14	8.26	0.26
2022	5.46	18.76	0.29
2023	2.97	13.86	0.21
2024	4.27	15.89	0.27
2025	5.80	19.46	0.30
2026	1.26	8.20	0.15
2027	0.81	7.45	0.11
Average	**3.20**	**13.49**	**0.21**

1.4 WATER BUDGET CHANGES

Table 1-35 Change in Total Volume from Historical to Current Conditions

Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	112,492	131,469	18,977
2	33,421	45,446	12,025
3	32,934	39,958	7,024
4	50,146	61,942	11,796
5	28,646	37,190	8,543
6	22,791	28,715	5,924
7	53,369	62,116	8,747
8	41,016	49,267	8,251
9	81,644	95,151	13,507
10	38,448	49,617	11,169
11	70,223	89,063	18,841
12	32,036	41,813	9,777
13	13,780	19,668	5,888
Average	**46,996**	**57,801**	**10,805**

Table 1-36 Change in Total Volume from Current to Future Conditions

Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	131,469	151,902	20,433
2	45,446	56,342	10,896
3	39,958	45,354	5,395
4	61,942	73,894	11,953
5	37,190	44,427	7,237
6	28,715	32,902	4,187
7	62,116	70,620	8,504
8	49,267	57,081	7,814
9	95,151	108,258	13,108
10	49,617	59,759	10,142
11	89,063	108,174	19,110
12	41,813	50,769	8,956
13	19,668	23,321	3,653
Average	**57,801**	**67,908**	**10,107**

Table 1-37 Change in Direct Runoff from Historical to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	80,242	84,567	4,325
2	14,838	19,762	4,924
3	18,579	22,728	4,148
4	26,637	29,413	2,776
5	11,585	14,948	3,363
6	9,394	12,237	2,843
7	32,702	33,797	1,095
8	22,510	25,479	2,969
9	55,269	57,401	2,132
10	19,485	24,153	4,668
11	43,977	50,198	6,220
12	14,027	17,012	2,985
13	2,354	5,674	3,320
Average	**27,046**	**30,567**	**3,521**

Table 1-38 Change in Direct Runoff from Current to Future Conditions

Year	Current Direct Runoff (ac-ft) 1995-2007	Future Direct Runoff (ac-ft) 2015-2027	Direct Runoff Change (ac-ft) (future-current)
1	84,567	90,235	5,668
2	19,762	24,460	4,699
3	22,728	26,088	3,360
4	29,413	32,018	2,606
5	14,948	18,366	3,418
6	12,237	14,478	2,241
7	33,797	35,655	1,858
8	25,479	28,753	3,274
9	57,401	59,771	2,370
10	24,153	28,498	4,344
11	50,198	56,957	6,759
12	17,012	19,854	2,842
13	5,674	8,228	2,554
Average	**30,567**	**34,105**	**3,538**

2.0 ALLIGATOR CREEK BASIN

2.1 CURRENT CONDITIONS

Table 2-1 Monthly Rainfall for Alligator Creek Basin (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	3.42	1.91	1.42	2.86	0.91	17.06	17.88	9.03	11.22	11.90	0.87	1.51	80.00
1996	1949	2016	3.66	1.63	4.60	1.67	5.55	3.98	3.64	7.85	4.70	5.97	0.15	0.61	44.01
1997	1950	2017	1.72	0.38	1.07	6.17	1.49	2.93	4.07	4.02	7.99	2.49	4.18	6.94	43.44
1998	1951	2018	4.34	5.35	4.86	0.15	1.68	2.19	5.91	5.14	7.24	0.60	4.30	0.91	42.67
1999	1952	2019	2.51	0.09	1.94	0.35	1.32	6.73	5.51	9.62	6.65	3.48	0.50	1.86	40.55
2000	1953	2020	0.99	0.48	0.75	2.30	0.84	6.24	5.97	6.99	6.20	0.02	0.79	0.92	32.51
2001	1954	2021	0.30	0.00	6.56	0.21	0.21	7.74	12.76	5.59	11.67	1.07	0.14	0.32	46.56
2002	1955	2022	0.51	4.16	0.25	1.52	2.72	6.32	4.23	11.44	3.62	1.60	4.50	5.05	45.91
2003	1956	2023	0.04	0.88	1.70	3.33	4.13	15.02	6.25	13.46	13.33	0.73	0.47	4.54	63.89
2004	1957	2024	1.57	4.09	0.61	4.71	1.24	6.68	7.27	8.24	4.81	2.86	2.34	3.14	47.55
2005	1958	2025	1.91	3.11	4.74	2.73	4.61	16.02	8.97	4.01	2.87	9.21	3.44	0.36	61.97
2006	1959	2026	0.46	2.92	0.73	0.07	1.98	5.48	10.58	8.31	5.84	1.40	0.45	2.40	40.62
2007	1960	2027	1.13	1.64	0.41	2.55	0.53	4.39	3.87	3.02	4.97	4.30	0.31	0.80	27.91
		Average	**1.74**	**2.05**	**2.28**	**2.20**	**2.09**	**7.75**	**7.45**	**7.44**	**7.01**	**3.51**	**1.73**	**2.26**	**47.51**

Table 2-2 Current Total Volume for Alligator Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	924.2	528.1	491.1	438.6	251.4	5,077.8	6,714.0	3,471.1	5,037.8	5,074.5	1,048.1	694.1	29,750.7
1996	1,247.0	637.6	894.7	536.0	1,227.5	663.4	754.3	2,003.1	1,154.8	2,201.2	587.3	438.9	12,345.7
1997	479.7	220.5	271.3	1,001.9	220.7	378.0	408.4	425.7	2,030.1	658.6	1,269.6	2,149.3	9,513.7
1998	1,851.6	1,995.6	2,124.0	584.3	514.7	464.6	982.6	839.7	1,617.7	734.5	1,533.7	386.9	13,629.9
1999	544.5	208.8	301.9	150.4	181.6	630.3	936.6	1,926.2	2,114.6	1,493.3	650.0	702.3	9,840.6
2000	394.4	237.4	202.6	374.1	186.5	596.0	726.9	2,003.1	1,732.8	583.8	413.4	350.1	7,801.2
2001	235.5	171.0	1,317.1	158.6	133.1	969.6	3,157.2	2,347.3	4,410.5	1,022.5	571.5	408.9	14,902.8
2002	311.7	956.8	206.3	252.1	445.1	589.6	566.3	2,523.7	1,462.4	851.1	1,822.7	1,398.7	11,386.4
2003	570.8	370.6	353.7	894.1	855.7	4,044.3	1,686.7	5,364.4	5,912.5	1,129.7	623.3	1,527.6	23,333.3
2004	454.3	1,238.5	370.1	987.5	290.1	1,001.8	1,395.3	2,343.6	1,789.5	1,454.1	982.8	1,075.3	13,383.2
2005	792.2	1,110.5	1,417.2	551.2	1,107.3	4,471.6	3,475.6	1,310.1	970.3	3,370.3	1,333.3	604.7	20,514.4
2006	392.8	729.2	294.8	191.5	246.5	534.4	1,854.1	2,288.9	1,888.2	998.5	501.5	681.7	10,602.1
2007	359.7	327.1	189.5	426.6	136.2	381.2	310.4	273.1	579.4	699.3	330.0	270.7	4,283.2
Average	**658.3**	**671.7**	**648.8**	**503.6**	**445.9**	**1,523.3**	**1,766.8**	**2,086.2**	**2,361.6**	**1,559.4**	**897.5**	**822.2**	**13,945.2**

Table 2-3 Current Direct Runoff for Alligator Creek Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	441.2	128.1	104.5	164.7	33.7	4,569.8	5,587.7	1,993.6	3,476.9	3,406.0	40.2	92.7	20,039.1
1996	560.7	170.8	496.1	159.9	905.6	339.4	359.5	1,425.3	507.9	1,258.2	0.4	25.2	6,209.2
1997	177.4	7.0	84.0	847.9	66.3	251.8	264.1	233.2	1,785.6	342.5	944.9	1,515.5	6,520.3
1998	1,001.0	1,038.7	1,252.4	0.1	90.5	154.3	706.8	468.5	979.1	20.8	1,057.4	48.2	6,817.8
1999	277.9	0.1	125.1	11.5	62.8	514.1	642.1	1,340.5	1,196.1	432.9	28.8	273.7	4,905.6
2000	85.8	13.5	15.3	221.5	54.6	475.4	533.1	1,503.6	1,017.6	0.0	25.5	53.1	3,998.9
2001	6.2	0.0	1,160.5	3.6	2.7	853.2	2,520.1	1,101.0	3,088.2	35.7	2.0	4.2	8,777.4
2002	11.2	737.0	7.1	95.7	311.3	455.4	308.8	1,995.9	384.3	165.9	1,355.0	757.8	6,585.5
2003	0.0	25.9	74.1	678.5	664.4	3,508.3	668.9	3,657.8	4,387.0	42.2	9.6	1,071.0	14,787.7
2004	117.8	944.0	41.6	741.4	70.5	808.4	950.3	1,298.3	665.0	599.1	441.6	675.8	7,353.8
2005	423.1	846.1	1,056.8	218.7	748.0	3,485.9	1,972.8	301.9	253.5	2,565.5	584.2	2.3	12,458.7
2006	9.0	416.5	39.0	0.2	86.3	390.9	1,473.6	1,418.4	779.8	216.2	22.2	330.9	5,183.0
2007	85.2	115.9	12.0	285.3	15.9	277.3	201.1	123.2	373.1	375.7	8.3	43.2	1,916.3
Average	**245.9**	**341.8**	**343.7**	**263.8**	**239.4**	**1,237.2**	**1,245.3**	**1,297.0**	**1,453.4**	**727.8**	**347.7**	**376.4**	**8,119.5**

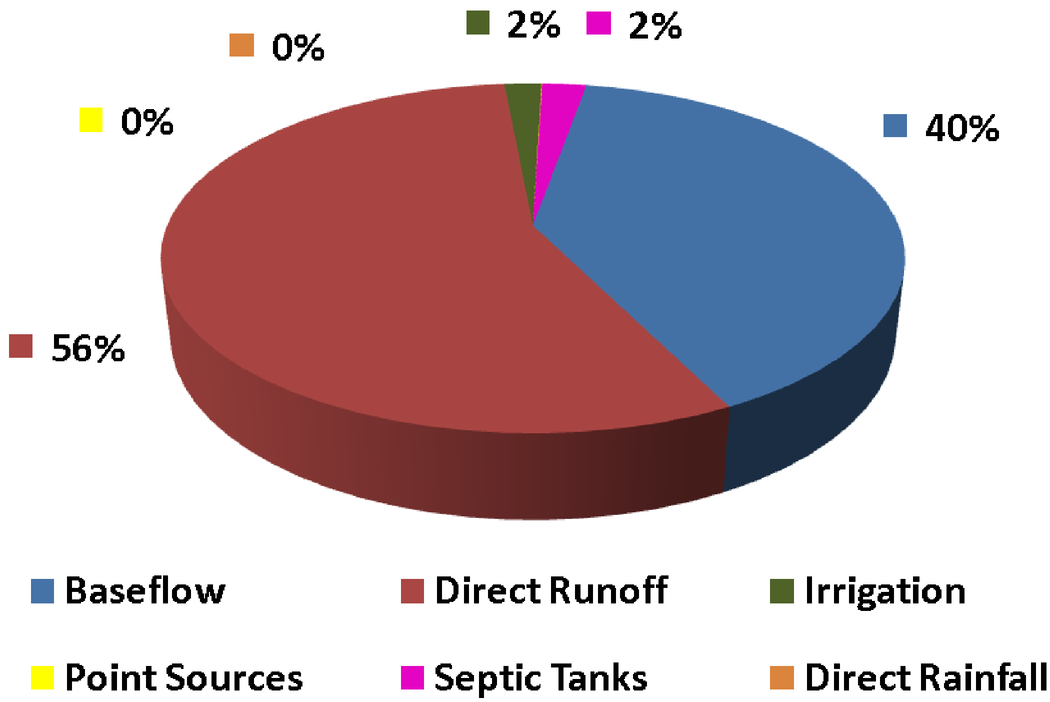

Figure 2-1 Alligator Creek Basin Current Total Volume Water Budget

Table 2-4 Summary of Annual Current Total Volume Inputs for Alligator Creek Basin (ac-ft/yr)

Volume Inputs	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	9,271.9	20,039.1	195.8	3.4	240.5	0.0
1996	5,689.7	6,209.2	201.3	3.4	242.2	0.0
1997	2,545.4	6,520.3	200.5	3.4	244.0	0.0
1998	6,357.8	6,817.8	205.3	3.3	245.6	0.0
1999	4,475.8	4,905.6	207.3	2.9	249.0	0.0
2000	3,335.9	3,998.9	212.4	3.4	250.5	0.0
2001	5,653.4	8,777.4	216.4	2.9	252.8	0.0
2002	4,323.2	6,585.5	218.5	3.1	256.1	0.0
2003	8,065.1	14,787.7	218.8	2.7	259.0	0.0
2004	5,541.7	7,353.8	221.9	3.1	262.7	0.0
2005	7,565.5	12,458.7	221.9	3.4	264.9	0.0
2006	4,928.9	5,183.0	221.9	3.5	264.9	0.0
2007	1,877.5	1,916.3	221.9	2.6	264.9	0.0
Average	**5,356.3**	**8,119.5**	**212.6**	**3.2**	**253.6**	**0.0**

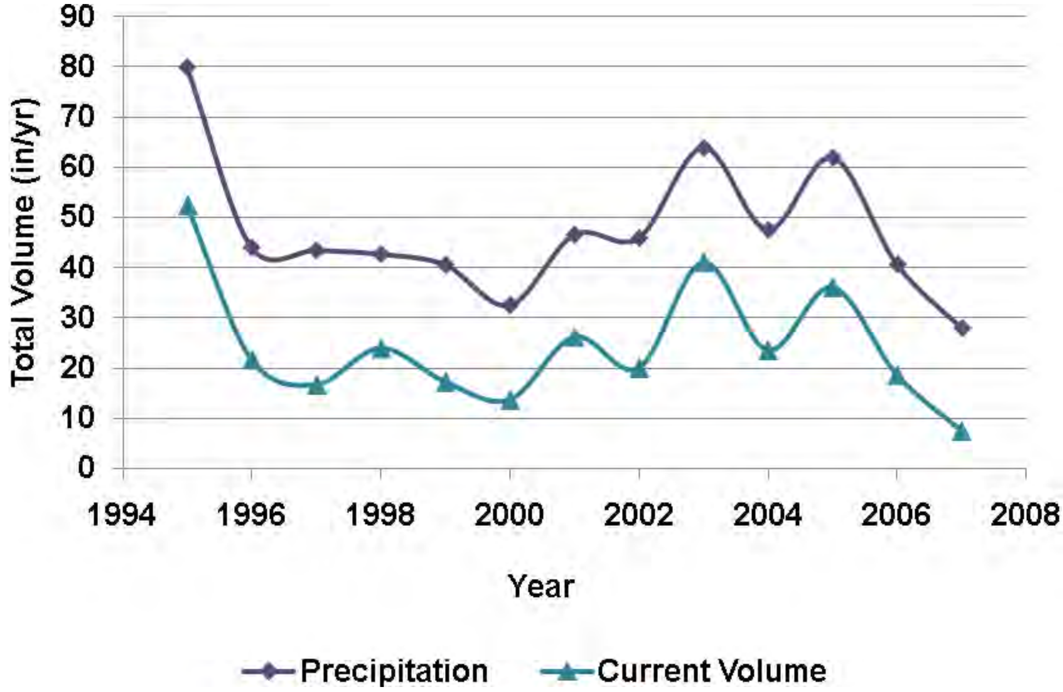

Figure 2-2 Annual Variability of Precipitation and Total Volume for Alligator Creek Basin

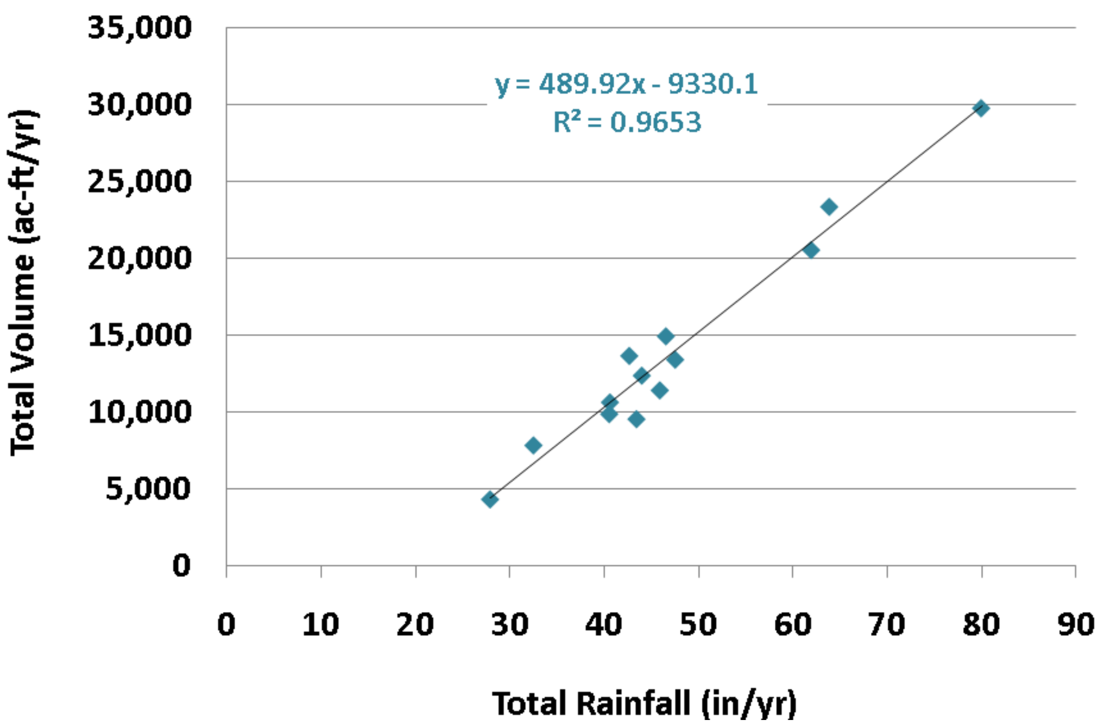

Figure 2-3 Correlation of Annual Total Volume to Rainfall for Alligator Creek Basin

Table 2-5 Annual Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1995	52.51	80.00	0.66
1996	21.79	44.01	0.50
1997	16.79	43.44	0.39
1998	24.06	42.67	0.56
1999	17.37	40.55	0.43
2000	13.77	32.51	0.42
2001	26.30	46.56	0.56
2002	20.10	45.91	0.44
2003	41.18	63.89	0.64
2004	23.62	47.55	0.50
2005	36.21	61.97	0.58
2006	18.71	40.62	0.46
2007	7.56	27.91	0.27
Average	**24.61**	**47.51**	**0.49**

Figure 2-4 Variability of Average Monthly Total Volume in Alligator Creek Basin

Table 2-6 Average Monthly Rainfall to Total Volume Coefficients for Alligator Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.16	1.74	0.67
Feb	1.19	2.05	0.58
Mar	1.15	2.28	0.50
Apr	0.89	2.20	0.40
May	0.79	2.09	0.38
Jun	2.69	7.75	0.35
Jul	3.12	7.45	0.42
Aug	3.68	7.44	0.49
Sep	4.17	7.01	0.59
Oct	2.75	3.51	0.78
Nov	1.58	1.73	0.92
Dec	1.45	2.26	0.64

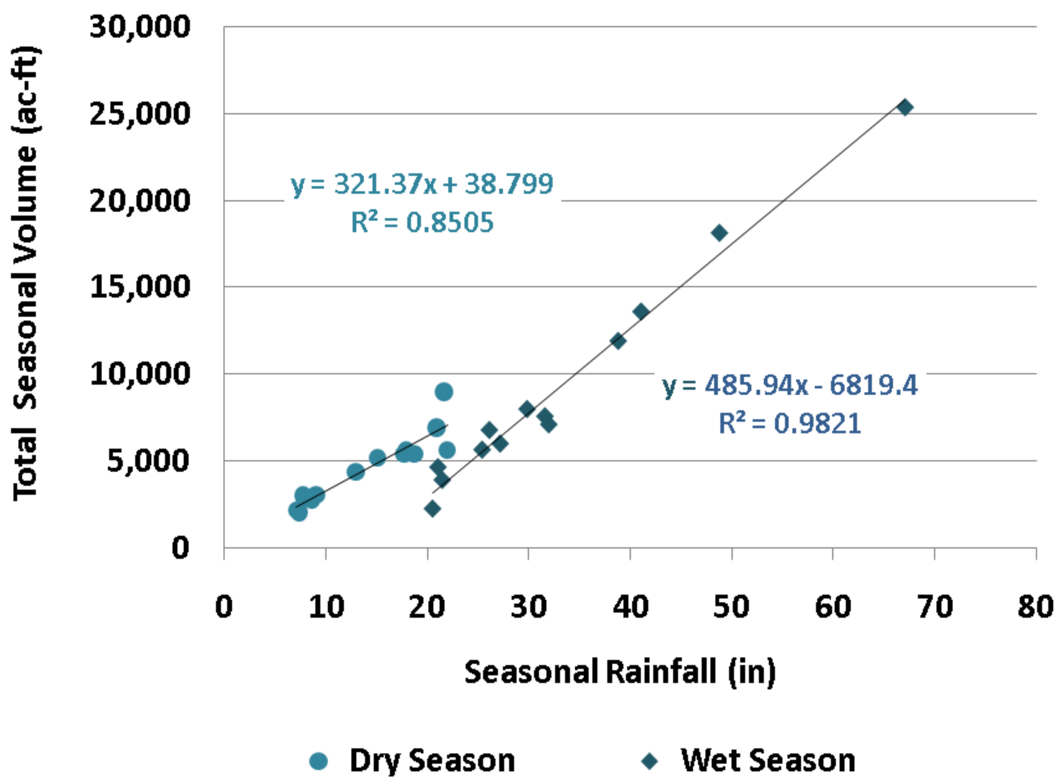

Figure 2-5 Correlation of Seasonal Total Volume to Rainfall for Alligator Creek Basin

Table 2-7 Wet Season Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	44.79	67.09	0.67
1996	11.96	26.14	0.46
1997	6.88	21.50	0.32
1998	8.19	21.08	0.39
1999	12.53	31.99	0.39
2000	9.96	25.43	0.39
2001	21.02	38.83	0.54
2002	10.58	27.21	0.39
2003	32.01	48.80	0.66
2004	14.09	29.86	0.47
2005	24.00	41.08	0.58
2006	13.35	31.61	0.42
2007	3.96	20.55	0.19
Average	**16.41**	**33.17**	**0.45**

Table 2-8 Dry Season Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	7.72	12.92	0.60
1996	9.83	17.87	0.55
1997	9.91	21.94	0.45
1998	15.87	21.60	0.73
1999	4.83	8.56	0.56
2000	3.81	7.08	0.54
2001	5.29	7.73	0.68
2002	9.52	18.71	0.51
2003	9.17	15.09	0.61
2004	9.53	17.69	0.54
2005	12.21	20.89	0.58
2006	5.36	9.01	0.60
2007	3.60	7.36	0.49
Average	**8.20**	**14.34**	**0.57**

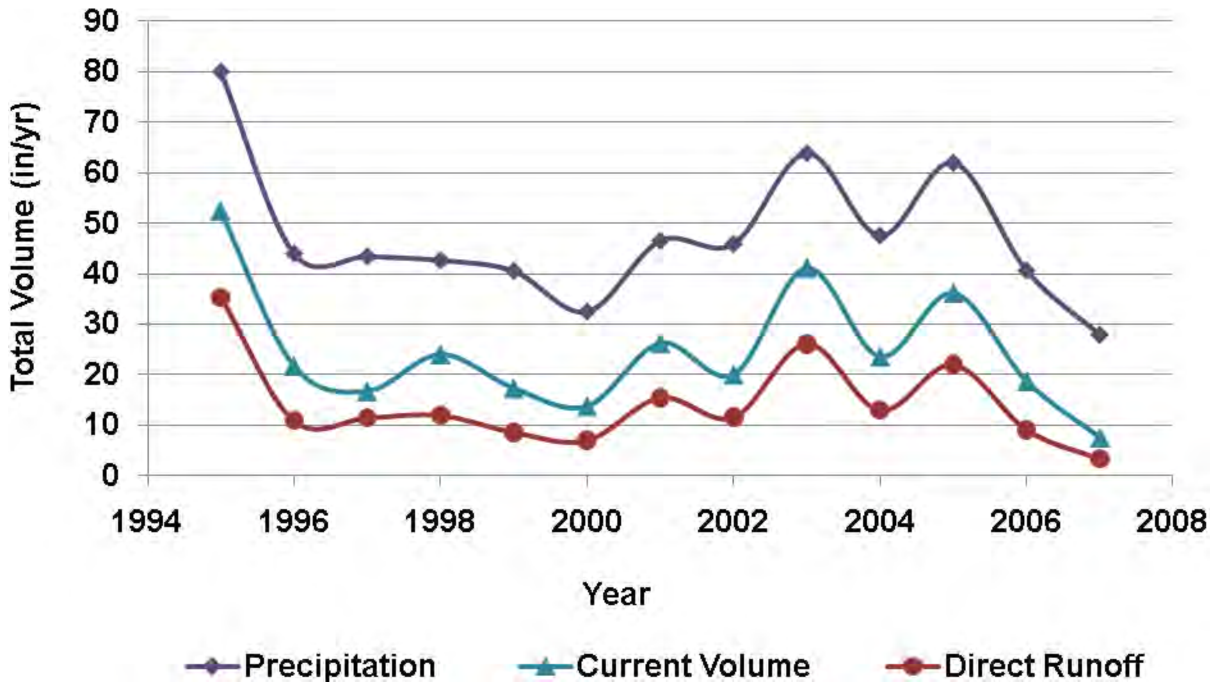

Figure 2-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Alligator Creek Basin

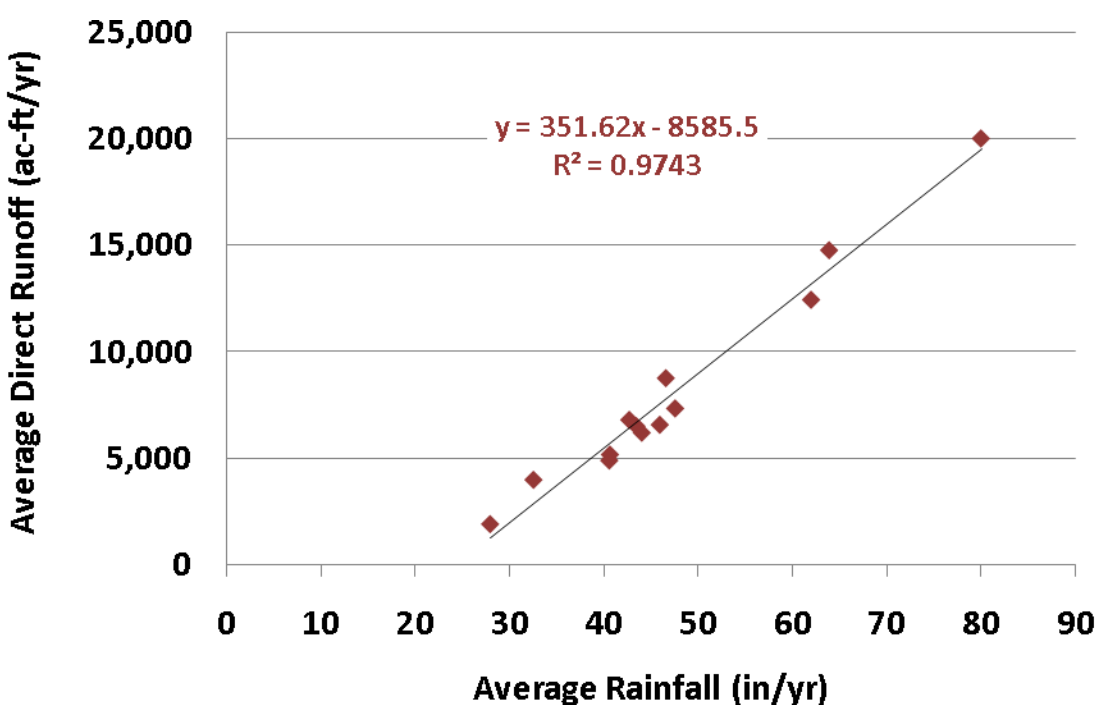

Figure 2-7 Correlation of Average Annual Direct Runoff to Rainfall

Table 2-9 Annual Direct Runoff to Rainfall Coefficients for Alligator Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	35.37	80.00	0.44
1996	10.96	44.01	0.25
1997	11.51	43.44	0.26
1998	12.03	42.67	0.28
1999	8.66	40.55	0.21
2000	7.06	32.51	0.22
2001	15.49	46.56	0.33
2002	11.62	45.91	0.25
2003	26.10	63.89	0.41
2004	12.98	47.55	0.27
2005	21.99	61.97	0.35
2006	9.15	40.62	0.23
2007	3.38	27.91	0.12
Average	**14.33**	**47.51**	**0.28**

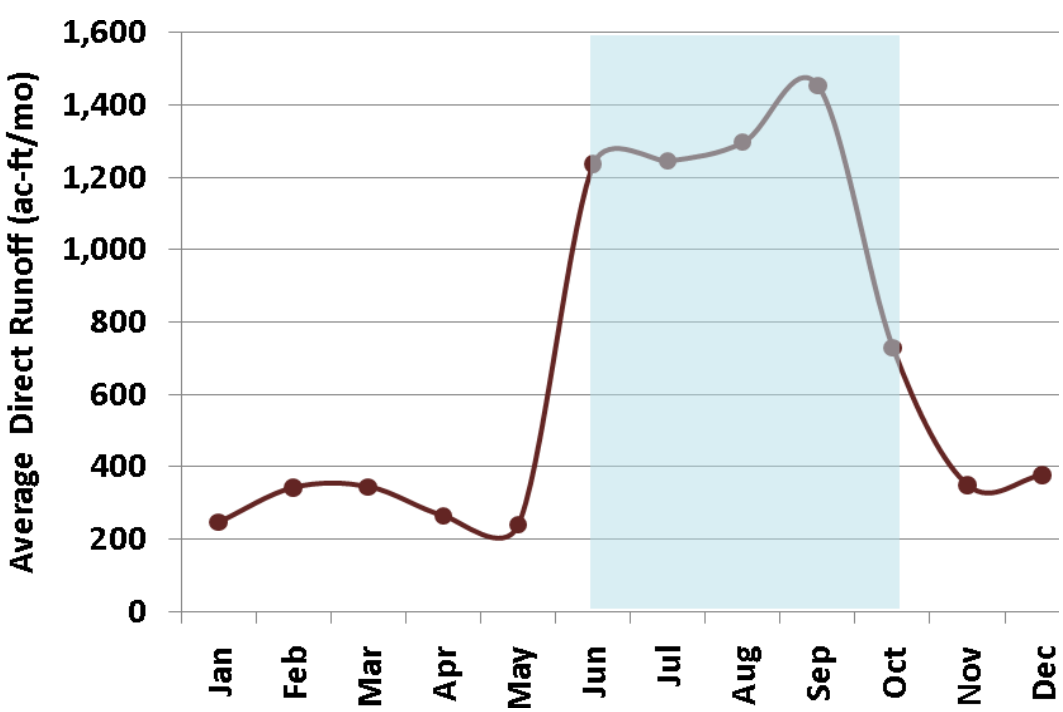

Figure 2-8 Variability of Average Monthly Direct Runoff to Alligator Creek Basin

Table 2-10 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.43	1.74	0.25
Feb	0.60	2.05	0.29
Mar	0.61	2.28	0.27
Apr	0.47	2.20	0.21
May	0.42	2.09	0.20
Jun	2.18	7.75	0.28
Jul	2.20	7.45	0.29
Aug	2.29	7.44	0.31
Sep	2.57	7.01	0.37
Oct	1.28	3.51	0.37
Nov	0.61	1.73	0.36
Dec	0.66	2.26	0.29

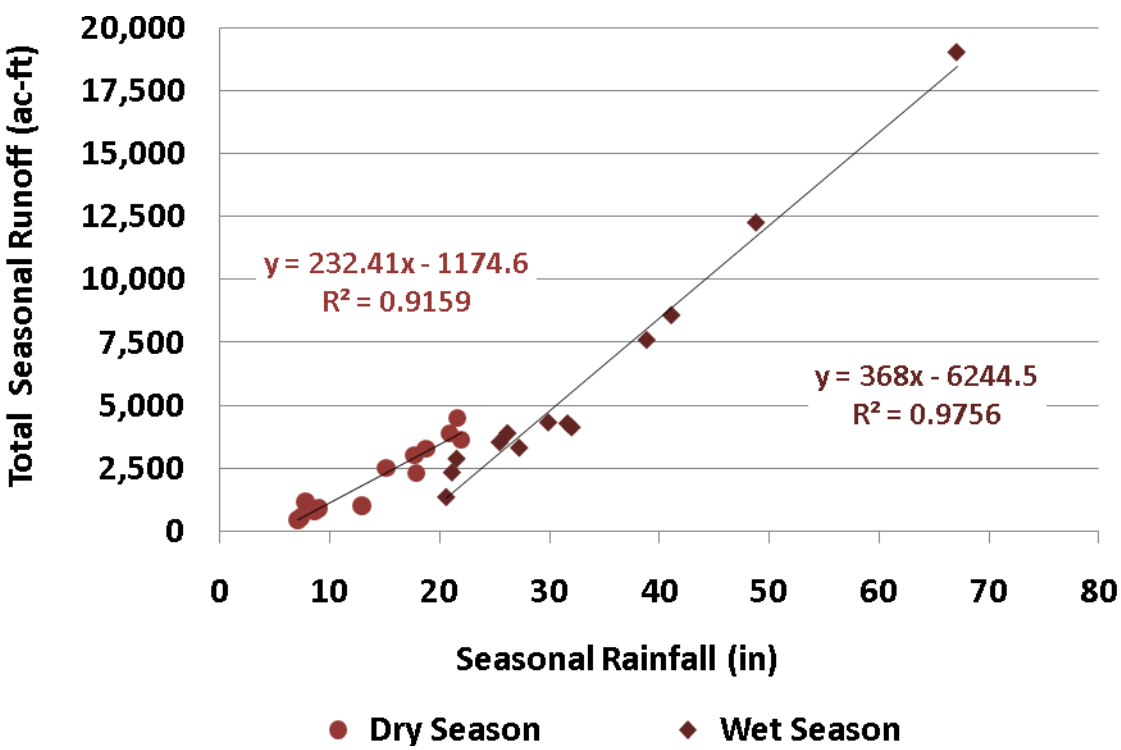

Figure 2-9 Correlation of Seasonal Direct Runoff to Rainfall

Table 2-11 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	33.59	67.09	0.50
1996	6.87	26.14	0.26
1997	5.08	21.50	0.24
1998	4.11	21.08	0.20
1999	7.28	31.99	0.23
2000	6.23	25.43	0.24
2001	13.41	38.83	0.35
2002	5.84	27.21	0.21
2003	21.65	48.80	0.44
2004	7.63	29.86	0.26
2005	15.14	41.08	0.37
2006	7.55	31.61	0.24
2007	2.38	20.55	0.12
Average	**10.52**	**33.17**	**0.28**

Table 2-12 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	1.77	12.92	0.14
1996	4.09	17.87	0.23
1997	6.43	21.94	0.29
1998	7.92	21.60	0.37
1999	1.38	8.56	0.16
2000	0.83	7.08	0.12
2001	2.08	7.73	0.27
2002	5.78	18.71	0.31
2003	4.45	15.09	0.30
2004	5.35	17.69	0.30
2005	6.85	20.89	0.33
2006	1.60	9.01	0.18
2007	1.00	7.36	0.14
Average	**3.81**	**14.34**	**0.24**

2.2 HISTORICAL CONDITIONS

Table 2-13 Historical Total Volume for Alligator Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	504.0	255.9	216.3	174.7	141.1	4,138.1	5,872.9	2,375.9	3,807.6	3,963.3	506.3	319.8	22,275.9
1949	691.3	327.0	480.5	279.6	777.6	319.7	333.5	1,157.3	570.4	1,438.2	326.8	264.0	6,965.8
1950	324.4	157.1	175.9	731.2	135.1	206.0	203.5	198.7	1,301.4	320.3	914.0	1,549.8	6,217.3
1951	1,401.6	1,573.1	1,346.1	321.1	276.5	281.9	672.4	477.1	1,071.6	390.4	1,043.9	248.3	9,104.1
1952	320.6	163.6	163.1	122.7	109.5	318.3	714.8	1,222.0	1,330.4	756.5	315.0	380.5	5,917.0
1953	240.3	164.2	146.2	237.9	116.2	274.6	442.6	1,528.3	1,114.1	333.8	247.9	216.8	5,063.0
1954	169.1	128.9	831.8	163.7	138.3	769.6	2,951.3	1,738.3	3,274.8	438.5	284.3	234.2	11,122.9
1955	191.8	812.9	149.4	133.4	199.3	341.6	376.5	1,871.7	795.5	401.1	1,315.1	935.3	7,523.7
1956	376.8	252.9	232.4	805.1	765.8	3,516.1	874.9	3,903.9	4,864.2	475.1	287.1	1,026.5	17,380.8
1957	262.9	785.5	258.2	686.2	236.5	584.1	886.1	1,463.6	981.2	726.8	516.6	711.1	8,098.8
1958	492.3	778.5	993.3	288.3	667.4	3,415.0	2,292.7	474.5	384.7	2,324.5	783.3	326.6	13,221.0
1959	239.1	386.9	179.8	141.2	123.9	215.7	1,339.9	1,524.3	971.1	446.6	256.4	399.5	6,224.4
1960	249.9	181.5	139.0	196.0	103.6	125.4	117.0	140.8	240.4	328.6	179.4	127.7	2,129.1
Average	**420.3**	**459.1**	**408.6**	**329.3**	**291.6**	**1,115.9**	**1,313.7**	**1,390.5**	**1,592.9**	**949.5**	**536.6**	**518.5**	**9,326.4**

Table 2-14 Historical Direct Runoff for Alligator Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	227.88	33.50	5.76	11.03	0.56	3,742.47	5,249.82	1,729.58	3,101.50	3,203.06	13.69	3.83	17,322.68
1949	319.73	36.04	213.12	43.66	546.15	93.14	101.15	873.20	257.99	934.86	0.00	0.36	3,419.39
1950	112.71	0.01	29.33	607.58	2.81	95.66	65.56	36.76	1,126.29	103.99	706.43	1,145.89	4,033.01
1951	863.19	1,016.40	863.19	0.00	17.58	78.41	453.45	175.79	671.19	0.04	732.69	0.95	4,872.89
1952	111.03	0.00	13.21	0.02	3.48	203.56	415.15	802.86	857.55	265.43	0.11	124.73	2,797.13
1953	32.20	0.06	0.06	112.83	3.74	165.61	247.30	1,132.92	699.20	0.00	0.90	10.77	2,405.61
1954	0.01	0.00	704.31	0.00	0.00	642.18	2,406.02	1,139.80	2,679.25	0.44	0.00	0.00	7,572.01
1955	0.00	663.34	0.01	12.95	91.39	220.74	137.07	1,514.73	243.59	49.02	1,032.59	527.56	4,492.98
1956	0.00	0.11	0.41	610.71	572.02	3,117.28	364.69	3,141.65	4,191.08	0.39	0.00	745.52	12,743.86
1957	13.34	562.64	0.93	474.24	33.18	400.03	580.13	943.13	492.10	344.41	235.61	463.71	4,543.44
1958	231.83	583.14	731.31	43.13	420.63	2,867.45	1,682.08	72.26	71.01	1,941.94	363.99	1.12	9,009.89
1959	0.01	183.23	0.21	0.00	1.55	93.30	1,023.09	1,034.06	482.88	85.36	0.49	183.85	3,088.01
1960	53.17	24.60	0.00	78.70	0.00	33.94	15.11	4.51	86.65	135.64	0.16	0.46	432.96
Average	**151.16**	**238.70**	**197.07**	**153.45**	**130.24**	**904.14**	**980.05**	**969.33**	**1,150.79**	**543.43**	**237.44**	**246.83**	**5,902.60**

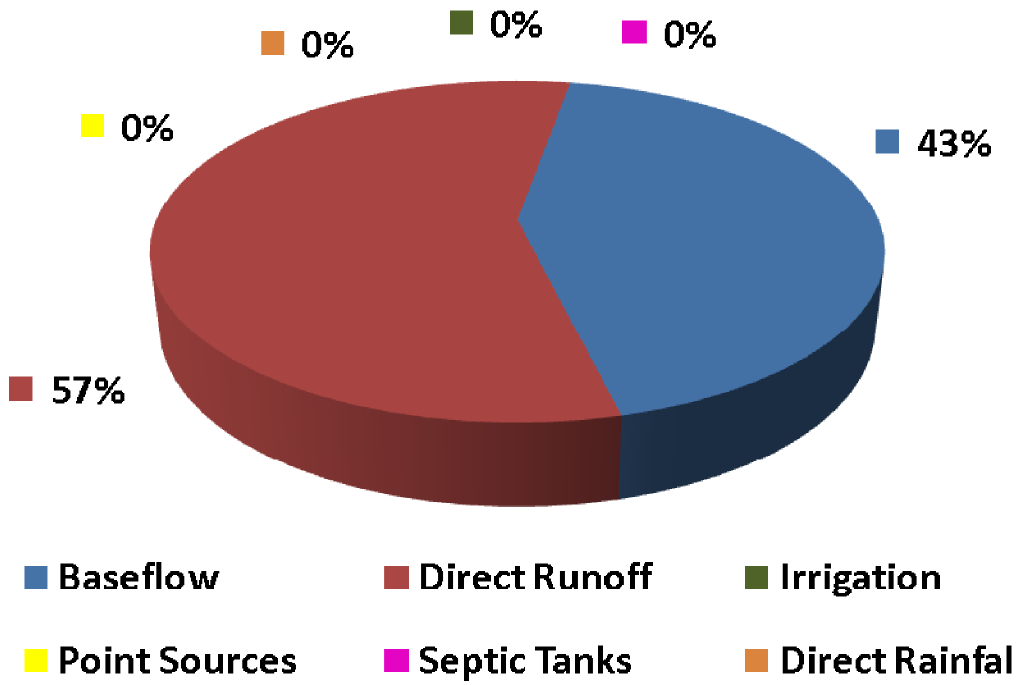

Figure 2-10 Alligator Creek Basin Historical Total Volume Water Budget

Table 2-15 Summary of Annual Historical Total Volume Inputs for Alligator Creek Basin (ac-ft/yr)						
	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	4,953.2	17,322.7	0.0	0.0	0.0	0.0
1949	3,546.3	3,419.4	0.0	0.0	0.0	0.0
1950	2,184.2	4,033.0	0.0	0.0	0.0	0.0
1951	4,231.2	4,872.9	0.0	0.0	0.0	0.0
1952	3,119.8	2,797.1	0.0	0.0	0.0	0.0
1953	2,657.3	2,405.6	0.0	0.0	0.0	0.0
1954	3,550.8	7,572.0	0.0	0.0	0.0	0.0
1955	3,030.6	4,493.0	0.0	0.0	0.0	0.0
1956	4,636.8	12,743.9	0.0	0.0	0.0	0.0
1957	3,555.3	4,543.4	0.0	0.0	0.0	0.0
1958	4,211.0	9,009.9	0.0	0.0	0.0	0.0
1959	3,136.3	3,088.0	0.0	0.0	0.0	0.0
1960	1,696.1	433.0	0.0	0.0	0.0	0.0
Average	**3,423.8**	**5,902.6**	**0.0**	**0.0**	**0.0**	**0.0**

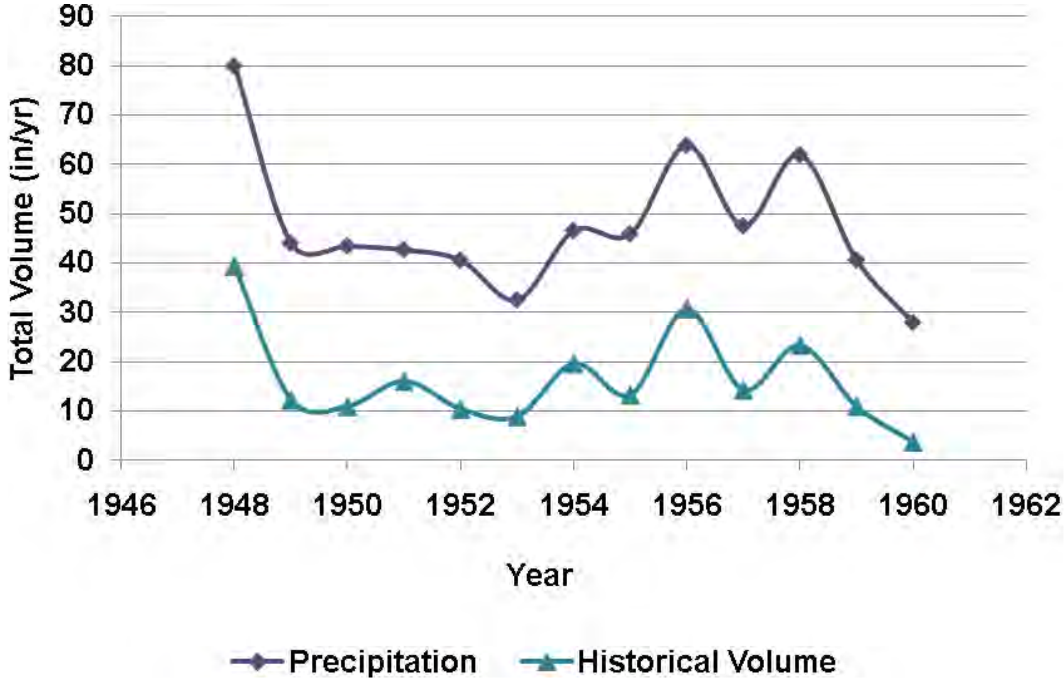

Figure 2-11 Annual Historical Variability of Precipitation and Total Volume for Alligator Creek Basin

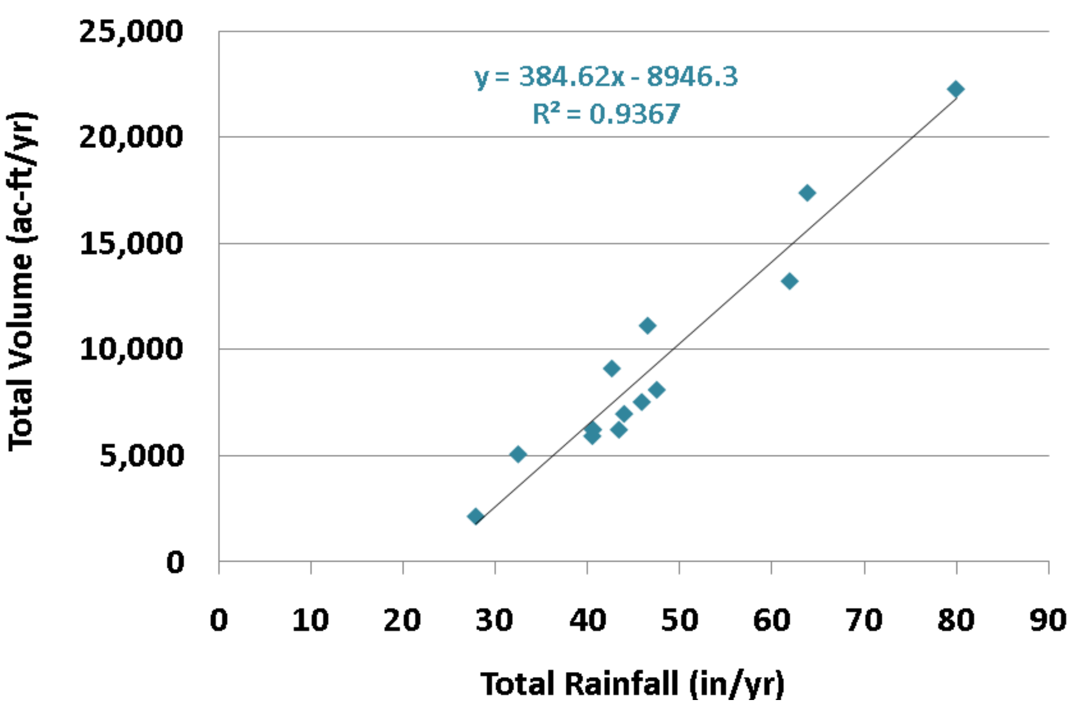

Figure 2-12 Correlation of Annual Total Volume to Rainfall for Alligator Creek Basin

Table 2-16 Annual Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	39.32	80.00	0.49
1949	12.29	44.01	0.28
1950	10.97	43.44	0.25
1951	16.07	42.67	0.38
1952	10.44	40.55	0.26
1953	8.94	32.51	0.27
1954	19.63	46.56	0.42
1955	13.28	45.91	0.29
1956	30.68	63.89	0.48
1957	14.29	47.55	0.30
1958	23.33	61.97	0.38
1959	10.99	40.62	0.27
1960	3.76	27.91	0.13
Average	**16.46**	**47.51**	**0.32**

Figure 2-13 Variability of Average Monthly Total Volume in Alligator Creek Basin

Table 2-17 Average Monthly Rainfall to Total Volume Coefficients for Alligator Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.74	1.74	0.43
Feb	0.81	2.05	0.40
Mar	0.72	2.28	0.32
Apr	0.58	2.20	0.26
May	0.51	2.09	0.25
Jun	1.97	7.75	0.25
Jul	2.32	7.45	0.31
Aug	2.45	7.44	0.33
Sep	2.81	7.01	0.40
Oct	1.68	3.51	0.48
Nov	0.95	1.73	0.55
Dec	0.92	2.26	0.41

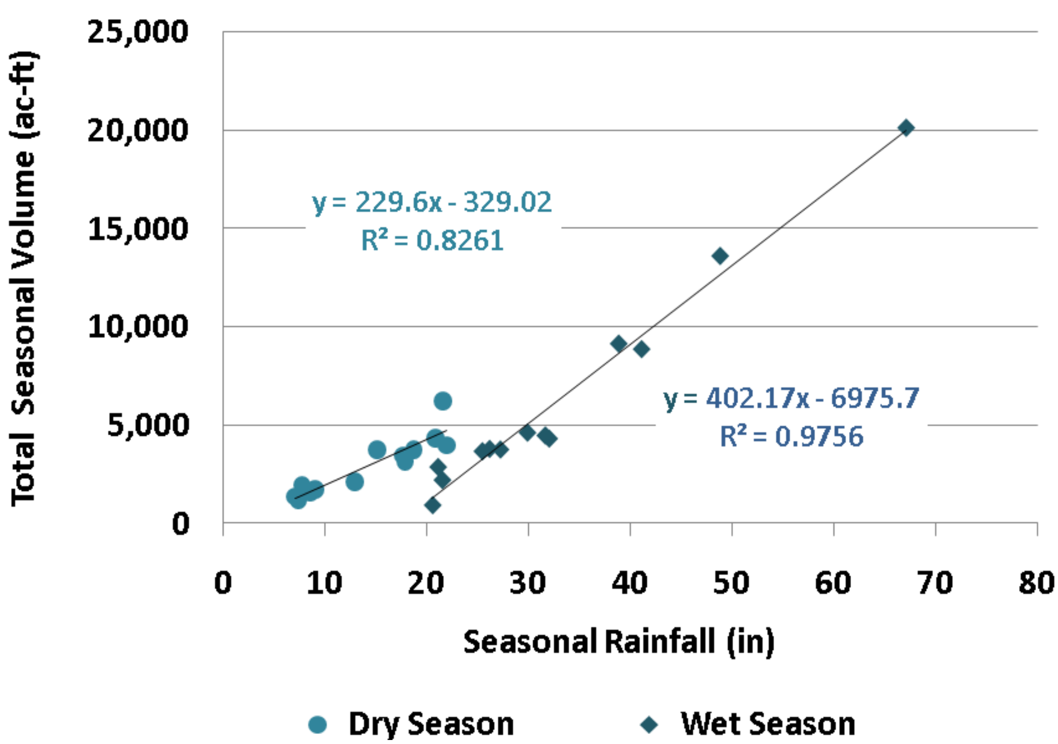

Figure 2-14 Correlation of Seasonal Total Volume to Rainfall for Alligator Creek Basin

Table 2-18 Wet Season Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	35.58	67.09	0.53
1996	6.74	26.14	0.26
1997	3.94	21.50	0.18
1998	5.11	21.08	0.24
1999	7.66	31.99	0.24
2000	6.52	25.43	0.26
2001	16.19	38.83	0.42
2002	6.68	27.21	0.25
2003	24.06	48.80	0.49
2004	8.19	29.86	0.27
2005	15.69	41.08	0.38
2006	7.94	31.61	0.25
2007	1.68	20.55	0.08
Average	**11.23**	**33.17**	**0.30**

Table 2-19 Dry Season Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	3.74	12.92	0.29
1996	5.55	17.87	0.31
1997	7.04	21.94	0.32
1998	10.96	21.60	0.51
1999	2.78	8.56	0.32
2000	2.42	7.08	0.34
2001	3.44	7.73	0.45
2002	6.60	18.71	0.35
2003	6.61	15.09	0.44
2004	6.10	17.69	0.34
2005	7.64	20.89	0.37
2006	3.05	9.01	0.34
2007	2.08	7.36	0.28
Average	**5.23**	**14.34**	**0.36**

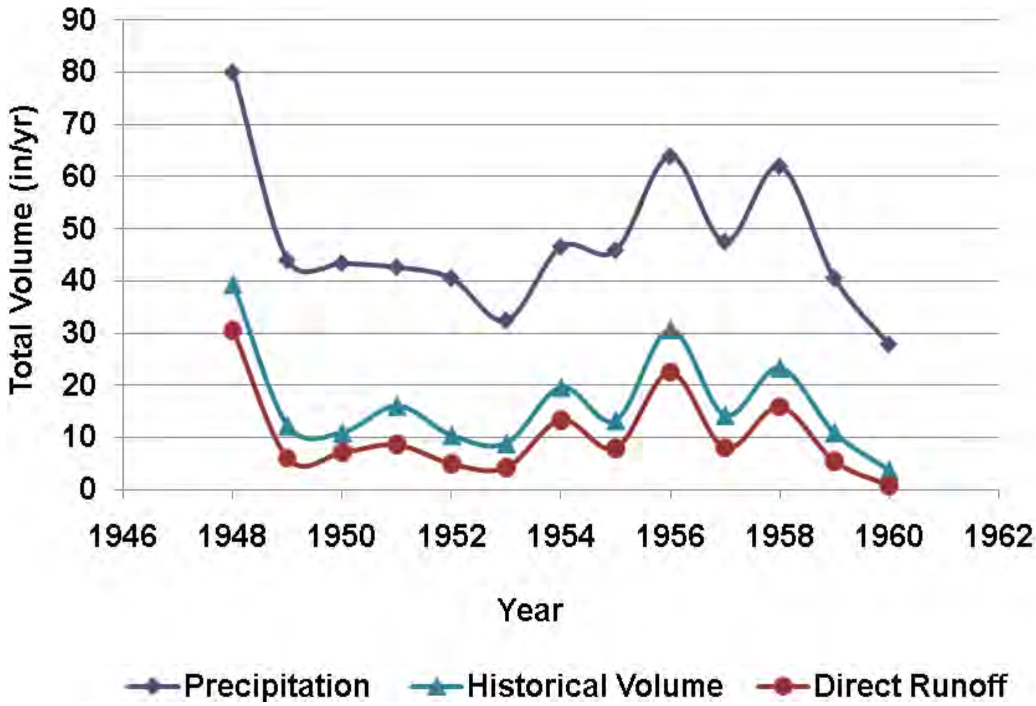

Figure 2-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Alligator Creek Basin

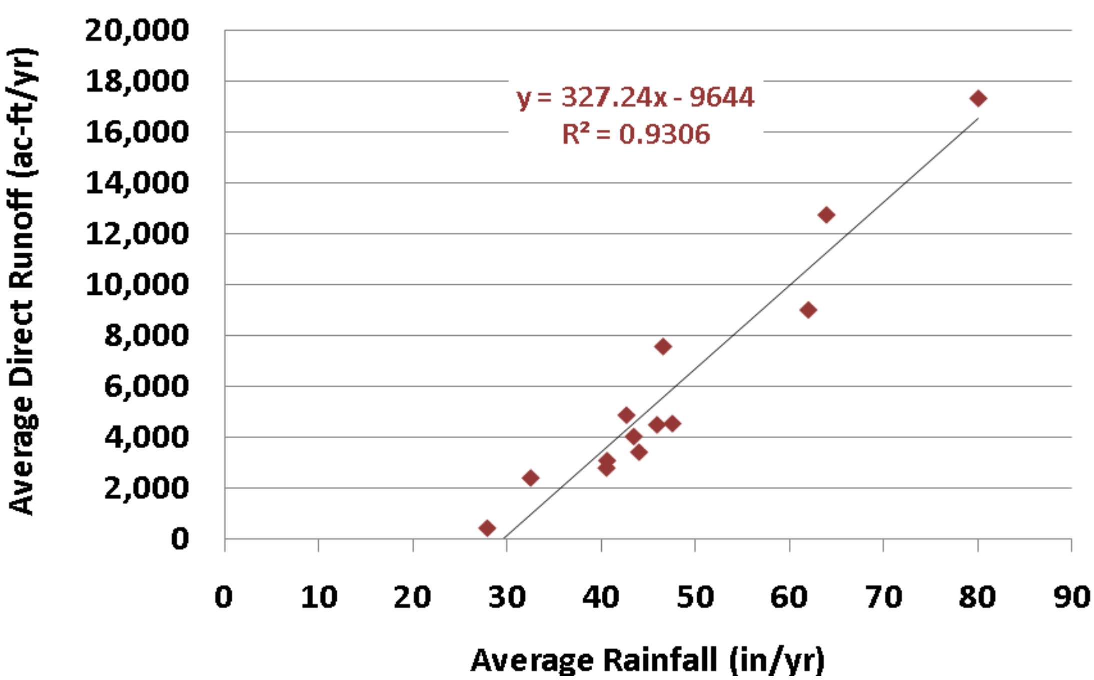

Figure 2-16 Correlation of Average Annual Direct Runoff to Rainfall

Table 2-20 Annual Direct Runoff to Rainfall Coefficients for Alligator Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	30.57	80.00	0.38
1949	6.04	44.01	0.14
1950	7.12	43.44	0.16
1951	8.60	42.67	0.20
1952	4.94	40.55	0.12
1953	4.25	32.51	0.13
1954	13.36	46.56	0.29
1955	7.93	45.91	0.17
1956	22.49	63.89	0.35
1957	8.02	47.55	0.17
1958	15.90	61.97	0.26
1959	5.45	40.62	0.13
1960	0.76	27.91	0.03
Average	**10.42**	**47.51**	**0.20**

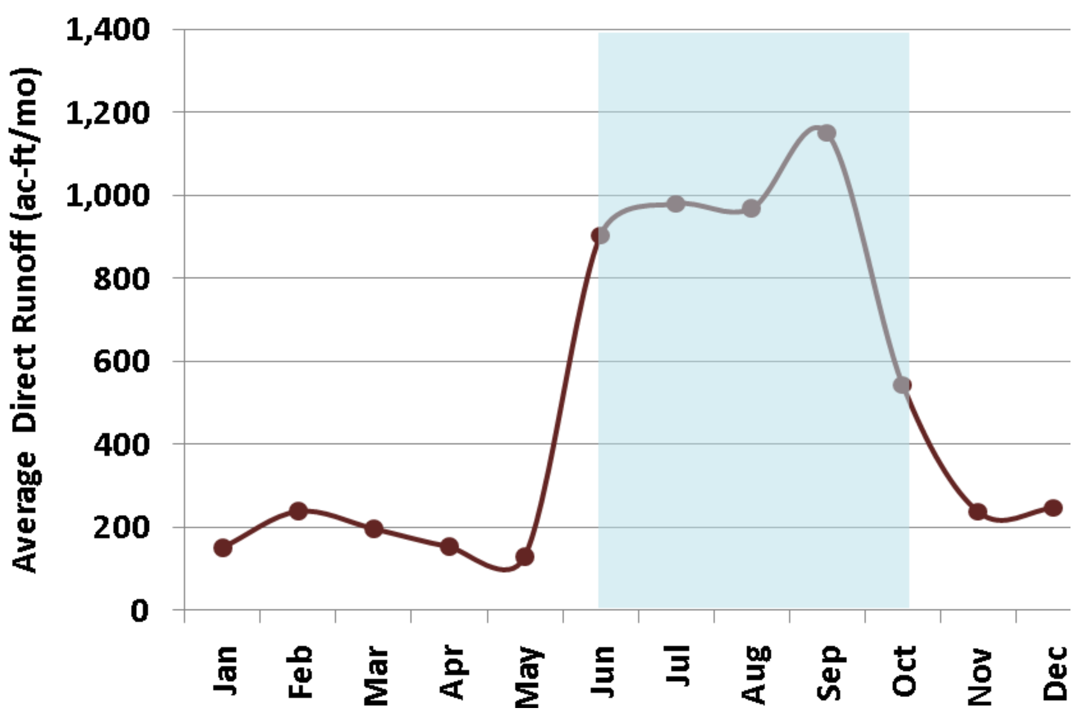

Figure 2-17 Variability of Average Monthly Direct Runoff to Alligator Creek Basin

Table 2-21 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.27	1.74	0.15
Feb	0.42	2.05	0.21
Mar	0.35	2.28	0.15
Apr	0.27	2.20	0.12
May	0.23	2.09	0.11
Jun	1.60	7.75	0.21
Jul	1.73	7.45	0.23
Aug	1.71	7.44	0.23
Sep	2.03	7.01	0.29
Oct	0.96	3.51	0.27
Nov	0.42	1.73	0.24
Dec	0.44	2.26	0.19

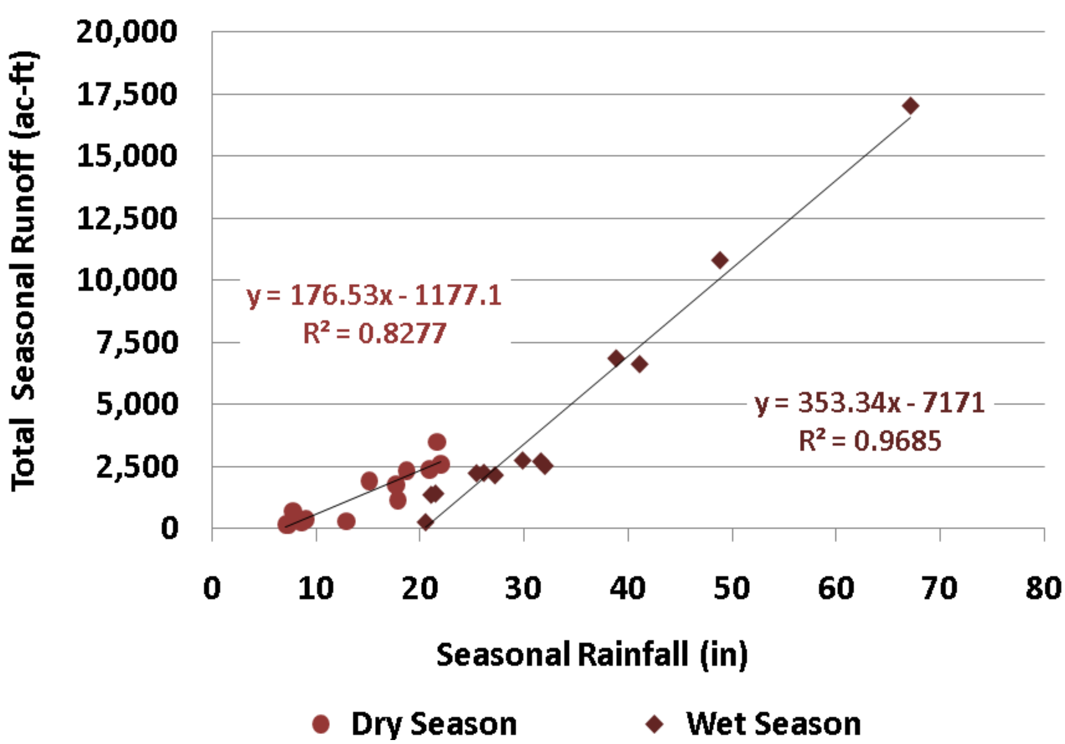

Figure 2-18 Correlation of Seasonal Direct Runoff to Rainfall

Table 2-22 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	30.05	67.09	0.45
1949	3.99	26.14	0.15
1950	2.52	21.50	0.12
1951	2.43	21.08	0.12
1952	4.49	31.99	0.14
1953	3.96	25.43	0.16
1954	12.12	38.83	0.31
1955	3.82	27.21	0.14
1956	19.09	48.80	0.39
1957	4.87	29.86	0.16
1958	11.71	41.08	0.29
1959	4.80	31.61	0.15
1960	0.49	20.55	0.02
Average	**8.03**	**33.17**	**0.20**

Table 2-23 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.52	12.92	0.04
1949	2.05	17.87	0.11
1950	4.60	21.94	0.21
1951	6.17	21.60	0.29
1952	0.45	8.56	0.05
1953	0.28	7.08	0.04
1954	1.24	7.73	0.16
1955	4.11	18.71	0.22
1956	3.40	15.09	0.23
1957	3.15	17.69	0.18
1958	4.19	20.89	0.20
1959	0.65	9.01	0.07
1960	0.28	7.36	0.04
Average	**2.39**	**14.34**	**0.14**

2.3 FUTURE CONDITIONS

Table 2-24 Future Total Volume for Alligator Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	1,021.0	588.6	548.3	485.3	271.5	5,294.1	6,949.3	3,812.1	5,397.8	5,398.9	1,203.7	788.8	31,759.5
2016	1,374.6	704.7	975.0	583.6	1,320.6	734.2	842.9	2,192.5	1,299.8	2,415.1	663.9	484.6	13,591.4
2017	501.8	232.7	280.6	1,000.7	229.5	400.1	429.3	455.6	2,144.9	729.2	1,354.1	2,280.1	10,038.7
2018	1,936.0	2,099.1	2,307.4	662.4	568.8	497.6	1,028.5	918.5	1,760.5	842.7	1,644.2	417.2	14,682.9
2019	577.9	211.0	313.6	148.0	184.3	663.9	968.8	2,063.1	2,292.0	1,660.4	728.5	764.8	10,576.3
2020	416.8	248.1	209.0	379.4	190.1	627.7	765.6	2,102.2	1,883.7	651.2	452.0	373.9	8,299.9
2021	247.2	176.0	1,380.8	153.9	127.1	968.8	3,186.4	2,488.8	4,690.5	1,162.1	636.8	445.7	15,664.1
2022	332.9	948.7	212.5	263.8	471.2	614.4	591.9	2,598.4	1,596.7	942.3	1,910.8	1,487.4	11,971.0
2023	609.4	388.3	366.4	875.0	839.8	4,116.0	1,846.5	5,667.0	6,105.6	1,274.4	697.4	1,597.7	24,383.5
2024	480.0	1,294.6	379.0	995.7	291.6	1,034.5	1,478.1	2,470.9	1,959.0	1,588.9	1,062.6	1,136.0	14,171.0
2025	830.0	1,151.0	1,475.4	578.7	1,141.9	4,622.2	3,701.6	1,459.3	1,071.3	3,555.1	1,436.2	656.8	21,679.5
2026	415.3	772.6	305.5	192.9	255.2	560.1	1,910.3	2,430.8	2,079.0	1,114.8	554.3	709.7	11,300.4
2027	382.8	344.6	193.4	446.3	135.7	406.8	328.8	282.3	608.2	749.7	350.2	282.6	4,511.3
Average	**702.0**	**704.6**	**688.2**	**520.5**	**463.6**	**1,580.0**	**1,848.3**	**2,226.3**	**2,529.9**	**1,698.8**	**976.5**	**878.9**	**14,817.7**

2

Table 2-25 Future Direct Runoff for Alligator Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	488.5	146.2	121.1	190.0	42.5	4,749.7	5,647.0	2,050.7	3,556.3	3,430.9	44.0	109.7	20,576.7
2016	603.4	193.8	546.9	179.3	980.3	384.7	400.9	1,532.1	554.3	1,334.5	0.7	29.6	6,740.6
2017	177.5	8.9	87.9	844.9	76.1	276.6	288.3	261.1	1,884.2	382.1	998.4	1,575.3	6,861.4
2018	984.6	1,010.2	1,318.0	0.2	98.4	160.6	741.2	520.6	1,037.4	24.6	1,117.9	54.9	7,068.6
2019	301.9	0.1	138.6	13.2	70.6	553.2	678.8	1,436.9	1,261.5	453.5	32.9	296.4	5,237.7
2020	88.9	15.4	17.8	226.1	59.6	509.8	578.2	1,570.8	1,080.9	0.0	29.0	56.3	4,232.8
2021	7.0	0.0	1,222.2	4.7	3.4	859.9	2,511.0	1,078.9	3,183.2	41.5	2.3	4.8	8,919.0
2022	12.7	719.0	7.9	105.8	338.0	482.4	335.3	2,030.5	388.3	180.3	1,402.7	793.1	6,796.1
2023	0.0	29.3	82.2	660.8	653.1	3,549.5	712.8	3,739.4	4,386.4	46.0	10.6	1,103.2	14,973.2
2024	129.8	993.5	45.7	751.5	77.4	847.1	1,011.5	1,303.7	678.5	629.2	466.6	707.4	7,641.8
2025	446.3	881.4	1,103.6	238.8	773.3	3,543.1	2,012.6	327.1	273.5	2,665.4	618.3	2.5	12,885.9
2026	10.0	445.9	42.8	0.2	96.2	419.4	1,515.5	1,467.3	822.4	232.5	24.0	329.8	5,405.8
2027	93.0	127.2	13.5	305.9	18.0	306.3	223.6	136.7	402.2	412.0	10.0	46.5	2,094.9
Average	**257.2**	**351.6**	**365.2**	**270.9**	**252.8**	**1,280.2**	**1,281.3**	**1,342.7**	**1,500.7**	**756.3**	**366.0**	**393.0**	**8,418.0**

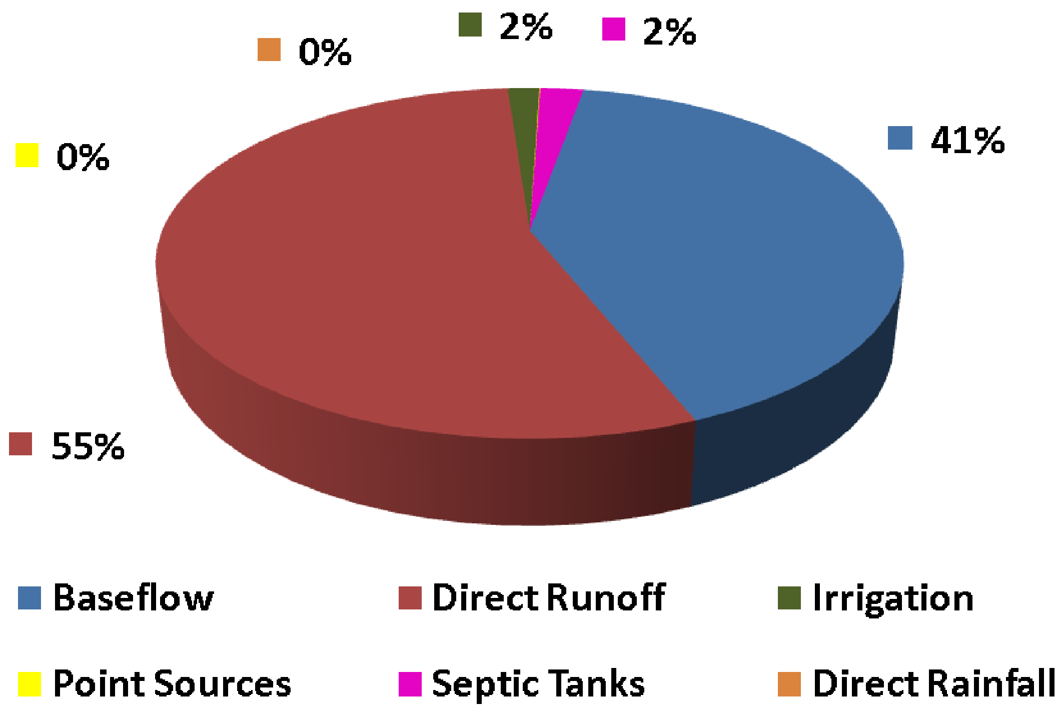

Figure 2-19 Alligator Creek Basin Future Total Volume Water Budget

Table 2-26 Summary of Annual Future Total Volume Inputs for Alligator Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	10,720.5	20,576.7	193.3	5.1	263.9	0.0
2016	6,388.5	6,740.6	193.3	5.1	263.9	0.0
2017	2,715.1	6,861.4	193.3	5.1	263.9	0.0
2018	7,152.1	7,068.6	193.3	5.0	263.9	0.0
2019	4,876.9	5,237.7	193.3	4.5	263.9	0.0
2020	3,604.7	4,232.8	193.3	5.2	263.9	0.0
2021	6,283.6	8,919.0	193.3	4.3	263.9	0.0
2022	4,713.0	6,796.1	193.3	4.7	263.9	0.0
2023	8,948.6	14,973.2	193.3	4.6	263.9	0.0
2024	6,067.3	7,641.8	193.3	4.7	263.9	0.0
2025	8,331.3	12,885.9	193.3	5.1	263.9	0.0
2026	5,432.1	5,405.8	193.3	5.3	263.9	0.0
2027	1,954.8	2,094.9	193.3	4.5	263.9	0.0
Average	**5,937.6**	**8,418.0**	**193.3**	**4.9**	**263.9**	**0.0**

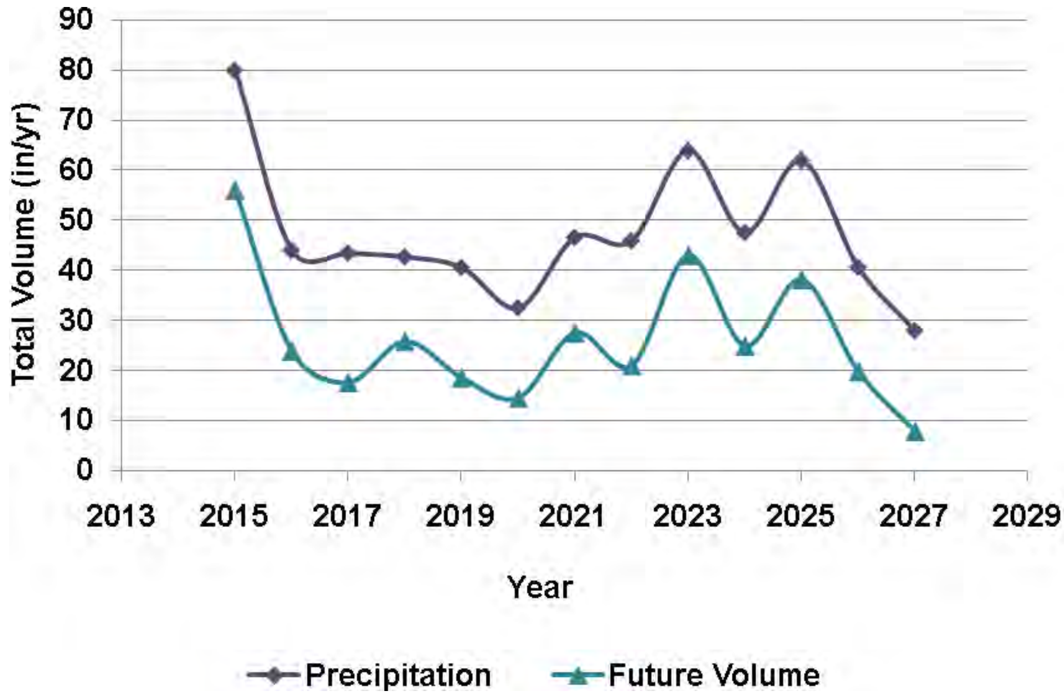

Figure 2-20 Annual Variability of Precipitation and Total Volume for Alligator Creek Basin

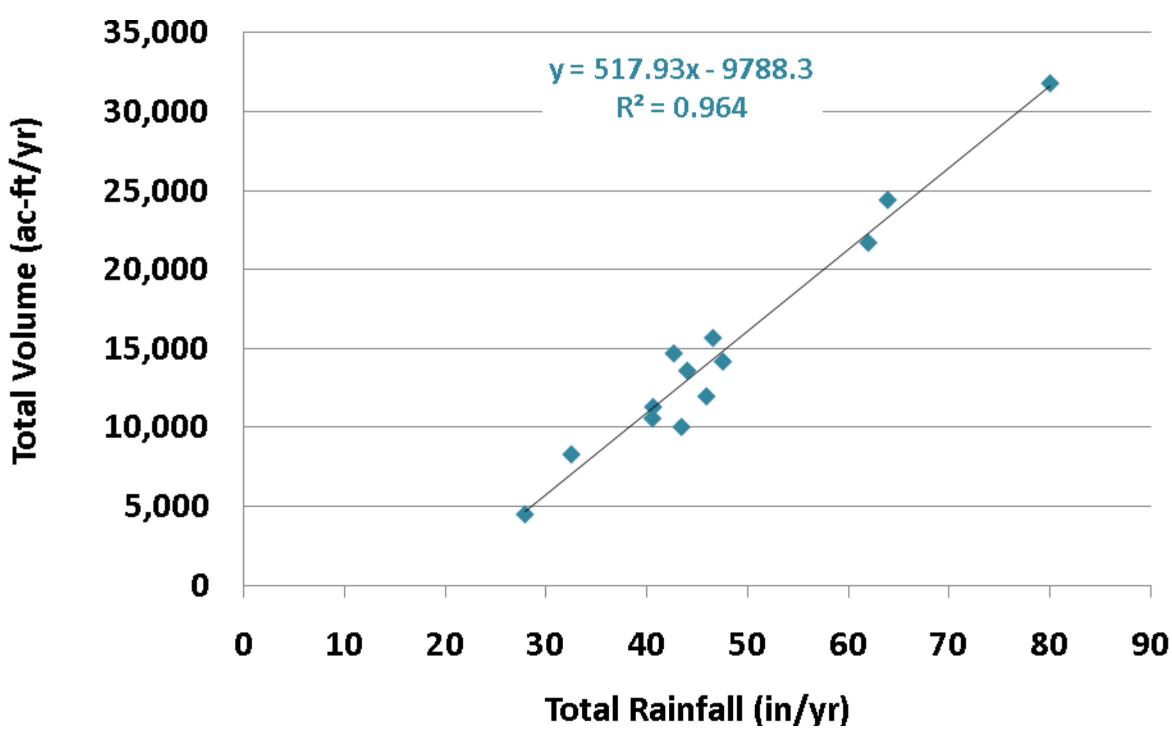

Figure 2-21 Correlation of Annual Total Volume to Rainfall for Alligator Creek Basin

Table 2-27 Annual Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	56.05	80.00	0.70
2016	23.99	44.01	0.55
2017	17.72	43.44	0.41
2018	25.91	42.67	0.61
2019	18.67	40.55	0.46
2020	14.65	32.51	0.45
2021	27.65	46.56	0.59
2022	21.13	45.91	0.46
2023	43.04	63.89	0.67
2024	25.01	47.55	0.53
2025	38.26	61.97	0.62
2026	19.94	40.62	0.49
2027	7.96	27.91	0.29
Average	**26.15**	**47.51**	**0.52**

Figure 2-22 Variability of Average Monthly Total Volume in Alligator Creek Basin

Table 2-28 Average Monthly Rainfall to Total Volume Coefficients for Alligator Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.24	1.74	0.71
Feb	1.24	2.05	0.61
Mar	1.21	2.28	0.53
Apr	0.92	2.20	0.42
May	0.82	2.09	0.39
Jun	2.79	7.75	0.36
Jul	3.26	7.45	0.44
Aug	3.93	7.44	0.53
Sep	4.47	7.01	0.64
Oct	3.00	3.51	0.85
Nov	1.72	1.73	1.00
Dec	1.55	2.26	0.69

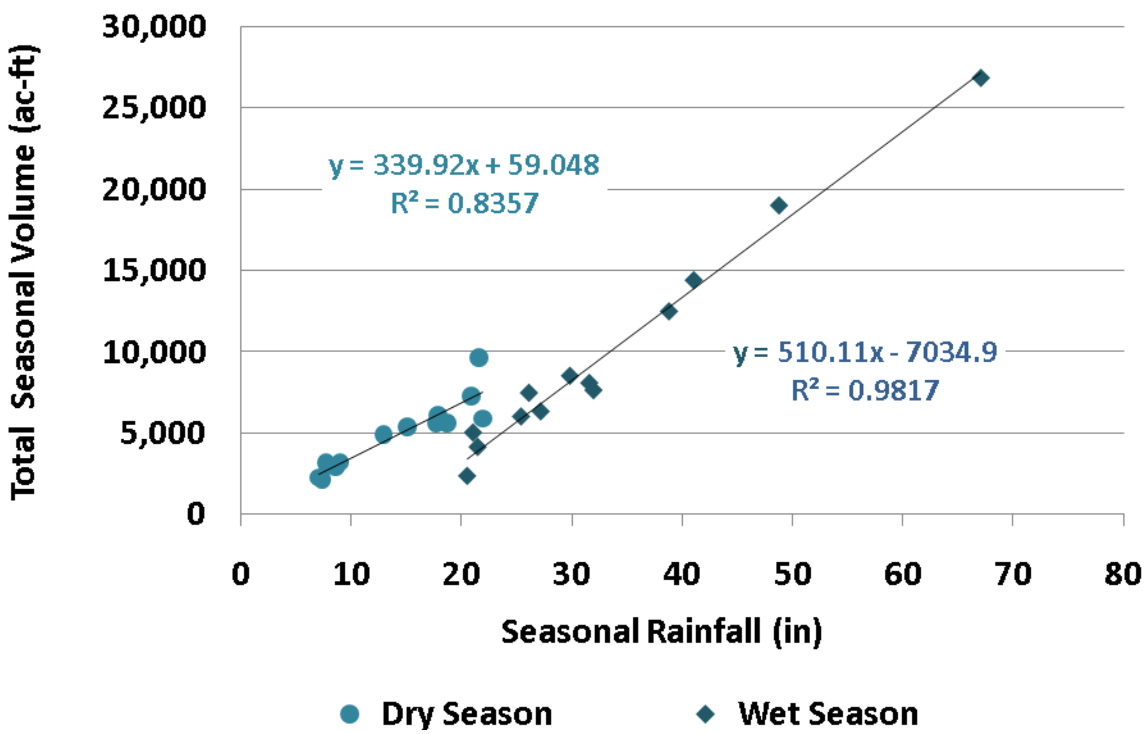

Figure 2-23 Correlation of Seasonal Total Volume to Rainfall for Alligator Creek Basin

Table 2-29 Wet Season Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	47.39	67.09	0.71
2016	13.21	26.14	0.51
2017	7.34	21.50	0.34
2018	8.91	21.08	0.42
2019	13.50	31.99	0.42
2020	10.64	25.43	0.42
2021	22.06	38.83	0.57
2022	11.20	27.21	0.41
2023	33.55	48.80	0.69
2024	15.06	29.86	0.50
2025	25.43	41.08	0.62
2026	14.29	31.61	0.45
2027	4.19	20.55	0.20
Average	**17.44**	**33.17**	**0.48**

Table 2-30 Dry Season Total Volume to Rainfall Coefficients for Alligator Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	8.66	12.92	0.67
2016	10.78	17.87	0.60
2017	10.38	21.94	0.47
2018	17.01	21.60	0.79
2019	5.17	8.56	0.60
2020	4.01	7.08	0.57
2021	5.59	7.73	0.72
2022	9.93	18.71	0.53
2023	9.48	15.09	0.63
2024	9.95	17.69	0.56
2025	12.83	20.89	0.61
2026	5.66	9.01	0.63
2027	3.77	7.36	0.51
Average	**8.71**	**14.34**	**0.61**

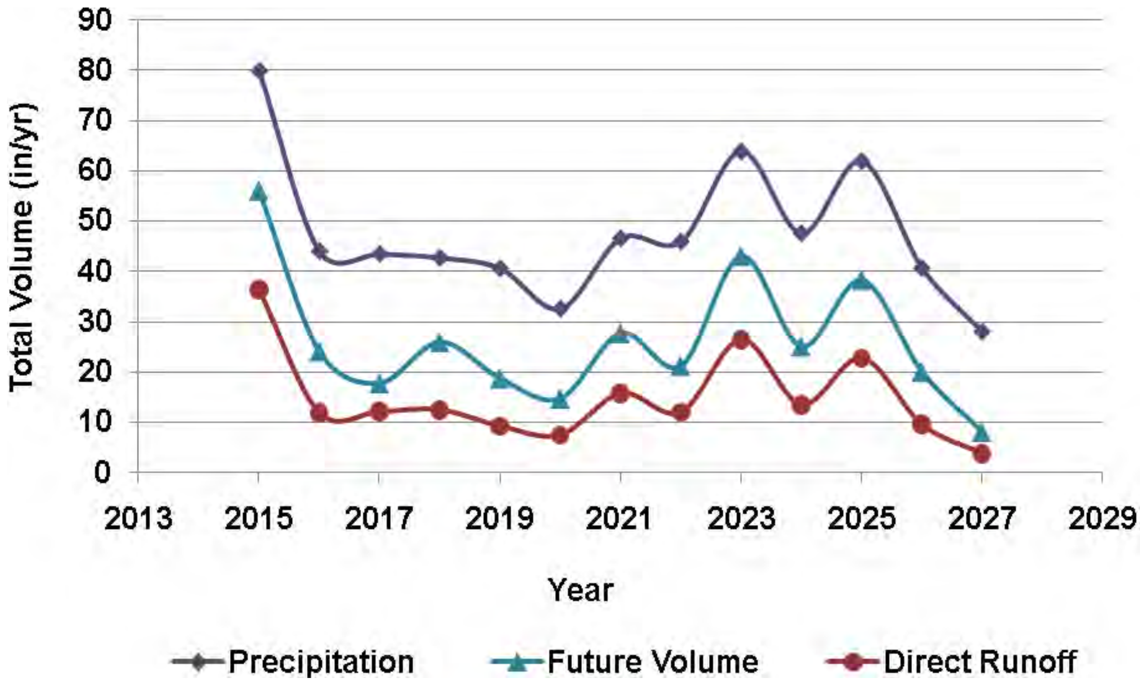

Figure 2-24 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Alligator Creek Basin

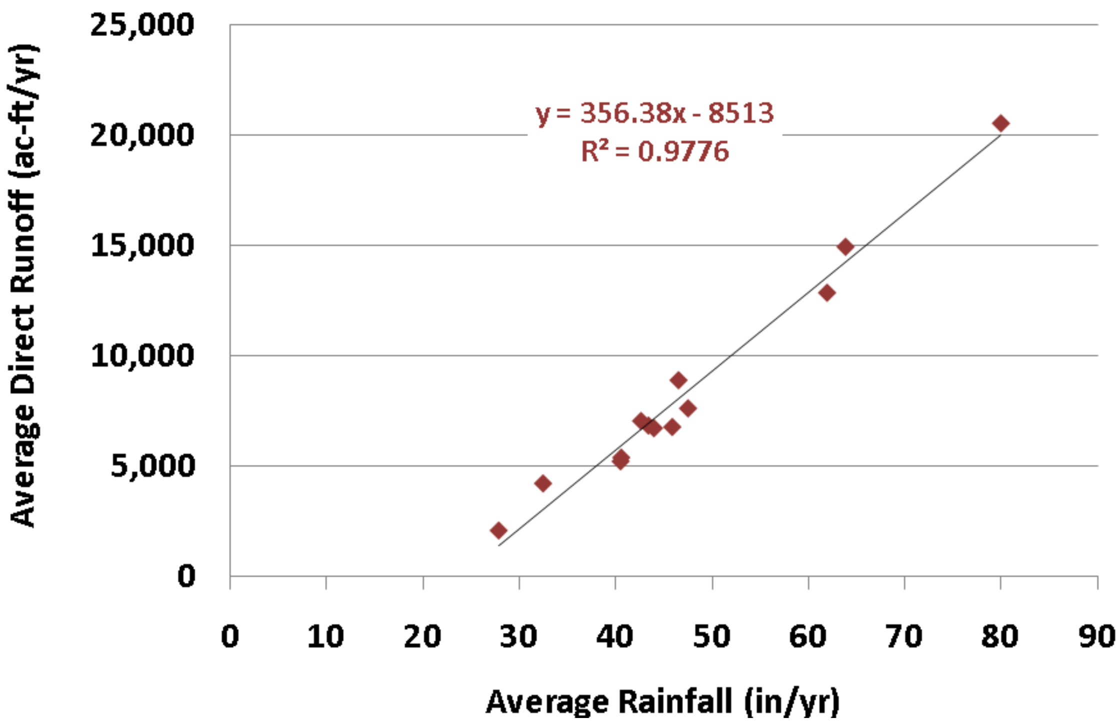

Figure 2-25 Correlation of Average Annual Direct Runoff to Rainfall

Table 2-31 Annual Direct Runoff to Rainfall Coefficients for Alligator Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	36.32	80.00	0.45
2016	11.90	44.01	0.27
2017	12.11	43.44	0.28
2018	12.48	42.67	0.29
2019	9.24	40.55	0.23
2020	7.47	32.51	0.23
2021	15.74	46.56	0.34
2022	11.99	45.91	0.26
2023	26.43	63.89	0.41
2024	13.49	47.55	0.28
2025	22.74	61.97	0.37
2026	9.54	40.62	0.23
2027	3.70	27.91	0.13
Average	**14.86**	**47.51**	**0.29**

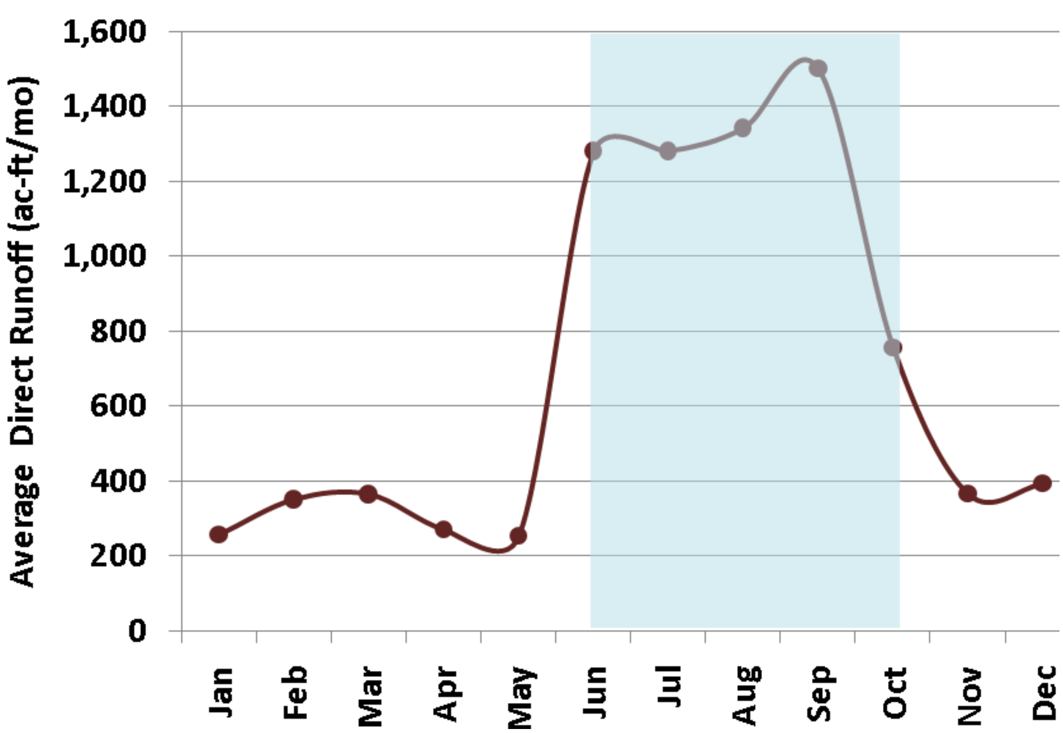

Figure 2-26 Variability of Average Monthly Direct Runoff to Alligator Creek Basin

Table 2-32 Average Monthly Rainfall to Direct Runoff Coefficients for Alligator Creek Basin

	Average Direct Runoff Volume (in)	Average Rainfall (in)	Average Direct Runoff Volume / Average Rainfall
Jan	0.45	1.74	0.26
Feb	0.62	2.05	0.30
Mar	0.64	2.28	0.28
Apr	0.48	2.20	0.22
May	0.45	2.09	0.21
Jun	2.26	7.75	0.29
Jul	2.26	7.45	0.30
Aug	2.37	7.44	0.32
Sep	2.65	7.01	0.38
Oct	1.33	3.51	0.38
Nov	0.65	1.73	0.37
Dec	0.69	2.26	0.31

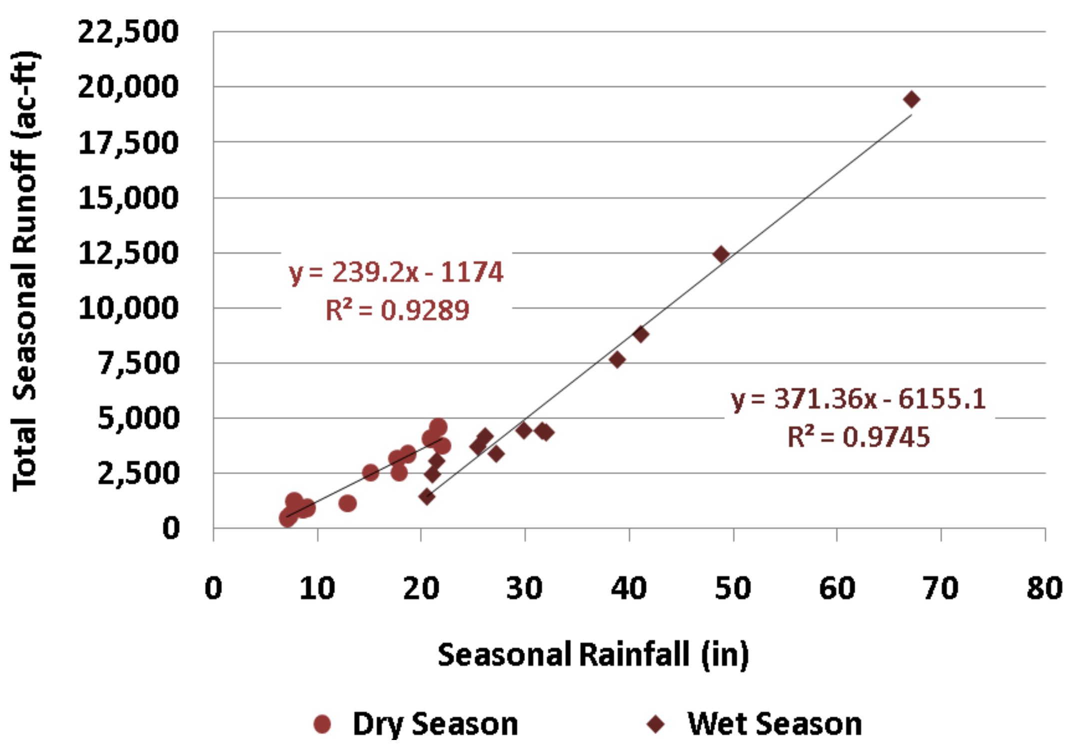

Figure 2-27 Correlation of Seasonal Direct Runoff to Rainfall

Table 2-33 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	34.30	67.09	0.51
2016	7.42	26.14	0.28
2017	5.46	21.50	0.25
2018	4.38	21.08	0.21
2019	7.74	31.99	0.24
2020	6.60	25.43	0.26
2021	13.54	38.83	0.35
2022	6.03	27.21	0.22
2023	21.95	48.80	0.45
2024	7.89	29.86	0.26
2025	15.57	41.08	0.38
2026	7.87	31.61	0.25
2027	2.61	20.55	0.13
Average	**10.87**	**33.17**	**0.29**

Table 2-34 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	2.02	12.92	0.16
2016	4.47	17.87	0.25
2017	6.65	21.94	0.30
2018	8.09	21.60	0.37
2019	1.51	8.56	0.18
2020	0.87	7.08	0.12
2021	2.20	7.73	0.28
2022	5.96	18.71	0.32
2023	4.48	15.09	0.30
2024	5.60	17.69	0.32
2025	7.17	20.89	0.34
2026	1.67	9.01	0.19
2027	1.08	7.36	0.15
Average	**3.98**	**14.34**	**0.25**

2.4 WATER BUDGET CHANGES

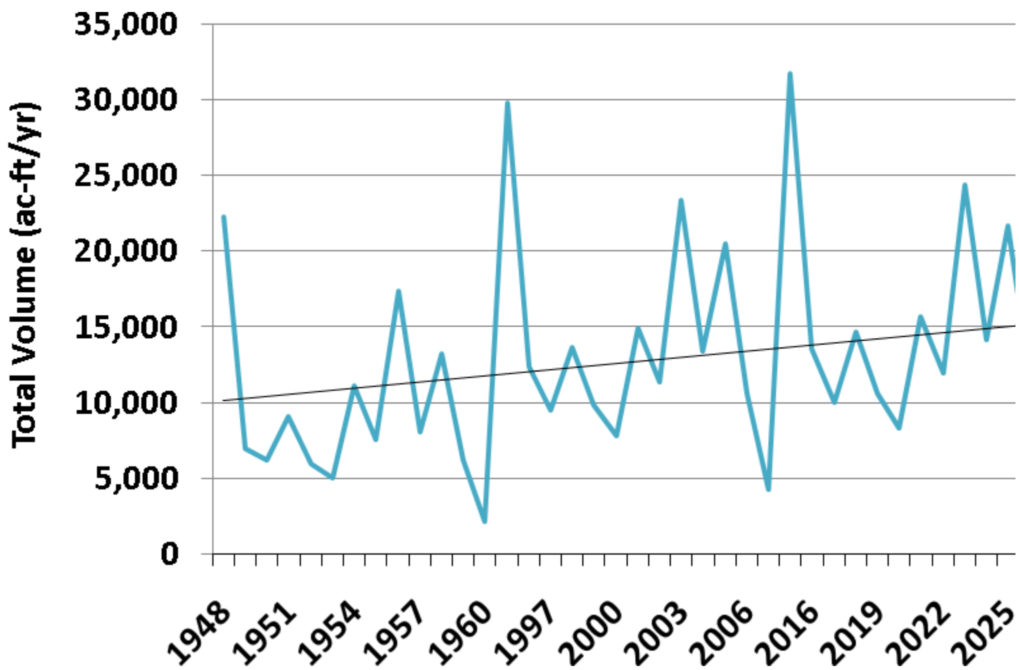

Figure 2-28 Trend in Total Volume from Historical through Future Time Series

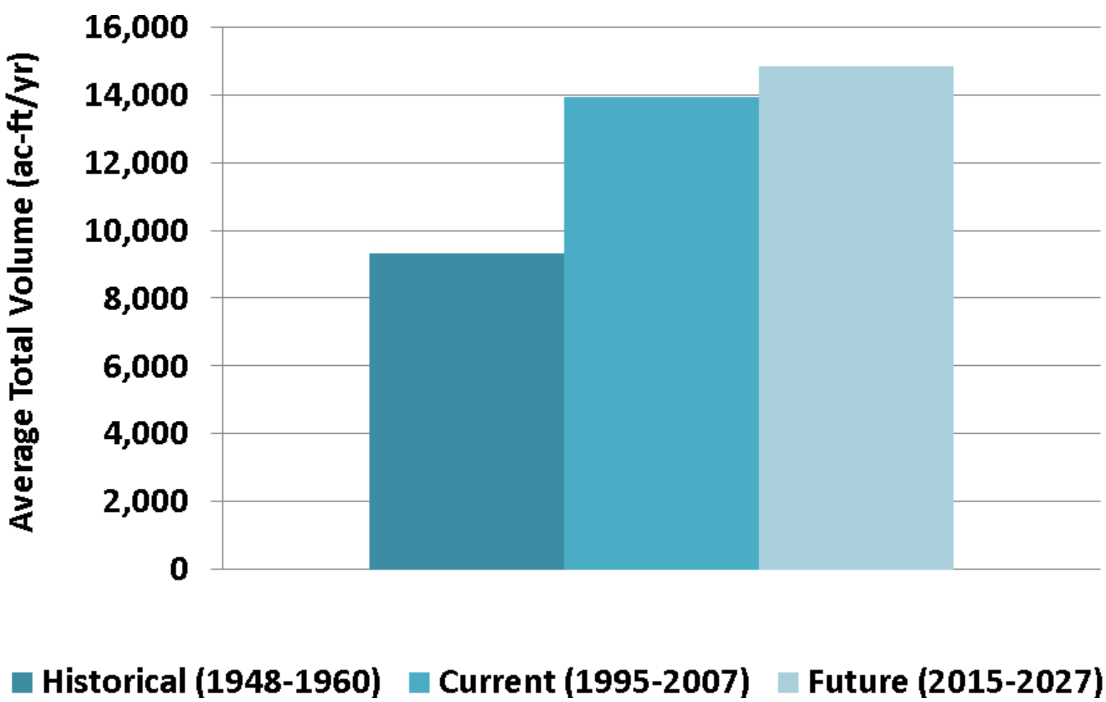

Figure 2-29 Historical, Current, and Future Average Annual Total Volume to Lemon Bay

Table 2-35 Change in Total Volume from Historical to Current Conditions

Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	22,276	29,751	7,475
2	6,966	12,346	5,380
3	6,217	9,514	3,296
4	9,104	13,630	4,526
5	5,917	9,841	3,924
6	5,063	7,801	2,738
7	11,123	14,903	3,780
8	7,524	11,386	3,863
9	17,381	23,333	5,953
10	8,099	13,383	5,284
11	13,221	20,514	7,293
12	6,224	10,602	4,378
13	2,129	4,283	2,154
Average	**9,326**	**13,945**	**4,619**

Table 2-36 Change in Total Volume from Current to Future Conditions

Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	29,751	31,759	2,009
2	12,346	13,591	1,246
3	9,514	10,039	525
4	13,630	14,683	1,053
5	9,841	10,576	736
6	7,801	8,300	499
7	14,903	15,664	761
8	11,386	11,971	585
9	23,333	24,383	1,050
10	13,383	14,171	788
11	20,514	21,679	1,165
12	10,602	11,300	698
13	4,283	4,511	228
Average	**13,945**	**14,818**	**872**

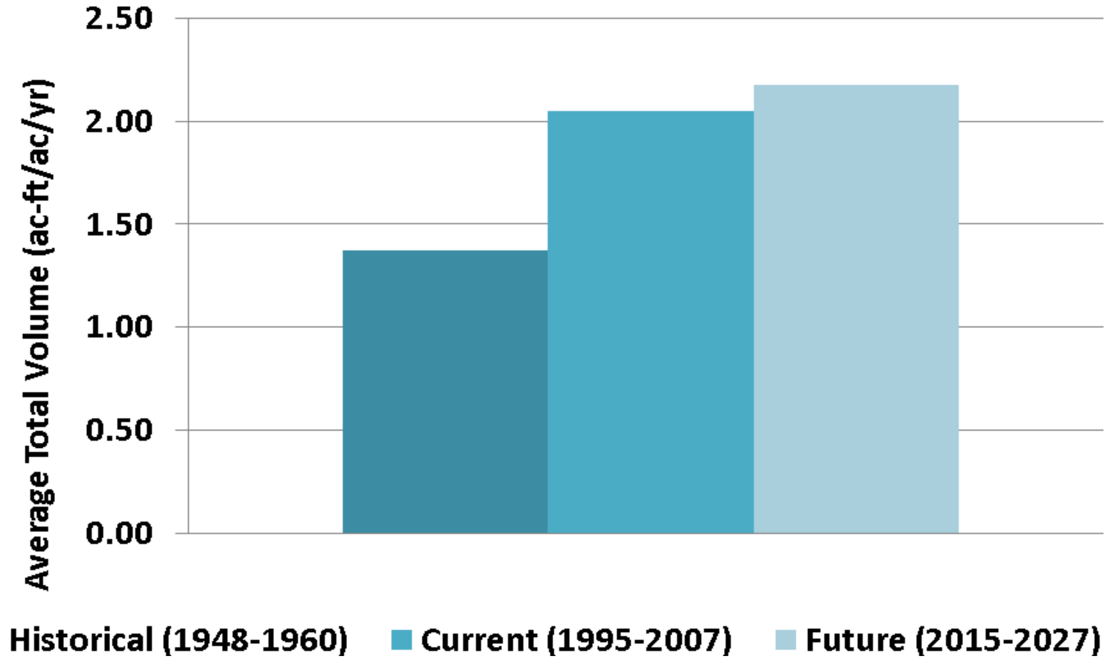

Figure 2-30 Normalized Historical, Current, and Future Average Annual Total Volume to Lemon Bay

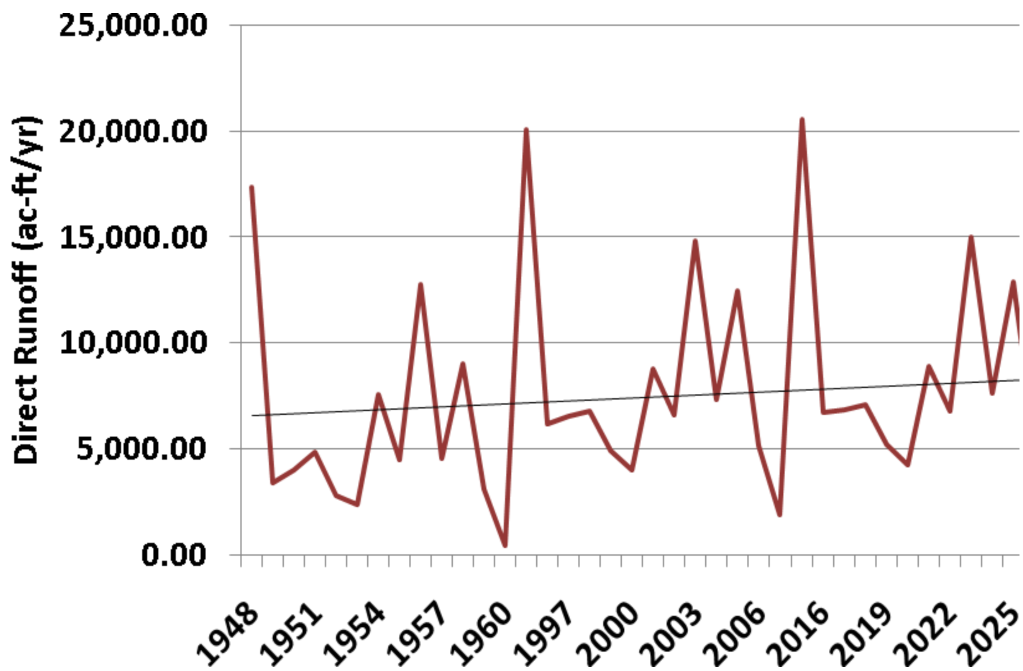

Figure 2-31 Trend in Direct Runoff from Historical through Future Time Series

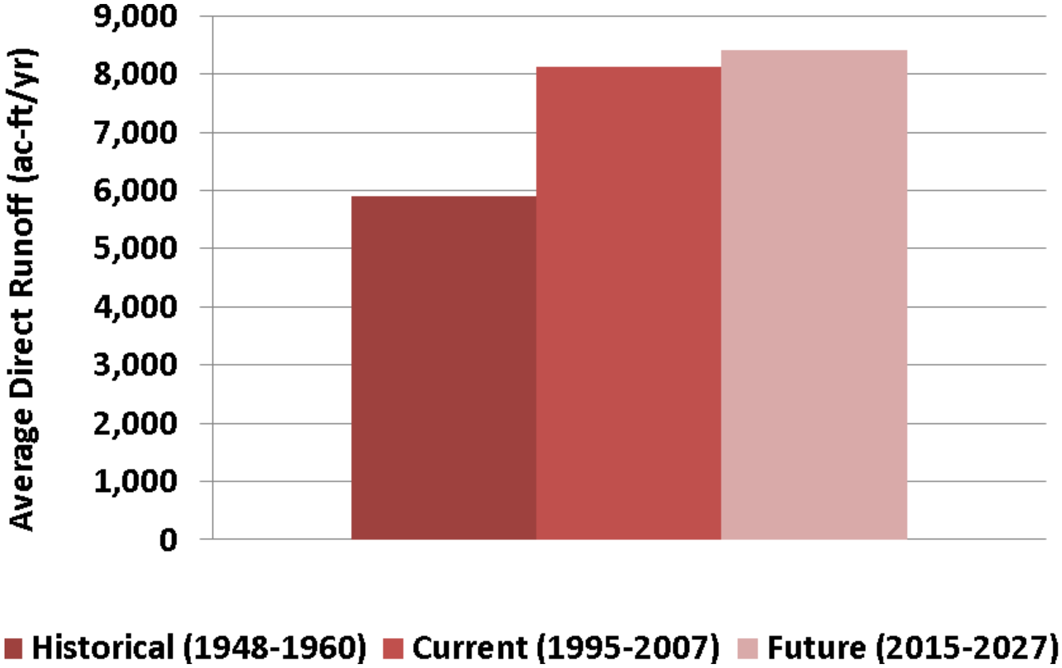

Figure 2-32 Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

Table 2-37 Change in Direct Runoff from Historical to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	17,323	20,039	2,716
2	3,419	6,209	2,790
3	4,033	6,520	2,487
4	4,873	6,818	1,945
5	2,797	4,906	2,108
6	2,406	3,999	1,593
7	7,572	8,777	1,205
8	4,493	6,586	2,093
9	12,744	14,788	2,044
10	4,543	7,354	2,810
11	9,010	12,459	3,449
12	3,088	5,183	2,095
13	433	1,916	1,483
Average	**5,903**	**8,119**	**2,217**

Table 2-38 Change in Direct Runoff from Current to Future Conditions			
Year	Current Direct Runoff (ac-ft) 1995-2007	Future Direct Runoff (ac-ft) 2015-2027	Direct Runoff Change (ac-ft) (future-current)
1	20,039	20,577	538
2	6,209	6,741	531
3	6,520	6,861	341
4	6,818	7,069	251
5	4,906	5,238	332
6	3,999	4,233	234
7	8,777	8,919	142
8	6,586	6,796	211
9	14,788	14,973	186
10	7,354	7,642	288
11	12,459	12,886	427
12	5,183	5,406	223
13	1,916	2,095	179
Average	**8,119**	**8,418**	**299**

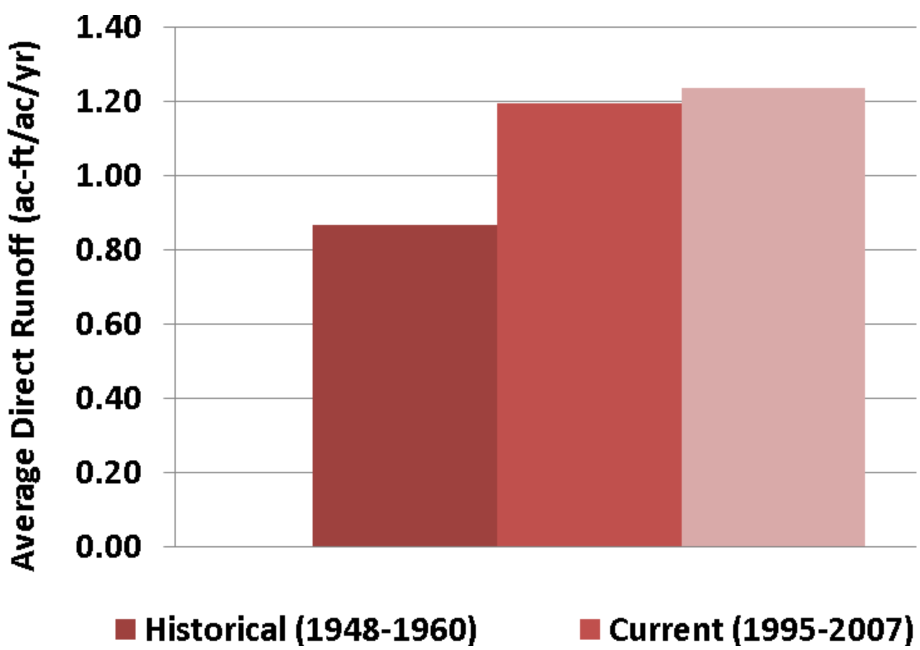

Figure 2-33 Normalized Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

3.0 WOODMERE CREEK BASIN

3.1 CURRENT CONDITIONS

Table 3-1 Monthly Rainfall for Woodmere Creek Basin (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	3.18	2.01	1.32	2.99	0.31	18.90	17.71	6.65	10.95	10.99	0.88	1.34	77.22
1996	1949	2016	3.67	1.42	4.13	1.60	3.94	3.34	3.68	6.34	3.65	5.61	0.16	0.54	38.08
1997	1950	2017	1.62	0.23	1.14	5.67	1.34	2.87	3.30	2.96	7.33	2.54	4.05	6.55	39.61
1998	1951	2018	4.41	5.16	4.15	0.18	1.74	2.32	5.58	4.47	7.44	0.47	4.12	0.72	40.75
1999	1952	2019	2.54	0.08	1.64	0.25	0.79	6.41	4.24	8.89	7.43	2.85	0.52	1.84	37.49
2000	1953	2020	1.17	0.50	0.58	2.25	0.83	5.66	4.30	7.67	6.17	0.00	0.87	0.74	30.73
2001	1954	2021	0.29	0.01	6.56	0.21	0.16	6.79	13.05	6.30	10.77	1.19	0.09	0.28	45.69
2002	1955	2022	0.48	4.13	0.25	1.47	2.86	4.85	3.92	12.02	4.07	0.75	4.45	5.03	44.28
2003	1956	2023	0.04	0.86	1.45	3.46	3.95	13.36	5.02	14.04	13.26	0.58	0.45	4.25	60.72
2004	1957	2024	1.32	4.26	0.83	3.95	1.23	5.86	5.71	5.60	4.26	3.44	2.63	2.92	42.00
2005	1958	2025	1.97	3.30	4.44	2.42	4.79	17.01	8.02	4.60	2.86	8.32	3.54	0.28	61.52
2006	1959	2026	0.36	2.80	0.24	0.06	1.78	5.23	10.14	6.28	5.32	1.30	0.33	2.37	36.21
2007	1960	2027	1.14	1.63	0.35	2.68	0.62	4.52	4.39	3.27	4.72	4.49	0.54	0.71	29.07
		Average	**1.71**	**2.03**	**2.08**	**2.09**	**1.87**	**7.47**	**6.85**	**6.85**	**6.79**	**3.27**	**1.74**	**2.12**	**44.87**

Table 3-2 Current Total Volume for Woodmere Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	168.5	102.7	95.8	86.9	47.6	1,217.2	1,421.7	584.2	1,012.9	981.6	233.8	155.1	6,107.9
1996	248.8	121.9	146.5	92.8	182.1	90.6	99.3	238.6	136.0	383.9	107.9	85.6	1,934.0
1997	88.3	49.7	59.7	149.3	43.4	62.9	56.9	48.2	271.7	81.5	198.6	381.6	1,492.0
1998	371.7	422.4	400.0	127.1	111.4	101.2	178.5	123.1	306.5	159.4	309.6	80.8	2,691.6
1999	107.2	44.7	56.2	34.2	34.2	106.3	86.8	289.0	446.1	272.8	135.5	147.3	1,760.2
2000	91.2	55.8	47.1	70.4	42.4	86.3	74.3	414.1	316.1	109.6	85.2	68.8	1,461.4
2001	52.3	40.8	268.5	34.6	29.9	134.3	626.9	555.0	849.7	225.2	129.6	95.9	3,042.7
2002	74.9	176.9	50.8	56.6	79.4	70.2	81.3	428.1	320.2	154.9	361.3	272.3	2,127.0
2003	127.4	86.2	78.8	180.8	156.3	676.2	286.2	1,140.8	1,256.9	248.6	145.5	275.4	4,658.9
2004	88.8	254.6	81.6	142.6	56.4	113.7	142.8	248.0	251.6	289.2	203.9	210.5	2,083.5
2005	164.0	250.6	275.7	94.0	209.0	984.5	710.6	273.2	207.0	612.3	261.4	132.9	4,175.2
2006	89.9	133.3	55.8	43.7	50.2	86.4	280.7	305.3	320.2	190.1	104.2	125.2	1,785.1
2007	76.9	68.7	44.5	83.3	34.7	78.8	70.0	52.2	88.6	144.2	71.9	54.2	868.0
Average	**134.6**	**139.1**	**127.8**	**92.0**	**82.8**	**293.0**	**316.6**	**361.5**	**444.9**	**296.4**	**180.6**	**160.4**	**2,629.8**

Table 3-3 Current Direct Runoff for Woodmere Creek Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	70.6	19.6	14.8	28.0	0.4	1,117.3	1,158.7	258.8	676.0	611.1	6.2	14.8	3,976.4
1996	106.2	22.7	65.6	21.7	126.2	45.5	54.9	161.0	54.9	232.9	0.3	4.3	896.3
1997	24.2	0.9	15.2	112.0	10.3	34.7	30.5	23.2	245.4	47.7	150.6	260.9	955.6
1998	184.2	200.7	210.8	0.1	15.8	28.8	116.1	59.9	185.3	1.4	206.2	4.8	1,214.2
1999	48.1	0.0	16.4	1.2	4.9	80.4	56.1	205.0	270.5	58.6	5.1	52.9	799.2
2000	20.6	2.6	1.1	32.2	8.7	57.0	46.1	360.4	200.6	0.0	7.0	5.8	742.1
2001	0.9	0.0	230.4	0.9	0.0	107.8	498.0	267.3	561.3	8.0	0.1	0.9	1,675.8
2002	1.7	121.5	1.3	16.1	44.1	39.2	49.7	361.8	88.2	4.8	262.0	140.4	1,130.5
2003	0.0	4.7	10.7	127.3	110.8	571.8	91.5	789.2	928.2	4.2	1.0	169.4	2,808.9
2004	11.9	192.7	15.3	91.6	13.6	77.9	92.9	125.9	88.7	139.1	97.4	128.9	1,076.0
2005	87.8	191.5	203.8	26.9	144.4	768.2	383.1	64.2	56.7	452.3	102.8	0.1	2,481.6
2006	1.2	68.3	0.9	0.0	12.6	54.1	220.1	154.5	117.9	34.6	1.5	46.1	711.9
2007	15.0	21.0	2.3	48.0	4.4	52.6	44.9	25.2	53.9	85.1	4.9	4.4	361.7
Average	**44.0**	**65.1**	**60.6**	**38.9**	**38.2**	**233.5**	**218.7**	**219.7**	**271.4**	**129.2**	**65.0**	**64.1**	**1,448.5**

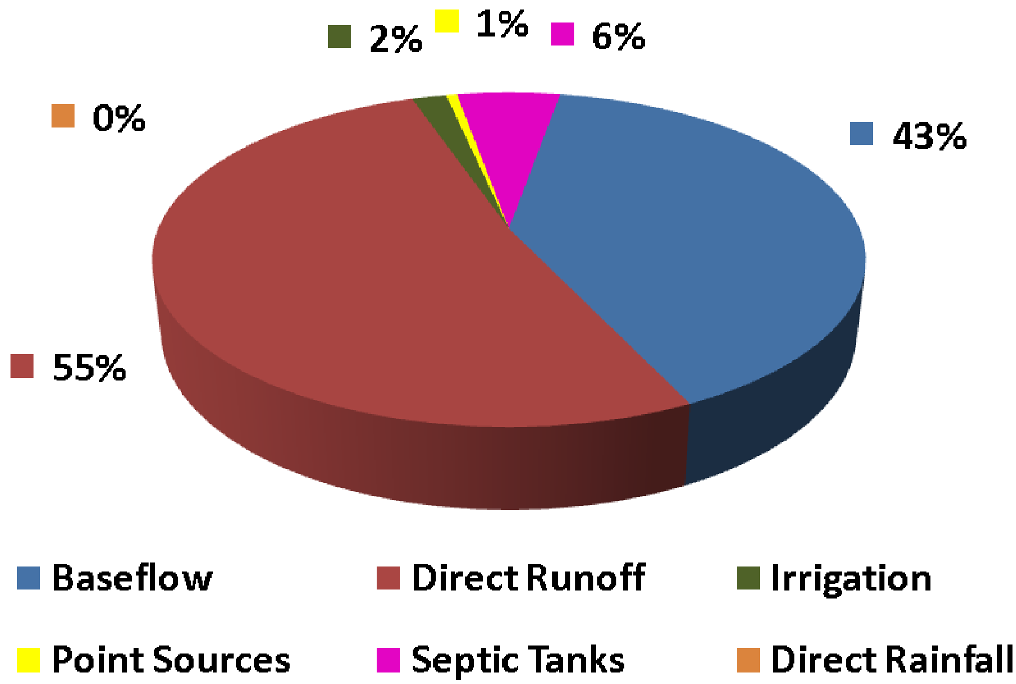

Figure 3-1 Woodmere Creek Basin Current Total Volume Water Budget

Table 3-4 Summary of Annual Current Total Volume Inputs for Woodmere Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	1,966.4	3,976.4	39.9	14.6	110.6	0.0
1996	871.1	896.3	39.9	14.6	112.2	0.0
1997	367.8	955.6	39.9	14.6	114.1	0.0
1998	1,306.3	1,214.2	40.7	14.6	115.8	0.0
1999	793.8	799.2	40.7	9.3	117.4	0.0
2000	552.9	742.1	40.7	6.8	118.9	0.0
2001	1,199.3	1,675.8	40.7	6.7	120.3	0.0
2002	821.0	1,130.5	40.7	12.0	122.8	0.0
2003	1,660.8	2,808.9	40.7	24.1	124.5	0.0
2004	824.8	1,076.0	40.7	16.2	125.9	0.0
2005	1,512.8	2,481.6	40.7	12.8	127.3	0.0
2006	893.4	711.9	40.7	11.9	127.3	0.0
2007	324.2	361.7	40.7	14.2	127.3	0.0
Average	**1,114.2**	**1,520.0**	**40.5**	**13.3**	**120.3**	**0.0**

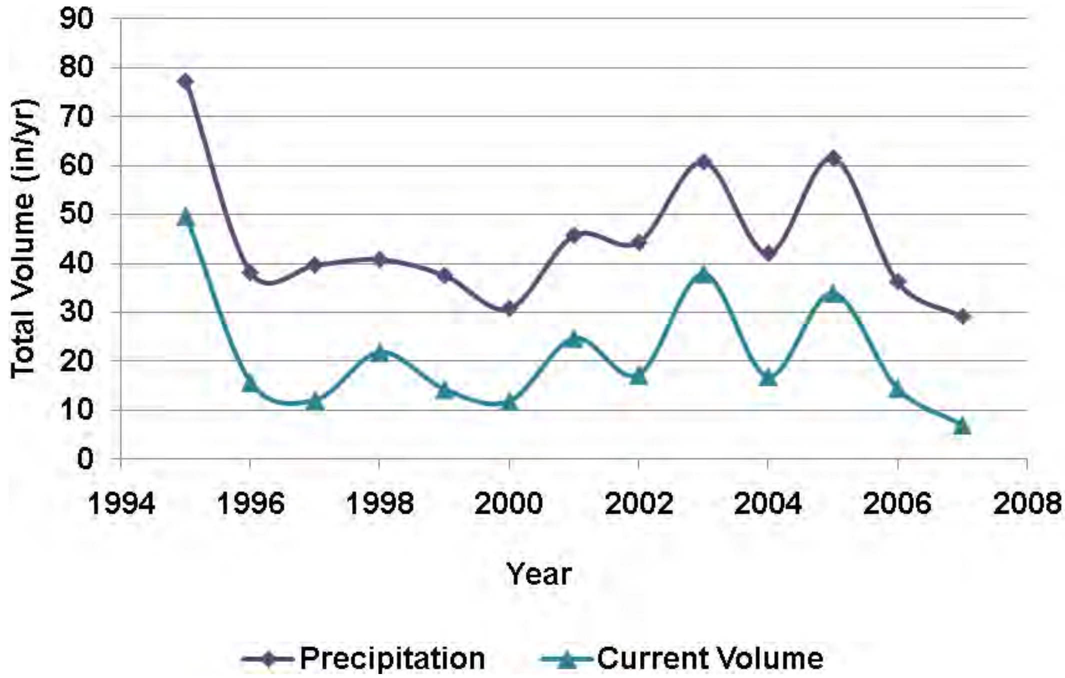

Figure 3-2 Annual Variability of Precipitation and Total Volume for Woodmere Creek Basin

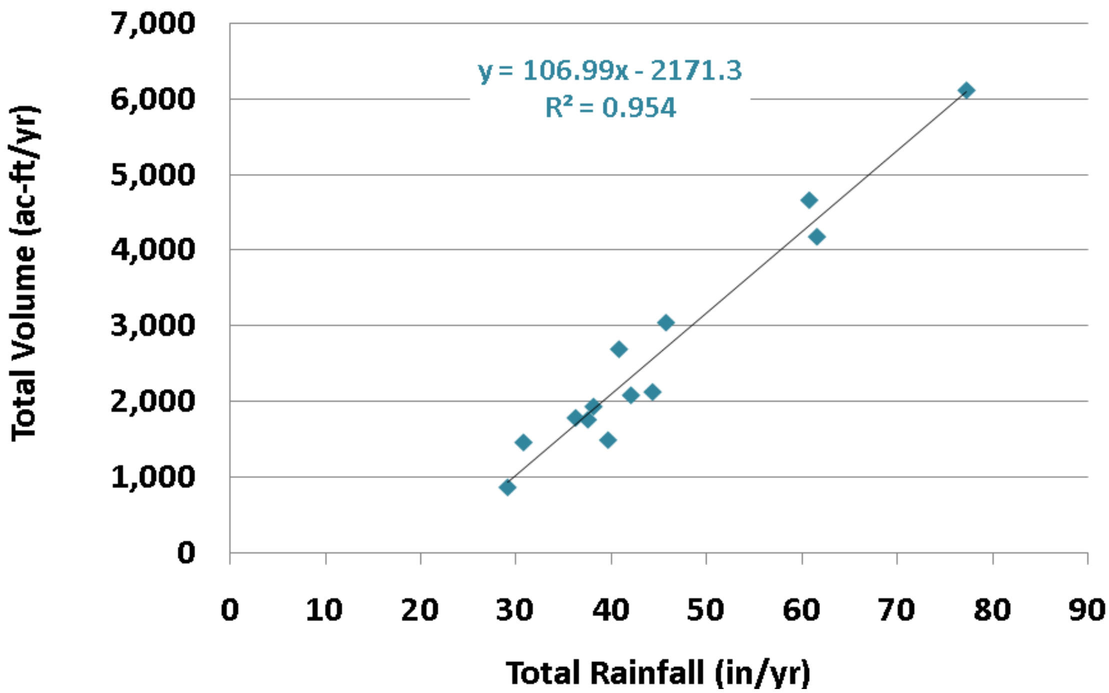

Figure 3-3 Correlation of Annual Total Volume to Rainfall for Woodmere Creek Basin

Table 3-5 Annual Total Volume to Rainfall Coefficients for Woodmere Creek Basin

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1995	49.70	77.22	0.64
1996	15.74	38.08	0.41
1997	12.14	39.61	0.31
1998	21.90	40.75	0.54
1999	14.32	37.49	0.38
2000	11.89	30.73	0.39
2001	24.76	45.69	0.54
2002	17.31	44.28	0.39
2003	37.91	60.72	0.62
2004	16.95	42.00	0.40
2005	33.97	61.52	0.55
2006	14.53	36.21	0.40
2007	7.06	29.07	0.24
Average	**21.40**	**44.87**	**0.45**

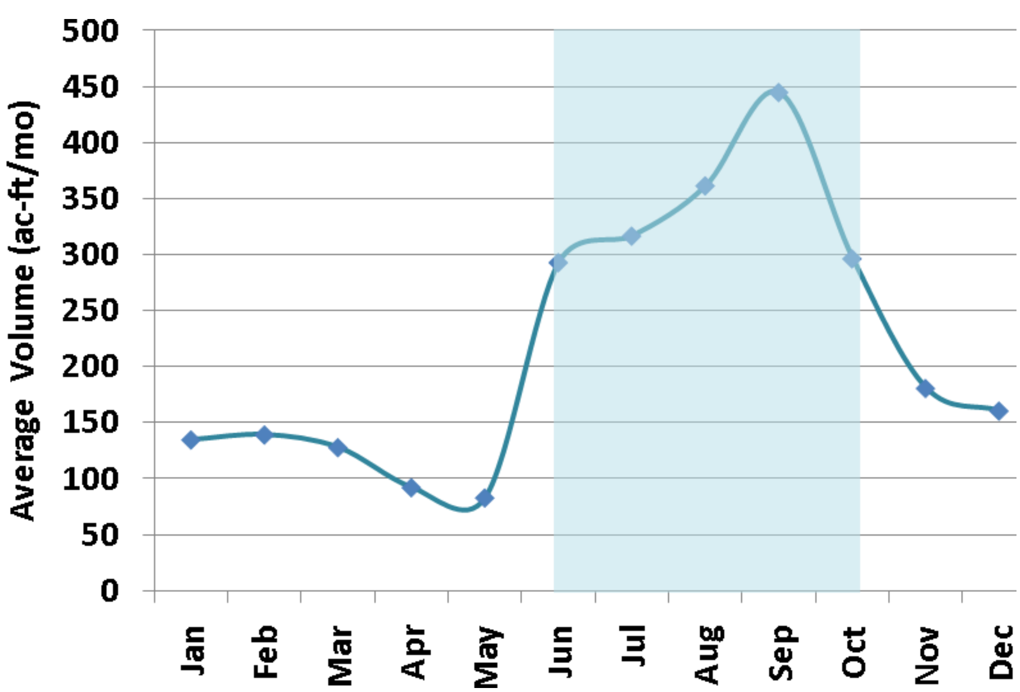

Figure 3-4 Variability of Average Monthly Total Volume in Woodmere Creek Basin

Table 3-6 Average Monthly Rainfall to Total Volume Coefficients for Woodmere Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.10	1.71	0.64
Feb	1.13	2.03	0.56
Mar	1.04	2.08	0.50
Apr	0.75	2.09	0.36
May	0.67	1.87	0.36
Jun	2.38	7.47	0.32
Jul	2.58	6.85	0.38
Aug	2.94	6.85	0.43
Sep	3.62	6.79	0.53
Oct	2.41	3.27	0.74
Nov	1.47	1.74	0.84
Dec	1.31	2.12	0.62

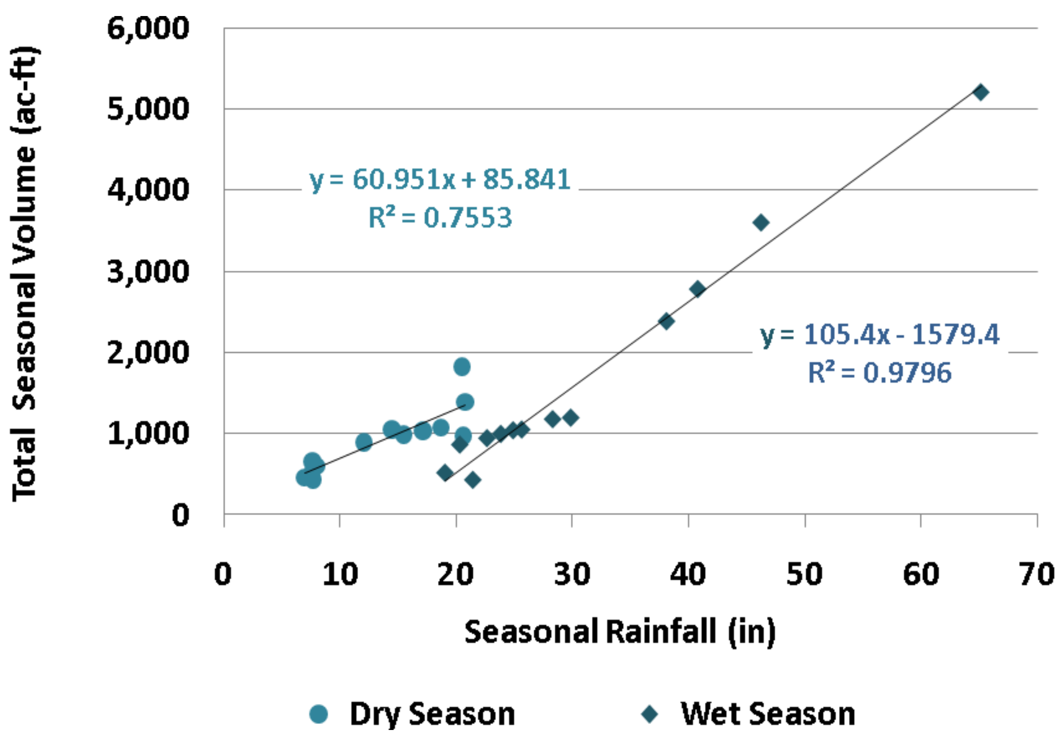

Figure 3-5 Correlation of Seasonal Total Volume to Rainfall for Woodmere Creek Basin

Table 3-7 Wet Season Total Volume to Rainfall Coefficients for Woodmere Creek Basin

	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	42.46	65.19	0.65
1996	7.72	22.62	0.34
1997	4.24	19.00	0.22
1998	7.07	20.27	0.35
1999	9.77	29.83	0.33
2000	8.14	23.80	0.34
2001	19.46	38.09	0.51
2002	8.58	25.61	0.34
2003	29.36	46.25	0.63
2004	8.50	24.87	0.34
2005	22.68	40.79	0.56
2006	9.62	28.28	0.34
2007	3.53	21.40	0.16
Average	**13.93**	**31.23**	**0.39**

Table 3-8 Dry Season Total Volume to Rainfall Coefficients for Woodmere Creek Basin

	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	7.25	12.03	0.60
1996	8.02	15.47	0.52
1997	7.90	20.61	0.38
1998	14.83	20.48	0.72
1999	4.55	7.66	0.59
2000	3.75	6.93	0.54
2001	5.30	7.60	0.70
2002	8.73	18.67	0.47
2003	8.55	14.47	0.59
2004	8.45	17.13	0.49
2005	11.29	20.72	0.54
2006	4.90	7.93	0.62
2007	3.53	7.67	0.46
Average	**7.47**	**13.64**	**0.56**

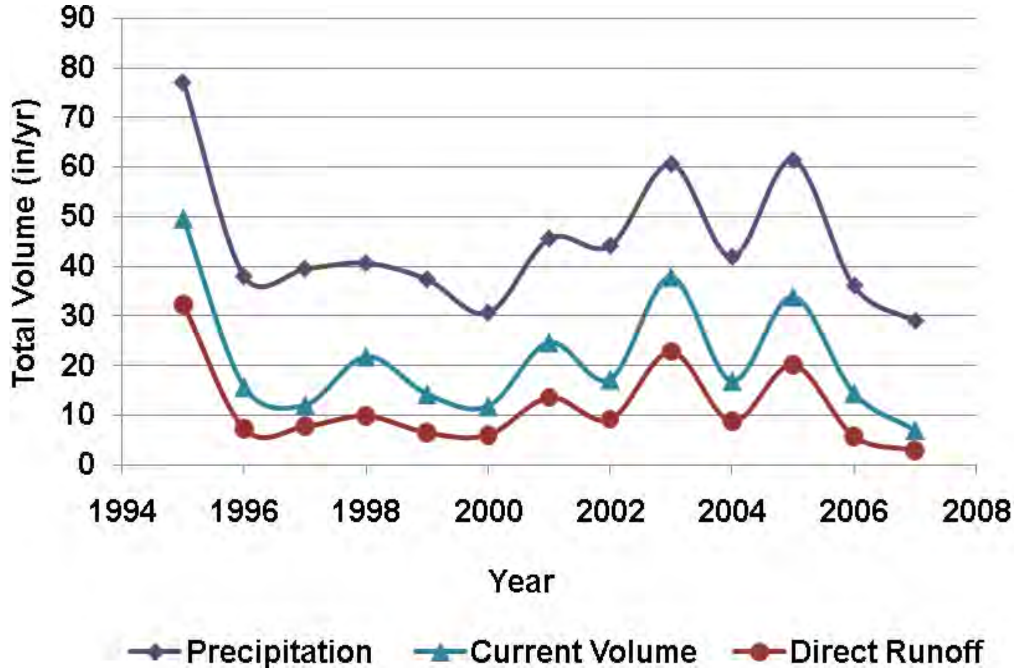

Figure 3-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Woodmere Creek Basin

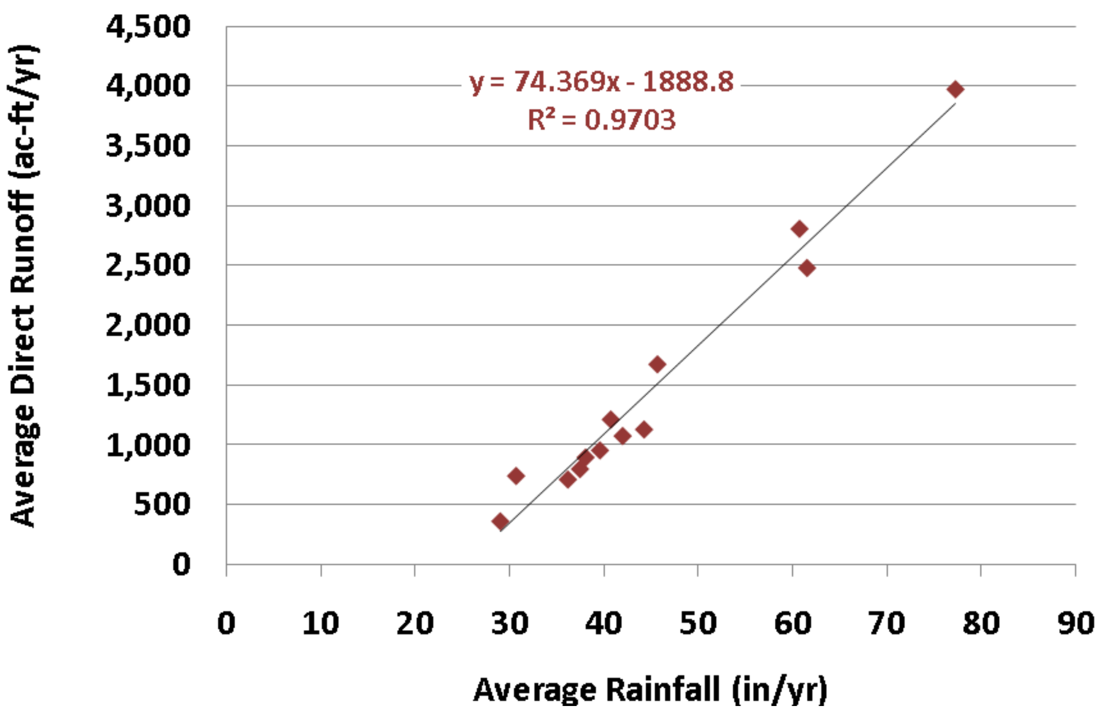

Figure 3-7 Correlation of Average Annual Direct Runoff to Rainfall

Table 3-9 Annual Direct Runoff to Rainfall Coefficients for Woodmere Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	32.36	77.22	0.42
1996	7.29	38.08	0.19
1997	7.78	39.61	0.20
1998	9.88	40.75	0.24
1999	6.50	37.49	0.17
2000	6.04	30.73	0.20
2001	13.64	45.69	0.30
2002	9.20	44.28	0.21
2003	22.86	60.72	0.38
2004	8.76	42.00	0.21
2005	20.19	61.52	0.33
2006	5.79	36.21	0.16
2007	2.94	29.07	0.10
Average	**11.79**	**44.87**	**0.24**

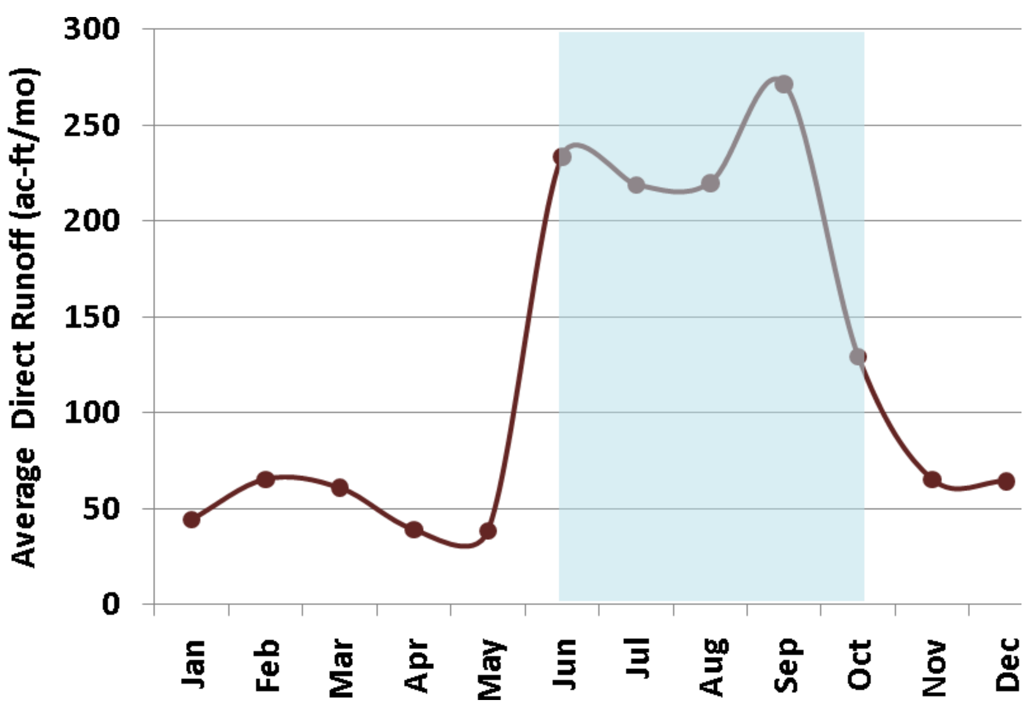

Figure 3-8 Variability of Average Monthly Direct Runoff to Woodmere Creek Basin

Table 3-10 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.36	1.71	0.21
Feb	0.53	2.03	0.26
Mar	0.49	2.08	0.24
Apr	0.32	2.09	0.15
May	0.31	1.87	0.17
Jun	1.90	7.47	0.25
Jul	1.78	6.85	0.26
Aug	1.79	6.85	0.26
Sep	2.21	6.79	0.33
Oct	1.05	3.27	0.32
Nov	0.53	1.74	0.30
Dec	0.52	2.12	0.25

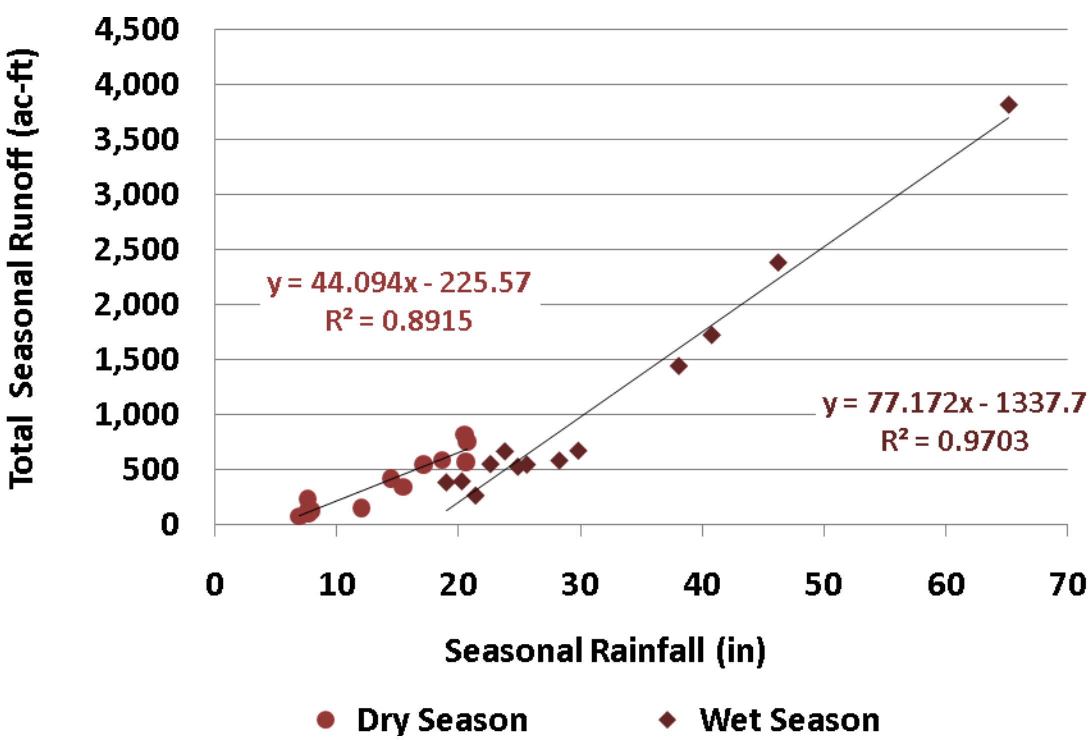

Figure 3-9 Correlation of Seasonal Direct Runoff to Rainfall

Table 3-11 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	31.10	65.19	0.48
1996	4.47	22.62	0.20
1997	3.10	19.00	0.16
1998	3.19	20.27	0.16
1999	5.46	29.83	0.18
2000	5.40	23.80	0.23
2001	11.74	38.09	0.31
2002	4.42	25.61	0.17
2003	19.41	46.25	0.42
2004	4.27	24.87	0.17
2005	14.03	40.79	0.34
2006	4.73	28.28	0.17
2007	2.13	21.40	0.10
Average	**8.73**	**31.23**	**0.24**

Table 3-12 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	1.26	12.03	0.10
1996	2.82	15.47	0.18
1997	4.67	20.61	0.23
1998	6.69	20.48	0.33
1999	1.05	7.66	0.14
2000	0.63	6.93	0.09
2001	1.90	7.60	0.25
2002	4.78	18.67	0.26
2003	3.45	14.47	0.24
2004	4.49	17.13	0.26
2005	6.16	20.72	0.30
2006	1.06	7.93	0.13
2007	0.81	7.67	0.11
Average	**3.06**	**13.64**	**0.20**

3.2 HISTORICAL CONDITIONS

Table 3-13 Historical Total Volume for Woodmere Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	84.2	37.4	28.7	24.0	21.2	1,076.7	1,272.1	317.5	693.4	716.4	87.1	57.6	4,416.4
1949	150.5	51.7	63.1	40.2	143.4	39.5	33.7	102.7	55.5	231.7	45.8	40.9	998.8
1950	53.1	27.3	35.4	110.0	21.5	37.1	23.4	16.4	150.1	22.6	152.2	264.6	913.6
1951	249.9	328.9	225.6	52.0	51.8	58.0	143.2	64.1	201.4	60.8	201.6	41.5	1,679.0
1952	61.3	27.7	30.1	22.8	20.7	48.6	62.1	178.7	276.1	102.6	51.8	72.7	955.3
1953	51.7	31.1	29.0	45.1	22.7	33.6	43.3	348.5	208.4	51.6	43.1	37.9	945.9
1954	32.6	25.8	187.6	25.1	22.6	112.7	649.7	396.6	616.2	68.0	48.5	43.0	2,228.4
1955	36.9	158.1	27.9	26.0	34.9	20.3	45.1	323.7	162.5	56.0	252.2	196.1	1,339.6
1956	66.2	47.3	45.5	174.6	146.7	613.5	132.7	868.8	994.3	77.8	49.6	191.9	3,408.9
1957	40.2	154.7	40.8	101.7	38.8	46.1	72.9	115.8	128.9	135.9	102.0	149.7	1,127.5
1958	91.4	170.1	186.5	35.8	110.9	817.1	444.6	73.1	65.5	431.8	113.9	49.9	2,590.6
1959	40.9	67.0	29.9	25.3	22.9	29.5	227.5	166.4	128.3	69.5	44.5	72.3	923.9
1960	47.3	32.0	24.6	40.2	18.8	24.7	21.4	14.3	23.2	74.6	19.7	16.8	357.6
Average	**77.4**	**89.2**	**73.4**	**55.6**	**52.1**	**227.5**	**244.0**	**229.7**	**284.9**	**161.5**	**93.2**	**95.0**	**1,683.5**

Table 3-14 Historical Direct Runoff for Woodmere Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	43.81	6.68	0.37	0.60	0.00	1,020.62	1,171.03	217.77	584.27	594.16	3.37	1.49	3,644.17
1949	90.87	2.72	19.10	4.22	111.31	12.54	9.60	77.01	32.15	180.31	0.00	0.25	540.06
1950	18.17	0.00	8.94	87.59	0.50	19.30	7.26	2.44	137.82	9.52	137.50	216.63	645.67
1951	167.14	238.40	151.78	0.00	5.87	19.84	105.51	28.79	153.13	0.00	153.90	0.00	1,024.37
1952	25.77	0.00	3.23	0.00	0.01	31.03	41.72	134.26	211.62	32.21	0.00	27.14	506.99
1953	13.15	0.00	0.00	20.67	0.63	14.82	26.00	322.82	160.55	0.00	0.55	0.08	559.28
1954	0.00	0.00	162.24	0.00	0.00	92.92	571.39	296.60	527.50	0.11	0.00	0.00	1,650.75
1955	0.00	128.99	0.00	2.51	13.66	2.38	28.49	300.17	78.55	0.14	206.75	131.46	893.10
1956	0.00	0.00	0.54	137.09	113.08	557.98	61.15	756.73	890.55	0.01	0.00	145.58	2,662.72
1957	0.09	121.65	2.68	70.19	10.73	22.36	51.07	78.81	69.69	85.10	59.50	111.75	683.60
1958	54.60	140.22	151.76	2.61	81.24	740.56	350.36	16.67	21.17	383.28	53.57	0.09	1,996.13
1959	0.00	35.52	0.00	0.00	0.03	10.13	195.93	106.83	66.54	13.80	0.00	32.63	461.40
1960	13.63	6.23	0.00	19.38	0.00	8.67	6.86	1.71	12.03	59.30	0.63	0.00	128.43
Average	**32.86**	**52.34**	**38.51**	**26.53**	**25.93**	**196.40**	**202.03**	**180.05**	**226.58**	**104.46**	**47.37**	**51.32**	**1,184.36**

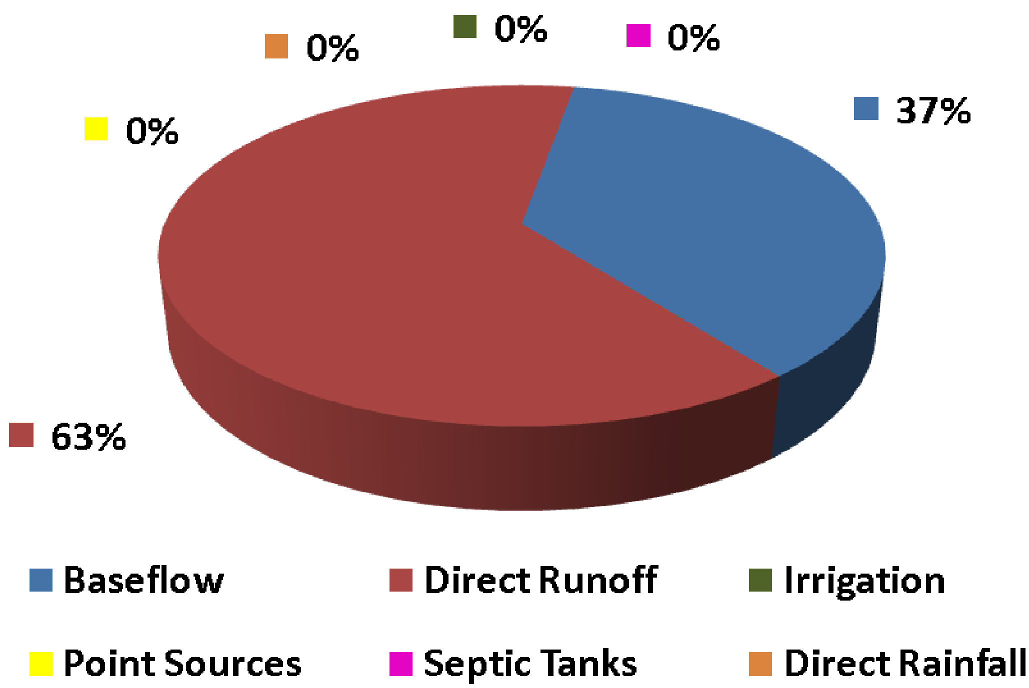

Figure 3-10 Woodmere Creek Basin Historical Total Volume Water Budget

Table 3-15 Summary of Annual Historical Total Volume Inputs for Woodmere Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	772.3	3,644.2	0.0	0.0	0.0	0.0
1949	458.7	540.1	0.0	0.0	0.0	0.0
1950	268.0	645.7	0.0	0.0	0.0	0.0
1951	654.6	1,024.4	0.0	0.0	0.0	0.0
1952	448.3	507.0	0.0	0.0	0.0	0.0
1953	386.7	559.3	0.0	0.0	0.0	0.0
1954	577.6	1,650.8	0.0	0.0	0.0	0.0
1955	446.5	893.1	0.0	0.0	0.0	0.0
1956	746.2	2,662.7	0.0	0.0	0.0	0.0
1957	443.9	683.6	0.0	0.0	0.0	0.0
1958	594.4	1,996.1	0.0	0.0	0.0	0.0
1959	462.5	461.4	0.0	0.0	0.0	0.0
1960	229.2	128.4	0.0	0.0	0.0	0.0
Average	**499.1**	**1,184.4**	**0.0**	**0.0**	**0.0**	**0.0**

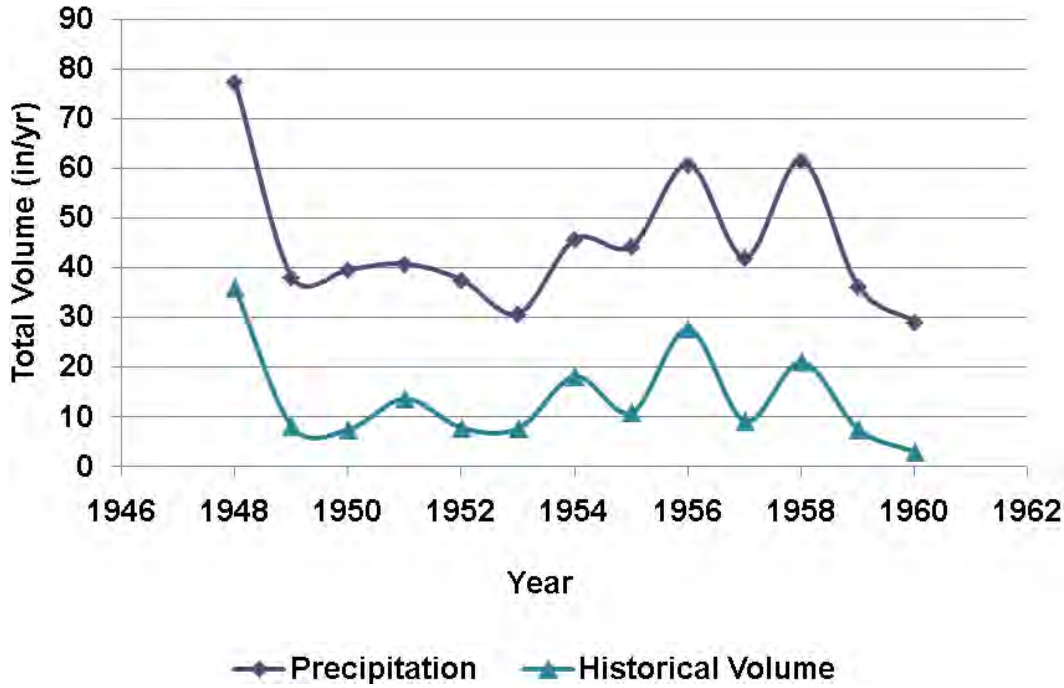

Figure 3-11 Annual Historical Variability of Precipitation and Total Volume for Woodmere Creek Basin

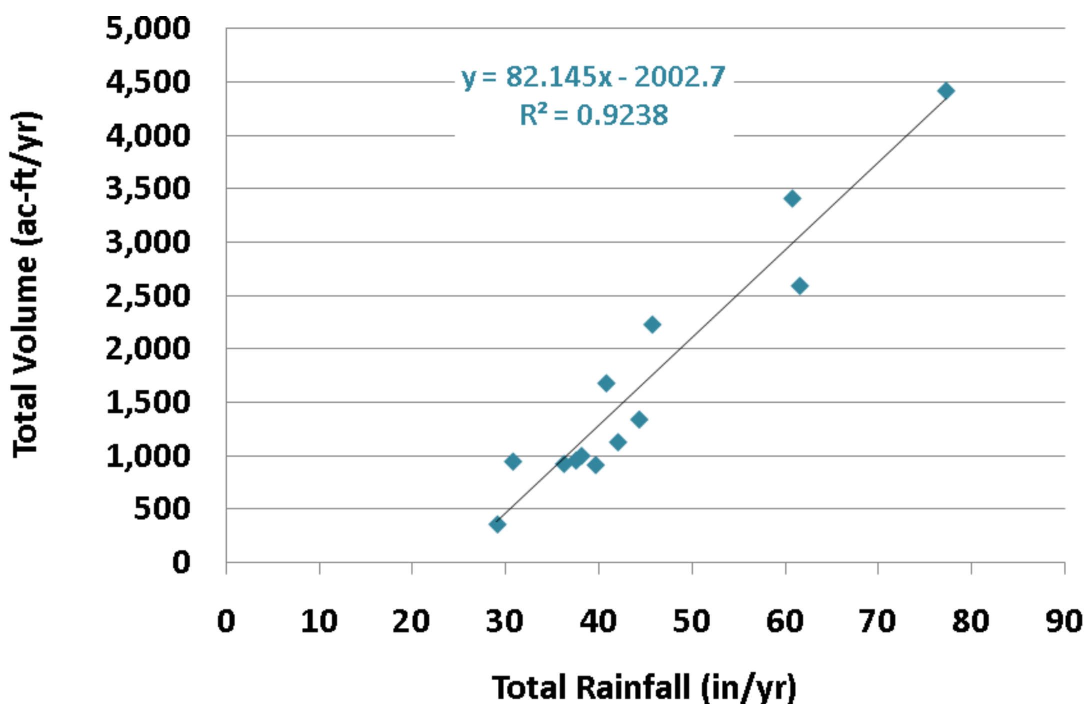

Figure 3-12 Correlation of Annual Total Volume to Rainfall for Woodmere Creek Basin

Table 3-16 Annual Total Volume to Rainfall Coefficients for Woodmere Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	35.94	77.22	0.47
1949	8.13	38.08	0.21
1950	7.43	39.61	0.19
1951	13.66	40.75	0.34
1952	7.77	37.49	0.21
1953	7.70	30.73	0.25
1954	18.13	45.69	0.40
1955	10.90	44.28	0.25
1956	27.74	60.72	0.46
1957	9.17	42.00	0.22
1958	21.08	61.52	0.34
1959	7.52	36.21	0.21
1960	2.91	29.07	0.10
Average	**13.70**	**44.87**	**0.28**

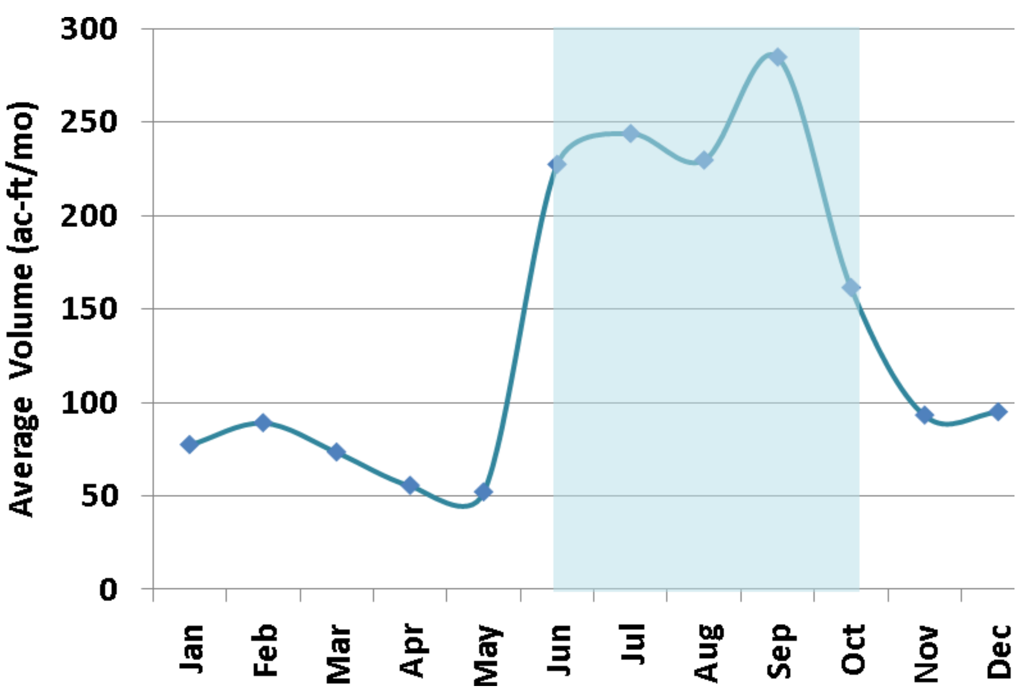

Figure 3-13 Variability of Average Monthly Total Volume in Woodmere Creek Basin

Table 3-17 Average Monthly Rainfall to Total Volume Coefficients for Woodmere Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.63	1.71	0.37
Feb	0.73	2.03	0.36
Mar	0.60	2.08	0.29
Apr	0.45	2.09	0.22
May	0.42	1.87	0.23
Jun	1.85	7.47	0.25
Jul	1.99	6.85	0.29
Aug	1.87	6.85	0.27
Sep	2.32	6.79	0.34
Oct	1.31	3.27	0.40
Nov	0.76	1.74	0.44
Dec	0.77	2.12	0.36

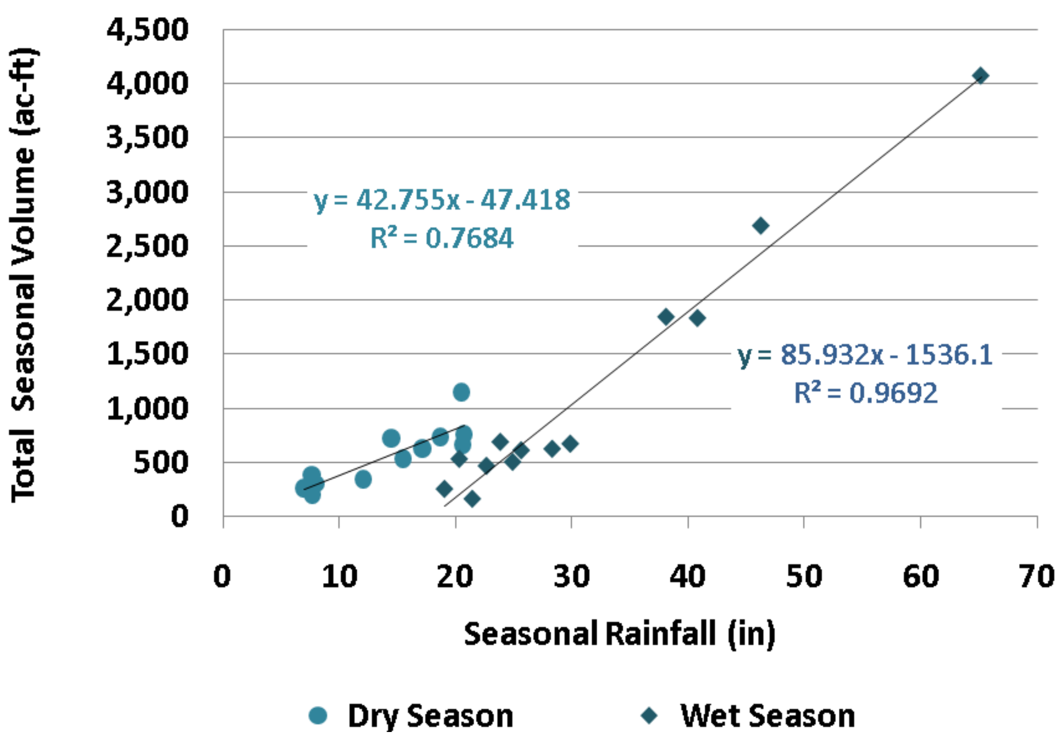

Figure 3-14 Correlation of Seasonal Total Volume to Rainfall for Woodmere Creek Basin

Table 3-18 Wet Season Total Volume to Rainfall Coefficients for Woodmere Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1948	33.17	65.19	0.51
1949	3.77	22.62	0.17
1950	2.03	19.00	0.11
1951	4.29	20.27	0.21
1952	5.44	29.83	0.18
1953	5.58	23.80	0.23
1954	15.00	38.09	0.39
1955	4.94	25.61	0.19
1956	21.87	46.25	0.47
1957	4.06	24.87	0.16
1958	14.91	40.79	0.37
1959	5.05	28.28	0.18
1960	1.29	21.40	0.06
Average	**9.34**	**31.23**	**0.25**

Table 3-19 Dry Season Total Volume to Rainfall Coefficients for Woodmere Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1948	2.77	12.03	0.23
1949	4.36	15.47	0.28
1950	5.40	20.61	0.26
1951	9.37	20.48	0.46
1952	2.34	7.66	0.31
1953	2.12	6.93	0.31
1954	3.13	7.60	0.41
1955	5.96	18.67	0.32
1956	5.87	14.47	0.41
1957	5.11	17.13	0.30
1958	6.17	20.72	0.30
1959	2.46	7.93	0.31
1960	1.62	7.67	0.21
Average	**4.36**	**13.64**	**0.32**

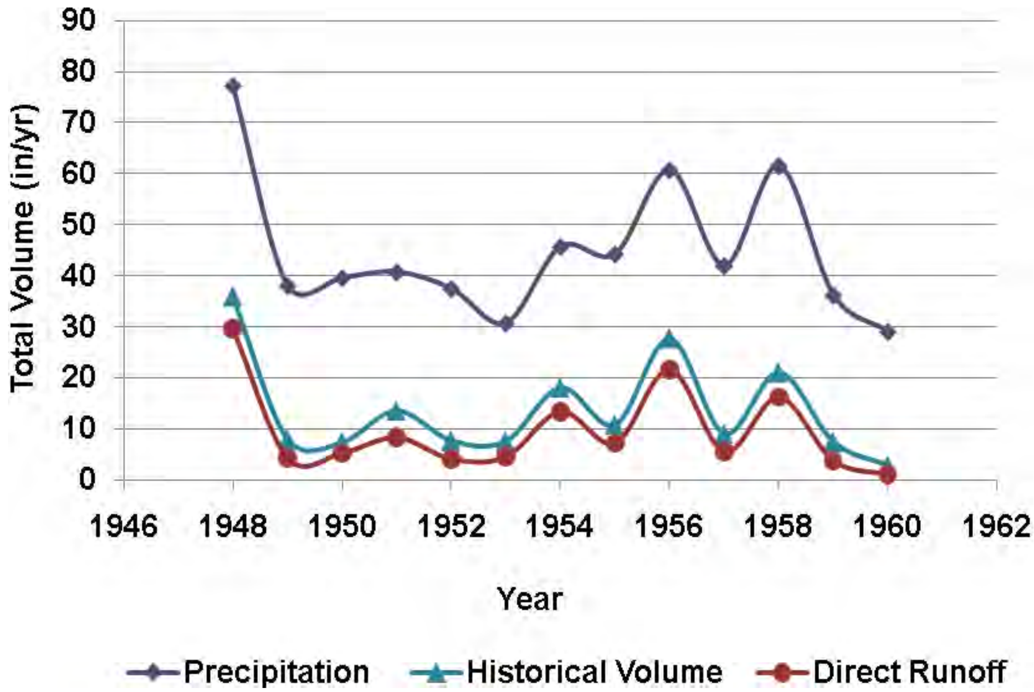

Figure 3-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Woodmere Creek Basin

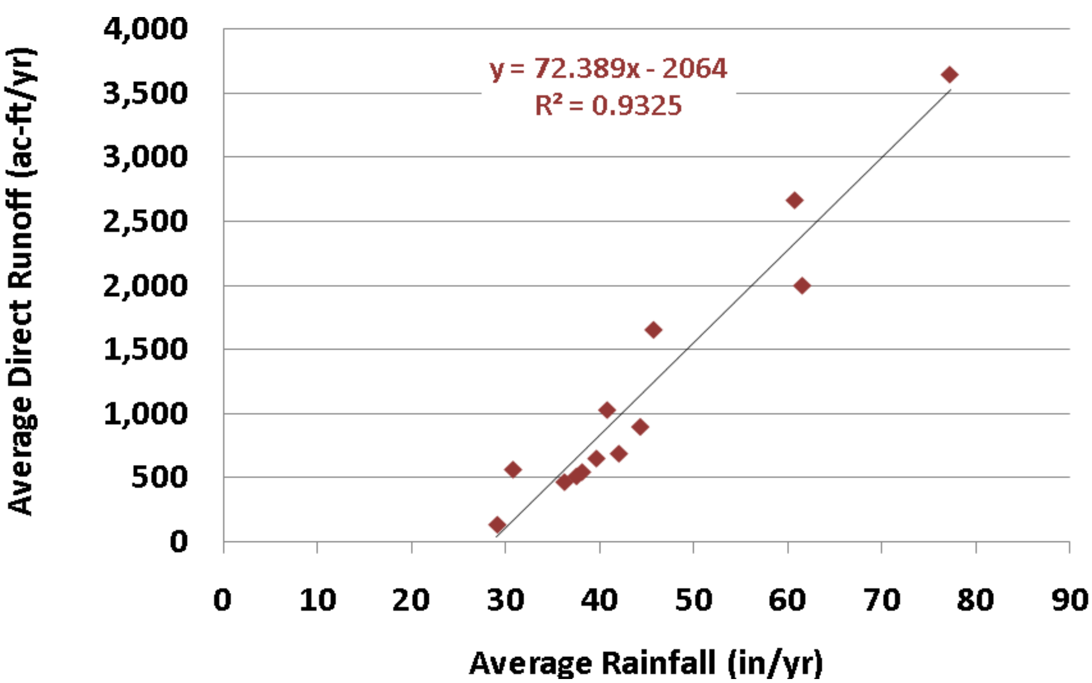

Figure 3-16 Correlation of Average Annual Direct Runoff to Rainfall

Table 3-20 Annual Direct Runoff to Rainfall Coefficients for Woodmere Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	29.65	77.22	0.38
1949	4.39	38.08	0.12
1950	5.25	39.61	0.13
1951	8.34	40.75	0.20
1952	4.13	37.49	0.11
1953	4.55	30.73	0.15
1954	13.43	45.69	0.29
1955	7.27	44.28	0.16
1956	21.67	60.72	0.36
1957	5.56	42.00	0.13
1958	16.24	61.52	0.26
1959	3.75	36.21	0.10
1960	1.05	29.07	0.04
Average	**9.64**	**44.87**	**0.19**

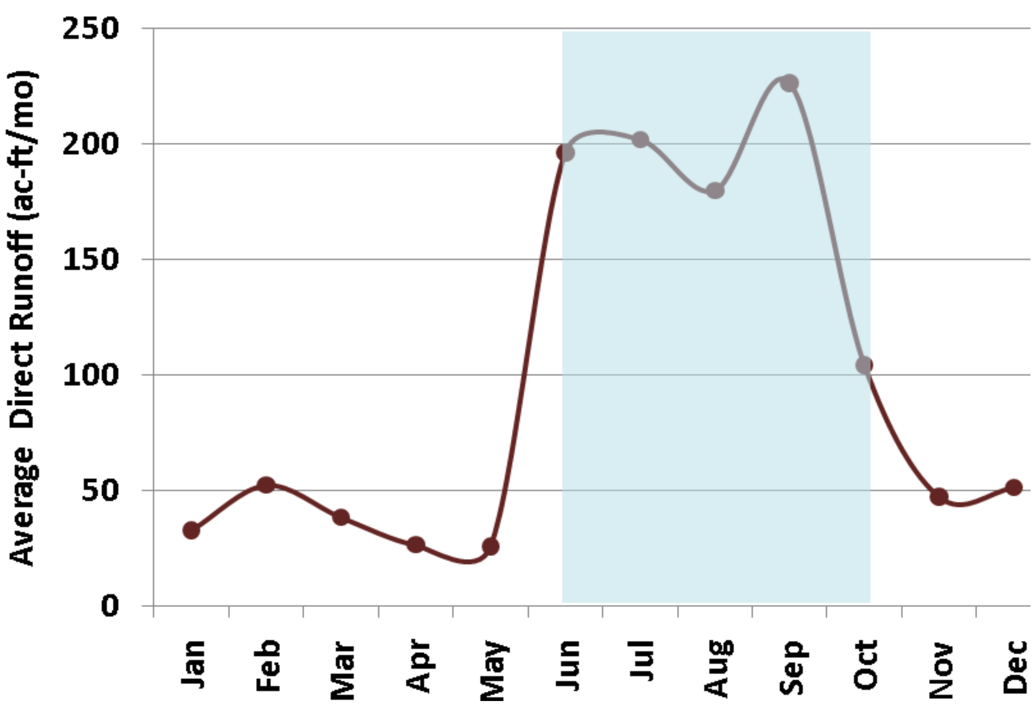

Figure 3-17 Variability of Average Monthly Direct Runoff to Woodmere Creek Basin

Table 3-21 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.27	1.71	0.16
Feb	0.43	2.03	0.21
Mar	0.31	2.08	0.15
Apr	0.22	2.09	0.10
May	0.21	1.87	0.11
Jun	1.60	7.47	0.21
Jul	1.64	6.85	0.24
Aug	1.47	6.85	0.21
Sep	1.84	6.79	0.27
Oct	0.85	3.27	0.26
Nov	0.39	1.74	0.22
Dec	0.42	2.12	0.20

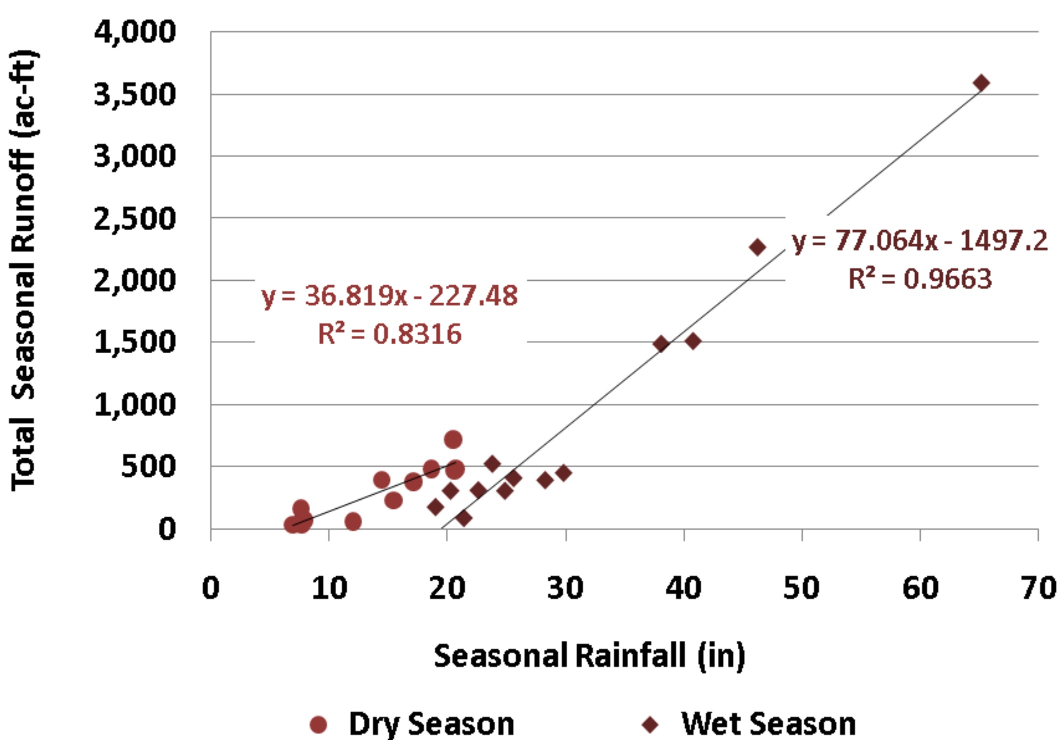

Figure 3-18 Correlation of Seasonal Direct Runoff to Rainfall

Table 3-22 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	29.20	65.19	0.45
1949	2.54	22.62	0.11
1950	1.44	19.00	0.08
1951	2.50	20.27	0.12
1952	3.67	29.83	0.12
1953	4.27	23.80	0.18
1954	12.11	38.09	0.32
1955	3.33	25.61	0.13
1956	18.44	46.25	0.40
1957	2.50	24.87	0.10
1958	12.30	40.79	0.30
1959	3.20	28.28	0.11
1960	0.72	21.40	0.03
Average	**7.40**	**31.23**	**0.19**

Table 3-23 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.46	12.03	0.04
1949	1.86	15.47	0.12
1950	3.82	20.61	0.19
1951	5.84	20.48	0.28
1952	0.46	7.66	0.06
1953	0.29	6.93	0.04
1954	1.32	7.60	0.17
1955	3.93	18.67	0.21
1956	3.22	14.47	0.22
1957	3.06	17.13	0.18
1958	3.94	20.72	0.19
1959	0.55	7.93	0.07
1960	0.32	7.67	0.04
Average	**2.24**	**13.64**	**0.14**

3.3 FUTURE CONDITIONS

Table 3-24 Future Total Volume for Woodmere Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	187.7	116.5	109.0	98.6	52.2	1,261.7	1,469.2	647.9	1,097.0	1,053.3	266.9	175.6	6,535.5
2016	275.9	135.0	161.6	101.3	183.1	98.5	110.5	268.8	155.4	420.3	120.7	93.7	2,124.9
2017	93.7	53.3	63.2	152.7	46.3	68.5	62.4	52.9	290.0	91.7	212.4	415.0	1,602.2
2018	397.6	446.5	435.0	142.1	122.1	107.5	186.2	134.6	332.2	177.6	331.1	86.8	2,899.4
2019	113.3	46.2	59.1	34.6	34.8	117.2	91.4	313.8	486.1	308.0	151.3	160.5	1,916.4
2020	96.5	58.9	48.9	72.4	44.2	94.2	77.6	423.7	344.0	119.4	91.5	72.8	1,544.3
2021	54.1	41.6	286.3	34.1	28.9	139.6	634.4	587.8	910.0	258.0	145.5	105.4	3,225.7
2022	80.9	177.0	53.4	60.4	86.6	77.0	85.8	455.6	353.4	173.2	380.9	295.1	2,279.3
2023	137.3	91.7	82.9	176.2	152.4	696.6	319.6	1,207.9	1,317.5	284.2	164.6	290.2	4,921.2
2024	96.3	271.1	87.5	148.0	58.2	122.2	156.8	275.0	278.6	317.6	222.4	224.8	2,258.4
2025	175.7	263.9	292.3	103.0	223.8	1,034.8	771.3	314.4	234.0	654.6	289.4	148.1	4,505.1
2026	97.7	144.9	58.5	44.6	52.4	94.1	295.2	334.6	358.7	212.1	114.1	130.7	1,937.7
2027	81.8	73.3	46.0	90.1	35.1	85.8	76.2	56.1	96.9	157.1	78.3	57.9	934.7
Average	**145.3**	**147.7**	**137.2**	**96.8**	**86.2**	**307.5**	**333.6**	**390.2**	**481.1**	**325.2**	**197.6**	**173.6**	**2,821.9**

2

Table 3-25 Future Direct Runoff for Woodmere Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	78.5	22.9	17.5	33.2	0.7	1,154.7	1,170.0	269.8	706.8	625.0	7.1	17.4	4,103.7
2016	116.0	26.3	74.7	24.8	124.3	51.6	63.6	180.5	62.4	248.3	0.4	5.0	977.9
2017	24.5	1.1	15.9	113.5	12.2	39.6	35.4	27.5	262.7	55.0	158.5	279.8	1,025.6
2018	189.5	197.6	221.7	0.2	17.4	29.6	120.6	68.2	198.9	1.8	217.9	5.7	1,269.0
2019	51.4	0.0	18.5	1.5	5.8	91.6	61.2	224.8	289.5	64.8	6.0	57.6	872.9
2020	21.1	3.1	1.4	33.4	10.1	64.9	49.4	366.9	217.2	0.0	8.1	6.8	782.2
2021	1.1	0.0	247.9	1.1	0.0	114.1	499.5	261.1	579.3	9.4	0.1	1.0	1,714.7
2022	2.0	118.1	1.5	18.5	50.5	45.8	54.0	383.5	93.2	5.7	272.9	152.1	1,197.7
2023	0.0	5.6	12.5	122.0	107.2	585.3	102.1	806.1	941.0	5.0	1.3	173.7	2,861.7
2024	14.1	205.5	17.4	95.5	15.3	87.0	104.9	138.6	96.8	148.9	104.8	136.6	1,165.3
2025	93.9	201.2	215.0	31.3	155.4	792.2	393.5	73.6	62.9	473.5	112.6	0.1	2,605.2
2026	1.5	75.6	1.1	0.0	14.9	62.1	232.7	169.1	130.0	38.2	1.8	46.0	773.1
2027	16.7	23.7	2.6	54.3	5.2	60.4	51.9	29.6	61.6	93.5	5.6	5.3	410.5
Average	**46.9**	**67.8**	**65.2**	**40.7**	**39.9**	**244.5**	**226.1**	**230.7**	**284.8**	**136.1**	**69.0**	**68.2**	**1,520.0**

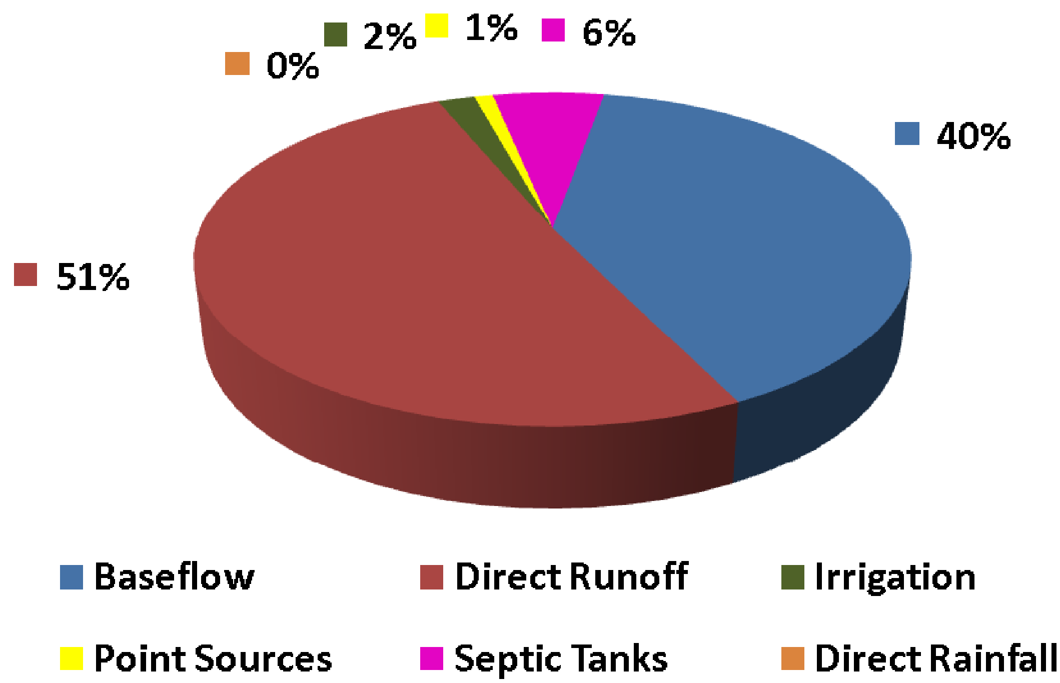

Figure 3-19 Woodmere Creek Basin Current Total Volume Water Budget

Table 3-26 Summary of Annual Future Total Volume Inputs for Woodmere Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	2,242.0	4,103.7	40.5	22.6	126.7	0.0
2016	957.1	977.9	40.5	22.6	126.7	0.0
2017	386.7	1,025.6	40.5	22.6	126.7	0.0
2018	1,440.6	1,269.0	40.5	22.6	126.7	0.0
2019	862.0	872.9	40.5	14.3	126.7	0.0
2020	584.3	782.2	40.5	10.6	126.7	0.0
2021	1,333.5	1,714.7	40.5	10.3	126.7	0.0
2022	895.8	1,197.7	40.5	18.6	126.7	0.0
2023	1,855.0	2,861.7	40.5	37.2	126.7	0.0
2024	900.9	1,165.3	40.5	25.0	126.7	0.0
2025	1,712.9	2,605.2	40.5	19.8	126.7	0.0
2026	978.9	773.1	40.5	18.5	126.7	0.0
2027	335.0	410.5	40.5	21.9	126.7	0.0
Average	**1,114.2**	**1,520.0**	**40.5**	**20.5**	**126.7**	**0.0**

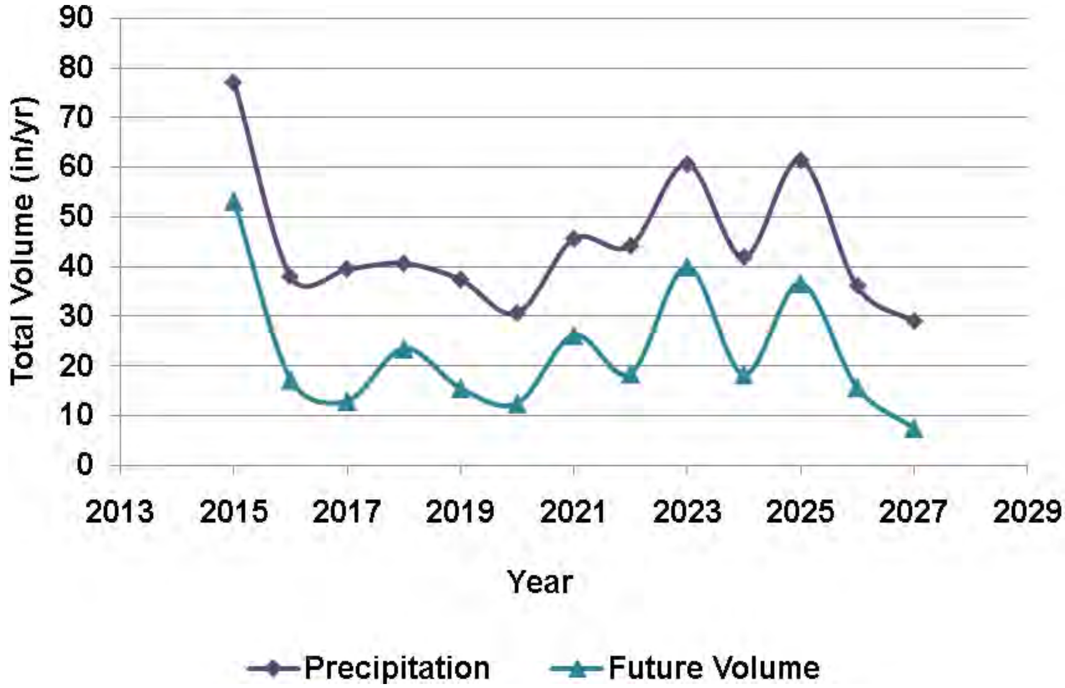

Figure 3-20 Annual Variability of Precipitation and Total Volume for Woodmere Creek Basin

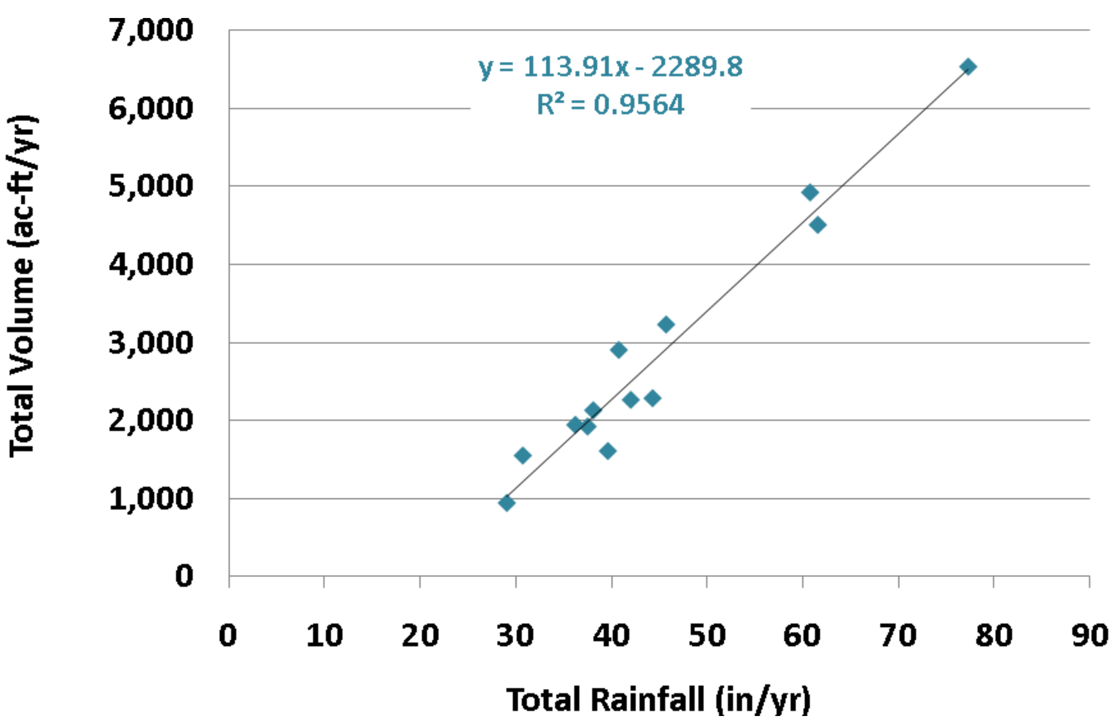

Figure 3-21 Correlation of Annual Total Volume to Rainfall for Woodmere Creek Basin

Table 3-27 Annual Total Volume to Rainfall Coefficients for Woodmere Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	53.18	77.22	0.69
2016	17.29	38.08	0.45
2017	13.04	39.61	0.33
2018	23.59	40.75	0.58
2019	15.59	37.49	0.42
2020	12.57	30.73	0.41
2021	26.25	45.69	0.57
2022	18.55	44.28	0.42
2023	40.04	60.72	0.66
2024	18.38	42.00	0.44
2025	36.66	61.52	0.60
2026	15.77	36.21	0.44
2027	7.61	29.07	0.26
Average	**22.96**	**44.87**	**0.48**

Figure 3-22 Variability of Average Monthly Total Volume in Woodmere Creek Basin

Table 3-28 Average Monthly Rainfall to Total Volume Coefficients for Woodmere Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.18	1.71	0.69
Feb	1.20	2.03	0.59
Mar	1.12	2.08	0.54
Apr	0.79	2.09	0.38
May	0.70	1.87	0.37
Jun	2.50	7.47	0.34
Jul	2.71	6.85	0.40
Aug	3.18	6.85	0.46
Sep	3.91	6.79	0.58
Oct	2.65	3.27	0.81
Nov	1.61	1.74	0.92
Dec	1.41	2.12	0.67

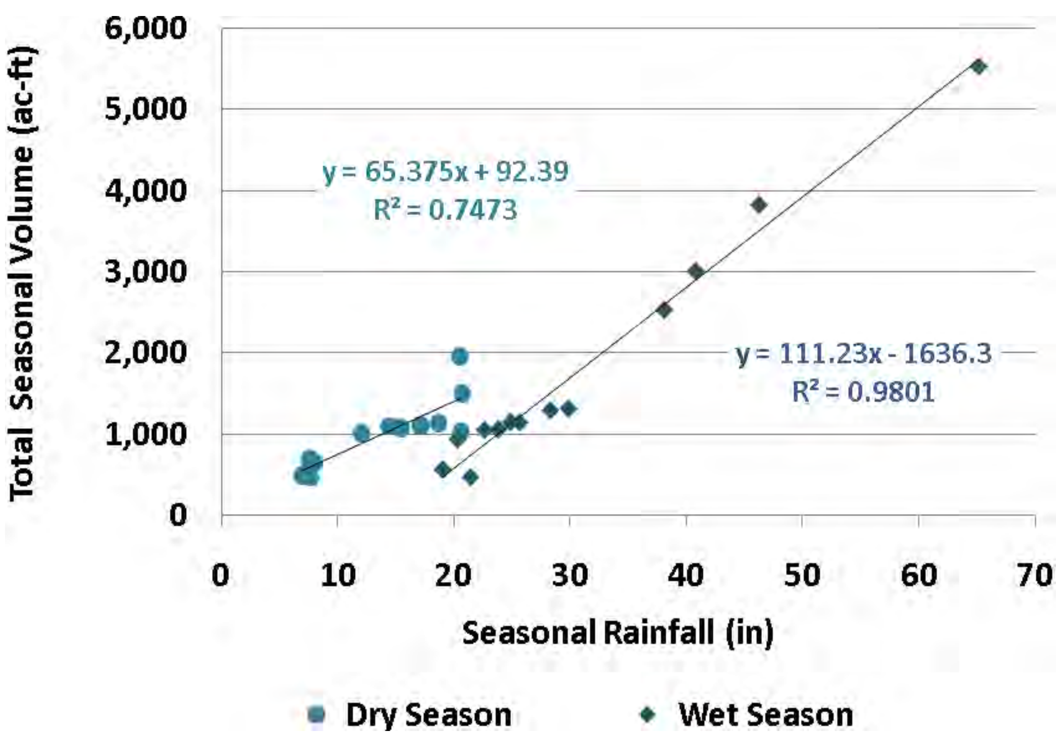

Figure 3-23 Correlation of Seasonal Total Volume to Rainfall for Woodmere Creek Basin

Table 3-29 Wet Season Total Volume to Rainfall Coefficients for Woodmere Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	44.99	65.19	0.69
2016	8.57	22.62	0.38
2017	4.60	19.00	0.24
2018	7.63	20.27	0.38
2019	10.71	29.83	0.36
2020	8.62	23.80	0.36
2021	20.59	38.09	0.54
2022	9.32	25.61	0.36
2023	31.13	46.25	0.67
2024	9.36	24.87	0.38
2025	24.48	40.79	0.60
2026	10.54	28.28	0.37
2027	3.84	21.40	0.18
Average	**14.95**	**31.23**	**0.42**

Table 3-30 Dry Season Total Volume to Rainfall Coefficients for Woodmere Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	8.19	12.03	0.68
2016	8.72	15.47	0.56
2017	8.44	20.61	0.41
2018	15.96	20.48	0.78
2019	4.88	7.66	0.64
2020	3.95	6.93	0.57
2021	5.66	7.60	0.75
2022	9.23	18.67	0.49
2023	8.91	14.47	0.62
2024	9.02	17.13	0.53
2025	12.17	20.72	0.59
2026	5.23	7.93	0.66
2027	3.76	7.67	0.49
Average	**8.01**	**13.64**	**0.60**

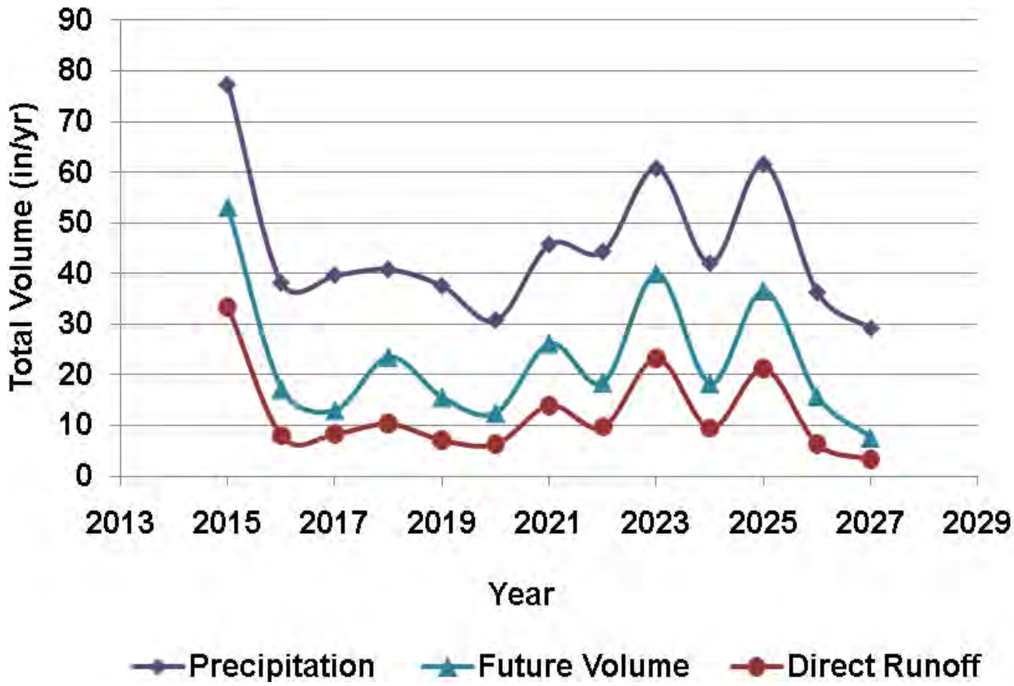

Figure 3-24 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Woodmere Creek Basin

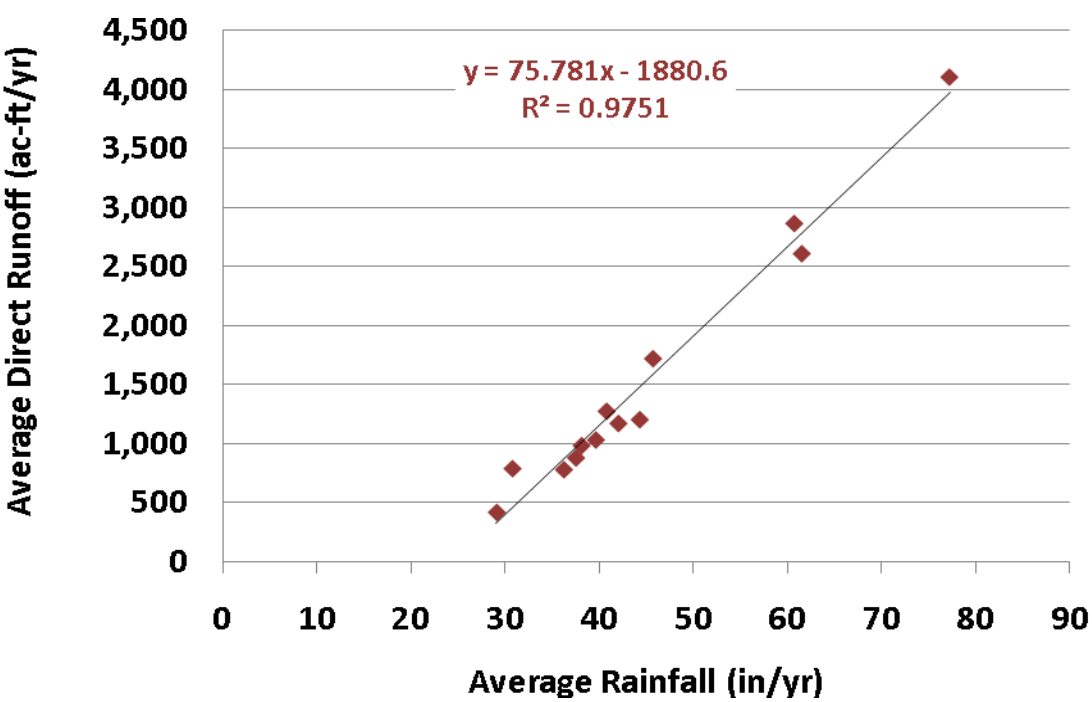

Figure 3-25 Correlation of Average Annual Direct Runoff to Rainfall

Table 3-31 Annual Direct Runoff to Rainfall Coefficients for Woodmere Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	33.39	77.22	0.43
2016	7.96	38.08	0.21
2017	8.35	39.61	0.21
2018	10.33	40.75	0.25
2019	7.10	37.49	0.19
2020	6.36	30.73	0.21
2021	13.95	45.69	0.31
2022	9.75	44.28	0.22
2023	23.29	60.72	0.38
2024	9.48	42.00	0.23
2025	21.20	61.52	0.34
2026	6.29	36.21	0.17
2027	3.34	29.07	0.11
Average	**12.37**	**44.87**	**0.25**

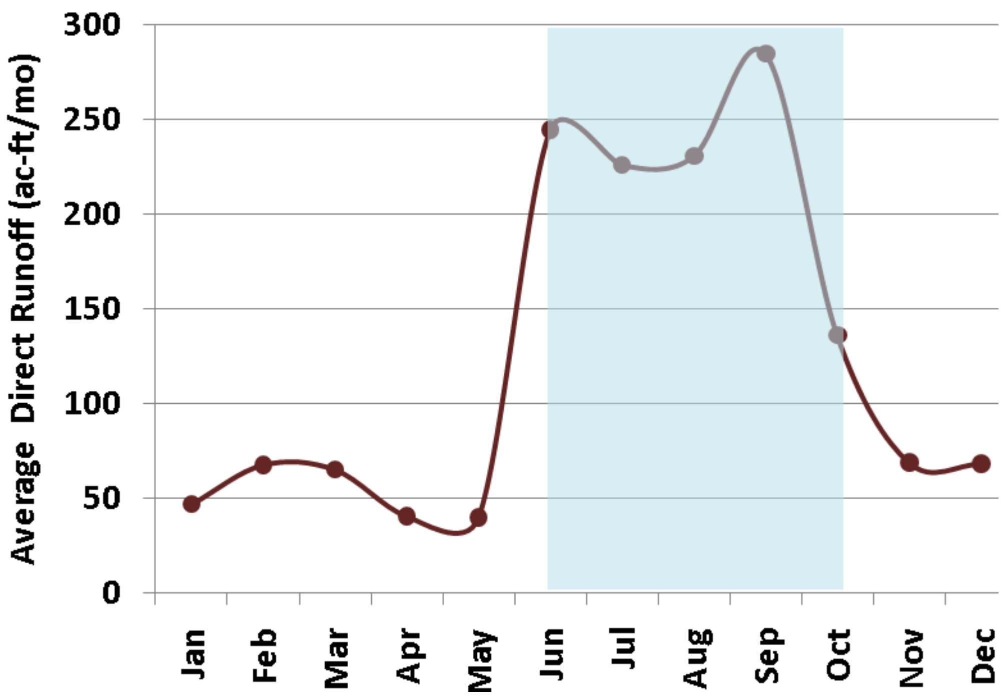

Figure 3-26 Variability of Average Monthly Direct Runoff to Woodmere Creek Basin

Table 3-32 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.38	1.71	0.22
Feb	0.55	2.03	0.27
Mar	0.53	2.08	0.25
Apr	0.33	2.09	0.16
May	0.32	1.87	0.17
Jun	1.99	7.47	0.27
Jul	1.84	6.85	0.27
Aug	1.88	6.85	0.27
Sep	2.32	6.79	0.34
Oct	1.11	3.27	0.34
Nov	0.56	1.74	0.32
Dec	0.56	2.12	0.26

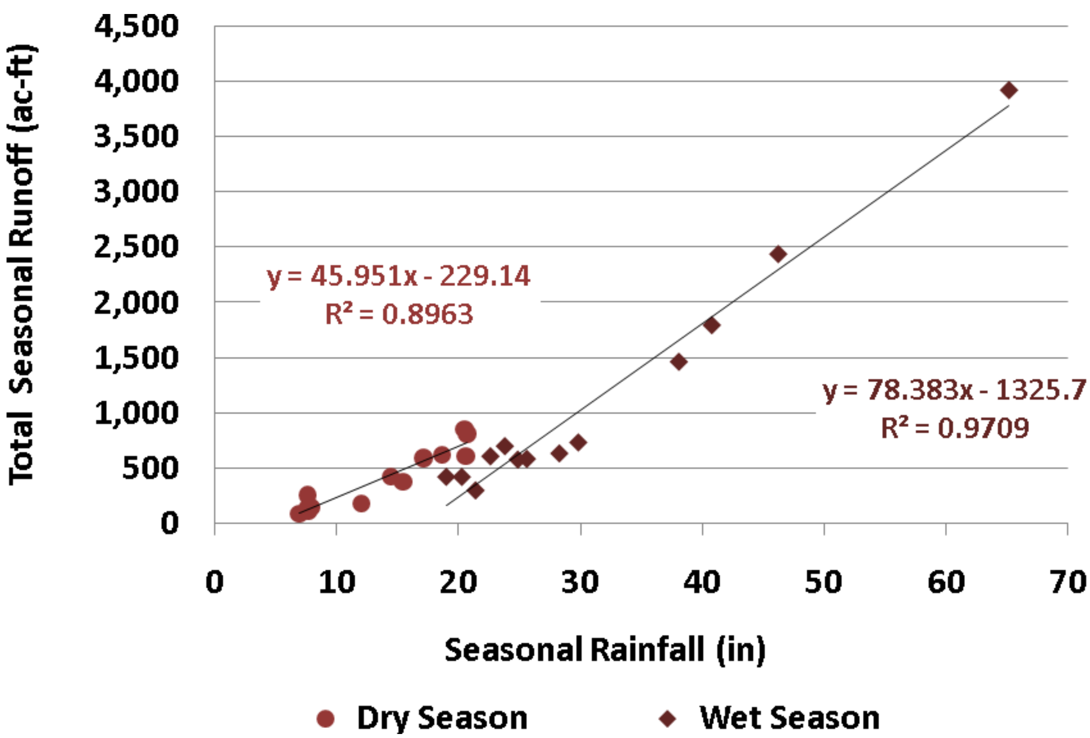

Figure 3-27 Correlation of Seasonal Direct Runoff to Rainfall

Table 3-33 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	31.95	65.19	0.49
2016	4.93	22.62	0.22
2017	3.42	19.00	0.18
2018	3.41	20.27	0.17
2019	5.96	29.83	0.20
2020	5.68	23.80	0.24
2021	11.91	38.09	0.31
2022	4.74	25.61	0.18
2023	19.85	46.25	0.43
2024	4.69	24.87	0.19
2025	14.61	40.79	0.36
2026	5.14	28.28	0.18
2027	2.42	21.40	0.11
Average	**9.13**	**31.23**	**0.25**

Table 3-34 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	1.44	12.03	0.12
2016	3.02	15.47	0.20
2017	4.93	20.61	0.24
2018	6.92	20.48	0.34
2019	1.15	7.66	0.15
2020	0.68	6.93	0.10
2021	2.04	7.60	0.27
2022	5.01	18.67	0.27
2023	3.44	14.47	0.24
2024	4.79	17.13	0.28
2025	6.59	20.72	0.32
2026	1.15	7.93	0.14
2027	0.92	7.67	0.12
Average	**3.24**	**13.64**	**0.21**

3.4 WATER BUDGET CHANGES

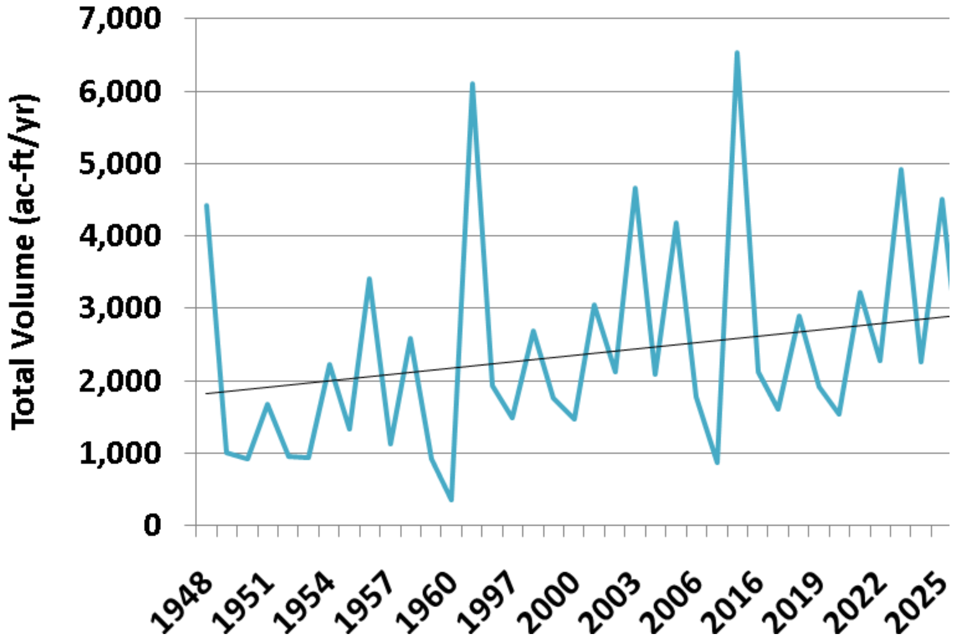

Figure 3-28 Trend in Total Volume from Historical through Future Time Series

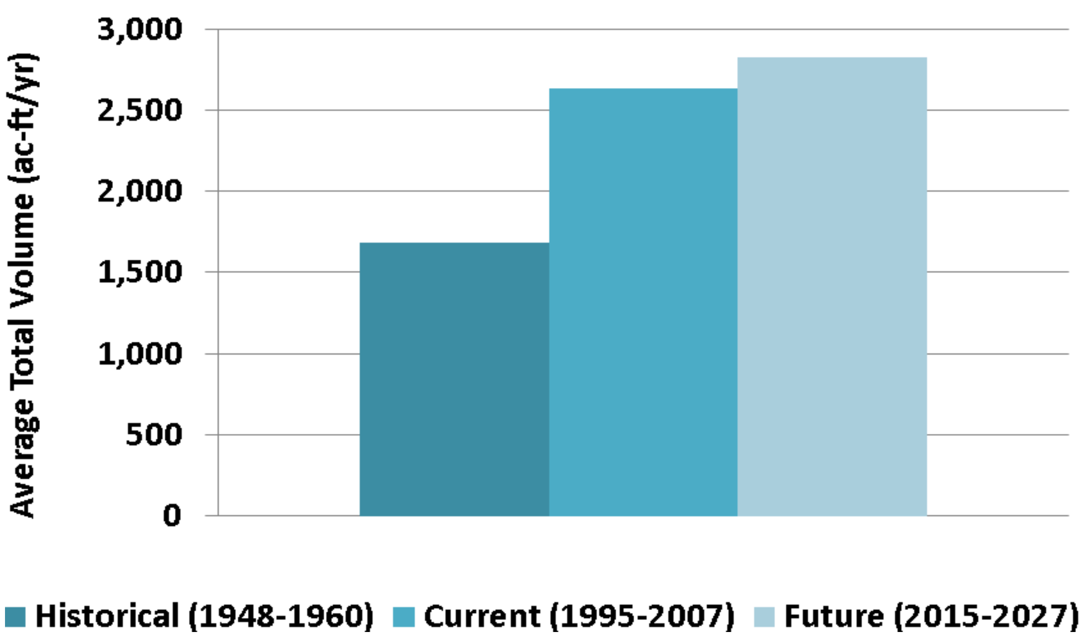

Figure 3-29 Historical, Current, and Future Average Annual Total Volume to Lemon Bay

Table 3-35 Change in Total Volume from Historical to Current Conditions			
Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	4,416	6,108	1,691
2	999	1,934	935
3	914	1,492	578
4	1,679	2,692	1,013
5	955	1,760	805
6	946	1,461	515
7	2,228	3,043	814
8	1,340	2,127	787
9	3,409	4,659	1,250
10	1,127	2,083	956
11	2,591	4,175	1,585
12	924	1,785	861
13	358	868	510
Average	**1,683**	**2,630**	**946**

Table 3-36 Change in Total Volume from Current to Future Conditions			
Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	6,108	6,536	428
2	1,934	2,125	191
3	1,492	1,602	110
4	2,692	2,899	208
5	1,760	1,916	156
6	1,461	1,544	83
7	3,043	3,226	183
8	2,127	2,279	152
9	4,659	4,921	262
10	2,083	2,258	175
11	4,175	4,505	330
12	1,785	1,938	153
13	868	935	67
Average	**2,630**	**2,822**	**192**

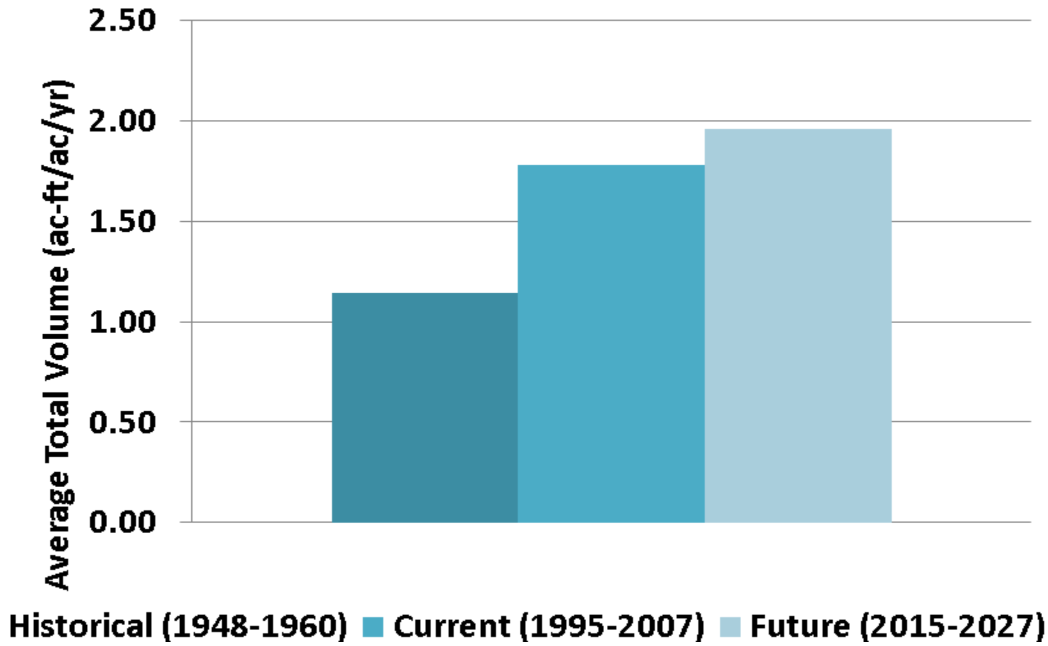

Figure 3-30 Normalized Historical, Current, and Future Average Annual Total Volume to Lemon Bay

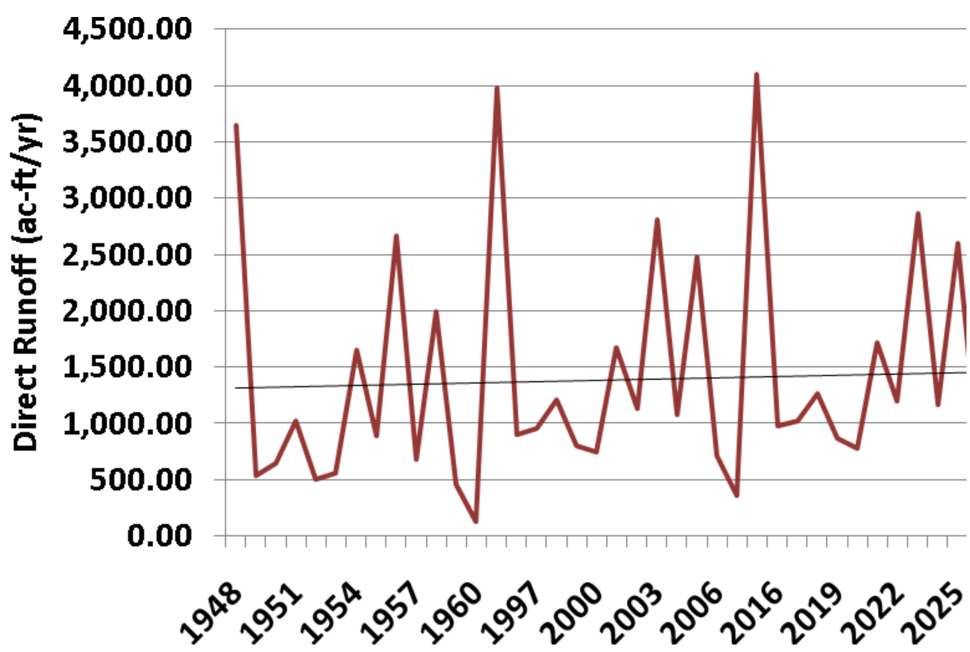

Figure 3-31 Trend in Direct Runoff from Historical through Future Time Series

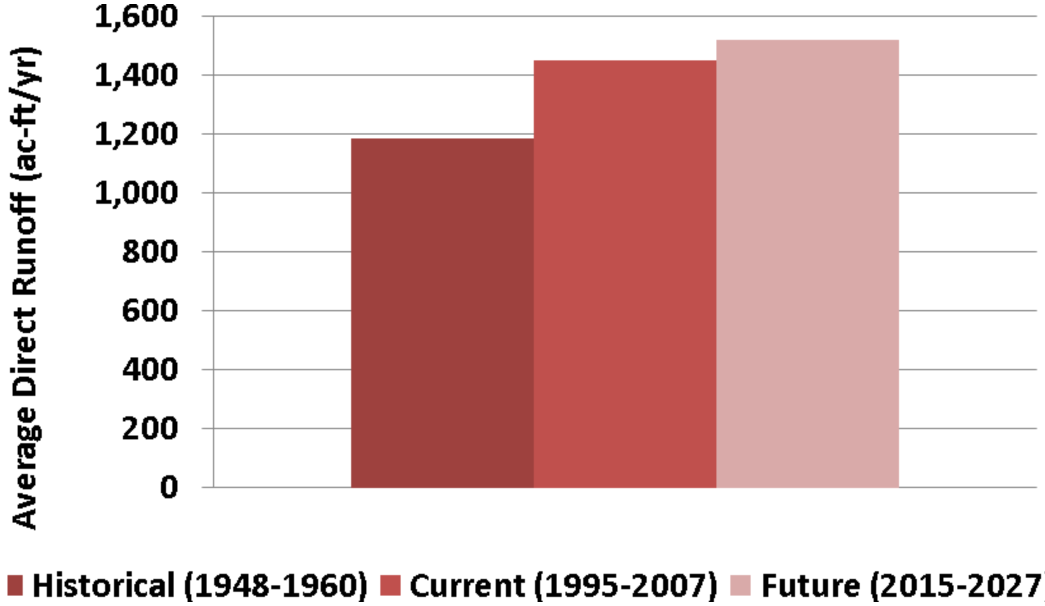

Figure 3-32 Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

Table 3-37 Change in Direct Runoff from Historical to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	3,644	3,976	332
2	540	896	356
3	646	956	310
4	1,024	1,214	190
5	507	799	292
6	559	742	183
7	1,651	1,676	25
8	893	1,131	237
9	2,663	2,809	146
10	684	1,076	392
11	1,996	2,482	485
12	461	712	250
13	128	362	233
Average	**1,184**	**1,448**	**264**

Table 3-38 Change in Direct Runoff from Current to Future Conditions			
Year	Current Direct Runoff (ac-ft) 1995-2007	Future Direct Runoff (ac-ft) 2015-2027	Direct Runoff Change (ac-ft) (future-current)
1	3,976	4,104	127
2	896	978	82
3	956	1,026	70
4	1,214	1,269	55
5	799	873	74
6	742	782	40
7	1,676	1,715	39
8	1,131	1,198	67
9	2,809	2,862	53
10	1,076	1,165	89
11	2,482	2,605	124
12	712	773	61
13	362	411	49
Average	**1,448**	**1,520**	**71**

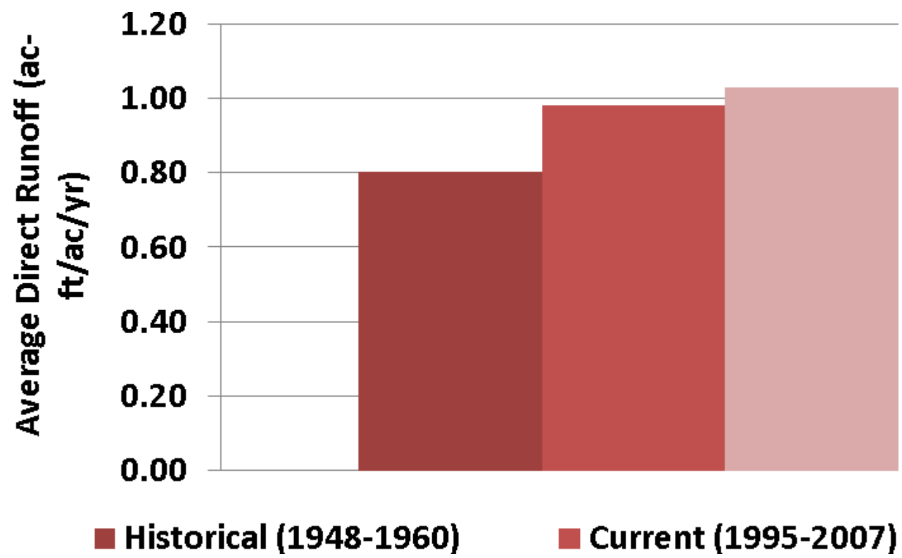

Figure 3-33 Normalized Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

4.0 FORKED CREEK BASIN

4.1 CURRENT CONDITIONS

Table 4-1 Monthly Rainfall for Forked Creek Basin (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	3.41	2.16	1.30	2.96	0.64	21.52	18.18	7.41	9.57	10.56	0.86	1.46	80.03
1996	1949	2016	3.45	1.45	4.09	1.88	4.55	3.86	3.52	6.22	4.49	6.05	0.36	0.86	40.78
1997	1950	2017	1.58	0.21	1.31	5.85	1.46	3.37	3.16	3.52	9.38	2.56	4.35	6.12	42.88
1998	1951	2018	5.37	5.09	4.56	0.15	1.74	2.50	6.84	5.23	8.35	0.92	3.93	0.57	45.25
1999	1952	2019	2.42	0.06	1.78	0.34	0.50	6.56	5.79	7.97	8.12	2.57	0.58	1.68	38.37
2000	1953	2020	1.18	0.47	0.69	2.05	0.68	5.13	4.43	8.67	5.78	0.03	1.15	0.52	30.78
2001	1954	2021	0.33	0.01	7.04	0.40	0.28	6.83	12.99	5.69	10.54	1.62	0.18	0.27	46.19
2002	1955	2022	0.55	4.22	0.26	1.47	3.30	5.57	3.71	12.02	3.90	0.78	5.07	4.69	45.54
2003	1956	2023	0.04	0.86	1.97	3.43	3.79	14.56	4.56	13.62	12.84	0.63	0.51	3.95	60.77
2004	1957	2024	1.36	3.88	0.85	3.32	1.11	6.06	6.95	6.28	4.62	3.13	2.54	2.97	43.07
2005	1958	2025	1.85	3.05	4.47	2.32	4.96	18.30	7.96	5.01	3.59	9.27	3.34	0.24	64.36
2006	1959	2026	0.36	2.66	0.18	0.03	1.86	5.33	9.50	7.11	5.56	1.23	0.30	2.36	36.48
2007	1960	2027	1.38	1.61	0.30	2.38	0.71	5.08	4.74	3.51	5.04	5.04	1.02	0.75	31.54
		Average	**1.79**	**1.98**	**2.22**	**2.05**	**1.97**	**8.05**	**7.10**	**7.10**	**7.06**	**3.41**	**1.86**	**2.03**	**46.62**

Table 4-2 Current Total Volume for Forked Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	478.8	255.3	217.1	198.7	124.4	5,612.8	5,496.4	1,922.4	2,967.8	2,984.3	559.9	379.8	21,197.6
1996	664.6	301.0	451.8	252.1	683.4	301.2	262.7	794.8	520.7	1,312.1	317.6	273.0	6,135.1
1997	289.4	137.8	196.2	601.0	116.0	226.8	158.3	165.3	1,537.7	356.7	850.8	1,303.5	5,939.6
1998	1,742.2	1,471.3	1,335.8	313.5	297.6	283.1	905.8	518.0	1,284.9	506.4	1,006.6	242.3	9,907.6
1999	310.9	137.8	171.2	106.5	90.4	294.5	611.4	873.3	1,536.1	753.6	337.8	372.8	5,596.3
2000	260.8	150.2	132.6	190.9	105.3	180.0	182.8	1,922.8	827.6	278.4	238.1	176.4	4,645.9
2001	141.3	108.0	962.3	108.2	91.4	507.2	2,685.3	1,588.7	2,585.8	547.8	310.6	236.8	9,873.5
2002	188.8	665.0	134.7	142.8	272.1	233.0	227.9	1,709.3	896.4	367.4	1,383.7	795.4	7,016.5
2003	332.2	226.5	237.6	657.2	501.2	2,967.1	740.3	3,531.7	4,415.4	543.4	320.0	799.2	15,271.7
2004	227.2	661.9	211.9	403.1	139.8	362.6	536.3	932.5	784.5	780.9	561.1	648.4	6,250.3
2005	459.0	701.6	893.7	235.8	684.4	4,080.5	2,157.4	729.5	638.6	2,373.7	817.8	350.7	14,122.7
2006	248.0	381.7	157.0	125.5	133.8	235.7	887.7	1,006.5	972.5	499.4	282.5	365.8	5,296.0
2007	227.2	171.0	118.8	198.6	91.7	194.4	190.7	143.8	256.3	552.3	283.6	190.0	2,618.4
Average	**428.5**	**413.0**	**401.6**	**271.8**	**256.3**	**1,190.7**	**1,157.2**	**1,218.4**	**1,478.8**	**912.0**	**559.2**	**471.9**	**8,759.3**

Table 4-3 Current Direct Runoff for Forked Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	245.7	57.5	25.1	54.4	3.2	5,266.8	4,793.2	1,142.3	2,175.0	2,120.7	19.6	40.9	15,944.3
1996	303.2	42.3	239.5	68.2	524.3	159.1	112.2	564.3	265.2	846.5	3.6	33.2	3,161.5
1997	103.0	0.8	70.4	497.1	19.4	146.6	79.5	90.2	1,441.0	192.4	671.0	925.5	4,237.1
1998	1,210.2	881.4	857.4	0.3	51.4	93.2	689.5	260.2	849.5	17.3	687.6	3.5	5,601.5
1999	125.4	0.0	46.1	4.5	0.4	217.5	448.7	578.6	1,053.3	210.7	12.8	125.0	2,822.9
2000	69.1	4.5	4.4	85.5	12.6	101.6	105.9	1,758.5	527.9	0.0	31.5	5.7	2,707.3
2001	1.2	0.0	859.5	4.2	0.9	428.7	2,292.1	951.4	1,931.5	42.2	2.1	1.1	6,514.8
2002	3.8	525.0	3.0	37.4	180.1	149.1	119.3	1,522.7	305.2	5.9	1,129.1	436.9	4,417.7
2003	0.0	9.0	45.7	501.4	362.1	2,645.1	230.8	2,721.4	3,670.3	10.8	2.9	543.0	10,742.5
2004	27.6	501.4	35.6	264.2	21.3	264.0	407.3	563.6	359.1	432.6	308.9	440.9	3,626.5
2005	248.6	540.8	699.2	57.6	513.9	3,516.0	1,377.5	236.7	205.3	1,923.1	349.9	0.1	9,668.6
2006	2.1	201.4	0.1	0.0	24.2	143.9	711.9	614.0	421.7	84.4	1.6	143.3	2,348.8
2007	52.0	39.7	2.9	105.3	10.5	125.3	123.8	67.0	154.0	348.9	45.7	11.4	1,086.3
Average	**184.0**	**215.7**	**222.2**	**129.2**	**132.6**	**1,019.8**	**884.0**	**851.6**	**1,027.6**	**479.7**	**251.3**	**208.5**	**5,606.1**

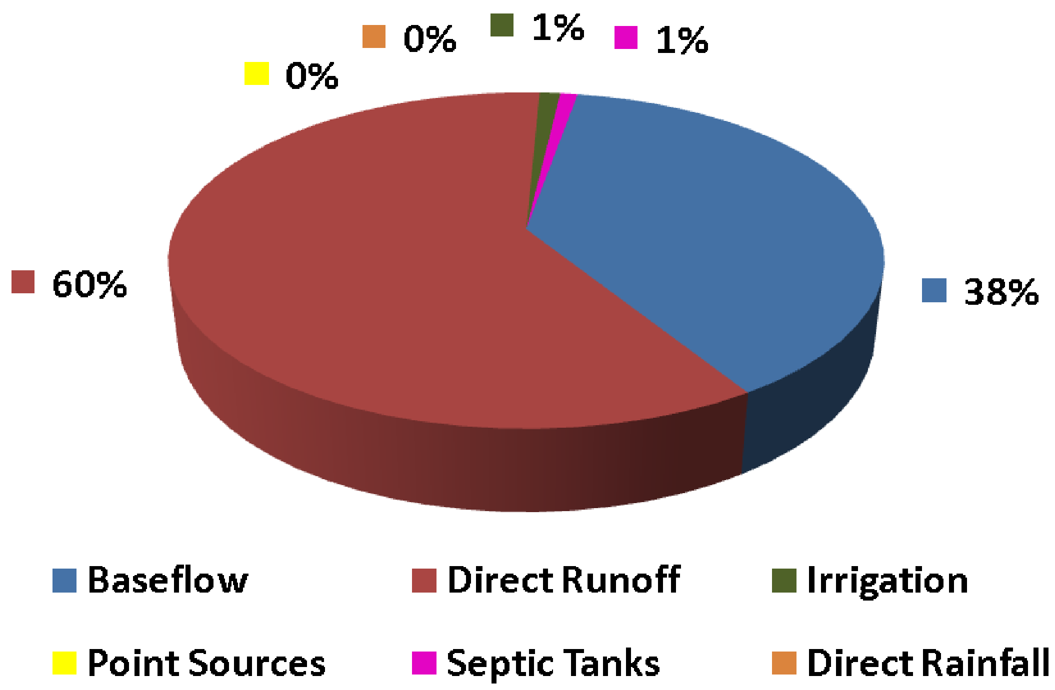

Figure 4-1 Forked Creek Basin Current Total Volume Water Budget

Table 4-4 Summary of Annual Current Total Volume Inputs for Forked Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	5,123.5	15,944.3	71.8	0.0	58.0	0.0
1996	2,842.5	3,161.5	72.4	0.0	58.7	0.0
1997	1,571.4	4,237.1	72.1	0.0	59.1	0.0
1998	4,174.6	5,601.5	72.1	0.0	59.4	0.0
1999	2,641.2	2,822.9	72.1	0.0	60.1	0.0
2000	1,805.9	2,707.3	72.1	0.0	60.6	0.0
2001	3,224.9	6,514.8	72.7	0.0	61.0	0.0
2002	2,464.0	4,417.7	73.6	0.0	61.3	0.0
2003	4,393.7	10,742.5	73.6	0.0	61.8	0.0
2004	2,486.8	3,626.5	74.4	0.0	62.6	0.0
2005	4,316.3	9,668.6	74.4	0.0	63.3	0.0
2006	2,809.5	2,348.8	74.4	0.0	63.3	0.0
2007	1,394.4	1,086.3	74.4	0.0	63.3	0.0
Average	**4,503.4**	**6,402.3**	**43.8**	**0.0**	**61.0**	**0.0**

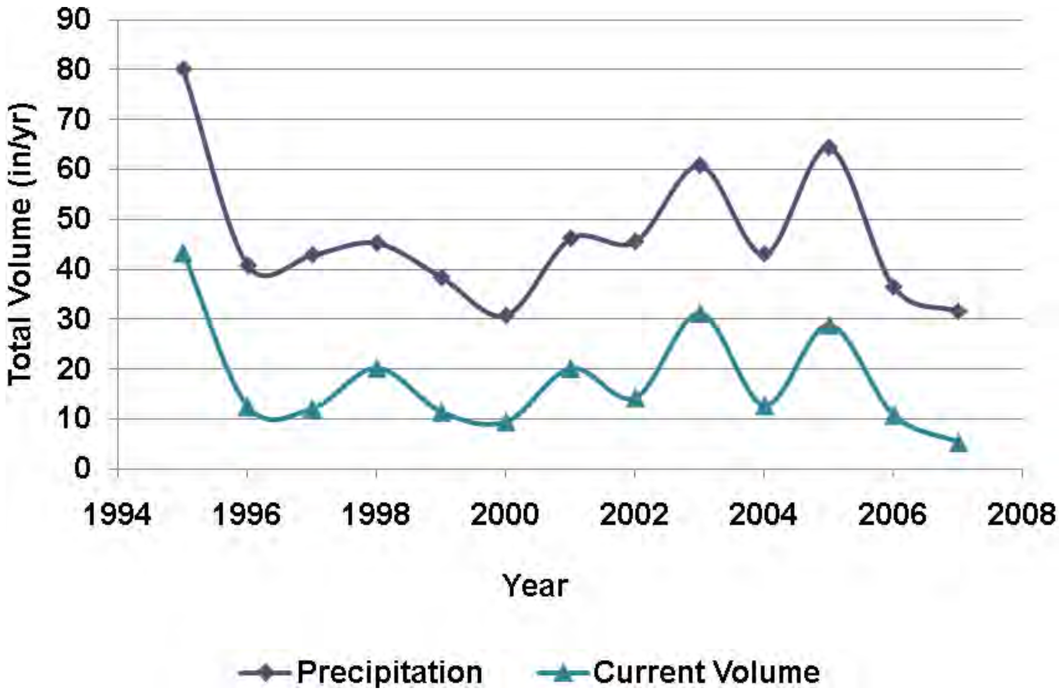

Figure 4-2 Annual Variability of Precipitation and Total Volume for Forked Creek Basin

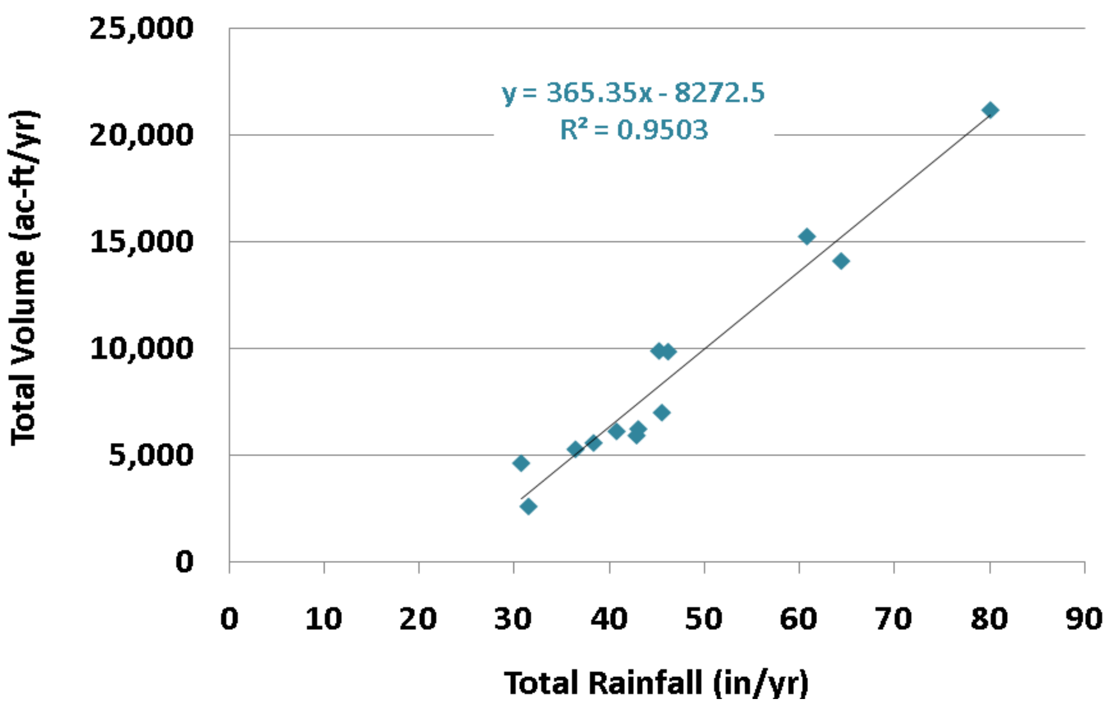

Figure 4-3 Correlation of Annual Total Volume to Rainfall for Forked Creek Basin

Table 4-5 Annual Total Volume to Rainfall Coefficients for Forked Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
1995	43.39	80.03	0.54
1996	12.56	40.78	0.31
1997	12.16	42.88	0.28
1998	20.28	45.25	0.45
1999	11.45	38.37	0.30
2000	9.51	30.78	0.31
2001	20.21	46.19	0.44
2002	14.36	45.54	0.32
2003	31.26	60.77	0.51
2004	12.79	43.07	0.30
2005	28.91	64.36	0.45
2006	10.84	36.48	0.30
2007	5.36	31.54	0.17
Average	**17.93**	**46.62**	**0.36**

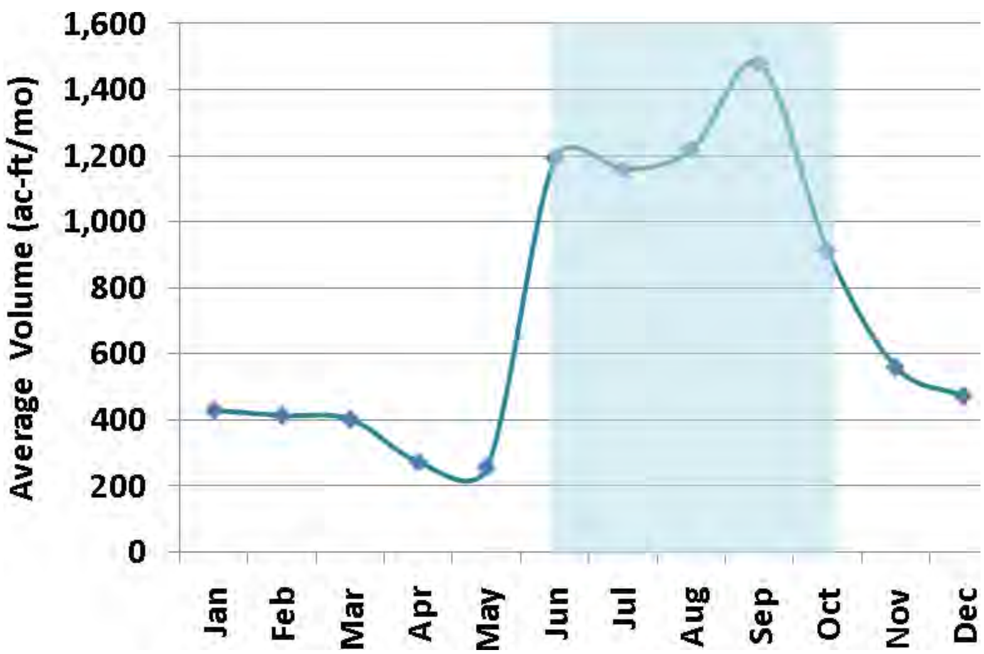

Figure 4-4 Variability of Average Monthly Total Volume in Forked Creek Basin

Table 4-6 Average Monthly Rainfall to Total Volume Coefficients for Forked Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.88	1.79	0.49
Feb	0.85	1.98	0.43
Mar	0.82	2.22	0.37
Apr	0.56	2.05	0.27
May	0.52	1.97	0.27
Jun	2.44	8.05	0.30
Jul	2.37	7.10	0.33
Aug	2.49	7.10	0.35
Sep	3.03	7.06	0.43
Oct	1.87	3.41	0.55
Nov	1.14	1.86	0.61
Dec	0.97	2.03	0.47

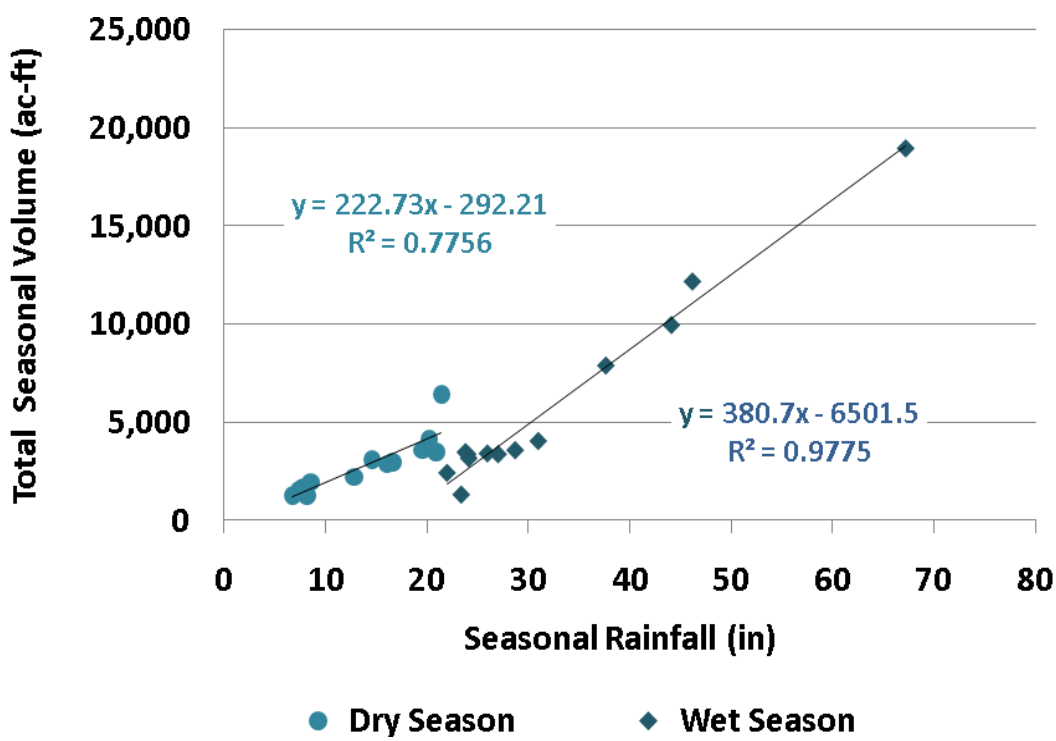

Figure 4-5 Correlation of Seasonal Total Volume to Rainfall for Forked Creek Basin

Table 4-7 Wet Season Total Volume to Rainfall Coefficients for Forked Creek Basin

	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	38.86	67.24	0.58
1996	6.53	24.14	0.27
1997	5.00	22.01	0.23
1998	7.16	23.83	0.30
1999	8.33	31.00	0.27
2000	6.94	24.04	0.29
2001	16.20	37.67	0.43
2002	7.03	25.99	0.27
2003	24.97	46.21	0.54
2004	6.95	27.04	0.26
2005	20.43	44.13	0.46
2006	7.37	28.73	0.26
2007	2.74	23.41	0.12
Average	**12.19**	**32.72**	**0.33**

Table 4-8 Dry Season Total Volume to Rainfall Coefficients for Forked Creek Basin

	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	4.53	12.78	0.35
1996	6.03	16.64	0.36
1997	7.15	20.88	0.34
1998	13.12	21.42	0.61
1999	3.13	7.36	0.42
2000	2.57	6.74	0.38
2001	4.01	8.52	0.47
2002	7.33	19.56	0.37
2003	6.29	14.56	0.43
2004	5.84	16.03	0.36
2005	8.48	20.23	0.42
2006	3.47	7.76	0.45
2007	2.62	8.14	0.32
Average	**5.74**	**13.89**	**0.41**

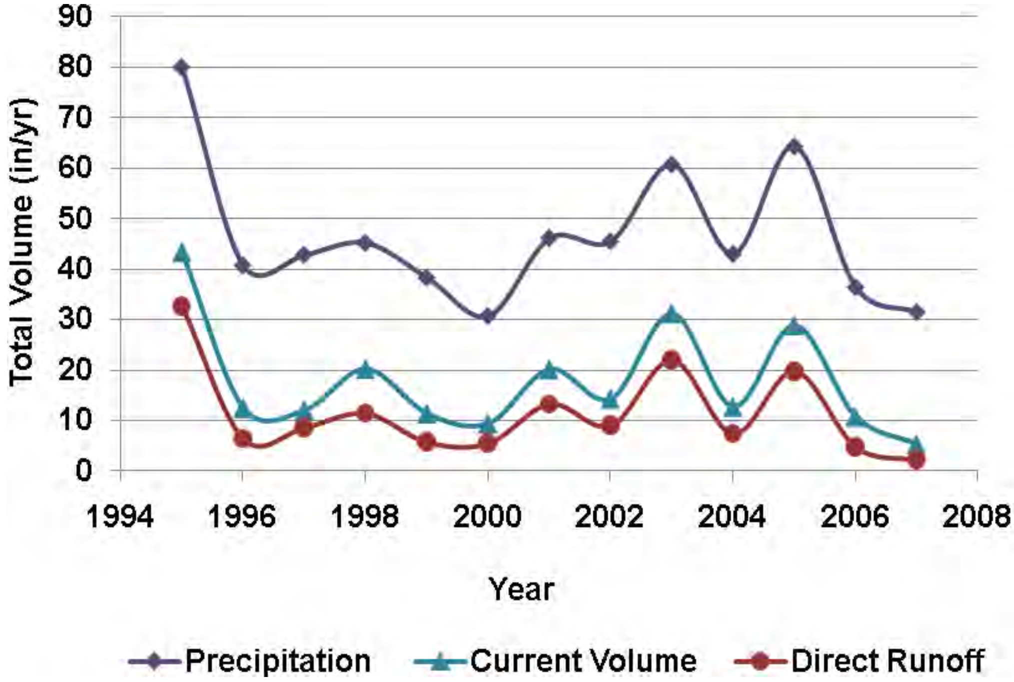

Figure 4-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Forked Creek Basin

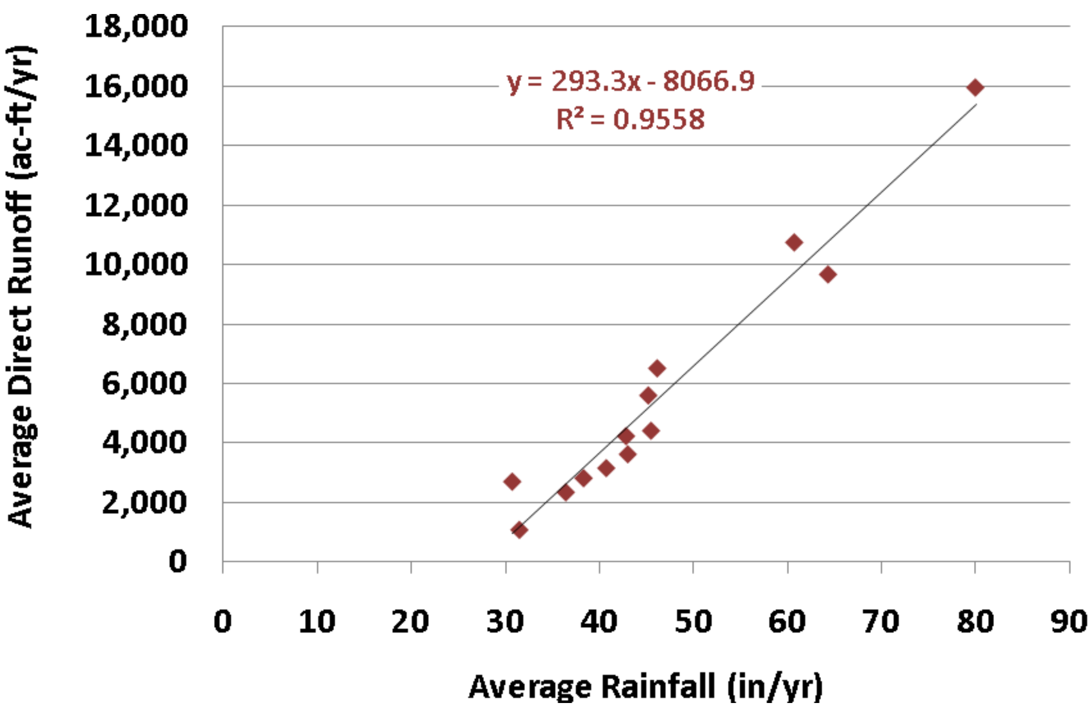

Figure 4-7 Correlation of Average Annual Direct Runoff to Rainfall

Table 4-9 Annual Direct Runoff to Rainfall Coefficients for Forked Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	32.64	80.03	0.41
1996	6.47	40.78	0.16
1997	8.67	42.88	0.20
1998	11.47	45.25	0.25
1999	5.78	38.37	0.15
2000	5.54	30.78	0.18
2001	13.34	46.19	0.29
2002	9.04	45.54	0.20
2003	21.99	60.77	0.36
2004	7.42	43.07	0.17
2005	19.79	64.36	0.31
2006	4.81	36.48	0.13
2007	2.22	31.54	0.07
Average	**11.48**	**46.62**	**0.22**

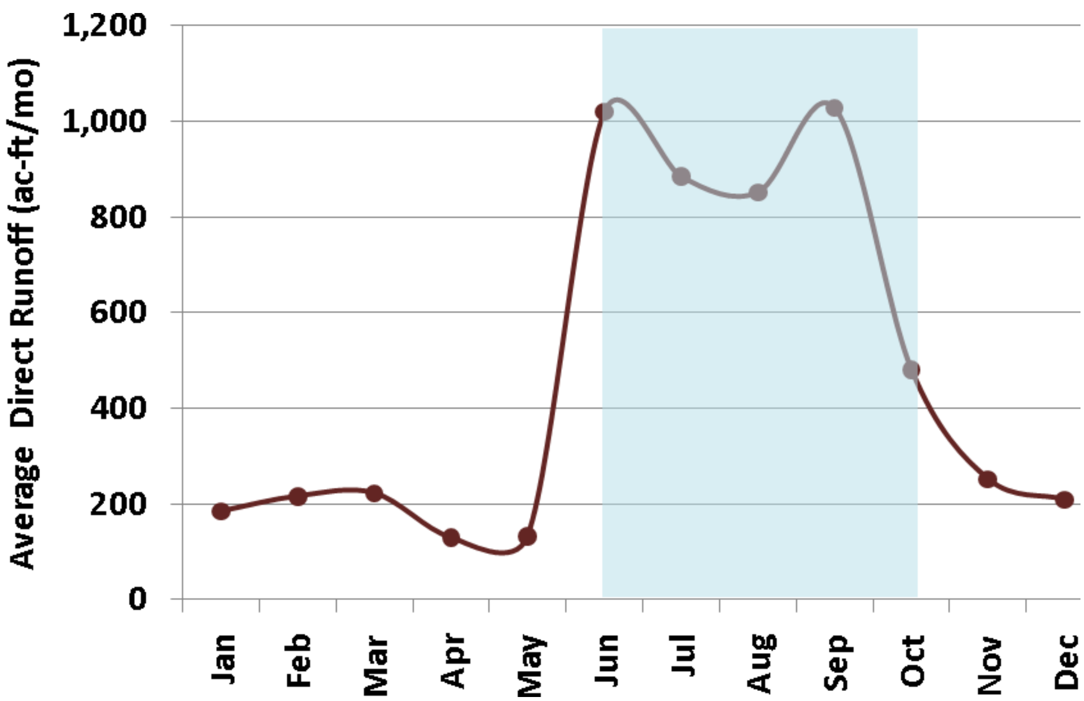

Figure 4-8 Variability of Average Monthly Direct Runoff to Forked Creek Basin

Table 4-10 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.38	1.79	0.21
Feb	0.44	1.98	0.22
Mar	0.45	2.22	0.21
Apr	0.26	2.05	0.13
May	0.27	1.97	0.14
Jun	2.09	8.05	0.26
Jul	1.81	7.10	0.25
Aug	1.74	7.10	0.25
Sep	2.10	7.06	0.30
Oct	0.98	3.41	0.29
Nov	0.51	1.86	0.28
Dec	0.43	2.03	0.21

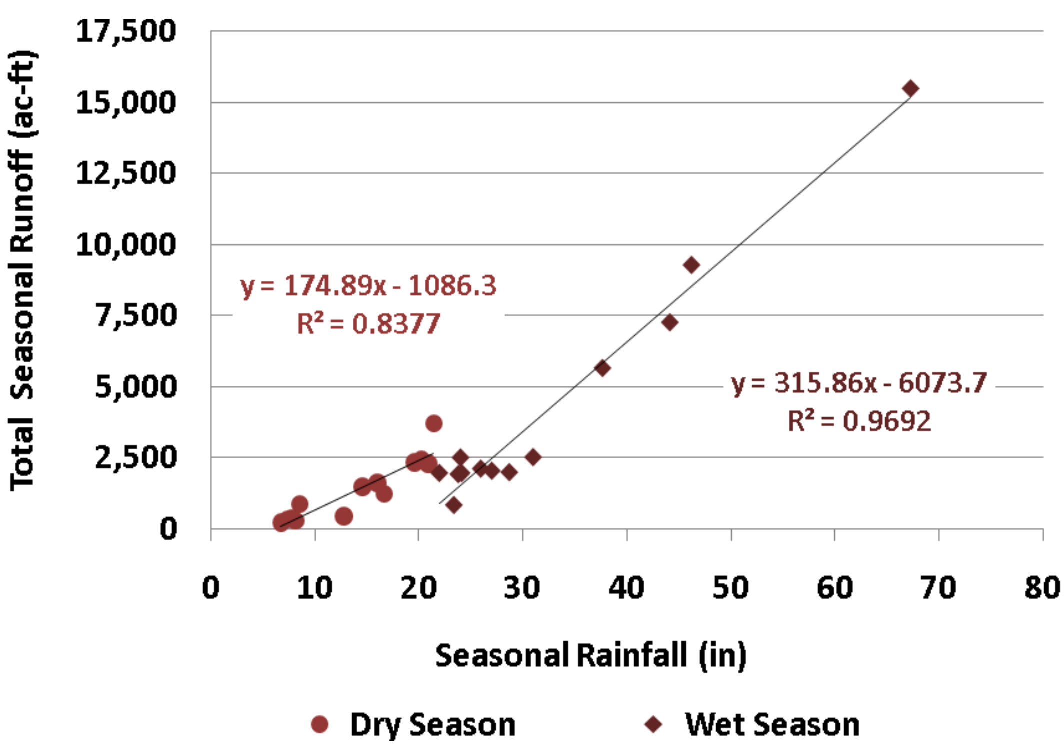

Figure 4-9 Correlation of Seasonal Direct Runoff to Rainfall

Table 4-11 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	31.72	67.24	0.47
1996	3.99	24.14	0.17
1997	3.99	22.01	0.18
1998	3.91	23.83	0.16
1999	5.14	31.00	0.17
2000	5.10	24.04	0.21
2001	11.56	37.67	0.31
2002	4.30	25.99	0.17
2003	18.99	46.21	0.41
2004	4.15	27.04	0.15
2005	14.86	44.13	0.34
2006	4.04	28.73	0.14
2007	1.68	23.41	0.07
Average	**8.73**	**32.72**	**0.23**

Table 4-12 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	0.91	12.78	0.07
1996	2.49	16.64	0.15
1997	4.68	20.88	0.22
1998	7.56	21.42	0.35
1999	0.64	7.36	0.09
2000	0.44	6.74	0.06
2001	1.78	8.52	0.21
2002	4.74	19.56	0.24
2003	3.00	14.56	0.21
2004	3.27	16.03	0.20
2005	4.93	20.23	0.24
2006	0.76	7.76	0.10
2007	0.55	8.14	0.07
Average	**2.75**	**13.89**	**0.17**

4.2 HISTORICAL CONDITIONS

Table 4-13 Historical Total Volume for Forked Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	356.7	153.9	116.3	98.1	85.2	5,328.5	5,139.4	1,504.3	2,501.5	2,499.9	323.2	216.6	18,323.5
1949	497.6	196.4	334.6	166.2	625.7	191.6	131.3	525.7	338.0	1,017.3	187.9	175.6	4,387.9
1950	221.3	110.3	155.5	540.9	87.0	200.2	116.1	110.0	1,364.1	218.5	732.1	1,139.5	4,995.4
1951	1,522.0	1,296.2	1,017.1	191.7	199.3	211.3	885.6	434.3	1,134.6	273.5	806.1	167.7	8,139.5
1952	238.4	112.4	131.9	92.2	83.6	215.5	597.3	731.5	1,243.8	471.1	195.0	258.9	4,371.7
1953	198.0	117.0	109.4	150.3	84.4	111.8	116.5	1,757.8	680.3	190.2	174.9	138.4	3,829.0
1954	119.3	94.4	829.2	95.5	85.6	486.5	2,805.8	1,316.7	2,249.2	287.1	188.1	166.3	8,723.7
1955	142.9	641.5	111.1	105.5	194.7	179.3	173.4	1,597.5	601.8	209.8	1,205.0	712.8	5,875.2
1956	245.9	177.5	186.6	641.0	467.8	2,973.8	482.5	3,137.6	4,029.3	281.5	184.9	689.8	13,498.2
1957	151.7	511.5	145.6	345.8	109.5	230.7	445.4	699.8	572.0	547.1	444.2	587.3	4,790.7
1958	333.3	608.7	722.7	142.1	467.0	3,845.0	1,702.0	367.7	317.8	2,031.6	592.0	214.4	11,344.4
1959	177.9	301.2	130.9	110.3	100.6	159.8	826.4	791.3	651.4	266.0	172.0	269.1	3,956.7
1960	179.2	121.1	93.1	139.0	71.4	97.5	89.9	67.6	130.6	364.1	143.6	105.7	1,602.8
Average	**337.2**	**341.7**	**314.1**	**216.8**	**204.8**	**1,094.7**	**1,039.4**	**1,003.2**	**1,216.5**	**666.0**	**411.5**	**372.5**	**7,218.4**

Table 4-14 Historical Direct Runoff for Forked Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	203.66	33.16	1.85	3.86	0.00	5,083.83	4,744.68	1,111.62	2,086.56	2,043.12	13.06	8.63	15,334.03
1949	276.69	14.79	170.91	31.40	504.88	89.18	39.26	419.96	225.81	775.45	0.04	10.09	2,558.45
1950	79.87	0.00	48.56	450.27	2.04	127.92	49.74	51.82	1,301.24	119.03	631.25	913.05	3,774.80
1951	1,189.31	950.28	742.57	0.00	29.98	70.41	713.78	243.52	873.48	0.80	612.54	0.02	5,426.70
1952	94.72	0.00	23.11	0.10	0.00	144.34	464.82	524.99	969.54	177.38	0.71	87.80	2,487.51
1953	52.85	0.03	0.34	58.11	0.99	40.87	52.09	1,647.28	489.59	0.00	18.83	0.16	2,361.15
1954	0.00	0.00	736.19	0.10	0.00	411.31	2,503.11	953.82	1,913.94	21.02	0.01	0.00	6,539.50
1955	0.01	528.75	2.27	13.92	111.76	106.67	94.05	1,481.73	268.00	0.14	1,033.92	459.73	4,100.95
1956	0.00	0.10	17.89	500.23	340.44	2,748.81	191.16	2,707.79	3,641.24	1.72	0.00	519.13	10,668.52
1957	5.23	391.63	13.80	236.65	11.57	147.58	361.14	482.00	323.61	344.56	279.58	439.40	3,036.75
1958	187.08	490.80	594.05	25.30	360.94	3,533.68	1,334.06	145.84	126.14	1,800.72	308.12	0.14	8,906.89
1959	0.02	163.39	0.00	0.00	0.86	75.05	691.96	550.40	390.54	49.02	0.01	116.32	2,037.56
1960	49.87	22.84	0.04	60.36	0.19	37.05	34.75	16.78	81.75	277.72	20.71	0.32	602.38
Average	**164.56**	**199.67**	**180.89**	**106.18**	**104.90**	**970.52**	**867.28**	**795.20**	**976.27**	**431.59**	**224.52**	**196.52**	**5,218.09**

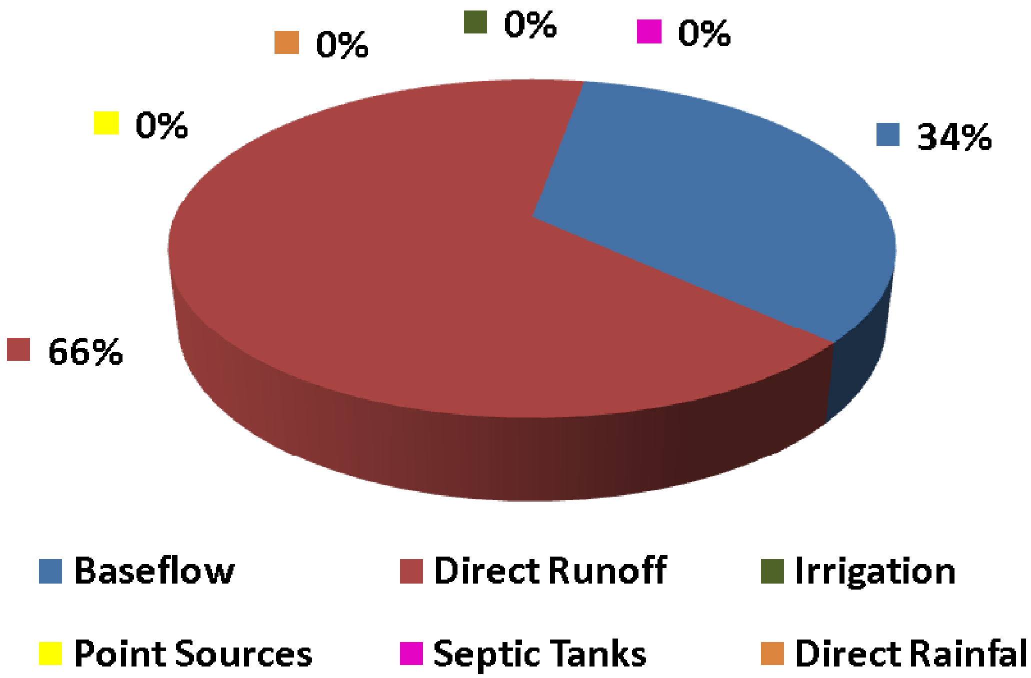

Figure 4-10 Forked Creek Basin Historical Total Volume Water Budget

Table 4-15 Summary of Annual Historical Total Volume Inputs for Forked Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	2,989.5	15,334.0	0.0	0.0	0.0	0.0
1949	1,829.5	2,558.4	0.0	0.0	0.0	0.0
1950	1,220.6	3,774.8	0.0	0.0	0.0	0.0
1951	2,712.8	5,426.7	0.0	0.0	0.0	0.0
1952	1,884.2	2,487.5	0.0	0.0	0.0	0.0
1953	1,467.9	2,361.2	0.0	0.0	0.0	0.0
1954	2,184.2	6,539.5	0.0	0.0	0.0	0.0
1955	1,774.2	4,101.0	0.0	0.0	0.0	0.0
1956	2,829.7	10,668.5	0.0	0.0	0.0	0.0
1957	1,753.9	3,036.8	0.0	0.0	0.0	0.0
1958	2,437.5	8,906.9	0.0	0.0	0.0	0.0
1959	1,919.1	2,037.6	0.0	0.0	0.0	0.0
1960	1,000.5	602.4	0.0	0.0	0.0	0.0
Average	**2,000.3**	**5,218.1**	**0.0**	**0.0**	**0.0**	**0.0**

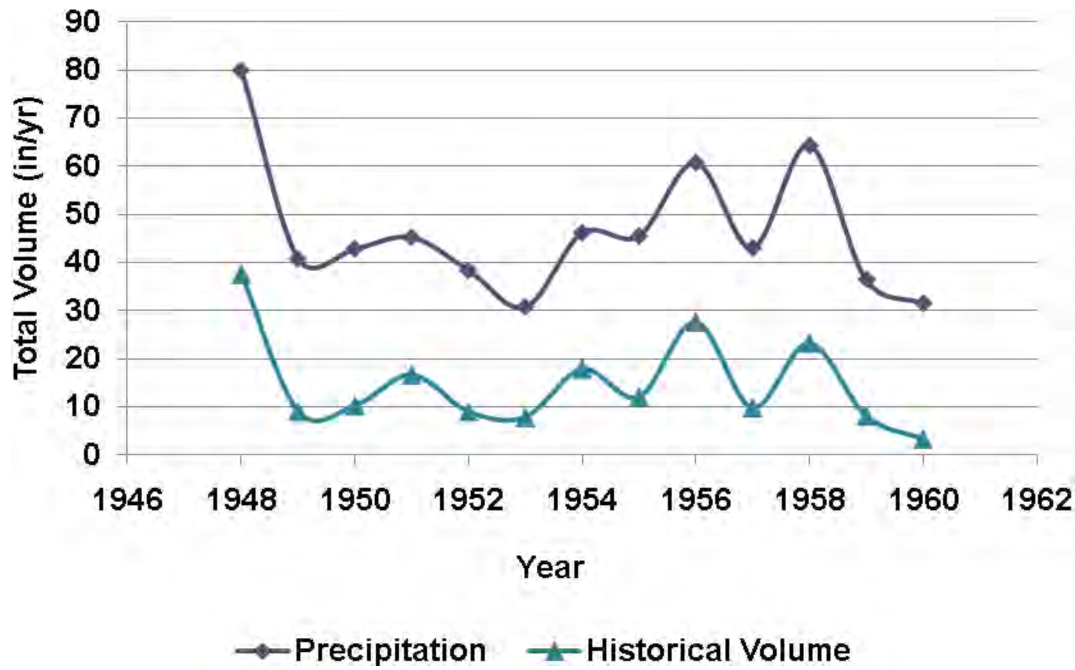

Figure 4-11 Annual Historical Variability of Precipitation and Total Volume for Forked Creek Basin

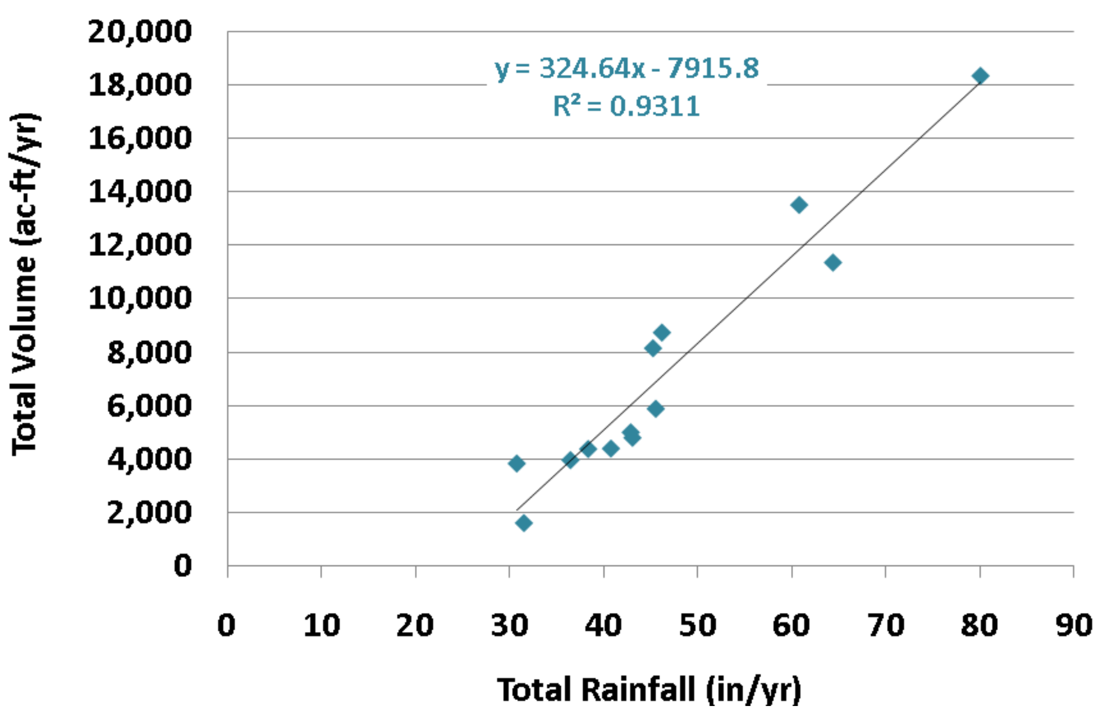

Figure 4-12 Correlation of Annual Total Volume to Rainfall for Forked Creek Basin

Table 4-16 Annual Total Volume to Rainfall Coefficients for Forked Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	37.51	80.03	0.47
1949	8.98	40.78	0.22
1950	10.23	42.88	0.24
1951	16.66	45.25	0.37
1952	8.95	38.37	0.23
1953	7.84	30.78	0.25
1954	17.86	46.19	0.39
1955	12.03	45.54	0.26
1956	27.63	60.77	0.45
1957	9.81	43.07	0.23
1958	23.22	64.36	0.36
1959	8.10	36.48	0.22
1960	3.28	31.54	0.10
Average	**14.78**	**46.62**	**0.29**

Figure 4-13 Variability of Average Monthly Total Volume in Forked Creek Basin

Table 4-17 Average Monthly Rainfall to Total Volume Coefficients for Forked Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.69	1.79	0.39
Feb	0.70	1.98	0.35
Mar	0.64	2.22	0.29
Apr	0.44	2.05	0.22
May	0.42	1.97	0.21
Jun	2.24	8.05	0.28
Jul	2.13	7.10	0.30
Aug	2.05	7.10	0.29
Sep	2.49	7.06	0.35
Oct	1.36	3.41	0.40
Nov	0.84	1.86	0.45
Dec	0.76	2.03	0.37

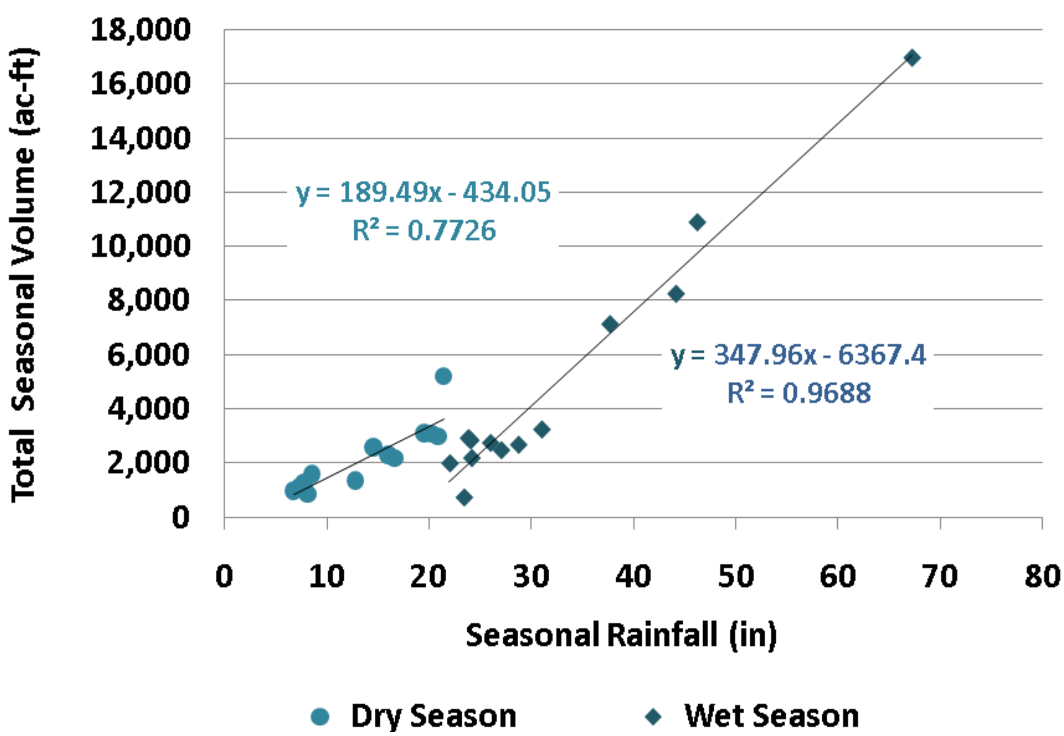

Figure 4-14 Correlation of Seasonal Total Volume to Rainfall for Forked Creek Basin

Table 4-18 Wet Season Total Volume to Rainfall Coefficients			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	34.74	67.24	0.52
1996	4.51	24.14	0.19
1997	4.11	22.01	0.19
1998	6.02	23.83	0.25
1999	6.67	31.00	0.22
2000	5.85	24.04	0.24
2001	14.63	37.67	0.39
2002	5.65	25.99	0.22
2003	22.32	46.21	0.48
2004	5.11	27.04	0.19
2005	16.92	44.13	0.38
2006	5.52	28.73	0.19
2007	1.53	23.41	0.07
Average	**10.27**	**32.72**	**0.27**

Table 4-19 Dry Season Total Volume to Rainfall Coefficients			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	2.76	12.78	0.22
1996	4.47	16.64	0.27
1997	6.11	20.88	0.29
1998	10.64	21.42	0.50
1999	2.28	7.36	0.31
2000	1.99	6.74	0.30
2001	3.23	8.52	0.38
2002	6.37	19.56	0.33
2003	5.31	14.56	0.36
2004	4.70	16.03	0.29
2005	6.30	20.23	0.31
2006	2.58	7.76	0.33
2007	1.75	8.14	0.21
Average	**4.50**	**13.89**	**0.32**

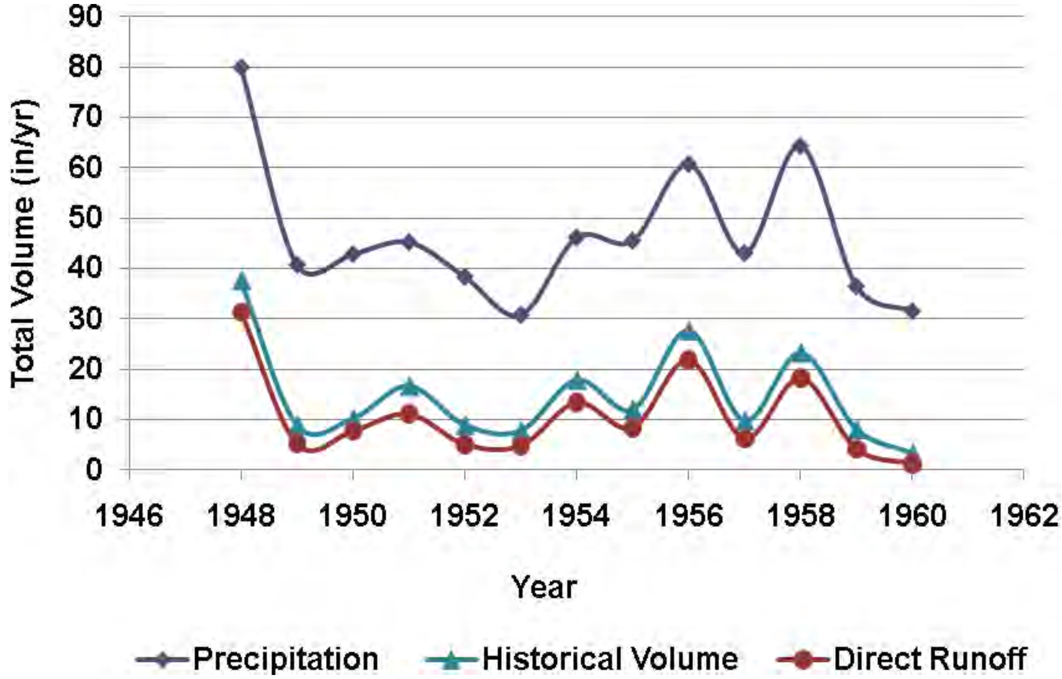

Figure 4-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Forked Creek Basin

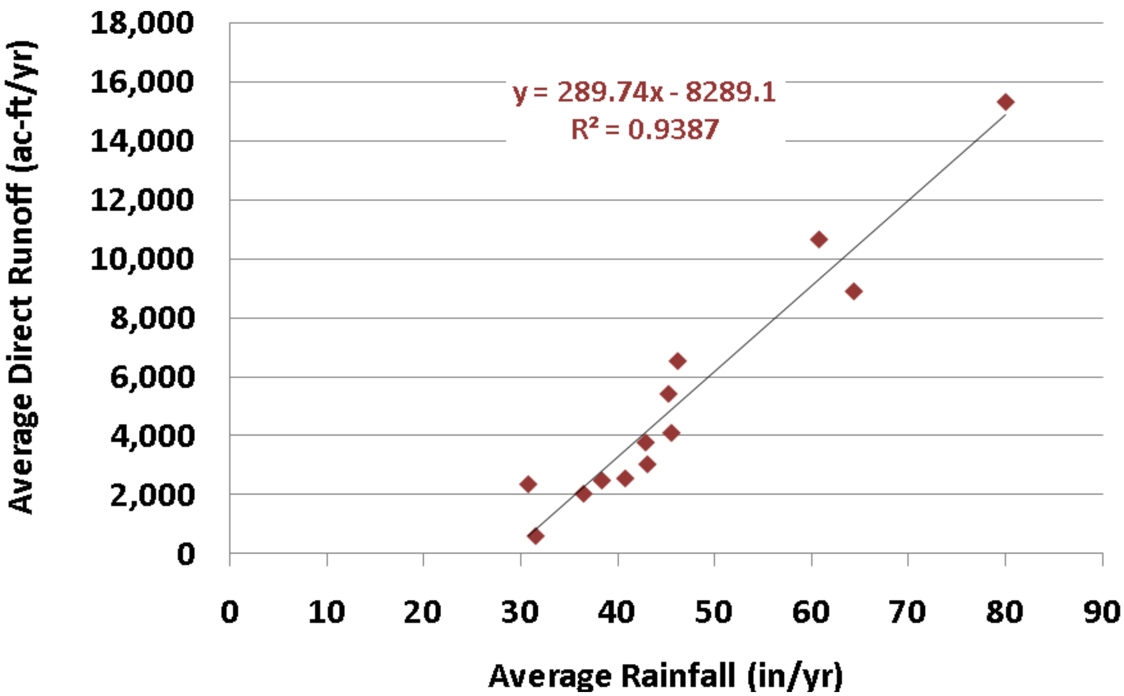

Figure 4-16 Correlation of Average Annual Direct Runoff to Rainfall

Table 4-20 Annual Direct Runoff to Rainfall Coefficients for Forked Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	31.39	80.03	0.39
1949	5.24	40.78	0.13
1950	7.73	42.88	0.18
1951	11.11	45.25	0.25
1952	5.09	38.37	0.13
1953	4.83	30.78	0.16
1954	13.39	46.19	0.29
1955	8.39	45.54	0.18
1956	21.84	60.77	0.36
1957	6.22	43.07	0.14
1958	18.23	64.36	0.28
1959	4.17	36.48	0.11
1960	1.23	31.54	0.04
Average	**10.68**	**46.62**	**0.20**

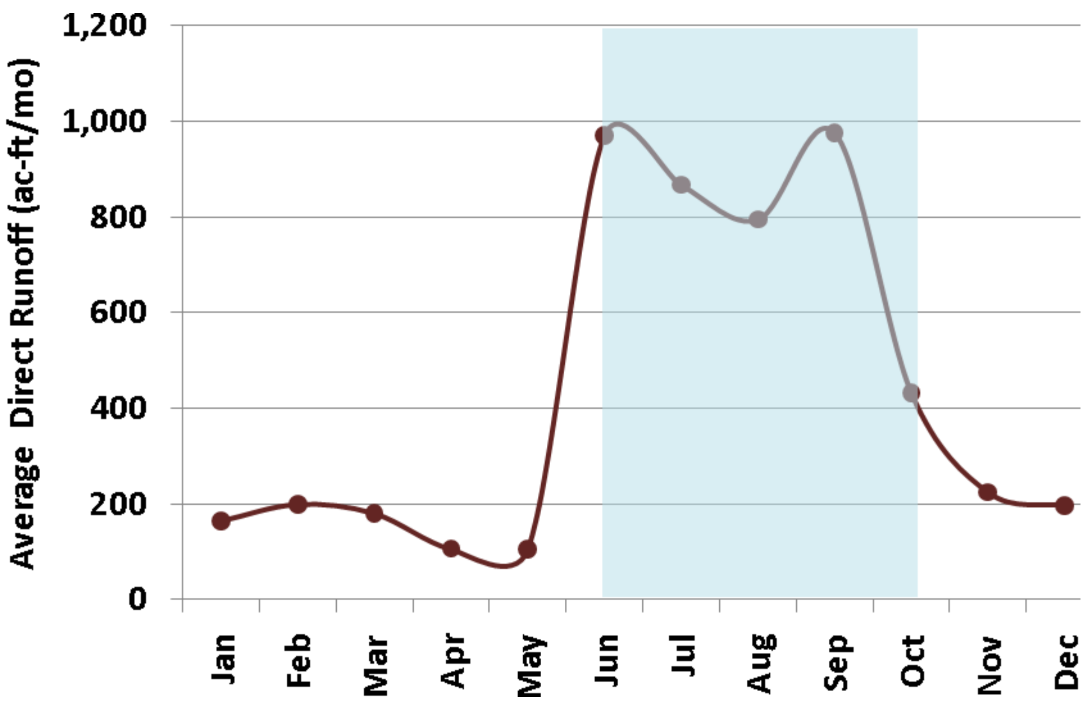

Figure 4-17 Variability of Average Monthly Direct Runoff to Forked Creek Basin

Table 4-21 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.34	1.79	0.19
Feb	0.41	1.98	0.21
Mar	0.37	2.22	0.17
Apr	0.22	2.05	0.11
May	0.21	1.97	0.11
Jun	1.99	8.05	0.25
Jul	1.78	7.10	0.25
Aug	1.63	7.10	0.23
Sep	2.00	7.06	0.28
Oct	0.88	3.41	0.26
Nov	0.46	1.86	0.25
Dec	0.40	2.03	0.20

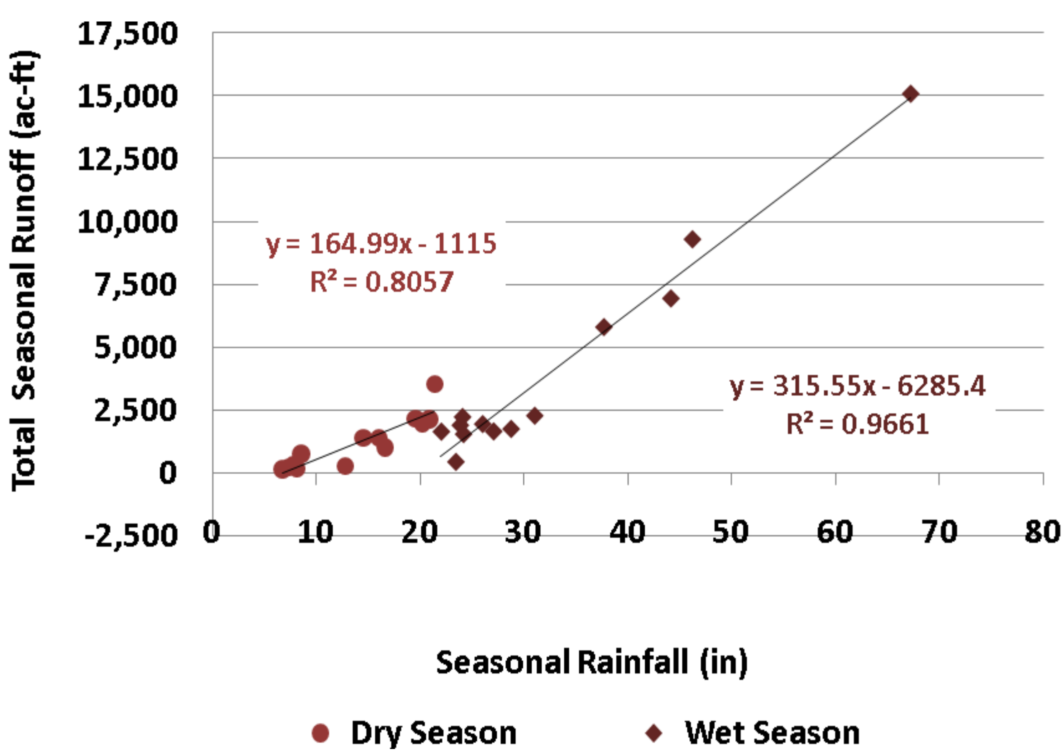

Figure 4-18 Correlation of Seasonal Direct Runoff to Rainfall

Table 4-22 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	30.85	67.24	0.46
1949	3.17	24.14	0.13
1950	3.38	22.01	0.15
1951	3.89	23.83	0.16
1952	4.67	31.00	0.15
1953	4.56	24.04	0.19
1954	11.88	37.67	0.32
1955	3.99	25.99	0.15
1956	19.02	46.21	0.41
1957	3.40	27.04	0.13
1958	14.21	44.13	0.32
1959	3.60	28.73	0.13
1960	0.92	23.41	0.04
Average	**8.27**	**32.72**	**0.21**

Table 4-23 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.54	12.78	0.04
1949	2.06	16.64	0.12
1950	4.35	20.88	0.21
1951	7.21	21.42	0.34
1952	0.42	7.36	0.06
1953	0.27	6.74	0.04
1954	1.51	8.52	0.18
1955	4.40	19.56	0.23
1956	2.82	14.56	0.19
1957	2.82	16.03	0.18
1958	4.03	20.23	0.20
1959	0.57	7.76	0.07
1960	0.32	8.14	0.04
Average	**2.41**	**13.89**	**0.15**

4.3 FUTURE CONDITIONS

Table 4-24 Future Total Volume for Forked Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	672.6	387.4	325.9	294.3	155.7	6,085.4	6,085.9	2,676.9	3,845.6	3,794.5	924.0	598.6	25,846.9
2016	957.2	439.2	603.5	331.3	717.2	433.3	427.7	1,161.4	805.1	1,761.9	478.4	371.3	8,487.5
2017	330.9	155.1	210.7	582.6	132.3	278.4	190.8	207.2	1,756.9	524.6	1,050.3	1,590.7	7,010.7
2018	1,912.0	1,727.3	1,780.6	497.6	424.1	362.2	1,027.1	704.4	1,675.4	840.6	1,309.5	329.8	12,590.8
2019	382.2	146.6	193.6	101.9	82.0	393.9	676.6	1,163.1	2,037.2	1,142.2	524.0	520.5	7,363.8
2020	308.0	174.7	146.6	206.5	111.0	261.4	228.8	2,006.7	1,148.4	394.6	306.6	214.6	5,507.8
2021	155.6	108.5	1,184.3	93.5	70.8	538.0	2,668.7	1,974.2	3,321.5	983.7	499.8	338.7	11,937.3
2022	248.2	643.9	149.9	177.7	362.9	316.0	260.7	1,981.9	1,293.6	609.0	1,651.0	1,043.3	8,738.1
2023	429.1	271.4	270.2	584.1	457.8	3,212.0	1,147.7	4,452.0	5,024.6	971.6	540.4	971.7	18,332.6
2024	309.8	841.1	267.7	432.9	149.0	439.2	728.7	1,274.8	1,210.6	1,145.2	795.9	825.7	8,420.5
2025	585.1	826.4	1,081.0	320.1	851.5	4,589.5	2,873.9	1,293.8	1,097.0	2,971.0	1,183.2	533.0	18,205.5
2026	326.8	500.1	167.2	121.4	153.9	306.7	1,039.3	1,365.4	1,499.7	812.8	423.9	447.8	7,165.0
2027	297.0	217.5	129.3	266.3	96.9	295.7	268.5	186.8	366.9	775.2	399.1	241.5	3,540.8
Average	**531.9**	**495.3**	**500.8**	**308.5**	**289.6**	**1,347.1**	**1,355.7**	**1,573.0**	**1,929.4**	**1,286.7**	**775.9**	**617.5**	**11,011.3**

3

Table 4-25 Future Direct Runoff for Forked Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	350.1	106.4	55.0	109.6	14.5	5,639.1	4,884.8	1,224.1	2,423.1	2,263.6	30.5	71.3	17,172.0
2016	410.2	89.9	348.5	110.8	534.2	252.3	209.4	784.4	378.5	1,022.8	8.1	49.3	4,198.3
2017	103.7	2.0	79.2	480.5	42.6	208.5	124.0	144.4	1,644.8	301.2	801.3	1,055.8	4,988.0
2018	1,123.6	785.9	1,004.1	0.4	69.1	110.1	785.8	391.9	1,006.3	30.9	831.8	13.4	6,153.3
2019	162.8	0.0	71.2	9.2	4.7	330.7	538.3	805.4	1,286.9	254.2	24.8	180.4	3,668.6
2020	70.0	9.6	11.8	102.5	24.6	192.1	163.3	1,821.0	715.2	0.0	43.1	15.0	3,168.2
2021	4.4	0.0	1,087.4	11.5	3.6	483.1	2,201.2	866.3	2,134.2	74.7	3.7	2.8	6,872.8
2022	9.6	478.6	6.5	71.2	275.3	240.7	160.6	1,721.1	326.1	15.8	1,282.4	557.7	5,145.7
2023	0.0	20.5	72.9	438.9	337.5	2,801.2	308.8	2,992.3	3,701.4	24.3	6.0	599.0	11,302.6
2024	59.0	652.7	65.3	289.6	38.4	354.1	581.2	697.7	462.2	542.0	403.2	539.9	4,685.3
2025	319.3	640.1	844.5	108.1	654.0	3,702.7	1,441.3	370.1	309.6	2,187.7	454.4	0.2	11,031.9
2026	3.8	289.8	2.0	0.0	53.8	227.3	856.2	802.2	571.2	126.9	3.9	144.9	3,081.9
2027	79.3	68.3	6.9	174.5	21.7	234.9	211.9	120.4	251.7	496.3	75.1	20.9	1,761.8
Average	**207.4**	**241.8**	**281.2**	**146.7**	**159.5**	**1,136.7**	**959.0**	**980.1**	**1,170.1**	**564.6**	**305.2**	**250.1**	**6,402.3**

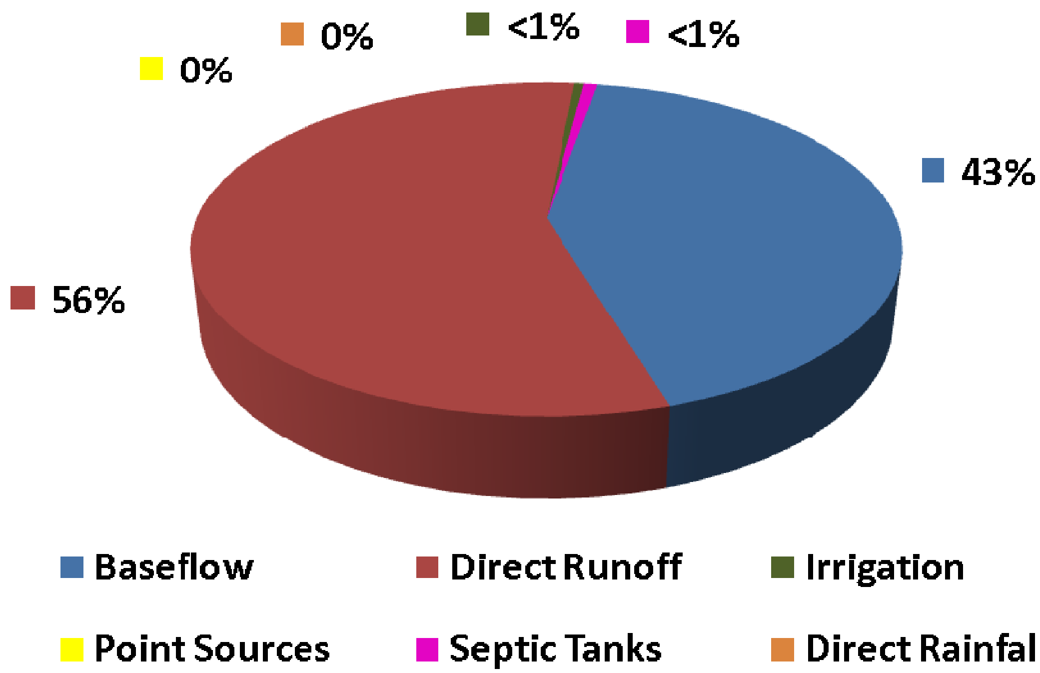

Figure 4-19 Forked Creek Basin Current Total Volume Water Budget

Table 4-26 Summary of Annual Future Total Volume Inputs for Forked Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	8,569.4	17,172.0	43.8	0.0	61.8	0.0
2016	4,183.6	4,198.3	43.8	0.0	61.8	0.0
2017	1,917.1	4,988.0	43.8	0.0	61.8	0.0
2018	6,331.8	6,153.3	43.8	0.0	61.8	0.0
2019	3,589.5	3,668.6	43.8	0.0	61.8	0.0
2020	2,234.0	3,168.2	43.8	0.0	61.8	0.0
2021	4,958.9	6,872.8	43.8	0.0	61.8	0.0
2022	3,486.7	5,145.7	43.8	0.0	61.8	0.0
2023	6,924.4	11,302.6	43.8	0.0	61.8	0.0
2024	3,629.7	4,685.3	43.8	0.0	61.8	0.0
2025	7,068.1	11,031.9	43.8	0.0	61.8	0.0
2026	3,977.6	3,081.9	43.8	0.0	61.8	0.0
2027	1,673.5	1,761.8	43.8	0.0	61.8	0.0
Average	**4,503.4**	**6,402.3**	**43.8**	**0.0**	**61.8**	**0.0**

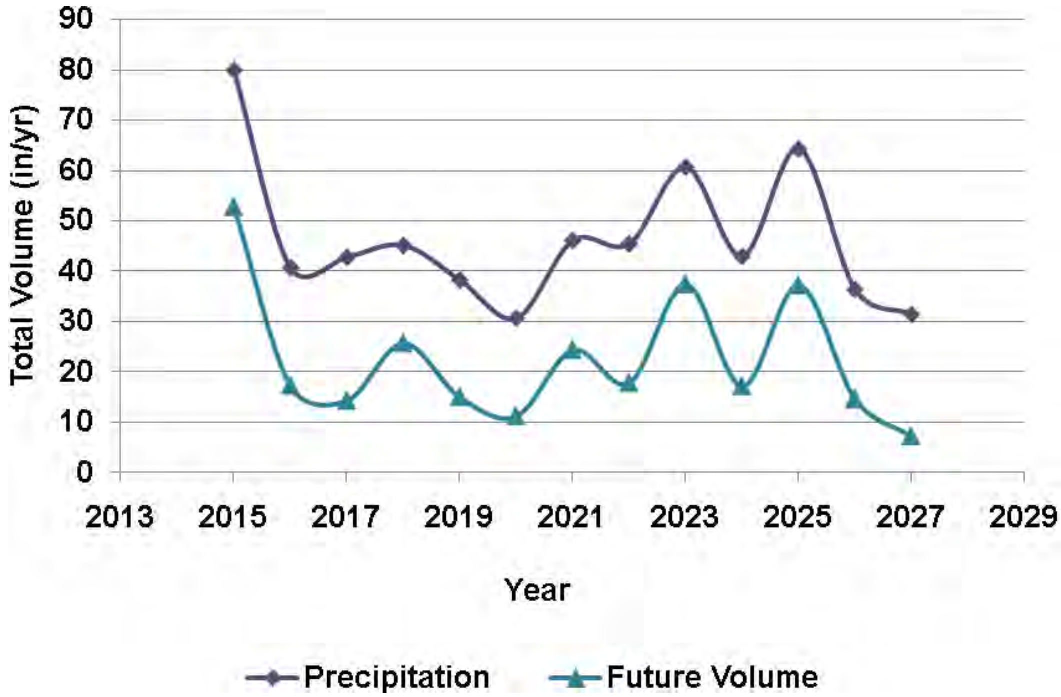

Figure 4-20 Annual Variability of Precipitation and Total Volume for Forked Creek Basin

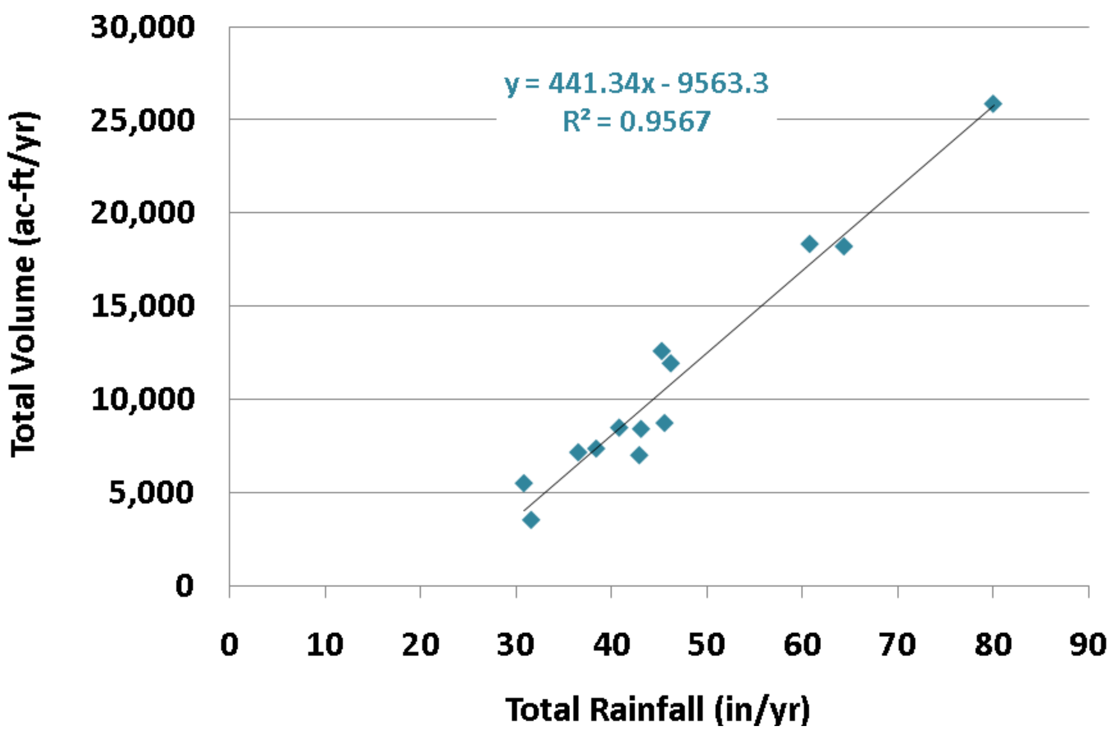

Figure 4-21 Correlation of Annual Total Volume to Rainfall for Forked Creek Basin

Table 4-27 Annual Total Volume to Rainfall Coefficients for Forked Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	52.91	80.03	0.66
2016	17.37	40.78	0.43
2017	14.35	42.88	0.33
2018	25.77	45.25	0.57
2019	15.07	38.37	0.39
2020	11.27	30.78	0.37
2021	24.43	46.19	0.53
2022	17.89	45.54	0.39
2023	37.52	60.77	0.62
2024	17.24	43.07	0.40
2025	37.26	64.36	0.58
2026	14.67	36.48	0.40
2027	7.25	31.54	0.23
Average	**22.54**	**46.62**	**0.45**

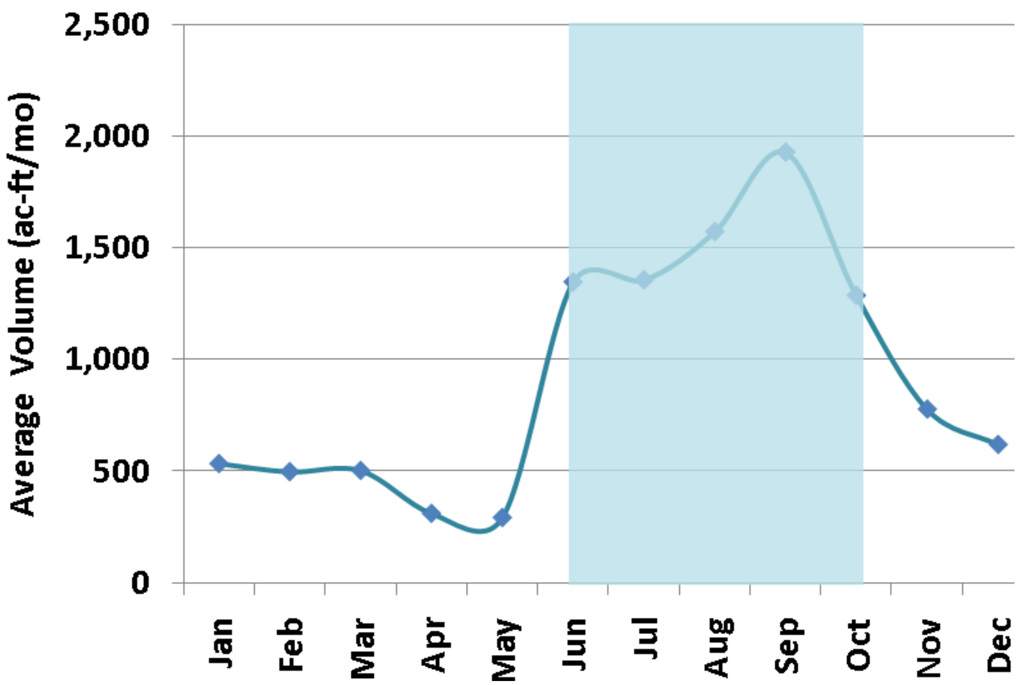

Figure 4-22 Variability of Average Monthly Total Volume in Forked Creek Basin

Table 4-28 Average Monthly Rainfall to Total Volume Coefficients for Forked Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.09	1.79	0.61
Feb	1.01	1.98	0.51
Mar	1.03	2.22	0.46
Apr	0.63	2.05	0.31
May	0.59	1.97	0.30
Jun	2.76	8.05	0.34
Jul	2.78	7.10	0.39
Aug	3.22	7.10	0.45
Sep	3.95	7.06	0.56
Oct	2.63	3.41	0.77
Nov	1.59	1.86	0.85
Dec	1.26	2.03	0.62

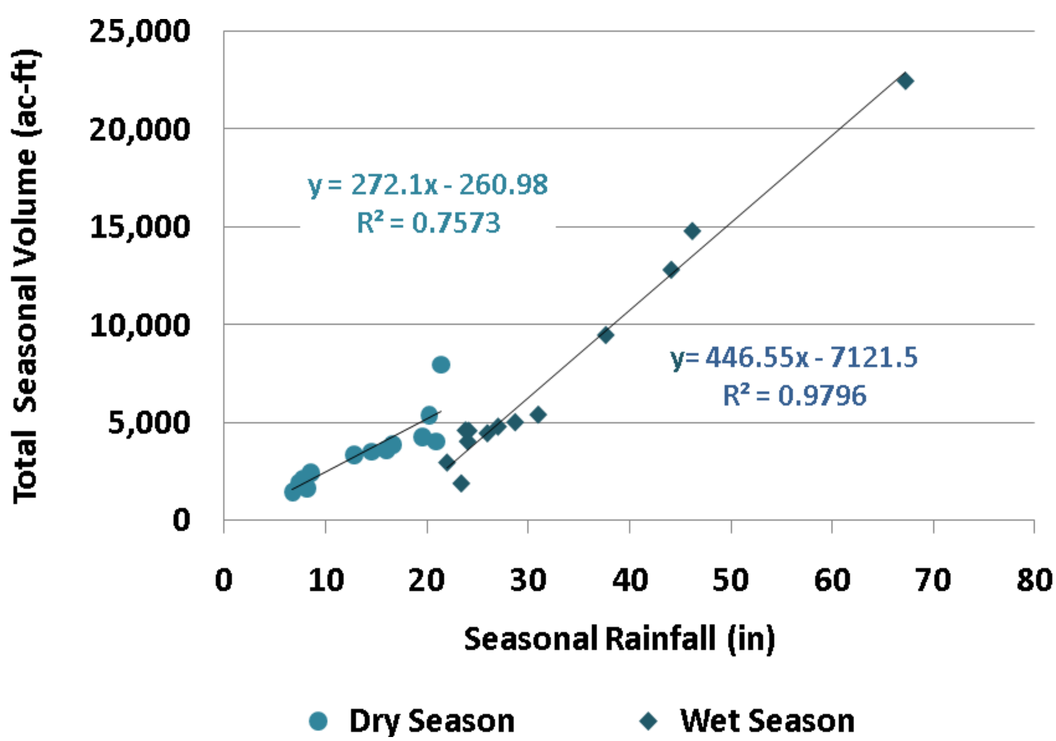

Figure 4-23 Correlation of Seasonal Total Volume to Rainfall for Forked Creek Basin

Table 4-29 Wet Season Total Volume to Rainfall Coefficients for Forked Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	46.03	67.24	0.68
2016	9.39	24.14	0.39
2017	6.05	22.01	0.28
2018	9.44	23.83	0.40
2019	11.08	31.00	0.36
2020	8.27	24.04	0.34
2021	19.42	37.67	0.52
2022	9.13	25.99	0.35
2023	30.31	46.21	0.66
2024	9.82	27.04	0.36
2025	26.25	44.13	0.59
2026	10.28	28.73	0.36
2027	3.88	23.41	0.17
Average	**15.33**	**32.72**	**0.42**

Table 4-30 Dry Season Total Volume to Rainfall Coefficients for Forked Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	6.87	12.78	0.54
2016	7.98	16.64	0.48
2017	8.30	20.88	0.40
2018	16.34	21.42	0.76
2019	3.99	7.36	0.54
2020	3.00	6.74	0.45
2021	5.02	8.52	0.59
2022	8.75	19.56	0.45
2023	7.21	14.56	0.50
2024	7.41	16.03	0.46
2025	11.01	20.23	0.54
2026	4.38	7.76	0.56
2027	3.37	8.14	0.41
Average	**7.20**	**13.89**	**0.51**

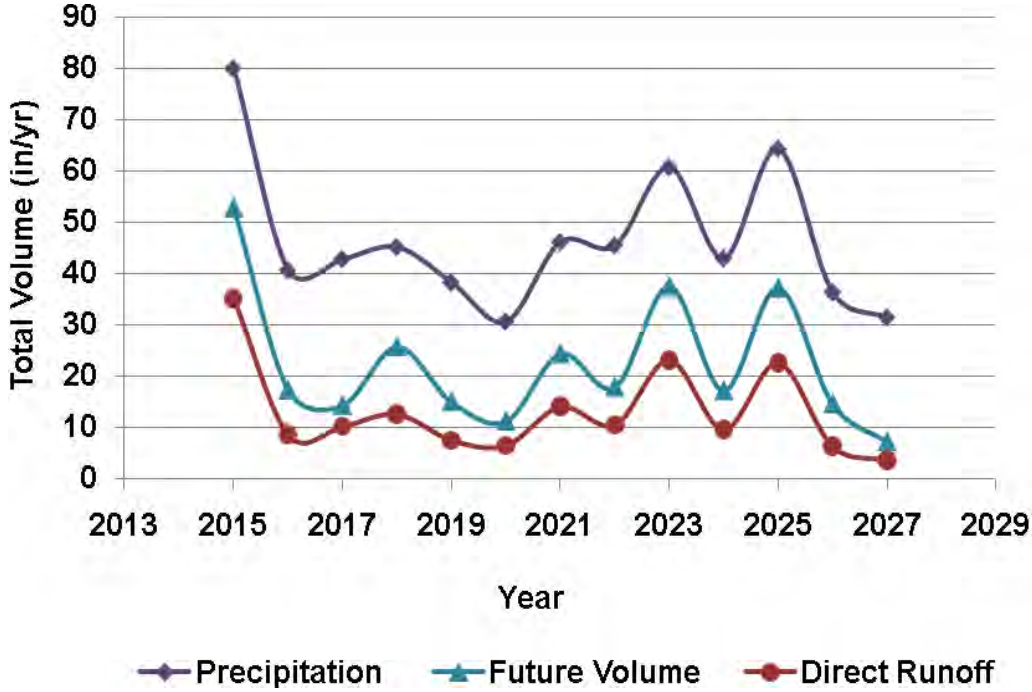

Figure 4-24 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Forked Creek Basin

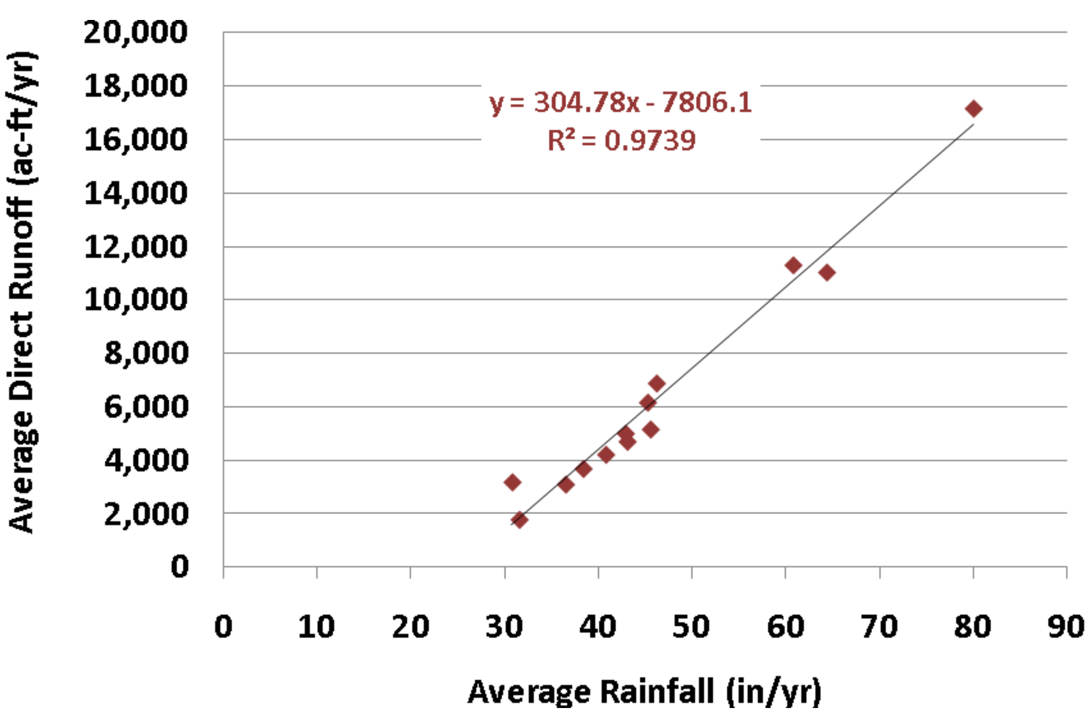

Figure 4-25 Correlation of Average Annual Direct Runoff to Rainfall

Table 4-31 Annual Direct Runoff to Rainfall Coefficients for Forked Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	35.15	80.03	0.44
2016	8.59	40.78	0.21
2017	10.21	42.88	0.24
2018	12.60	45.25	0.28
2019	7.51	38.37	0.20
2020	6.48	30.78	0.21
2021	14.07	46.19	0.30
2022	10.53	45.54	0.23
2023	23.13	60.77	0.38
2024	9.59	43.07	0.22
2025	22.58	64.36	0.35
2026	6.31	36.48	0.17
2027	3.61	31.54	0.11
Average	**13.10**	**46.62**	**0.26**

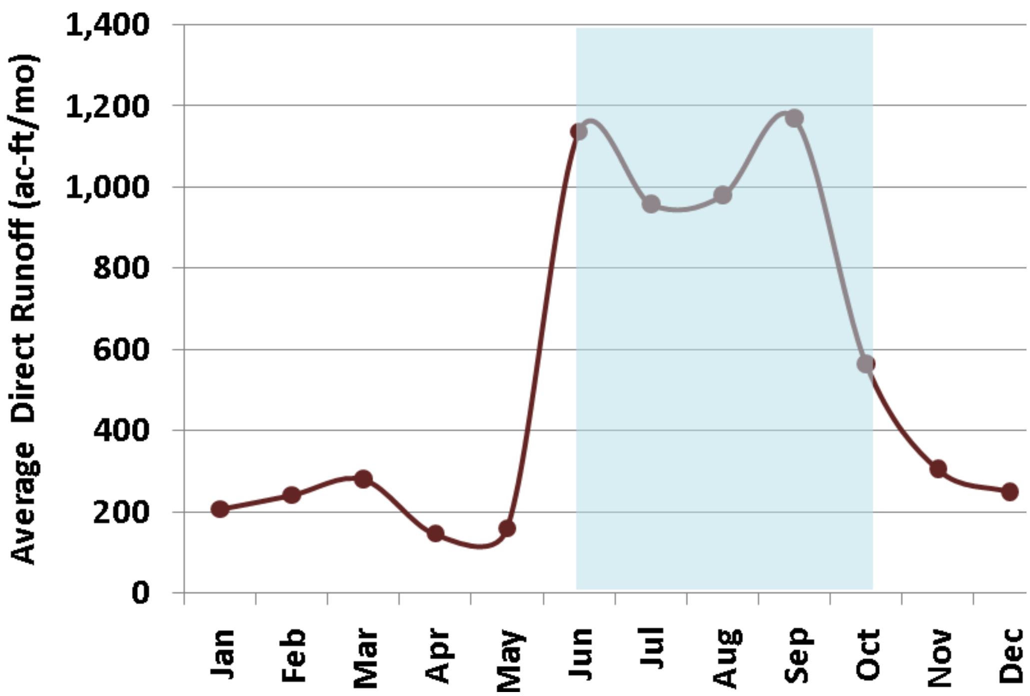

Figure 4-26 Variability of Average Monthly Direct Runoff to Forked Creek Basin

Table 4-32 Average Monthly Rainfall to Direct Runoff Coefficients for Forked Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.42	1.79	0.24
Feb	0.49	1.98	0.25
Mar	0.58	2.22	0.26
Apr	0.30	2.05	0.15
May	0.33	1.97	0.17
Jun	2.33	8.05	0.29
Jul	1.96	7.10	0.28
Aug	2.01	7.10	0.28
Sep	2.40	7.06	0.34
Oct	1.16	3.41	0.34
Nov	0.62	1.86	0.34
Dec	0.51	2.03	0.25

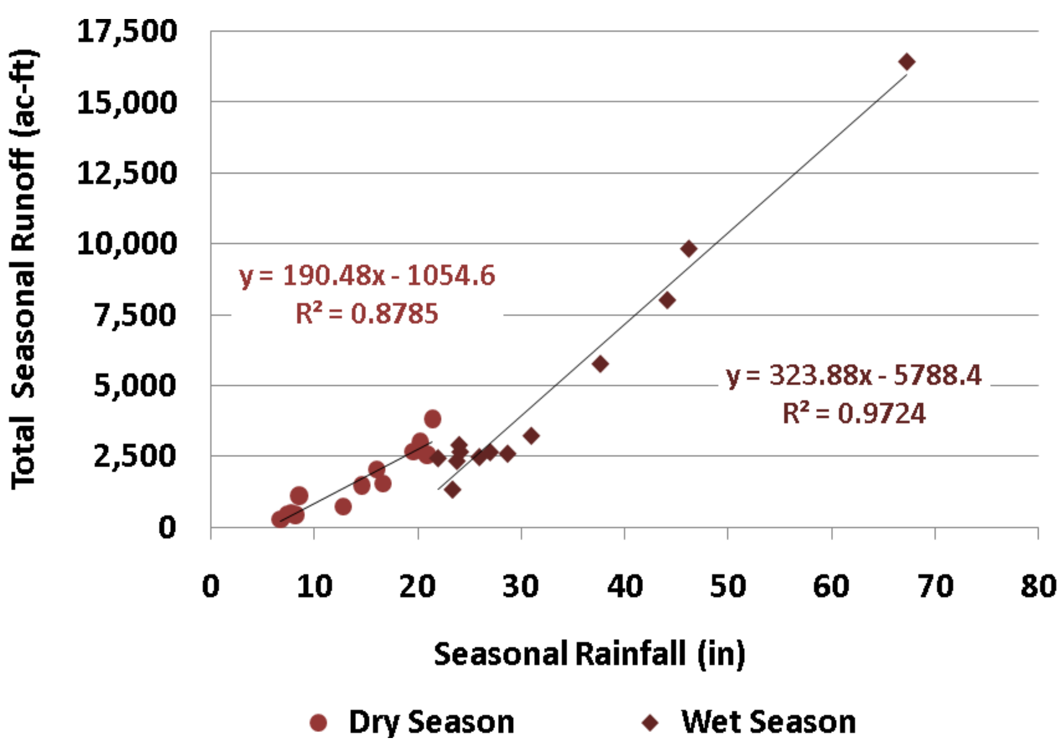

Figure 4-27 Correlation of Seasonal Direct Runoff to Rainfall

Table 4-33 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	33.64	67.24	0.50
2016	5.42	24.14	0.22
2017	4.96	22.01	0.23
2018	4.76	23.83	0.20
2019	6.58	31.00	0.21
2020	5.92	24.04	0.25
2021	11.79	37.67	0.31
2022	5.04	25.99	0.19
2023	20.12	46.21	0.44
2024	5.40	27.04	0.20
2025	16.40	44.13	0.37
2026	5.29	28.73	0.18
2027	2.69	23.41	0.12
Average	**9.85**	**32.72**	**0.26**

Table 4-34 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	1.51	12.78	0.12
2016	3.17	16.64	0.19
2017	5.25	20.88	0.25
2018	7.84	21.42	0.37
2019	0.93	7.36	0.13
2020	0.57	6.74	0.08
2021	2.28	8.52	0.27
2022	5.49	19.56	0.28
2023	3.02	14.56	0.21
2024	4.19	16.03	0.26
2025	6.18	20.23	0.31
2026	1.02	7.76	0.13
2027	0.91	8.14	0.11
Average	**3.26**	**13.89**	**0.21**

4.4 WATER BUDGET CHANGES

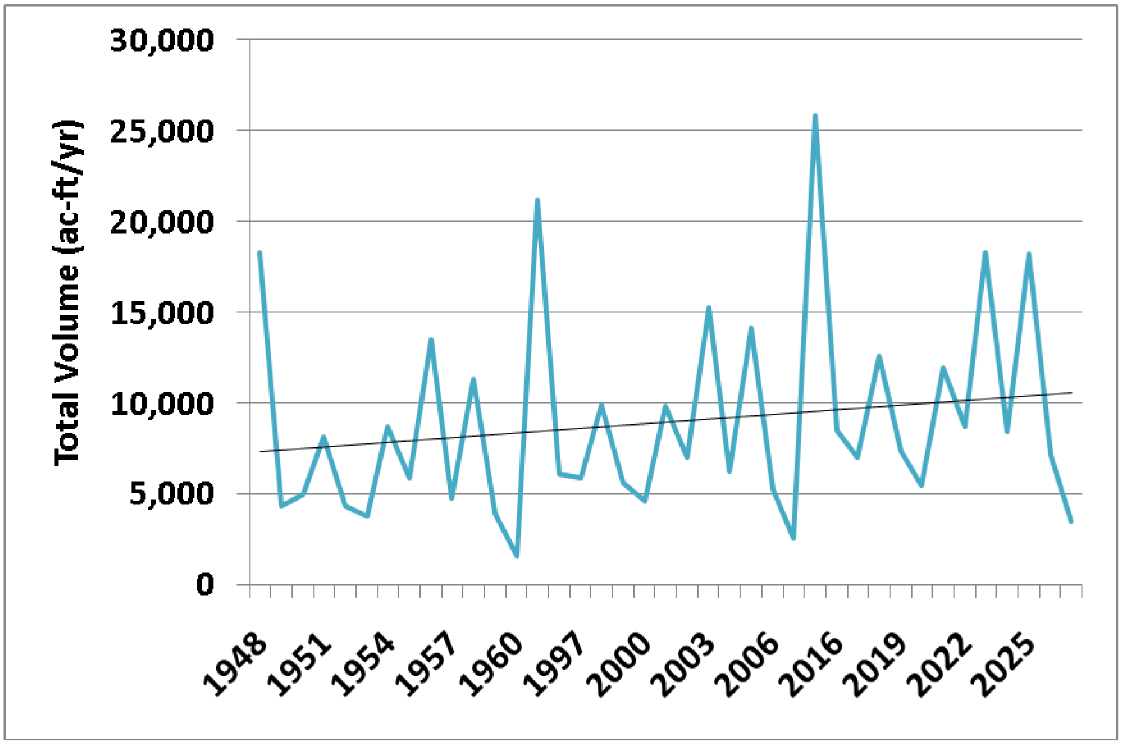

Figure 4-28 Trend in Total Volume from Historical through Future Time Series

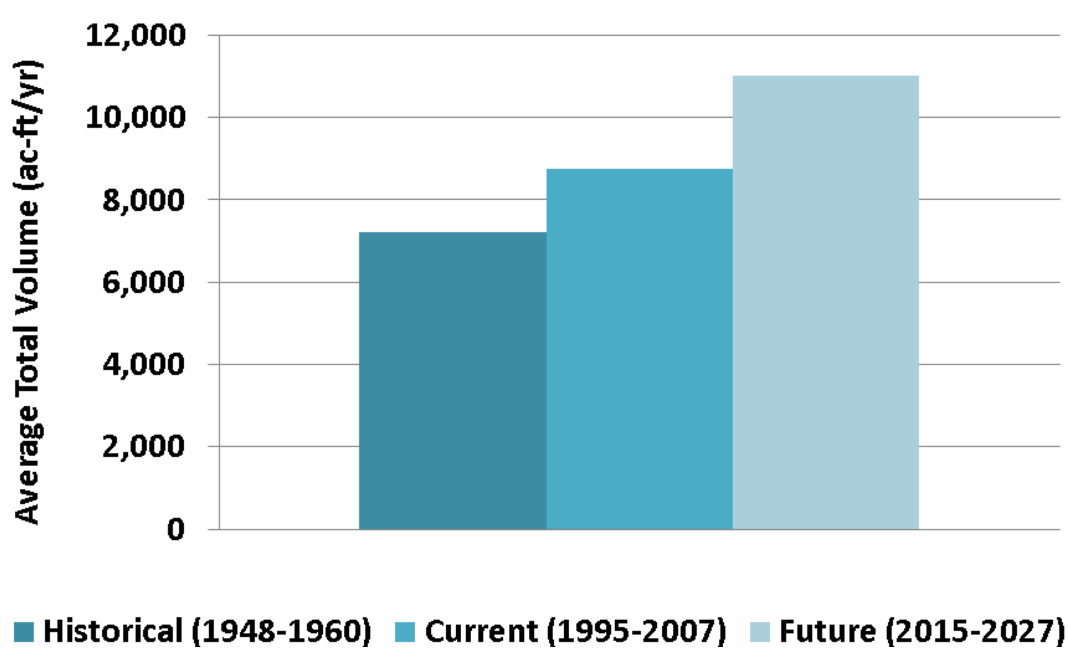

Figure 4-29 Historical, Current, and Future Average Annual Total Volume to Lemon Bay

Table 4-35 Change in Total Volume from Historic to Current Conditions

Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	18,324	21,198	2,874
2	4,388	6,135	1,747
3	4,995	5,940	944
4	8,139	9,908	1,768
5	4,372	5,596	1,225
6	3,829	4,646	817
7	8,724	9,873	1,150
8	5,875	7,017	1,141
9	13,498	15,272	1,773
10	4,791	6,250	1,460
11	11,344	14,123	2,778
12	3,957	5,296	1,339
13	1,603	2,618	1,016
Average	**7,218**	**8,759**	**1,541**

Table 4-36 Change in Total Volume from Current to Future Conditions

Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	21,198	25,847	4,649
2	6,135	8,488	2,352
3	5,940	7,011	1,071
4	9,908	12,591	2,683
5	5,596	7,364	1,767
6	4,646	5,508	862
7	9,873	11,937	2,064
8	7,017	8,738	1,722
9	15,272	18,333	3,061
10	6,250	8,421	2,170
11	14,123	18,206	4,083
12	5,296	7,165	1,869
13	2,618	3,541	922
Average	**8,759**	**11,011**	**2,252**

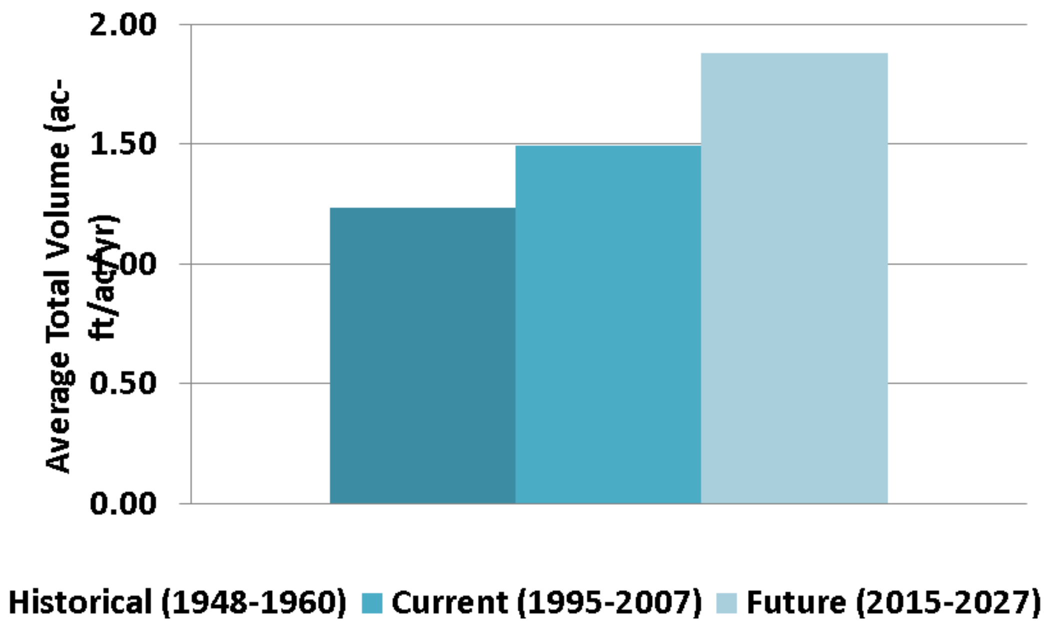

Figure 4-30 Normalized Historical, Current, and Future Average Annual Total Volume to Lemon Bay

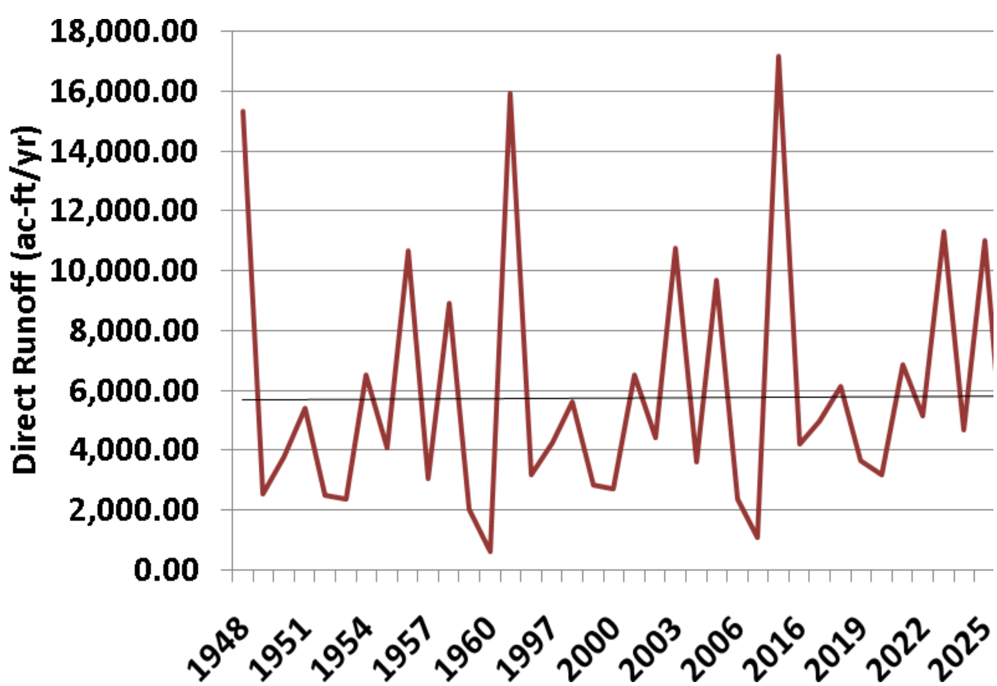

Figure 4-31 Trend in Direct Runoff from Historical through Future Time Series

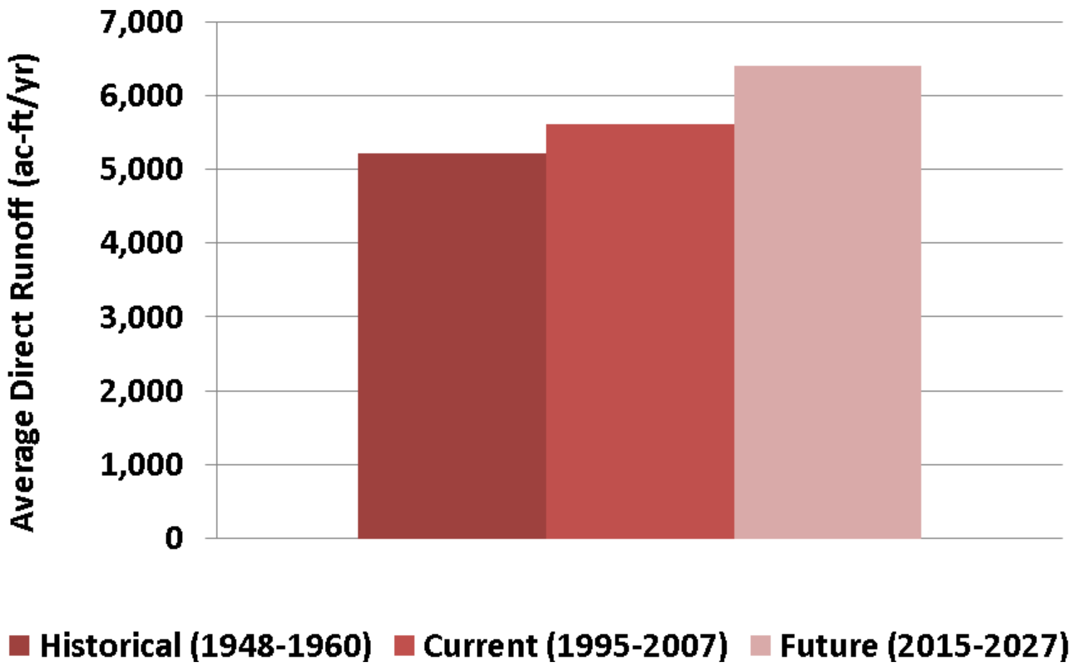

Figure 4-32 Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

Table 4-37 Change in Direct Runoff from Historic to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	15,334	15,944	610
2	2,558	3,161	603
3	3,775	4,237	462
4	5,427	5,601	175
5	2,488	2,823	335
6	2,361	2,707	346
7	6,539	6,515	-25
8	4,101	4,418	317
9	10,669	10,743	74
10	3,037	3,626	590
11	8,907	9,669	762
12	2,038	2,349	311
13	602	1,086	484
Average	**5,218**	**5,606**	**388**

Table 4-38 Change in Direct Runoff from Current to Future Conditions			
Year	Current Direct Runoff (ac-ft) 1995-2007	Future Direct Runoff (ac-ft) 2015-2027	Direct Runoff Change (ac-ft) (future-current)
1	15,944	17,172	1,228
2	3,161	4,198	1,037
3	4,237	4,988	751
4	5,601	6,153	552
5	2,823	3,669	846
6	2,707	3,168	461
7	6,515	6,873	358
8	4,418	5,146	728
9	10,743	11,303	560
10	3,626	4,685	1,059
11	9,669	11,032	1,363
12	2,349	3,082	733
13	1,086	1,762	675
Average	**5,606**	**6,402**	**796**

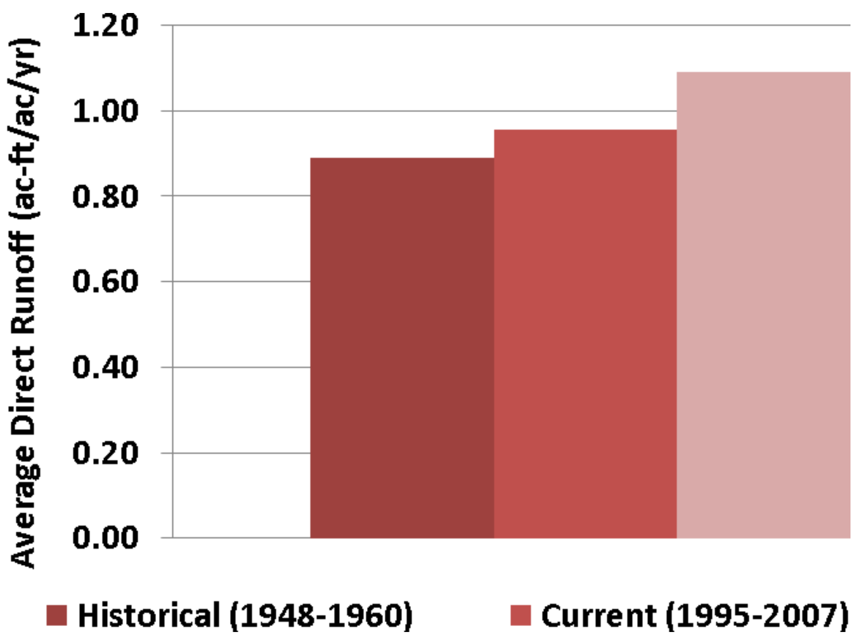

Figure 4-33 Normalized Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

5.0 GOTTFRIED CREEK BASIN

5.1 CURRENT CONDITIONS

Table 5-1 Monthly Rainfall for Gottfried Creek Basin (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	3.59	2.56	1.33	2.94	0.44	24.44	16.23	8.50	8.25	10.19	0.89	1.27	80.63
1996	1949	2016	3.34	1.04	3.69	2.30	5.23	3.85	3.59	4.73	5.00	6.67	0.57	0.92	40.93
1997	1950	2017	1.81	0.36	1.51	5.52	1.40	3.33	3.32	3.44	10.45	2.21	3.71	5.78	42.86
1998	1951	2018	6.40	4.93	4.54	0.21	1.83	2.58	7.46	5.25	8.16	1.16	4.13	0.50	47.15
1999	1952	2019	2.21	0.06	1.72	0.35	0.77	6.34	5.72	6.31	8.69	2.21	0.63	1.75	36.75
2000	1953	2020	1.25	0.44	1.07	1.79	0.54	4.87	4.24	6.60	5.55	0.36	0.61	0.49	27.81
2001	1954	2021	0.17	0.01	7.78	0.42	0.42	6.47	12.78	5.52	10.92	1.90	0.22	0.34	46.96
2002	1955	2022	0.61	4.77	0.23	1.65	3.12	7.50	2.95	11.75	3.33	0.86	5.71	4.67	47.17
2003	1956	2023	0.05	0.77	2.32	3.30	3.71	16.85	4.47	12.83	11.84	0.64	0.64	3.46	60.90
2004	1957	2024	1.81	4.10	0.88	3.42	1.12	5.47	7.48	8.10	5.42	3.17	1.88	3.14	46.00
2005	1958	2025	1.49	2.86	4.57	2.16	5.51	17.32	9.37	5.69	4.31	10.30	3.17	0.28	67.03
2006	1959	2026	0.44	2.93	0.17	0.04	1.85	5.61	11.35	6.88	5.30	1.12	0.49	2.64	38.81
2007	1960	2027	1.58	1.47	0.29	2.27	0.72	4.62	4.76	4.14	5.04	3.84	0.64	1.04	30.39
Average			1.90	2.02	2.32	2.03	2.05	8.40	7.21	6.90	7.10	3.43	1.79	2.02	47.18

Table 5-2 Current Total Volume for Gottfried Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	643.0	410.9	317.0	273.8	171.9	8,541.3	5,479.3	2,501.3	2,966.7	3,383.9	638.0	420.5	25,747.6
1996	718.1	332.1	499.9	382.0	988.9	352.0	389.5	519.0	606.4	1,625.3	371.7	305.4	7,090.4
1997	415.4	167.9	291.2	643.7	150.3	285.5	232.0	235.2	2,297.4	443.3	704.8	1,442.3	7,308.9
1998	2,627.9	1,677.7	1,597.7	352.4	356.7	311.3	1,062.9	650.6	1,520.8	591.2	1,228.0	287.0	12,264.0
1999	337.1	166.0	208.2	128.3	112.9	334.2	754.2	638.5	1,803.0	736.4	361.1	440.6	6,020.6
2000	322.5	173.4	173.9	213.9	117.8	191.6	203.8	1,219.2	852.6	296.0	228.9	191.9	4,185.3
2001	152.9	119.2	1,303.7	152.9	127.4	616.6	3,074.9	1,774.4	3,048.4	663.5	377.7	284.2	11,695.7
2002	228.0	1,013.6	182.6	211.2	367.4	622.6	305.2	2,101.5	893.5	418.2	2,000.1	933.8	9,277.7
2003	400.7	278.6	354.3	781.1	644.3	4,821.9	951.9	3,690.5	4,677.4	581.2	363.0	740.4	18,285.2
2004	355.8	903.6	289.7	601.4	182.3	428.2	687.1	1,603.4	1,291.0	1,201.7	531.1	791.8	8,867.3
2005	420.4	744.1	1,122.1	245.0	936.0	4,211.1	2,910.7	1,006.0	886.3	3,251.9	999.8	434.9	17,168.4
2006	311.1	576.7	207.5	163.0	170.7	374.6	1,740.0	1,262.6	1,085.5	545.8	324.0	510.3	7,271.8
2007	271.7	191.1	144.0	249.8	108.2	218.4	244.6	206.9	362.7	411.9	205.7	196.2	2,811.1
Average	**554.2**	**519.6**	**514.8**	**338.3**	**341.1**	**1,639.2**	**1,387.4**	**1,339.2**	**1,714.7**	**1,088.5**	**641.1**	**536.9**	**10,614.9**

Table 5-3 Current Direct Runoff for Gottfried Creek Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	348.4	140.6	45.9	71.1	2.3	8,109.7	4,700.3	1,598.3	2,049.3	2,404.7	21.9	28.6	19,521.0
1996	311.9	34.8	251.5	176.7	796.8	170.1	201.1	326.2	371.8	1,108.4	7.2	23.8	3,780.3
1997	192.5	2.2	139.4	514.9	22.7	179.8	118.1	115.0	2,122.7	182.0	469.3	1,004.6	5,063.2
1998	2,029.2	1,011.1	1,067.6	2.1	79.1	95.3	792.1	315.1	995.2	41.4	858.2	5.4	7,291.8
1999	117.5	0.0	56.8	4.9	4.6	238.8	546.2	382.5	1,352.5	169.0	15.6	170.1	3,058.6
2000	106.3	5.0	24.7	89.3	8.6	98.6	102.0	1,037.2	543.5	7.5	10.9	7.5	2,041.1
2001	0.1	0.0	1,187.7	11.1	5.1	510.3	2,630.1	1,058.4	2,327.9	77.2	7.7	1.3	7,816.9
2002	5.6	839.7	6.4	72.2	247.7	488.5	83.2	1,802.2	231.6	10.7	1,695.6	507.4	5,990.9
2003	0.0	13.6	118.2	588.4	471.2	4,394.6	264.7	2,824.5	3,857.2	15.4	7.4	454.9	13,010.1
2004	132.2	707.6	54.3	415.1	23.2	293.8	468.7	1,071.7	653.2	748.1	215.4	535.9	5,319.1
2005	188.5	573.3	915.7	57.2	748.7	3,606.6	2,028.0	353.4	311.1	2,621.7	386.1	0.3	11,790.5
2006	1.7	339.6	1.9	0.0	29.4	253.6	1,399.0	682.6	462.5	88.0	9.0	258.9	3,526.0
2007	66.6	29.9	2.8	137.1	10.8	136.1	163.0	99.0	232.5	203.1	11.6	44.6	1,137.2
Average	**269.3**	**284.4**	**297.9**	**164.6**	**188.5**	**1,428.9**	**1,038.2**	**897.4**	**1,193.2**	**590.5**	**285.8**	**234.1**	**6,872.8**

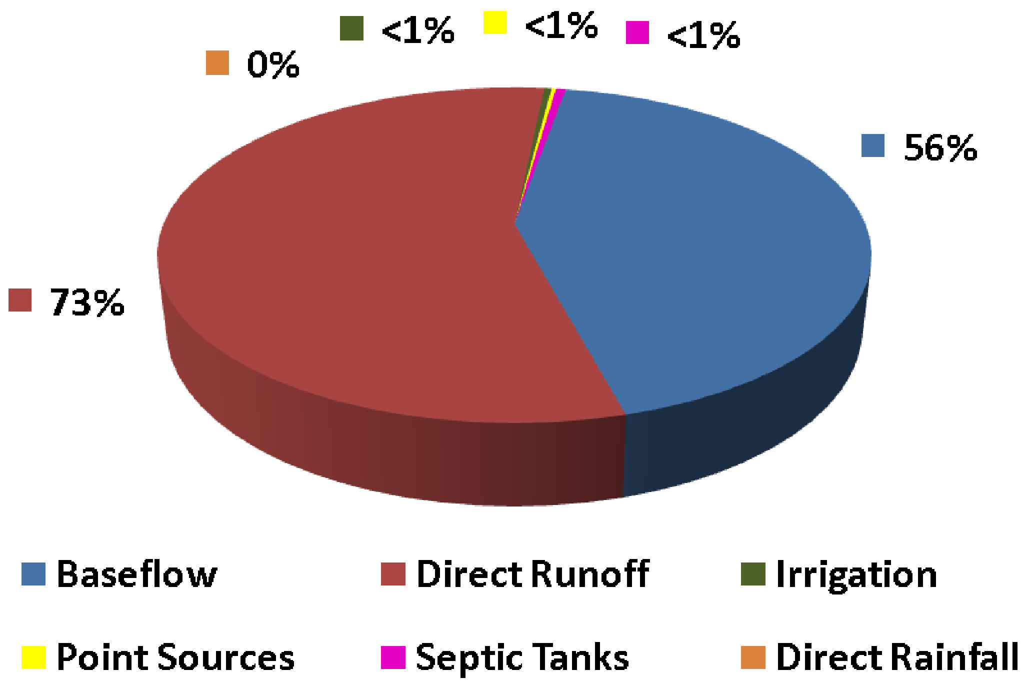

Figure 5-1 Gottfried Creek Basin Current Total Volume Water Budget

Table 5-4 Summary of Annual Current Total Volume Inputs for Gottfried Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	6,049.3	19,521.0	78.4	47.3	51.6	0.0
1996	3,132.2	3,780.3	78.4	47.3	52.2	0.0
1997	2,067.3	5,063.2	78.4	47.3	52.7	0.0
1998	4,793.8	7,291.8	78.4	47.3	52.7	0.0
1999	2,815.2	3,058.6	78.4	15.6	52.7	0.0
2000	1,968.6	2,041.1	78.4	44.4	52.8	0.0
2001	3,715.1	7,816.9	78.4	32.4	52.8	0.0
2002	3,122.9	5,990.9	78.4	32.5	53.0	0.0
2003	5,115.5	13,010.1	79.3	27.3	53.1	0.0
2004	3,414.9	5,319.1	80.2	0.0	53.1	0.0
2005	5,244.5	11,790.5	80.2	0.0	53.2	0.0
2006	3,612.5	3,526.0	80.2	0.0	53.2	0.0
2007	1,540.6	1,137.2	80.2	0.0	53.2	0.0
Average	**5,581.1**	**7,963.9**	**38.7**	**26.3**	**52.8**	**0.0**

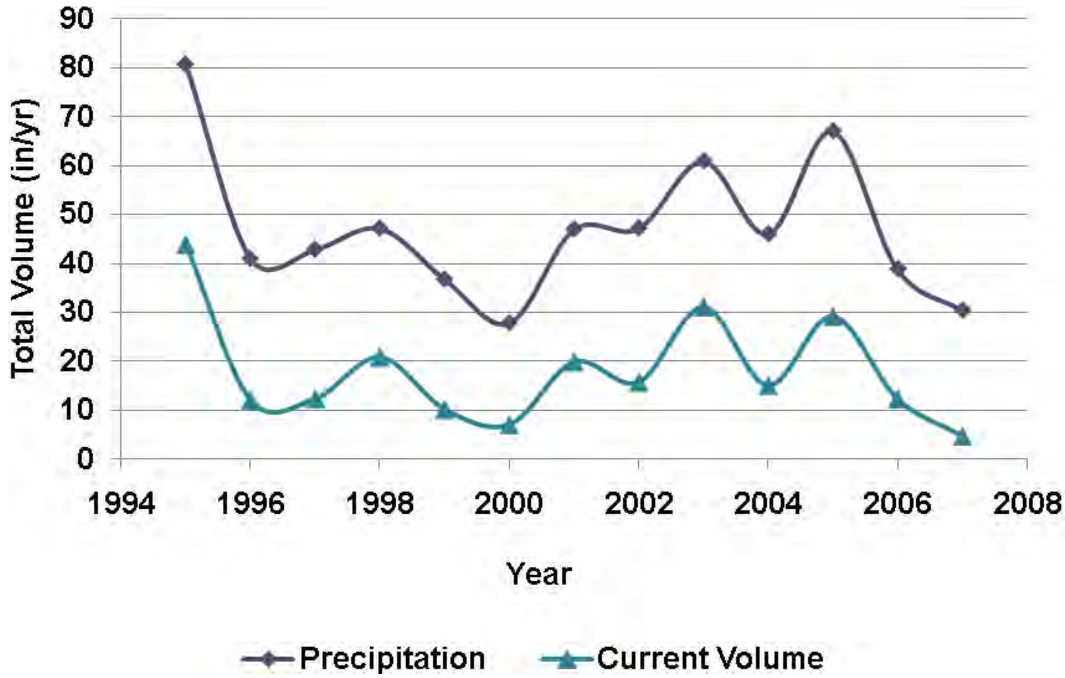

Figure 5-2 Annual Variability of Precipitation and Total Volume for Gottfried Creek Basin

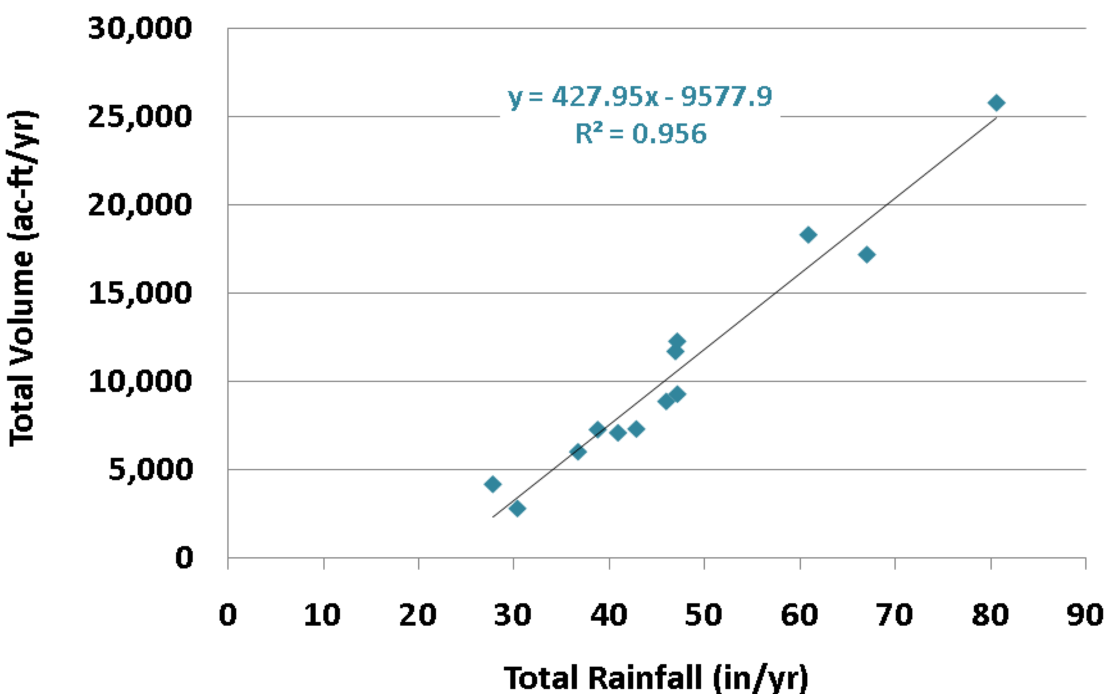

Figure 5-3 Correlation of Annual Total Volume to Rainfall for Gottfried Creek Basin

Table 5-5 Annual Total Volume to Rainfall Coefficients for Gottfried Creek Basin

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1995	43.90	80.63	0.54
1996	12.09	40.93	0.30
1997	12.46	42.86	0.29
1998	20.91	47.15	0.44
1999	10.27	36.75	0.28
2000	7.14	27.81	0.26
2001	19.94	46.96	0.42
2002	15.82	47.17	0.34
2003	31.18	60.90	0.51
2004	15.12	46.00	0.33
2005	29.27	67.03	0.44
2006	12.40	38.81	0.32
2007	4.79	30.39	0.16
Average	**18.10**	**47.18**	**0.36**

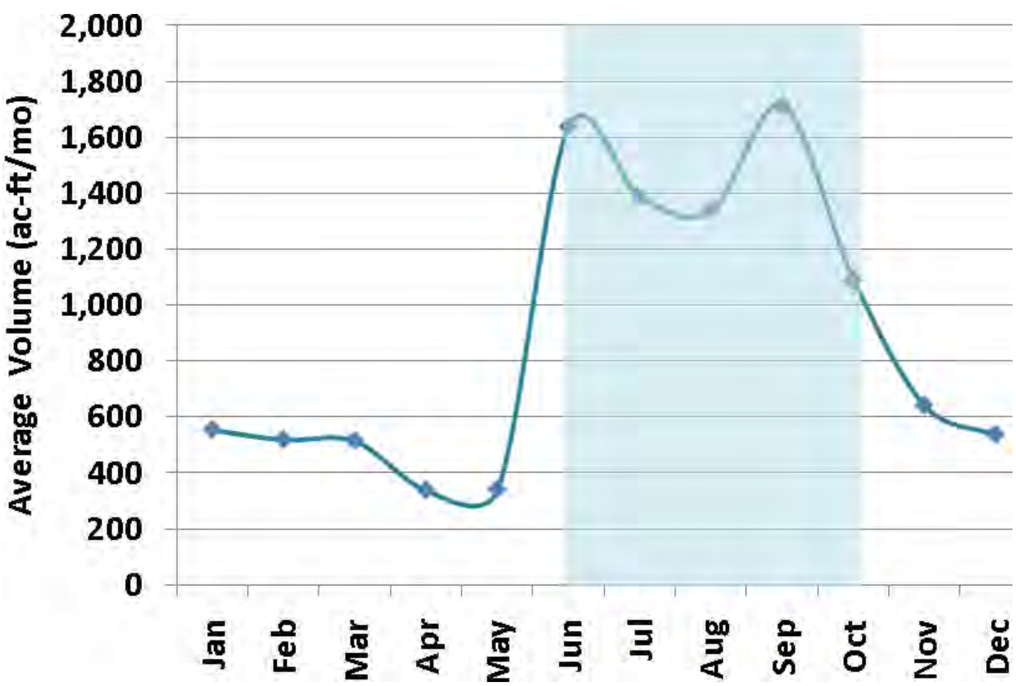

Figure 5-4 Variability of Average Monthly Total Volume in Gottfried Creek Basin

Table 5-6 Average Monthly Rainfall to Total Volume Coefficients for Gottfried Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.94	1.90	0.50
Feb	0.89	2.02	0.44
Mar	0.88	2.32	0.38
Apr	0.58	2.03	0.28
May	0.58	2.05	0.28
Jun	2.79	8.40	0.33
Jul	2.37	7.21	0.33
Aug	2.28	6.90	0.33
Sep	2.92	7.10	0.41
Oct	1.86	3.43	0.54
Nov	1.09	1.79	0.61
Dec	0.92	2.02	0.45

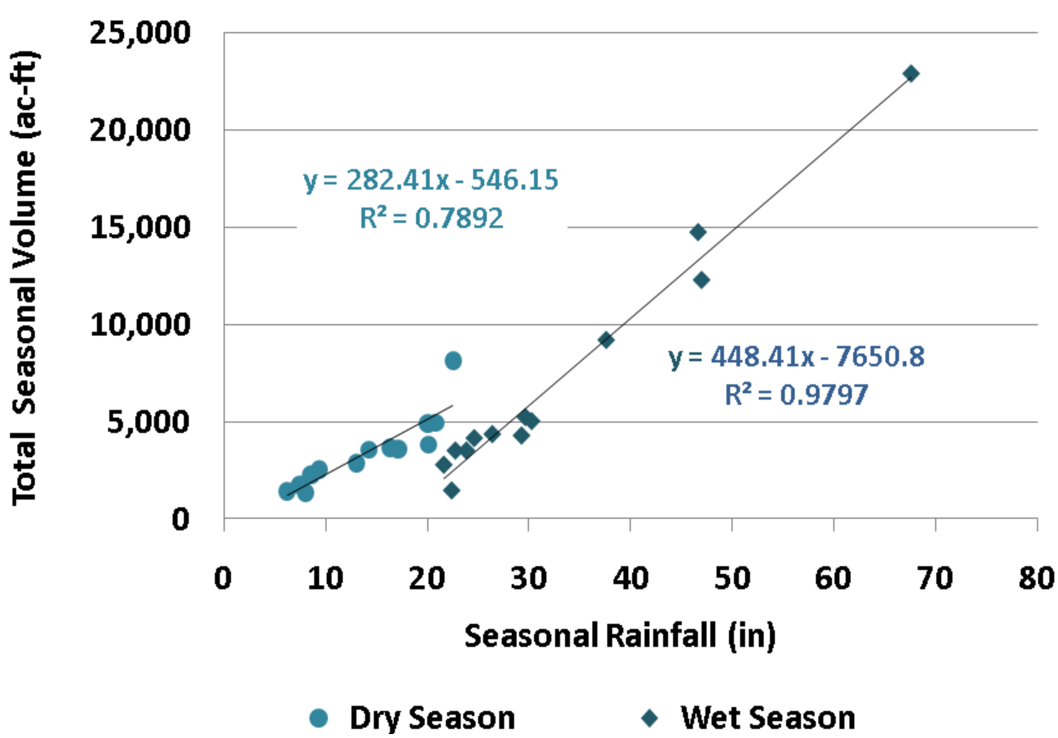

Figure 5-5 Correlation of Seasonal Total Volume to Rainfall for Gottfried Creek Basin

Table 5-7 Wet Season Total Volume to Rainfall Coefficients for Gottfried Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	39.00	67.61	0.58
1996	5.95	23.84	0.25
1997	5.96	22.75	0.26
1998	7.05	24.61	0.29
1999	7.27	29.27	0.25
2000	4.71	21.62	0.22
2001	15.65	37.60	0.42
2002	7.40	26.40	0.28
2003	25.10	46.64	0.54
2004	8.89	29.65	0.30
2005	20.91	46.99	0.45
2006	8.54	30.26	0.28
2007	2.46	22.39	0.11
Average	**12.22**	**33.05**	**0.32**

Table 5-8 Dry Season Total Volume to Rainfall Coefficients for Gottfried Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	4.90	13.02	0.38
1996	6.13	17.09	0.36
1997	6.51	20.11	0.32
1998	13.86	22.54	0.61
1999	2.99	7.48	0.40
2000	2.42	6.19	0.39
2001	4.29	9.36	0.46
2002	8.42	20.77	0.41
2003	6.07	14.25	0.43
2004	6.23	16.35	0.38
2005	8.36	20.05	0.42
2006	3.86	8.55	0.45
2007	2.33	8.00	0.29
Average	**5.88**	**14.14**	**0.41**

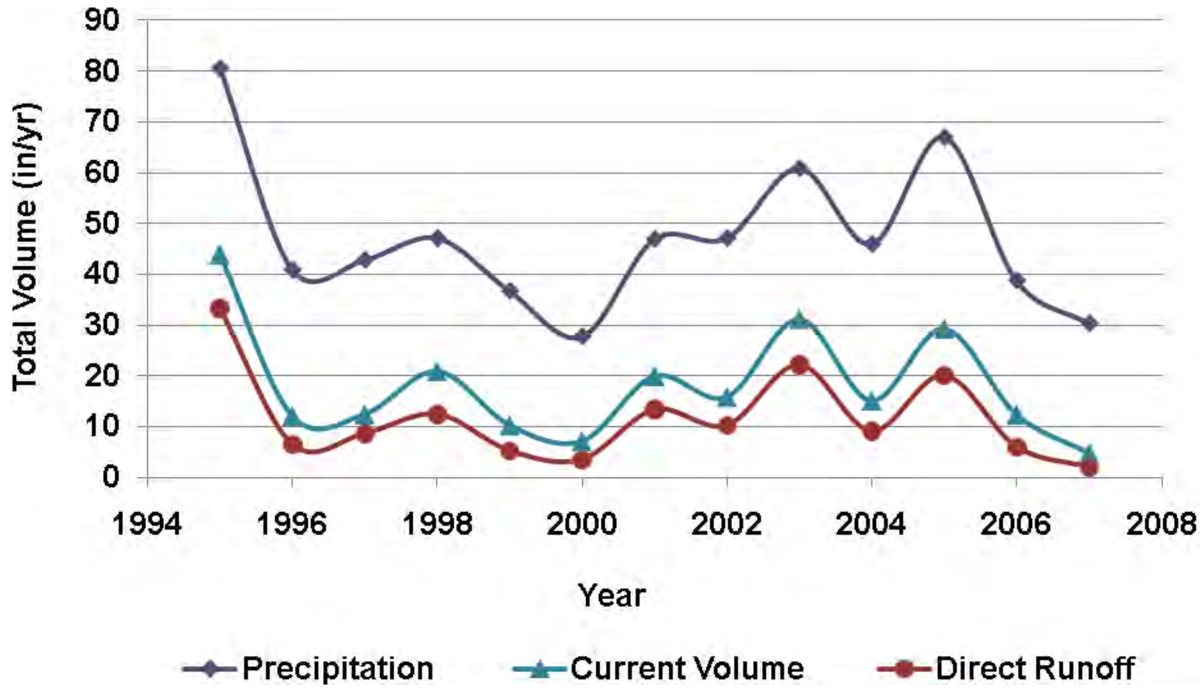

Figure 5-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Gottfried Creek Basin

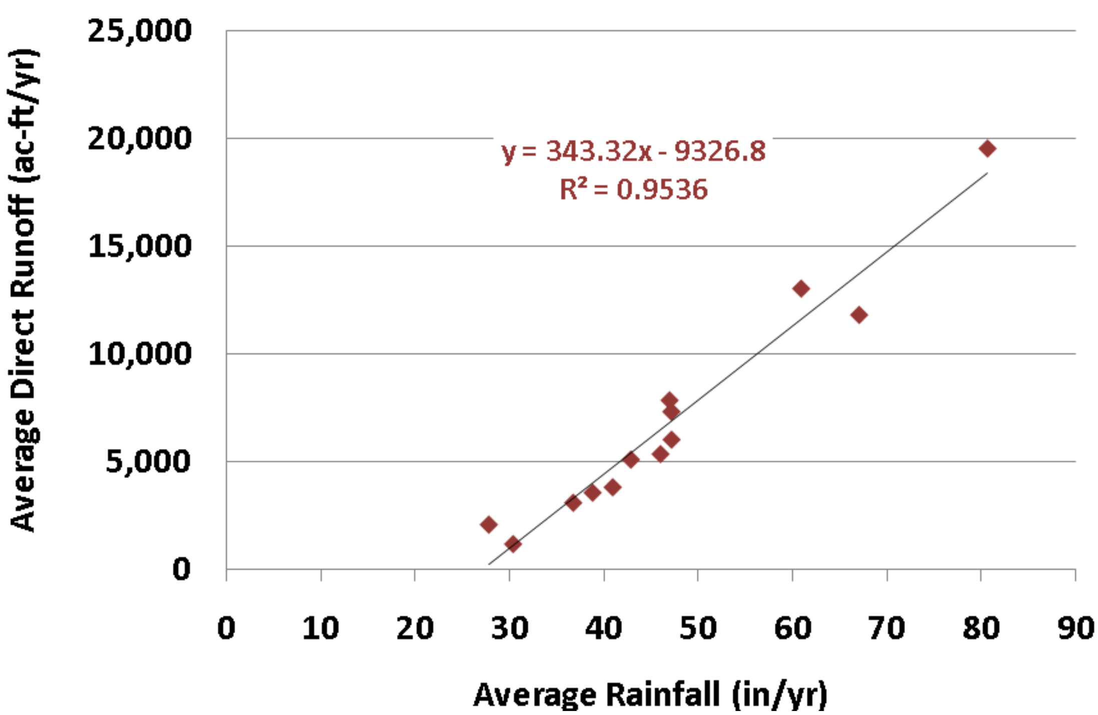

Figure 5-7 Correlation of Average Annual Direct Runoff to Rainfall

Table 5-9 Annual Direct Runoff to Rainfall Coefficients for Gottfried Creek Basin

	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	33.28	80.63	0.41
1996	6.45	40.93	0.16
1997	8.63	42.86	0.20
1998	12.43	47.15	0.26
1999	5.21	36.75	0.14
2000	3.48	27.81	0.13
2001	13.33	46.96	0.28
2002	10.21	47.17	0.22
2003	22.18	60.90	0.36
2004	9.07	46.00	0.20
2005	20.10	67.03	0.30
2006	6.01	38.81	0.15
2007	1.94	30.39	0.06
Average	**11.72**	**47.18**	**0.22**

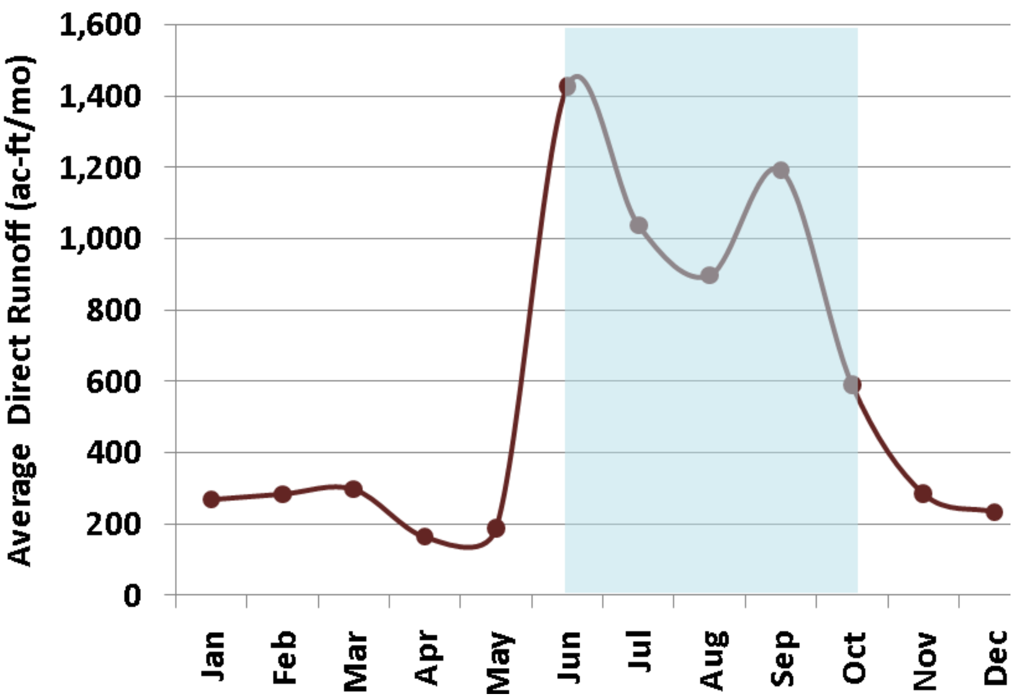

Figure 5-8 Variability of Average Monthly Direct Runoff to Gottfried Creek Basin

Table 5-10 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.46	1.90	0.24
Feb	0.48	2.02	0.24
Mar	0.51	2.32	0.22
Apr	0.28	2.03	0.14
May	0.32	2.05	0.16
Jun	2.44	8.40	0.29
Jul	1.77	7.21	0.25
Aug	1.53	6.90	0.22
Sep	2.03	7.10	0.29
Oct	1.01	3.43	0.29
Nov	0.49	1.79	0.27
Dec	0.40	2.02	0.20

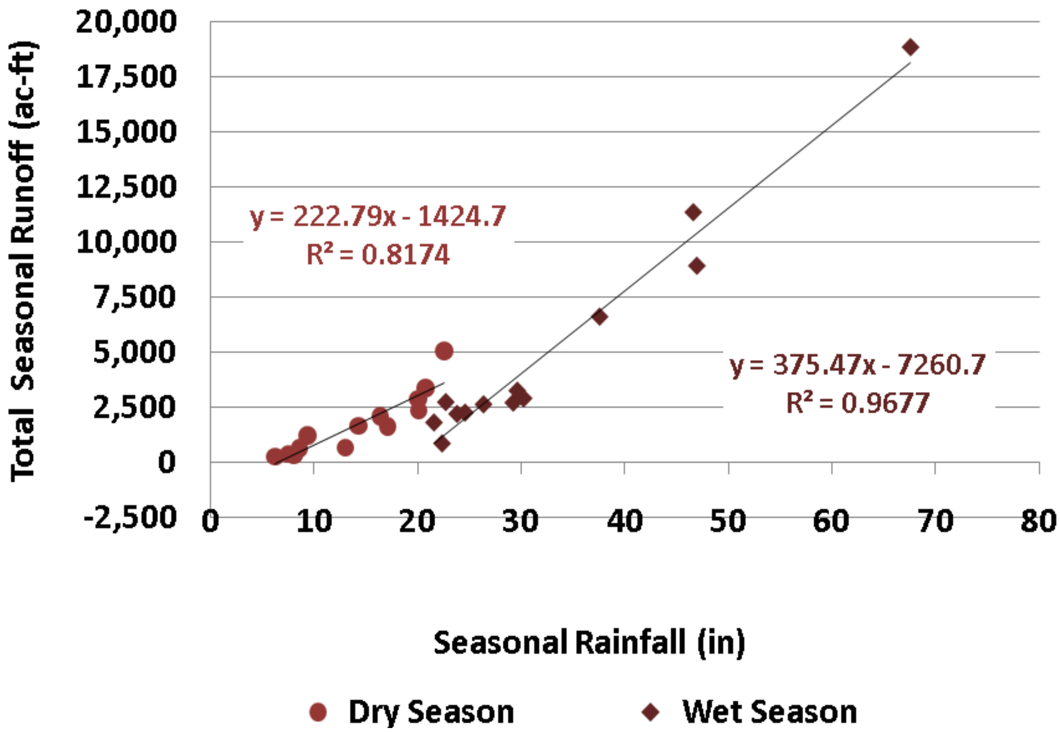

Figure 5-9 Correlation of Seasonal Direct Runoff to Rainfall

Table 5-11 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	32.16	67.61	0.48
1996	3.71	23.84	0.16
1997	4.63	22.75	0.20
1998	3.82	24.61	0.16
1999	4.58	29.27	0.16
2000	3.05	21.62	0.14
2001	11.26	37.60	0.30
2002	4.46	26.40	0.17
2003	19.36	46.64	0.42
2004	5.52	29.65	0.19
2005	15.21	46.99	0.32
2006	4.92	30.26	0.16
2007	1.42	22.39	0.06
Average	**8.78**	**33.05**	**0.22**

Table 5-12 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	1.12	13.02	0.09
1996	2.73	17.09	0.16
1997	4.00	20.11	0.20
1998	8.61	22.54	0.38
1999	0.63	7.48	0.08
2000	0.43	6.19	0.07
2001	2.07	9.36	0.22
2002	5.75	20.77	0.28
2003	2.82	14.25	0.20
2004	3.55	16.35	0.22
2005	4.89	20.05	0.24
2006	1.09	8.55	0.13
2007	0.52	8.00	0.06
Average	**2.94**	**14.14**	**0.18**

5.2 HISTORICAL CONDITIONS

Table 5-13 Historical Total Volume for Gottfried Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	500.6	244.7	180.6	151.4	125.3	8,295.6	5,127.7	2,067.8	2,500.4	2,829.9	384.3	260.1	22,668.2
1949	555.9	225.1	341.1	276.5	847.8	241.5	220.9	329.8	367.7	1,254.3	220.5	195.2	5,076.4
1950	308.9	129.2	210.4	481.6	101.0	237.6	159.5	143.2	2,027.8	281.1	559.0	1,313.5	5,952.9
1951	2,342.0	1,496.2	1,268.1	235.2	251.0	223.9	1,032.5	547.7	1,305.4	348.1	1,006.6	207.2	10,263.8
1952	260.2	138.0	150.0	112.9	102.3	237.6	741.5	508.0	1,548.9	475.7	233.5	328.4	4,837.0
1953	252.0	140.1	133.8	151.7	99.8	111.8	119.2	1,018.4	707.2	198.4	166.3	146.6	3,245.3
1954	127.0	100.7	1,102.3	131.9	111.6	560.7	3,096.6	1,486.1	2,706.5	377.7	242.7	212.9	10,256.6
1955	182.3	925.5	146.6	148.7	269.7	642.2	187.9	1,902.1	593.1	255.7	1,790.9	854.0	7,898.7
1956	305.4	220.0	279.4	720.7	581.6	4,906.0	640.2	3,250.6	4,220.4	316.1	226.0	591.0	16,257.3
1957	253.4	710.3	198.1	543.8	135.1	290.6	592.2	1,353.9	1,003.2	891.2	392.0	718.1	7,082.0
1958	298.9	632.9	929.4	126.3	616.0	3,912.0	2,414.6	553.7	436.8	2,859.6	734.6	285.9	13,800.7
1959	237.7	479.8	172.2	144.6	131.9	274.0	1,682.0	964.1	768.7	308.0	206.5	401.8	5,771.2
1960	206.1	129.3	110.9	161.4	84.7	105.6	113.3	91.3	198.8	209.7	102.5	101.5	1,615.0
Average	**448.5**	**428.6**	**401.8**	**260.5**	**266.0**	**1,541.5**	**1,240.6**	**1,093.6**	**1,414.2**	**815.8**	**482.0**	**432.0**	**8,825.0**

Table 5-14 Historical Direct Runoff for Gottfried Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	305.97	75.55	9.57	11.75	0.04	7,985.45	4,671.61	1,575.89	1,989.37	2,285.42	9.45	2.90	18,922.96
1949	293.87	11.30	148.40	117.92	705.39	120.17	111.90	233.19	271.01	988.62	0.18	1.13	3,003.08
1950	142.98	0.02	85.29	375.16	0.92	152.53	82.94	72.48	1,926.96	114.43	415.25	1,031.94	4,400.92
1951	1,937.10	1,060.08	934.36	0.06	43.33	51.37	814.29	304.31	981.59	14.04	767.25	0.06	6,907.83
1952	83.35	0.00	16.57	0.06	0.05	150.23	582.94	333.39	1,265.03	128.19	0.81	123.15	2,683.77
1953	78.01	0.00	3.27	41.60	0.30	27.19	41.95	900.24	512.52	0.46	2.61	0.19	1,608.35
1954	0.00	0.00	1,001.45	7.91	0.66	464.45	2,763.43	1,053.75	2,299.46	39.77	1.27	0.00	7,632.17
1955	0.01	781.31	5.89	30.81	163.02	538.71	39.41	1,722.28	191.56	0.48	1,576.36	543.54	5,593.38
1956	0.00	0.17	70.44	547.15	424.44	4,607.73	236.80	2,774.96	3,778.08	3.79	0.10	389.48	12,833.14
1957	86.06	567.92	20.57	396.70	3.18	179.12	459.90	1,026.59	640.08	631.00	182.29	532.05	4,725.47
1958	132.71	503.89	793.66	6.11	506.42	3,557.02	1,953.52	244.31	175.25	2,529.53	351.36	0.67	10,754.45
1959	0.00	296.94	0.03	0.00	1.66	163.67	1,445.99	610.17	458.38	53.04	1.15	219.58	3,250.62
1960	51.49	12.06	0.05	67.93	0.23	34.15	48.75	33.11	136.80	115.74	1.72	13.80	515.83
Average	**239.35**	**254.56**	**237.66**	**123.32**	**142.28**	**1,387.06**	**1,019.50**	**837.28**	**1,125.08**	**531.12**	**254.60**	**219.88**	**6,371.69**

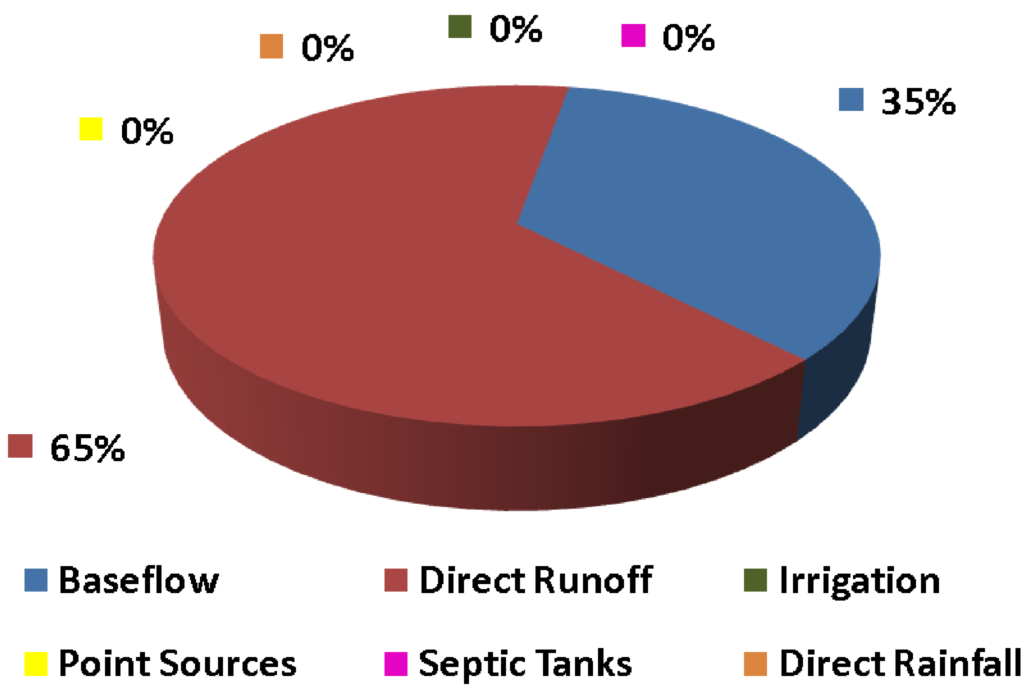

Figure 5-10 Gottfried Creek Basin Historical Total Volume Water Budget

Table 5-15 Summary of Annual Historical Total Volume Inputs for Gottfried Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	3,745.3	18,923.0	0.0	0.0	0.0	0.0
1949	2,073.3	3,003.1	0.0	0.0	0.0	0.0
1950	1,552.0	4,400.9	0.0	0.0	0.0	0.0
1951	3,356.0	6,907.8	0.0	0.0	0.0	0.0
1952	2,153.2	2,683.8	0.0	0.0	0.0	0.0
1953	1,637.0	1,608.4	0.0	0.0	0.0	0.0
1954	2,624.5	7,632.2	0.0	0.0	0.0	0.0
1955	2,305.3	5,593.4	0.0	0.0	0.0	0.0
1956	3,424.1	12,833.1	0.0	0.0	0.0	0.0
1957	2,356.5	4,725.5	0.0	0.0	0.0	0.0
1958	3,046.2	10,754.5	0.0	0.0	0.0	0.0
1959	2,520.6	3,250.6	0.0	0.0	0.0	0.0
1960	1,099.2	515.8	0.0	0.0	0.0	0.0
Average	**2,453.3**	**6,371.7**	**0.0**	**0.0**	**0.0**	**0.0**

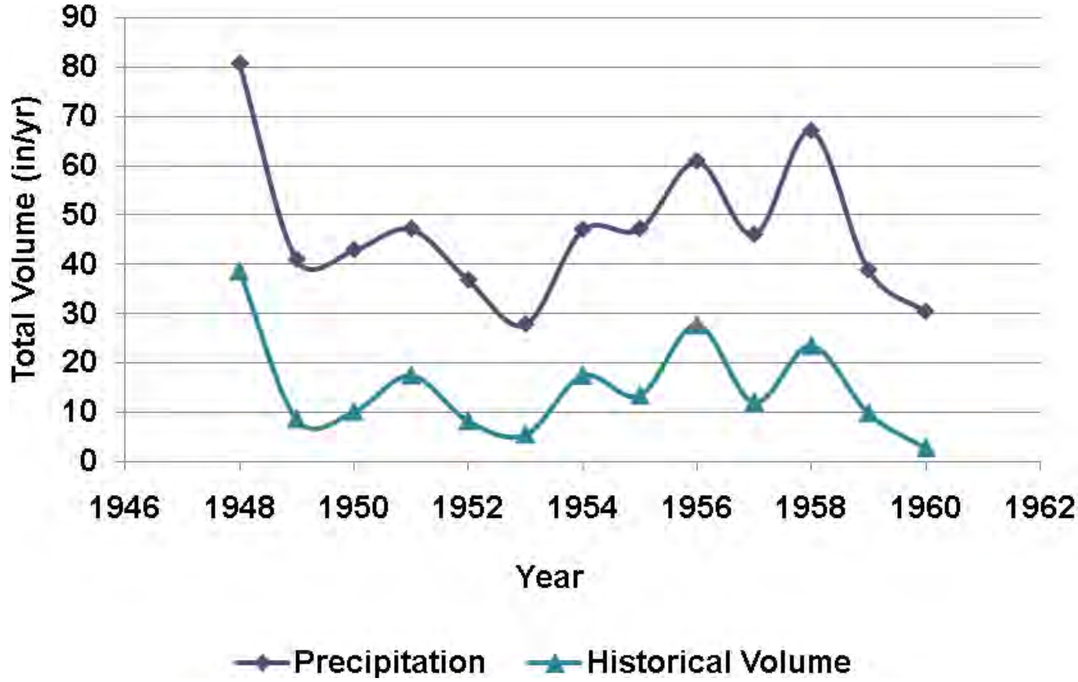

Figure 5-11 Annual Historical Variability of Precipitation and Total Volume for Gottfried Creek Basin

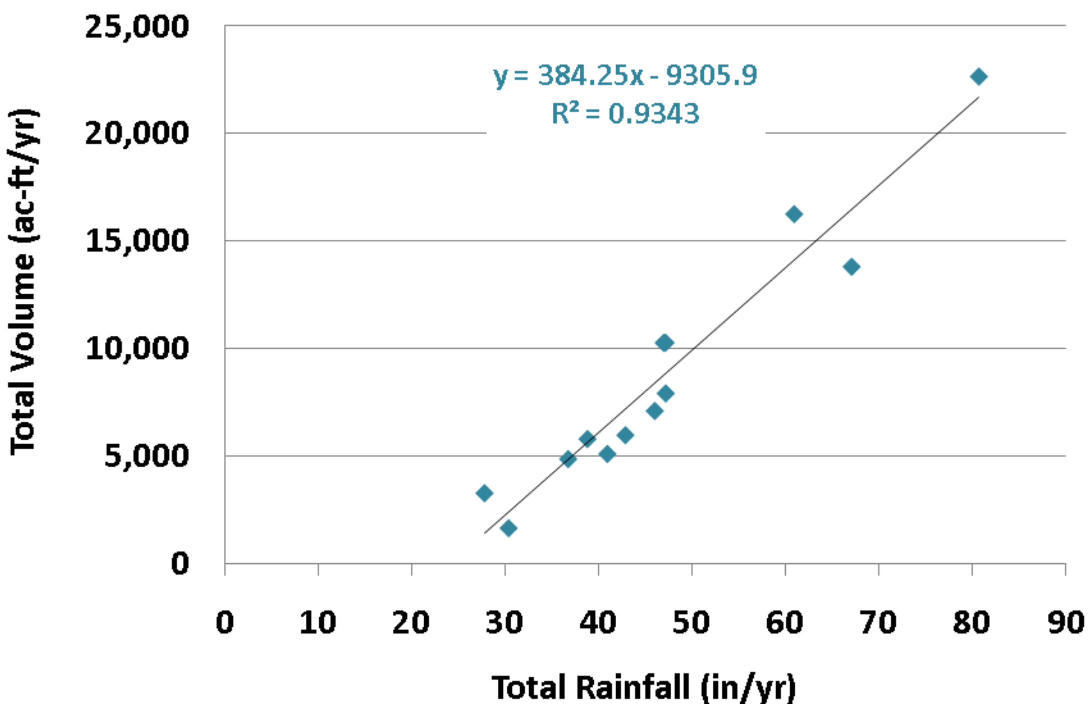

Figure 5-12 Correlation of Annual Total Volume to Rainfall for Gottfried Creek Basin

Table 5-16 Annual Total Volume to Rainfall Coefficients for Gottfried Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	38.65	80.63	0.48
1949	8.66	40.93	0.21
1950	10.15	42.86	0.24
1951	17.50	47.15	0.37
1952	8.25	36.75	0.22
1953	5.53	27.81	0.20
1954	17.49	46.96	0.37
1955	13.47	47.17	0.29
1956	27.72	60.90	0.46
1957	12.07	46.00	0.26
1958	23.53	67.03	0.35
1959	9.84	38.81	0.25
1960	2.75	30.39	0.09
Average	**15.05**	**47.18**	**0.29**

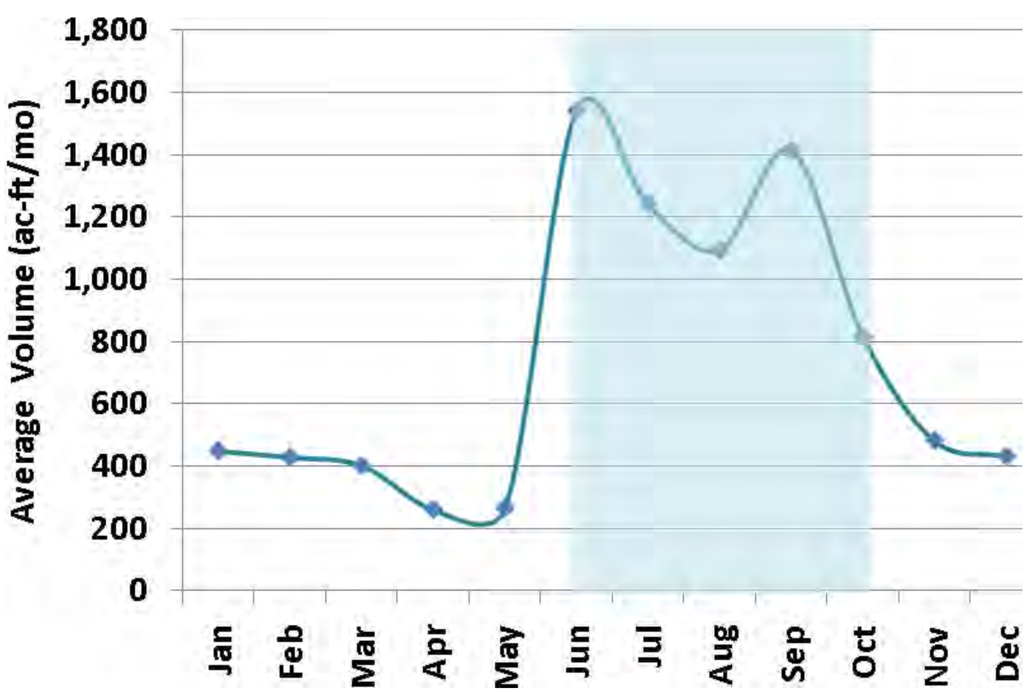

Figure 5-13 Variability of Average Monthly Total Volume in Gottfried Creek Basin

Table 5-17 Average Monthly Rainfall to Total Volume Coefficients for Gottfried Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.76	1.90	0.40
Feb	0.73	2.02	0.36
Mar	0.69	2.32	0.30
Apr	0.44	2.03	0.22
May	0.45	2.05	0.22
Jun	2.63	8.40	0.31
Jul	2.12	7.21	0.29
Aug	1.86	6.90	0.27
Sep	2.41	7.10	0.34
Oct	1.39	3.43	0.41
Nov	0.82	1.79	0.46
Dec	0.74	2.02	0.36

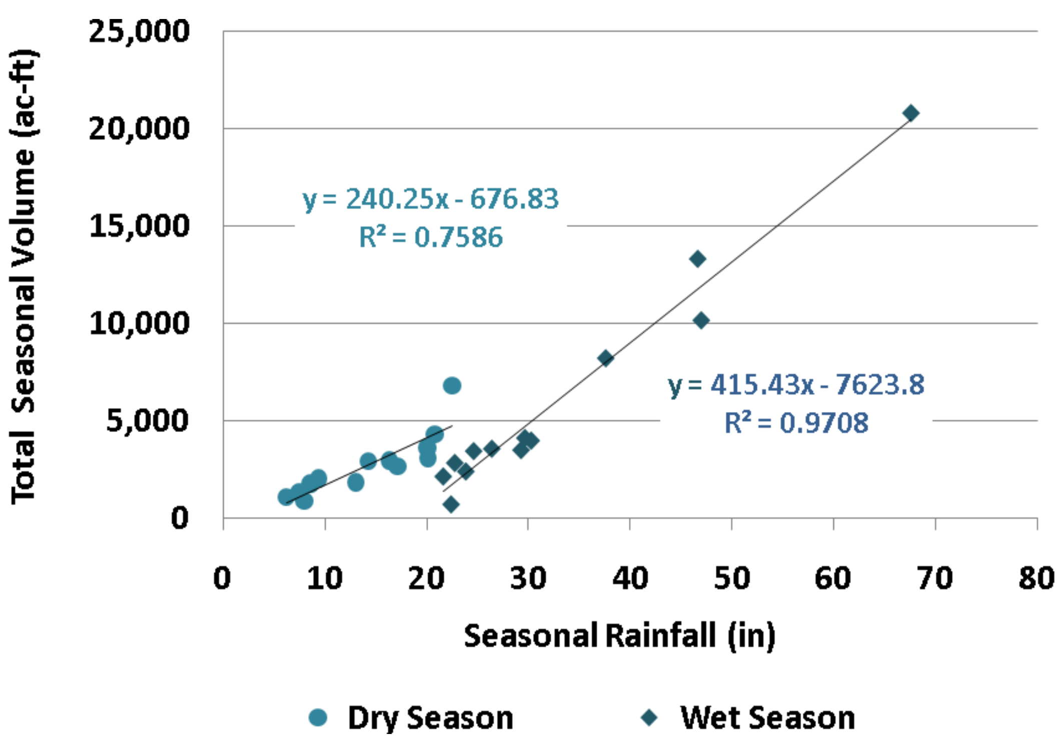

Figure 5-14 Correlation of Seasonal Total Volume to Rainfall for Gottfried Creek Basin

Table 5-18 Wet season Total Volume to Rainfall Coefficients for Gottfried Creek Basin

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	35.50	67.61	0.53
1949	4.12	23.84	0.17
1950	4.86	22.75	0.21
1951	5.90	24.61	0.24
1952	5.99	29.27	0.20
1953	3.67	21.62	0.17
1954	14.03	37.60	0.37
1955	6.11	26.40	0.23
1956	22.73	46.64	0.49
1957	7.04	29.65	0.24
1958	17.35	46.99	0.37
1959	6.81	30.26	0.23
1960	1.23	22.39	0.05
Average	**10.41**	**33.05**	**0.27**

Table 5-19 Dry season Total Volume to Rainfall Coefficients for Gottfried Creek Basin

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	3.15	13.02	0.24
1949	4.54	17.09	0.27
1950	5.29	20.11	0.26
1951	11.60	22.54	0.51
1952	2.26	7.48	0.30
1953	1.86	6.19	0.30
1954	3.46	9.36	0.37
1955	7.36	20.77	0.35
1956	4.99	14.25	0.35
1957	5.03	16.35	0.31
1958	6.18	20.05	0.31
1959	3.03	8.55	0.35
1960	1.53	8.00	0.19
Average	**4.64**	**14.14**	**0.32**

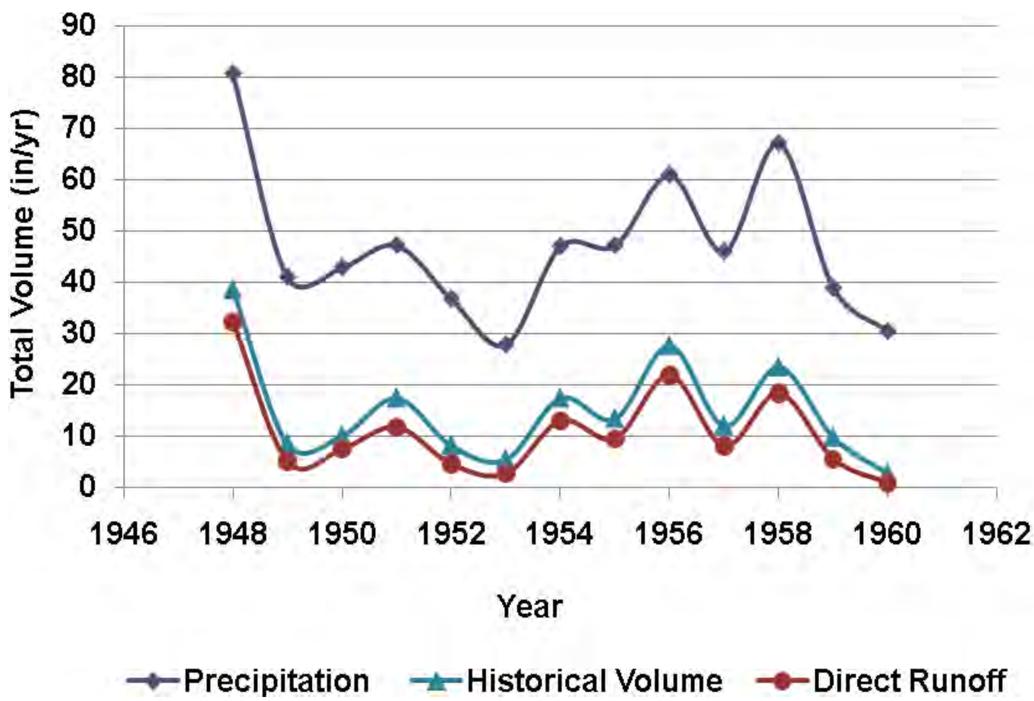

Figure 5-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Gottfried Creek Basin

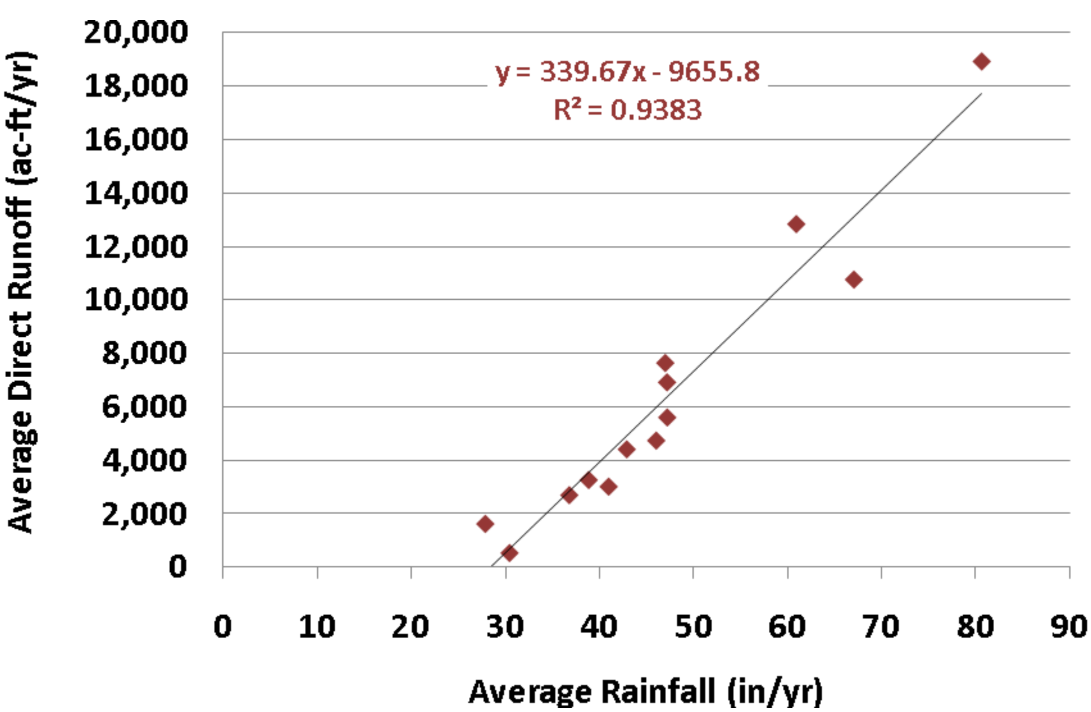

Figure 5-16 Correlation of Average Annual Direct Runoff to Rainfall

Table 5-20 Annual Direct Runoff to Rainfall Coefficients for Gottfried Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	32.26	80.63	0.40
1949	5.12	40.93	0.13
1950	7.50	42.86	0.18
1951	11.78	47.15	0.25
1952	4.58	36.75	0.12
1953	2.74	27.81	0.10
1954	13.01	46.96	0.28
1955	9.54	47.17	0.20
1956	21.88	60.90	0.36
1957	8.06	46.00	0.18
1958	18.34	67.03	0.27
1959	5.54	38.81	0.14
1960	0.88	30.39	0.03
Average	**10.86**	**47.18**	**0.20**

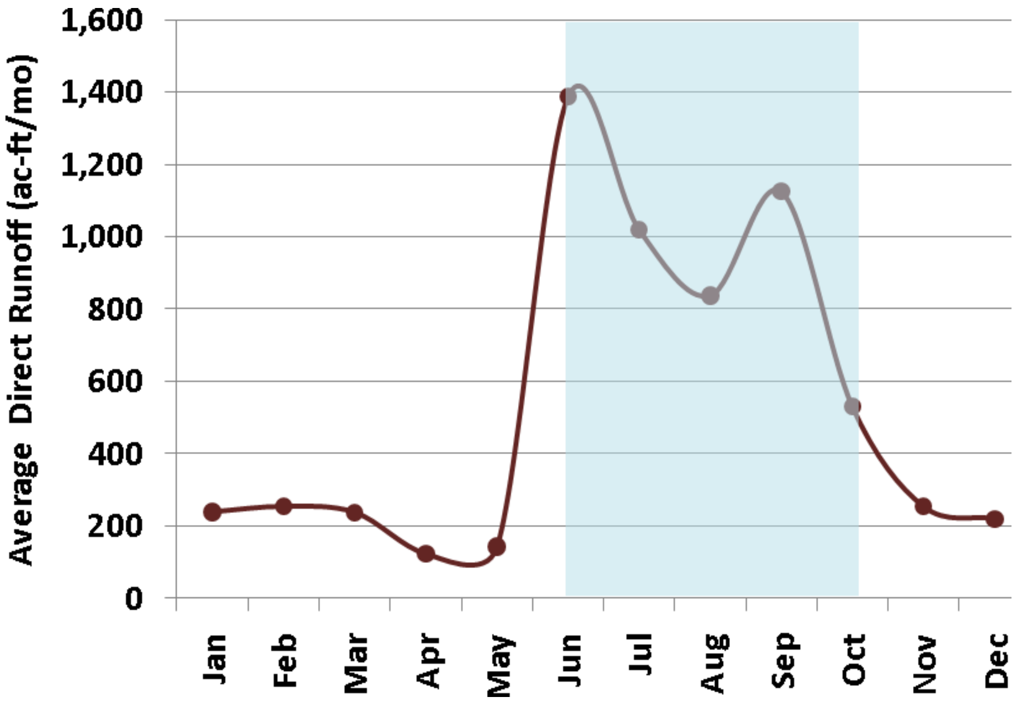

Figure 5-17 Variability of Average Monthly Direct Runoff to Gottfried Creek Basin

Table 5-21 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.41	1.90	0.21
Feb	0.43	2.02	0.21
Mar	0.41	2.32	0.17
Apr	0.21	2.03	0.10
May	0.24	2.05	0.12
Jun	2.36	8.40	0.28
Jul	1.74	7.21	0.24
Aug	1.43	6.90	0.21
Sep	1.92	7.10	0.27
Oct	0.91	3.43	0.26
Nov	0.43	1.79	0.24
Dec	0.37	2.02	0.19

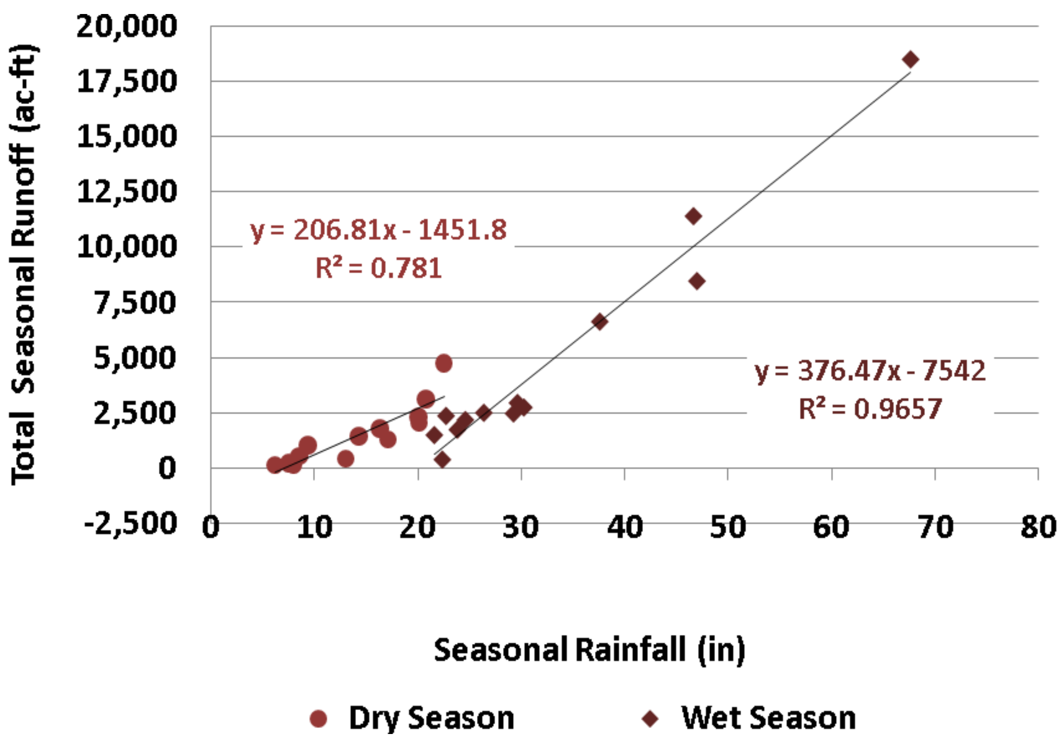

Figure 5-18 Correlation of Seasonal Direct Runoff to Rainfall

Table 5-22 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	31.56	67.61	0.47
1949	2.94	23.84	0.12
1950	4.01	22.75	0.18
1951	3.69	24.61	0.15
1952	4.19	29.27	0.14
1953	2.53	21.62	0.12
1954	11.29	37.60	0.30
1955	4.25	26.40	0.16
1956	19.44	46.64	0.42
1957	5.01	29.65	0.17
1958	14.42	46.99	0.31
1959	4.66	30.26	0.15
1960	0.63	22.39	0.03
Average	**8.35**	**33.05**	**0.21**

Table 5-23 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.71	13.02	0.05
1949	2.18	17.09	0.13
1950	3.50	20.11	0.17
1951	8.09	22.54	0.36
1952	0.38	7.48	0.05
1953	0.21	6.19	0.03
1954	1.72	9.36	0.18
1955	5.29	20.77	0.25
1956	2.44	14.25	0.17
1957	3.05	16.35	0.19
1958	3.91	20.05	0.20
1959	0.89	8.55	0.10
1960	0.25	8.00	0.03
Average	**2.51**	**14.14**	**0.15**

5.3 FUTURE CONDITIONS

Table 5-24 Future Total Volume for Gottfried Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	912.3	621.2	472.4	401.6	203.5	8,873.3	6,540.5	3,573.7	4,067.8	4,504.4	1,103.9	698.7	31,973.1
2016	1,065.1	483.4	685.8	422.3	1,151.6	546.4	642.3	863.6	1,019.6	2,285.6	609.8	444.3	10,219.7
2017	479.6	194.9	302.3	638.5	170.3	340.5	276.1	294.2	2,694.0	646.3	946.8	1,782.5	8,765.9
2018	2,876.6	2,015.0	2,162.5	583.9	515.2	427.0	1,255.1	934.4	2,098.2	1,059.9	1,652.6	413.0	15,993.5
2019	467.1	188.1	250.5	131.7	118.4	467.7	856.6	942.1	2,410.4	1,182.7	591.1	625.3	8,231.6
2020	373.1	200.8	198.0	239.5	120.5	294.9	268.4	1,354.9	1,219.1	424.5	296.4	231.6	5,221.7
2021	162.3	117.5	1,603.7	117.1	90.3	637.9	3,032.2	2,222.0	3,982.7	1,232.2	612.9	406.5	14,217.5
2022	298.7	976.3	202.0	263.6	487.2	751.6	356.8	2,475.1	1,425.5	718.5	2,356.5	1,240.4	11,552.1
2023	523.7	336.1	389.6	688.3	582.1	4,997.4	1,582.1	5,071.3	5,560.1	1,088.4	619.4	1,010.1	22,448.6
2024	495.5	1,140.4	353.6	622.3	194.3	522.0	934.0	2,133.1	1,992.0	1,735.5	824.9	1,036.7	11,984.4
2025	561.8	784.6	1,389.7	376.7	1,275.7	5,120.5	3,942.0	1,868.8	1,623.2	4,153.4	1,527.5	694.4	23,318.4
2026	419.1	757.9	227.5	161.9	200.9	441.3	1,972.1	1,820.0	1,813.7	994.4	536.2	628.4	9,973.3
2027	378.2	251.0	163.5	336.2	120.4	339.9	361.1	290.5	523.2	624.7	307.7	261.2	3,957.6
Average	**693.3**	**620.6**	**646.2**	**383.4**	**402.3**	**1,827.7**	**1,693.8**	**1,834.1**	**2,340.7**	**1,588.5**	**922.0**	**728.7**	**13,681.3**

3

Table 5-25 Future Direct Runoff for Gottfried Creek Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	492.3	229.2	88.6	142.2	7.4	8,269.1	5,087.0	1,798.2	2,334.4	2,661.4	36.6	61.9	21,208.4
2016	440.0	74.8	387.6	202.4	931.4	290.6	328.7	513.7	562.4	1,377.3	20.0	44.5	5,173.4
2017	197.7	5.0	141.1	510.5	51.3	247.7	177.3	187.1	2,481.7	294.5	612.1	1,139.6	6,045.6
2018	1,948.0	893.6	1,255.4	3.5	101.5	132.7	944.2	484.1	1,193.7	82.4	1,049.5	13.7	8,102.3
2019	189.7	0.0	93.2	12.0	20.1	385.6	664.5	603.5	1,666.1	203.1	32.5	241.8	4,112.1
2020	102.5	10.6	42.9	118.1	20.9	214.9	182.3	1,164.4	776.5	12.8	20.5	19.0	2,685.6
2021	0.6	0.0	1,497.9	20.5	12.9	574.0	2,545.1	981.7	2,598.6	130.5	10.1	3.8	8,375.8
2022	15.1	773.9	10.1	123.7	374.6	630.6	146.0	2,059.9	283.3	25.3	1,912.4	658.9	7,013.8
2023	0.0	27.5	145.3	508.2	433.3	4,396.7	336.8	3,359.5	3,996.2	34.4	16.4	587.6	13,841.8
2024	202.9	908.4	91.9	433.6	46.9	406.2	695.2	1,242.4	773.7	892.7	305.7	670.1	6,669.7
2025	267.3	584.1	1,107.4	119.7	1,027.1	4,096.3	2,207.0	557.6	475.7	2,995.2	509.9	0.4	13,947.7
2026	3.7	470.4	3.7	0.0	69.2	334.7	1,575.2	904.6	636.4	144.0	14.4	253.3	4,409.6
2027	104.9	57.8	6.7	220.1	26.5	265.0	289.9	192.3	367.6	322.3	28.3	64.2	1,945.6
Average	**305.0**	**310.4**	**374.7**	**185.8**	**240.2**	**1,557.2**	**1,167.6**	**1,080.7**	**1,395.9**	**705.8**	**351.4**	**289.1**	**7,963.9**

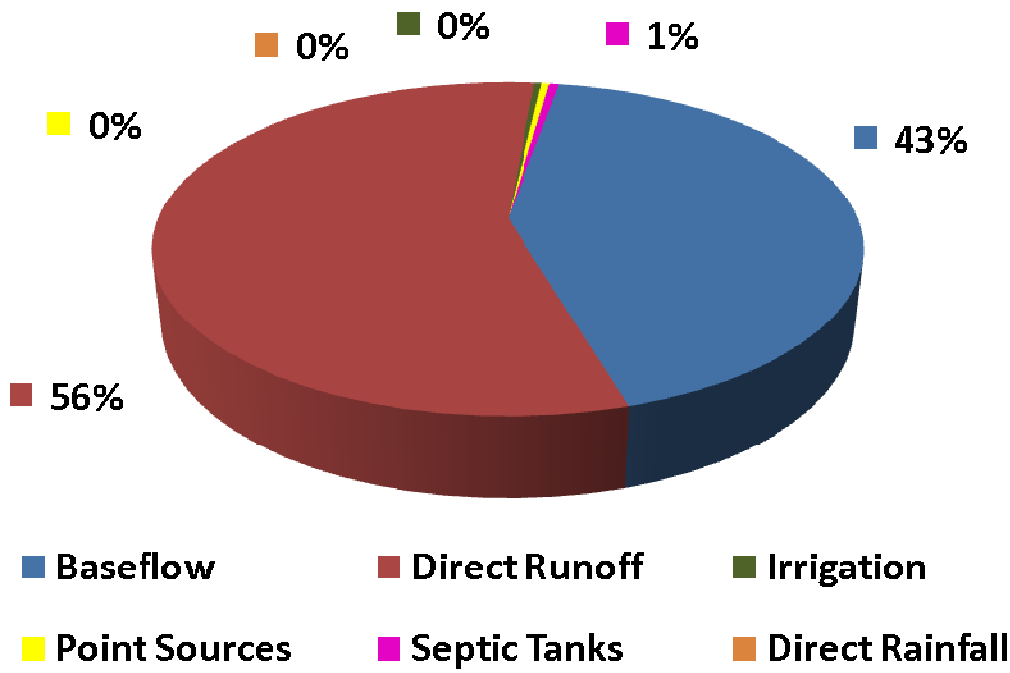

Figure 5-19 Gottfried Creek Basin Future Total Volume Water Budget

Table 5-26 Summary of Annual Future Total Volume Inputs for Gottfried Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	10,600.0	21,208.4	38.7	73.2	52.8	0.0
2016	4,881.5	5,173.4	38.7	73.2	52.8	0.0
2017	2,555.7	6,045.6	38.7	73.2	52.8	0.0
2018	7,726.5	8,102.3	38.7	73.2	52.8	0.0
2019	3,954.4	4,112.1	38.7	73.5	52.8	0.0
2020	2,375.8	2,685.6	38.7	68.7	52.8	0.0
2021	5,700.0	8,375.8	38.7	50.2	52.8	0.0
2022	4,396.5	7,013.8	38.7	50.3	52.8	0.0
2023	8,469.2	13,841.8	38.7	46.0	52.8	0.0
2024	5,223.2	6,669.7	38.7	0.0	52.8	0.0
2025	9,279.2	13,947.7	38.7	0.0	52.8	0.0
2026	5,472.3	4,409.6	38.7	0.0	52.8	0.0
2027	1,920.5	1,945.6	38.7	0.0	52.8	0.0
Average	**5,581.1**	**7,963.9**	**38.7**	**44.7**	**52.8**	**0.0**

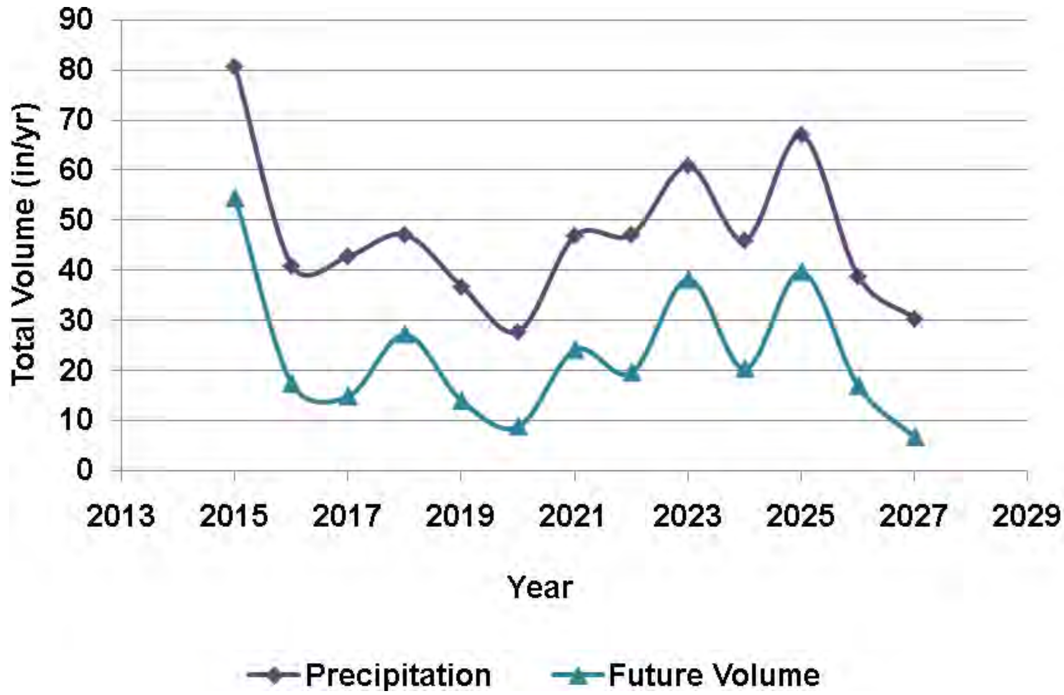

Figure 5-20 Annual Variability of Precipitation and Total Volume for Gottfried Creek Basin

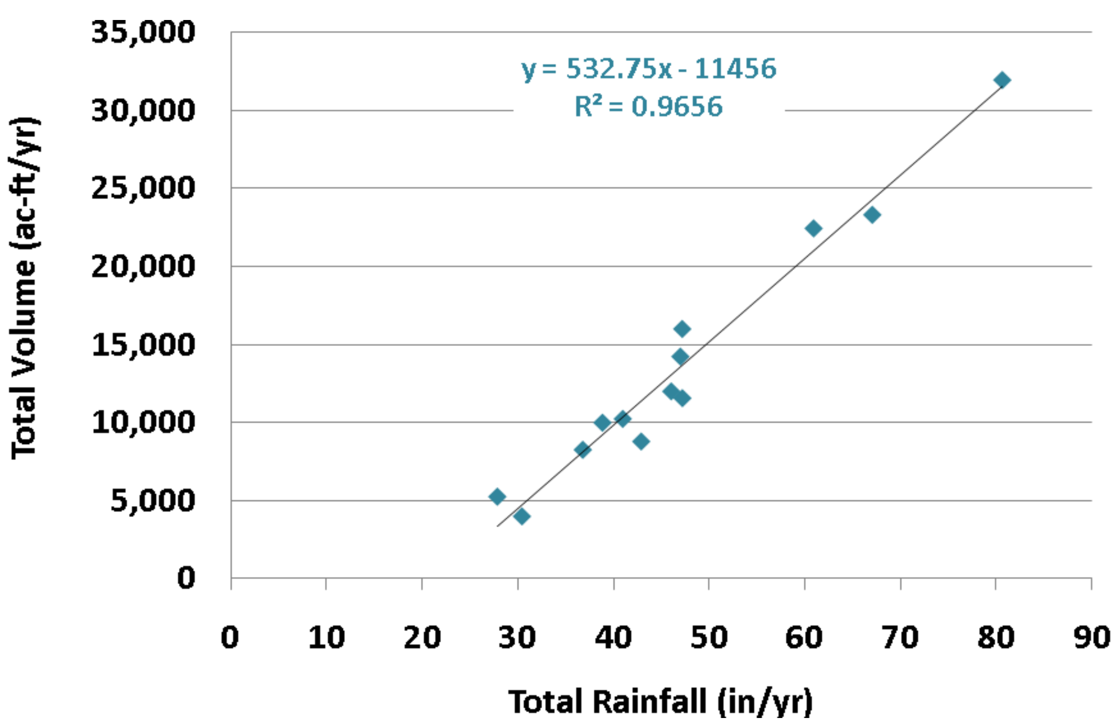

Figure 5-21 Correlation of Annual Total Volume to Rainfall for Gottfried Creek Basin

Table 5-27 Annual Total Volume to Rainfall Coefficients for Gottfried Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	54.51	80.63	0.68
2016	17.42	40.93	0.43
2017	14.95	42.86	0.35
2018	27.27	47.15	0.58
2019	14.03	36.75	0.38
2020	8.90	27.81	0.32
2021	24.24	46.96	0.52
2022	19.70	47.17	0.42
2023	38.27	60.90	0.63
2024	20.43	46.00	0.44
2025	39.76	67.03	0.59
2026	17.00	38.81	0.44
2027	6.75	30.39	0.22
Average	**23.33**	**47.18**	**0.46**

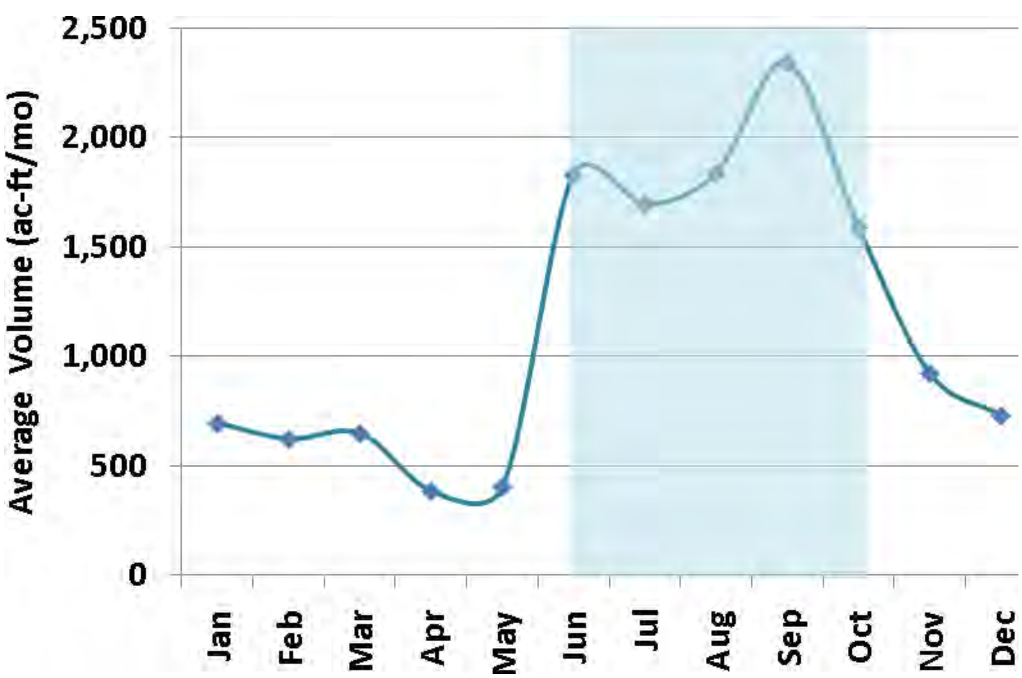

Figure 5-22 Variability of Average Monthly Total Volume in Gottfried Creek Basin

Table 5-28 Average Monthly Rainfall to Total Volume Coefficients for Gottfried Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.18	1.90	0.62
Feb	1.06	2.02	0.52
Mar	1.10	2.32	0.48
Apr	0.65	2.03	0.32
May	0.69	2.05	0.33
Jun	3.12	8.40	0.37
Jul	2.89	7.21	0.40
Aug	3.13	6.90	0.45
Sep	3.99	7.10	0.56
Oct	2.71	3.43	0.79
Nov	1.57	1.79	0.88
Dec	1.24	2.02	0.61

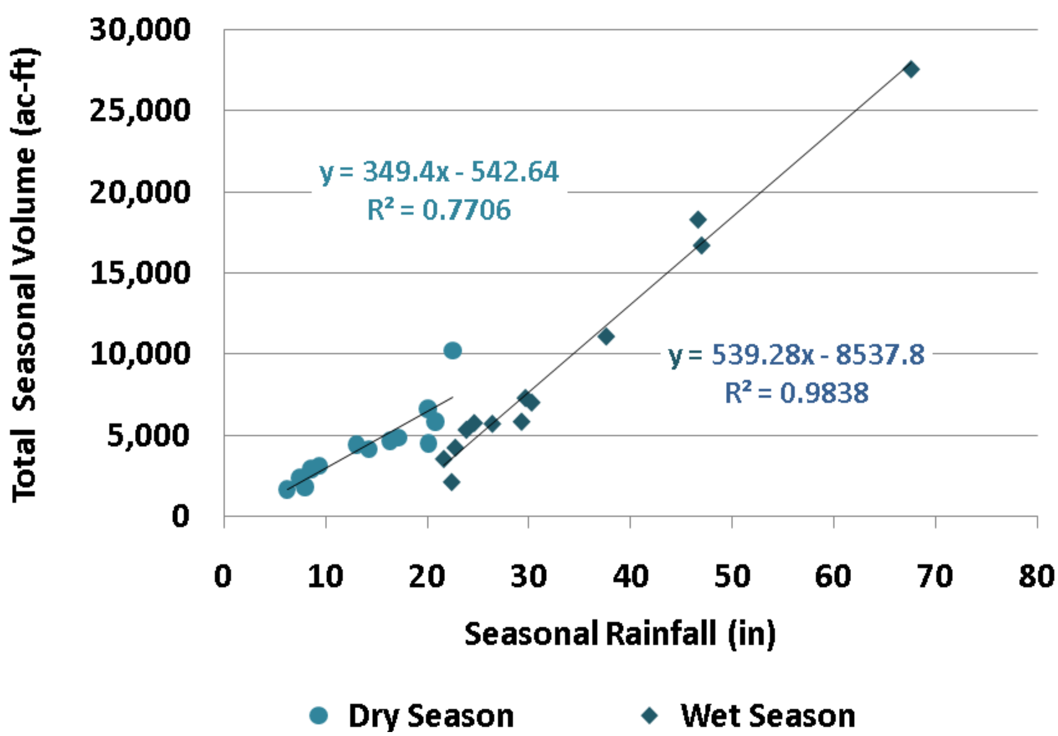

Figure 5-23 Correlation of Seasonal Total Volume to Rainfall for Gottfried Creek Basin

Table 5-29 Wet Season Total Volume to Rainfall Coefficients for Gottfried Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	46.99	67.61	0.70
2016	9.13	23.84	0.38
2017	7.25	22.75	0.32
2018	9.85	24.61	0.40
2019	9.99	29.27	0.34
2020	6.07	21.62	0.28
2021	18.94	37.60	0.50
2022	9.77	26.40	0.37
2023	31.20	46.64	0.67
2024	12.47	29.65	0.42
2025	28.49	46.99	0.61
2026	12.01	30.26	0.40
2027	3.65	22.39	0.16
Average	**15.83**	**33.05**	**0.43**

Table 5-30 Dry Season Total Volume to Rainfall Coefficients for Gottfried Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	7.53	13.02	0.58
2016	8.29	17.09	0.48
2017	7.70	20.11	0.38
2018	17.42	22.54	0.77
2019	4.04	7.48	0.54
2020	2.83	6.19	0.46
2021	5.30	9.36	0.57
2022	9.93	20.77	0.48
2023	7.07	14.25	0.50
2024	7.96	16.35	0.49
2025	11.27	20.05	0.56
2026	5.00	8.55	0.58
2027	3.10	8.00	0.39
Average	**7.50**	**14.14**	**0.52**

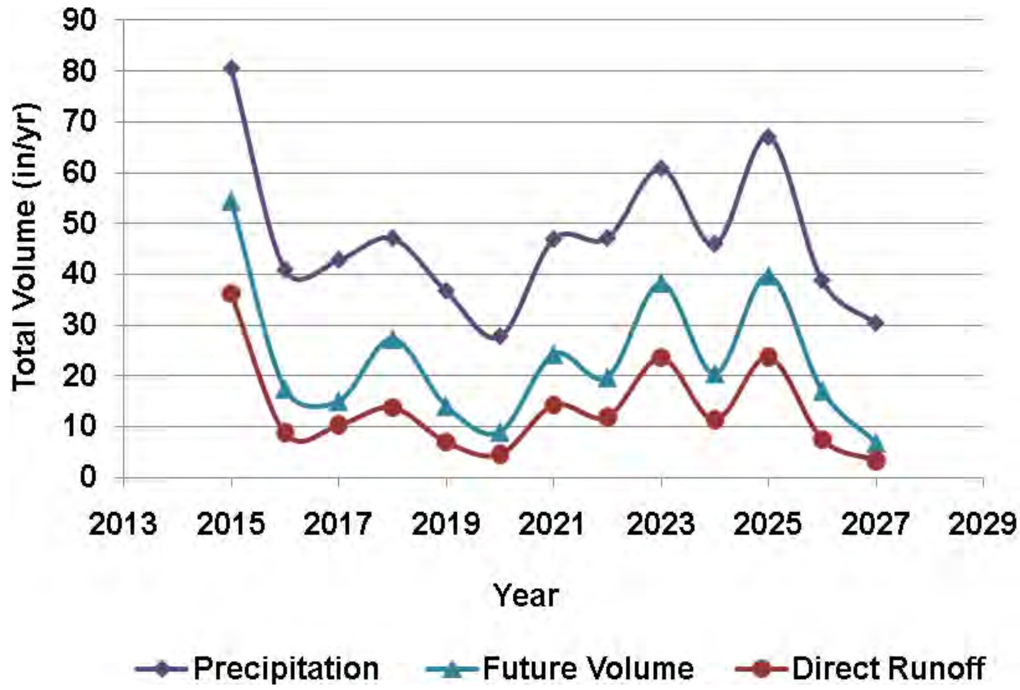

Figure 5-24 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Gottfried Creek Basin

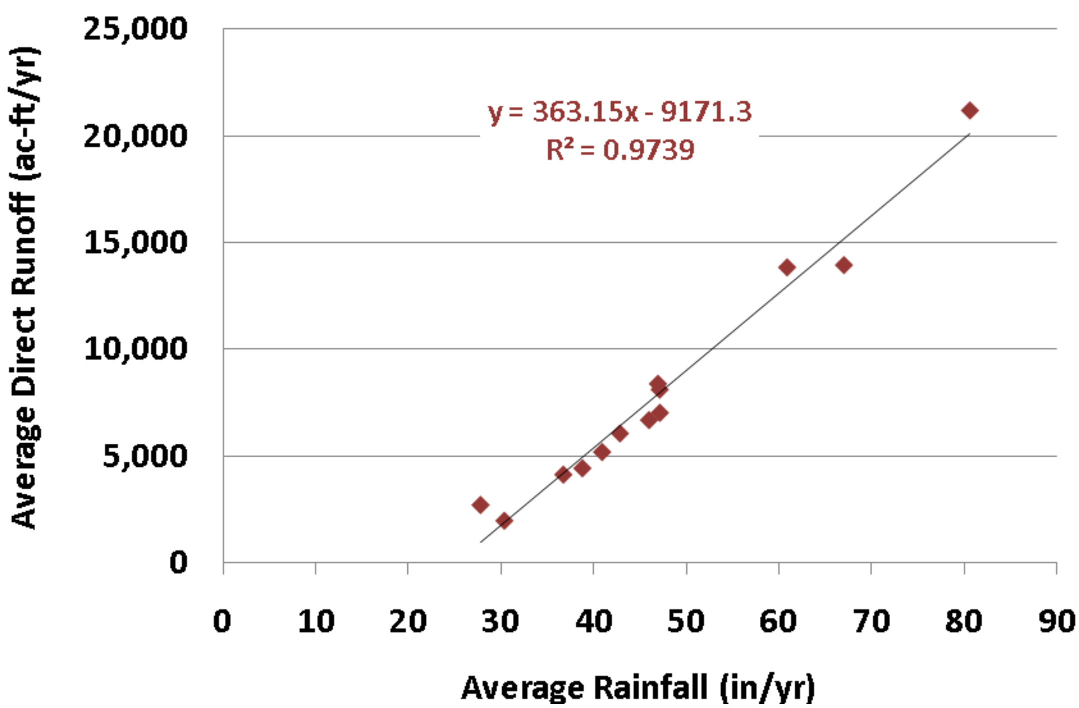

Figure 5-25 Correlation of Average Annual Direct Runoff to Rainfall

Table 5-31 Annual Direct Runoff to Rainfall Coefficients for Gottfried Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	36.16	80.63	0.45
2016	8.82	40.93	0.22
2017	10.31	42.86	0.24
2018	13.81	47.15	0.29
2019	7.01	36.75	0.19
2020	4.58	27.81	0.16
2021	14.28	46.96	0.30
2022	11.96	47.17	0.25
2023	23.60	60.90	0.39
2024	11.37	46.00	0.25
2025	23.78	67.03	0.35
2026	7.52	38.81	0.19
2027	3.32	30.39	0.11
Average	**13.58**	**47.18**	**0.26**

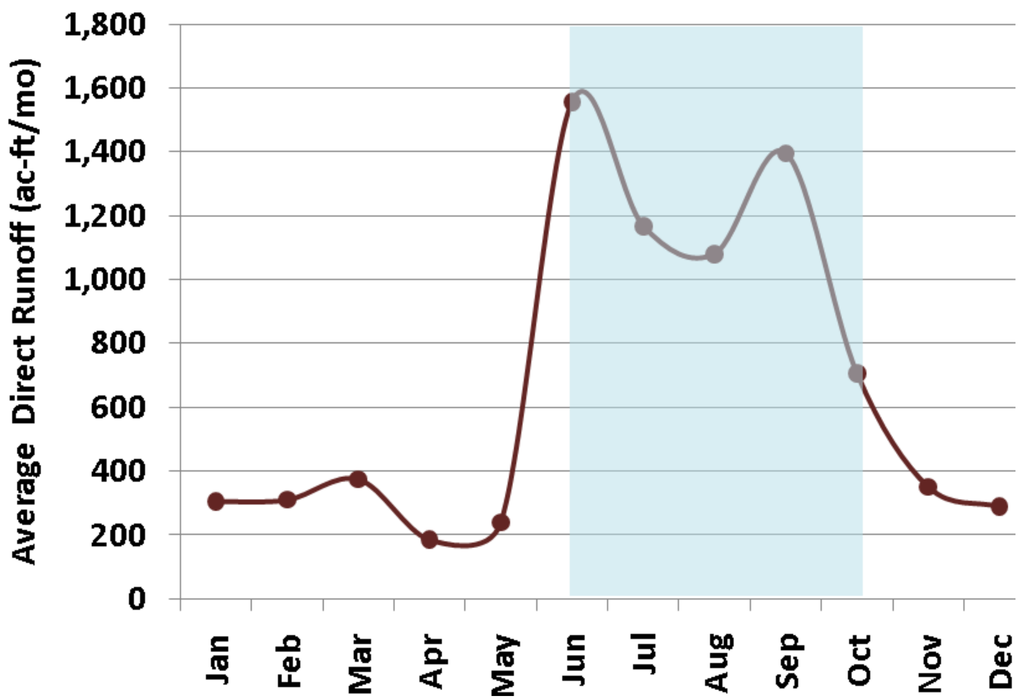

Figure 5-26 Variability of Average Monthly Direct Runoff to Gottfried Creek Basin

Table 5-32 Average Monthly Rainfall to Direct Runoff Coefficients for Gottfried Creek Basin

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.52	1.90	0.27
Feb	0.53	2.02	0.26
Mar	0.64	2.32	0.28
Apr	0.32	2.03	0.16
May	0.41	2.05	0.20
Jun	2.66	8.40	0.32
Jul	1.99	7.21	0.28
Aug	1.84	6.90	0.27
Sep	2.38	7.10	0.34
Oct	1.20	3.43	0.35
Nov	0.60	1.79	0.33
Dec	0.49	2.02	0.24

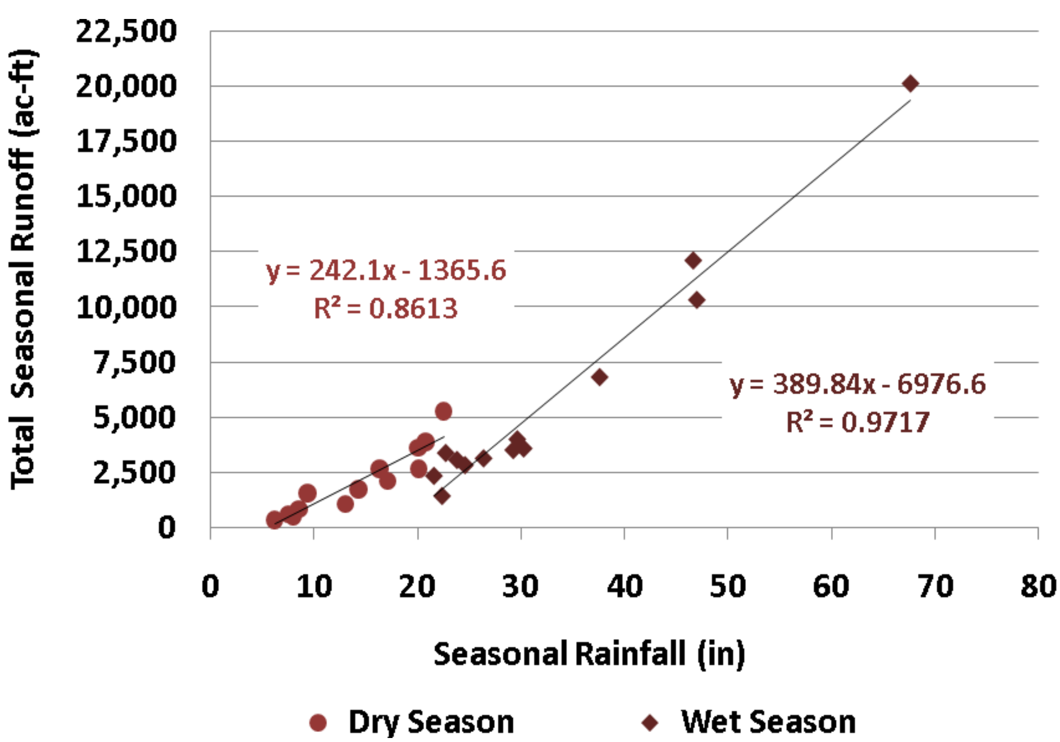

Figure 5-27 Correlation of Seasonal Direct Runoff to Rainfall

Table 5-33 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	34.36	67.61	0.51
2016	5.24	23.84	0.22
2017	5.78	22.75	0.25
2018	4.84	24.61	0.20
2019	6.01	29.27	0.21
2020	4.01	21.62	0.19
2021	11.64	37.60	0.31
2022	5.36	26.40	0.20
2023	20.67	46.64	0.44
2024	6.84	29.65	0.23
2025	17.62	46.99	0.37
2026	6.13	30.26	0.20
2027	2.45	22.39	0.11
Average	**10.07**	**33.05**	**0.26**

Table 5-34 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	1.80	13.02	0.14
2016	3.58	17.09	0.21
2017	4.53	20.11	0.23
2018	8.98	22.54	0.40
2019	1.00	7.48	0.13
2020	0.57	6.19	0.09
2021	2.64	9.36	0.28
2022	6.60	20.77	0.32
2023	2.93	14.25	0.21
2024	4.53	16.35	0.28
2025	6.17	20.05	0.31
2026	1.39	8.55	0.16
2027	0.87	8.00	0.11
Average	**3.51**	**14.14**	**0.22**

5.4 WATER BUDGET CHANGES

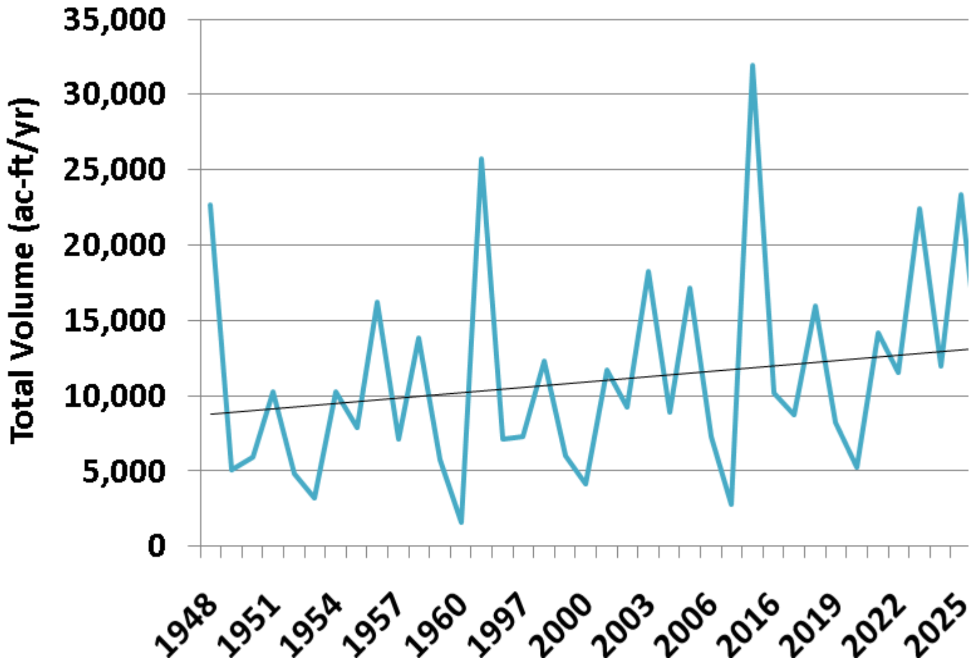

Figure 5-28 Trend in Total Volume from Historical through Future Time Series

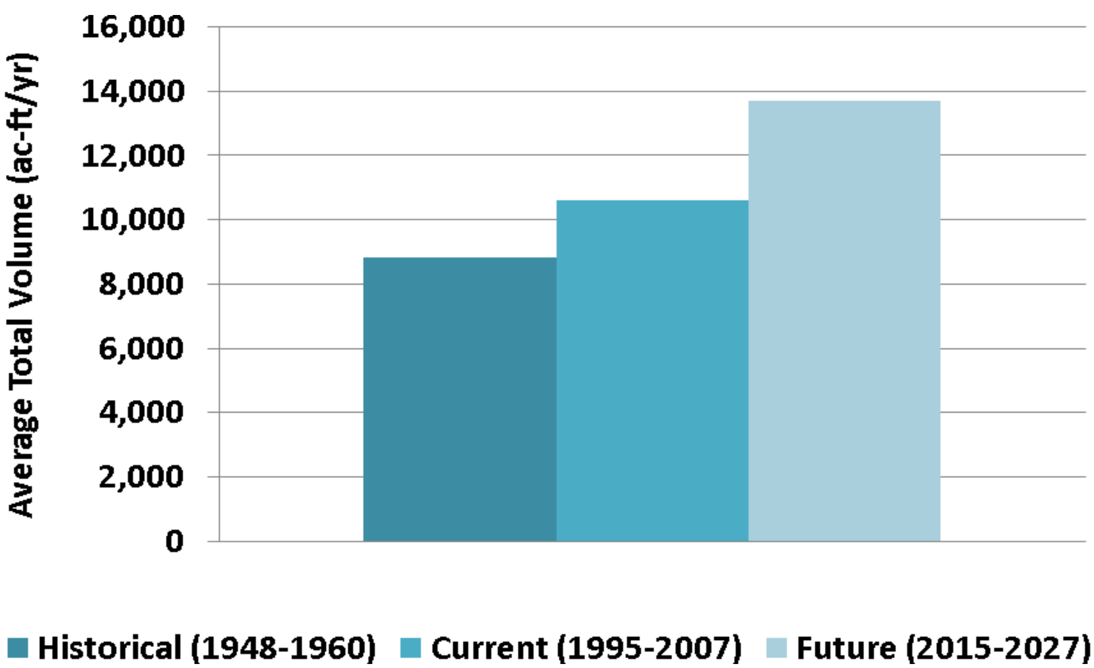

Figure 5-29 Historical, Current, and Future Average Annual Total Volume to Lemon Bay

Table 5-35 Change in Total Volume from Historical to Current Conditions

Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	22,668	25,748	3,079
2	5,076	7,090	2,014
3	5,953	7,309	1,356
4	10,264	12,264	2,000
5	4,837	6,021	1,184
6	3,245	4,185	940
7	10,257	11,696	1,439
8	7,899	9,278	1,379
9	16,257	18,285	2,028
10	7,082	8,867	1,785
11	13,801	17,168	3,368
12	5,771	7,272	1,501
13	1,615	2,811	1,196
Average	**8,825**	**10,615**	**1,790**

Table 5-36 Change in Total Volume from Current to Future Conditions

Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	25,748	31,973	6,226
2	7,090	10,220	3,129
3	7,309	8,766	1,457
4	12,264	15,994	3,729
5	6,021	8,232	2,211
6	4,185	5,222	1,036
7	11,696	14,217	2,522
8	9,278	11,552	2,274
9	18,285	22,449	4,163
10	8,867	11,984	3,117
11	17,168	23,318	6,150
12	7,272	9,973	2,702
13	2,811	3,958	1,146
Average	**10,615**	**13,681**	**3,066**

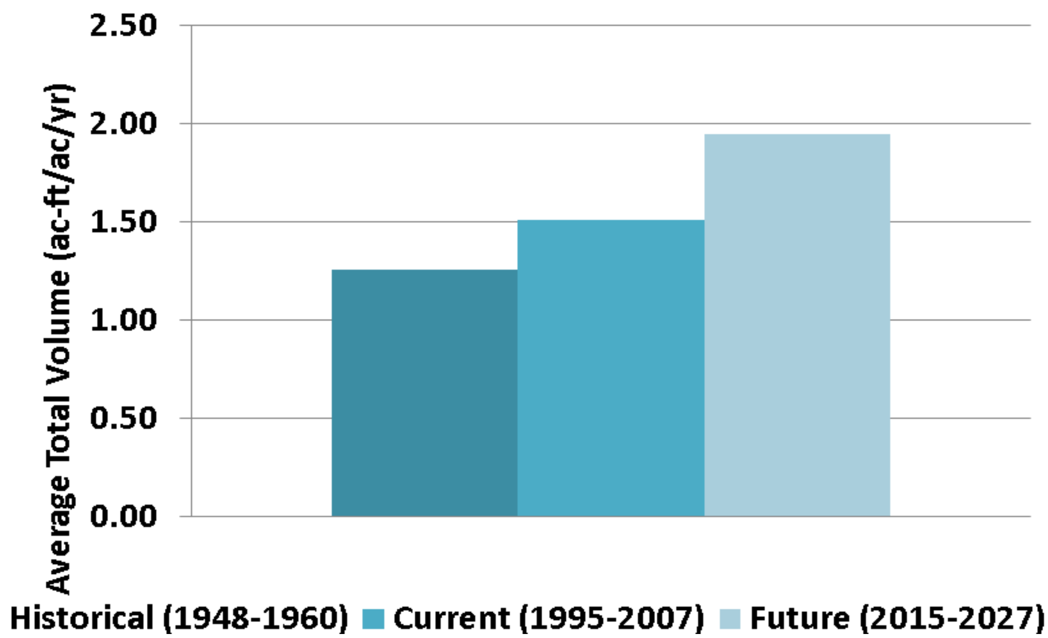

Figure 5-30 Normalized Historical, Current, and Future Average Annual Total Volume to Lemon Bay

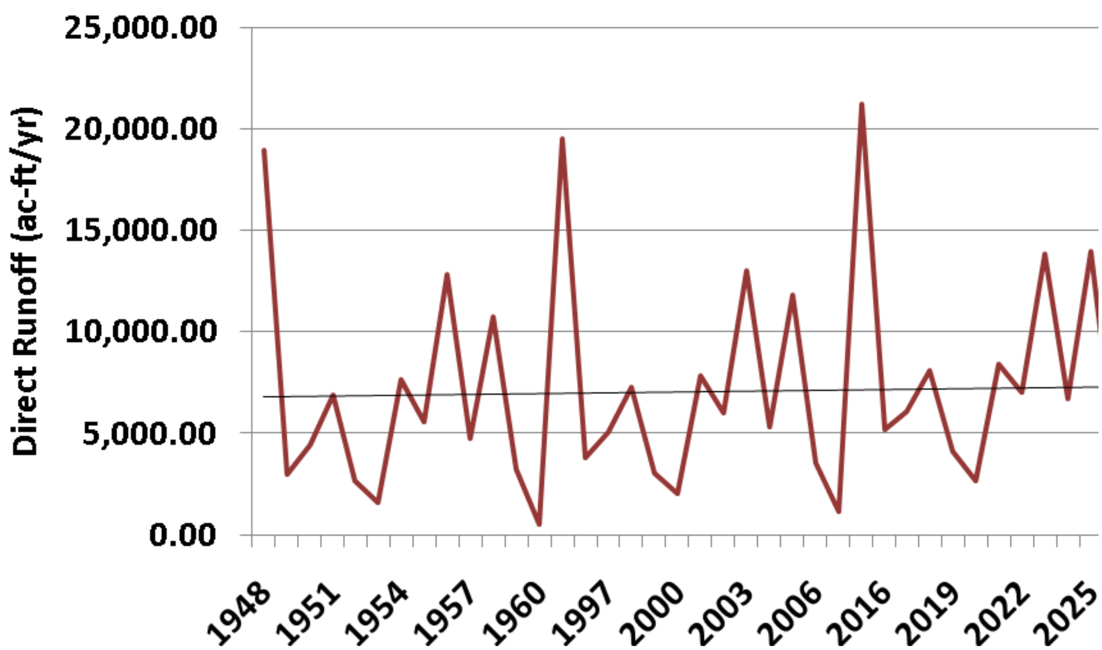

Figure 5-31 Trend in Direct Runoff from Historical through Future Time Series

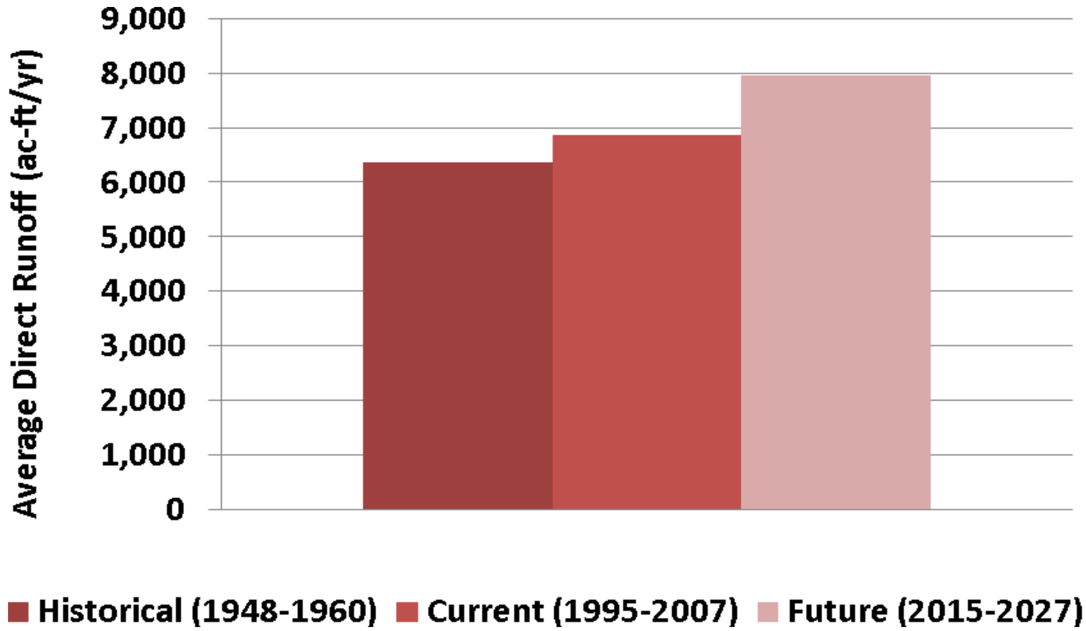

Figure 5-32 Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

Table 5-37 Change in Direct Runoff from Historical to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	18,923	19,521	598
2	3,003	3,780	777
3	4,401	5,063	662
4	6,908	7,292	384
5	2,684	3,059	375
6	1,608	2,041	433
7	7,632	7,817	185
8	5,593	5,991	398
9	12,833	13,010	177
10	4,725	5,319	594
11	10,754	11,790	1,036
12	3,251	3,526	275
13	516	1,137	621
Average	**6,372**	**6,873**	**501**

Table 5-38 Change in Direct Runoff from Current to Future Conditions

Year	Current Direct Runoff (ac-ft) 1948-1960	Future Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (future-historical)
1	19,521	21,208	1,687
2	3,780	5,173	1,393
3	5,063	6,046	982
4	7,292	8,102	811
5	3,059	4,112	1,053
6	2,041	2,686	645
7	7,817	8,376	559
8	5,991	7,014	1,023
9	13,010	13,842	832
10	5,319	6,670	1,351
11	11,790	13,948	2,157
12	3,526	4,410	884
13	1,137	1,946	808
Average	**6,873**	**7,964**	**1,091**

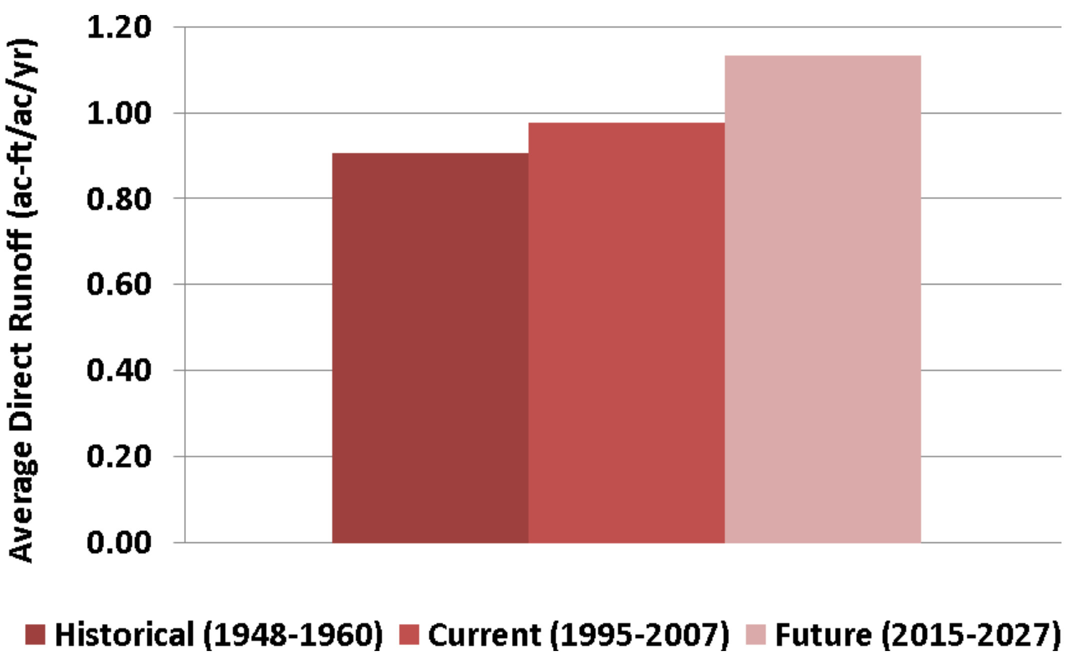

Figure 5-33 Normalized Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

6.0 AINGER CREEK BASIN

6.1 CURRENT CONDITIONS

Table 6-1 Monthly Rainfall for Ainger Creek Basin (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	3.55	2.85	1.39	3.08	0.84	25.74	16.87	10.19	7.76	10.66	0.85	1.12	84.92
1996	1949	2016	3.47	0.85	4.13	2.39	5.70	5.21	4.03	5.57	6.04	7.33	0.43	0.95	46.10
1997	1950	2017	1.93	0.46	1.43	5.54	1.72	3.73	5.47	4.35	11.20	1.85	3.91	5.72	47.31
1998	1951	2018	6.05	5.04	4.81	0.27	1.84	3.10	8.49	5.57	8.02	0.97	4.14	0.36	48.67
1999	1952	2019	2.23	0.04	1.48	0.43	2.03	6.12	5.00	7.05	7.61	2.05	0.62	1.57	36.24
2000	1953	2020	1.22	0.36	1.06	1.46	0.46	5.41	5.93	7.41	5.69	0.67	0.60	0.51	30.78
2001	1954	2021	0.12	0.00	7.18	0.56	0.67	6.41	12.67	5.47	11.07	2.04	0.34	0.42	46.98
2002	1955	2022	0.59	4.83	0.21	2.36	2.92	9.79	3.84	12.64	3.87	0.86	5.41	4.11	51.44
2003	1956	2023	0.04	0.74	2.32	2.96	4.10	19.63	5.22	12.93	11.61	0.41	0.51	3.37	63.83
2004	1957	2024	1.91	4.18	0.97	3.21	1.33	6.28	9.43	9.79	4.91	3.48	1.85	3.34	50.68
2005	1958	2025	1.17	2.70	4.38	2.35	5.81	17.63	10.60	6.80	4.75	9.32	3.07	0.30	68.88
2006	1959	2026	0.67	3.13	0.26	0.04	1.61	6.25	14.18	8.57	5.04	1.09	0.68	2.85	44.37
2007	1960	2027	1.63	1.27	0.35	2.03	0.71	4.79	5.22	4.19	4.83	3.76	0.42	0.71	29.91
		Average	**1.89**	**2.04**	**2.31**	**2.05**	**2.29**	**9.24**	**8.23**	**7.73**	**7.11**	**3.42**	**1.76**	**1.95**	**50.01**

Table 6-2 Current Total Volume for Ainger Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	392.9	325.1	202.3	163.9	124.5	7,428.2	4,460.2	2,254.6	2,001.2	2,838.6	399.5	258.6	20,849.6
1996	485.2	196.2	369.2	249.7	756.3	458.4	327.7	452.7	752.2	1,603.1	250.9	204.6	6,106.3
1997	311.3	121.0	190.5	434.1	92.4	228.6	308.0	262.1	2,086.6	299.0	541.4	1,085.5	5,960.4
1998	1,912.8	1,325.0	1,114.8	231.6	229.6	225.8	1,007.4	557.8	1,076.6	358.8	809.3	181.5	9,031.1
1999	197.6	110.9	116.2	87.3	91.8	209.2	526.6	450.5	1,002.7	416.3	224.8	258.0	3,691.7
2000	208.9	114.6	107.0	114.4	78.1	138.1	320.0	815.8	751.9	242.2	179.1	153.4	3,223.7
2001	126.7	98.1	801.2	104.5	92.9	452.3	2,355.9	1,331.1	2,221.5	437.7	240.0	192.5	8,454.5
2002	158.0	742.1	115.2	185.0	220.4	963.1	293.4	1,964.7	707.0	284.3	1,421.8	576.7	7,631.8
2003	250.1	181.7	216.2	491.2	532.6	4,943.3	791.5	2,884.6	3,319.7	364.1	235.3	459.7	14,670.0
2004	254.4	642.0	183.5	383.2	116.7	383.4	836.7	1,571.9	958.8	947.8	311.8	661.7	7,251.9
2005	196.8	448.8	718.2	127.5	680.6	3,316.9	2,253.5	851.2	615.6	2,063.7	614.7	260.4	12,148.0
2006	196.8	402.7	134.3	108.8	104.1	270.9	2,196.3	1,473.5	789.0	336.4	207.7	316.1	6,536.4
2007	182.2	113.1	94.5	119.6	70.5	112.8	119.9	123.5	154.3	238.0	105.6	88.6	1,522.8
Average	**374.9**	**370.9**	**335.6**	**215.5**	**245.4**	**1,471.6**	**1,215.2**	**1,153.4**	**1,264.4**	**802.3**	**426.3**	**361.3**	**8,236.8**

Table 6-3 Current Direct Runoff for Ainger Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	203.4	147.2	21.8	24.3	3.7	7,157.0	3,975.1	1,675.8	1,398.2	2,202.1	8.8	5.9	16,823.4
1996	240.0	6.8	205.9	118.1	634.6	330.8	176.9	301.3	537.9	1,209.0	1.6	4.5	3,767.5
1997	150.2	0.8	77.9	340.8	7.8	158.0	238.1	143.3	1,888.6	65.3	358.0	762.7	4,191.6
1998	1,503.4	888.6	772.9	0.6	38.9	74.3	808.8	302.7	715.3	15.3	579.8	0.4	5,701.1
1999	51.0	0.0	12.4	1.3	15.1	143.5	395.5	284.0	726.4	70.2	3.9	77.1	1,780.4
2000	62.6	0.5	3.5	28.6	1.9	72.6	234.3	624.5	481.4	7.6	1.6	2.1	1,521.2
2001	0.0	0.0	706.5	3.1	4.0	376.9	2,057.1	871.5	1,767.4	67.6	2.0	0.4	5,856.5
2002	1.4	622.2	2.8	93.3	139.1	865.5	84.2	1,681.1	233.3	6.4	1,219.1	309.4	5,257.8
2003	0.0	3.3	52.2	357.4	414.8	4,642.2	328.8	2,320.0	2,816.7	1.3	1.5	268.6	11,206.9
2004	105.6	520.1	37.8	264.9	13.0	296.6	626.5	1,130.1	495.1	662.4	107.7	493.6	4,753.4
2005	58.0	347.2	602.4	22.5	582.6	2,902.8	1,689.7	407.8	246.2	1,696.4	236.5	0.1	8,792.2
2006	0.9	254.1	0.9	0.0	8.0	190.3	1,887.7	977.0	355.8	50.9	2.7	146.1	3,874.5
2007	44.7	10.3	0.9	43.0	2.8	56.2	67.7	67.7	84.2	114.8	0.8	4.9	498.2
Average	**186.2**	**215.5**	**192.2**	**99.8**	**143.6**	**1,328.2**	**967.0**	**829.8**	**903.6**	**474.6**	**194.1**	**159.7**	**5,694.2**

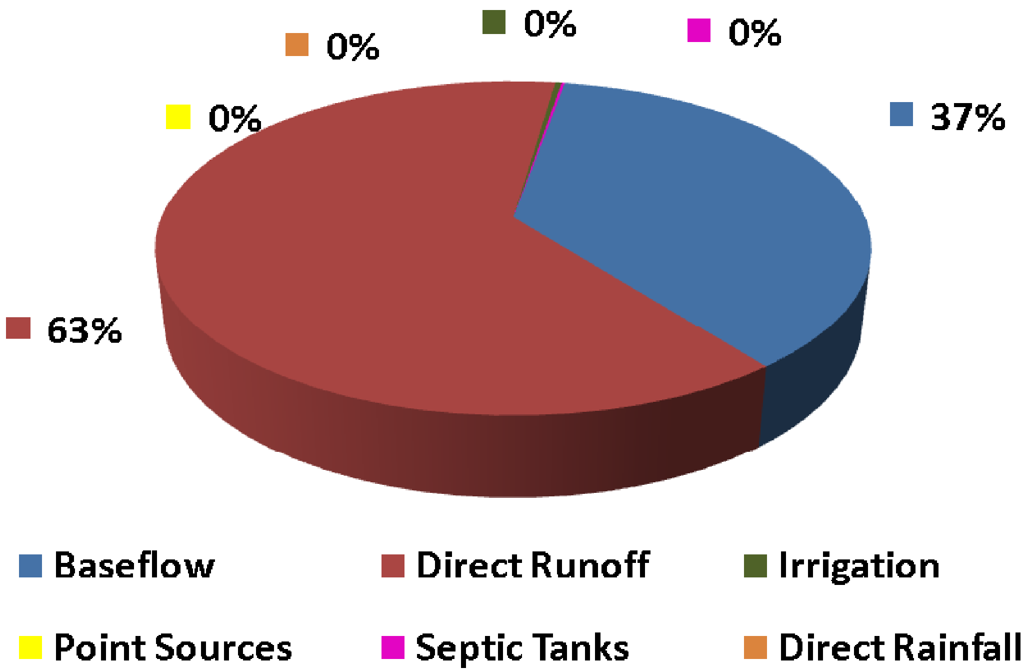

Figure 6-1 Ainger Creek Basin Current Total Volume Water Budget

Table 6-4 Summary of Annual Current Total Volume Inputs for Ainger Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	3,999.7	16,823.4	17.8	0.0	8.6	0.0
1996	2,312.3	3,767.5	17.8	0.0	8.7	0.0
1997	1,742.1	4,191.6	17.8	0.0	8.8	0.0
1998	3,303.3	5,701.1	17.8	0.0	8.9	0.0
1999	1,884.7	1,780.4	17.8	0.0	8.9	0.0
2000	1,675.8	1,521.2	17.8	0.0	8.9	0.0
2001	2,571.2	5,856.5	17.8	0.0	9.0	0.0
2002	2,347.0	5,257.8	17.8	0.0	9.1	0.0
2003	3,434.6	11,206.9	19.1	0.0	9.3	0.0
2004	2,470.0	4,753.4	19.1	0.0	9.3	0.0
2005	3,327.2	8,792.2	19.1	0.0	9.5	0.0
2006	2,633.3	3,874.5	19.1	0.0	9.5	0.0
2007	995.9	498.2	19.1	0.0	9.5	0.0
Average	**2,515.2**	**5,694.2**	**18.3**	**0.0**	**9.1**	**0.0**

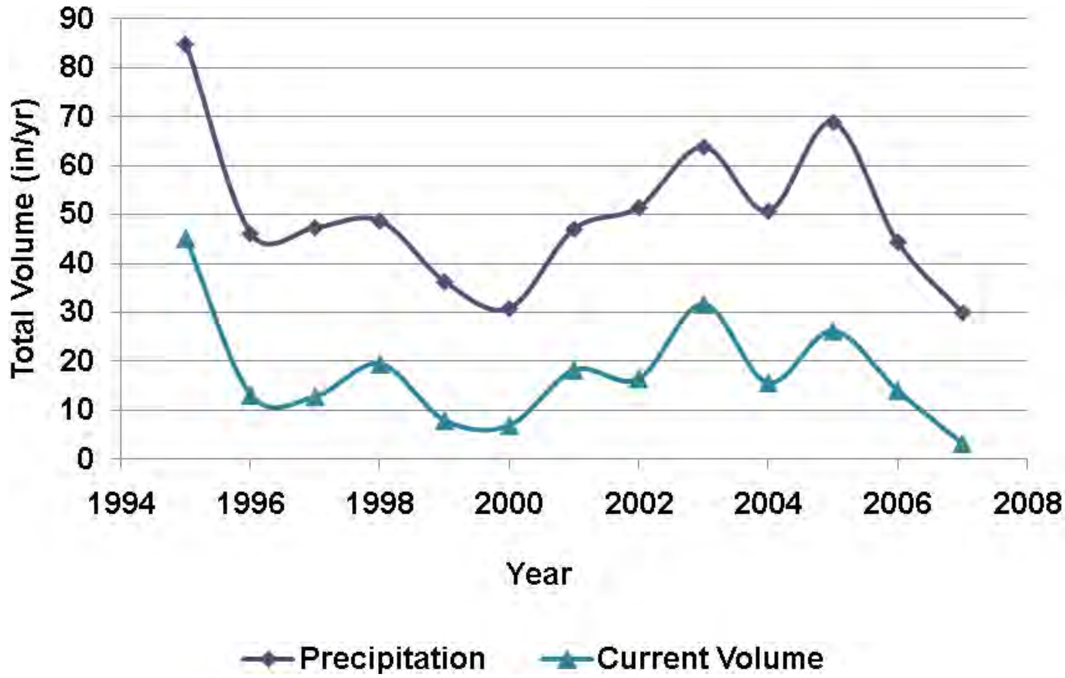

Figure 6-2 Annual Variability of Precipitation and Total Volume for Ainger Creek Basin

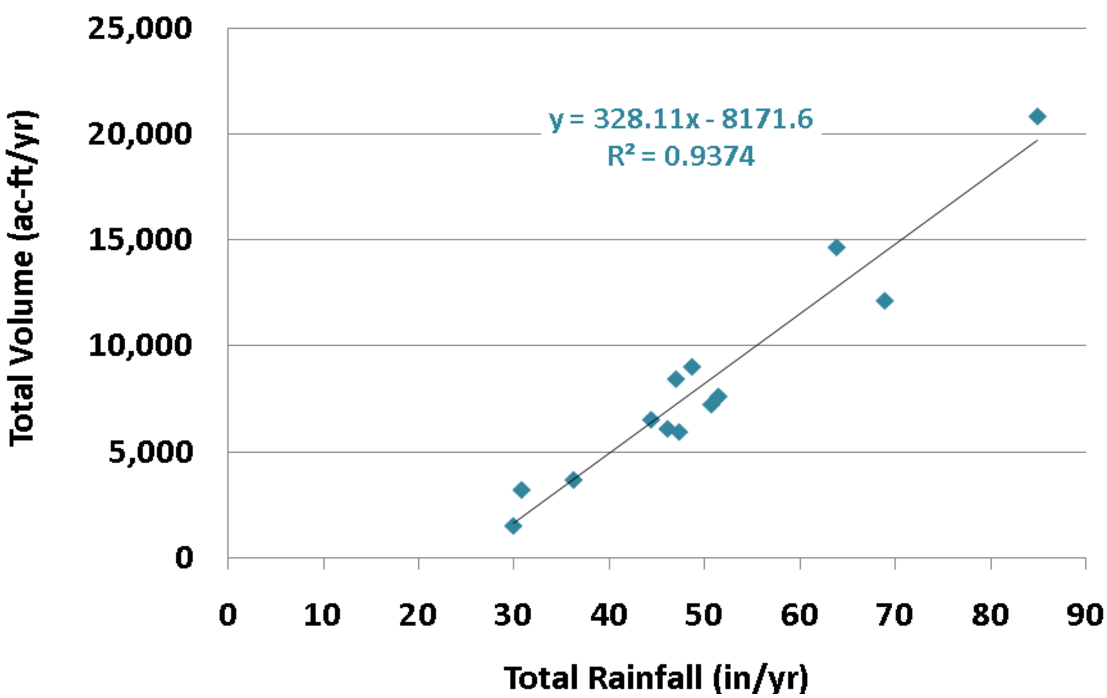

Figure 6-3 Correlation of Annual Total Volume to Rainfall for Ainger Creek Basin

Table 6-5 Annual Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1995	45.00	84.92	0.53
1996	13.18	46.10	0.29
1997	12.87	47.31	0.27
1998	19.49	48.67	0.40
1999	7.97	36.24	0.22
2000	6.96	30.78	0.23
2001	18.25	46.98	0.39
2002	16.47	51.44	0.32
2003	31.66	63.83	0.50
2004	15.65	50.68	0.31
2005	26.22	68.88	0.38
2006	14.11	44.37	0.32
2007	3.29	29.91	0.11
Average	**17.78**	**50.01**	**0.33**

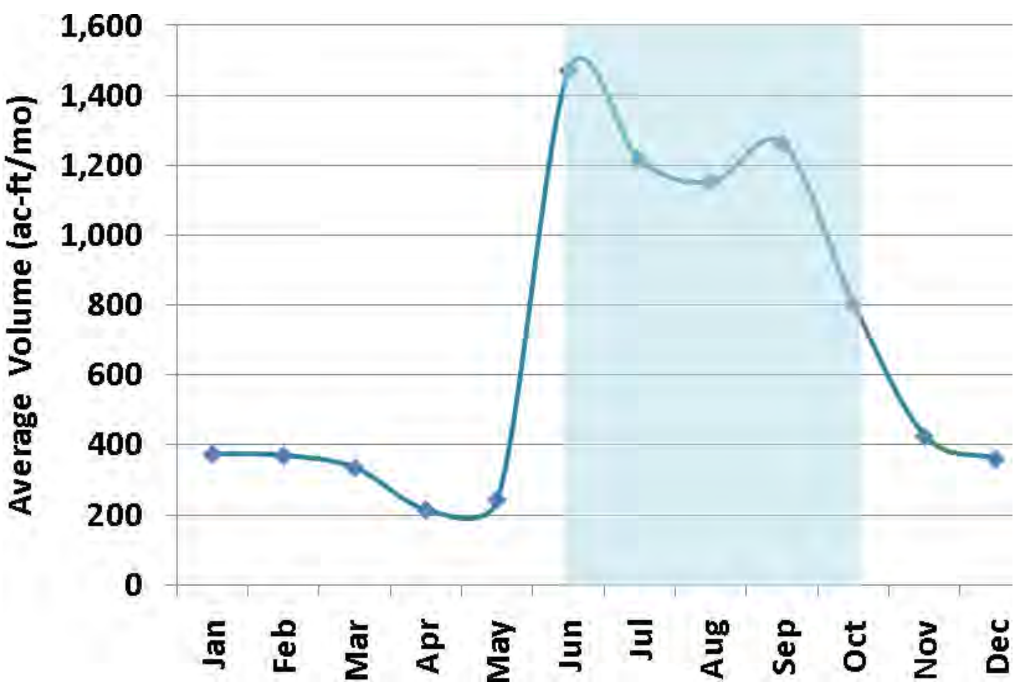

Figure 6-4 Variability of Average Monthly Total Volume in Ainger Creek Basin

Table 6-6 Average Monthly Rainfall to Total Volume Coefficients for Ainger Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.81	1.89	0.43
Feb	0.80	2.04	0.39
Mar	0.72	2.31	0.31
Apr	0.47	2.05	0.23
May	0.53	2.29	0.23
Jun	3.18	9.24	0.34
Jul	2.62	8.23	0.32
Aug	2.49	7.73	0.32
Sep	2.73	7.11	0.38
Oct	1.73	3.42	0.51
Nov	0.92	1.76	0.52
Dec	0.78	1.95	0.40

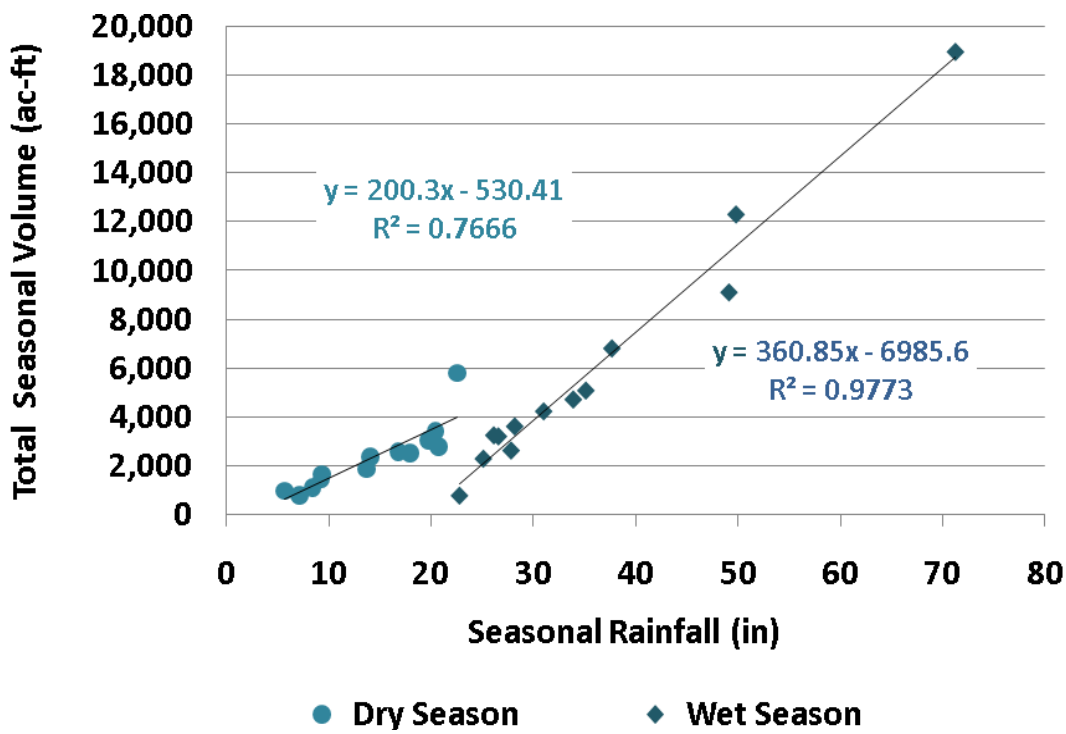

Figure 6-5 Correlation of Seasonal Total Volume to Rainfall for Ainger Creek Basin

Table 6-7 Wet Season Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	40.97	71.22	0.58
1996	7.76	28.19	0.28
1997	6.87	26.59	0.26
1998	6.96	26.14	0.27
1999	5.62	27.82	0.20
2000	4.90	25.12	0.19
2001	14.67	37.67	0.39
2002	9.09	31.01	0.29
2003	26.56	49.80	0.53
2004	10.14	33.90	0.30
2005	19.64	49.11	0.40
2006	10.93	35.13	0.31
2007	1.62	22.79	0.07
Average	**12.75**	**35.73**	**0.31**

Table 6-8 Dry Season Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	4.03	13.70	0.29
1996	5.42	17.91	0.30
1997	5.99	20.72	0.29
1998	12.53	22.52	0.56
1999	2.35	8.42	0.28
2000	2.06	5.66	0.36
2001	3.57	9.31	0.38
2002	7.38	20.43	0.36
2003	5.11	14.04	0.36
2004	5.51	16.79	0.33
2005	6.58	19.78	0.33
2006	3.17	9.24	0.34
2007	1.67	7.13	0.23
Average	**5.03**	**14.28**	**0.34**

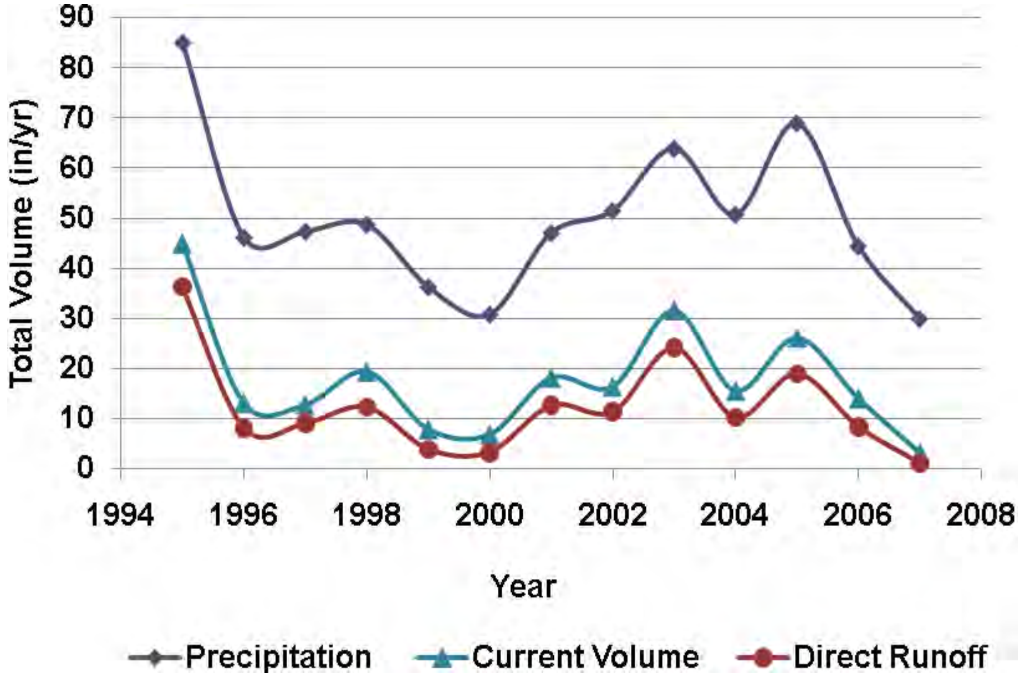

Figure 6-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Ainger Creek Basin

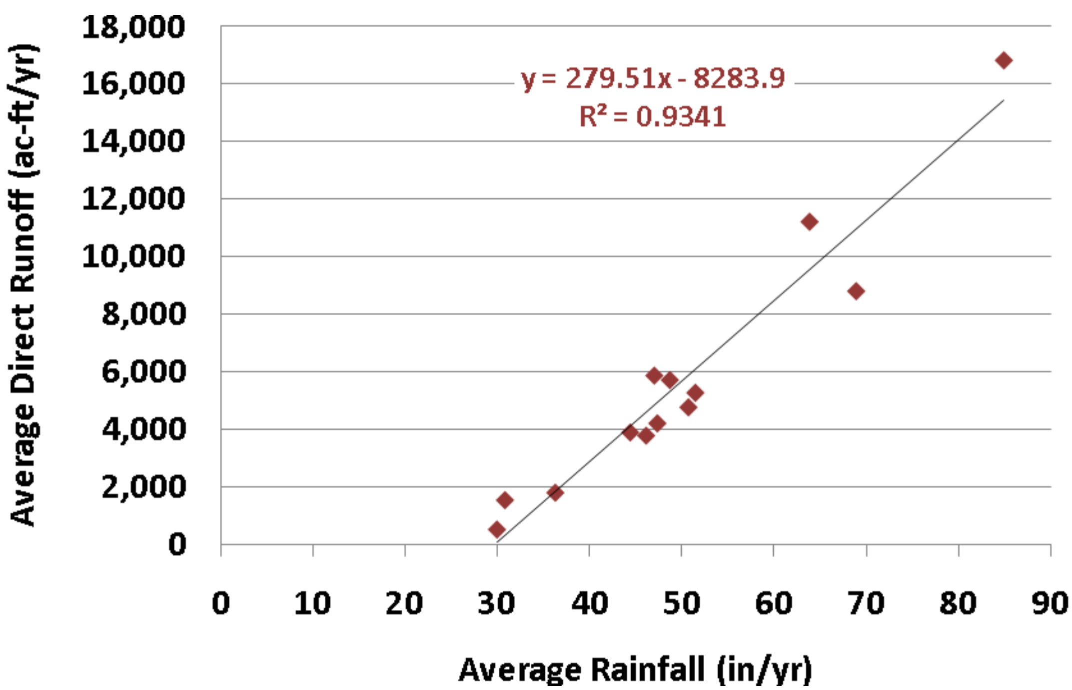

Figure 6-7 Correlation of Average Annual Direct Runoff to Rainfall

Table 6-9 Annual Direct Runoff to Rainfall Coefficients for Ainger Creek Basin

	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	36.31	84.92	0.43
1996	8.13	46.10	0.18
1997	9.05	47.31	0.19
1998	12.31	48.67	0.25
1999	3.84	36.24	0.11
2000	3.28	30.78	0.11
2001	12.64	46.98	0.27
2002	11.35	51.44	0.22
2003	24.19	63.83	0.38
2004	10.26	50.68	0.20
2005	18.98	68.88	0.28
2006	8.36	44.37	0.19
2007	1.08	29.91	0.04
Average	**12.29**	**50.01**	**0.22**

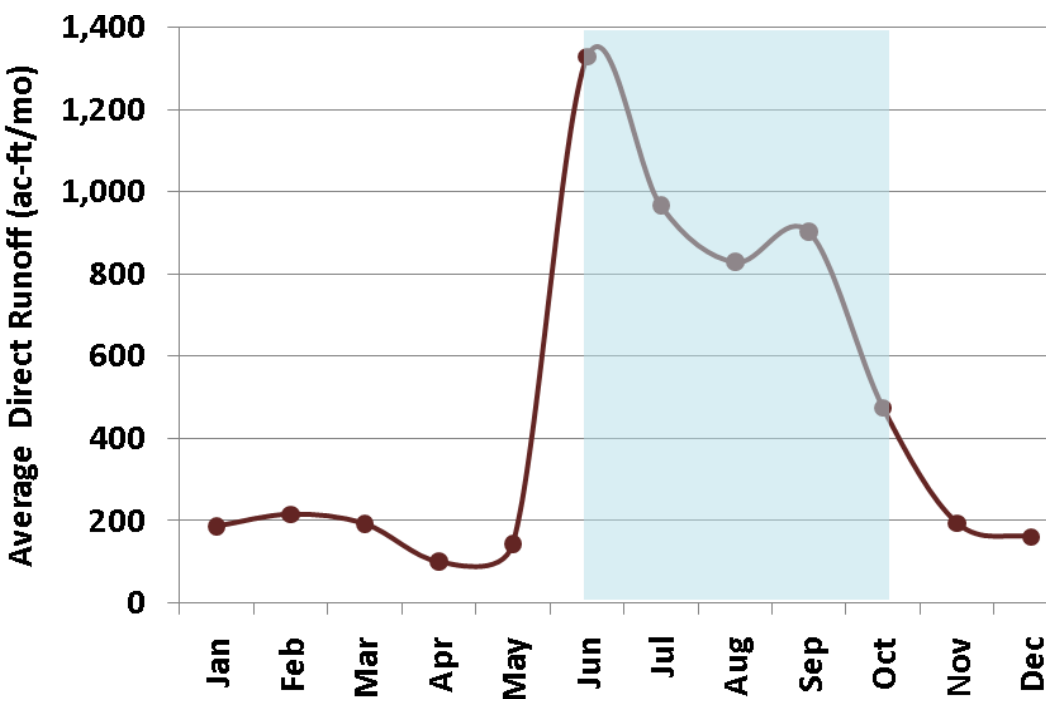

Figure 6-8 Variability of Average Monthly Direct Runoff to Ainger Creek Basin

Table 6-10 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.40	1.89	0.21
Feb	0.47	2.04	0.23
Mar	0.41	2.31	0.18
Apr	0.22	2.05	0.10
May	0.31	2.29	0.14
Jun	2.87	9.24	0.31
Jul	2.09	8.23	0.25
Aug	1.79	7.73	0.23
Sep	1.95	7.11	0.27
Oct	1.02	3.42	0.30
Nov	0.42	1.76	0.24
Dec	0.34	1.95	0.18

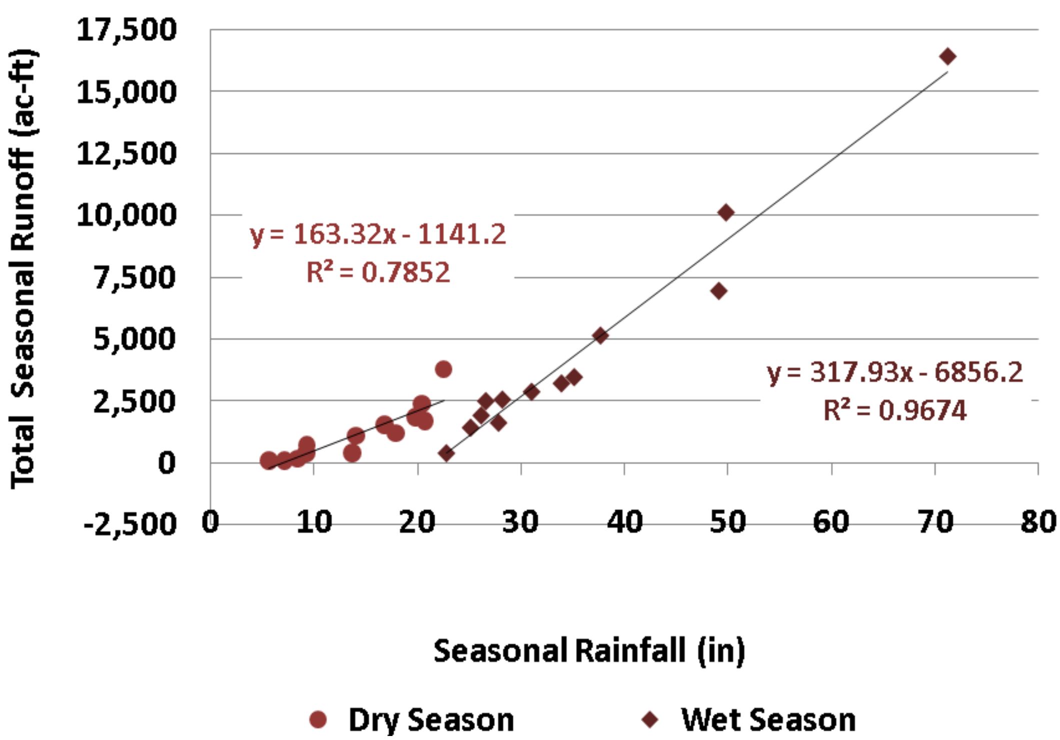

Figure 6-9 Correlation of Seasonal Direct Runoff to Rainfall

Table 6-11 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	35.42	71.22	0.50
1996	5.52	28.19	0.20
1997	5.38	26.59	0.20
1998	4.14	26.14	0.16
1999	3.50	27.82	0.13
2000	3.07	25.12	0.12
2001	11.10	37.67	0.29
2002	6.20	31.01	0.20
2003	21.82	49.80	0.44
2004	6.93	33.90	0.20
2005	14.99	49.11	0.31
2006	7.47	35.13	0.21
2007	0.84	22.79	0.04
Average	**9.72**	**35.73**	**0.23**

Table 6-12 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	0.90	13.70	0.07
1996	2.62	17.91	0.15
1997	3.67	20.72	0.18
1998	8.17	22.52	0.36
1999	0.35	8.42	0.04
2000	0.22	5.66	0.04
2001	1.55	9.31	0.17
2002	5.15	20.43	0.25
2003	2.37	14.04	0.17
2004	3.33	16.79	0.20
2005	3.99	19.78	0.20
2006	0.89	9.24	0.10
2007	0.23	7.13	0.03
Average	**2.57**	**14.28**	**0.15**

6.2 HISTORICAL CONDITIONS

Table 6-13 Historical Total Volume for Ainger Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	340.8	295.3	152.7	126.1	105.6	7,629.6	4,493.0	2,176.6	1,867.8	2,731.3	271.3	179.7	20,370.0
1949	468.8	155.3	345.5	227.7	778.0	456.4	272.5	431.2	762.8	1,555.6	172.6	152.6	5,779.0
1950	279.6	101.8	173.4	414.0	80.6	264.9	317.1	276.5	2,142.9	225.6	537.9	1,125.5	5,939.9
1951	1,841.8	1,303.7	970.3	167.4	180.0	193.9	1,069.4	576.5	1,059.4	230.8	742.8	142.1	8,478.0
1952	175.0	96.1	98.6	79.9	84.9	218.8	591.4	459.2	1,011.5	321.0	162.7	217.3	3,516.4
1953	180.9	99.5	93.2	102.0	71.8	125.8	322.0	805.4	772.7	181.4	144.5	129.3	3,028.7
1954	112.1	89.0	829.8	99.6	91.0	500.1	2,578.6	1,247.7	2,198.1	307.2	173.7	152.7	8,379.5
1955	131.5	752.6	105.4	182.0	218.8	1,177.9	254.1	2,046.7	549.6	195.6	1,352.2	623.7	7,590.1
1956	204.5	154.8	192.9	491.0	532.2	5,278.9	652.9	2,853.1	3,178.2	223.9	157.5	409.6	14,329.3
1957	215.0	582.9	154.7	409.8	101.6	420.2	931.0	1,604.6	859.6	813.2	240.3	683.4	7,016.4
1958	157.9	432.6	672.9	89.7	667.5	3,541.1	2,103.2	736.8	452.2	2,021.5	513.0	185.7	11,574.0
1959	155.4	372.6	114.9	97.3	88.9	275.0	2,398.7	1,389.7	659.3	223.5	146.8	271.5	6,193.8
1960	169.6	95.0	81.1	106.7	62.9	91.1	94.8	119.7	132.7	182.8	71.6	63.7	1,271.8
Average	**341.0**	**348.6**	**306.6**	**199.5**	**235.7**	**1,551.8**	**1,236.8**	**1,132.6**	**1,203.6**	**708.7**	**360.5**	**333.6**	**7,959.0**

Table 6-14 Historical Direct Runoff for Ainger Creek Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	196.80	160.84	12.16	10.71	1.61	7,415.82	4,177.12	1,818.68	1,479.54	2,324.22	8.15	0.34	17,605.99
1949	281.89	1.20	205.29	111.79	674.20	357.54	162.51	321.49	615.60	1,290.52	0.03	0.19	4,022.25
1950	149.06	0.00	74.45	329.90	2.09	197.56	252.47	174.64	1,984.68	48.48	399.05	885.62	4,498.02
1951	1,541.99	1,000.33	734.51	0.00	31.12	69.39	903.08	380.86	816.72	6.81	579.09	0.00	6,063.91
1952	52.72	0.00	4.89	0.01	11.86	155.24	477.03	328.24	818.75	85.19	0.38	73.36	2,007.67
1953	58.00	0.00	0.07	22.96	0.02	63.08	242.54	645.40	572.76	3.45	0.01	0.06	1,608.37
1954	0.00	0.00	741.47	0.48	1.92	423.37	2,334.81	945.58	1,909.51	63.90	0.06	0.00	6,421.10
1955	0.00	648.43	4.40	96.48	140.72	1,089.54	80.03	1,835.95	231.99	5.90	1,198.39	410.41	5,742.22
1956	0.00	0.04	44.73	367.19	420.47	5,055.40	360.40	2,506.45	2,867.28	0.08	0.00	268.14	11,890.18
1957	96.68	481.79	27.21	303.90	6.11	338.74	757.07	1,301.76	565.82	629.40	92.99	551.66	5,153.14
1958	44.94	346.05	582.14	9.08	594.39	3,273.18	1,762.21	473.21	239.21	1,796.84	255.93	0.07	9,377.26
1959	0.00	251.78	0.15	0.00	0.42	199.33	2,162.44	1,057.90	393.58	40.63	0.17	140.56	4,246.96
1960	58.62	10.14	0.01	37.78	0.05	37.43	46.00	74.46	84.48	104.11	0.00	0.79	453.87
Average	**190.82**	**223.12**	**187.04**	**99.25**	**145.00**	**1,436.59**	**1,055.21**	**912.66**	**967.69**	**492.27**	**194.94**	**179.32**	**6,083.92**

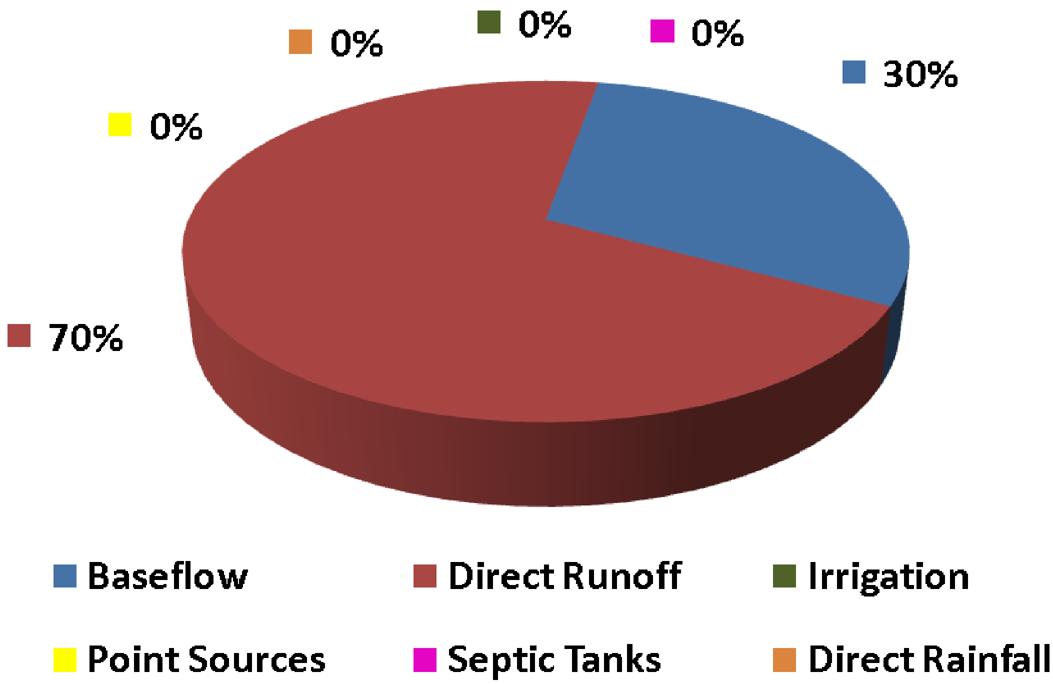

Figure 6-10 Ainger Creek Basin Historical Total Volume Water Budget

Table 6-15 Summary of Annual Historical Total Volume Inputs for Ainger Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	2,764.0	17,606.0	0.0	0.0	0.0	0.0
1949	1,756.8	4,022.3	0.0	0.0	0.0	0.0
1950	1,441.9	4,498.0	0.0	0.0	0.0	0.0
1951	2,414.1	6,063.9	0.0	0.0	0.0	0.0
1952	1,508.8	2,007.7	0.0	0.0	0.0	0.0
1953	1,420.3	1,608.4	0.0	0.0	0.0	0.0
1954	1,958.4	6,421.1	0.0	0.0	0.0	0.0
1955	1,847.9	5,742.2	0.0	0.0	0.0	0.0
1956	2,439.1	11,890.2	0.0	0.0	0.0	0.0
1957	1,863.2	5,153.1	0.0	0.0	0.0	0.0
1958	2,196.8	9,377.3	0.0	0.0	0.0	0.0
1959	1,946.8	4,247.0	0.0	0.0	0.0	0.0
1960	817.9	453.9	0.0	0.0	0.0	0.0
Average	**1,875.1**	**6,083.9**	**0.0**	**0.0**	**0.0**	**0.0**

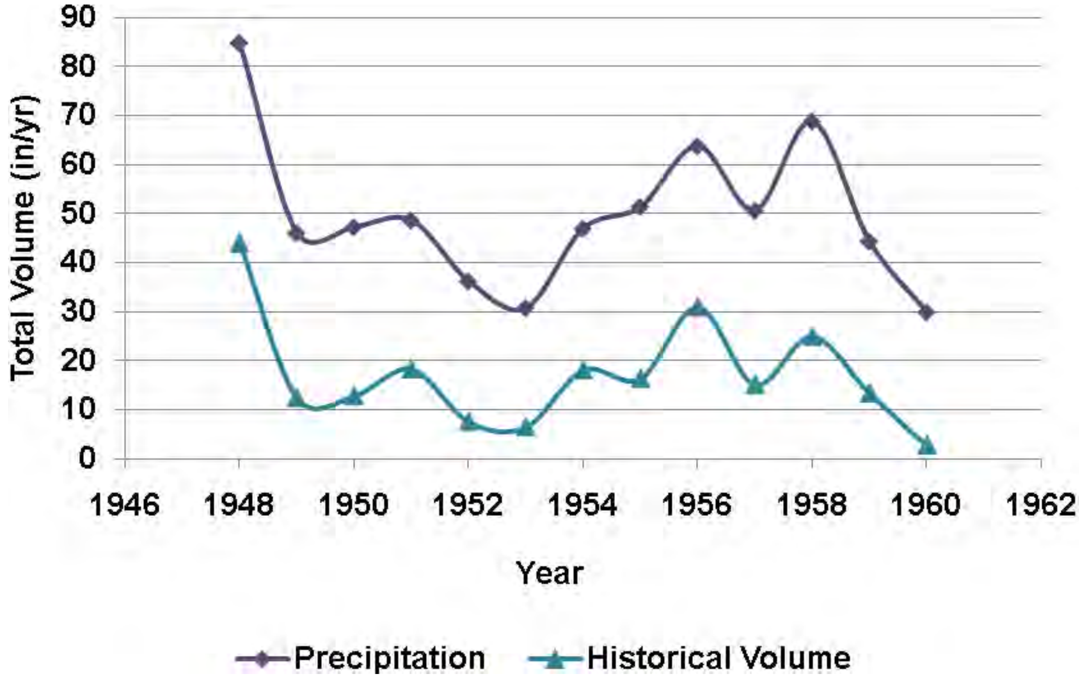

Figure 6-11 Annual Historical Variability of Precipitation and Total Volume for Ainger Creek Basin

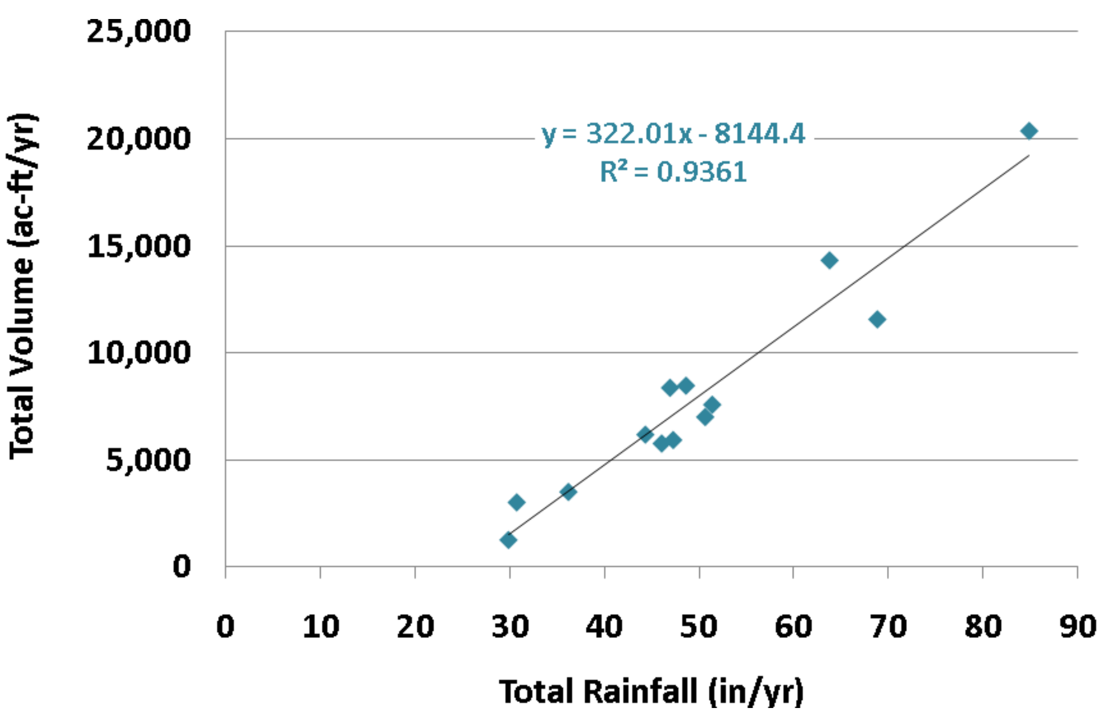

Figure 6-12 Correlation of Annual Total Volume to Rainfall for Ainger Creek Basin

Table 6-16 Annual Total Volume to Rainfall Coefficients for Ainger Creek Basin

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	43.97	84.92	0.52
1949	12.47	46.10	0.27
1950	12.82	47.31	0.27
1951	18.30	48.67	0.38
1952	7.59	36.24	0.21
1953	6.54	30.78	0.21
1954	18.09	46.98	0.38
1955	16.38	51.44	0.32
1956	30.93	63.83	0.48
1957	15.14	50.68	0.30
1958	24.98	68.88	0.36
1959	13.37	44.37	0.30
1960	2.75	29.91	0.09
Average	**17.18**	**50.01**	**0.32**

Figure 6-13 Variability of Average Monthly Total Volume in Ainger Creek Basin

Table 6-17 Average Monthly Rainfall to Total Volume Coefficients for Ainger Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.74	1.89	0.39
Feb	0.75	2.04	0.37
Mar	0.66	2.31	0.29
Apr	0.43	2.05	0.21
May	0.51	2.29	0.22
Jun	3.35	9.24	0.36
Jul	2.67	8.23	0.32
Aug	2.44	7.73	0.32
Sep	2.60	7.11	0.37
Oct	1.53	3.42	0.45
Nov	0.78	1.76	0.44
Dec	0.72	1.95	0.37

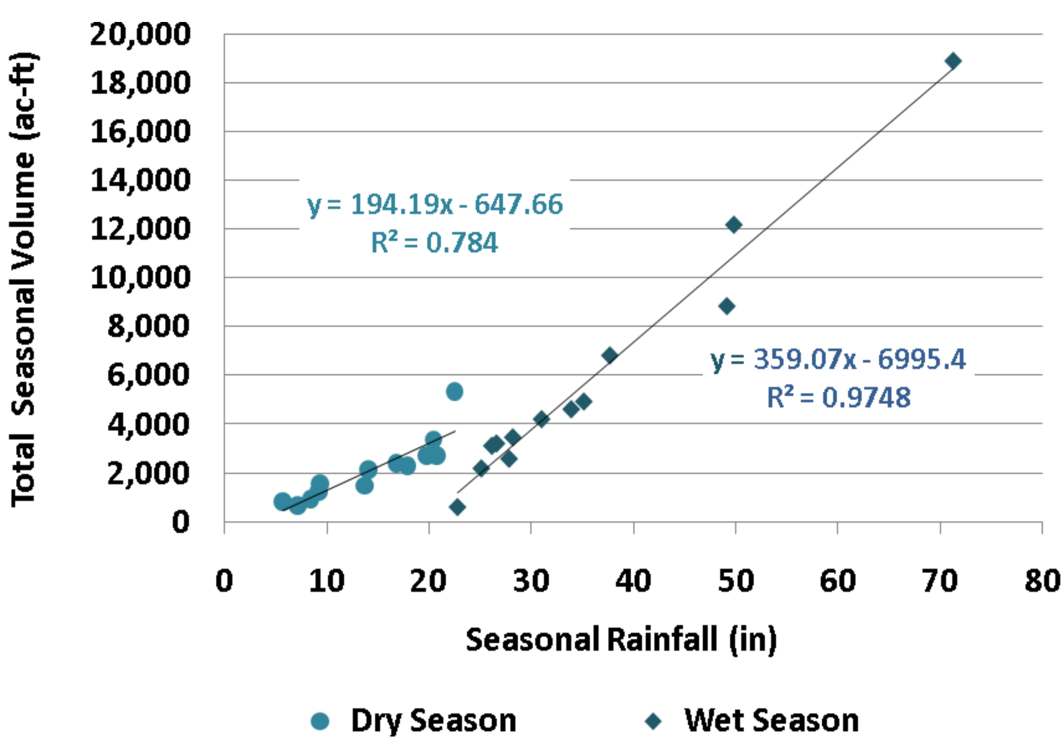

Figure 6-14 Correlation of Seasonal Total Volume to Rainfall for Ainger Creek Basin

Table 6-18 Wet Season Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	40.79	71.22	0.57
1996	7.51	28.19	0.27
1997	6.97	26.59	0.26
1998	6.76	26.14	0.26
1999	5.62	27.82	0.20
2000	4.76	25.12	0.19
2001	14.75	37.67	0.39
2002	9.12	31.01	0.29
2003	26.31	49.80	0.53
2004	9.99	33.90	0.29
2005	19.11	49.11	0.39
2006	10.68	35.13	0.30
2007	1.34	22.79	0.06
Average	**12.59**	**35.73**	**0.31**

Table 6-19 Dry Season Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	3.18	13.70	0.23
1996	4.97	17.91	0.28
1997	5.86	20.72	0.28
1998	11.54	22.52	0.51
1999	1.97	8.42	0.23
2000	1.77	5.66	0.31
2001	3.34	9.31	0.36
2002	7.27	20.43	0.36
2003	4.62	14.04	0.33
2004	5.15	16.79	0.31
2005	5.87	19.78	0.30
2006	2.69	9.24	0.29
2007	1.40	7.13	0.20
Average	**4.59**	**14.28**	**0.31**

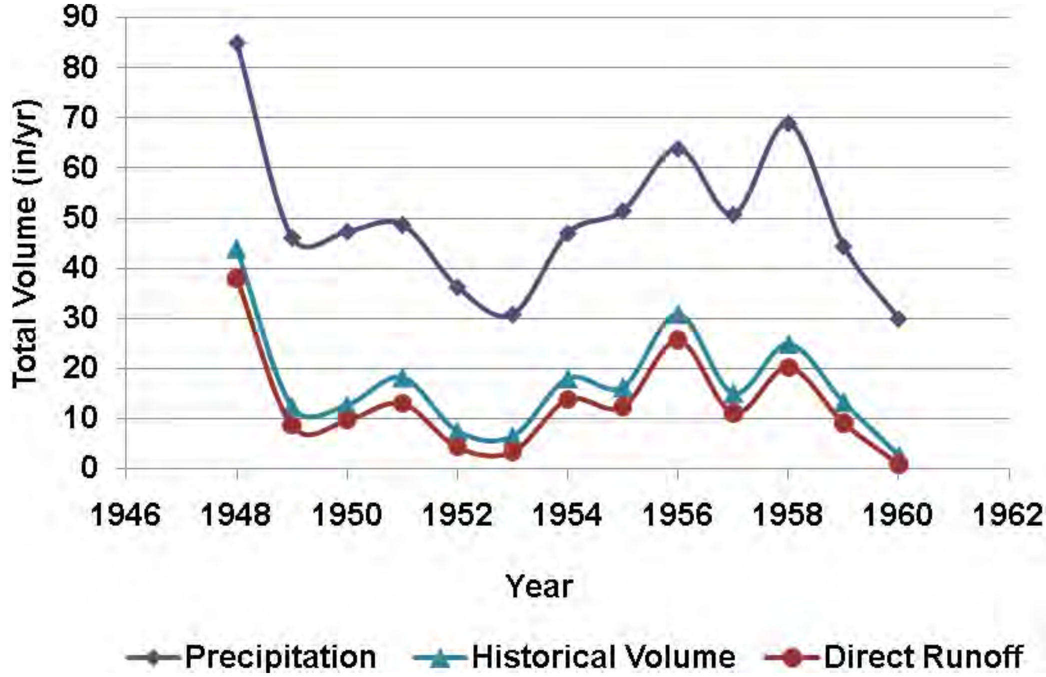

Figure 6-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Ainger Creek Basin

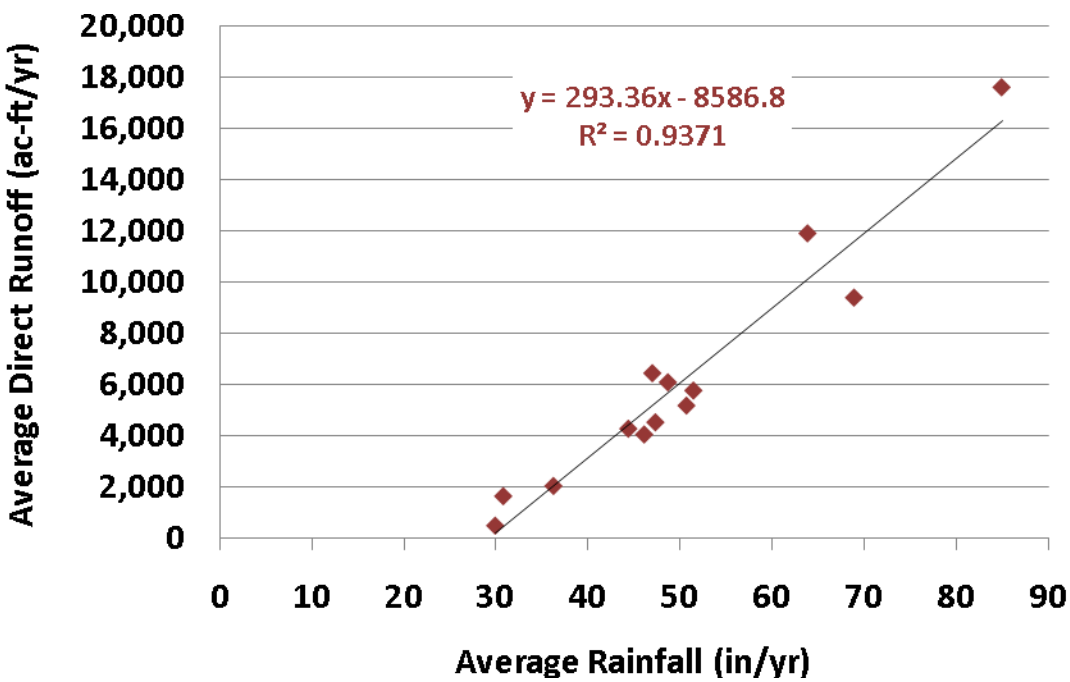

Figure 6-16 Correlation of Average Annual Direct Runoff to Rainfall

Table 6-20 Annual Direct Runoff to Rainfall Coefficients for Ainger Creek Basin

	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	38.00	84.92	0.45
1949	8.68	46.10	0.19
1950	9.71	47.31	0.21
1951	13.09	48.67	0.27
1952	4.33	36.24	0.12
1953	3.47	30.78	0.11
1954	13.86	46.98	0.30
1955	12.39	51.44	0.24
1956	25.66	63.83	0.40
1957	11.12	50.68	0.22
1958	20.24	68.88	0.29
1959	9.17	44.37	0.21
1960	0.98	29.91	0.03
Average	**13.13**	**50.01**	**0.23**

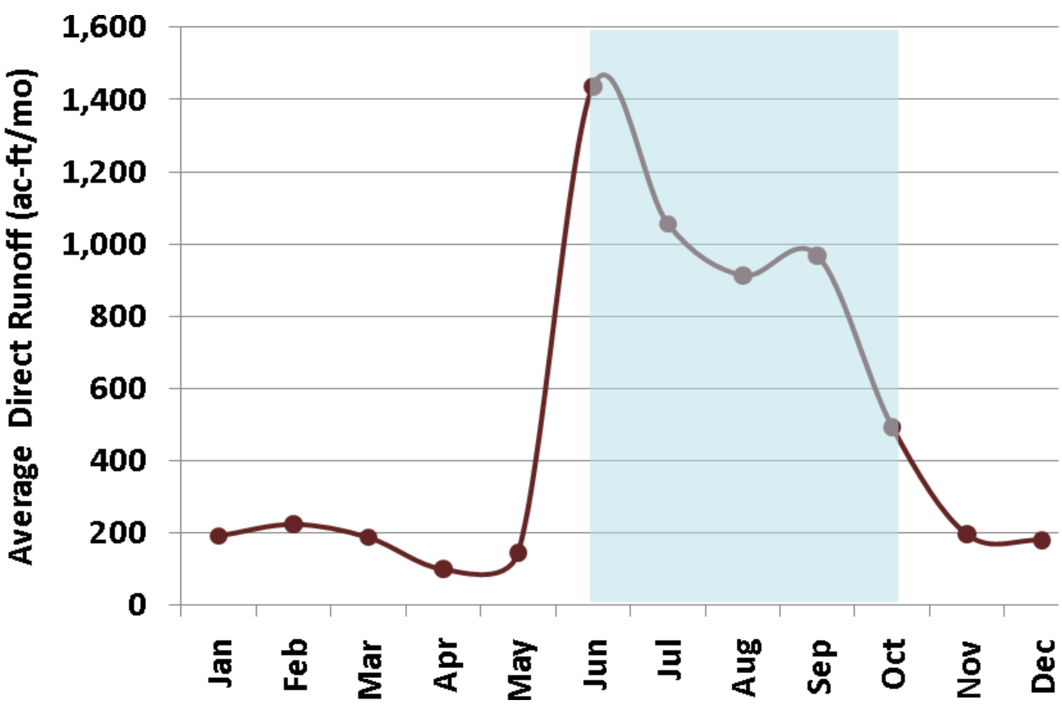

Figure 6-17 Variability of Average Monthly Direct Runoff to Ainger Creek Basin

Table 6-21 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.41	1.89	0.22
Feb	0.48	2.04	0.24
Mar	0.40	2.31	0.17
Apr	0.21	2.05	0.10
May	0.31	2.29	0.14
Jun	3.10	9.24	0.34
Jul	2.28	8.23	0.28
Aug	1.97	7.73	0.25
Sep	2.09	7.11	0.29
Oct	1.06	3.42	0.31
Nov	0.42	1.76	0.24
Dec	0.39	1.95	0.20

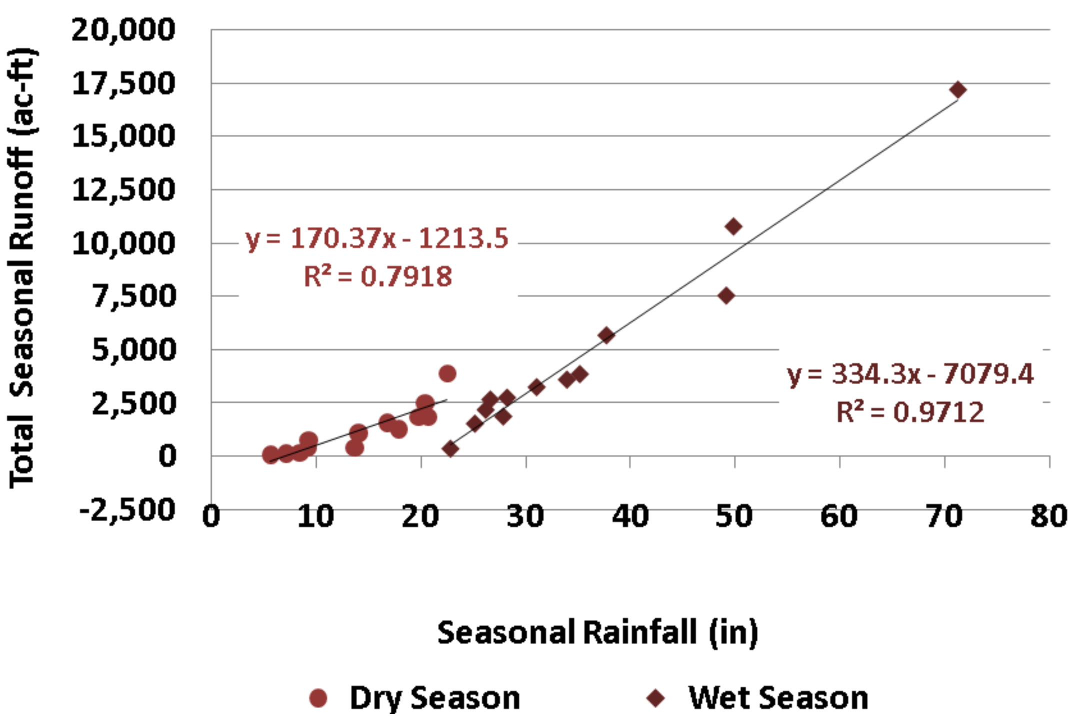

Figure 6-18 Correlation of Seasonal Direct Runoff to Rainfall

Table 6-22 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	37.16	71.22	0.52
1949	5.93	28.19	0.21
1950	5.74	26.59	0.22
1951	4.70	26.14	0.18
1952	4.02	27.82	0.14
1953	3.30	25.12	0.13
1954	12.25	37.67	0.33
1955	7.00	31.01	0.23
1956	23.29	49.80	0.47
1957	7.75	33.90	0.23
1958	16.28	49.11	0.33
1959	8.32	35.13	0.24
1960	0.75	22.79	0.03
Average	**10.50**	**35.73**	**0.25**

Table 6-23 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.84	13.70	0.06
1949	2.75	17.91	0.15
1950	3.97	20.72	0.19
1951	8.39	22.52	0.37
1952	0.31	8.42	0.04
1953	0.18	5.66	0.03
1954	1.61	9.31	0.17
1955	5.39	20.43	0.26
1956	2.38	14.04	0.17
1957	3.37	16.79	0.20
1958	3.96	19.78	0.20
1959	0.85	9.24	0.09
1960	0.23	7.13	0.03
Average	**2.63**	**14.28**	**0.15**

6.3 FUTURE CONDITIONS

Table 6-24 Future Total Volume for Ainger Creek Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	705.5	597.3	388.0	309.6	172.0	7,947.2	5,425.8	3,418.6	2,977.8	3,825.7	855.2	524.2	27,146.9
2016	805.0	309.4	559.1	296.5	927.6	741.6	654.3	883.8	1,268.2	2,307.2	557.0	393.3	9,703.1
2017	393.8	171.2	213.0	438.6	129.2	288.3	404.2	416.4	2,663.1	597.6	862.7	1,461.5	8,039.5
2018	2,177.3	1,658.7	1,671.6	463.1	387.0	358.3	1,195.4	886.1	1,756.5	836.0	1,214.4	300.1	12,904.5
2019	320.2	132.5	154.9	92.3	133.7	314.2	603.5	756.1	1,580.2	843.3	429.1	406.7	5,766.9
2020	255.4	135.5	129.0	138.6	77.4	241.8	414.7	1,147.2	1,253.0	482.7	297.0	226.4	4,798.7
2021	159.6	112.4	1,082.9	93.2	80.5	465.0	2,423.1	1,769.1	3,124.6	995.9	467.8	304.7	11,078.8
2022	218.6	693.1	136.7	275.4	330.8	1,155.3	442.5	2,545.0	1,376.8	658.5	1,793.0	857.0	10,482.7
2023	342.7	221.0	241.3	411.5	453.4	5,017.0	1,509.2	4,328.6	4,113.2	887.6	506.4	714.2	18,746.1
2024	391.3	873.7	228.3	376.0	130.0	480.2	1,287.3	2,302.1	1,730.4	1,507.9	602.2	915.4	10,824.9
2025	321.5	480.6	982.8	282.6	1,091.2	4,317.7	3,451.5	1,841.5	1,446.2	2,939.8	1,128.2	513.7	18,797.4
2026	313.6	629.6	190.4	132.8	145.2	370.7	2,494.7	2,191.9	1,565.7	787.7	429.4	509.7	9,761.5
2027	289.7	169.8	117.7	189.6	82.0	230.6	240.7	210.2	310.3	481.7	204.5	157.0	2,683.8
Average	**514.9**	**475.8**	**468.9**	**269.2**	**318.5**	**1,686.7**	**1,580.5**	**1,745.9**	**1,935.9**	**1,319.3**	**719.0**	**560.3**	**11,595.0**

4

Table 6-25 Future Direct Runoff for Ainger Creek Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	341.0	253.0	66.7	100.9	17.6	7,523.2	4,323.4	1,995.1	1,595.5	2,354.6	22.4	28.4	18,621.6
2016	368.4	31.0	358.9	148.3	769.2	498.7	324.2	525.4	760.8	1,421.6	7.4	25.3	5,239.4
2017	140.0	5.1	72.6	332.3	41.3	221.2	338.8	256.9	2,330.3	148.0	510.5	888.0	5,285.1
2018	1,438.2	774.2	957.0	4.2	61.2	128.3	936.8	455.7	955.3	41.8	758.8	3.4	6,514.9
2019	117.2	0.0	44.6	9.3	64.8	258.6	469.5	505.4	1,003.7	116.8	21.4	129.5	2,740.7
2020	62.5	3.6	21.7	57.0	10.0	188.5	340.0	856.8	704.8	26.7	8.3	12.3	2,292.1
2021	0.0	0.0	984.1	15.8	18.0	415.2	2,057.2	814.4	2,038.5	132.5	8.9	3.4	6,487.9
2022	9.8	549.2	5.7	180.7	254.5	1,064.9	179.4	1,936.9	296.1	21.7	1,416.0	448.3	6,363.2
2023	0.0	17.5	79.9	295.5	361.4	4,487.2	408.6	2,912.3	2,862.0	6.8	5.5	365.4	11,802.2
2024	154.8	710.0	78.0	264.0	40.8	411.9	965.9	1,274.2	603.7	812.4	185.0	626.8	6,127.5
2025	109.3	340.2	779.4	96.0	907.6	3,396.4	2,075.2	661.9	433.2	2,034.7	349.0	1.3	11,184.1
2026	7.9	392.6	5.6	0.0	37.4	287.2	2,021.7	1,100.2	490.3	99.9	15.8	218.2	4,676.8
2027	87.1	32.5	6.0	107.5	15.5	178.8	196.2	149.7	199.1	236.9	5.4	17.2	1,231.8
Average	**218.2**	**239.1**	**266.2**	**124.0**	**199.9**	**1,466.2**	**1,125.9**	**1,034.2**	**1,098.0**	**573.4**	**255.0**	**212.9**	**6,812.9**

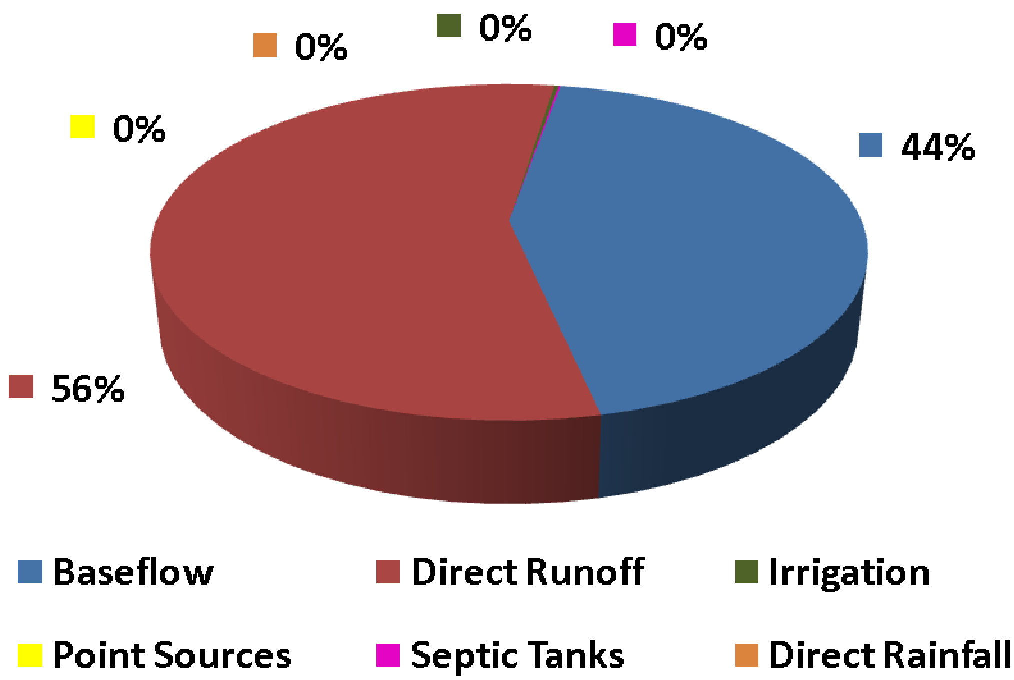

Figure 6-19 Ainger Creek Basin Future Total Volume Water Budget

Table 6-26 Summary of Annual Future Total Volume Inputs for Ainger Creek Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	8,498.0	18,621.6	18.9	0.0	8.4	0.0
2016	4,436.4	5,239.4	18.9	0.0	8.4	0.0
2017	2,727.1	5,285.1	18.9	0.0	8.4	0.0
2018	6,362.4	6,514.9	18.9	0.0	8.4	0.0
2019	2,998.9	2,740.7	18.9	0.0	8.4	0.0
2020	2,479.3	2,292.1	18.9	0.0	8.4	0.0
2021	4,563.6	6,487.9	18.9	0.0	8.4	0.0
2022	4,092.2	6,363.2	18.9	0.0	8.4	0.0
2023	6,916.6	11,802.2	18.9	0.0	8.4	0.0
2024	4,670.2	6,127.5	18.9	0.0	8.4	0.0
2025	7,586.0	11,184.1	18.9	0.0	8.4	0.0
2026	5,057.4	4,676.8	18.9	0.0	8.4	0.0
2027	1,424.6	1,231.8	18.9	0.0	8.4	0.0
Average	**4,754.8**	**6,812.9**	**18.9**	**0.0**	**8.4**	**0.0**

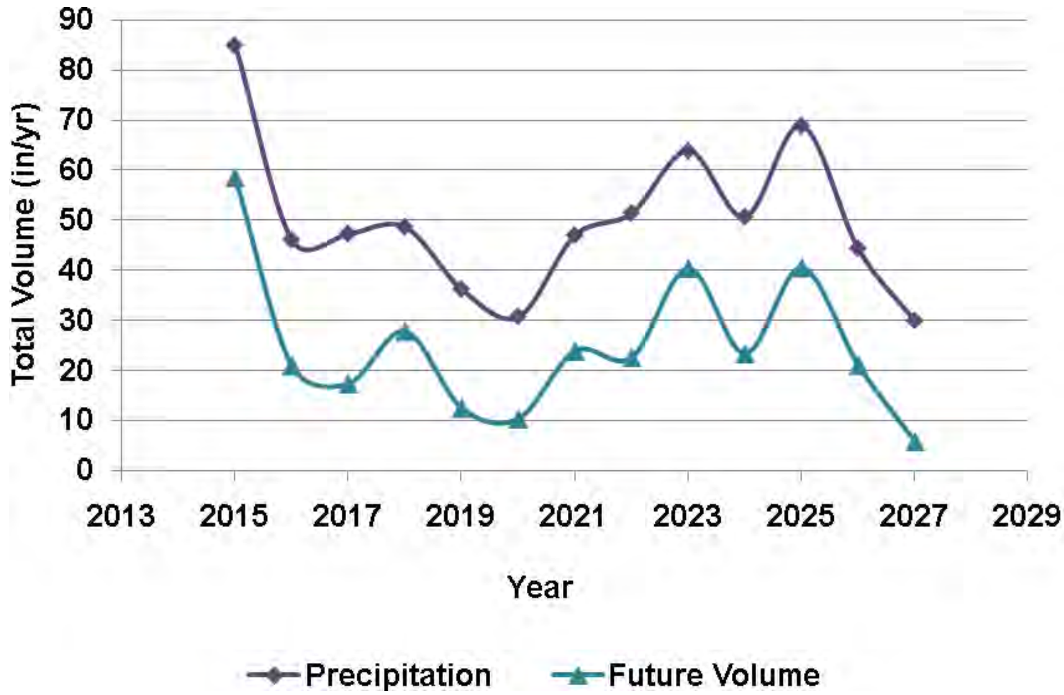

Figure 6-20 Annual Variability of Precipitation and Total Volume for Ainger Creek Basin

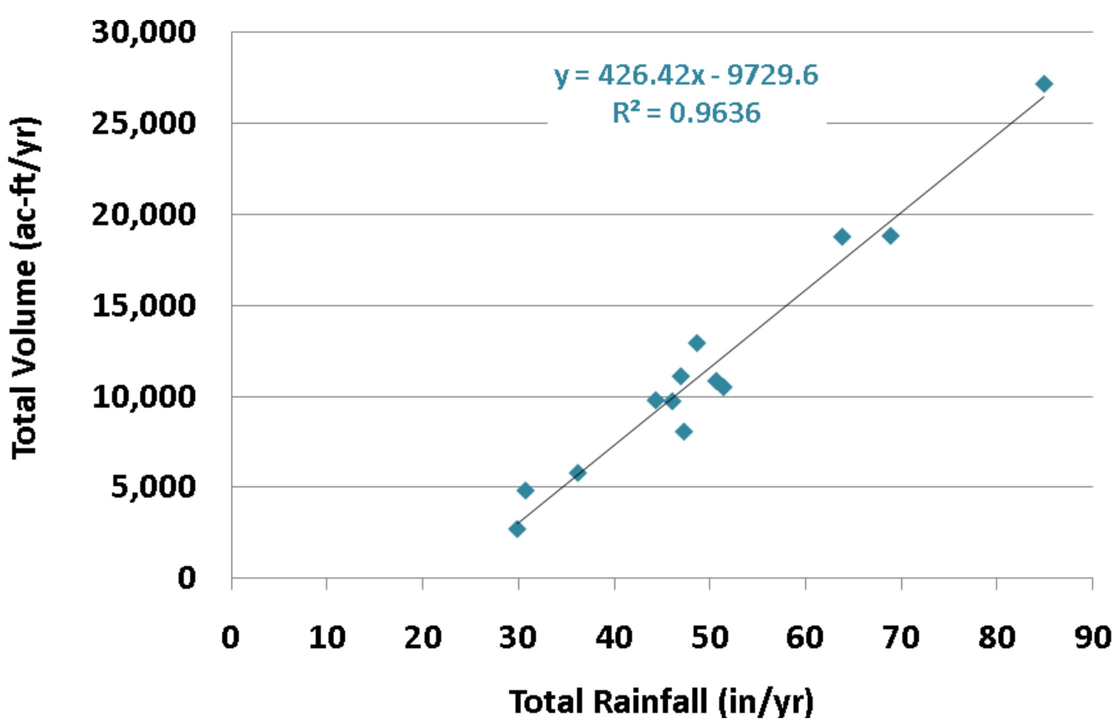

Figure 6-21 Correlation of Annual Total Volume to Rainfall for Ainger Creek Basin

Table 6-27 Annual Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	58.60	84.92	0.69
2016	20.94	46.10	0.45
2017	17.35	47.31	0.37
2018	27.85	48.67	0.57
2019	12.45	36.24	0.34
2020	10.36	30.78	0.34
2021	23.91	46.98	0.51
2022	22.63	51.44	0.44
2023	40.46	63.83	0.63
2024	23.37	50.68	0.46
2025	40.57	68.88	0.59
2026	21.07	44.37	0.47
2027	5.79	29.91	0.19
Average	**25.03**	**50.01**	**0.47**

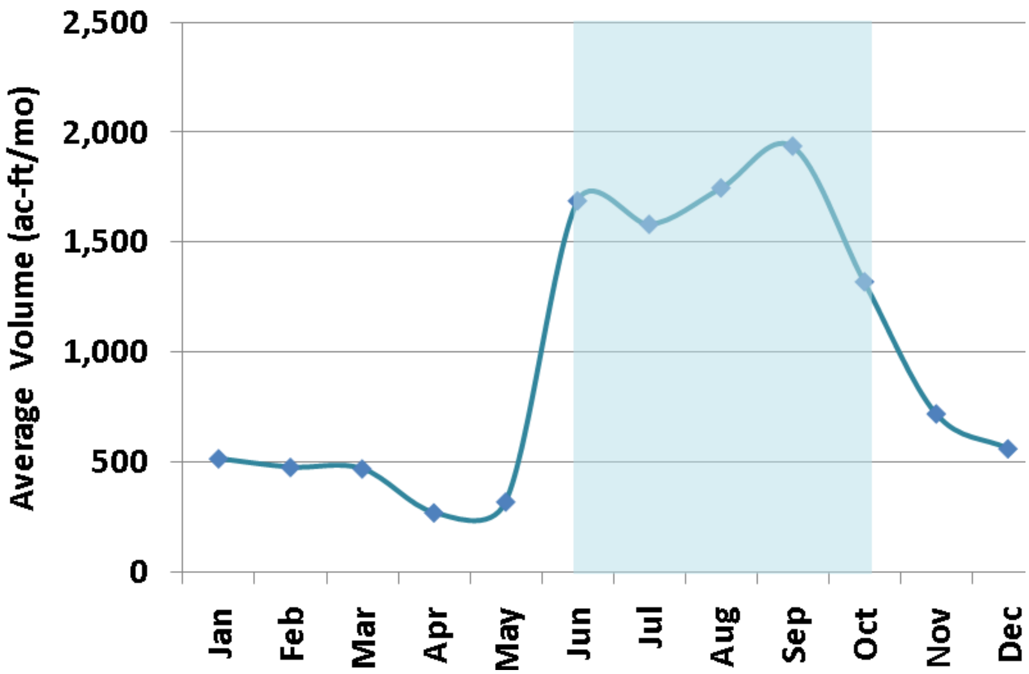

Figure 6-22 Variability of Average Monthly Total Volume in Ainger Creek Basin

Table 6-28 Average Monthly Rainfall to Total Volume Coefficients for Ainger Creek Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.11	1.89	0.59
Feb	1.03	2.04	0.50
Mar	1.01	2.31	0.44
Apr	0.58	2.05	0.28
May	0.69	2.29	0.30
Jun	3.64	9.24	0.39
Jul	3.41	8.23	0.41
Aug	3.77	7.73	0.49
Sep	4.18	7.11	0.59
Oct	2.85	3.42	0.83
Nov	1.55	1.76	0.88
Dec	1.21	1.95	0.62

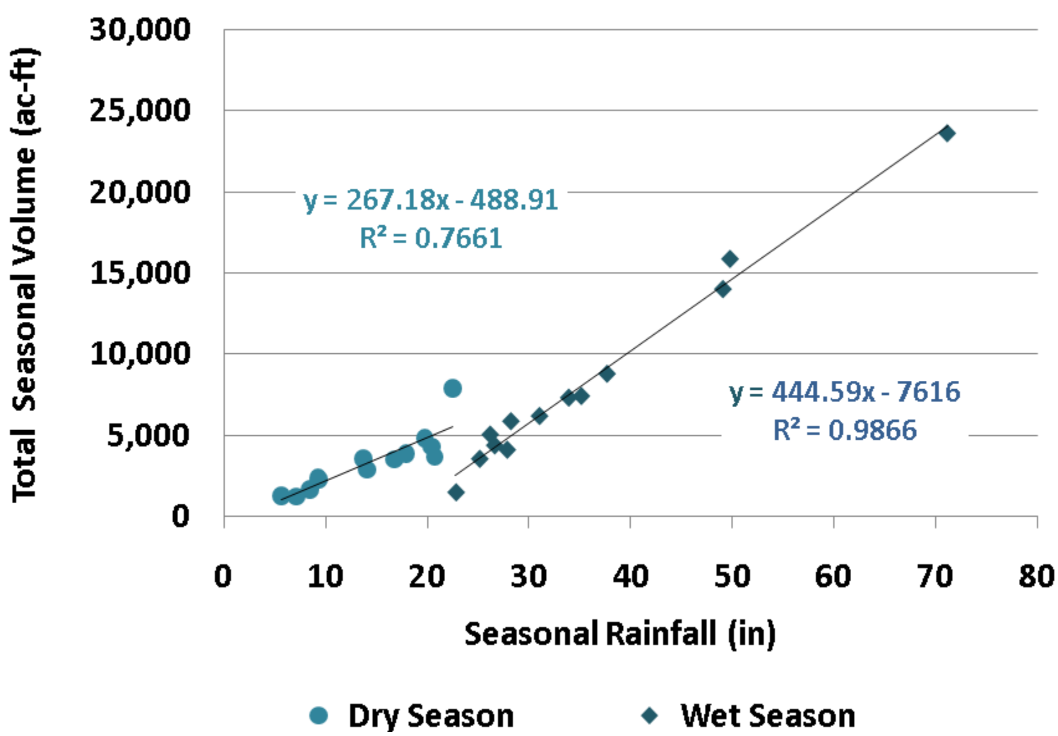

Figure 6-23 Correlation of Seasonal Total Volume to Rainfall for Ainger Creek Basin

Table 6-29 Wet Season Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	50.93	71.22	0.72
2016	12.64	28.19	0.45
2017	9.43	26.59	0.35
2018	10.86	26.14	0.42
2019	8.84	27.82	0.32
2020	7.64	25.12	0.30
2021	18.95	37.67	0.50
2022	13.34	31.01	0.43
2023	34.22	49.80	0.69
2024	15.77	33.90	0.47
2025	30.21	49.11	0.62
2026	16.00	35.13	0.46
2027	3.18	22.79	0.14
Average	**17.85**	**35.73**	**0.45**

Table 6-30 Dry Season Total Volume to Rainfall Coefficients for Ainger Creek Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	7.67	13.70	0.56
2016	8.31	17.91	0.46
2017	7.92	20.72	0.38
2018	16.99	22.52	0.75
2019	3.60	8.42	0.43
2020	2.72	5.66	0.48
2021	4.97	9.31	0.53
2022	9.29	20.43	0.45
2023	6.24	14.04	0.44
2024	7.59	16.79	0.45
2025	10.36	19.78	0.52
2026	5.07	9.24	0.55
2027	2.61	7.13	0.37
Average	**7.18**	**14.28**	**0.49**

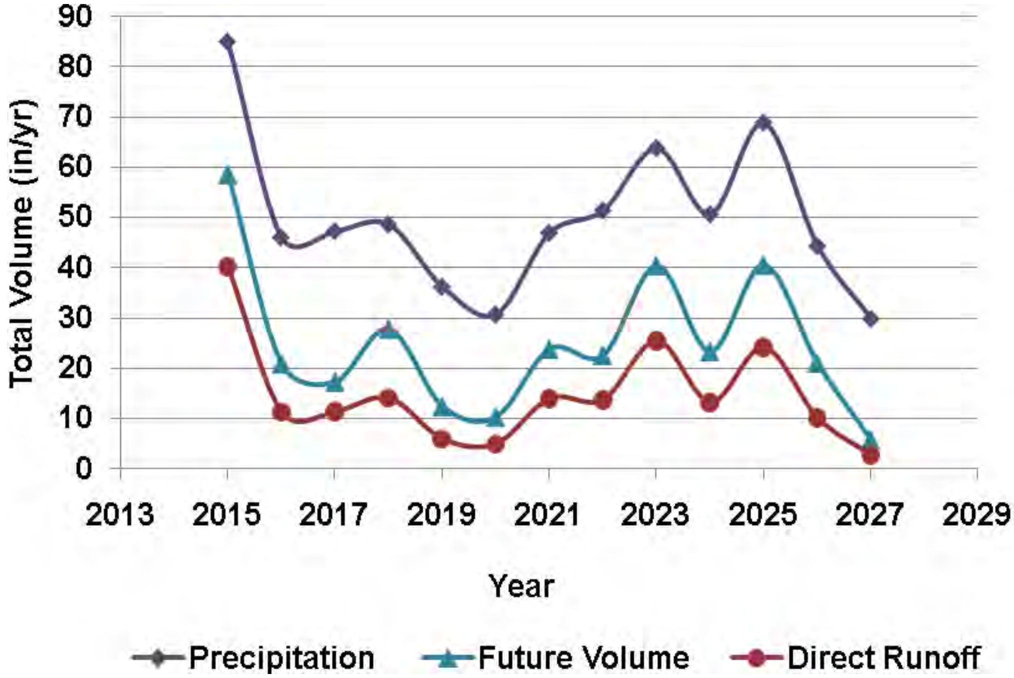

Figure 6-24 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Ainger Creek Basin

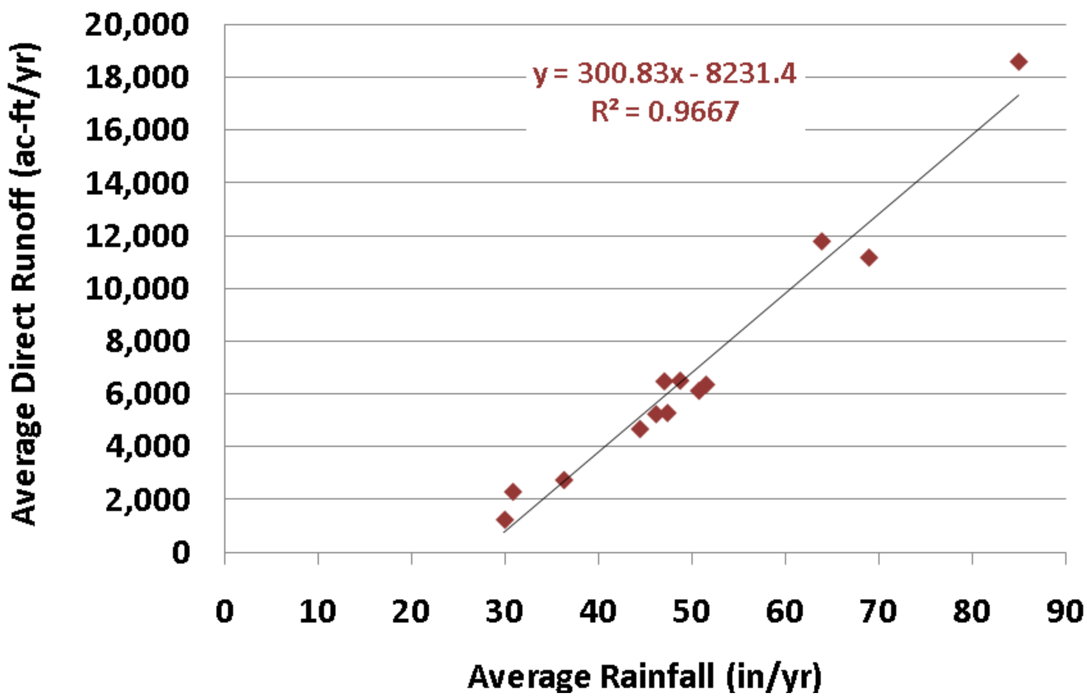

Figure 6-25 Correlation of Average Annual Direct Runoff to Rainfall

Table 6-31 Annual Direct Runoff to Rainfall Coefficients for Ainger Creek Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	40.19	84.92	0.47
2016	11.31	46.10	0.25
2017	11.41	47.31	0.24
2018	14.06	48.67	0.29
2019	5.92	36.24	0.16
2020	4.95	30.78	0.16
2021	14.00	46.98	0.30
2022	13.73	51.44	0.27
2023	25.47	63.83	0.40
2024	13.23	50.68	0.26
2025	24.14	68.88	0.35
2026	10.09	44.37	0.23
2027	2.66	29.91	0.09
Average	**14.71**	**50.01**	**0.27**

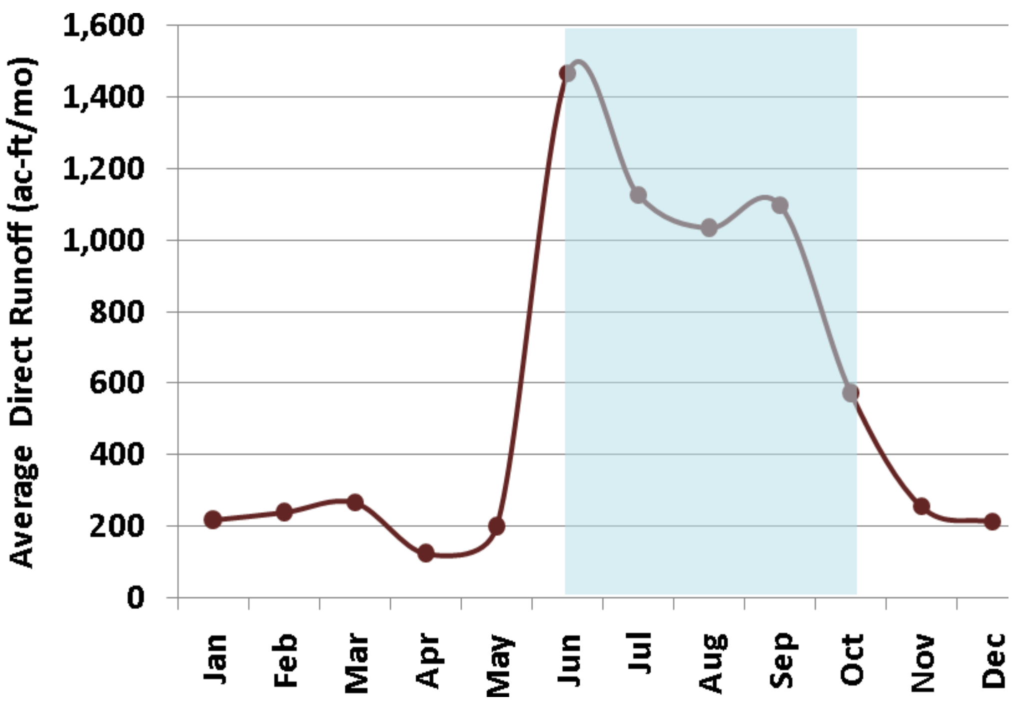

Figure 6-26 Variability of Average Monthly Direct Runoff to Ainger Creek Basin

Table 6-32 Average Monthly Rainfall to Direct Runoff Coefficients for Ainger Creek Basin

	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	0.47	1.89	0.25
Feb	0.52	2.04	0.25
Mar	0.57	2.31	0.25
Apr	0.27	2.05	0.13
May	0.43	2.29	0.19
Jun	3.16	9.24	0.34
Jul	2.43	8.23	0.30
Aug	2.23	7.73	0.29
Sep	2.37	7.11	0.33
Oct	1.24	3.42	0.36
Nov	0.55	1.76	0.31
Dec	0.46	1.95	0.24

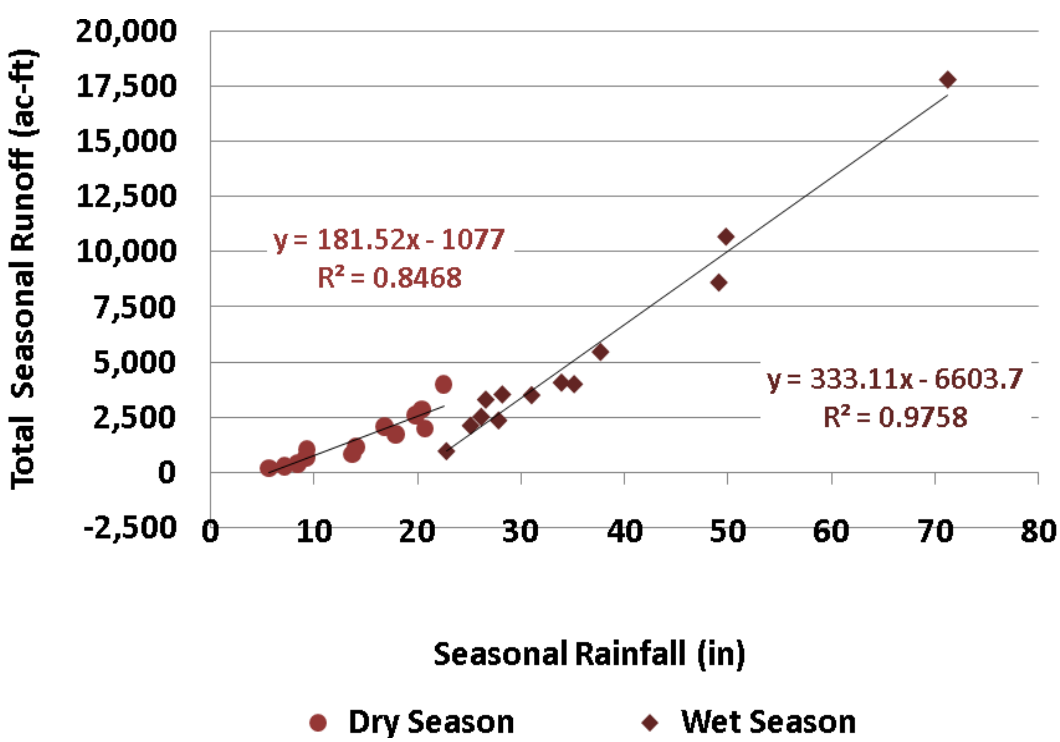

Figure 6-27 Correlation of Seasonal Direct Runoff to Rainfall

Table 6-33 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	38.40	71.22	0.54
2016	7.62	28.19	0.27
2017	7.11	26.59	0.27
2018	5.43	26.14	0.21
2019	5.08	27.82	0.18
2020	4.57	25.12	0.18
2021	11.78	37.67	0.31
2022	7.55	31.01	0.24
2023	23.05	49.80	0.46
2024	8.78	33.90	0.26
2025	18.57	49.11	0.38
2026	8.63	35.13	0.25
2027	2.07	22.79	0.09
Average	**11.43**	**35.73**	**0.28**

Table 6-34 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	1.79	13.70	0.13
2016	3.69	17.91	0.21
2017	4.30	20.72	0.21
2018	8.63	22.52	0.38
2019	0.83	8.42	0.10
2020	0.38	5.66	0.07
2021	2.22	9.31	0.24
2022	6.18	20.43	0.30
2023	2.43	14.04	0.17
2024	4.45	16.79	0.26
2025	5.57	19.78	0.28
2026	1.46	9.24	0.16
2027	0.58	7.13	0.08
Average	**3.27**	**14.28**	**0.20**

6.4 WATER BUDGET CHANGES

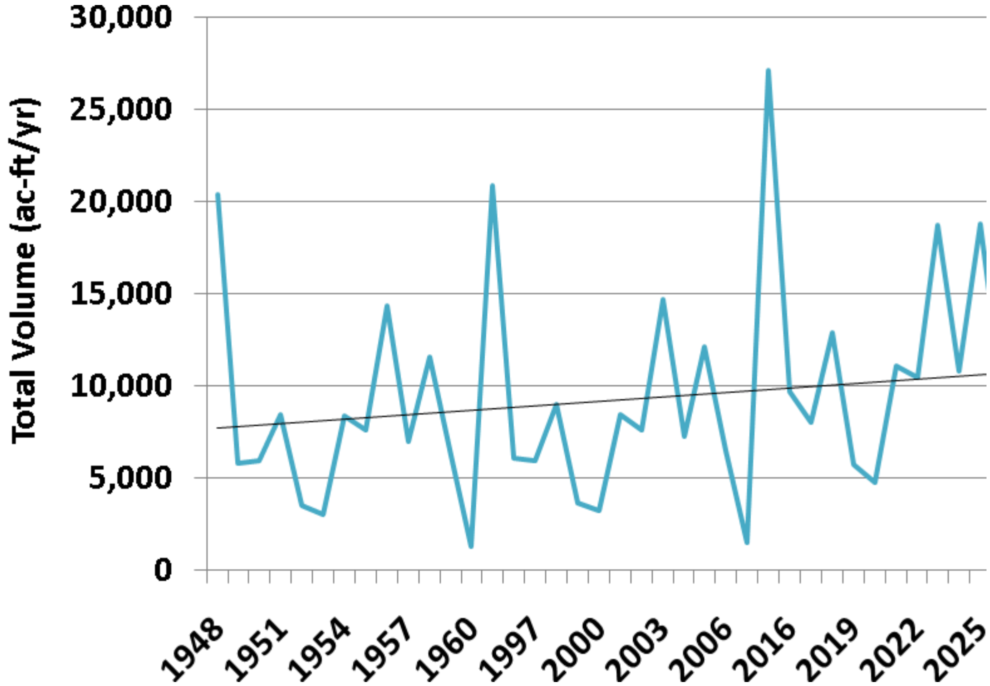

Figure 6-28 Trend in Total Volume from Historical through Future Time Series

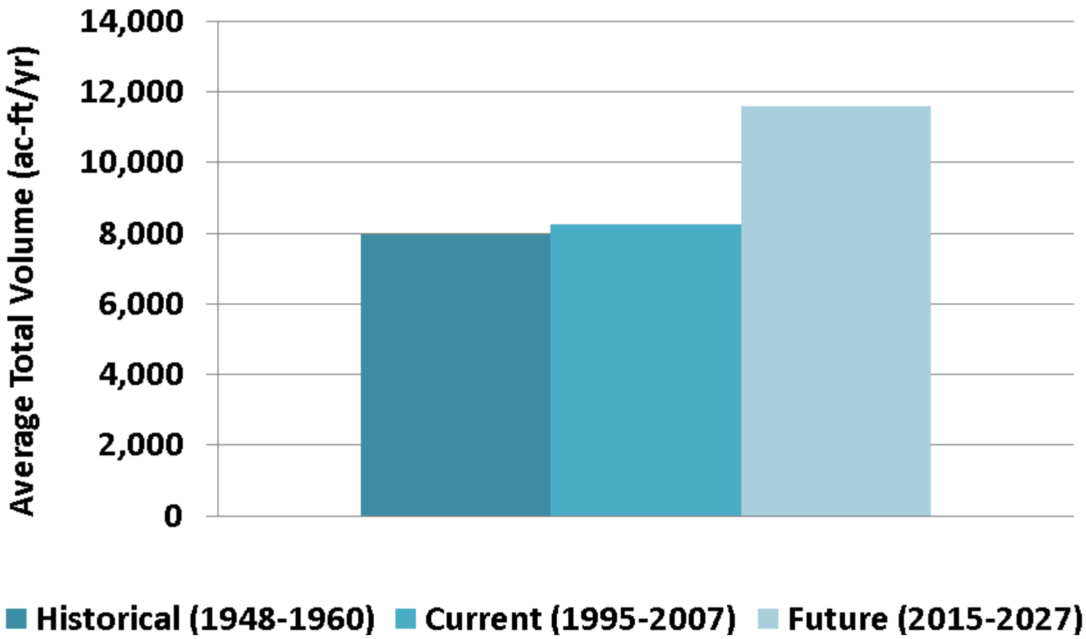

Figure 6-29 Historical, Current, and Future Average Annual Total Volume to Lemon Bay

Table 6-35 Change in Total Volume from Historical to Current Conditions

Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	20,370	20,850	480
2	5,779	6,106	327
3	5,940	5,960	20
4	8,478	9,031	553
5	3,516	3,692	175
6	3,029	3,224	195
7	8,380	8,455	75
8	7,590	7,632	42
9	14,329	14,670	341
10	7,016	7,252	236
11	11,574	12,148	574
12	6,194	6,536	343
13	1,272	1,523	251
Average	**7,959**	**8,237**	**278**

Table 6-36 Change in Total Volume from Current to Future Conditions

Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	20,850	27,147	6,297
2	6,106	9,703	3,597
3	5,960	8,039	2,079
4	9,031	12,905	3,873
5	3,692	5,767	2,075
6	3,224	4,799	1,575
7	8,455	11,079	2,624
8	7,632	10,483	2,851
9	14,670	18,746	4,076
10	7,252	10,825	3,573
11	12,148	18,797	6,649
12	6,536	9,762	3,225
13	1,523	2,684	1,161
Average	**8,237**	**11,595**	**3,358**

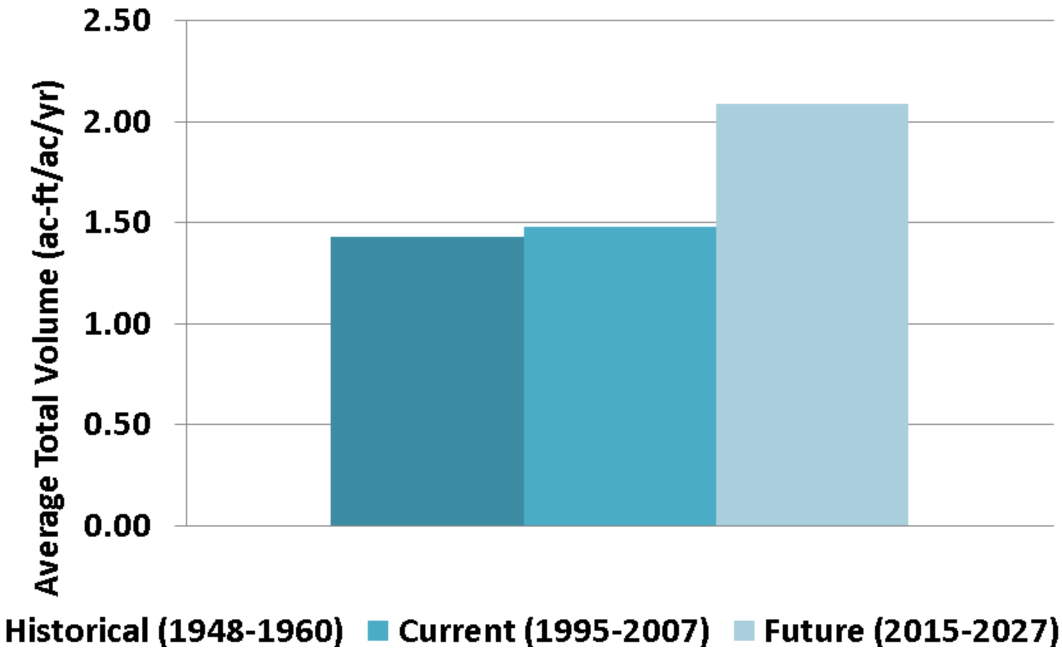

Figure 6-30 Normalized Historical, Current, and Future Average Annual Total Volume to Lemon Bay

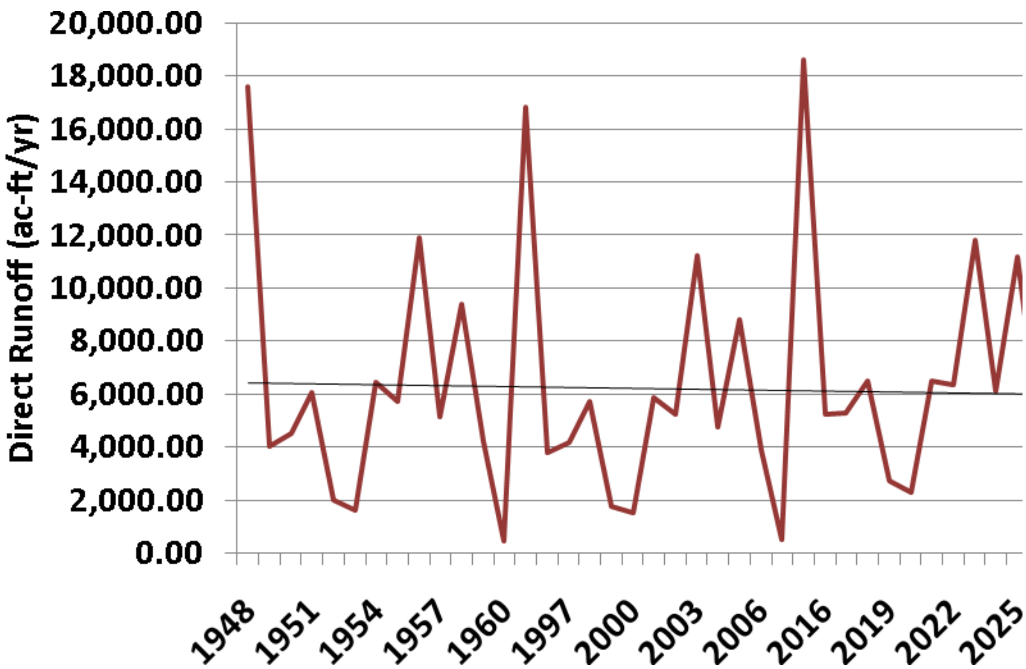

Figure 6-31 Trend in Direct Runoff from Historical through Future Time Series

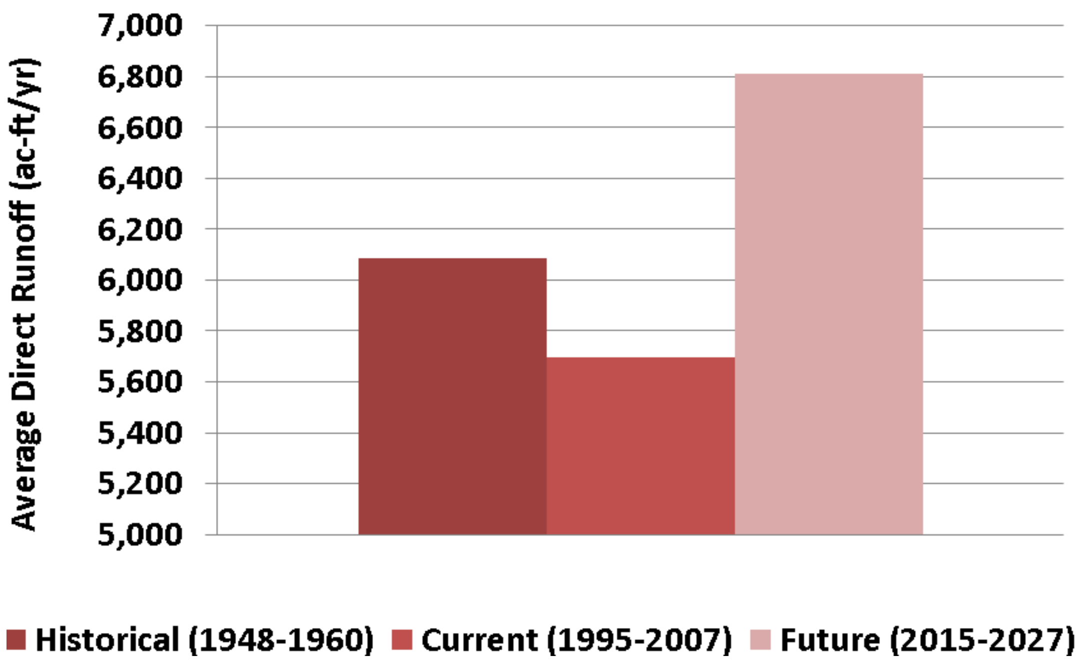

Figure 6-32 Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

Table 6-37 Change in Direct Runoff from Historical to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	17,606	16,823	-783
2	4,022	3,767	-255
3	4,498	4,192	-306
4	6,064	5,701	-363
5	2,008	1,780	-227
6	1,608	1,521	-87
7	6,421	5,856	-565
8	5,742	5,258	-484
9	11,890	11,207	-683
10	5,153	4,753	-400
11	9,377	8,792	-585
12	4,247	3,875	-372
13	454	498	44
Average	**6,084**	**5,694**	**-390**

Table 6-38 Change in Direct Runoff from Current to Future Conditions

Year	Current Direct Runoff (ac-ft) 1995-2007	Future Direct Runoff (ac-ft) 2015-2027	Direct Runoff Change (ac-ft) (future-current)
1	16,823	18,622	1,798
2	3,767	5,239	1,472
3	4,192	5,285	1,093
4	5,701	6,515	814
5	1,780	2,741	960
6	1,521	2,292	771
7	5,856	6,488	631
8	5,258	6,363	1,105
9	11,207	11,802	595
10	4,753	6,127	1,374
11	8,792	11,184	2,392
12	3,875	4,677	802
13	498	1,232	734
Average	**5,694**	**6,813**	**1,119**

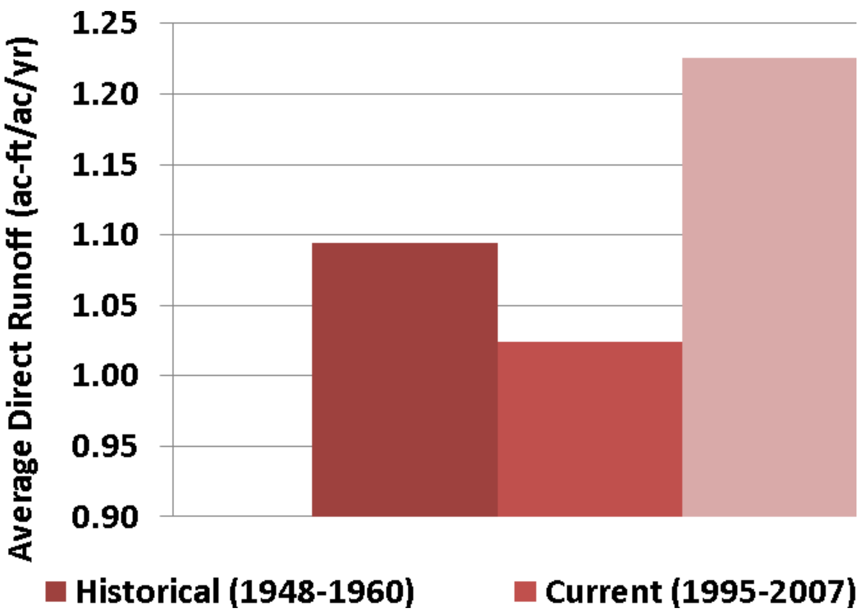

Figure 6-33 Normalized Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay

7.0 LEMON BAY COASTAL BASIN

7.1 CURRENT CONDITIONS

Table 7-1 Monthly Rainfall for Lemon Bay Coastal Basin (inches)

Current Year	Historical Equivalent Year	Future Equivalent Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	1948	2015	6.42	4.76	2.56	6.00	0.48	44.05	32.01	14.08	19.45	21.18	1.91	2.80	155.69
1996	1949	2016	6.79	1.93	8.34	3.95	8.58	6.35	6.45	13.23	8.87	13.79	0.55	1.91	80.77
1997	1950	2017	3.55	0.54	2.55	11.25	2.53	4.85	5.19	5.90	14.00	4.49	7.88	12.03	74.76
1998	1951	2018	11.77	10.36	8.76	0.42	3.69	4.30	12.24	9.18	15.95	1.65	7.83	0.98	87.13
1999	1952	2019	4.47	0.13	3.46	0.67	0.84	12.24	8.26	14.69	17.74	5.35	1.26	3.42	72.54
2000	1953	2020	2.09	1.10	1.53	3.98	1.07	8.21	8.21	13.55	11.10	0.33	1.67	1.11	53.94
2001	1954	2021	0.33	0.02	14.17	0.63	0.44	11.56	24.65	11.77	20.18	3.36	0.59	0.57	88.27
2002	1955	2022	1.14	8.80	0.54	2.40	4.62	11.68	6.23	20.64	6.97	1.68	10.03	9.06	83.78
2003	1956	2023	0.11	1.85	3.88	6.12	7.93	30.29	6.87	20.65	23.40	1.05	1.08	7.21	110.45
2004	1957	2024	3.09	7.63	1.73	6.86	2.06	10.28	12.99	12.22	9.50	6.40	3.74	5.87	82.37
2005	1958	2025	3.67	5.93	8.74	4.21	10.22	32.46	16.54	10.48	7.55	18.55	7.05	0.53	125.92
2006	1959	2026	0.83	5.33	0.47	0.15	3.20	8.97	18.53	14.01	10.74	2.22	1.01	5.45	70.91
2007	1960	2027	2.87	3.13	0.55	4.79	1.43	9.14	8.64	8.21	9.76	8.99	1.47	2.17	61.15
		Average	**3.63**	**3.96**	**4.41**	**3.96**	**3.62**	**14.95**	**12.83**	**12.97**	**13.48**	**6.85**	**3.54**	**4.09**	**88.28**

Table 7-2 Current Total Volume for Lemon Bay Coastal Basin (ac-ft/mo)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	932.1	684.6	418.9	736.1	131.3	7,432.5	5,755.3	2,683.0	3,831.7	3,938.3	681.3	590.9	27,816.0
1996	1,116.6	386.2	1,095.2	570.3	1,208.8	747.0	793.5	1,743.2	1,191.2	2,289.0	300.4	392.9	11,834.4
1997	546.6	149.2	371.5	1,393.8	319.5	551.5	567.8	652.6	1,805.8	530.6	1,058.6	1,796.3	9,743.8
1998	2,180.1	1,876.2	1,756.7	303.8	589.3	598.7	1,596.2	1,142.3	2,212.4	525.1	1,385.2	251.5	14,417.5
1999	608.9	98.9	443.3	128.7	126.1	1,335.2	938.7	1,802.6	2,744.8	1,048.8	397.1	607.2	10,280.2
2000	368.1	212.9	248.0	504.9	161.1	852.8	887.7	1,908.0	1,560.8	204.5	286.0	202.3	7,397.2
2001	106.7	62.4	1,965.8	121.4	83.6	1,287.2	3,540.4	2,163.7	3,449.4	806.8	321.4	238.0	14,146.7
2002	251.2	1,239.3	147.2	331.8	569.5	1,339.8	720.5	2,557.9	1,123.6	426.9	1,799.3	1,321.1	11,828.1
2003	237.5	337.6	538.4	877.5	1,045.7	4,653.6	1,141.8	3,473.4	4,570.8	544.1	377.4	1,133.9	18,931.6
2004	492.2	1,154.7	317.6	877.5	275.5	1,152.1	1,508.3	1,744.5	1,444.4	1,225.5	644.0	944.5	11,780.8
2005	646.6	960.7	1,380.2	556.3	1,410.8	4,953.8	3,109.5	1,659.8	1,337.2	3,306.6	1,262.8	350.2	20,934.7
2006	266.5	775.0	145.6	97.8	395.8	1,013.0	2,216.7	1,998.0	1,686.5	582.9	325.0	818.5	10,321.1
2007	442.9	419.4	128.1	602.1	204.5	1,034.5	971.8	946.3	1,096.3	1,116.8	272.4	329.4	7,564.6
Average	**630.5**	**642.8**	**689.0**	**546.3**	**501.7**	**2,073.2**	**1,826.8**	**1,882.7**	**2,158.1**	**1,272.8**	**700.8**	**690.5**	**13,615.1**

Table 7-3 Current Direct Runoff for Lemon Bay Coastal Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1995	135.8	52.3	29.5	52.4	0.3	2,774.5	2,137.2	603.2	1,305.8	1,127.6	13.4	31.0	8,262.9
1996	175.5	25.6	151.8	53.2	284.4	60.2	94.2	349.5	139.0	587.3	2.0	24.1	1,946.9
1997	68.6	1.4	34.9	244.1	17.5	44.9	55.1	47.5	451.6	75.3	257.4	461.9	1,760.1
1998	622.7	405.9	512.9	0.8	35.7	52.7	232.2	122.1	376.3	12.2	407.5	5.4	2,786.2
1999	71.7	0.0	33.0	4.0	6.0	138.0	103.3	332.6	676.3	110.7	12.0	93.8	1,581.5
2000	30.8	6.0	8.4	57.9	9.0	79.1	83.1	591.6	337.6	1.1	12.1	9.7	1,226.2
2001	0.8	0.0	529.9	3.6	0.6	153.9	953.2	492.7	982.6	32.5	4.8	1.0	3,155.5
2002	4.6	271.9	3.0	23.1	79.0	103.4	78.4	541.1	129.2	16.6	623.6	223.2	2,097.0
2003	0.0	13.2	35.4	204.2	197.9	1,442.6	80.9	934.1	1,666.9	6.7	4.1	258.6	4,844.5
2004	37.0	317.5	30.4	144.7	16.1	118.0	193.1	306.0	176.6	326.0	124.5	234.9	2,024.6
2005	159.1	289.7	408.0	42.0	296.1	1,421.9	788.1	153.4	151.2	1,082.6	213.7	0.2	5,005.9
2006	2.4	131.7	2.8	0.2	20.1	92.1	348.5	390.1	202.7	57.0	5.8	114.5	1,367.8
2007	32.5	33.5	2.1	90.5	9.2	88.7	79.1	64.4	91.3	142.9	19.7	20.5	674.5
Average	**103.2**	**119.1**	**137.1**	**70.8**	**74.8**	**505.4**	**402.0**	**379.1**	**514.4**	**275.2**	**130.8**	**113.8**	**2,825.7**

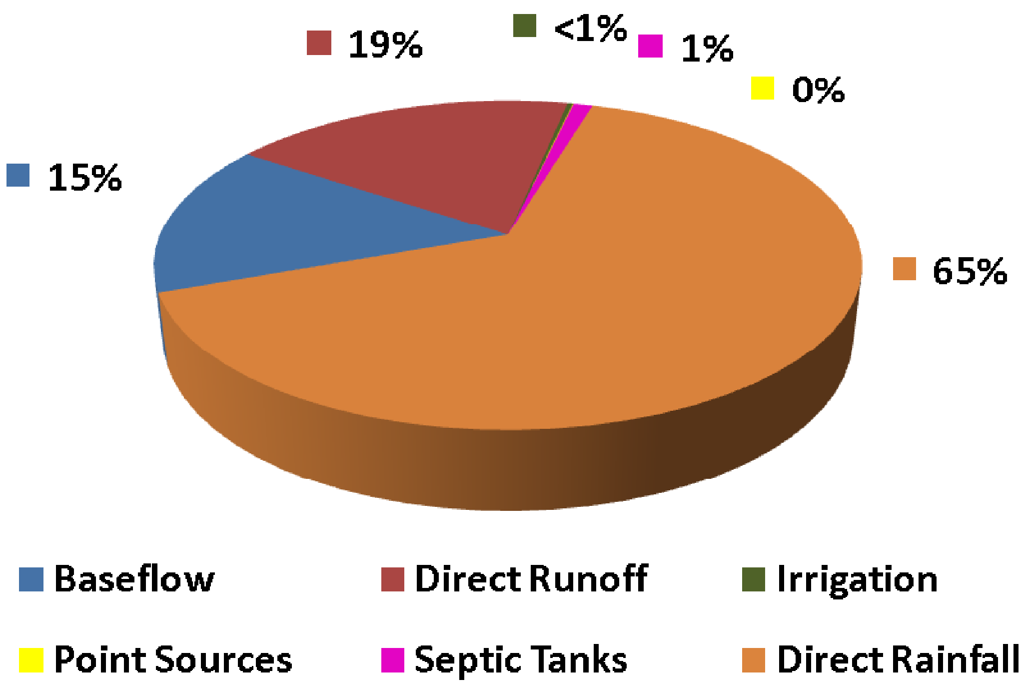

Figure 7-1 Lemon Bay Coastal Basin Current Total Volume Water Budget

Table 7-4 Summary of Annual Current Total Volume Inputs for Lemon Bay Coastal Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1995	4,277.7	8,262.9	34.2	0.7	117.2	620.0
1996	1,933.9	1,946.9	34.5	0.7	118.2	652.9
1997	772.6	1,760.1	34.5	0.7	119.6	346.3
1998	2,939.7	2,786.2	34.5	0.7	120.6	1,193.8
1999	1,647.8	1,581.5	34.5	4.8	122.3	417.5
2000	1,012.6	1,226.2	34.5	4.6	124.1	198.8
2001	2,312.5	3,155.5	34.5	4.0	126.0	27.8
2002	1,530.4	2,097.0	34.5	3.5	127.6	110.9
2003	3,327.9	4,844.5	35.0	3.5	129.5	10.9
2004	1,633.3	2,024.6	35.0	4.1	130.6	311.0
2005	3,442.7	5,005.9	35.0	4.9	131.0	353.7
2006	1,949.7	1,367.8	35.0	5.8	131.0	70.5
2007	715.8	674.5	35.0	0.0	131.0	286.1
Average	**2,115.1**	**2,825.7**	**34.6**	**2.9**	**125.3**	**353.9**

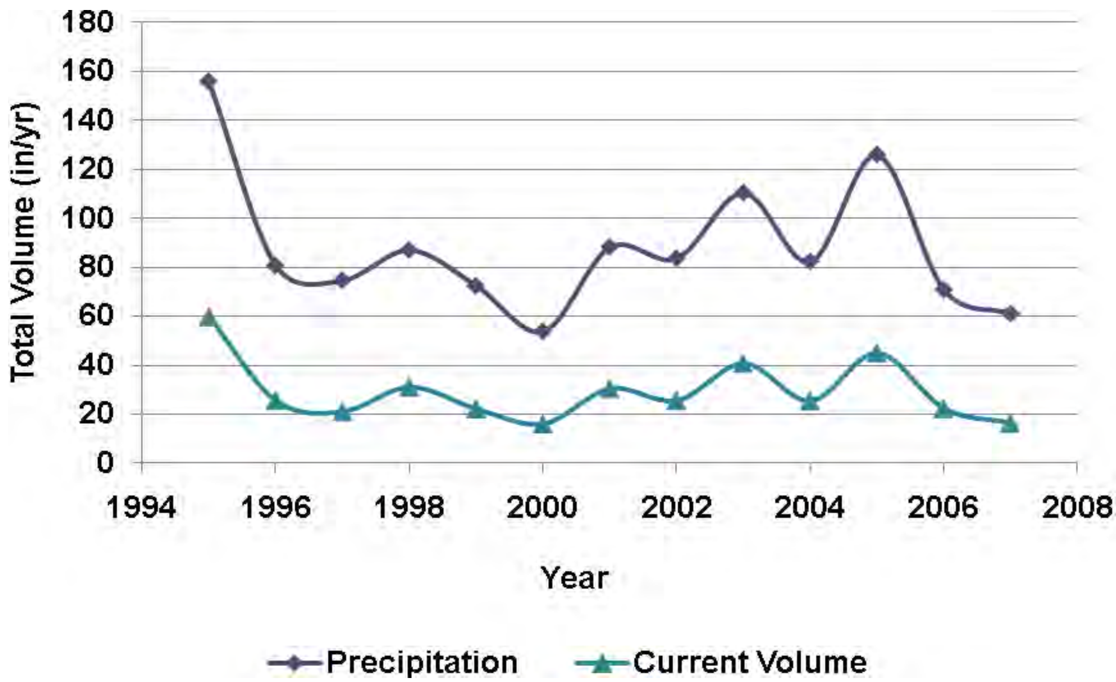

Figure 7-2 Annual Variability of Precipitation and Total Volume for Lemon Bay Coastal Basin

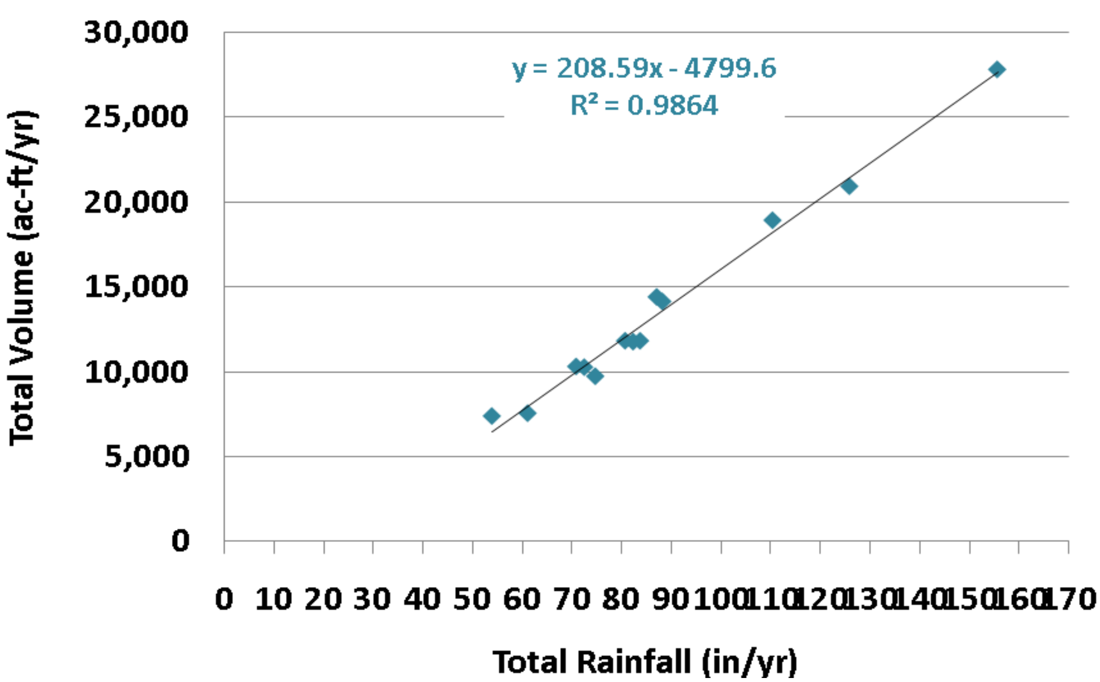

Figure 7-3 Correlation of Annual Total Volume to Rainfall for Lemon Bay Coastal Basin

Table 7-5 Annual Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1995	59.88	155.69	0.38
1996	25.48	80.77	0.32
1997	20.98	74.76	0.28
1998	31.04	87.13	0.36
1999	22.13	72.54	0.31
2000	15.92	53.94	0.30
2001	30.45	88.27	0.35
2002	25.46	83.78	0.30
2003	40.75	110.45	0.37
2004	25.36	82.37	0.31
2005	45.07	125.92	0.36
2006	22.22	70.91	0.31
2007	16.28	61.15	0.27
Average	**29.31**	**88.28**	**0.32**

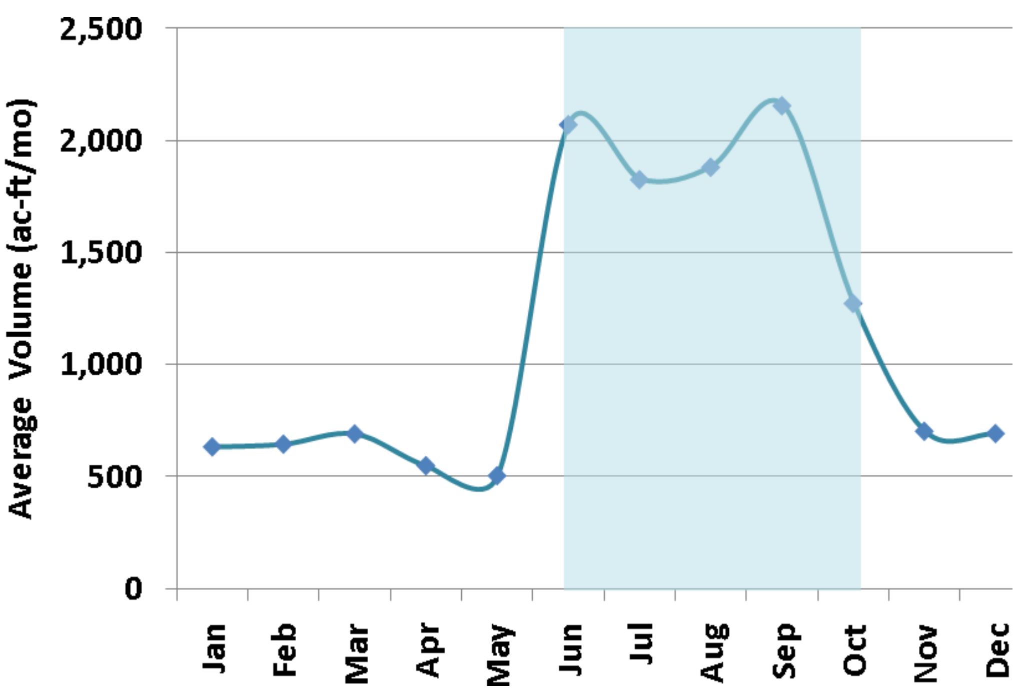

Figure 7-4 Variability of Average Monthly Total Volume in Lemon Bay Coastal Basin

Table 7-6 Average Monthly Rainfall to Total Volume Coefficients for Lemon Bay Coastal Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.36	3.63	0.37
Feb	1.38	3.96	0.35
Mar	1.48	4.41	0.34
Apr	1.18	3.96	0.30
May	1.08	3.62	0.30
Jun	4.46	14.95	0.30
Jul	3.93	12.83	0.31
Aug	4.05	12.97	0.31
Sep	4.65	13.48	0.34
Oct	2.74	6.85	0.40
Nov	1.51	3.54	0.43
Dec	1.49	4.09	0.36

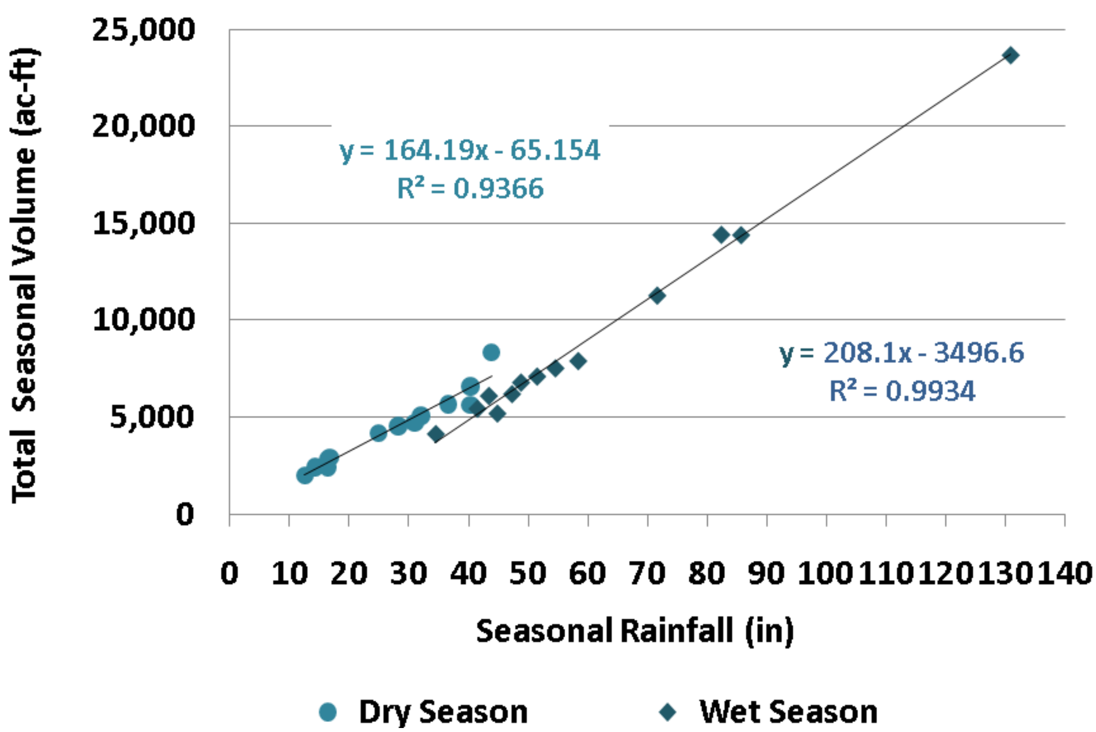

Figure 7-5 Correlation of Seasonal Total Volume to Rainfall for Lemon Bay Coastal Basin

Table 7-7 Wet Season Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin

	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1995	50.89	130.76	0.39
1996	14.56	48.69	0.30
1997	8.84	34.43	0.26
1998	13.08	43.31	0.30
1999	16.94	58.27	0.29
2000	11.65	41.39	0.28
2001	24.21	71.52	0.34
2002	13.28	47.19	0.28
2003	30.96	82.27	0.38
2004	15.23	51.38	0.30
2005	30.93	85.58	0.36
2006	16.14	54.46	0.30
2007	11.12	44.74	0.25
Average	**19.83**	**61.08**	**0.31**

Table 7-8 Dry Season Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin

	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1995	8.99	24.93	0.36
1996	10.92	32.07	0.34
1997	12.13	40.33	0.30
1998	17.96	43.82	0.41
1999	5.19	14.26	0.36
2000	4.27	12.55	0.34
2001	6.24	16.74	0.37
2002	12.18	36.59	0.33
2003	9.79	28.17	0.35
2004	10.13	30.99	0.33
2005	14.14	40.34	0.35
2006	6.08	16.45	0.37
2007	5.16	16.41	0.31
Average	**9.48**	**27.20**	**0.35**

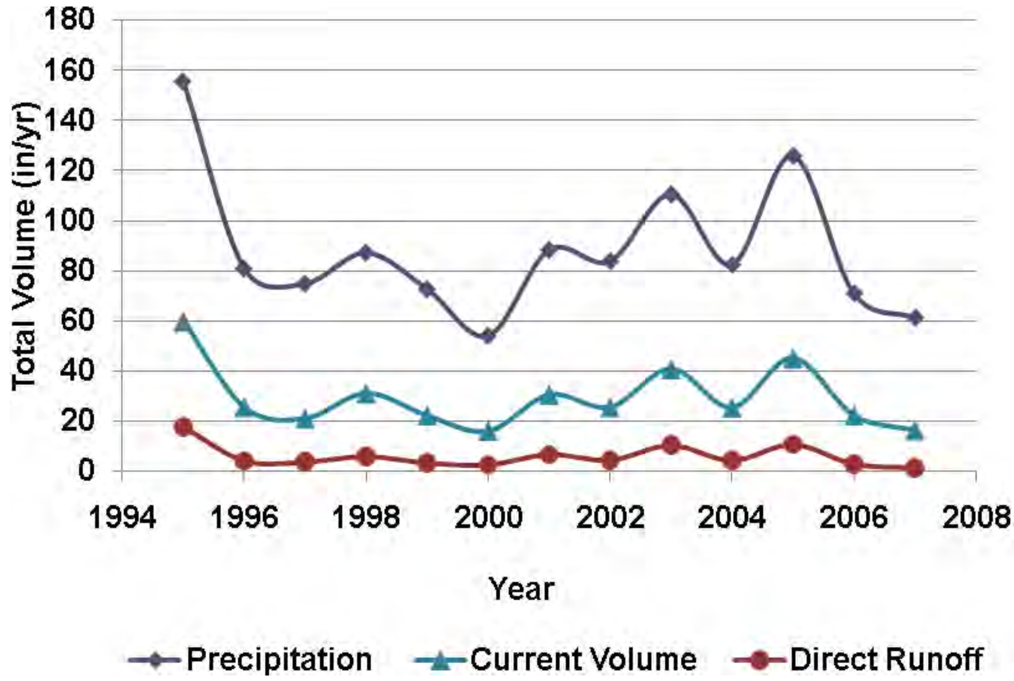

Figure 7-6 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Lemon Bay Coastal Basin

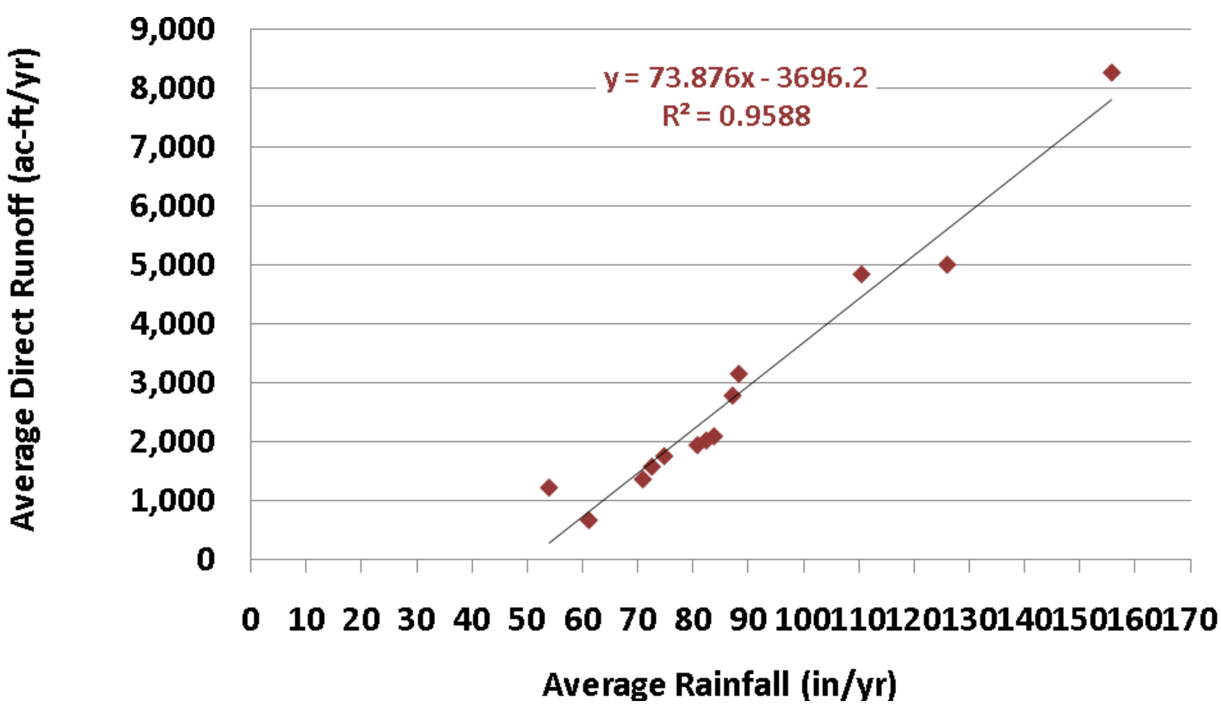

Figure 7-7 Correlation of Average Annual Direct Runoff to Rainfall

Table 7-9 Annual Direct Runoff to Rainfall Coefficients for Lemon Bay Coastal Basin

	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1995	17.79	155.69	0.11
1996	4.19	80.77	0.05
1997	3.79	74.76	0.05
1998	6.00	87.13	0.07
1999	3.40	72.54	0.05
2000	2.64	53.94	0.05
2001	6.79	88.27	0.08
2002	4.51	83.78	0.05
2003	10.43	110.45	0.09
2004	4.36	82.37	0.05
2005	10.78	125.92	0.09
2006	2.94	70.91	0.04
2007	1.45	61.15	0.02
Average	**6.08**	**88.28**	**0.06**

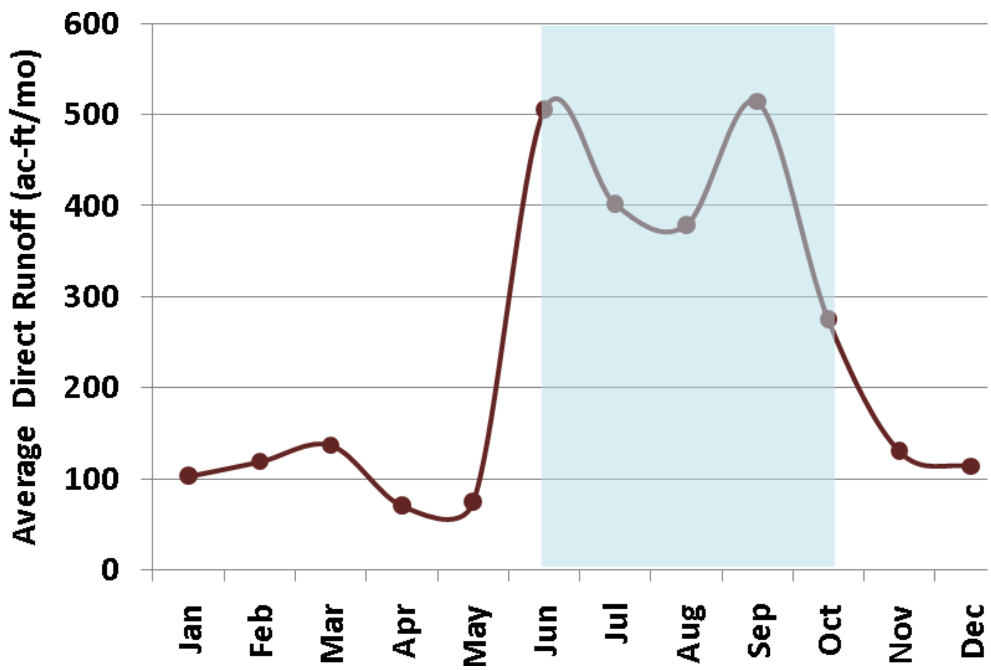

Figure 7-8 Variability of Average Monthly Direct Runoff to Lemon Bay Coastal Basin

Table 7-10 Average Monthly Rainfall to Direct Runoff Coefficients

	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.22	3.63	0.06
Feb	0.26	3.96	0.06
Mar	0.30	4.41	0.07
Apr	0.15	3.96	0.04
May	0.16	3.62	0.04
Jun	1.09	14.95	0.07
Jul	0.87	12.83	0.07
Aug	0.82	12.97	0.06
Sep	1.11	13.48	0.08
Oct	0.59	6.85	0.09
Nov	0.28	3.54	0.08
Dec	0.24	4.09	0.06

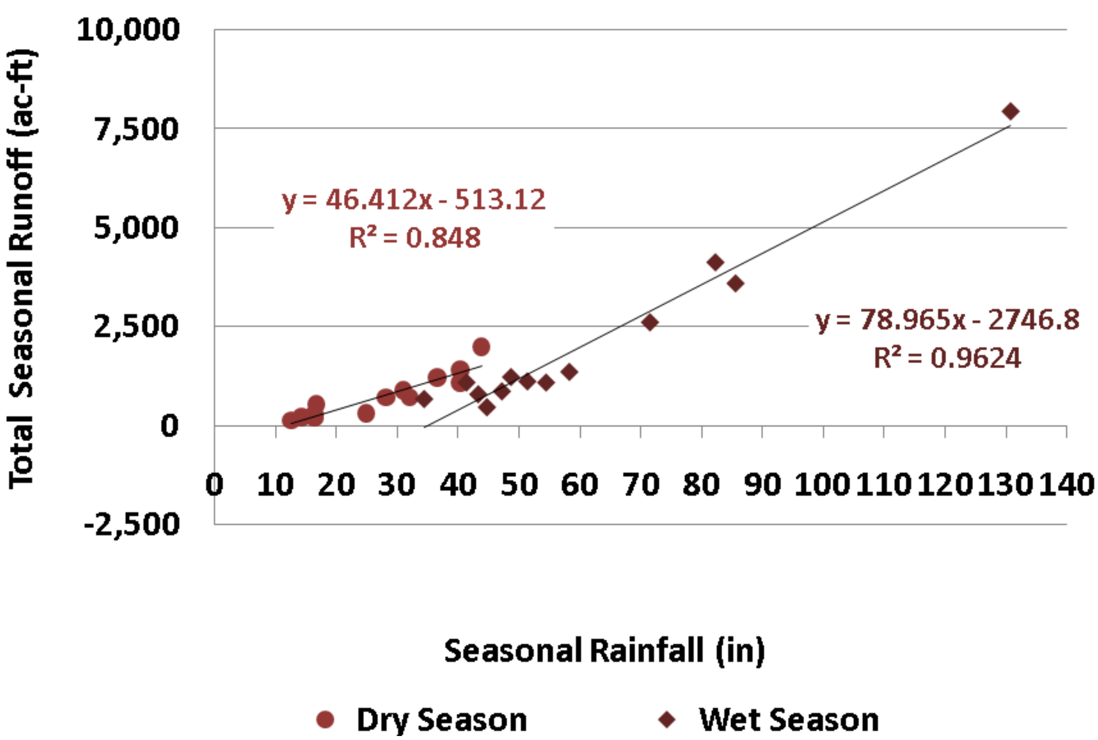

Figure 7-9 Correlation of Seasonal Direct Runoff to Rainfall

Table 7-11 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1995	17.11	130.76	0.13
1996	2.65	48.69	0.05
1997	1.45	34.43	0.04
1998	1.71	43.31	0.04
1999	2.93	58.27	0.05
2000	2.35	41.39	0.06
2001	5.63	71.52	0.08
2002	1.87	47.19	0.04
2003	8.89	82.27	0.11
2004	2.41	51.38	0.05
2005	7.74	85.58	0.09
2006	2.35	54.46	0.04
2007	1.00	44.74	0.02
Average	**4.47**	**61.08**	**0.06**

Table 7-12 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1995	0.68	24.93	0.03
1996	1.54	32.07	0.05
1997	2.34	40.33	0.06
1998	4.29	43.82	0.10
1999	0.47	14.26	0.03
2000	0.29	12.55	0.02
2001	1.16	16.74	0.07
2002	2.64	36.59	0.07
2003	1.54	28.17	0.05
2004	1.95	30.99	0.06
2005	3.03	40.34	0.08
2006	0.60	16.45	0.04
2007	0.45	16.41	0.03
Average	**1.61**	**27.20**	**0.05**

7.2 HISTORICAL CONDITIONS

Table 7-13 Historical Total Volume for Lemon Bay Coastal Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	808.0	578.4	320.9	644.1	102.6	7,175.5	5,314.0	2,166.5	3,211.9	3,304.0	400.5	412.0	24,438.3
1949	928.0	289.3	982.5	507.6	1,157.1	678.9	700.7	1,552.7	1,008.0	1,943.7	168.2	296.4	10,213.0
1950	481.7	119.8	335.2	1,340.3	292.7	509.1	523.4	608.7	1,627.9	465.7	984.2	1,626.3	8,915.0
1951	1,943.9	1,659.0	1,421.8	173.5	488.8	531.5	1,540.9	1,040.2	1,996.6	315.5	1,184.7	185.2	12,481.5
1952	543.4	78.3	404.9	117.7	116.0	1,254.2	921.1	1,657.5	2,436.1	770.7	255.5	493.5	9,049.1
1953	314.8	183.0	225.2	473.2	146.9	793.5	832.8	1,789.2	1,380.7	135.0	236.8	168.3	6,679.3
1954	88.8	50.3	1,805.2	115.6	81.1	1,253.6	3,489.7	1,872.7	3,020.3	525.5	189.4	166.1	12,658.3
1955	205.3	1,229.6	127.2	301.1	510.2	1,293.7	688.0	2,411.2	884.6	293.1	1,649.0	1,195.8	10,788.9
1956	155.9	288.1	494.0	881.2	1,049.2	4,557.2	861.3	2,953.9	4,019.1	264.7	229.6	1,015.3	16,769.4
1957	411.2	1,009.7	262.0	812.4	256.2	1,063.4	1,418.0	1,525.8	1,229.2	981.9	509.8	853.1	10,332.6
1958	536.9	871.7	1,213.4	466.3	1,198.0	4,516.6	2,547.6	1,254.2	988.0	2,932.4	978.6	188.5	17,692.1
1959	184.5	679.5	117.2	83.0	367.1	943.7	2,128.7	1,793.4	1,349.7	364.8	216.1	738.3	8,966.0
1960	396.5	375.5	110.3	540.0	189.3	955.4	900.8	888.7	1,006.0	986.5	189.1	265.1	6,803.2
Average	**538.4**	**570.2**	**601.5**	**496.6**	**458.1**	**1,963.6**	**1,682.1**	**1,655.0**	**1,858.3**	**1,021.8**	**553.2**	**584.9**	**11,983.6**

Table 7-14 Historical Direct Runoff for Lemon Bay Coastal Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1948	87.20	15.62	2.26	3.16	0.00	2,601.73	2,039.40	539.72	1,132.53	982.12	3.93	4.69	7,412.35
1949	131.26	4.60	82.29	25.92	254.21	7.88	19.43	238.59	62.60	462.95	0.01	4.96	1,294.69
1950	50.79	0.00	18.30	204.25	0.31	8.77	15.67	8.97	281.52	23.64	215.40	399.41	1,227.05
1951	566.41	442.79	391.75	0.00	15.84	35.70	208.63	58.01	304.36	0.84	316.56	0.01	2,340.90
1952	41.50	0.00	6.75	0.04	0.09	59.92	89.75	236.36	532.64	80.69	0.35	53.76	1,101.85
1953	19.49	0.01	0.38	35.27	0.18	23.54	31.47	499.40	236.76	0.01	2.88	1.66	851.05
1954	0.00	0.00	377.75	1.44	0.00	121.70	966.61	508.39	899.37	11.19	0.05	0.00	2,886.50
1955	0.00	287.22	1.31	2.65	25.67	62.17	54.07	427.97	87.95	5.39	540.77	192.47	1,687.66
1956	0.00	0.12	8.89	215.12	201.36	1,435.11	37.15	816.44	1,527.71	0.07	0.00	228.15	4,470.13
1957	7.21	208.13	8.18	98.36	7.32	35.47	124.30	203.33	138.45	232.19	80.21	199.73	1,342.88
1958	102.17	237.83	302.66	10.63	133.89	1,227.92	682.41	59.01	73.53	958.08	144.49	0.21	3,932.83
1959	0.01	79.83	0.00	0.00	0.22	28.56	281.81	296.29	129.65	26.03	0.19	99.39	941.97
1960	25.34	14.60	0.01	38.10	0.10	14.32	11.99	14.38	19.35	74.26	5.99	2.08	220.51
Average	**79.34**	**99.29**	**92.35**	**48.84**	**49.17**	**435.60**	**350.98**	**300.53**	**417.42**	**219.80**	**100.83**	**91.27**	**2,285.41**

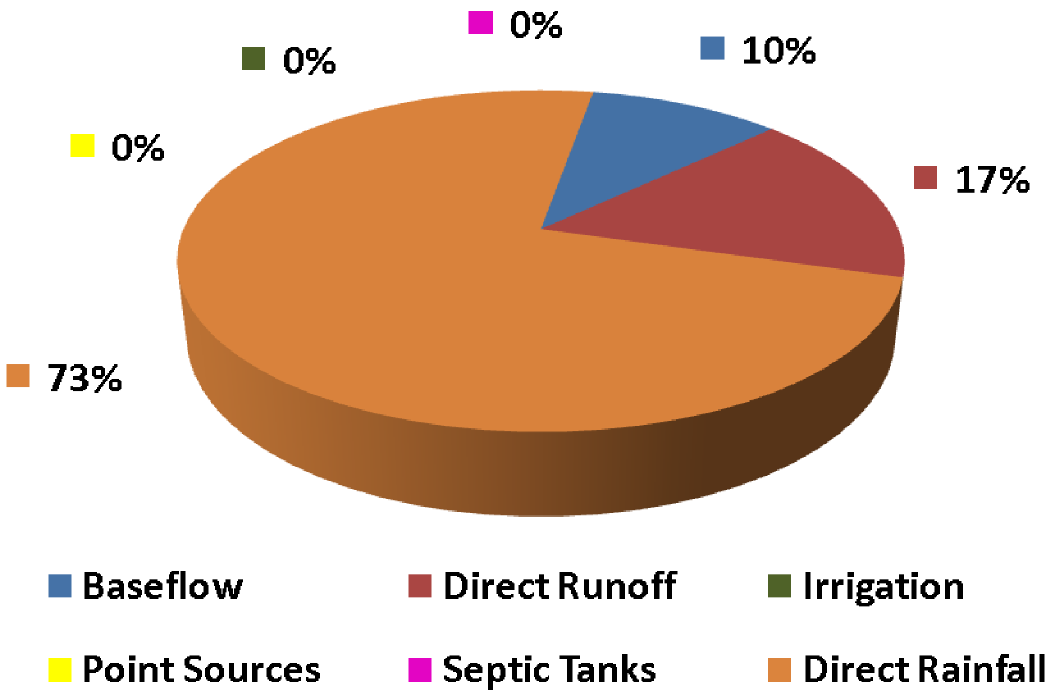

Figure 7-10 Lemon Bay Coastal Basin Historical Total Volume Water Budget

Table 7-15 Summary of Annual Historical Total Volume Inputs for Lemon Bay Coastal Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
1948	1,902.6	7,412.3	0.0	0.0	0.0	15,123.4
1949	1,118.2	1,294.7	0.0	0.0	0.0	7,800.2
1950	631.6	1,227.0	0.0	0.0	0.0	7,056.3
1951	1,604.8	2,340.9	0.0	0.0	0.0	8,535.8
1952	1,057.9	1,101.8	0.0	0.0	0.0	6,889.3
1953	833.0	851.1	0.0	0.0	0.0	4,995.2
1954	1,257.5	2,886.5	0.0	0.0	0.0	8,514.2
1955	1,066.1	1,687.7	0.0	0.0	0.0	8,035.1
1956	1,708.1	4,470.1	0.0	0.0	0.0	10,591.2
1957	1,036.6	1,342.9	0.0	0.0	0.0	7,953.2
1958	1,444.0	3,932.8	0.0	0.0	0.0	12,315.3
1959	1,192.3	942.0	0.0	0.0	0.0	6,831.8
1960	574.4	220.5	0.0	0.0	0.0	6,008.3
Average	**1,186.7**	**2,285.4**	**0.0**	**0.0**	**0.0**	**8,511.5**

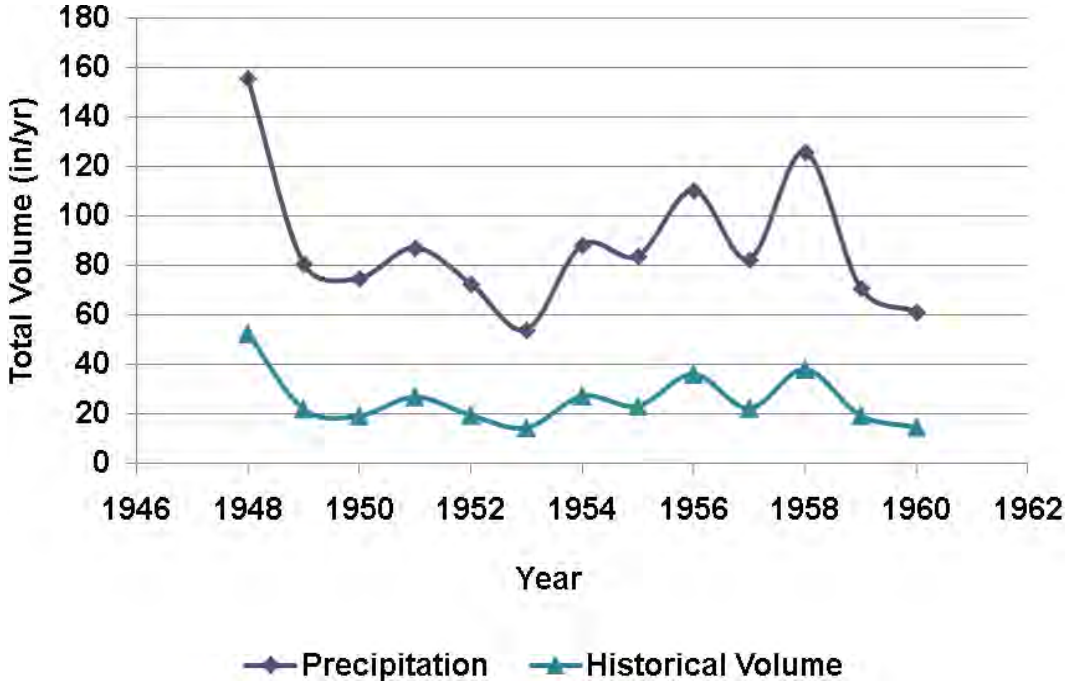

Figure 7-11 Annual Historical Variability of Precipitation and Total Volume for Lemon Bay Coastal Basin

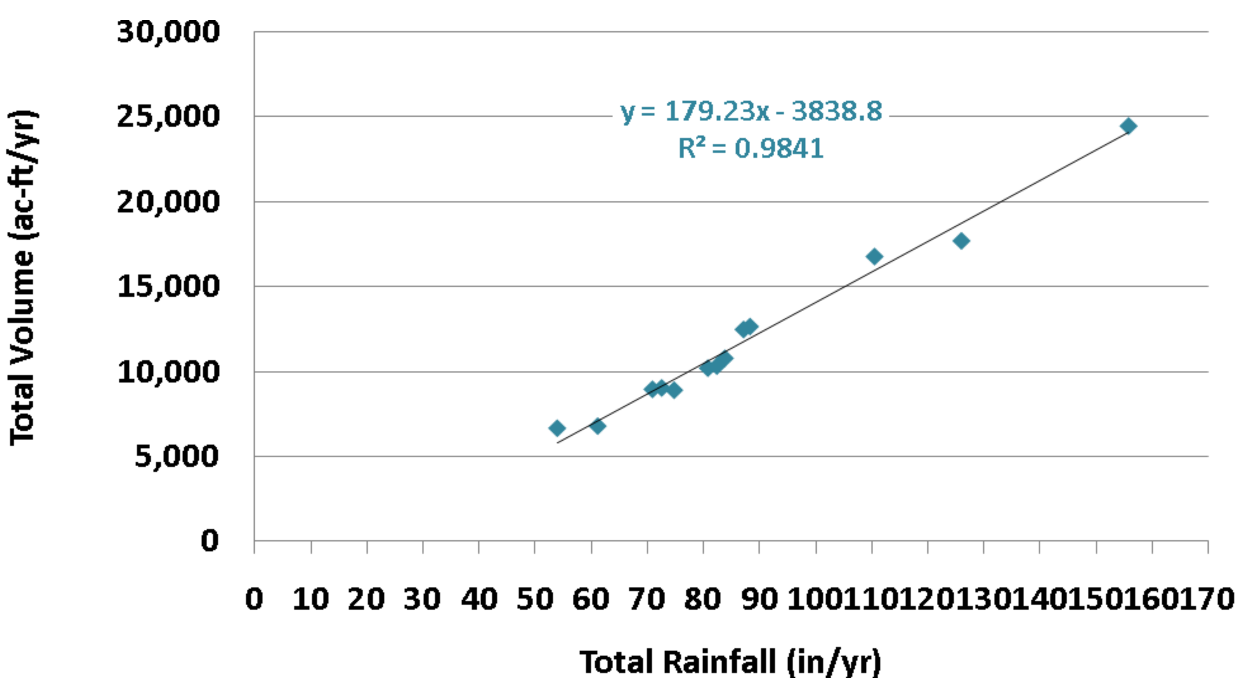

Figure 7-12 Correlation of Annual Total Volume to Rainfall for Lemon Bay Coastal Basin

Table 7-16 Annual Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin

	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
1948	52.61	155.69	0.34
1949	21.99	80.77	0.27
1950	19.19	74.76	0.26
1951	26.87	87.13	0.31
1952	19.48	72.54	0.27
1953	14.38	53.94	0.27
1954	27.25	88.27	0.31
1955	23.23	83.78	0.28
1956	36.10	110.45	0.33
1957	22.24	82.37	0.27
1958	38.09	125.92	0.30
1959	19.30	70.91	0.27
1960	14.65	61.15	0.24
Average	**25.80**	**88.28**	**0.29**

Figure 7-13 Variability of Average Monthly Total Volume in Lemon Bay Coastal Basin

Table 7-17 Average Monthly Rainfall to Total Volume Coefficients for Lemon Bay Coastal Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.16	3.63	0.32
Feb	1.23	3.96	0.31
Mar	1.29	4.41	0.29
Apr	1.07	3.96	0.27
May	0.99	3.62	0.27
Jun	4.23	14.95	0.28
Jul	3.62	12.83	0.28
Aug	3.56	12.97	0.27
Sep	4.00	13.48	0.30
Oct	2.20	6.85	0.32
Nov	1.19	3.54	0.34
Dec	1.26	4.09	0.31

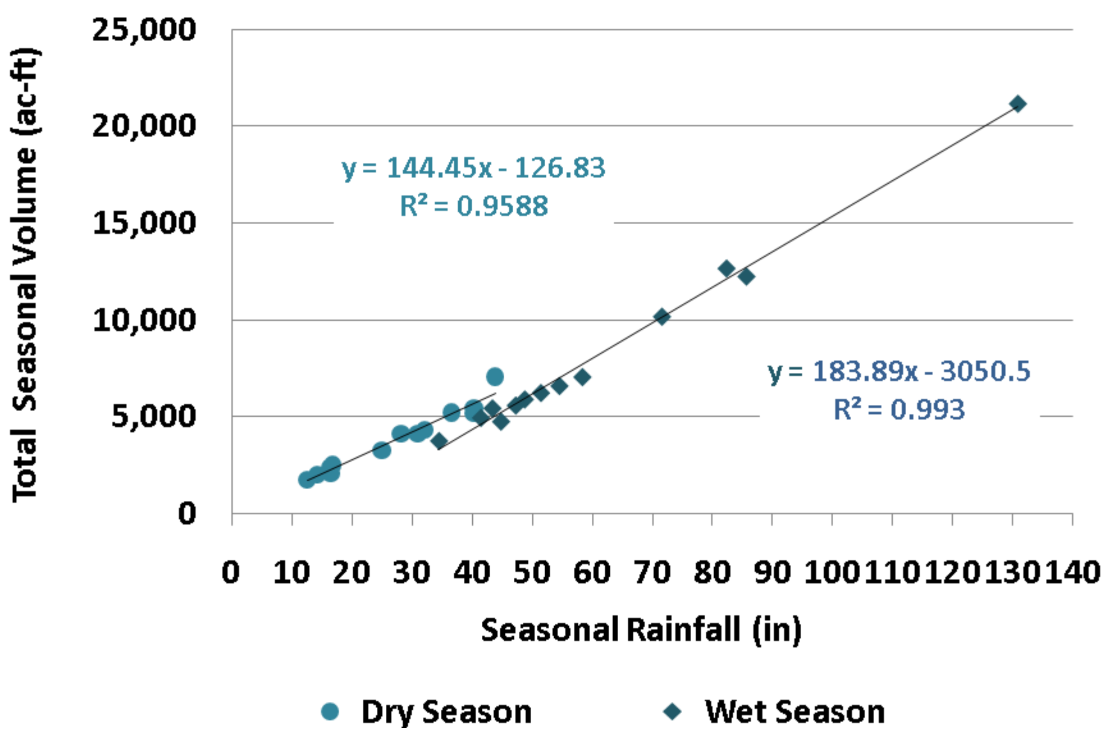

Figure 7-14 Correlation of Seasonal Total Volume to Rainfall for Lemon Bay Coastal Basin

Table 7-18 Wet Season Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin			
	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
1948	45.58	130.76	0.35
1949	12.67	48.69	0.26
1950	8.04	34.43	0.23
1951	11.68	43.31	0.27
1952	15.15	58.27	0.26
1953	10.62	41.39	0.26
1954	21.88	71.52	0.31
1955	11.99	47.19	0.25
1956	27.25	82.27	0.33
1957	13.39	51.38	0.26
1958	26.35	85.58	0.31
1959	14.17	54.46	0.26
1960	10.20	44.74	0.23
Average	**17.61**	**61.08**	**0.28**

Table 7-19 Dry Season Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin			
	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
1948	7.03	24.93	0.28
1949	9.32	32.07	0.29
1950	11.15	40.33	0.28
1951	15.19	43.82	0.35
1952	4.33	14.26	0.30
1953	3.76	12.55	0.30
1954	5.37	16.74	0.32
1955	11.23	36.59	0.31
1956	8.85	28.17	0.31
1957	8.86	30.99	0.29
1958	11.74	40.34	0.29
1959	5.14	16.45	0.31
1960	4.45	16.41	0.27
Average	**8.19**	**27.20**	**0.30**

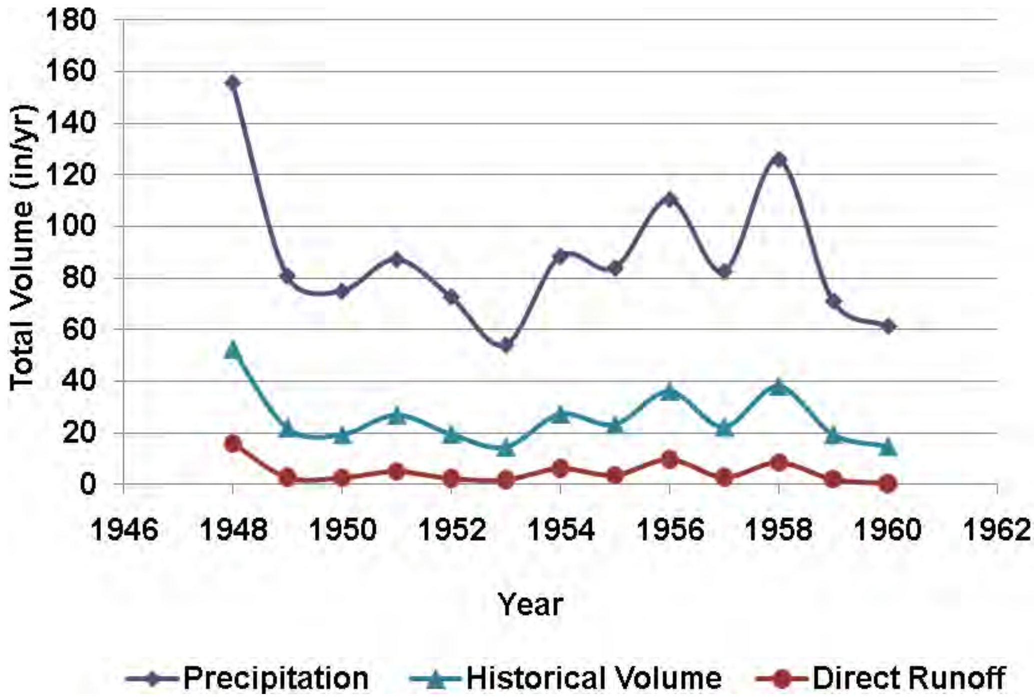

Figure 7-15 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Lemon Bay Coastal

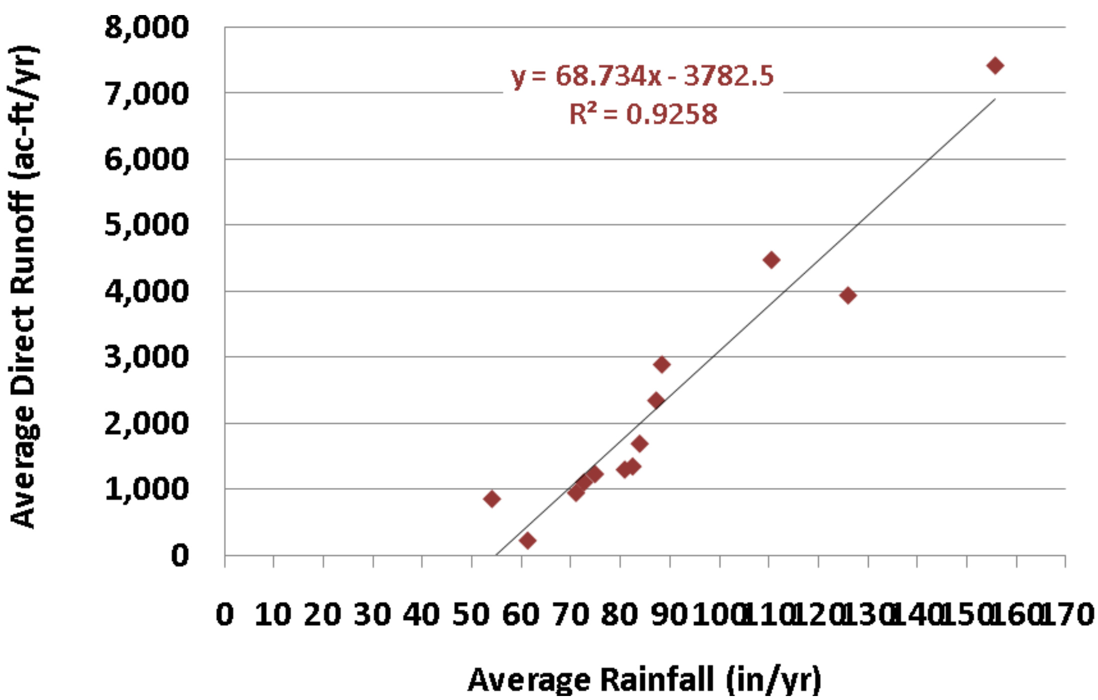

Figure 7-16 Correlation of Average Annual Direct Runoff to Rainfall

Table 7-20 Annual Direct Runoff Volume to Rainfall Coefficients for Lemon Bay Coastal Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
1948	15.96	155.69	0.10
1949	2.79	80.77	0.03
1950	2.64	74.76	0.04
1951	5.04	87.13	0.06
1952	2.37	72.54	0.03
1953	1.83	53.94	0.03
1954	6.21	88.27	0.07
1955	3.63	83.78	0.04
1956	9.62	110.45	0.09
1957	2.89	82.37	0.04
1958	8.47	125.92	0.07
1959	2.03	70.91	0.03
1960	0.47	61.15	0.01
Average	**4.92**	**88.28**	**0.05**

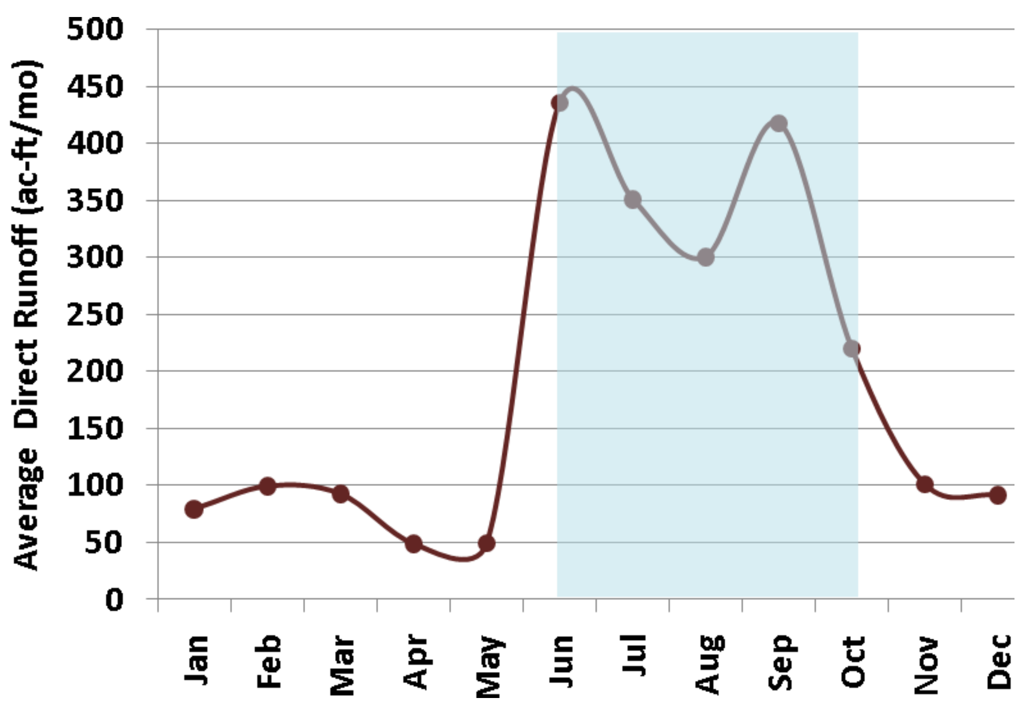

Figure 7-17 Variability of Average Monthly Direct Runoff to Lemon Bay Coastal Basin

Table 7-21 Average Monthly Rainfall to Direct Runoff Coefficients			
	Average Direct Runoff (in)	Average Rainfall (in)	Average Direct Runoff / Average Rainfall
Jan	0.17	3.63	0.05
Feb	0.21	3.96	0.05
Mar	0.20	4.41	0.05
Apr	0.11	3.96	0.03
May	0.11	3.62	0.03
Jun	0.94	14.95	0.06
Jul	0.76	12.83	0.06
Aug	0.65	12.97	0.05
Sep	0.90	13.48	0.07
Oct	0.47	6.85	0.07
Nov	0.22	3.54	0.06
Dec	0.20	4.09	0.05

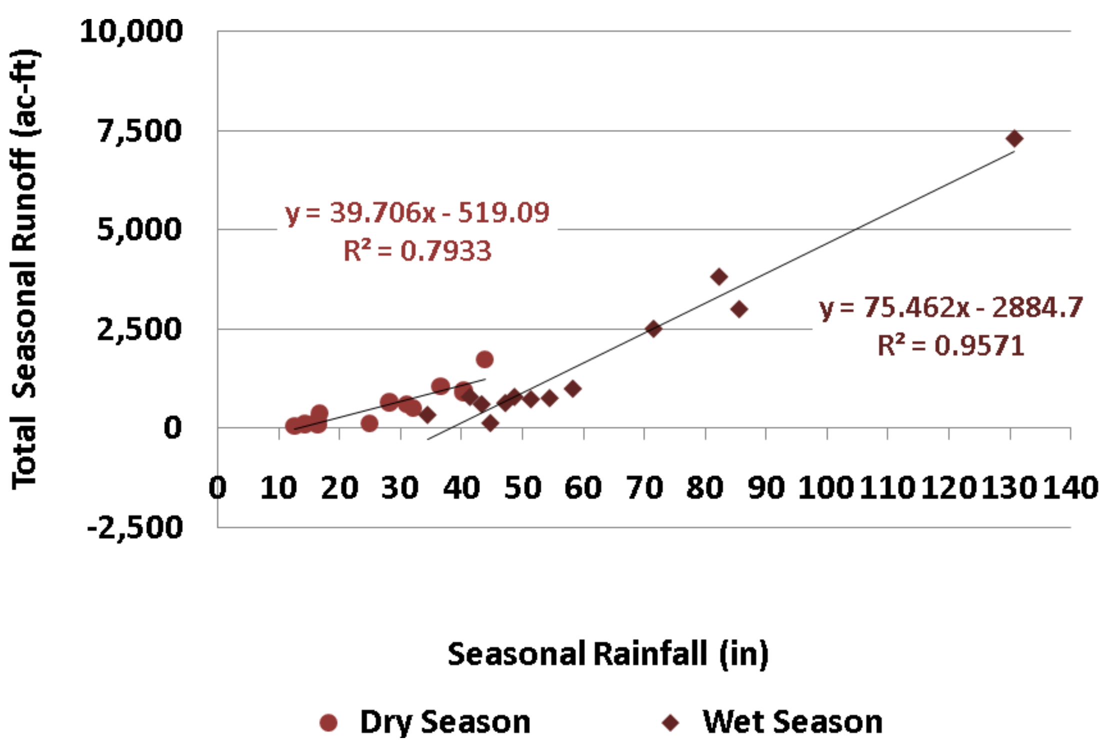

Figure 7-18 Correlation of Seasonal Direct Runoff to Rainfall

Table 7-22 Wet Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
1948	15.71	130.76	0.12
1949	1.70	48.69	0.03
1950	0.73	34.43	0.02
1951	1.31	43.31	0.03
1952	2.15	58.27	0.04
1953	1.70	41.39	0.04
1954	5.40	71.52	0.08
1955	1.37	47.19	0.03
1956	8.22	82.27	0.10
1957	1.58	51.38	0.03
1958	6.46	85.58	0.08
1959	1.64	54.46	0.03
1960	0.29	44.74	0.01
Average	**3.71**	**61.08**	**0.05**

Table 7-23 Dry Season Direct Runoff to Rainfall Coefficients

	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
1948	0.25	24.93	0.01
1949	1.08	32.07	0.03
1950	1.91	40.33	0.05
1951	3.73	43.82	0.09
1952	0.22	14.26	0.02
1953	0.13	12.55	0.01
1954	0.82	16.74	0.05
1955	2.26	36.59	0.06
1956	1.41	28.17	0.05
1957	1.31	30.99	0.04
1958	2.01	40.34	0.05
1959	0.39	16.45	0.02
1960	0.19	16.41	0.01
Average	**1.21**	**27.20**	**0.04**

7.3 FUTURE CONDITIONS

Table 7-24 Future Total Volume for Lemon Bay Coastal Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	964.0	708.6	440.3	755.8	136.6	7,505.2	5,873.1	2,800.1	3,989.0	4,099.8	740.4	627.0	28,640.0
2016	1,164.8	405.6	1,122.2	580.8	1,216.4	760.4	815.0	1,802.1	1,233.5	2,375.4	327.9	410.9	12,215.1
2017	554.7	153.1	374.9	1,395.9	322.7	558.0	576.8	660.2	1,840.3	540.9	1,069.4	1,849.6	9,896.6
2018	2,227.9	1,924.4	1,825.7	331.6	609.4	610.3	1,612.1	1,162.8	2,266.4	562.8	1,426.8	262.9	14,823.2
2019	620.4	100.5	448.4	128.7	126.2	1,354.7	947.6	1,848.2	2,825.1	1,114.7	427.3	630.0	10,571.7
2020	376.8	216.8	249.5	506.9	161.4	862.8	896.0	1,935.9	1,605.7	217.1	293.7	206.7	7,529.3
2021	107.4	62.0	2,002.6	119.6	81.0	1,299.9	3,577.7	2,224.2	3,558.8	865.5	347.1	251.2	14,496.9
2022	258.8	1,234.8	148.3	334.3	579.3	1,351.5	723.2	2,610.1	1,174.3	451.7	1,831.7	1,360.1	12,058.0
2023	251.0	343.5	543.0	867.8	1,037.5	4,697.3	1,200.9	3,606.1	4,699.8	605.3	408.5	1,165.7	19,426.3
2024	505.6	1,183.3	326.4	887.2	277.0	1,167.0	1,534.9	1,797.7	1,500.4	1,276.5	673.3	970.2	12,099.3
2025	667.0	973.8	1,413.7	574.2	1,455.9	5,082.8	3,243.2	1,749.4	1,409.7	3,388.6	1,326.0	383.6	21,667.8
2026	281.3	794.8	148.0	97.2	398.5	1,024.7	2,249.1	2,056.6	1,770.4	630.9	346.9	832.6	10,631.0
2027	453.0	427.1	128.3	613.5	204.4	1,049.0	983.4	955.8	1,112.9	1,143.1	284.3	337.9	7,692.8
Average	**648.6**	**656.0**	**705.5**	**553.4**	**508.2**	**2,101.8**	**1,864.1**	**1,939.2**	**2,229.7**	**1,328.6**	**731.0**	**714.5**	**13,980.6**

Table 7-25 Future Direct Runoff for Lemon Bay Coastal Basin (ac-ft/mo)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2015	151.4	60.9	35.1	63.1	0.4	2,832.3	2,183.5	623.5	1,367.0	1,183.6	15.6	36.1	8,552.5
2016	193.3	30.4	171.9	58.0	289.5	72.1	113.3	389.8	157.0	625.7	2.4	27.2	2,130.6
2017	68.9	1.7	36.5	245.7	21.1	52.3	65.3	56.5	487.4	86.0	264.6	496.1	1,882.1
2018	635.7	401.5	536.4	0.8	39.3	54.8	244.0	139.2	406.8	14.9	429.9	6.7	2,909.9
2019	79.0	0.0	38.0	4.8	7.5	158.9	115.3	370.3	720.9	122.2	14.3	102.5	1,733.9
2020	32.8	7.3	9.5	60.6	10.8	91.1	93.3	616.9	368.1	1.3	14.0	11.3	1,317.1
2021	0.8	0.0	567.7	4.2	0.8	169.3	985.0	491.6	1,021.1	37.4	5.2	1.2	3,284.4
2022	5.6	264.8	3.6	26.5	90.5	117.1	83.4	590.5	143.3	19.7	645.4	246.0	2,236.4
2023	0.0	15.3	40.1	197.1	193.6	1,473.3	93.6	981.8	1,707.1	8.2	5.1	274.0	4,989.3
2024	43.0	341.7	35.2	153.8	19.0	135.1	219.2	335.2	194.9	344.3	135.9	250.8	2,208.1
2025	171.1	298.1	430.6	50.0	333.5	1,501.7	823.9	176.5	168.0	1,114.8	233.8	0.2	5,302.3
2026	3.1	145.8	3.7	0.3	24.5	106.0	380.2	425.3	228.3	64.3	7.3	117.6	1,506.5
2027	37.2	39.7	2.6	103.5	11.3	105.6	93.3	76.4	108.0	160.3	22.0	24.0	783.9
Average	**109.4**	**123.6**	**147.0**	**74.5**	**80.1**	**528.5**	**422.6**	**405.7**	**544.5**	**291.0**	**138.1**	**122.6**	**2,987.5**

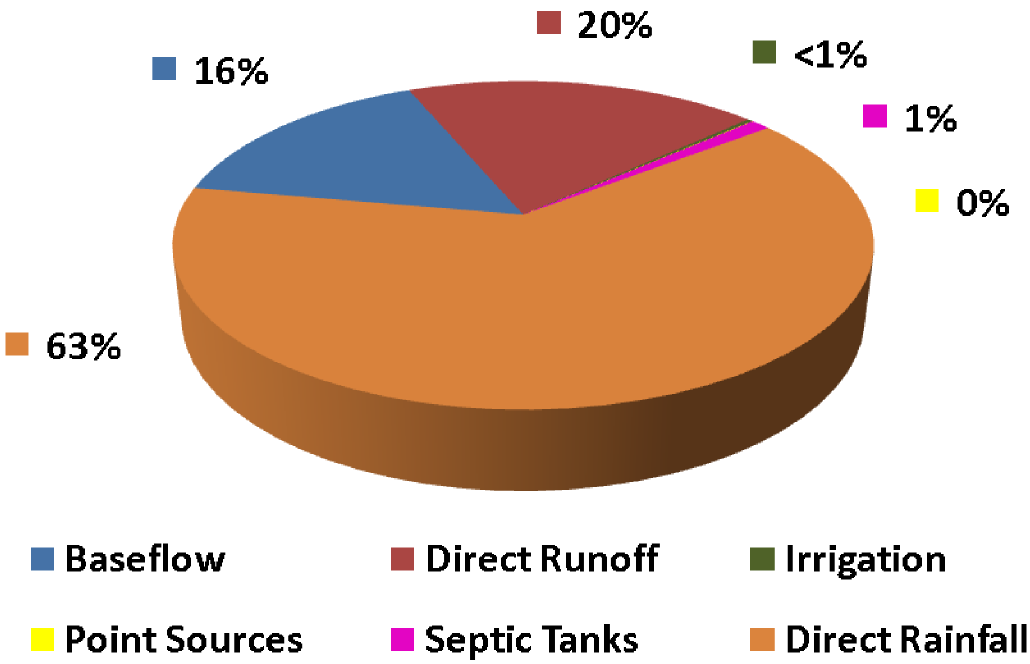

Figure 7-19 Lemon Bay Coastal Basin Current Total Volume Water Budget

Table 7-26 Summary of Annual Future Total Volume Inputs for Lemon Bay Coastal Basin (ac-ft/yr)

	Baseflow	Direct Runoff	Irrigation	Point Sources	Septic Tanks	Direct Rainfall
2015	4,798.4	8,552.5	34.5	1.0	130.2	15,123.4
2016	2,118.7	2,130.6	34.5	1.0	130.2	7,800.2
2017	792.5	1,882.1	34.5	1.0	130.2	7,056.3
2018	3,205.3	2,909.9	34.5	7.5	130.2	8,535.8
2019	1,776.9	1,733.9	34.5	7.0	130.2	6,889.3
2020	1,046.7	1,317.1	34.5	5.7	130.2	4,995.2
2021	2,527.7	3,284.4	34.5	6.0	130.2	8,514.2
2022	1,616.3	2,236.4	34.5	5.6	130.2	8,035.1
2023	3,674.9	4,989.3	34.5	6.2	130.2	10,591.2
2024	1,766.7	2,208.1	34.5	6.6	130.2	7,953.2
2025	3,878.7	5,302.3	34.5	6.9	130.2	12,315.3
2026	2,124.6	1,506.5	34.5	3.6	130.2	6,831.8
2027	736.0	783.9	34.5	0.0	130.2	6,008.3
Average	**2,312.6**	**2,987.5**	**34.5**	**4.5**	**130.2**	**8,511.5**

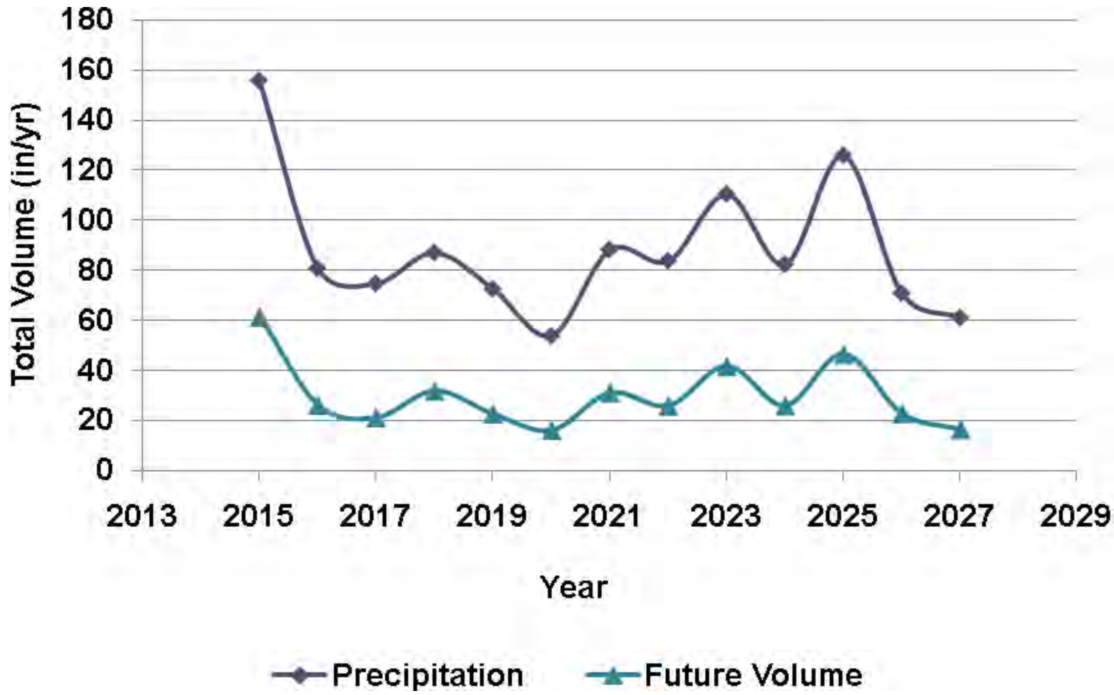

Figure 7-20 Annual Variability of Precipitation and Total Volume for Lemon Bay Coastal Basin

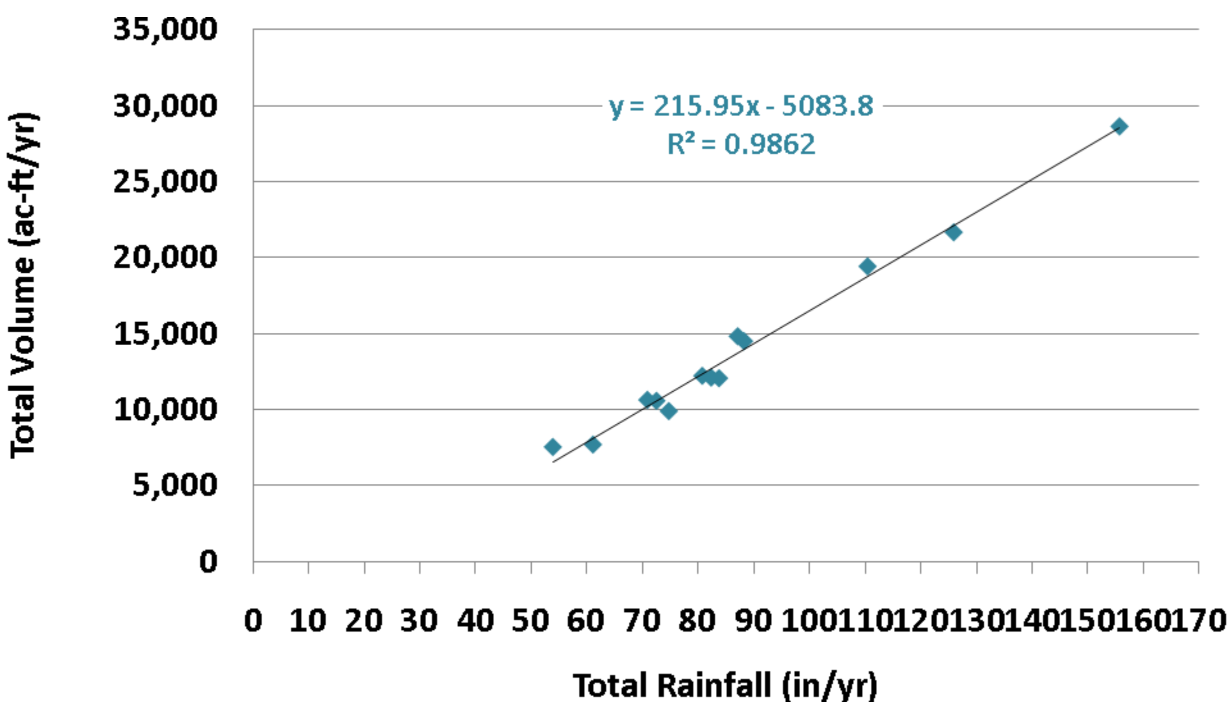

Figure 7-21 Correlation of Annual Total Volume to Rainfall for Lemon Bay Coastal Basin

Table 7-27 Annual Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin			
	Total Volume (in/yr)	Rainfall (in/yr)	Total Volume / Rainfall
2015	61.65	155.69	0.40
2016	26.30	80.77	0.33
2017	21.30	74.76	0.28
2018	31.91	87.13	0.37
2019	22.76	72.54	0.31
2020	16.21	53.94	0.30
2021	31.21	88.27	0.35
2022	25.96	83.78	0.31
2023	41.82	110.45	0.38
2024	26.05	82.37	0.32
2025	46.65	125.92	0.37
2026	22.89	70.91	0.32
2027	16.56	61.15	0.27
Average	**30.10**	**88.28**	**0.33**

Figure 7-22 Variability of Average Monthly Total Volume in Lemon Bay Coastal Basin

Table 7-28 Average Monthly Rainfall to Total Volume Coefficients for Lemon Bay Coastal Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.40	3.63	0.39
Feb	1.41	3.96	0.36
Mar	1.52	4.41	0.34
Apr	1.19	3.96	0.30
May	1.09	3.62	0.30
Jun	4.52	14.95	0.30
Jul	4.01	12.83	0.31
Aug	4.17	12.97	0.32
Sep	4.80	13.48	0.36
Oct	2.86	6.85	0.42
Nov	1.57	3.54	0.44
Dec	1.54	4.09	0.38

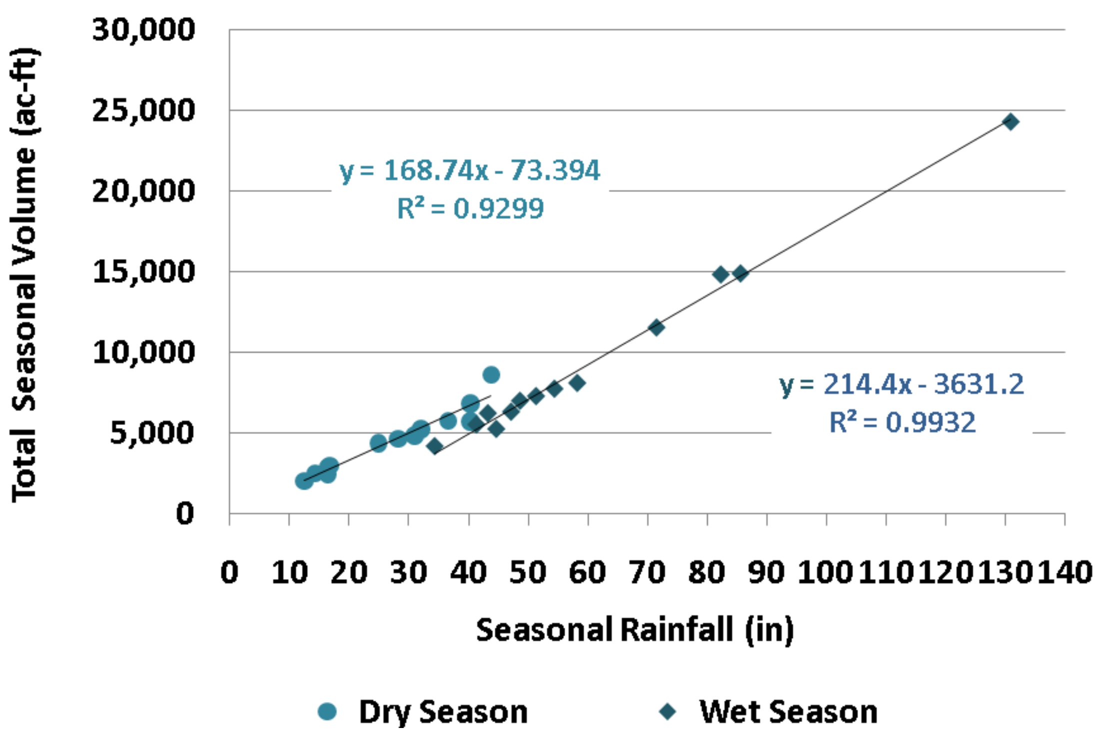

Figure 7-23 Correlation of Seasonal Total Volume to Rainfall for Lemon Bay Coastal Basin

Table 7-29 Wet Season Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin

	Total Volume (in/wet season)	Rainfall (in/wet season)	Total Volume / Rainfall
2015	52.24	130.76	0.40
2016	15.04	48.69	0.31
2017	8.99	34.43	0.26
2018	13.38	43.31	0.31
2019	17.42	58.27	0.30
2020	11.88	41.39	0.29
2021	24.81	71.52	0.35
2022	13.59	47.19	0.29
2023	31.88	82.27	0.39
2024	15.66	51.38	0.30
2025	32.02	85.58	0.37
2026	16.64	54.46	0.31
2027	11.29	44.74	0.25
Average	**20.37**	**61.08**	**0.32**

Table 7-30 Dry Season Total Volume to Rainfall Coefficients for Lemon Bay Coastal Basin

	Total Volume (in/dry season)	Rainfall (in/dry season)	Total Volume / Rainfall
2015	9.41	24.93	0.38
2016	11.26	32.07	0.35
2017	12.31	40.33	0.31
2018	18.53	43.82	0.42
2019	5.34	14.26	0.37
2020	4.33	12.55	0.35
2021	6.40	16.74	0.38
2022	12.37	36.59	0.34
2023	9.94	28.17	0.35
2024	10.38	30.99	0.33
2025	14.63	40.34	0.36
2026	6.24	16.45	0.38
2027	5.27	16.41	0.32
Average	**9.72**	**27.20**	**0.36**

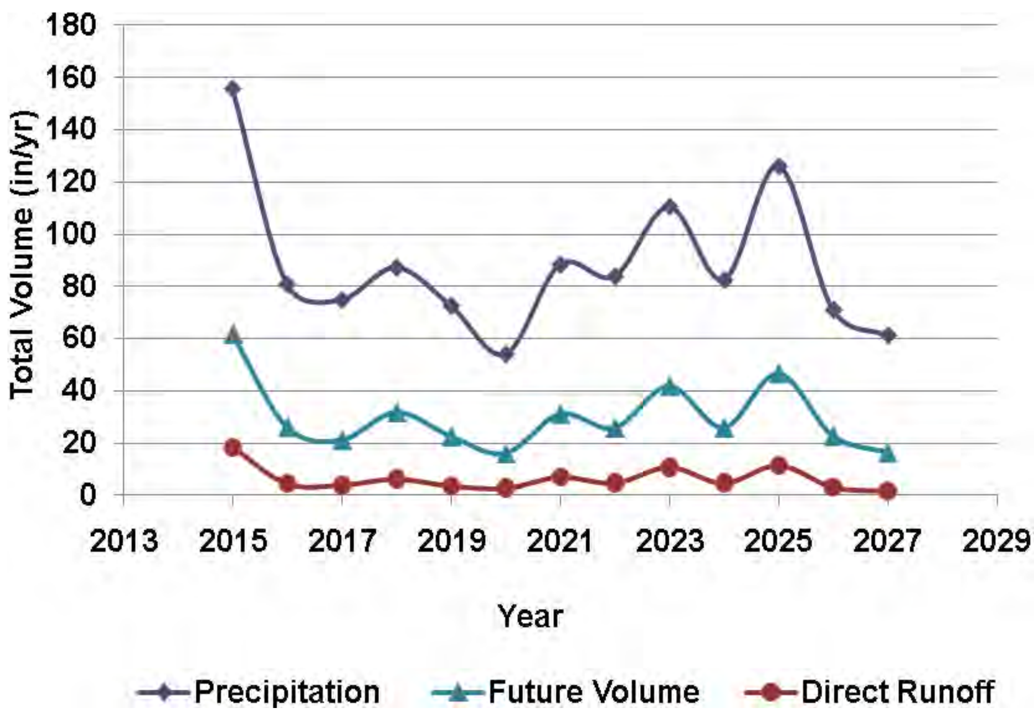

Figure 7-24 Annual Variability of Total Volume, Direct Runoff, and Rainfall for Lemon Bay Coastal Basin

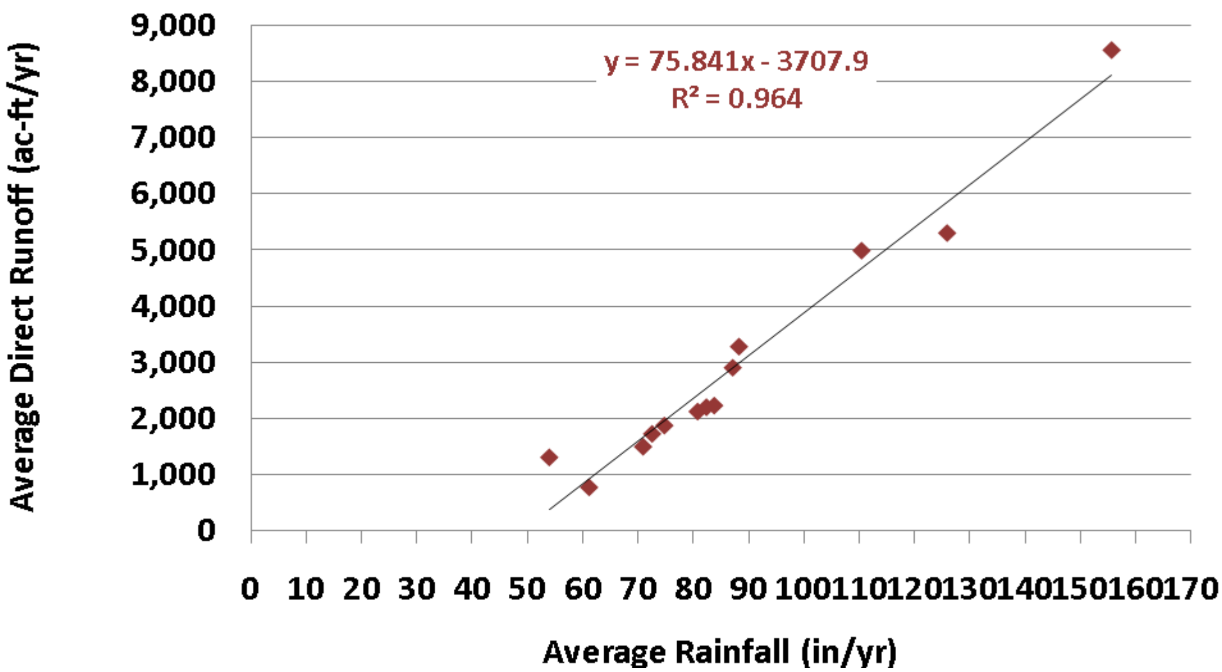

Figure 7-25 Correlation of Average Annual Direct Runoff to Rainfall

Table 7-31 Annual Direct Runoff to Rainfall Coefficients for Lemon Bay Coastal Basin			
	Direct Runoff (in/yr)	Rainfall (in/yr)	Direct Runoff / Rainfall
2015	18.41	155.69	0.12
2016	4.59	80.77	0.06
2017	4.05	74.76	0.05
2018	6.26	87.13	0.07
2019	3.73	72.54	0.05
2020	2.84	53.94	0.05
2021	7.07	88.27	0.08
2022	4.81	83.78	0.06
2023	10.74	110.45	0.10
2024	4.75	82.37	0.06
2025	11.41	125.92	0.09
2026	3.24	70.91	0.05
2027	1.69	61.15	0.03
Average	**6.43**	**88.28**	**0.07**

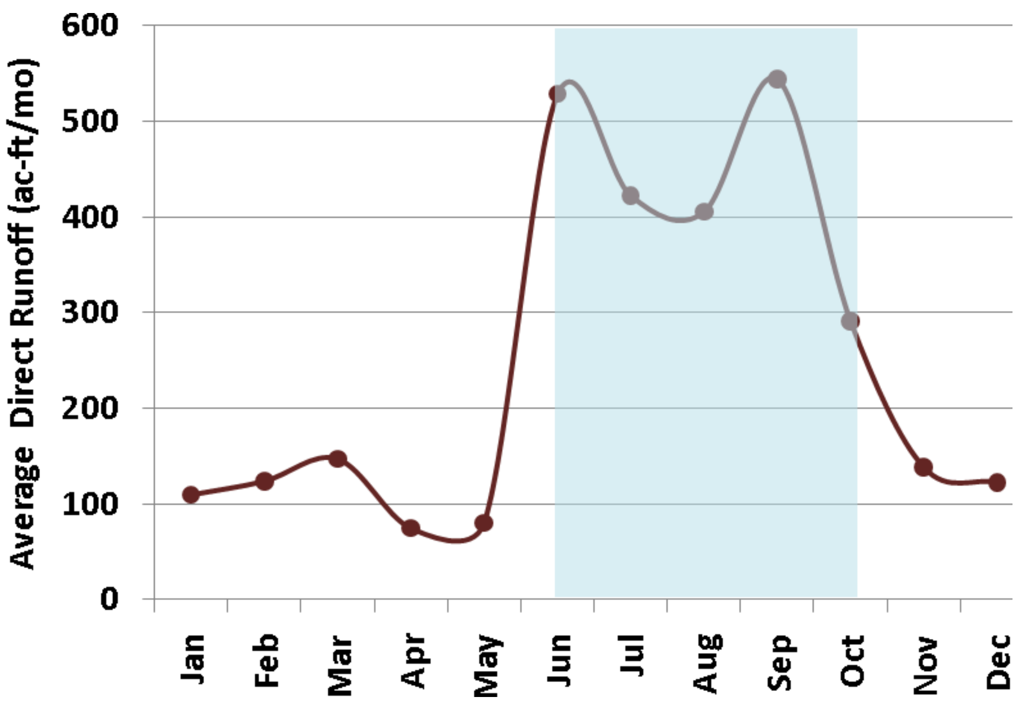

Figure 7-26 Variability of Average Monthly Direct Runoff to Lemon Bay Coastal Basin

Table 7-32 Average Monthly Rainfall to Direct Runoff Coefficients for Lemon Bay Coastal Basin			
	Average Total Volume (in)	Average Rainfall (in)	Average Total Volume / Average Rainfall
Jan	1.40	3.63	0.39
Feb	1.41	3.96	0.36
Mar	1.52	4.41	0.34
Apr	1.19	3.96	0.30
May	1.09	3.62	0.30
Jun	4.52	14.95	0.30
Jul	4.01	12.83	0.31
Aug	4.17	12.97	0.32
Sep	4.80	13.48	0.36
Oct	2.86	6.85	0.42
Nov	1.57	3.54	0.44
Dec	1.54	4.09	0.38

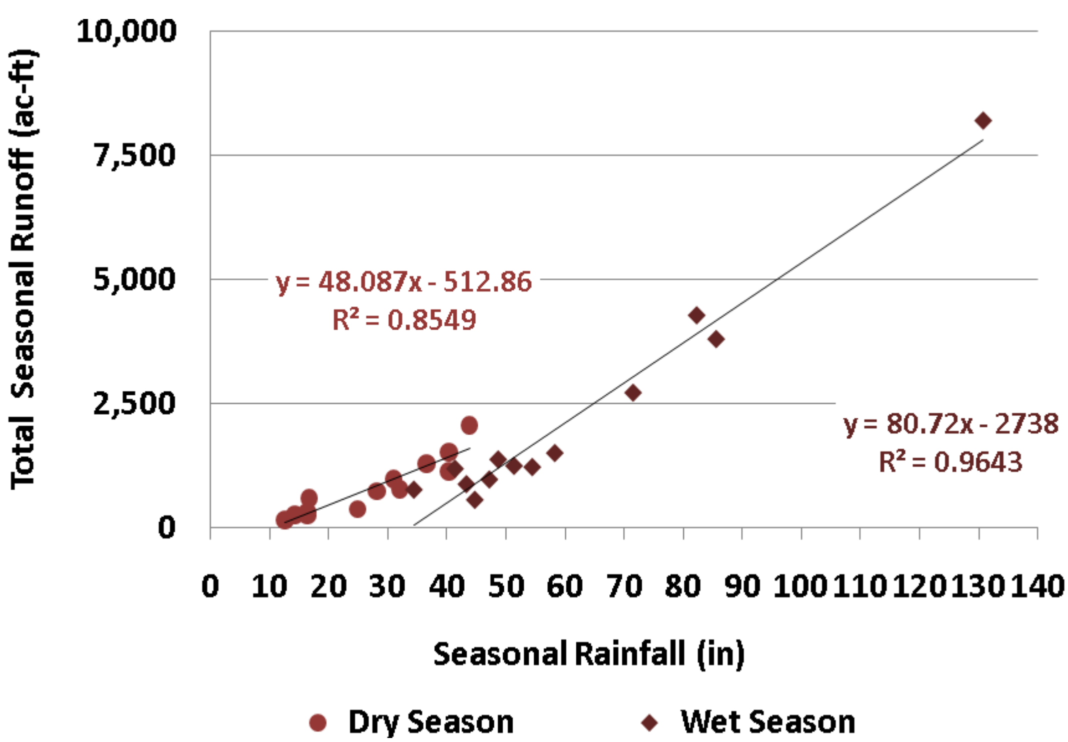

Figure 7-27 Correlation of Seasonal Direct Runoff to Rainfall

Table 7-33 Wet Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/wet season)	Rainfall (in/wet season)	Direct Runoff / Rainfall
2015	17.63	130.76	0.13
2016	2.92	48.69	0.06
2017	1.61	34.43	0.05
2018	1.85	43.31	0.04
2019	3.20	58.27	0.05
2020	2.52	41.39	0.06
2021	5.82	71.52	0.08
2022	2.05	47.19	0.04
2023	9.18	82.27	0.11
2024	2.65	51.38	0.05
2025	8.15	85.58	0.10
2026	2.59	54.46	0.05
2027	1.17	44.74	0.03
Average	**4.72**	**61.08**	**0.07**

Table 7-34 Dry Season Direct Runoff to Rainfall Coefficients			
	Direct Runoff (in/dry season)	Rainfall (in/dry season)	Direct Runoff / Rainfall
2015	0.78	24.93	0.03
2016	1.66	32.07	0.05
2017	2.44	40.33	0.06
2018	4.41	43.82	0.10
2019	0.53	14.26	0.04
2020	0.32	12.55	0.03
2021	1.25	16.74	0.07
2022	2.76	36.59	0.08
2023	1.56	28.17	0.06
2024	2.11	30.99	0.07
2025	3.27	40.34	0.08
2026	0.65	16.45	0.04
2027	0.52	16.41	0.03
Average	**1.71**	**27.20**	**0.06**

7.4 WATER BUDGET CHANGES

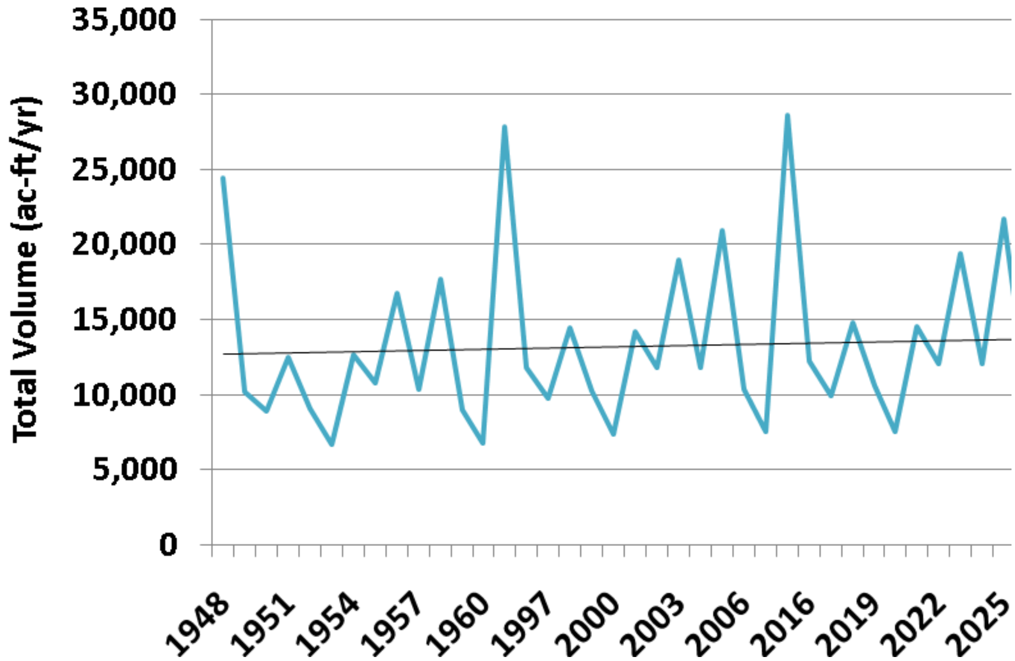

Figure 7-28 Trend in Total Volume from Historical through Future Time Series

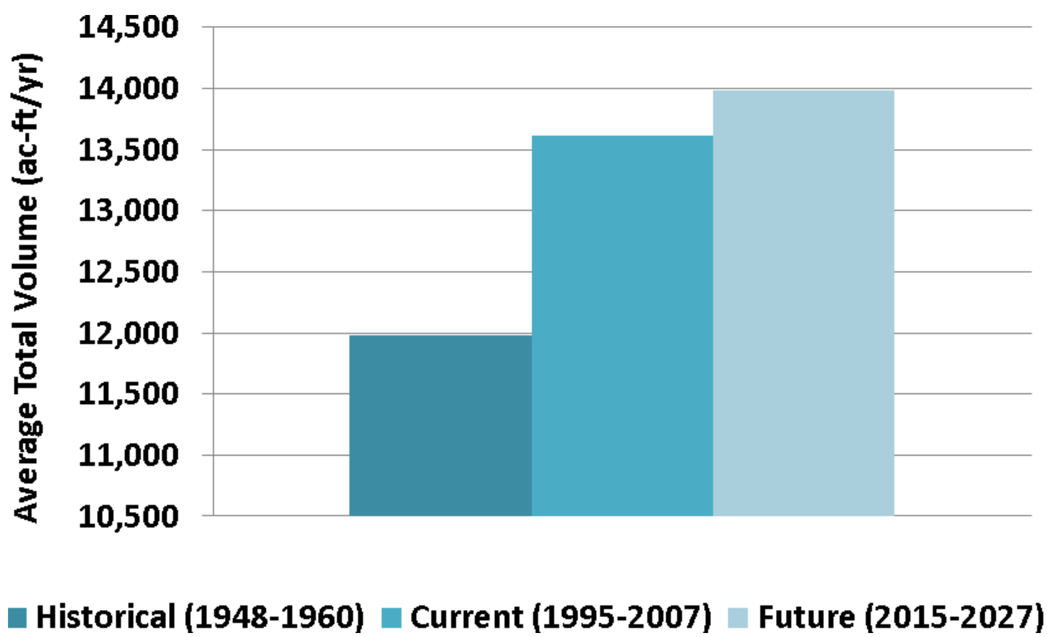

Figure 7-29 Historical, Current, and Future Average Annual Total Volume to Lemon Bay Coastal Basin

Table 7-35 Change in Total Volume from Historical to Current Conditions			
Year	Historical Volume (ac-ft) 1948-1960	Current Volume (ac-ft) 1995-2007	Volume Change (ac-ft) (current-historical)
1	24,438	27,816	3,378
2	10,213	11,834	1,621
3	8,915	9,744	829
4	12,482	14,417	1,936
5	9,049	10,280	1,231
6	6,679	7,397	718
7	12,658	14,147	1,488
8	10,789	11,828	1,039
9	16,769	18,932	2,162
10	10,333	11,781	1,448
11	17,692	20,935	3,243
12	8,966	10,321	1,355
13	6,803	7,565	761
Average	**11,984**	**13,615**	**1,632**

Table 7-36 Change in Total Volume from Current to Future Conditions			
Year	Current Volume (ac-ft) 1995-2007	Future Volume (ac-ft) 2015-2027	Volume Change (ac-ft) (future-current)
1	27,816	28,640	824
2	11,834	12,215	381
3	9,744	9,897	153
4	14,417	14,823	406
5	10,280	10,572	291
6	7,397	7,529	132
7	14,147	14,497	350
8	11,828	12,058	230
9	18,932	19,426	495
10	11,781	12,099	318
11	20,935	21,668	733
12	10,321	10,631	310
13	7,565	7,693	128
Average	**13,615**	**13,981**	**365**

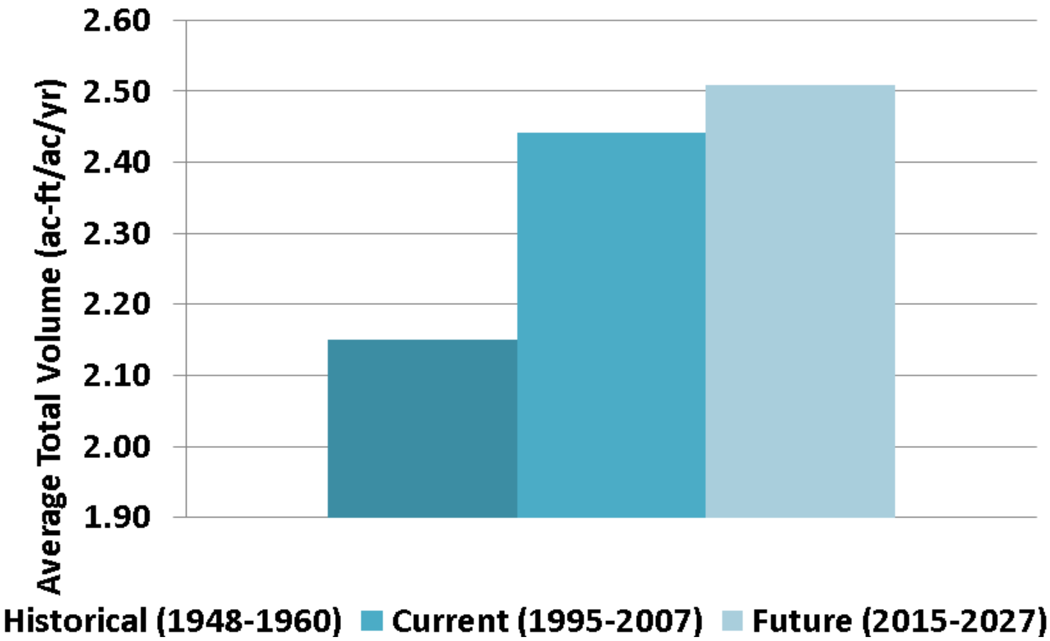

Figure 7-30 Normalized Historical, Current, and Future Average Annual Total Volume to Lemon Bay Coastal Basin

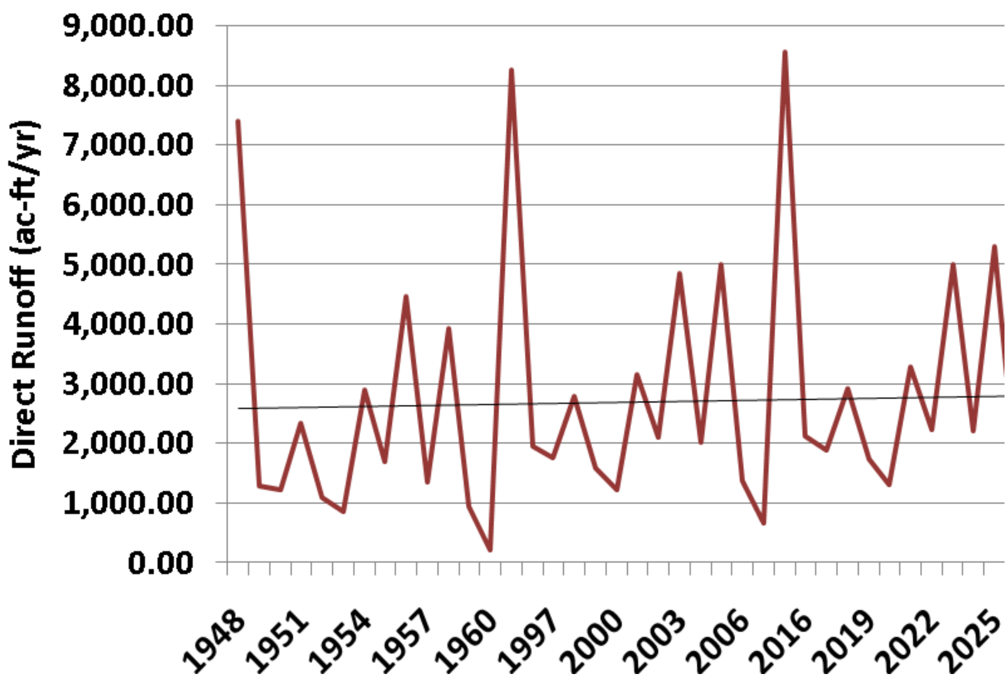

Figure 7-31 Trend in Direct Runoff from Historical through Future Time Series

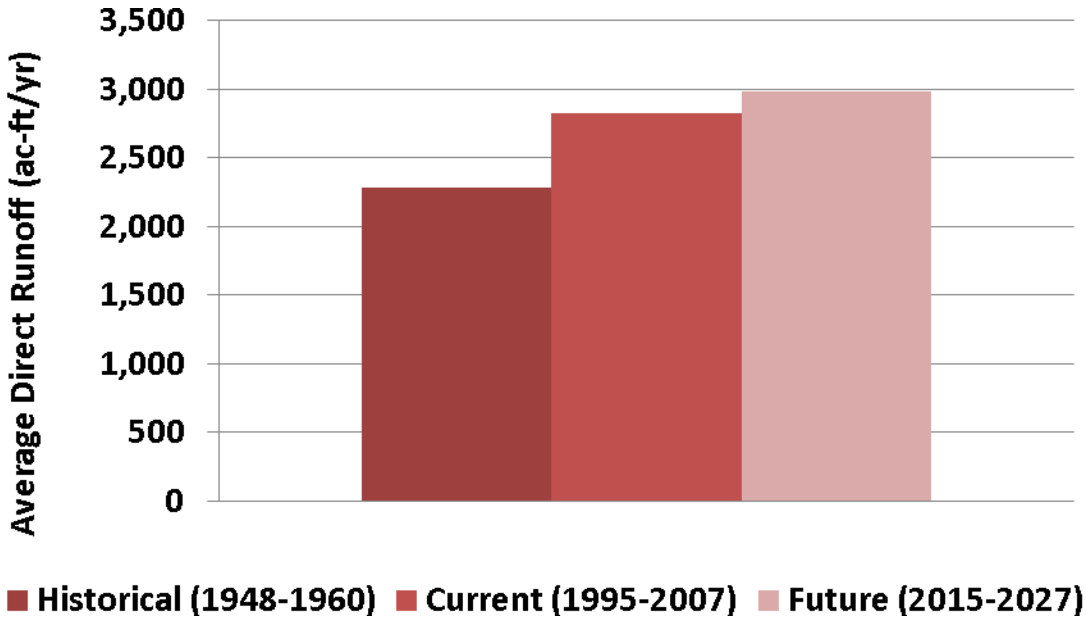

Figure 7-32 Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay Coastal Basin

Table 7-37 Change in Direct Runoff from Historical to Current Conditions

Year	Historical Direct Runoff (ac-ft) 1948-1960	Current Direct Runoff (ac-ft) 1995-2007	Direct Runoff Change (ac-ft) (current-historical)
1	7,412	8,263	851
2	1,295	1,947	652
3	1,227	1,760	533
4	2,341	2,786	445
5	1,102	1,581	480
6	851	1,226	375
7	2,886	3,156	269
8	1,688	2,097	409
9	4,470	4,845	374
10	1,343	2,025	682
11	3,933	5,006	1,073
12	942	1,368	426
13	221	675	454
Average	**2,285**	**2,826**	**540**

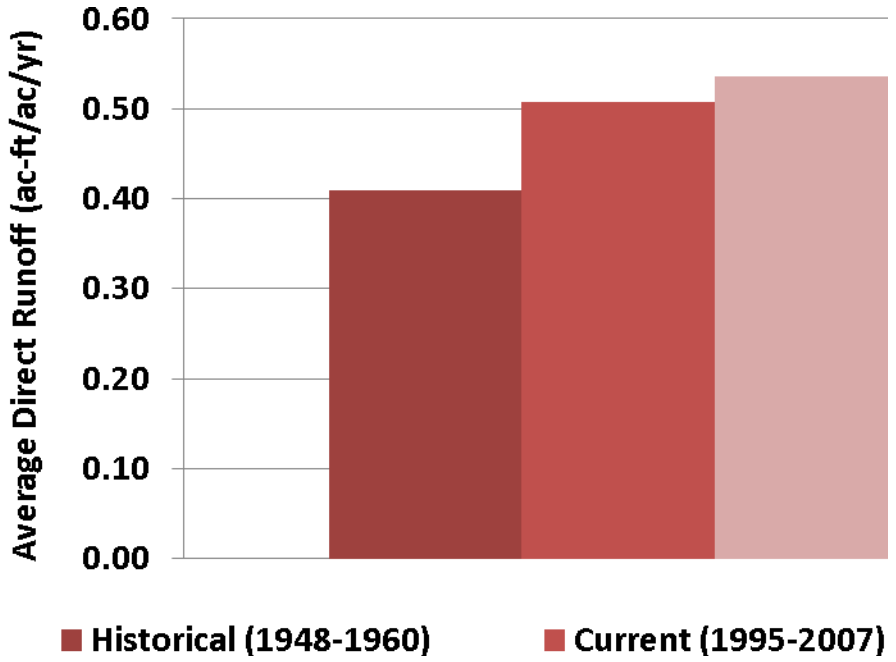

Figure 7-33 Normalized Historical, Current, and Future Average Annual Direct Runoff to Lemon Bay Coastal Basin

Appendix F

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August 2010

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Southwest Florida Water Management District

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