26TH ANNUAL REPORT OF THE CONTINUING SURFACE WATER QUALITY MONITORING PROGRAM FOR CATFISH, NORTH AND SOUTH CREEKS ON THE PALMER RANCH SARASOTA COUNTY, FLORIDA JANUARY – DECEMBER 2010

February 2011

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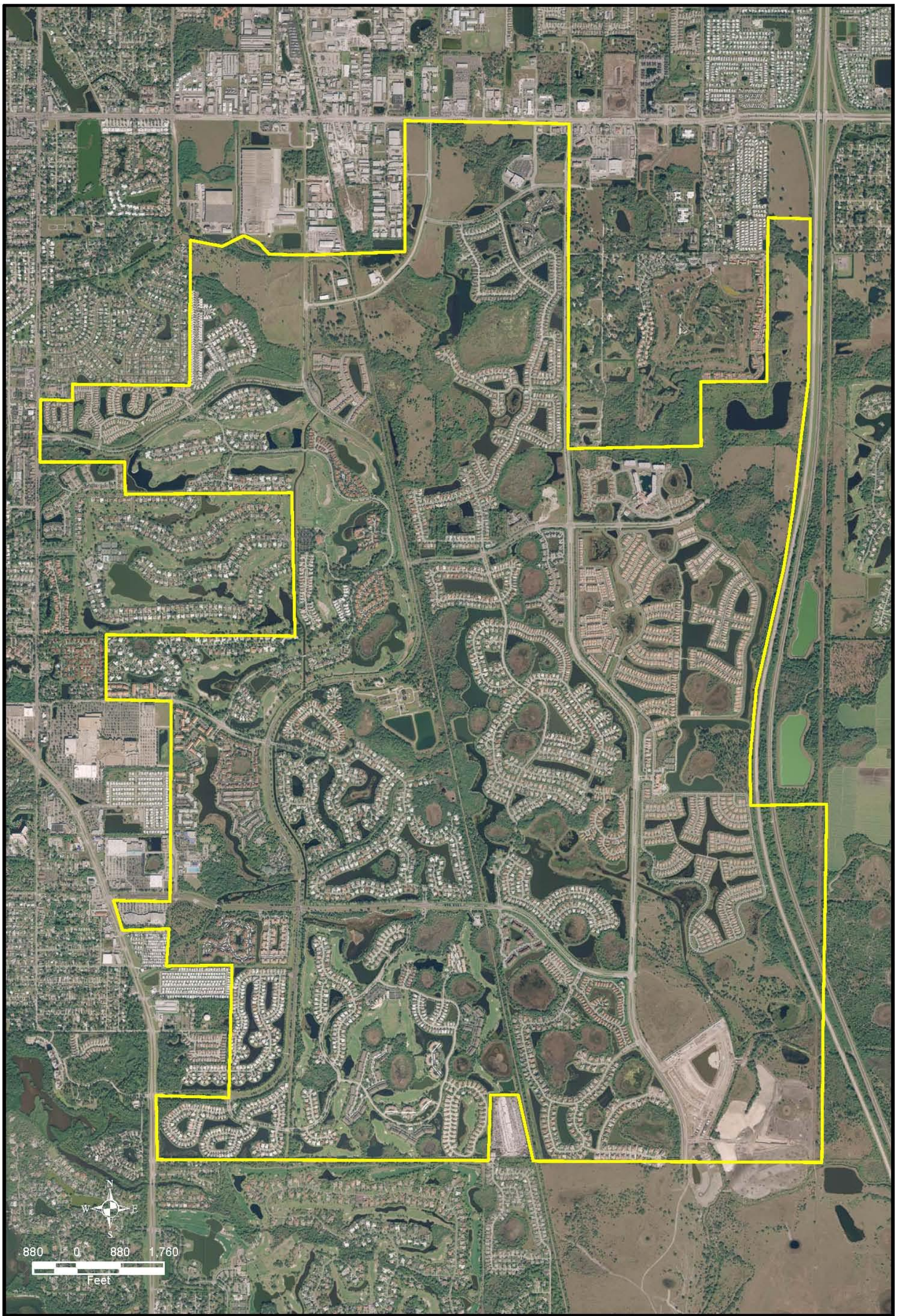
Introduction

A master development plan for the Palmer Ranch is being implemented pursuant to the terms and conditions of the Amended and Restated Master Development Order (Amended MDO, Resolution No. 91-170) for the Palmer Ranch Development of Regional Impact (DRI) which was adopted on July 12, 1991, by the Board of County Commissioners of Sarasota County. The amended and original MDO's call for planning and developing the 5,119-acre Palmer Ranch DRI in incremental developments. Construction of the first incremental development (Prestancia) was initiated in 1986. The Palmer Ranch is located in west-central Sarasota County as shown in **Figure 1.1**.

Pursuant to the conditions of the original MDO, a "Continuing Surface Water Quality Monitoring Program" was required to be performed before and during construction, except during the period in which a "Pollutant Loading Monitoring Program" was to be performed as specified in the Agreement of Understanding between Sarasota County and Palmer Venture established during August 1987.

The original monitoring program, which was initiated in May 1984 by GeoScience, Inc., employed a bimonthly sampling frequency as required for the first year of monitoring. Subsequently, the scope of the monitoring program for the following two-year period was revised during an agency review meeting in June 1985. This meeting involved the developer's representative, Mr. T. W. Goodell, and Mr. Russ Klier of Sarasota County Pollution Control Division (personal communication with Mr. T. W. Goodell). The revised work scope entailed a 13-station network with a quarterly sampling frequency for the parameters monitored during the first year, except trace elements and organochlorine pesticides that would receive annual audits (refer to July 28, 1986 correspondence of Mr. T. W. Goodell to Mr. Russ Klier).

Palmer Ranch Holdings, Ltd. (f.k.a. Palmer Venture and Palmer Ranch Development, Ltd.) contracted Vanasse Hangen Brustlin, Inc. (f.k.a. CCI Environmental Services, Inc. and Conservation Consultants, Inc.) to implement the "Continuing Surface Water Quality Monitoring Program" during the second year of the monitoring program. Vanasse Hangen Brustlin, Inc. (VHB) began monitoring on September 16, 1985, pursuant to the instructions provided by Palmer Ranch Holdings, Ltd. Except for an annual sampling event conducted in September 1988, the "Continuing Surface Water Quality Monitoring Program" was suspended in June 1988, due to the initiation of the "Pollutant Loading Monitoring Program". The Stormwater Pollutant Loading



Date: 1/08

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Figure 1.1
General Site Location
Palmer Ranch
Sarasota County, Florida

Vanasse Hangen Brustlin, Inc.
8043 Cooper Creek Blvd.
Suite 201
University Park, Florida 34201

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Monitoring Program was performed between June 1988 and December 1989 and a report submitted to Sarasota County on May 29, 1992. Subsequent to an agreement between the Sarasota County Pollution Control Division and Palmer Ranch Holdings, Ltd., the "Continuing Surface Water Quality Monitoring Program" was resumed in December 1989 with a single annual sampling event conducted during the fifth monitoring year. After resumption of monitoring in December 1989, the surface water quality monitoring was performed quarterly at all stations until December 10, 1991.

With adoption of Exhibit "E" to the Amended and Restated Master Development Order for the Palmer Ranch Development of Regional Impact (**Appendix A**), a revised water quality monitoring program was implemented in 1992. This revised monitoring program consisted of quarterly water quality measurements and grab sample collection in Catfish Creek, North Creek and South Creek at a total of 10 monitoring stations. In accordance with Exhibit "E", monitoring in the South Creek Basin was suspended until one month before any development activity occurring in the basin. Upon intent to reinitiate monitoring of the South Creek Basin, Sarasota County Pollution Control Division was notified of dates of sampling and stations to be sampled. Monitoring of the South Creek Basin was reinitiated with the first quarterly sampling occurring on January 13, 1994. As specified in Exhibit "E", this pre-development monitoring event included water quality grab sampling and in situ measurements at four (4) monitoring stations along South Creek. Following this initial monitoring event, all subsequent monitoring shall be performed quarterly during the development phase. During development, all stations located downstream of an area under development shall be monitored. Additionally, one sampling site located upstream of a development area shall also be monitored to determine baseline water quality conditions. Once an area is substantially developed as agreed to by the Sarasota County Pollution Control Division and Palmer Ranch Development, Ltd., a modification of the monitoring program shall be subject to discussion for change in water quality monitoring frequency from quarterly to semi-annually or to be discontinued.

Under the amended and approved monitoring plan as stated in Exhibit "E", monitoring of Catfish Creek and North Creek was to continue quarterly for a maximum of two years or until substantial development occurs. On April 29, 1994, Mr. Kent Kimes of the Sarasota County Pollution Control Division approved a reduction in sampling frequency for the Catfish Creek and North Creek monitoring stations from quarterly to semi-annually.

The water quality conditions recorded during sampling events conducted during the period from January through December 2010 in the Catfish Creek, North Creek and South Creek basins are reported herein. This report includes a discussion of the results with respect to applicable water quality criteria, observed spatial and temporal trends, and comparisons with results obtained during previous monitoring events.

2

General Environmental Setting

2.1 Climate

Prevailing climatic conditions in west central Florida are subtropical, characterized by abundant rainfall and moderate temperatures. Average monthly temperatures derived from two separate 30-year periods of record are provided in **Table 2.1** below:

Table 2.1 Average Monthly Air Temperatures (National Weather Service, Tampa, Florida)

Month	Air Temperature			
	1941-1970[a]		1931-1960[b]	
	°C	°F	°C	°F
January	16.4	61.6	16.9	62.4
February	17.2	62.9	17.7	63.8
March	19.4	66.9	19.4	67.0
April	22.3	72.1	22.1	71.8
May	24.8	76.7	24.9	76.8
June	26.8	80.3	26.9	80.4
July	27.6	81.6	27.6	81.6
August	27.7	81.9	27.8	82.0
September	26.9	80.5	27.0	80.6
October	23.9	75.0	23.9	75.1
November	19.8	67.7	19.9	67.9
December	17.1	62.8	17.4	63.4
Annual Average	22.5	72.5	22.6	72.7

[a]Thompson, 1976
[b]Bradley, 1974

Based on a 30-year period of record, rainfall in Bradenton, Florida (NOAA, 1977) averages 56 inches per year. The minimum annual rainfall recorded during the 30-year period was 29 inches while the maximum was 93 inches. Historical rainfall trends for this area show that a wet season occurs during the period of June through September followed by a dry season during the period of October through January. On average, 62 percent (35 inches) of the annual rainfall occurs during the summer

with only 13 percent (7 inches) during the fall. The dry season is followed by a short wet period during February and March and subsequently a short dry period during April and May.

2.2 Soils

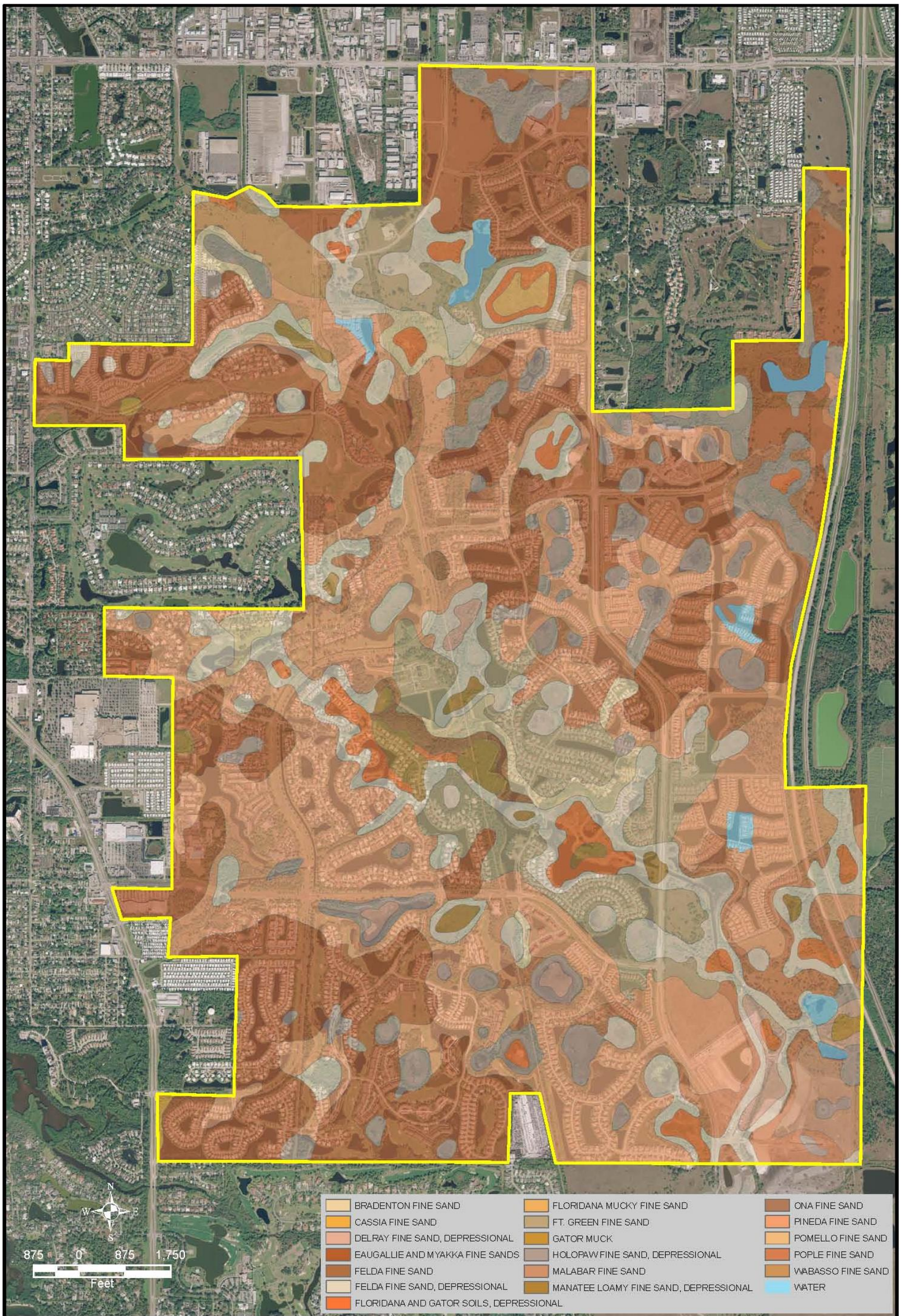
Soils of the Palmer Ranch are generally sandy except in areas of low relief and poor drainage where peaty mucks are common (Florida Division of State Planning, 1975). Upland soils of Palmer Ranch are predominately of the Myakka-Immokalee-Basinger Association. This soil association is defined as nearly level with poorly drained sandy soils (Florida Division of State Planning, 1975).

Along the well-incised banks of several drainage ditches traversing the Palmer Ranch (e.g., lower reach of Catfish Creek), it is evident that a natural marine deposit exists a few feet below the ground surface. This marine deposit contains a thin layer of shells and shell fragments. **Figure 2.1** and **Table 2.2** provide the locations and descriptions of the soil types that occur in the Palmer Ranch.

2.3 Land Use and Vegetation

Historically, the primary land use within the Palmer Ranch has been cattle ranching. However, changes in land uses on the Palmer Ranch have included the following: construction of surface water management systems; construction of roads, golf courses, homes, wastewater treatment facilities and associated domestic wastewater spray effluent fields, and land disposal of sludge. During the second monitoring year (April 1985 - March 1986), the land application of sludge wastes on the Palmer Ranch was discontinued and construction of the Central County Utilities Regional Treatment Plant and an adjacent golf course was completed. Subsequently, construction of a residential development was initiated during the third monitoring year.

Land uses located upstream of the ranch include golf courses, roads and highways, residential developments, a mobile home park, commercial businesses, a dairy farm that was changed to a sod farm (effective August 1, 1987), light industry, and a metal salvage operation. The primary vegetation associations found on the undeveloped areas of the ranch include pine flatwoods, improved and semi-improved pastures, wet prairies, marshes and sloughs, swamps, and mesic hammocks.



Date: 1/08

Revised:

Figure 2.1
Soils
Palmer Ranch
Sarasota County, Florida

Vanasse Hangen Brustlin, Inc.
8043 Cooper Creek Blvd.
Suite 201
University Park, Florida 34201

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Table 2.2 Descriptions of Soil Types

Definition	Map Unit No.	Soil Type Description
Areas dominated by moderately well to poorly drained soils not subject to inundation.	4	Bradenton fine sand: Nearly level, poorly drained soils on low ridges and hammocks adjacent to floodplains, sloughs and depressions.
	7	Cassia fine sand: Nearly level, somewhat poorly drained soils on low ridges that are slightly higher than the adjacent flatwoods and on shoulder slopes adjacent to drainageways.
	10	EauGallie and Myakka fine sands: Nearly level, poorly drained soils on broad flatwoods.
	11	Felda fine sand: Nearly level, poorly drained soil in sloughs and in poorly drained drainagways.
	21	Ft. Green fine sand: Deep, nearly level, poorly drained soil on broad flatwoods.
	25	Malabar fine sand: Nearly level, poorly drained soil in low, narrow to broad sloughs and poorly drained drainageways and on flats.
	30	Ona fine sand: Nearly level, poorly drained soils on broad flatwoods.
	31	Pineda fine sand: Nearly level, poorly drained soil on low hammocks and in broad poorly defined sloughs.
	33	Pomello fine sand: Nearly level, moderately well drained soil on low ridges and knolls on flatwoods.
	36	Nearly level, poorly drained soil on low hammocks and in poorly defined drainageways and broad sloughs.
	41	Wabasso fine sand: Nearly level, poorly drained soil on broad flatwoods.

Table 2.2 Descriptions of Soil Types

Definition	Map Unit No.	Soil Type Description
Areas dominated by very poorly drained soils subject to inundation.	8	Delray fine sand, depressional: Nearly level, very poorly drained soil in depressions on flatwoods. Slopes are concave and are less than 2 percent.
	12	Felda fine sand, depressional: Nearly level, very poorly drained soil in depressions. Slopes are concave and are less than 2 percent.
	15	Floridana and Gator soils, depressional: Very poorly drained, nearly level soils in depressions. They are subject to ponding. Slopes are dominantly concave and are less than 2 percent.
	14	Floridana mucky fine sand: Nearly level, very poorly drained soil in poorly defined drainageways on broad, low flats. Slopes are smooth or concave and range from 0 to 2 percent.
	17	Gator muck: Nearly level, very poorly drained soil in freshwater swamps and marshes. Slopes are smooth and are less than 1 percent.
	22	Holopaw fine sand ,depressional: Nearly level, very poorly drained soil in depressions. Slopes are concave and less than 2 percent.
	26	Manatee loamy fine sand, depressional: Nearly level, very poorly drained soils in depressions. Slopes are concave and are less than 1 percent.

2.4 Drainage

The Palmer Ranch DRI is divided into six primary drainage basins that ultimately discharge into Little Sarasota Bay and Drymond Bay. Two basins, the Catfish Creek/ Trunk Ditch Basin and the South Creek Basin, drain most of the North Tract. Approximately 2,590 acres of the Catfish Creek-Trunk Ditch Basin, that has a total drainage area of 3,700 acres, and approximately 1,770 acres of the South Creek Basin, that has a total drainage area of approximately 12,000 acres, are located on the North Tract. Four minor basins also drain portions of the property. These include Matheny Creek Basin (40 acres), Elligraw Bayou Basin (180 acres), North Creek Basin (460 acres), and Clower Creek Basin (80 acres). A general description of the major streams in these basins is provided in the following sections.

2.4.1 Catfish Creek

Catfish Creek within the limits of the Palmer Ranch DRI was a man-made ditch/ channel system that flowed southwest to the southern boundary of the property, intersecting Trunk Ditch, a straight man-made canal, at five locations. The upper portion of Catfish Creek receives off-site drainage from commercial and industrial areas near Clark Road. Many of these commercial and industrial areas lack stormwater management systems. The lower portion of the Catfish Creek drainage system receives stormwater runoff from various stormwater management systems located throughout the Palmer Ranch residential development.

Immediately downstream of the Palmer Ranch, the Catfish Creek drainage system receives drainage at times and "overflow" from the wastewater treatment ponds associated with a mobile home park. Farther downstream, drainage from residential areas and runoff from U.S. Highway 41 enter the creek. Beyond U.S. Highway 41, Catfish Creek is affected by tidal changes from Little Sarasota Bay.

2.4.2 Trunk Ditch

Trunk Ditch was originally constructed to improve drainage. Initially, it extended from the northern boundary of the Palmer Ranch property to North Creek and resulted in scouring velocities during major storm events. These high velocities resulted in out-of-bank flooding and sediment transport. During early 1986, a segment of Trunk Ditch was reconstructed in association with the Development of Prestancia. This reconstruction resulted in an improved channel and the placement of two water level control weirs. Because of these two weirs, lentic conditions occur during the dry season. Vegetation in Trunk Ditch is dominated by hydrilla, water-weed, and other aquatic weeds. As mentioned earlier, Catfish Creek intersects Trunk Ditch at five locations.

Runoff entering the upper reaches of Trunk Ditch originates along Clark Road, including the adjacent commercial and industrial areas. Downstream, runoff enters Trunk Ditch from Prestancia's golf course and residential development, the Country Club of Sarasota and associated residential area, as well as pine flatwoods, improved pastures, and wetlands of the Palmer Ranch. Subsequently, three (3) additional weirs were added in the reconstructed portion of the Trunk Ditch during 1988 to 1991. Also, a drainage-basin divide between Catfish Creek and North Creek was created at that time with the construction of Central Sarasota Parkway.

2.4.3 North Creek

North Creek is connected to Trunk Ditch by a dredged tributary located near the southern boundary of the North Tract. The banks of this tributary are vegetated with grasses and trees resulting in a partially overhanging canopy. Most of the drainage into this dredged tributary originates from residential development, roadways, a marsh/ slough system, and an off-site metal salvage operation. Downstream of the North Tract, Trunk Ditch enters the main channel of North Creek, which subsequently flows into Little Sarasota Bay. Residential areas, U. S. Highway 41, and pine flatwoods drain into the downstream reach of North Creek.

2.4.4 South Creek

South Creek within the Palmer Ranch is largely a shallow ditch system constructed through historic, broad sloughs or interconnecting previously isolated marshes. The banks of South Creek are vegetated with grasses and occasional pines, while its channel is generally void of aquatic vegetation. Portions of the creek and associated wetlands have been restored in association with adjacent development. Upstream of the Palmer Ranch, South Creek receives drainage in its western tributary from a golf course and a mobile home park. At its eastern boundary, it receives drainage from agricultural and recreational land uses, as well as Interstate I-75. Before mid-1987, much of the area upstream of I-75 was used as a dairy farm.

Within the Palmer Ranch, South Creek receives drainage primarily from improved pastures, pine flatwoods and residential developments. Downstream of the Ranch, South Creek flows through Oscar Scherer State Park and subsequently into the tidal waters of Drymond Bay.

2.4.5 Elligraw Bayou

Elligraw Bayou is a channelized stream that flows southwesterly to Little Sarasota Bay. The banks of Elligraw Bayou are sloped and vegetated with grasses and trees. On the Ranch, Elligraw Bayou receives drainage from Increment II development areas and Prestancia (Increment I). Downstream of the Palmer Ranch, Elligraw Bayou flows through Ballantrae and several other residential areas before entering Little Sarasota Bay.

2.4.6 Matheny Creek

Matheny Creek is a channelized stream that originates in the marshes and sloughs northwest of the Palmer Ranch. It flows southwest and eventually discharges into Little Sarasota Bay. The banks of Matheny Creek are steep and vegetated with grasses and some trees. Drainage enters Matheny Creek from residential developments, commercial and industrial areas, and golf courses.

2.4.7 Clower Creek

Clower Creek forms the south border of the 70-acre Sarasota Square Mall. A 1.6 acre wet prairie located east of the mall on the Palmer Ranch most likely represents the headwaters of Clower Creek during the wet season. Drainage conveyed by Clower Creek flows westerly for 1,350 ft, and subsequently, through an underground pipeline along the north and west borders of a trailer park adjacent to the Sarasota Square Mall. After flowing underground for about 650 ft, drainage enters the mall's stormwater management system. Subsequently, discharge from the mall's stormwater management system drains through swales into culverts and underneath U.S. 41 to Little Sarasota Bay.

2.5 Water Quality Classification

The segments of the streams traversing the Palmer Ranch are non-tidal freshwater systems designated by the State as Class III waters pursuant to Subsection 62-302.400(1) of the Florida Administrative Code (FAC). Downstream, these streams flow into an estuarine system (Little Sarasota and Drymond Bays) which is classified as an Outstanding Florida Waters (OFW). In addition, the segment of South Creek that flows through Oscar Scherer State Park is classified as an OFW. State and Sarasota County water quality standards applicable to the "Continuing Water Quality Monitoring Program" (i.e., those applicable to Class III, predominantly fresh surface waters) are listed in **Table 2.3**.

Table 2.3 Applicable State and County Water Quality Criteria for Class III, Predominately Fresh Waters

Parameter	Water Quality Standard[a]
Arsenic	Not >50 µg/L
Biochemical Oxygen Demand	Not to be increased in a manner that would depress Dissolved Oxygen levels below criteria.
Fecal Coliform Bacteria	Not >800/100 Ml
Total Coliform Bacteria	Not >2,400/100 mL
Specific Conductance	Shall not be increased more than 50% above background or to 1,275 µmhos/cm, whichever is greater, in predominantly fresh waters.
Copper	Not >12.8 µg/L at a Total Hardness of 110 mg/L
Dissolved Oxygen	Not <5 mg/L
Lead	Not >3.6 µg/L at a Total Hardness of 110 mg/L
Nutrients	Concentrations in a body of water shall not be altered in such a manner as to cause an imbalance in natural populations of aquatic flora or fauna.
Ammonia Nitrogen (ionic plus non-ionic)	See Nutrients
Nitrite Nitrogen	See Nutrients
Nitrate Nitrogen	See Nutrients
Total Nitrogen	See Nutrients
Organic Nitrogen	See Nutrients
Oil and Greases	Not >5 mg/L
Orthophosphate	See Nutrients
Total Phosphorus	See Nutrients
pH	6.0 – 8.5
Turbidity	Not >29 NTU above background
Zinc	Not >115 µg/L at a Total Hardness of 110 mg/L

[a]State surface water quality criteria as listed in Chapter 62-302, Florida Administrative Code, and Sarasota County Ordinance No. 98-066.

3

Field and Laboratory Procedures

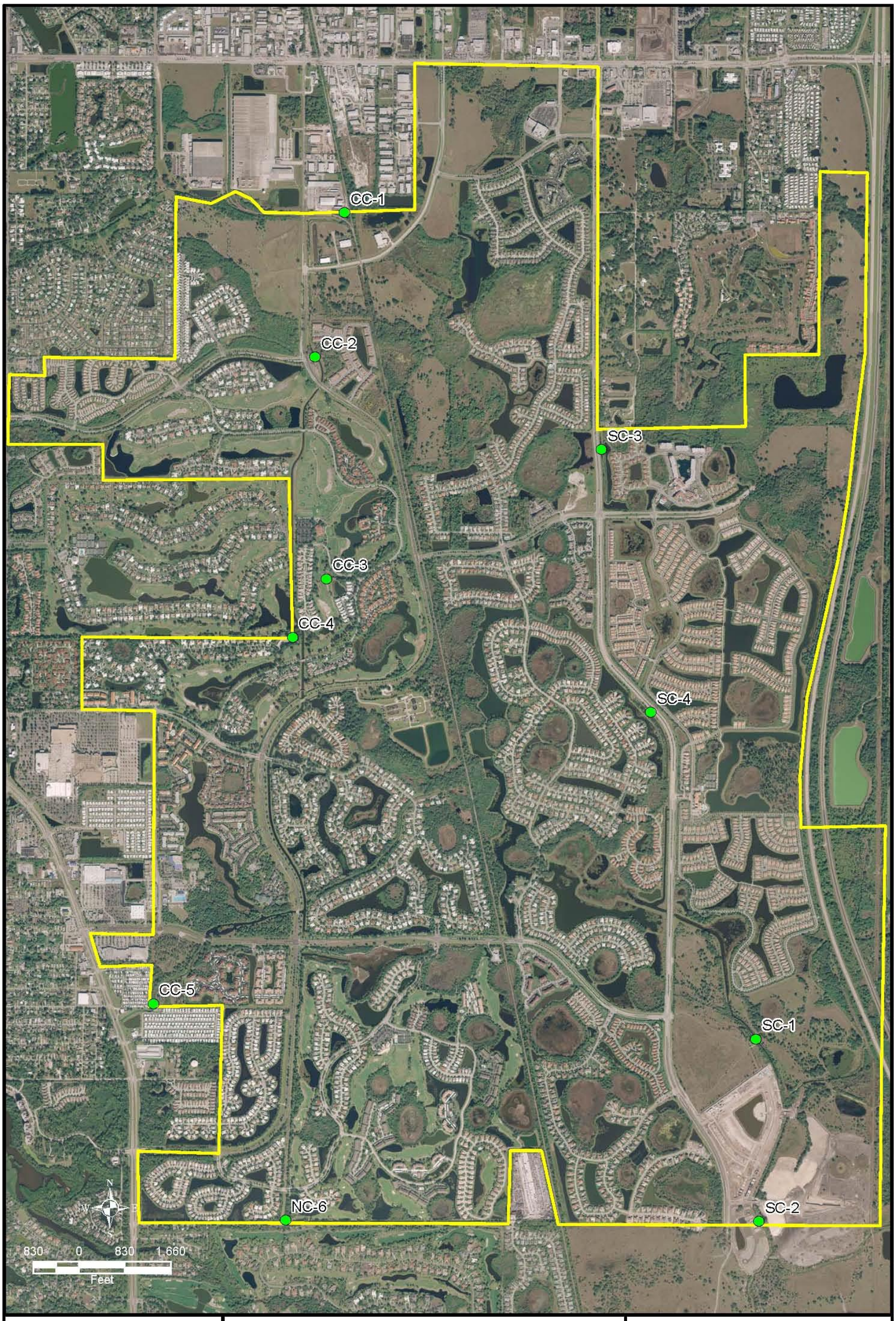
3.1 Station Locations and General Descriptions

The "Continuing Surface Water Quality Monitoring Program" employs a network of 10 sampling stations located at various sites along South Creek, Catfish Creek, North Creek, and Trunk Ditch (**Figure 3.1**). A general description of the characteristics of the 10 sampling stations is provided in **Table 3.1**.

In Catfish Creek, inflow into the Palmer Ranch was monitored at Station CC-1 while outflow was monitored at Station CC-5. Station CC-1 receives drainage from Clark Road, McIntosh Road, and various commercial/ industrial developments. Two tributaries of Catfish Creek were also monitored near their confluences with Trunk Ditch (Stations CC-2 and CC-3). These two stations represent stream segments that receive drainage from Prestancia and backwater effects of Trunk Ditch.

Trunk Ditch was monitored within its realigned segment within the Catfish Creek-Trunk Ditch Drainage Basin at Station CC-4. This site lays adjacent to and receives drainage from both the Country Club of Sarasota and Prestancia and sources farther upstream, as well as residential areas, pine flatwoods, improved pastures, and wetlands of the Palmer Ranch. Farther to the south, Trunk Ditch was monitored at a location within the North Creek Basin, i.e., Station NC-6.

South Creek was monitored at four (4) locations. These include one point of outflow (SC-2) and one point of inflow (SC-3), as well as in the interior of the North Tract at Stations SC-4 and SC-1. Station SC-3 is upstream of any development in the South Creek Basin. During some previous monitoring years, only Stations SC-1, SC-2, and SC-4 were monitored because no construction extended beyond Station SC-4. Sampling at Station SC-3 was reinitiated in October 1996 when construction activity moved upstream of Station SC-4.



Date: 1/08

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Figure 3.1
Surface Water Monitoring Locations
Palmer Ranch
Sarasota County, Florida

Vanasse Hangen Brustlin, Inc.
8043 Cooper Creek Blvd.
Suite 201
University Park, Florida 34201

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Table 3.1 General Descriptive Characteristics of Surface Water Quality Sampling Stations

Station	General Location	Water Depth[a] (ft)	Channel Width (ft)	Habitat
CC-1	Catfish Creek Site Entry	1.0-1.6	10	75-100% Canopy of Salix, Rooted Emergents, Incised Banks.
CC-2	Catfish Creek Upstream of Trunk Ditch	0.0-0.45	12	Aquatic Vegetation, Shallow Sloped Banks.
CC-3	Catfish Creek Upstream of Trunk Ditch	0.3-0.6	6	Aquatic Vegetation, Incised Banks.
CC-4[b]	Trunk Ditch Downstream of Catfish Creek Confluence	0.6-2.2	50	Sodded Banks, Rooted Emergents.
CC-5	Catfish Creek Outfall from Site	0.3-0.8	50	Shading in by Oaks, Willows, and Wax Myrtle, Sodded Banks.
NC-6	Trunk Ditch Downstream of Catfish Creek	1.7-2.7	12	Aquatic Vegetation.
SC-1	South Creek Mid-property	0.6-0.7	12	Sand covered with Organic Matter.
SC-2	South Creek at Site Exit	0.5-1.2	17	Rooted Emergents, Floating Aquatics, Palm Trees Shade Channel in A.M.
SC-3	South Creek Outfall from Large Wetland	0.0-0.7	10	Shallow banks, Aquatic Vegetation.
SC-4	South Creek near Honore Avenue	0.7-1.2	8	Rooted Emergents Cover 33% of Channel, Canopy of Pine.

[a]Range in depth recorded during monitoring period of April 1987 - March 1988.
[b]Depths reported are depths at sampling location - total depth at site averages 8.0 ft.

3.2 Parameters and Sampling Frequency

Semi-annual sampling of Catfish and North Creeks was performed during March and September 2010, and quarterly sampling was performed during January, April, July, and October 2010 in South Creek. The analysis of the annual parameters was performed for samples collected during the wet season events (i.e. September and October 2010). The dates and times of all sample collections are provided in **Table 3.2**. Weather conditions at the time of monitoring are provided in **Table 3.3**.

Table 3.2 Date and Time of Sampling for the 26th Annual Monitoring Period of January through December 2010

West Side

Event No.	Date of Sampling	Monitoring Stations					
		CC-1	CC-2	CC-3	CC-4	CC-5	NC-6
1	March 19, 2010	1430	1348	1222	1258	1146	1104
2	September 29, 2010	1432	1327	1155	1138	1058	1024

East Side

Event No.	Date of Sampling	Monitoring Stations			
		SC-1	SC-2	SC-3	SC-4
1	January 27, 2010	1217	1134	1259	1241
2	April 29, 2010	1118	1038	1310	1232
3	July 20, 2010	1137	1104	1239	1213
4	October 26, 2010	1052	1035	1115	1005

Table 3.3 Weather Conditions Observed during Sampling for the 26th Annual Monitoring Period of January through December 2010

Date	Air Temperature (F)	Cloud Cover (%)	Wind Speed	Wind Direction	Rain
January 27, 2010	65-70	0-10	5-10	NE	No
March 19, 2010	65-70	10-20	10-15	W	No
April 29, 2010	75-80	10-20	5-10	E	No
July 20, 2010	85-90	40-50	15-20	SE	No
September 29, 2010	80-85	70-80	10-15	NW	No
October 26, 2010	85-90	30-40	0-5	E	No

Surface water quality monitoring from January through December 2010 was performed by (1) the use of field instrumentation and in situ measurements; and (2) the collection of grab samples for subsequent laboratory analyses. A digital readout YSI multi-parameter water quality meter (YSI) was used for *in situ* measurements of dissolved oxygen, pH, specific conductance, and water temperature. Prior to deployment in the field, all instrumentation was calibrated according to the manufacturer's recommended procedures. All *in situ* measurements were taken at approximate midstream and mid-depth at each station. Grab samples were collected at each station during the six monitoring events, preserved, and analyzed in the laboratory within the recommended hold times for the following parameters:

Ammonia Nitrogen	Oil and Grease
Nitrate Nitrogen	Total Suspended Solids
Nitrite Nitrogen	Turbidity
Organic Nitrogen	Biochemical Oxygen Demand
Total Nitrogen	Fecal Coliform Bacteria
Orthophosphate	Total Coliform Bacteria
Total Phosphorus	

Additional surface water grab samples were collected at each of the ten monitoring stations during the September and October 2010 monitoring events for the laboratory analysis of the following parameters:

Arsenic	Copper
Lead	Zinc

All sampling was performed in accordance with the Florida Department of Environmental Protection Standard Operating Procedures. Laboratory analyses were performed in accordance with the procedures described in the 18th edition of Standard Methods for the Examination of Water and Wastewater (APHA, 1992), Methods for Chemical Analysis of Water and Wastes (USEPA, 1983) or other FDEP/ USEPA approved methodology. The methods used in the collection, preservation, handling, storage, and analysis of all surface water samples are provided by parameter in **Table 3.4**.

Laboratory analyses were performed by Benchmark EnviroAnalytical Inc's. laboratory which is certified for the analyses of environmental and drinking water samples.

Two additional parameters, stream flow and stream depth, were monitored at each sampling point concurrent with water quality monitoring as an aid in evaluating the water quality data although not formally part of the "Continuing Surface Water Quality Monitoring Program." Water velocity was determined using a Sontek Flowtracker. Stream flows were subsequently determined in accordance with the USGS two-point (i.e., area/ velocity) method (USGS, 1982). Stream depth was measured using with the YSI at each point of water quality sampling.

Table 3.4 Collection and Analytical Methods Used during the Surface Water Quality Monitoring Events

Parameter	Sample Type	Field Handling	Hold Time	Laboratory Handling	Analytical Method	Method Reference
Fecal Coliform Bacteria	Grab	Stored on Ice	30 Hours	Immediate Analysis	Multiple Tube Fermentation	APHA 9222 D
Total Coliform Bacteria	Grab	Stored on Ice	30 Hours	Immediate Analysis	Multiple Tube Fermentation	APHA 9222 B
Biochemical Oxygen Demand (BOD-5 Day)	Grab	Stored on Ice	48 Hours	Immediate Analysis	Membrane Electrode	APHA 5210 B
Conductivity	*In situ*	----	----	----	YSI Sonde	APHA 2510 B
Total Arsenic	Grab	HNO_3 to pH <2, Stored on Ice	6 Months	Stored at Room Temperature	Digestion, Atomic Absorption	APHA 3113 B
Total Copper	Grab	HNO_3 to pH <2, Stored on Ice	6 Months	Stored at Room Temperature	Digestion, Atomic Absorption	APHA 3113 B
Total Lead	Grab	HNO_3 to pH <2, Stored on Ice	6 Months	Stored at Room Temperature	Digestion, Atomic Absorption	APHA 3113 B
Ammonia Nitrogen	Grab	$H2SO_4$ to pH <2, Stored on Ice	28 Days	Stored at 4 °C	Automated Phenate	APHA 4500-NH3C
Nitrate + Nitrite Nitrogen	Grab	$H2SO_4$ to pH <2,	28 Days	Stored at 4 °C Stored on Ice	Automated Cadmium Reduction	EPA 353.2
Nitrite Nitrogen	Grab	Stored on Ice	48 Hours	Stored at °C	Automated Autoanalyzer	APHA 4500-NO2B
Nitrate Nitrogen	Grab	----	----	----	Calculation	EPA 353.2
Total Kjeldahl Nitrogen	Grab	$H2SO_4$ to pH <2, Stored on Ice	28 Days	Stored at 4 °C	Automated Block Digestion, Autoanalyzer	EPA 351.2
Total Nitrogen	Grab	----	----	----	Calculation	EPA 353+351

Table 3.4 Collection and Analytical Methods Used during the Surface Water Quality Monitoring Events (Continued)

Parameter	Sample Type	Field Handling	Hold Time	Laboratory Handling	Analytical Method	Method Reference
Oil and Grease	Grab	$H2SO_4$ to pH <2,	28 Days	Stored at 4 °C Stored on Ice	Gravimetric	EPA 1664 A
Dissolved Oxygen	*In situ*	----	----	----	YSI Sonde Membrane Electrode	APHA 4500 G
pH	*In situ*	----	----	----	YSI Sonde Electromagnetic	APHA 4500-H+
Orthophosphate	Grab	Stored on Ice	48 Hours	Immediate Analysis	Automated, Ascorbic Acid	EPA 365.3
Total Phosphorus	Grab	$H2SO_4$ to pH <2, Stored on Ice	28 Days	Stored at 4 °C	Automated Block Digestion, Autoanalyzer	EPA 365.3
Total Suspended Solids (TSS)	Grab	Stored on Ice	7 Days	Stored at 4 °C	Glass Fiber Filtration, Dried at 105 °C	APHA 2540 D
Temperature	*In situ*	----	----	----	YSI Sonde Thermistor	APHA 2550 B
Turbidity	Grab	Stored on Ice	48 Hours	Stored at 4 °C	Nephelometric	EPA 180.1
Total Zinc	Grab	HNO_3 to pH <2, Stored on Ice	6 Months	Stored at Room Temperature	Digestion, Atomic Absorption	EPA 200.7
Flow/Direction	*In situ*	----	----	----	Sontek Flowtracker	Manufacturer's Specifications

APHA - American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association.

EPA - U.S. Environmental Protection Agency, 1983. Methods for Chemical Analysis of Water and Wastes, EPA - 600/4-79-020, National Environmental Research Center, Cincinnati, Ohio.

4

Results and Discussion

During the 26th year of the "Continuing Surface Water Quality Monitoring Program" (i.e., January through December 2010), six surface water quality monitoring events were conducted by VHB. Sampling of Catfish and North Creeks was conducted on March 19 and September 29, 2010 and sampling of South Creek was conducted on January 27, April 29, July 20, and October 26, 2010. All monitoring was conducted in compliance with the conditions of the Amended and Restated Master Development Order for the Palmer Ranch Development of Regional Impact (Appendix A).

Individual results for the six events performed during the 2010 monitoring year for the "Continuing Surface Water Quality Monitoring Program" are tabulated by parameter in Appendix B and C for the Catfish Creek/ North Creek and South Creek sites, respectively. For each parameter, statistics (i.e., mean, minimum, maximum, standard deviation, and number of observations) are calculated across sampling events and sampling locations. Also, any violation of applicable water quality criteria are noted on each table.

Copies of the data tables for the samples collected during the 2010 monitoring year are provided in Appendix D. Comparison of the data with previous results and general conclusions are included with the discussion for each parameter or group of related parameters.

4.1 Rainfall and Hydrology

4.1.1 Rainfall

Rainfall data for telemetry sites near the Palmer Ranch (Oscar Scherer State Park, Laurel Park, and Osprey Stations) were not used because evaluation of data revealed numerous inconsistencies, and rainfall data collection for Oscar Scherer State Park was discontinued by the Southwest Florida Water Management District (SWFWMD). Consequently, determining antecedent rainfall accumulations during the 2-day, 2-week and 2-month periods prior to sampling were not possible. The Manasota Region Average Rainfall reported by SWFWMD is used to summarize hydrologic conditions for the water quality monitoring period. The annual rainfall amount recorded for the Manasota Region during the 26th year of the "Continuing Surface Water Quality Monitoring Program" is slightly lower than the historic average

annual rainfall of approximately 53.6 inches (based on a 30-year period of record, NOAA, 1982). Approximately 50.0 inches of precipitation were recorded during the period from October 1, 2009 through September 30, 2010 (**Table 4.1**) in comparison to a range of 24 to 74 inches recorded during the period of record. On Palmer Ranch, totals of 38 to 65 inches were recorded during previous monitoring years (CCI, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995, 1996, 1997, 1998 and 1999).

Table 4.1 Comparison of Manasota Regional Average Monthly Rainfall for for the Period of October 2009 through September 2010 with Manasota Regional Average Historical Rainfall

Date	Monthly Rainfall (Inches)	Historical Rainfall (Inches)	Percent of Historic
October 2009	1.06	3.23	33%
November 2009	2.25	1.91	118%
December 2009	4.33	2.09	207%
January 2010	2.77	2.44	114%
February 2010	2.20	2.77	79%
March 2010	6.33	3.07	206%
April 2010	2.41	2.44	99%
May 2010	1.79	3.09	58%
June 2010	5.83	7.47	78%
July 2010	6.10	8.45	72%
August 2010	11.04	8.79	126%
September 2010	3.90	7.82	50%
Water Year (October 2009 through September 2010)			
Annual Total	50.01	53.57	93%
Dry Season (October - May)	23.14	21.04	110%
Wet Season (June – September)	26.87	32.53	83%

Rainfall recorded during the 2010 monitoring year exhibited a typical seasonal trend for this region of Florida. **Figure 4.1** provides a comparison of the monthly distribution of rainfall measured for the period from October 2009 through September 2010 with the average monthly distribution of historic rainfall for the Manasota Region. Dry Season rainfall (October 2009 through May 2010) was 23.14 inches, or 10 percent above the historic average (Table 4.1). Wet Season rainfall (June 2010 through September 2010) was 26.87 inches, or 17 percent lower than the historic average. Consequently, the 2009-2010 monitoring period is generally considered a typical water year with normal rainfall during the dry season and wet season.

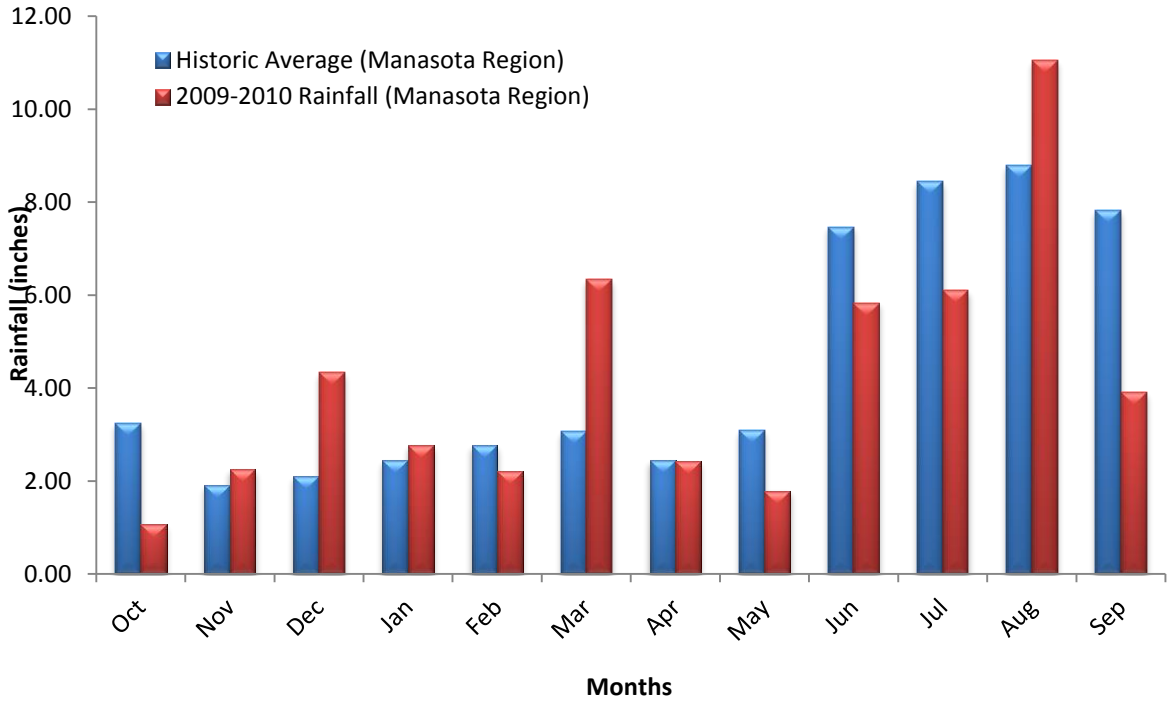


Figure 4.1 Historic Rainfall for the Period of Record and Average Rainfall for the Manasota Region for the Period October 2009 through September 2010

4.1.2 Stream Stage

West Side (Catfish and North Creeks)

Stream stages on the West Side of the Ranch during 2010 averaged 1.1 ft and ranged from 0.3 to 3.3 ft (**Appendix Table B-1**). Overall, stream stages measured during 2010 are slightly higher than those recorded last year (0.9 ft). Average stream stages in 2009 and 2010 for Catfish and North Creeks are slightly higher to those measured during 2004-2006 (0.3-0.9 ft) and comparable to measurements made from 2001-2003 (1.2-1.6 ft).

The deepest waters of the streams traversing the west side of the Palmer Ranch are located in Trunk Ditch. Here, depths of approximately 8 ft can be found near the center of its reconstructed segment that runs adjacent to the Country Club of Sarasota and Prestancia. Station CC-4, located downstream from the reconstructed segment of Trunk Ditch, exhibited an average depth of 0.8 ft, which is consistent with those recorded for previous years.

The lowest stream levels in Catfish Creek during the 2010 monitoring year were observed at Stations CC-4 and CC-5. Average stream stages in the dry season were expectedly lower than those in the wet season at 0.9 ft and 1.3 ft averages for the dry and wet season, respectively.

East Side (South Creek)

During the 2010 monitoring year, stream stages at the four monitoring stations in South Creek averaged 2.3 ft with a range from 1.1 to 3.6 ft (**Appendix Table C-1**). The average stream stages during 2010 were higher than those recorded for recent years, 2009 (1.6 ft), 2007 (1.5 ft), 2006 (1.7 ft), 2005 (1.4 ft), 2004 (1.4 ft), 2003 (1.1 ft), 2002 (0.8 ft), 2001 (1.3 ft), 2000 (0.6 ft), and 1999 (0.9 ft), and similar to those for 2008 (2.1).

Station SC-1 exhibited the greatest water depths (average 3.2 ft) when all sites were compared for the 2010 monitoring year. The shallowest stream stage was exhibited by Station SC-3, which averaged 1.9 ft deep for the four sampling events. Seasonally, the highest average water levels at the four South Creek monitoring stations were recorded during the April monitoring event. The lowest water level observed was during the October monitoring event at Station SC-2.

4.1.3 Stream Flow

West Side (Catfish and North Creeks)

Shown in Appendix **Table B-2**, stream flows measured during the 2010 monitoring year for all six monitoring stations in Catfish and North Creeks ranged from 0.0 to 4,398 gallons per minute (GPM) and averaged 746 GPM. During the 26th year of monitoring, stream flows in the Catfish Creek/ Trunk Ditch Basin ranged from 139 to 660 GPM in its upper reaches (CC-1 and CC-2), and from 0.0 to 530 GPM in its mid-reach (CC-3 and CC-4).

Seasonally, the highest stream flows during 2010 occurred during the March monitoring event with stream flows in Catfish Creek/ Trunk Ditch averaging 950 GPM. Higher stream flows typically coincide with the higher rainfall amounts (usually at the end of the wet season), however, March 2010 received rainfall amounts 106% higher than the historical average. The higher rainfall amounts reported for this period resulted in an elevated groundwater table and a higher percentage of runoff, both of which increased stream flow. No discernable flow was observed at Stations CC-3 or CC-4 during the dry season event (**Figure 4.2**). Station CC-5 demonstrated the highest flows averaging 2,998 GPM with a range of 1598 to 4,398 GPM.

During the 2010 monitoring year, positive stream flows (i.e., measurable flows) were recorded for 10 of the 12 measurements (i.e., 75%) taken. The percentage of positive flows measured during 2010 is higher than those reported for previous monitoring years. The high percentage of positive flows in these two basins can be attributed to improved basin geometry and hydraulic residence time in the watershed resulting in a more efficient drainage system.

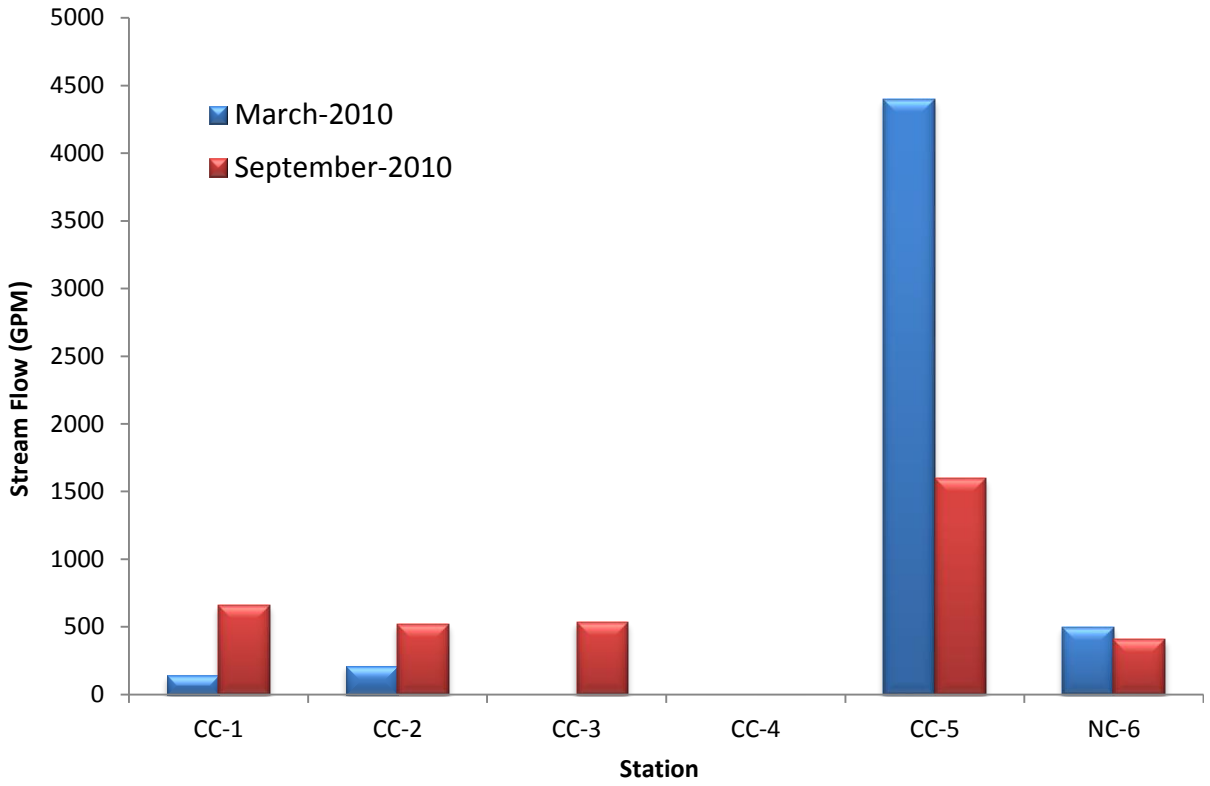


Figure 4.2 Stream Flows Measured during Monitoring Events Conducted on the West Side of the Palmer Ranch from January through December 2010

East Side (South Creek)

As evident in **Appendix Table C-2**, positive stream flows (i.e., measurable flows) were recorded for 6 of 16 measurements (i.e., 38 percent) taken during the 2010 monitoring year in the South Creek basin. The percentage of positive flows measured during 2010 is near the low end of the 25 to 100 percent range of positive flow measurements observed during most of the previous monitoring periods (CCI, 1992a, 1995, 1996, 1997, 1998, 1999 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). During 2010, stream flow in South Creek averaged 337 GPM and ranged from 0.0 to 1,858 GPM. The 2010 average was lower than those reported for many recent years, including 2006 (2,496 GPM), 2005 (1,552 GPM), 2003 (1,202 GPM), and 2001 (627 GPM), but comparable to those for 2002 (409 GPM), 1999 (279 GPM), 2008 (207 GPM), 2004 (125 GPM), and 2007 (124 GPM). Seasonally, the highest flows were observed during the January 2010 monitoring event when stream flows averaged 491 GPM (Appendix Table C-2).

Station SC-2, which is the furthest downstream, had a much higher average flow than the other stations (**Figure 4-3**). Spatially, stream flows followed expected trends with flows generally increasing in a downstream direction. No flow was observed in the upper reaches (i.e., Stations SC-3 and SC-4) during 2010, while the lower reach (SC-1 and SC-2) averaged 673 GPM for 2010.

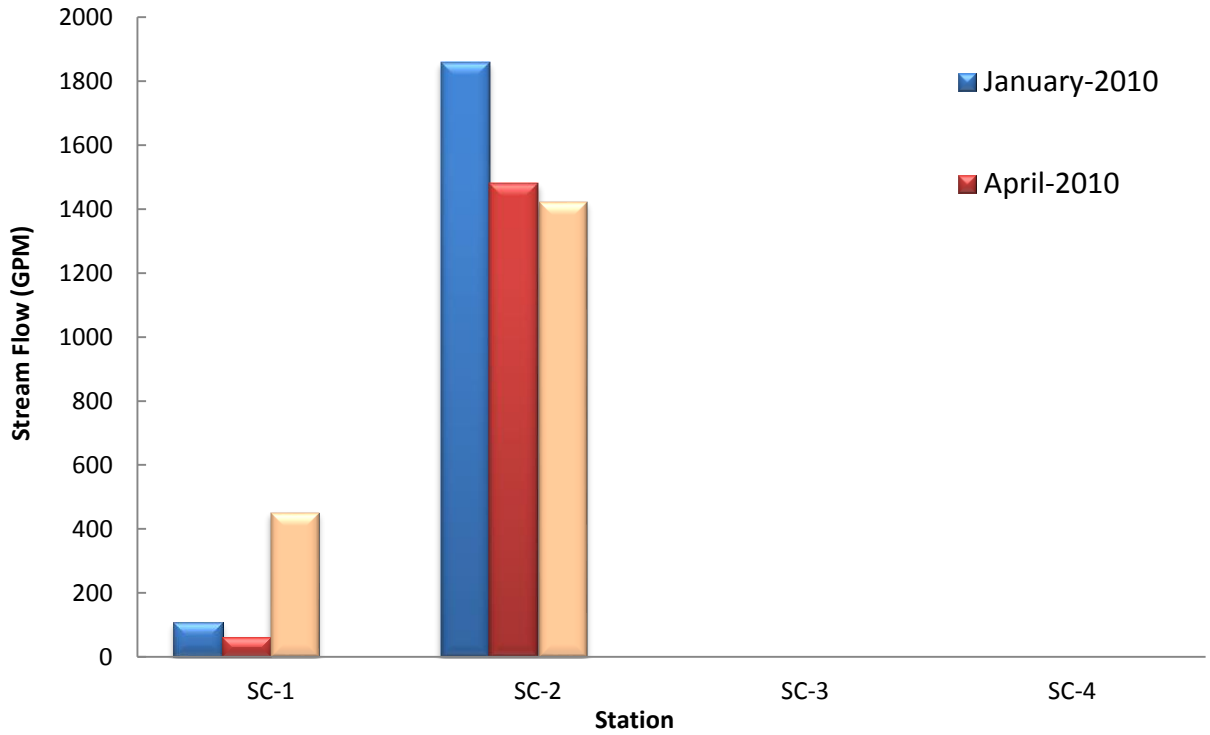


Figure 4.3 Stream Flows Measured during Monitoring Events Conducted on the East Side of the Palmer Ranch from January through December 2010

4.2 Physical Water Quality Parameters

4.2.1 Water Temperature

West Side (Catfish and North Creeks)

Water temperatures of the streams on the West Side of the Palmer Ranch averaged 23.3°C and ranged from 17.2 to 29.3°C during the two monitoring events (**Appendix Table B-3**). This range is similar to those recorded during previous years of monitoring (Palmer Venture, 1986; and CCI, 1986, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995, 1996, 1997, 1998, 1999 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010).

As expected, the lowest water temperatures were recorded in the streams on the west side during the March 2010 event with the highest water temperatures recorded during the September monitoring event. Water temperatures averaged 27.6°C during the September 2010 event, while an average temperature of 18.9°C was observed during the March event. Average temperatures for Catfish Creek and North Creek for each event are very similar with differences among the respective creeks generally being less than 3°C with 2 notable exceptions.

East Side (South Creek)

Water temperature in South Creek on the Palmer Ranch averaged 24.4 °C and ranged from 17.3 to 31.8 °C during the four monitoring events (**Appendix Table C-3**). The range in water temperatures for the four monitoring periods is similar to most previous monitoring reports (Palmer Venture, 1986; and CCI, 1986, 1988a, 1988b, 1991, 1992a, 1995, 1996, 1997, 1998, and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010).

As expected, the lowest water temperatures were recorded in the streams of the East Side during the winter quarterly event (January), with higher water temperatures recorded during the other monitoring events, although atypically low temperatures were observed during the October monitoring event. The highest average water temperature, averaging 30.6 °C, was recorded during the July 2010 (i.e., summer) monitoring event. Average water temperatures determined for each station in the South Creek basin generally exhibited temperature differences among stations of approximately 1°C or less, with 2 exceptions.

An evaluation of diurnal variations in water temperature in the Catfish Creek and South Creek Basins was performed during the 1985 dry season and the 1986 wet season. Results of the diurnal evaluation showed increases in water temperature to maximum levels by mid-afternoon followed by declines during the evening to minimal levels by early morning. The results of the diurnal study are provided in the report prepared by CCI (CCI, 1987).

4.2.2 Specific Conductance

West Side (Catfish and North Creeks)

Catfish Creek and North Creek exhibited an average specific conductance of 834 µmhos per centimeter (µmhos/ cm) with a range from 415 to 1,533 µmhos/ cm during 2010 (**Appendix Table B-4**). The average specific conductance was similar to those for the recent monitoring years 2006 (925 µmhos/ cm), 2005 (830 µmhos/ cm), 2004 (766 µmhos/ cm), 2003 (813 µmhos/ cm), 2001 (803 µmhos/ cm), and 2000 (852 µmhos/ cm), but 2002, 2007, 2008, and 2009 demonstrated higher specific conductance at 1,070, 1,023, 975, and 985 µmhos/ cm, respectively.

In a comparison of both streams within the west side of Palmer Ranch, the 2010 annual mean conductivities for North Creek and Catfish Creek Basins were 1,397 and

722 µmhos/ cm, respectively. Spatially, average conductivity levels in the mid reach of Catfish Creek Basin (885 µmhos/ cm) were higher than the levels in the upper reach (480 µmhos/ cm).

East Side (South Creek)

The specific conductance for South Creek averaged 972 µmhos/ cm and ranged from 492 to 1,669 µmhos/ cm during the 2010 monitoring events (**Appendix Table C-4**). The 2010 levels were similar to those recorded during the most recent sampling years, but at the lower end of the period of record (CCI, 1988b, 1991, 1992a, 1995, 1996, 1997, 1998, 1999 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). The higher conductivity measurements observed in October 2010 are likely the result of below average rainfall received during the month. Surface runoff of low conductivity storm water during a period of high rainfall usually translates to lower specific conductance of stream water.

Average conductivities measured in the South Creek Basin for the upper reaches (SC-3 and SC-4) and lower reaches (SC-1 and SC-2) during the 2010 monitoring period were 834 and 1,109 µmhos/ cm, respectively. This difference was relatively minor in magnitude and insignificant overall.

The State specific conductance criterion applicable to the streams of the Palmer Ranch allows an increase of not more than 50 percent above background levels or to a level of 1,275 µmhos/ cm, whichever is greater. One of the Catfish Creek and North Creek conductivity measurements (NC-6) exceeded this criterion during the September monitoring event. Two of the 16 South Creek basin conductivity measurements exceeded this criterion during 2010 during the October omintoring event.

4.2.3 Total Suspended Solids

West End (Catfish and North Creeks)

During the 2010 monitoring, Catfish Creek and North Creek in the Palmer Ranch exhibited a range of total suspended solids (TSS) from 1.20 to 40.2 mg/ L with an annual average of 13.1 mg/ L (**Appendix Table B-5**). Total suspended solid levels observed during 2010 are generally higher than the range of previous levels monitored during 2008 (7.8 mg/ L), 2007 (4.0 mg/ L), 2006 (3.85 mg/ L), 2005 (6.2 mg/ L), 2004 (13.6 mg/ L), 2003 (6.3 mg/ L), 2002 (1.5 mg/ L), 2001 (9.7 mg/ L), 2000 (8.4 mg/ L), 1999 (5.6 mg/ L), 1998 (6.5 mg/ L), and 1997 (3.3 mg/ L), and comparable to records from 2009 (15.3 mg/ L).

The highest TSS levels were recorded in the mid-reach of Catfish Creek where CC-3 averaged 30.1 mg/ L. The elevated TSS level probably resulted from higher organic matter content (i.e., aquatic plants) because of low water levels at this site and/ or from upstream contributions. The lowest TSS levels during 2010 were recorded in Catfish Creek Station CC-2 where TSS averaged 2.60 mg/ L.

East Side (South Creek)

During the 2010 monitoring year, stations along South Creek on the Palmer Ranch exhibited a range of total suspended solids from 2.20 to 59.5 mg/ L, with an annual average of 13.0 mg/ L (**Appendix Table C-5**). The average TSS level observed in 2010 is within the range for those recorded during the last nine years of monitoring.

The highest TSS level (59.5 mg/ L) was recorded in the lower reach of the creek at Station SC-1 during the October 2010 monitoring event. The lowest TSS level was recorded at Station SC-2 during April 2010. Overall, the lowest average TSS concentration was observed during the January event.

4.2.4 Turbidity

West Side (Catfish and North Creeks)

During the 2010 monitoring year, turbidity levels measured in Catfish Creek and North Creek ranged from 2.00 to 19.8 NTU and averaged 6.78 NTU (**Appendix Table B-6**). In comparison, a turbidity range of 0.3 to 44 NTU was exhibited since 1988 (CCI, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997, 1998 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010).

The lowest mean turbidity level (2.65 NTU) occurred at Station NC-6 in North Creek, and the highest mean level (16.1 NTU) occurred at Station CC-3. Seasonally, turbidity levels were similar during the March and September events (7.40 NTU and 6.17 NTU, respectively). Seasonal variations typically results from differences in rainfall amounts and the subsequent changes in storm water inputs to the surface waters, resulting in higher turbidity observations in the dry season.

East Side (South Creek)

During the 26th year of the monitoring program, turbidity levels measured in South Creek ranged from 0.850 to 145 NTU with an overall average of 17.5 NTU (**Appendix Table C-6**). The turbidity levels measured in 2010 are higher than those observed in 2009 (5.28 NTU), 2008 (3.4 NTU), 2007 (6.2 NTU), 2005 (3.3 NTU), 2004 (4.8 NTU), 2002 (8.4 NTU), 2001 (5.0 NTU) and 2000 (4.2 NTU) and lower than those recorded for 2006 (18.1 NTU) and 2003 (69.6 NTU). The lowest mean turbidity level (3.41 NTU) occurred during the January sampling event while the highest mean turbidity level (45.1 NTU) was determined for the April event.

The General Water Quality Criteria for all surface waters (FAC Chapter 62-302) specifies that turbidity shall not exceed 29 NTU above natural background. Based on turbidity measurements taken during previous years of monitoring, natural background turbidity levels are expected to be less than 25 NTU (mean plus one standard deviation), although higher background turbidities might occur because of natural processes, e.g., organic decay and import of particulate matter via stormwater runoff.

4.3 Oxygen Demand and Related Parameters

4.3.1 Biochemical Oxygen Demand

West Side (Catfish and North Creeks)

Biochemical oxygen demand can be defined as "….the amount of oxygen required by bacteria while stabilizing organic matter under aerobic conditions." (Sawyer and McCarthy, 1978). The decomposable organic matter present in Catfish Creek is mostly attributed to decaying vegetation and hydrocarbon inputs (i.e., automobile emission, oil leakage, etc.). As presented in **Appendix Table B-7**, the 5-day biochemical oxygen demand (BOD_5) recorded in the two streams of the West Side averaged 2.31 mg/ L and ranged from <0.5 to 4.54 mg/ L during the 2010 monitoring year. The average BOD_5 levels for the March and September events were 2.69 mg/ L and 1.94 mg/ L, respectively. In previous reports, a relatively higher BOD_5 was reported during the September event, presumably a result of higher storm water runoff during the summer wet season. Higher runoff typically results in more organic material being transported to the surface waters.

Biochemical oxygen demand levels in Catfish Creek averaged 2.65 mg/ L with a range of 1.03 to 4.54 mg/ L. BOD_5 within the upper and mid reach stations averaged 1.51 and 3.49 mg/ L, respectively. A similarly low mean BOD_5 level of 0.630 mg/ L was observed for the North Creek sampling station.

East Side (South Creek)

The decomposable organic matter present in South Creek is mostly attributed to decaying vegetation with a contribution of hydrocarbon input (i.e., automobile emission, oil leakage, etc.) resulting from runoff from Interstate-75 and developed areas. As presented in **Appendix Table C-7**, the BOD_5 recorded in the South Creek Basin during the 2010 monitoring year averaged 3.70 mg/ L and ranged from 1.31 to 8.32 mg/ L. Seasonally, the highest mean BOD_5 levels were determined during the July sampling event. Spatially, the mean BOD_5 levels for the lower reach (SC-1 and SC-2) were lower than the upper reach (SC-3 and SC-4).

The General Criteria for BOD_5 in all surface waters as designated by FAC Chapter 62-302, "Rules and Regulations of the Department of Environmental Protection," as well as Sarasota County Ordinance No. 98-066, as amended, specifies that BOD_5 shall not be increased to levels that would result in violations of dissolved oxygen. According to Hynes (1966), a BOD_5 of 3 mg/ L suggests "fairly clean" water while a BOD_5 of 5 mg/ L suggests "doubtful" quality water. In addition, a BOD_5 screening level of greater than 3.3 mg/ L has been established for Florida waters to indicate potential water quality problems (FDER, 1990). Based on BOD_5 measurements made in North Creek/ Catfish Creek and South Creek during the 2010 monitoring year, the surface water of the West Side and East Side generally exhibited clean conditions where a collective 18 of the 28 measurements were found below the 3.3 mg/ L screening level. Also, during the 26th year of monitoring, 3 of the 28 BOD_5 measurements collected

from the East Side and West Side exceeded the 5 mg/ L level which Hynes (1966) considered "doubtful" or between "fairly clean" and "bad" water quality.

4.3.2 Dissolved Oxygen

West Side (Catfish and North Creeks)

Dissolved oxygen concentrations for the West Side averaged 7.1 mg/ L and ranged from 2.6 to 11.2 mg/ L for the 2010 monitoring event (**Appendix Table B-8**). Dissolved oxygen concentrations in 2010 were comparable with those reported in previous monitoring years (CCI, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997, 1998 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). Historical average dissolved oxygen concentrations ranged from 4.5 to 8.5 mg/ L.

Seasonally, the lowest average dissolved oxygen levels were observed for the September monitoring event with concentrations averaging 4.8 mg/ L. Typically, higher dissolved oxygen levels are associated with the lower water temperatures observed during the March event. Correspondingly, dissolved oxygen concentrations for the March monitoring event averaged 9.4 mg/ L, presumably due to lower stream stage and flow during the dry season. Thus, the 2010 monitoring year follows seasonal trends similar to those observed for dissolved oxygen during previous monitoring years (CCI, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997, 1998 and VHB 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). Spatially, average dissolved oxygen concentrations were generally higher for stations within the Catfish Creek Basin (7.5 mg/ L) with lower concentrations recorded for Station NC-6 in the North Creek Basin (5.1 mg/ L).

Dissolved oxygen concentrations in the two streams of the West Side have previously documented levels below the 5.0 mg/ L criteria specified by FAC Chapter 62-302 for predominantly freshwater. Similarly, 3 of the 12 dissolved oxygen measurements made during 2010 were below the 5.0 mg/ L state criteria.

East Side (South Creek)

Overall, dissolved oxygen in South Creek during 2010 was found to average 5.7 mg/ L and range from 2.8 to 12.2 mg/ L (**Appendix Table C-8).** The highest dissolved oxygen concentration was recorded at Station SC-3 during the January event. The lowest dissolved oxygen level was recorded at Station SC-4 during the July event.

The average dissolved oxygen levels for 2010 generally followed seasonal trends and were generally lower during the warmer events. Seasonally, the highest average dissolved oxygen levels were observed for the January 2010 monitoring event with the lowest levels occurring during the July and October 2010 events. This is similar to levels recorded in the previous monitoring years (CCI, 1988a, 1988b, 1991, 1992a, 1993, 1996, 1997 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008 2009, and 2010) in that dissolved oxygen levels during January were generally higher than the other events. Most of the variability in dissolved oxygen levels is likely attributed to changes in the solubility of dissolved oxygen in the water column with changes in

water temperature, but other factors may have also affected the solubility. During the 2010 monitoring year, dissolved oxygen concentrations in South Creek occurred at levels below the 5.0 mg/ L criteria specified by FAC Chapter 62-302 for freshwater stations throughout the year. Of the 16 dissolved oxygen measurements made during the 2010 monitoring year, 6 measurements were below the 5.0 mg/ L state criterion.

An evaluation of diurnal variations in dissolved oxygen in Catfish Creek and South Creek was performed during the dry season of 1985 and the wet season of 1986. The results of the diurnal evaluation showed typical increases in dissolved oxygen during the day to maximum levels by mid-afternoon and declines during the night to minimal levels by midmorning, as well as diurnal trends characteristic of the stream community. A summary of the results of the diurnal study is provided in the report prepared by CCI (1987).

4.3.3 Water pH

West Side (Catfish and North Creeks)

Results of pH monitoring in Catfish Creek and North Creek during 2010 indicate minor variability during the two monitoring events and among the six different stations (**Appendix Table B-9**). During the 2010 monitoring year, pH levels in these two streams of the Palmer Ranch ranged from 7.0 to 8.1 and averaged 7.5. Similar pH measurements were observed during previous monitoring years (Palmer Venture, 1986; and CCI, 1986, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997, 1998, 1999 and VHB, 1999, 2000, 2001 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). Slight differences in pH distributions in Catfish Creek are primarily attributed to spatial variations in community metabolisms. Of the 12 measurements taken during the 2010 monitoring year, no measurements were outside the allowable 6.0 – 8.5 range designated by the state criteria.

East Side (South Creek)

Results of pH monitoring in South Creek during 2010 indicated a similar range as that found in Catfish/ North Creek (**Appendix Table C-9**). During the 2010 monitoring year, surface water quality stations along South Creek exhibited pH levels ranging from 7.0 to 8.2. The range of pH observed during the 2010 monitoring year was similar to that observed during previous years of monitoring (Palmer Venture, 1986; and CCI, 1986, 1988a, 1988b, 1991, 1992a, 1995, 1996, 1997, 1998, 1999 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). Slight differences in pH distributions in South Creek are primarily attributed to spatial variations in community metabolisms. None of the 16 measurements taken in 2010 exceeded the allowable range of 6.0-8.5 designated by the State criteria.

Differences or changes in pH are indicative of the effects of net community metabolisms on the level of carbon dioxide and pH. During periods of net community respiration, carbon dioxide (CO_2) is produced faster than it is assimilated.

When CO_2 is dissolved in water, carbonic acid (H_2CO_3) is formed in the following reaction: $\mathbf{H_2O + CO_{2(g)} \leftrightarrow H_2CO_{3(aq)} \leftrightarrow H^+ + HCO_3^-}$

As a result of CO_2 production during respiration, water pH is depressed due to the release of hydrogen ions (H+) as H_2CO_3 dissociates. In contrast, carbon dioxide is consumed faster than it is produced during periods of net community photosynthesis (primary production). Thus, the reaction will shift toward the left, thereby removing CO_2 and increasing pH.

Therefore, pH typically exhibits a diel trend of increases during the day and decreases during the night. The amplitude of the cycle normally depends on the rate of production and consumption and to a lesser extent on the buffering capacity, i.e., alkalinity, of the water and atmospheric exchange of carbon dioxide.

In a diurnal evaluation of Catfish Creek and South Creek, which was conducted during the dry season of 1985 and the wet season of 1986, CCI (1987) reported changes in pH characteristic of the different biological communities. During the day, Catfish Creek and South Creek exhibited changes in pH ranging up to a 1 to 2 unit increase with maximum diurnal changes observed in the lower reach of Catfish Creek (i.e., CC-5) where the greatest metabolic rates were encountered.

As specified in the General Criteria for all surface waters (FAC Chapter 62-302) and in Sarasota County Ordinance No. 98-066, as amended, the allowable variation in pH is 1.0 units above or below the normal pH if the pH is not lowered or elevated outside the range of 6.0 to 8.5. Additionally, if natural background is less than 6.0, the pH shall not vary below the natural backgrounds or vary more than one unit above natural background. Similarly, if natural background is above 8.5, pH shall not vary above natural background or vary more than one unit below background.

4.4 Macronutrients

4.4.1 Total Nitrogen

West Side (Catfish and North Creeks)

Overall, total nitrogen levels in Catfish Creek and North Creek ranged from 0.626 to 1.96 mg/ L and averaged 1.22 mg/ L during the 2010 monitoring year (**Appendix Table B-10**). Average total nitrogen concentrations of between 0.838 and 1.49 mg/ L were reported since 1997 (CCI, 1997, 1998, and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). Mean total nitrogen concentrations for the West Side have relatively minor variation during the last 20 years (**Figure 4.4**). Also included in Figure 4.4 is the average total nitrogen concentration measured in Catfish Creek during the "Stormwater Pollutant Loading Monitoring Program" performed at the Palmer Ranch (CCI, 1992b). The mean concentrations for each component of total nitrogen (i.e., ammonia, nitrate + nitrite, and organic nitrogen) also remained fairly consistent over the period of record.

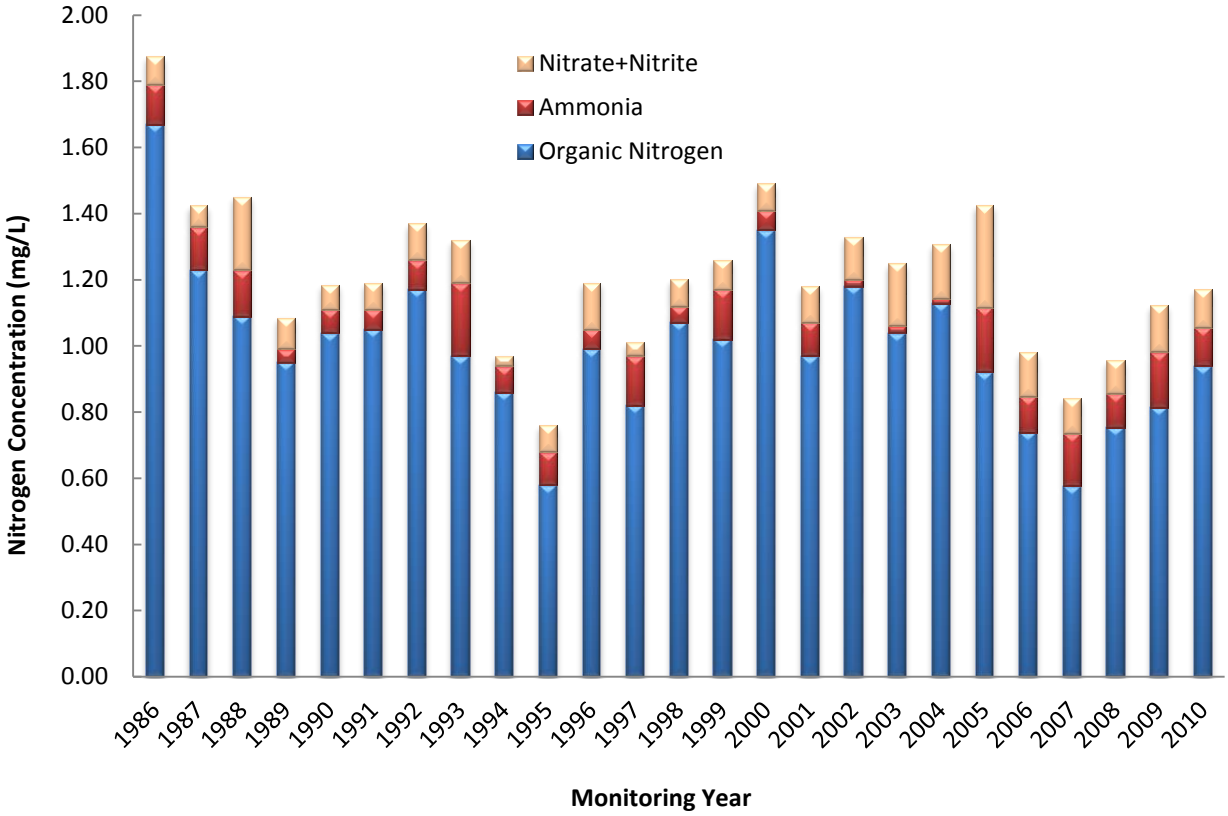


Figure 4.4 Average Nitrogen Concentrations Measured on the West Side of the Palmer Ranch from 1986 to 2010

Seasonally, average total nitrogen concentrations in September (1.23 mg/ L) were comparable to the average concentrations for March (1.22 mg/ L). In Catfish Creek during March, the lowest total nitrogen concentration (0.626 mg/ L) was observed at Station CC-1. The highest average total nitrogen concentration in Catfish Creek was 1.78 mg/ L, and was recorded at Station CC-5 during March 2010.

As reported for all previous monitoring years, the largest fraction of total nitrogen observed during 2010 is organic nitrogen. During the 2010 monitoring year, organic nitrogen represented approximately 80.2 percent of total nitrogen and averaged 0.940 mg/ L. For the period of record, organic nitrogen represented from 65 to 91 percent of the total nitrogen content and averaged from 0.58 to 1.67 mg/ L. The second most abundant form of nitrogen during 2010 was ammoniacal (i.e., ionized plus unionized ammonia) nitrogen, which represented approximately 9.9 percent of the total nitrogen with an average level of 0.116 mg/ L. During the period of record, ammoniacal nitrogen represented from 4 to 13 percent of the total, with concentrations averaging 0.01 to 0.22 mg/ L. Nitrate nitrogen represented 9.1 percent of the total nitrogen with an average concentration of 0.107 mg/ L. During the period of record, nitrate nitrogen represented approximately 4 to 21 percent of the total

nitrogen content with average nitrate levels ranging from <0.01 to 0.98 mg/ L. Nitrite nitrogen concentrations during 2010 averaged 0.009 mg/ L, or 0.8 percent of the total nitrogen concentration. During the period of record, nitrite represented about 1.9 percent of the total nitrogen present.

East Side (South Creek)

During the four 2010 sampling events, total nitrogen concentrations in South Creek averaged 1.94 mg/ L and ranged from 1.11 to 4.44 mg/ L (**Appendix Table C-10**). When compared to the period of record, overall total nitrogen concentrations measured during 2010 are similar to those determined previously (**Figure 4.5**). Prior to 1998, average total nitrogen concentrations in South Creek had generally decreased. The most pronounced decrease in nitrogen content occurred after the third monitoring year (i.e., 1987). At that time, an area located upstream of the eastern branch of South Creek on the Palmer Ranch property was used as a dairy farm (August 1987). Before the deactivation of the dairy farm, ammoniacal nitrogen comprised from 11 to 25 percent of the total nitrogen. After the deactivation of the dairy farm, 4 to 12 percent of the total nitrogen content of South Creek was in the form of ammonia. Not only have total nitrogen levels decreased, but the forms of nitrogen that are readily assimilated by algae and plants (i.e., nitrate + nitrite and ammonia) have also declined.

Spatially, the highest average total nitrogen concentration of 2.35 mg/ L was observed at Station SC-1 during the 2010 monitoring year. Station SC-4 exhibited the lowest average total nitrogen concentrations at 1.64 mg/ L. Seasonally, the highest mean total nitrogen concentration (2.71 mg/ L) was observed for the October monitoring event.

The mean concentrations for each component of total nitrogen (i.e., ammonia, nitrate + nitrite, and organic nitrogen) also remained fairly consistent over the period of record. The largest fraction of total nitrogen observed during the entire monitoring program is organic nitrogen. During the 2010 monitoring year, organic nitrogen represented approximately 81.0 percent of total nitrogen and averaged 1.58 mg/ L. Ammoniacal, nitrate, and nitrite nitrogen made up 10.3, 8.2, and 0.5 percent of the total nitrogen, respectively. As stated previously, different breakdowns of total nitrogen were reported for South Creek during earlier monitoring years (CCI, 1986, 1988a, 1988b, 1991 and 1992a). The largest fraction of total nitrogen observed during the previous years of monitoring also occurred in the form of organic nitrogen. Prior to 1988, organic nitrogen represented from 71 to 84 percent of the total nitrogen content and averaged from 1.08 to 2.18 mg/ L. The smallest fraction of total nitrogen for the period of record was nitrite, which represented less than 1 percent of the total nitrogen present for all monitored years.

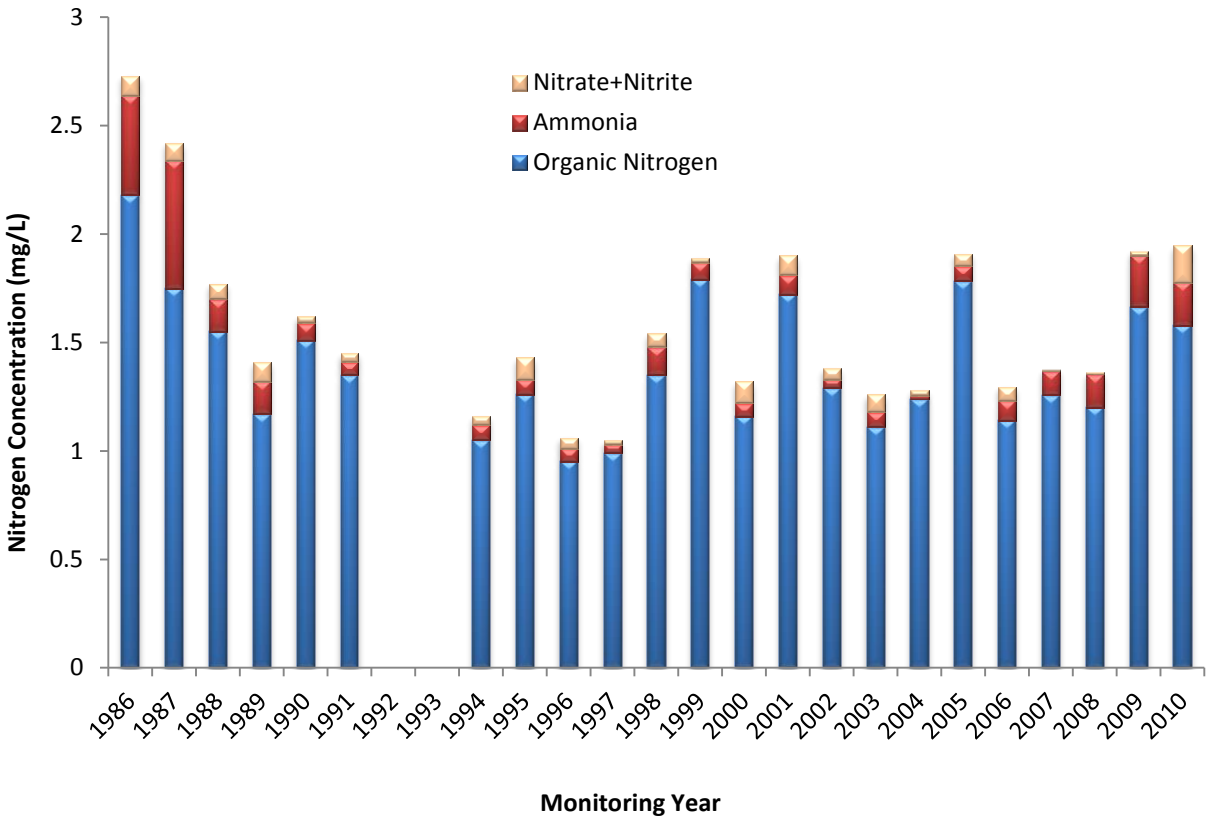


Figure 4.5 Average Nitrogen Concentrations Measured on the East Side of the Palmer Ranch from 1986 to 2010

As specified in FAC Chapter 62-302, nutrients, including total nitrogen, shall not be elevated to levels causing an imbalance in the natural flora and fauna, a condition characteristic of eutrophic or nutrient-rich streams. In this respect, there were some implications in the data acquired during the second, third, and fourth monitoring years that linked the observed total nitrogen levels to eutrophic conditions even though there appeared to be a general trend of decreasing nitrogen levels as previously discussed (CCI, 1986, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997 and 1998). Total nitrogen results obtained during 2010 were around the average measured during the twenty-six years of the monitoring program, and the average concentration for the year (1.94 mg/ L) did not exceed the 2.0 mg/ L screening level considered by the FDEP (FDER, 1990) to be characteristic of eutrophic conditions. Four of the 28 total nitrogen samples collected for the Palmer Ranch during 2010 exceeded the screening level of 2.0 mg/ L considered to be characteristic of eutrophic conditions, all within South Creek.

4.4.2 Nitrite

West Side (Catfish and North Creeks)

Nitrite levels observed in Catfish Creek and North Creek averaged 0.009 mg/ L and ranged from <0.003 to 0.058 mg/ L (**Appendix Table B-11**). As expected, nitrite concentrations throughout these two streams traversing the west side were much lower than for other forms of nitrogen, and too low to be a significant nutrient source. Three of the 12 samples collected during the 2010 monitoring year contained nitrite concentrations below the 0.003 mg/ L analytical detection limit. During the previous monitoring years, nitrite concentrations measured in Catfish Creek and North Creek averaged <0.01 to 0.04 mg/ L (CCI, 1987, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1997, 1998 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010).

East Side (South Creek)

Nitrite levels in South Creek during the 2010 monitoring period averaged 0.009 mg/ L (**Appendix Table C-11**). Nitrite concentrations throughout South Creek were similar to nitrate, but much lower than the other forms of nitrogen, and too low to be a significant nutrient source. Seven of the 16 samples collected during the 2010 monitoring year contained nitrite concentrations below the analytical detection limit. During the previous monitoring years, nitrite concentrations measured in South Creek averaged 0.003 to 0.02 mg/ L (CCI, 1986, 1987, 1988a, 1988b, 1991, 1992a, 1995, 1996, 1997, 1998 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010).

As a nutrient, nitrite is covered by the general water quality standard (FAC Chapter 62-302). However, due to the observed low concentrations, nitrite was generally of little importance as a nutrient in the streams of the Palmer Ranch. For all practical purposes, nitrite is considered to meet desired standards.

4.4.3 Nitrate

West Side (Catfish and North Creeks)

Nitrate levels observed for Catfish Creek and North Creek in the Palmer Ranch during 2010 exhibited a yearly average of 0.107 mg/ L with a range of <0.004 to 0.578 mg/ L (**Appendix Table B-12**). Nitrate concentrations for the West Side during 2010 were similar to those reported for the period of record, which historically averaged 0.10 mg/ L and ranged from 0.03 to 0.30 mg/ L. Nitrate in 2010 showed only minor variations spatially and seasonally for the West Side.

East Side (South Creek)

Nitrate levels from South Creek during 2010 averaged 0.161 mg/ L and ranged from <0.004 to 1.28 mg/ L (**Appendix Table C-12**). The 2010 nitrate concentrations are comparable to those determined for the period of record. Nitrate concentrations for South Creek also varied seasonally with greater concentrations during the October

event (0.339 mg/ L) than the other events. Spatially, the upper reach exhibited significantly lower concentrations (0.016 mg/ L) than the lower reach (0.306 mg/ L).

These low concentrations of nitrate probably are a result of low inputs of nutrients in the form of stormwater runoff as well as higher nutrient uptake by aquatic vegetation. As a nutrient, nitrate is designated as a parameter covered by the general water quality criteria (FAC Chapter 62-302), and is an important limiting nutrient in the streams of the Palmer Ranch. Therefore, increases in nitrate availability from anthropogenic sources would accelerate production rates of aquatic plants resulting in an imbalance in the flora and fauna that would be considered a violation of the nutrient standard. The nitrate concentrations determined during the 2010 monitoring year are not thought to represent an important source of nitrogen in the streams of the Palmer Ranch. Therefore, nitrate is considered to meet desired criteria.

4.4.4 Ammoniacal Nitrogen

West Side (Catfish and North Creeks)

Overall, ammoniacal nitrogen for the West Side exhibited an average of 0.116 mg/ L with a range from 0.026 to 0.299 mg/ L (**Appendix Table B-13**). As discussed previously, ammoniacal nitrogen represented approximately 9.9 percent of the total nitrogen measured during the 2010 monitoring year. Ammonia concentrations measured during 2010 were within the range determined for the previous years of monitoring (Palmer Venture, 1986; and CCI, 1986, 1988a, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997, 1998 and VHB, 1999, 2000, 200, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). Seasonally, ammoniacal nitrogen concentrations in Catfish Creek and North Creek averaged 0.109 and 0.123 mg/ L during the March and September sampling events, respectively.

East Side (South Creek)

Overall, ammoniacal nitrogen for South Creek exhibited an average of 0.201 mg/ L with a range from 0.024 to 1.08 mg/ L (**Appendix Table C-13**). As described previously, ammoniacal nitrogen represented 10.3 percent of the total nitrogen measured during the 2010 monitoring year. Higher levels reported during the mid 1980s can be attributed to runoff originating from a dairy farm upstream of the Palmer Ranch property. Historically, but not this year, the January and April events were consistently lower than the July monitoring events. These higher ammoniacal nitrogen concentrations are believed to be associated with the decay of vegetation in the creek. Additional ammoniacal nitrogen input is also associated with stormwater runoff entering the creek, which occurs during prolonged and/ or heavy amounts of precipitation contributing to higher concentratrions in July and October.

Although ammoniacal nitrogen is a nutrient and therefore has the potential to influence the growth of the primary producers (plants) and their balance with the consumers (bacteria and animals), FAC Chapter 62-302 does not provide a quantitative nutrient standard for ammoniacal nitrogen. Even though ammoniacal nitrogen is a potentially important nutrient to the primary producers in the streams

of the Palmer Ranch, results obtained during the monitoring program suggest that nitrate might be the preferred nitrogen source. This indication is based on trends observed during previous monitoring years as related to normal plant production and decay (CCI, 1996). Other freshwater studies (Wetzel, 1975) have also concluded that aquatic vegetation, including algae, prefer nitrate to ammonia. Although it might be less preferred than nitrate, increases in ammonia have the ability to accelerate plant production, and, in turn, influence the balance between the flora and fauna of the streams traversing the Palmer Ranch. Concentrations of ammoniacal nitrogen determined during the 2010 monitoring year were generally similar to those recorded during the previous years of monitoring. These levels are not thought to represent an important source of nitrogen in the streams of the Palmer Ranch. Therefore, ammonia is considered to meet desired criteria. Because the un-ionized fraction of ammoniacal nitrogen was not evaluated independently, comparisons to County and State criteria for un-ionized ammonia were not made.

4.4.5 Organic Nitrogen

West Side (Catfish and North Creeks)

Overall, an average organic nitrogen concentration of 0.940 mg/ L was measured in these streams on the West Side during the 2010 monitoring year with a range from 0.580 to 1.28 mg/ L (**Appendix Table B-14**). The average organic nitrogen concentration for Catfish and North Creeks during the 2010 monitoring period is within the range for the period of record averages (0.58 to 1.67 mg/ L). The 2010 monitoring year exhibited spatial variation with average organic nitrogen levels ranging from 0.638 mg/ L in the upper reach to 1.02 mg/ L in the mid-reach.

Typically, peaks in organic nitrogen during September are apparently associated with peaks in the standing crop of aquatic vegetation and storm water loadings, since this month represents the primary wet season. During the fall and winter, the standing crop of vegetation declines in association with low production rates and the decay of plant material. In past monitoring years, organic nitrogen concentrations have exhibited a concomitant decline as the plant material was depleted by the microbial heterotrophs during this period. Additionally, storm water loading rates most likely declined in association with minimal runoff during the relatively drier months of October through May.

East Side (South Creek)

Organic nitrogen concentrations in South Creek within the Palmer Ranch during the 2010 monitoring year averaged 1.58 mg/ L and ranged from 1.01 to 2.76 mg/ L (**Appendix Table C-14**). The average organic nitrogen concentration for South Creek during the 2010 monitoring period is within the range of the period of record averages (0.95 to 2.18 mg/ L). Seasonally, organic nitrogen concentrations were highest during the July and October events with organic nitrogen concentrations averaging 1.79 and 1.95 mg/ L, respectively. Lower organic nitrogen levels were recorded in the January and April events with average concentrations 1.31 and 1.25 mg/ L, respectively. This seasonal trend was also observed in 2007, 2008, and 2009,

but is not typical of previous years. Lower organic nitrogen concentrations usually result from flushing of the creek by increases in rainfall and subsequent storm water runoff causing less accumulation of decaying vegetation.

4.4.6 Total Phosphorus

West Side (Catfish and North Creeks)

During the 2010 monitoring year, total phosphorus in the Catfish Creek/ Trunk Ditch basin of the Palmer Ranch averaged 0.119 mg/ L and a range of 0.049 to 0.192 mg/ L (**Appendix Table B-15**). Similar total phosphorus distributions were observed during the 1989, 1990, 1991, 1995, 1996, 1998, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009 monitoring years, with concentrations averaging 0.12, 0.12, 0.15, 0.18, 0.17, 0.12, 0.15, 0.15, 0.15, 0.19, 0.13, 0.16, 0.13, 0.168, 0.111, and 0.164 mg/ L, respectively (CCI, 1990, 1991, 1992, 1996, 1997 and VHB 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010). The average total phosphorus concentration for 2010 for the West Side streams was within the range for the period of record (**Figure 4.6**). The highest average total phosphorus concentration during 2010 was reported for CC-3 (0.179 mg/ L) in the mid reach of Catfish Creek. The lowest mean total phosphorus concentrations were observed at Station CC-1 (0.100 mg/ L).

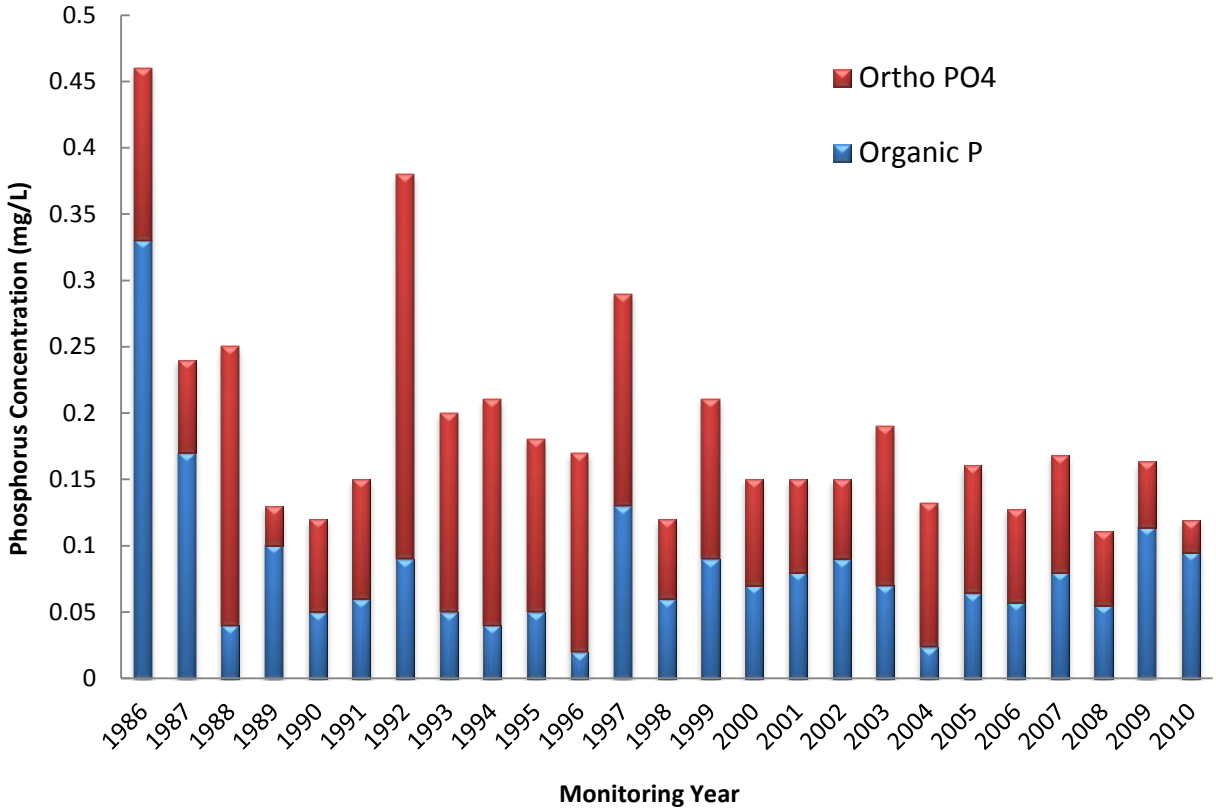


Figure 4.6 Average Phosphorus Concentrations Measured on the West Side of the Palmer Ranch from 1986 to 2010

Typically, increases in phosphorus can be attributed to higher rainfall amounts during the wet season, as was the case in Catfish Creek/ North Creek Basins during 2010, with the notable exceptions of CC-4 and NC-6. Lower phosphorus concentrations during the March monitoring event are likely attributed to the lower amount of rainfall that occurs during March than September.

East Side (South Creek)

During the 2010 monitoring year, total phosphorus in South Creek averaged 0.299 mg/ L with a range of 0.081 to 0.629 mg/ L (**Appendix Table C-15**). Mean total phosphorus for 2010 was within the range for the period of record, 0.126 to 1.63 mg/ L (**Figure 4.7**). A pronounced decrease in total phosphorus concentration from the early 1980s was observed after the deactivation of the dairy farm located upstream of the Palmer Ranch property.

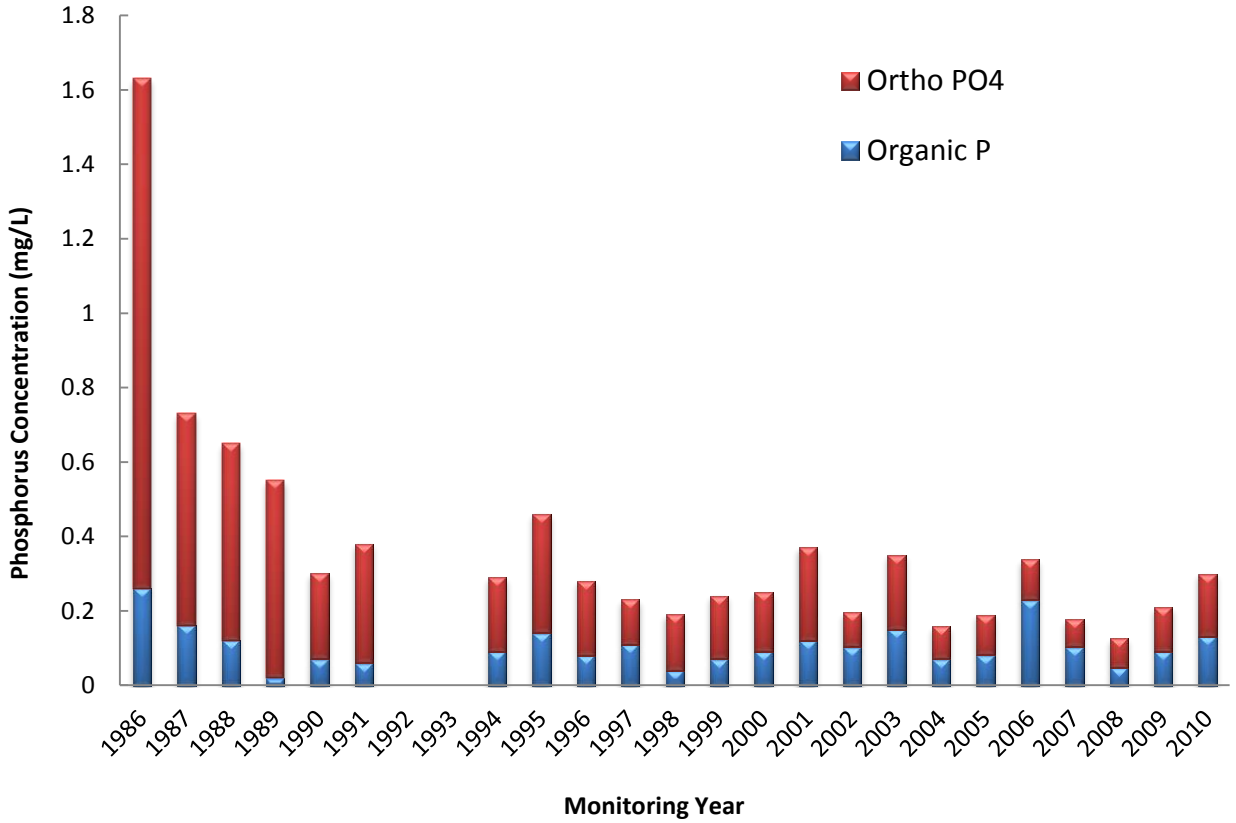


Figure 4.7 Average Phosphorus Concentrations Measured on the East Side of the Palmer Ranch from 1986 to 2010

Typically, increases in phosphorus can be attributed to higher rainfall amounts recorded during the wet season, and the highest concentrations of total phosphorus in the South Creek Basin for 2010 were found during the October monitoring event.

As a nutrient, phosphorus is required by algae and other plants for the primary production of organic matter and, therefore, as specified in FAC Chapter 62-302, shall not be elevated to levels that will cause an imbalance in the natural flora and fauna. The results of the 2010 monitoring year indicate that three of the 16 samples collected on the East Side of Palmer Ranch exhibited a total phosphorus concentration that exceeded the FDEP screening level of 0.46 mg/ L (FDER, 1990). Approximately 14 percent of all of the total phosphorus concentrations measured in Catfish Creek, North Creek and South Creek in 2010 were at or below the 0.09 mg/ L level determined to be the median concentration for Florida streams (FDER, 1990). Similar phosphorus concentrations are normally found in west central Florida because of the widespread deposits of naturally occurring phosphate (Sheldon, 1982). Interestingly, well driller's logs show that phosphates exist in shallow deposits on the Palmer Ranch (Patton and Associates, 1984). In the past years, a relatively high correlation was found between the total phosphorus concentrations and turbidity levels which suggests the controlling role of naturally occurring phosphate deposits on the phosphorus concentrations in the streams of the Palmer Ranch. In addition, Palmer Venture (1986) noted that the phosphate levels in the streams of the Palmer Ranch were significantly influenced by groundwater during periods when stream flow was augmented by groundwater exfiltration (i.e., low flow conditions). Consequently, phosphates originating from these naturally occurring deposits within, or upstream of, the Palmer Ranch should not be considered violations even though they exhibit the potential for contributing to high rates of primary production and a concomitant imbalance in the flora and fauna.

4.4.7 Orthophosphate

West Side (Catfish and North Creeks)

Overall, the Catfish Creek/ Trunk Ditch and North Creek basins of the Palmer Ranch exhibited an average orthophosphate concentration of 0.024 mg/ L with a range from <0.002 to 0.056 mg/ L (**Appendix Table B-16**). The average orthophosphate concentrations for 2010 were the lowest recorded for the historical data range of average orthophosphate concentrations (previously 0.03 to 0.29 mg/ L). In 2010, orthophosphate made up 20 percent of the total phosphate found in the water column of West Side streams, which is the lowest during the period of record that previously ranged from 23 to 88 percent.

Orthophosphate concentrations during 2010 exhibited spatial trends similar to those observed for previous years with greater concentrations in the upper reach of Catfish Creek (CC-1 and CC-2) than the mid reach (CC-3 and CC-4). Seasonally, the orthophosphate concenrations during the March monitoring event were lower than those for the September event, which is consistent with previous years. Generally, higher orthophosphate concentrations are observed during the September event and

reflect the high rainfall experienced prior to monitoring. This temporal increase in orthophosphate concentrations recorded at the end of the wet season is typically attributed to increased runoff during the wet season.

East Side (South Creek)

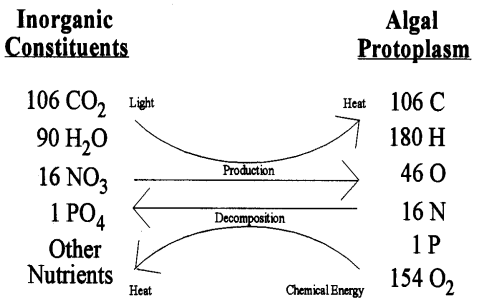
Orthophosphate concentrations for South Creek during the 2010 monitoring year averaged 0.167 mg/ L and ranged from 0.035 to 0.391 mg/ L (**Appendix Table C-16**). Higher orthophosphate levels were reported for the mid 1980s and were attributed to runoff that originated from a deactivated dairy farm that discharged into the eastern tributary of South Creek. In 2010, orthophosphate represented approximately 56 percent of the total phosphorus, which is within the range for the period of record. Historically, the percentage of total phosphorus consisting of orthophosphate has ranged from 32 to 96 percent. Low percentages like those found in 1997 (52 percent), 2002 (47 percent), 2004 (56 percent), 2006 (32 percent), 2009 (57 percent), and 2010 probably reflect lower concentrations of total phosphorus in the creek and/ or dry antecedent conditions.

The highest average orthophosphate concentrations observed during the 2010 monitoring year occurred in April and October and is likely due to the higher concentrations of total phosphate recorded at these monitoring events. The lowest concentration of orthophosphate observed in 2010 was at Station SC-4 in July 2010.

As a nutrient, orthophosphate is designated by FAC Chapter 62-302 as a general water quality parameter. This criterion specifies that the discharge of nutrients, such as orthophosphate, shall be limited to prevent an imbalance in the natural populations of aquatic flora and fauna. Although the observed levels are occasionally above the threshold considered to indicate eutrophic conditions as defined by FDEP (FDER, 1983), orthophosphate has been found to occur naturally on the Palmer Ranch. Consequently, other factors, such as nitrogen availability, are probably more growth limiting than orthophosphate. Therefore, the phosphate levels found during the 2010 monitoring year are not likely to have caused an imbalance in the aquatic flora and fauna.

4.4.8 Nutrient Ratios

Nitrate and phosphate are required by aquatic plants in proportions of approximately 6.8:1 on a weight basis (or 16:1 N:P on a molar basis) (Odum, 1959 and GESAMP, 1987). Nitrogen and phosphorus are assimilated in this proportion by the primary producers (rooted aquatic plants and algae) and converted into protoplasm during the process of photosynthesis. Conversely, the (unresistant or digestible) organic forms of nitrogen and phosphate are oxidized back into their biogenic salts during the process of aerobic respiration, e.g., organic decomposition, heterotrophic activity. This relationship can be illustrated as:



The primary forms of these biogenic salts are nitrate and orthophosphate. However, nitrate may be substituted by some plants for other forms of nitrogen, such as ammonia. Also of importance, orthophosphate may be accumulated and stored as polyphosphates by some algae, thereby alleviating a potential future phosphate limiting condition.

Importantly, other limiting factors such as low light and low dissolved oxygen could play as important, if not more important, roles in limiting the rate of primary production and decomposition in the streams of the Palmer Ranch, respectively. For example, if the availability of inorganic nitrogen is high and the Ni:Pi ratio is low, e.g., 2:1, it would indicate that some factor other than inorganic nitrogen is the real limiting factor. Even so, determinations and the use of nutrient ratios in light of other important and potentially limiting factors are helpful in evaluating the results of long-term monitoring programs when nutrient loading and its consequences are major concerns, such as for the "Continuing Surface Water Quality Monitoring Program."

Total nitrogen to total phosphorus ratios (Nt:Pt) are provided in **Appendix Tables B-17** and **C-17** with ratios of inorganic nitrogen (ammonia, nitrite, and nitrate) to orthophosphate (Ni:Pi) being given in **Appendix Tables B-18** and **C-18**. The most meaningful ratio in assessing nutrient limiting conditions is based on the inorganic forms (biogenic salts as previously discussed) since these constituents are immediately available to the primary producers whereas even the unresistant organic forms must be chemically transformed into the inorganic forms prior to photosynthesis.

West Side (Catfish and North Creeks)

The Nt:Pt ratios determined from 2010 nutrient data in the Catfish and North Creeks exhibited an overall average of 13.0:1 (Appendix Table B-17). Since the Nt:Pt ratio is higher than 6.8:1(algal protoplasm, by weight) it indicates a condition in which phosphorus would limit plant growth before nitrogen (Meybeck, 1982).

The Ni:Pi ratios determined from March 2010 nutrient data are found to average approximately 22.7:1 (Appendix Table B-18), and the average ratio observed for the

September event were 7.05:1. Generally, a high Ni:Pi ratio would be indicative of conditions in which orthophosphate would limit plant growth before fixed inorganic nitrogen. Nutrient data collected at Stations CC-4 and NC-6 yielded average Ni:Pi ratios of 18.8 and 45.5, respectively. These ratios suggest that surface waters at these stations may be limiting with respect to phosphorous. Further, these ratios indicate that the lower input of nitrogen to this station may be associated with decreased decomposition of organic matter in conjunction with decreased gross primary productivity.

Overall, the generally stable Ni:Pi ratios calculated from the 2010 data are attributed to the naturally low levels of orthophosphate, while total nitrogen is comprised of approximately 19.8 percent inorganic nitrogen. The higher Nt:Pt ratios determined during the 2010 monitoring events are indicative of the abundance of aquatic vegetation in the creeks and the high percentage of organic nutrients present.

East Side (South Creek)

The Ni:Pi ratios determined during 2010 for South Creek were found to average 3.17:1 (Appendix Table C-18). These ratios are normally indicative of conditions in which orthophosphate would not limit plant growth before fixed inorganic nitrogen. However, the Nt:Pt ratios for South Creek were found to average 8.77:1 indicating a slightly different balance with respect to nitrogen and phosphorus (Appendix Table C-17). In a nutrient-balanced system, neither nitrogen nor phosphorus limit plant growth because both are present in the proper proportions for plant growth. The lower Ni:Pi ratios calculated from the 2010 data are attributed to the slightly higher levels of orthophosphate, as well as the relatively high percentage of total phosphorus represented by orthophosphate (56 percent of total phosphorus) while approximately 19.7 percent of the total nitrogen is comprised of inorganic nitrogen.

During the 2010 monitoring event, the Ni:Pi and Nt:Pt ratios in South Creek were generally indicative of excess organic nitrogen with respect to inorganic phosphorus (i.e., some other factor such as low concentrations of dissolved oxygen may limit production before nitrogen sources). The highest Ni:Pi ratio average was 4.54:1 observed during the October event. The Ni:Pi ratios averaged 3.84:1, 1.58:1, and 2.74:1 during the January, April, and July events, respectively.

4.5 Oils and Greases

West Side (Catfish and North Creeks)

The concentration of oil and grease in the streams on the West Side averaged 2.98 mg/ L during the 2010 monitoring year (**Appendix Table B-19**). Three of the 12 oil and grease measurements for Catfish and North Creeks made during 2010 exceeded the State and County standard of 5.0 mg/ L specified in FAC Chapter 62-302. The concentrations of oils and greases previously reported in the streams of the West Side during the previous years of the monitoring program (Palmer Venture, 1986; and CCI, 1986, 1988a, 1988b, 1991, 1992a, 1993, 1994, 1995b, 1996, 1997, 1998 and VHB,

1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010) ranged from <0.1 mg/ L to 1.9 mg/ L. Most of the historic observations (356 of 366) were found to be less than the maximum allowable State criteria of 5.0 mg/ L.

East Side (South Creek)

Overall, oil and grease content in South Creek averaged 1.35 mg/ L and ranged from <0.992 to 4.64 mg/ L (**Appendix C-19**). All oil and grease measurements for South Creek made during 2010 fell below the State maximum standard of 5.0 mg/ L specified in FAC Chapter 62-302. The concentrations of oils and greases reported in South Creek during the previous years of the monitoring program ranged from <0.2 mg/ L to 11 mg/ L. Ninety-nine percent of the observations in previous years (i.e., 312 of 315) in the Palmer Ranch portion of South Creek were found to be lower than the maximum allowable State criteria of 5.0 mg/ L.

4.6 Bacteriological Parameters

4.6.1 Total Coliform

West Side (Catfish and North Creeks)

The streams of the West Side during the 2010 monitoring year had concentrations of total coliform bacteria ranging from 20 to 790 colonies/ 100 mL with an average of 298 colonies/ 100 mL (**Appendix Table B-20**). Of the 12 samples collected during the 2010 monitoring year, none exceeded the State and County water quality standards which allow up to 2,400 colonies/ 100 mL.

Like previous years of monitoring, the highest numbers of total coliform bacteria colonies during 2010 were observed after periods of rainfall, during the wet season. The mean total coliform level recorded for the September monitoring event in Catfish and North Creeks was 425 colonies/ 100 mL compared to an average of 170 colonies/ 100 mL for the March event.

East Side (South Creek)

The streams of the East Side during the 2010 monitoring year had concentrations of total coliform bacteria ranging from 70 to 10,500 colonies/ 100 mL with an average of 1,570 colonies/ 100 mL (**Appendix Table C-20**). Four of the 16 total coliform bacteria levels measured during 2010 exceeded the State water quality criteria, which allows up to 2,400 colonies/ 100 mL.

The lower reach of South Creek during 2010 had significantly lower average total coliform concentrations (531 colonies/ 100 mL) than the upper reach (2,609 colonies/ 100 mL). As in previous years, cattle and wild animals using the area around Station SC-3 were likely to represent the most significant source of bacteria in the area. Station SC-3, the most northern station in South Creek, reported the highest

average total coliform bacteria concentration (3,593 colonies/ mL) of all the monitoring stations during 2010.

As noted in previous years (CCI, 1988a, 1988b, 1991, 1992a, 1995, 1996, 1997, 1998 and VHB, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, and 2010), data shows that several sources of coliform bacteria exist on and upstream of the Palmer Ranch. A primary source is expected to be the naturally occurring coliform bacteria of the soils and vegetation on and upstream of the Ranch. During periods of land clearing coupled with significant runoff, this source is expected to be exacerbated. Such a condition probably occurred during the second and third monitoring years in the Catfish Creek/ Trunk Ditch basin as the construction of Prestancia was initiated. Another source of coliform bacteria is represented by the warm-blooded animals inhabiting the watershed, including dogs, cats, cattle, birds, feral hogs, deer, and rodents.

4.6.2 Fecal Coliform

West Side (Catfish and North Creeks)

During the 2010 monitoring year, the streams on the West Side exhibited fecal coliform densities ranging from <10 to 580 colonies/ 100 mL and averaged 169 colonies/ 100 mL (**Appendix Table B-21**). None of the 12 samples collected during 2010 contained fecal coliform bacteria densities exceeding the 800 colonies/ 100 mL maximum allowed by State and County water quality criteria for Class III surface waters.

Spatially, the the upper and mid reaches of the Catfish Creek/ Trunk Ditch basin experienced similar numbers of fecal coliform colonies during the 2010 monitoring year. The mean fecal coliform density for the September event (293 colonies/ 100 mL) was greater than for the March event (44 colonies/ 100 mL), and all stations in Catfish Creek and North Creek followed this seasonal trend.

East Side (South Creek)

During the 26th year of monitoring, the South Creek basin of the Palmer Ranch exhibited fecal coliform densities that ranged from <10 to 5,400 colonies/ 100 mL and averaged 556 colonies/ 100 mL (**Appendix Table C-21**). Three of the 16 samples collected during 2010 exceeded the fecal coliform density of 800 colonies/ 100 mL allowed by the Class III State and County Standard.

Spatially, Station SC-3 had the highest average concentration of fecal coliform colonies during the 2010 monitoring year. The higher bacteria levels in this portion of the creek probably reflect the greater number of warm-blooded animals in the stream communities associated with the upstream areas of the creek. Primary sources of fecal coliform bacteria are considered to be dogs, cats, birds, cattle, and other warm-blooded wild animals inhabiting the basin. The highest mean concentration (1,778 colonies/ 100 mL) was observed during the July monitoring event.

4.7 Trace Elements

West Side (Catfish and North Creeks)

During the September 2010 monitoring event, samples were collected for the analyses of trace elements (i.e., arsenic, copper, lead, and zinc). Arsenic concentrations during the 2010 monitoring year were between <0.800 and 3.82 µg/ L (**Appendix Table B-22**). Concentrations of total copper measured on the west side of the Palmer Ranch during the 2010 monitoring period were between <0.346 and 17.1 µg/ L. Total lead concentrations measured on the west side during 2010 were all below the <0.670 detection limit. The concentration of zinc determined for the six monitoring stations during 2010 ranged from <1.4 to 3.30 µg/ L and averaged 1.63 µg/ L.

East Side (South Creek)

Sampling for trace elements in South Creek was performed during the October 2010 monitoring event. The arsenic concentrations during the 2010 monitoring year ranged from 1.55 to 3.94. (**Appendix Table C-22**). The concentrations of copper ranged from <4 to 12.80 µg/ L. Total lead concentrations measured in the streams in the South Creek basin during 2010 were all below the <0.670 µg/ L detection limit for this parameter. Concentrations of zinc samples collected in South Creek during 2010 ranged from 5.10 to 11.4 µg/ L.

All arsenic concentrations measured during the 2010 monitoring year on Palmer Ranch were below the State standard of 50 µg/ L[1]. Possible sources of arsenic include naturally occurring minerals and the use of arsenic-based pesticides on and upstream of the Palmer Ranch. One of the six copper concentrations sampled from Catfish Creek and North Creek (Station CC-4) exceeded the State and County standard of 12.8 µg/ L[2]. None of the copper samples from South Creek exceeded the State and County standard. Possible sources of copper in the surface waters of the Palmer Ranch include the use of copper containing herbicides, fertilizers, algicides, and pesticides. None of the measured lead concentrations in streams on Palmer Ranch exceeded the State and County standard of 3.6 µg/ L[3]. Possible anthropogenic sources of lead in the surface waters of the Palmer Ranch included automobile emissions, roads and parking areas, and runoff from light industrial land uses located upstream of the Palmer Ranch property. All of the zinc concentrations during the 2010 monitoring events at both Catfish/ North Creek and South Creek streams were below the State and County standard of 115 µg/ L based upon a hardness of 110 mg/ L. Possible sources of zinc include the use of zinc containing fertilizers and runoff from roads on and upstream of the Palmer Ranch.

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[1] Based on a total hardness of 110 mg/L.
[2] *Ibid.*
[3] *Ibid.*

5

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Appendix A

Exhibit "E"

Exhibit "E" to the Amended and Restated
Master Development Order for the Palmer Ranch
Development of Regional Impact

(An Exhibit Containing Surface
Water Monitoring Program and
Consisting of Pages E-1 through E-5)

SURFACE WATER MONITORING PROGRAM

Locations

Water quality measurements and grab samples shall be performed in Catfish Creek, North Creek and South Creek. Sampling and measurements shall be made at a total of 10 monitoring stations (refer to FIGURE 5). Five stations are located in Catfish Creek (CC-1, CC-2, CC-3, CC-4 and CC-5); one station is located in North Creek (NC-6); and four stations are located in South Creek (SC-1, SC-2, SC-3 and SC-4)

Procedures

Monitoring shall be accomplished within a two-day period. At the time of grab sampling, simultaneous in situ measurements of dissolved oxygen, pH, temperature and specific conductance shall be made and flow rates shall be determined using velocity-area measurements. Additionally, water depths and pre- and post-event weather conditions shall be recorded. All sample collections and in situ measurements shall be made at approximate mid-depth and mid-stream at each of the ten stations.

Frequency

Due to the wealth of baseline monitoring data which currently exists, baseline monitoring of all South Creek sites shall be suspended until one month before development begins. One month prior to the commencement of sampling the Palmer Ranch will notify the Sarasota County Pollution Control Division the dates of sampling and stations to be sampled. At the time of sampling, water quality grab samples will be collected and in situ

measurements made at all monitoring stations along South Creek. Following this initial monitoring event, all subsequent monitoring shall be performed on a quarterly basis during the development phase. During development, all stations located downstream of an area under development shall be monitored. In addition, one sampling site upstream of a development area shall be maintained for baseline determination. Once an area is substantially developed as agreed to by the Sarasota County Pollution Control Division and Palmer Ranch, a modification of the monitoring program shall be subject to discussion at any time to change the frequency of water quality monitoring from quarterly to semi-annual or to discontinue the monitoring.

Monitoring of Catfish and North Creeks shall continue on a quarterly basis for a maximum of two years or until substantial development takes place. Once substantial development or a two-year period occurs as agreed to by the Sarasota County Pollution Control Division and Palmer Ranch, monitoring frequency for sites located in Catfish and North Creeks shall be subject to change from quarterly to a semi-annual depending on the monitoring results obtained up to that time. Semi-annual sampling, for both basins, shall be performed during a dry and wet season allowing for monitoring of low and high flow conditions.

Parameters

All water quality grab samples shall be analyzed for the following parameters:

- Biochemical Oxygen Demand, 5-day
- Nitrite
- Ortho-phosphate
- Total Suspended Solids
- Ammonia Nitrogen
- Fecal Coliform
- pH
- Conductivity
- Total Kjeldahl Nitrogen
- Nitrate
- Total Nitrogen
- Total Phosphorus
- Turbidity
- Oils and Greases
- Total Coliform
- Dissolved Oxygen

Additionally, analysis shall be done for the following parameters on an annual basis (the first analysis done for South Creek sites will be in conjunction with the initial monitoring event):

- o Copper
- o Arsenic
- o Lead
- o Zinc

No pesticide or mercury, chromium, cadmium and nickel analysis shall be performed because results obtained from the Palmer Ranch Continuous Water Quality Monitoring Program during April 1985 through June 1990 on sites along Catfish Creek indicate that these parameters have consistently been below detection limits and/or state and county standards. Therefore, it may be more important to monitor those parameters which have exhibited higher concentrations than those set by the state.

Methods

All laboratory analyses and in situ measurements shall be performed in accordance with procedures described in the 17th edition of Standard Methods (APHA, 1989) or the Methods for Chemical Analysis of water and Wastes (USEPA, 1993). Methods used for in situ measurements, sample collection, sample preservation and storage and sample analysis are provided in Table A. As changes in technology advance, the methods used in laboratory analysis may be modified to reflect these state-of-the-art procedures. The surface water monitoring program for Catfish Creek, North Creek and South Creek shall be performed on a continuous basis.

Additional Studies

In considering the water quality of lakes on the Palmer Ranch, the Aquatic Center of the University of Florida has expressed interest in conducting limnological research on the Palmer Ranch. One of the objectives of the research would be to develop state-of-the-art strategies in the control of hydrilla and water hyacinth that can be applied on a nation-wide basis.

Since the borrow pit lake in Parcel C has an overabundance of hydrilla, this area has been selected for research. The borrow pit lake was conditioned in the MDO to undergo limnological study as a result of a previous commitment by the Palmer Ranch. Its characters are similar to other borrow pit lakes located on the Palmer Ranch, as well as other borrow pit lakes in Sarasota County. Management of the lake will comply with the newly adopted earth-moving ordinance (Ordinance No. 89-112) which became effective March 13, 1990. This ordinance has provisions to deal with borrow pit lakes uniformly throughout the County. This lake will be used for stormwater management purposes which will be enhanced by the creation of a littoral shelf. The creation of a littoral shelf would promote improved water quality as desirable vegetation would utilize nutrients and lower BOD and TSS levels. Additionally, the Palmer Ranch has made application for a permit from the Florida Game and Fresh Water Fish Commission for the introduction of Triploid Grass Carp. These measures, along with other biological or chemical controls that may be implemented as part of the University of Florida research project for control of hydrilla and lake rehabilitation, would indicate that a further limnological study is unwarranted. Consequently, it is recommended that the future limnological study of the borrow pit as conditioned in the MDO be deleted.

Further, the MDO required the monitoring of an off-site dairy farm to determine the source and significance of water quality problems contributed to surface water. As a result of the water quality data collected from Station SC-7, which is the site used to monitor this off-site contribution, pollutants have significantly decreased. This is no doubt a result of the elimination of the dairy farm which has been converted to residential development (Serenoa). Therefore, it is recommended that monitoring of the site be terminated.

Reporting

A data report shall be submitted to the Sarasota County Pollution Control Division following each sampling event. The report will include: (1) a map of the monitoring stations; (2) narrative and/or tabulation of methods used in collecting, handling, storing and analyzing all samples; (3) a tabulation of all measurement and results of analyses; and (4) the signature(s) of the individual(s) responsible for the authenticity, precision and accuracy of t he data presented. Brief summaries of the responsibility an credentials of the project team members shall be included. In addition, an annual report of the interpretation of the data shall be prepared following each year of monitoring. The annual report will include hydrological information derived from in situ measurements as well as interpretation of the chemical parameters measured over the year. Also included in the annual report shall be tabular representations of all the data collected over the previous year for all of the sites and graphical representation of some of the chemical trends discovered over the year of monitoring.

Appendix B

Catfish and North Creek Water Quality Data

Appendix C

South Creek Water Quality Data

Appendix D

Quarterly Data Tables

Appendix E

Project Team

EMP Mobilization and Monitoring Haines City Water Use Permit
Project advisor for assisting the City of Haines City in obtaining a Water Use Permit (WUP) for the expansion of their wellfield. Permit assistance involved attending agency and project team meeting and responding to Southwest Florida Water Management District (SWFWMD) Request for Additional Information. The successfully negotiated WUP required the City to prepare an Environmental Management Plan (EMP) for the areas potentially affected by hydrologic drawdown. VHB prepared the draft EMP, negotiated it approval and finalized the document. The implementation of the multi-year EMP included: helping the City identify owners of property of potential EMP sites, installation of staff gages and piezometers, establishment of Wetland Assessment Procedure (WAP) monitoring transects, conducting baseline WAP monitoring and preparation of the annual report.

Tampa Bay Water, Brandon Urban Dispersed Wells, Hillsborough County, FL
Project Manager for the environmental monitoring of a series of dispersed water supply wells. The monitoring program was initiated immediately following permit issuance and involved establishment of WAP and quantitative monitoring stations (staff gages, piezometers) including permanent vegetative transects for a long-term ecological monitoring program to ascertain impacts of well pumping on wetlands. The objective of VHB's four-year assignment was to establish the ecological monitoring sites, conduct an initial year of baseline monitoring, and then continue monitoring to detect potential ecological and hydrological impacts associated with the newly initiated production at the wells. The monitoring project has been subsequently awarded to VHB for two additional four year terms. Cost: $813K for services ending in 2008

T. Mabry Carlton Jr. Memorial Reserve, Sarasota County, FL
Project Manager for an environmental monitoring and assessment program. Hydrologic, hydrogeologic and ecologic conditions of the T. Mabry Carlton Jr. Memorial Reserve Wellfield and surrounding area are being monitored to detect possible hydrogeologic and ecologic effects associated with groundwater withdrawals. Water level was monitored monthly by staff gauge, piezometer or well at 21 surficial, intermediate and Floridan aquifer wells, 11 ponds and 26 wetlands. Monthly maintenance and calibration were conducted on 12 telemetered rain gauges, 2 evaportranspiration stations, and 6 telemetered wetlands. Water quality data was collected and analyzed quarterly from 17 wells and surficial aquifer levels are monitored semi-annually at 46 wells. Quantitative wetland vegetation data were collected semi-annually from 27 herbaceous wetlands and annually at 6 forested wetlands. Color aerial photography was analyzed in GIS to determine changes in wetland zonation within 90 wetlands every other year. A Trimble GPS unit was used to field-verify the digitized wetland zonation in 20 wetlands every other year. Annual analysis and reporting included the data collected above, as well as continuous water level data from 17 monitoring and 12 production wells, and stream flow at three stations. Pumpage data and monthly water quality data from the production wells were also analyzed. A series of hydrologic and ecologic parameters were graphically analyzed using GIS. An analysis of the existing evapotranspiration equipment and data was conducted.

Mr. Gary Serviss has over 28 years of technical and project management experience in environmental assessments and permitting. He has extensive experience in wetlands evaluation/classification, mitigation design, wildlife evaluations, and habitat mapping. He has designed and coordinated numerous environmental investigations to serve as a basis for environmental permit applications and Development of Regional Impact Applications. He has served as an expert witness on environmental constraints, bald eagles and wetland impacts related to dredge and fill activities.

28 years of professional experience

Tampa Bay Water, Pasco County, FL
The ecological condition of the wellfield and surrounding areas were monitored to detect possible ecological effects attributable to wellfield pumpage. Water level and wildlife information was collected monthly at 29 sites. Qualitative vegetative information was collected biannually from 20 sites. Quantitative data on species composition and percent cover was collected biannually for herbaceous vegetation along nine quantitative transects and within 16 plots protected from cattle grazing. In addition, data on changes in herbaceous vegetation zonation are collected annually along linear transects. Tree mortality, recruitment, growth and size structure data was collected annually within nine plots. Water chemistry data was collected annually for five lakes. Infrared aerial photography was analyzed twice a year for land use and hydrologic changes. Progress reports were submitted quarterly and a comprehensive report was provided annually.

Biological Monitoring of the Evers Reservoir and the Braden River, Manatee County, FL
Task Manager for a biological monitoring program for the tidal portion of the Braden River downstream of the Evers Reservoir dam. Quantitative natural substrate sampling for benthic macroinvertebrates was conducted during the wet and dry season using replicate petite ponar grab samples at eleven stations. Macroinvertebrate grab samples were field sieved, preserved, picked, sorted and organisms identified to the lowest practical taxonomic level. Sediment samples were collected at the benthic macroinvertebrate stations and analyzed for particle size distribution and total organic carbon. Juvenile fish sampling was conducted with a seine net during the winter and fall at six stations distribution within the various reaches of the river. All fish collected were identified and enumerated, with recreationally and commercially important species being measured for standard length. A data summary report was prepared which included community parameters for the benthic macroinvertebrates and comparison of results along the length of the river. Designed and implemented a five-year water quality study of the Evers Reservoir and Braden River in compliance with water use permit conditions. Collected water quality samples from 2 stations within the Evers Reservoir and 11 stations within the Braden River for several parameters. Water quality data were collected quarterly over a five-year period with the results summarized in quarterly data reports. In addition, annual summary reports were prepared for the previous four quarterly events summarizing the overall results for that annual reporting period. An interpretative report will be prepared summarizing the five-year program.

Tampa Bay Water, South Central Hillsborough Regional Wellfield, Hillsborough Co., FL
Project Manager for a three-year project to monitor the ecological condition of the wellfield and surrounding areas to detect possible ecological effects attributable to well-field pumpage. Water level and wildlife information was collected monthly at 27 sites. Qualitative vegetative information was collected bi-annually from the 27 sites. Infrared aerial photography was analyzed twice a year for land use and hydrologic changes. Prepared progress reports bi-annually and a comprehensive annual report.

Sarasota County Stormwater Management, Sarasota Co., FL
Project Manager to coordinate flow monitoring and rating curve development: Perform monthly flow measurements at 21 stream sites. In addition to the regular monthly inspections, two high flow events were also measured to capture a full range of flow events. Stage data collected hourly from the County's gaging stations was obtained, QA/ QC performed, and the data processed to develop standard USGS primary computations and discharge calculations.

Continued, p. 3

City of Sarasota Wastewater Treatment Plant,
Project Manager to assist the City in the design and approval of the surface water ambient monitoring program through FDEP. VHB prepared the Plan of Study and field sampling and laboratory Quality Assurance Project Plans and obtained approval from FDEP. For the present five year contract VHB conducts quarterly water quality monitoring and annual biological monitoring of macroinvertebrates and algae at five stations. Reports of results are prepared following each event. A subconsultant also provides toxicity testing for the WWTP and RO Plant. Cost: $42K per year

Sarasota Bay Natural Estuary Program, Sarasota County, FL
Project Manager for the Sarasota Bay Juvenile Fisheries Habitat Assessment Study. Obtained available digital mapping data for the study area including color aerial photography, Southwest Florida Water Management District (SWFWMD) Land Use/ Land Cover Maps and SWFWMD seagrass maps. Prepared a shoreline routing system by established bay segments and identified the shoreline type within three tiers (geomorphic, shore morphology and vegetative). Refined the tidal flats mapping units to break out salt barrens and oyster bars. Sampled juvenile fish using the Florida Marine Research Institute's Fisheries Independent Monitoring protocol at 40 natural and restored sites during February and June 2002. Over 310,000 fish were counted during a total of 160 sampling events which were conducted in eight habitat types. In addition, fish species were counted at 14 sites located on three artificial reef sites within Sarasota Bay. A total of over 59,000 individuals were counted during a total of 56 sampling events. The data were analyzed to determine any preferences of fish species and selected taxa (commercially and recreationally important species) for various habitat types and microhabitats within the Sarasota Bay study area. The preference of species and species-specific size classes for various material types or configurations of artificial reef material were also evaluated. The results were summarized and recommendations were provided relative to artificial reef construction and habitat restoration within a report.

Education

MS, Marine Biology, Florida Institute of Technology, 1982

BS, Biological Sciences, Florida Institute of Technology, 1979

Professional Registrations/ Certifications

Certified Wetland Delineator

Leadership in Energy and Environmental Design Accredited

Publications

Sauers, S. and G. Serviss. 1985. Ecological Status of Little Sarasota Bay with reference to Midnight Pass. County of Sarasota, Florida. 92 pp.

Alevizon, W., R. Richardson, P. Pitts, and G. Serviss. 1985. Coral Zonations and Patterns of Community Structure in Bahamian Reef Fishes. Bull. Mar. Sci. 36(2): 304-318.

Melton, R. B., and G. Serviss. 2000. Florida Power Corporation – Anclote Power Plant Entrainment Survival of Zooplankton. Environmental Science & Policy 3:S233-S248.

Adam K. Olenoski, LEED AP

Environmental Scientist

Brandon Urban Dispersed Wells Project, Hillsborough County, Florida
Project scientist conducting bimonthly water level observations at staff gages and piezometers at 23 stations. Assisted in the collection of wetland assessment procedure (WAP) and quantitative data. Responsible for site mobilization and data QA/ QC.
Field Research Experience:

North Carlton-Smith Wetland Mitigation Area, Hillsborough County, FL
Field Scientist assisting with quantitative wetland mitigation area monitoring for nine created wetland systems totaling 101 acres. Data collection included herbaceous species within one meter square quadrats and tree and shrub species within belt transects.

MOSAIC Coastal and Stream Restoration Site, Hillsborough County
Project Scientist performing vegetation and hydrologic monitoring for a 300-acre wetland/ stream mitigation, restoration, and enhancement site. Conducts qualitative and quantitative evaluations of herbaceous, shrub, and tree vegetation. Performs installation, maintenance, and data collection for data logging piezometers. Prepares quarterly qualitative assessments and an annual interpretive report. Data entry, QA, and evaluation for water level and vegetation data.

T. Mabry Carlton, Jr., Memorial Reserve Wellfield, Sarasota County
Project scientist for the collection of monthly water level data from 46 wetlands and 27 wells as well as 6 manual rain gages. Assists in herbaceous vegetation monitoring of wellfield wetlands and forested wetlands. Installs and maintains surface water and groundwater level monitoring equipment. Also conducts water quality monitoring on a quarterly basis at 17 wells and annually uses a Trimble GPS unit to delineate wetland boundaries.

City of Haines City Environmental Monitoring Plan, Polk County, FL
Project Scientist assisting in the development of an Environmental Monitoring Plan for a water use permit modification to expand the existing wellfield. Performed installation, maintenance, and repair for seven piezometer wells using a jet system or gas auger and collected well construction data. Assisted in establishing Normal Pool and installing transects for WAP monitoring.

Whitaker Bayou and Bowlees Creek (Sarasota Bay), Sarasota , Florida
Project scientist responsible for monitoring program at five (5) stations to satisfy FDEP permit conditions which require ambient monitoring of wastewater discharge into Whitaker Bayou. Surface water samples for algal taxonomy were collected and field preserved. Macroinvertebrate and sediment samples were collected by using a petite ponar grab. Macroinvertebrate grab samples were field sieved, preserved, sorted and organisms identified to the lowest practical taxonomic level. Sediment samples were collected at the benthic macroinvertebrate stations and analyzed for particle size distribution and total organic carbon. A data summary report was prepared which included community parameters for the benthic macroinvertebrates and comparison of results between control and test sites.

Mr. Olenoski is an environmental scientist in VHB's Sarasota office. He has field experience in a variety of ecological and hydrological monitoring projects, which include sampling groundwater monitor wells, collecting water quality samples, and conducting qualitative vegetation and wildlife surveys. He has experience evaluating hydrologic data to determine hydroperiod trends and experience in preparing GIS maps and features. He is trained in the FDEP Standards of Operation Procedure for surface waters, groundwater, and wastewater.

7 years of professional experience

Evers Reservoir and Braden River, Manatee County
Project Scientist responsible for quarterly field collection of water quality samples and coordination with subcontract laboratory. Implements this on-going water quality study of the Evers Reservoir and Braden River in compliance with water use permit conditions. Collects water quality samples from 2 stations within the Evers Reservoir and 10 stations within the Braden River for several parameters. Water quality data are collected quarterly with the results summarized in quarterly data reports.

Palmer Ranch Development, Ltd., Sarasota County, Florida
Project scientist conducting semi-annual water quality monitoring and sampling at 10 stations within Catfish, South, and North Creeks. Prepares quarterly data reports discussing water quality analyses and an annual interpretive report.

Education	BS, Wildlife and Fisheries Science, Pennsylvania State University
Professional Registrations/ Certifications	Leadership in Energy and Environmental Design Accredited