NAPLES BAY SURFACE WATER IMPROVEMENT & MANAGEMENT PLAN RECONNAISANCE REPORT

FEBRUARY 2006

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TABLE OF CONTENTS

LIST OF ACRONYMS AND ABREVIATIONS

As	Arsenic
ASR	Aquifer Storage and Recovery
BCB-RCT	Big Cypress Basin Restoration Coordination Team
BCB – SFWMD	Big Cypress Basin division of South Florida Water Management District
BOD	Biologic Oxygen Demand, Biochemical Oxygen Demand
CERP	Comprehensive Everglades Restoration Plan
Cd	Cadmium
CDM	Camp Dresser & McKee
Cfs	Cubic feet per second
CHNEP	Charlotte Harbor National Estuary Program
CIWQFS	Comprehensive Integrated Water Quality Feasibility Study
COD	Chemical oxygen demand
Cr	Chromium
CREW	Corkscrew Regional Ecosystem Watershed
CSWCD	Collier Soil and Water Conservation District
Cu	Copper
CWA	Clean Water Act
DBHYDRO	SFWMD's environmental data retrieval system
DDT	Dichloro-diphenyl-trichloroethane
DHI	Danish Hydrologic Institute
DO	Dissolved oxygen
DP	Dissolved phosphorus
EIS	Environmental Impact Statement
EMAP	Environmental Monitoring and Assessment Program funded by EPA
FDEP	Florida Department of Environmental Protection
FDOH	Florida Department of Health
Fe	Iron
FEMA	Federal Emergency Management Act
FFWCC	Florida Freshwater Fish and Wildlife Conservation Commission
FGCU	Florida Gulf Coast University
FIRM	Flood Insurance Rate Map
FIU	Florida International University
FLUCCS	Florida Land Use, Cover and Forms Classification System developed by FDOT
FWC	Florida Fish and Wildlife Commission
FWRI	Florida Wildlife Research Institute (Part of FWC, formerly named the Florida Marine Research Institute (FMRI))
GIS	Geographic Information System
GWIS	Groundwater Information System
Hg	Mercury
HMW	High molecular weight
IN	Inorganic nitrogen
IWR	Impaired Waters Rule
LEGACY	Data from 1998 and earlier that was maintained in first edition EPA
MSTBU	Municipal Service Taxing Benefit Unit
NADP	National Atmospheric Deposition Program
NAWQA	National Water Quality Assessment Program
NH3, NH4	Ammonia, ammonium

LIST OF ACRONYMS AND ABREVIATIONS (continued)

NO2	Nitrite
NO3	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWIS	National Water Information System
ON	Organic nitrogen
ONRW	Outstanding National Resource Water
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PDF	Portable Document Format using Adobe Reader/Acrobat
PMP	Project Management Plan
PEL	Probable effect limit
PSU	Practical salinity units a calculated measure of parts per thousand
QAPP	Quality Assurance Program Plan
QAQC	Quality Assurance Quality Control
RBNERR	Rookery Bay National Estuarine Research Reserve
ROMA	Regional Offsite Mitigation Area
SBIO	Florida Department of Environmental Protection's Statewide Biological Database
SFWMD	South Florida Water Management District
Si	Silicon, Silicates
SMP	Submitochondrial particles
SOFIA	South Florida Information Access run by USGS
STORET	Storage and Retrieval EPA data repository (1999 to date)
SWFFS	Southwest Florida Feasibility Study
SWIM	Surface Water Improvement and Management
TBT	Tributytin
TDS	Total dissolved solids
TEL	Threshold effect limit
TIP	Transportation Improvement Program
TKN	Total kjeldahl nitrogen
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USF	University of South Florida
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WATSTOR	USGS Water Data Storage and Retrieval System
WBID	Water Body Identification
WMD	Water Management District
Zn	Zinc

ACKNOWLEDGEMENTS

This Naples Bay Surface Water Improvement and Management Reconnaissance Report was produced for the South Florida Water Management District by Debra Childs Woithe, Inc. Debra Woithe and Sherry Brandt-Williams, Ph.D., co-authored the report. Carla N. Palmer, P.E., Stormwater Management Division Director for the South Florida Water Management District, provided programmatic oversight and guidance and co-edited the report. Liz Abbott, PMP, lead project manager for the South Florida Water Management District, managed and co-edited the project. Special thanks to Scott Legg of Atlas Management, Inc. working for the South Florida Water Management District, and the numerous other participants and contributors for providing guidance and assistance with data and references for the report.

This report characterizes the Naples Bay Basin, past and present, and reviews information pertinent to the development of a Surface Water Improvement and Management (SWIM) Plan. It is an inventory of monitoring data, modeling efforts, studies, projects, plans and programs within the Study Area. Additional details of information within the main report and less relevant information that is not included in the main body of the report are provided in Appendix A. Credible sources of information were reviewed and summarized as presented. Interpretation and application of data was not within the scope of this effort, and was reserved for future efforts. Much of the text and graphic material in this report was taken directly from the source document.

1 INTRODUCTION

Naples Bay, on the coast of Collier County, Florida, is a long, narrow estuary formed by the confluence of the Gordon River, and other small tributaries, that empty into the Gulf of Mexico. The shallow, north-south oriented waterbody originates at the mouth of the Gordon River in downtown Naples. The Bay's connection to the Gulf is through Gordon Pass, several miles to the south. Dollar Bay, the southern lobe of the Naples Bay system south of Gordon Pass is connected to Rookery Bay and the Marco River further south by a shallow waterway with a dredged channel. The Naples Bay Basin is a flat, low elevation region with the City of Naples and Naples Bay in its southwestern corner (Figure 1). Moving northeast from Naples Bay, the Basin becomes increasingly more rural and is dominated by agriculture and forested wetlands.

The 120 square mile Naples Bay Basin lies within the Big Cypress Basin, and shares borders with the Corkscrew-Cocohatchee Basin to the north, Faka-Union Canal Basin to the east, and the Henderson Creek and District VI Basins along the southeast. The Naples Bay Basin is bounded by the Gulf of Mexico to the west and partially by Immokalee Road to the north. Its easternmost extent is along Everglades Boulevard., with a southeastern boundary crossing near the I-75-CR 951 junction, and terminating at the Gulf of

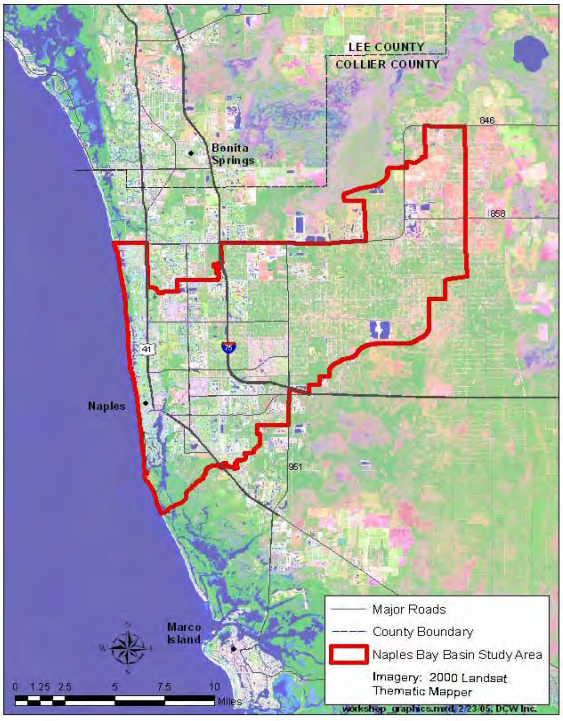

Figure 1. The Naples Bay Basin Study Area.

Mexico within the northwestern corner of the Rookery Bay Reserve.

During the past century, the Bay and its watershed have been heavily altered by drainage, agriculture, and most recently urban development activities. As a result, Bay water clarity and water quality, freshwater inflows, and surface water levels and natural habitats in the Basin are much different than their historic conditions. The Bay once received drainage from a 10 square-mile basin, but an extensive system of large drainage canals have extended the Basin to the east and north and enlarged it to approximately 120 square miles. On the edges of the Bay itself, extensive areas of mangroves and salt marsh have been replaced by canals, seawalls and bulkheads in the past 60 years. The headwaters of the Gordon River and other Naples Bay tributaries (including Rock and Haldeman Creeks) have been extensively channelized. This drainage canal system lowered surface water levels and facilitated extensive agricultural development. Urban development followed close behind. The most significant of these drainage features is the Golden Gate Canal which receives water from a series of canals to the north and east and empties into the Gordon River just north of Naples Airport.

A water body of regional and statewide significance, Naples Bay is currently ranked in Tier 2 of the SFWMD Priority Water Body List. The list was updated and approved in 2001 according to FDEP based criteria. The development of a SWIM plan for Naples Bay was authorized by the SFWMD Governing Board in 2003 (Bauer, 2003). In preparation for that effort, this Naples Bay SWIM Reconnaissance Report was authorized in 2005.

PROJECT DESCRIPTION

The project objective was to identify sources of existing data, identify gaps in existing data, and identify related programs within the Study Area. The intent of the report is to provide a meaningful resource for the development of the Naples Bay SWIM Plan. Information pertaining to the Naples Bay Basin was documented, reviewed and summarized in order to assess the Study Area in terms of current water quality, water quantity, and ecological features. In general, this scope of work consists of a review of existing studies and data, work group meetings, GIS mapping of land use and other data, and problem identification. All data and documents cited in this narrative were provided to SFWMD.

This project consisted of six tasks, defined below:

Task 1. Review of Studies and Data. Review and concisely summarize existing studies and relevant data. List and describe data sources compiled. Focus review process on technical aspects related to surface water movement/storage and factors affecting these activities.

Task 2. Land Use/Land Cover and Conservation Land Mapping. Map current and future land use/land cover, publicly owned land and land of potential significance for acquisition/

conservation. Aerial calculations and summaries.

Task 3. Working Group Meetings. Up to three inter-agency meetings to identify and characterize data, issues and other information for inclusion in the report.

Task 4. Additional GIS Mapping. Compile, document and provide relevant spatial data available for the study. Create maps for report.

Task 5. Problem Identification. Identify and summarize problems such as flooding; water quality; rare, endangered or protected ecosystems; and gaps in information that would be necessary to develop solutions and complete a SWIM plan.

Task 6. Reconnaissance Report. Summarize findings and list information gaps for above tasks. Provide a synopsis of available data and issues.

IMPAIRED WATERS RULE STATUS

Section 303(d) of the Federal Clean Water Act (CWA) requires states to list waters that do not meet applicable water quality standards and to establish Total Maximum Daily Loads (TMDLs) for those waters on a prioritized schedule. The 303(d) List is based primarily on the state's 1996 305(b) Water Quality Assessment Report, which uses a watershed approach to evaluate surface waters, ground waters, and wetlands. In 1998, EPA approved Florida's 1998 303(d) Impaired Waters List, which was based on existing, readily available data or best professional judgment However in 1999, the Florida Watershed Restoration Act, Section 403.067, F.S. was enacted by the Florida Legislature. This law requires FDEP to adopt by rule, a scientific methodology for analyzing environmental data and determining whether a water body is impaired or healthy. All water bodies on the 1998 303(d) List are required to be either 1) verified as impaired, 2) de-listed as they are meeting water quality standards, or 3) placed on a planning list if insufficient data exists (Category 3). FDEP's 2002 update to Florida's 1998 303(d) Impaired Waters List for Group 1 Basins was adopted August 2002 by FDEP Secretarial order and submitted to EPA October 2002. The verified list and de-list lists were amended by FDEP Secretarial order March 2003. The 2002 update was developed in accordance with EPA guidelines for Integrated Water Quality Monitoring and Assessment Reports.

TMDL's establish the maximum amount of pollutants a water body can assimilate without exceeding water quality standards. The Florida Watershed Restoration Act, Chapter 99-223, Laws of Florida, addresses processes for refining the list and for calculating and allocating TMDLs. According to EPA guidelines, waters expected to attain and maintain applicable water quality standards through other Federal, State, or Local requirements do not need to be included on the 303(d) list. (www.dep.state.fl.us/water, Eric Livingston, FDEP, personal communication).

SFWMD and FDEP will be working closely on BMPs and data modeling pertaining to both SWIM and TMDLs.

The Naples Bay Basin is a Group 1 Basin in FDEP's South District, and is in the Southwest Coast Planning Unit of the Everglades West Coast Basin. Planning units comprise a group of smaller assessment units referred to as WBIDs, for water body identification. Nine of the forty-one WBIDs in the Southwest Coast Planning Unit occur within the Naples Bay Basin (Table 1, Figure 2). Other WBIDs have boundaries that overlap the Naples Bay Basin, though their water body and watershed are not considered to be within the Basin. See Section 3, Geographic Analysis, for further discussion of basin and sub-basin delineation. Information from the FDEP 2002 Updated Master List and 2003 amendments lists was compiled into Table 1, below, for ease of reference. All information from those FDEP 303(d) lists for relevant WBIDs is provided in Appendix A1.

The status of each WBID is summarized according to the most limiting parameter in Figure 2. According to information provided in the 303(d) lists, the primary parameter of concern is dissolved oxygen (DO). Two water bodies, the Gordon River Canal and Henderson Creek Canal, are verified impaired due to low DO. Biological oxygen demand (BOD) is the causative pollutant in the Gordon River and Henderson Creek Canals.

Though several WBIDs meet standards for some parameters (turbidity and fecal coliform), all WBIDs have planning list status for at least one parameter. Planning list status includes no data, insufficient data, and sufficient data showing potential impairment (Categories 3a, 3b, and 3c). WBIDS on the planning list will undergo Impaired Water Rule assessments for TMDLs and receive a new listing in fall of 2006 after further monitoring is conducted. The projected year for TMDL development of all necessary WBIDs in the Naples Bay Basin is 2007.

Table 1. FDEP 303(d) Waterbody Status (compiled from the Updated Master List (October 2002), and the Amended Verified and De-list Lists (March 2003)).

WBID	Water Body Name	Proposed Status	Parameter	Priority
3259C	Gordon River	Planning List	DO	Low
		No Data	BOD	Low
		Planning List	Total Coliforms	Low
		Insufficient Data	Fecal Coliforms	Low
		De-listed	Nutrients	-
3258 D	Gordon River Canal	Verified List	DO	Medium
3259 E	Henderson Creek Canal	Verified List	DO	Medium
3259 F	Golden Gate Canal	Planning List	DO	-
		Meets Standard	Turbidity	-
3259 G	Naples Bay	Planning List	Nutrients (chlorophyll)	Low
		Planning List	DO	Low
3259H	Henderson Creek Canal	Planning List	DO	-
3259 Q	Outer Clam Bay	No data	-	-
3259 T	Lake Avalon Mid-Lake	Insufficient Data	-	-
3259 Y	Vanderbilt Way	Insufficient Data	-	

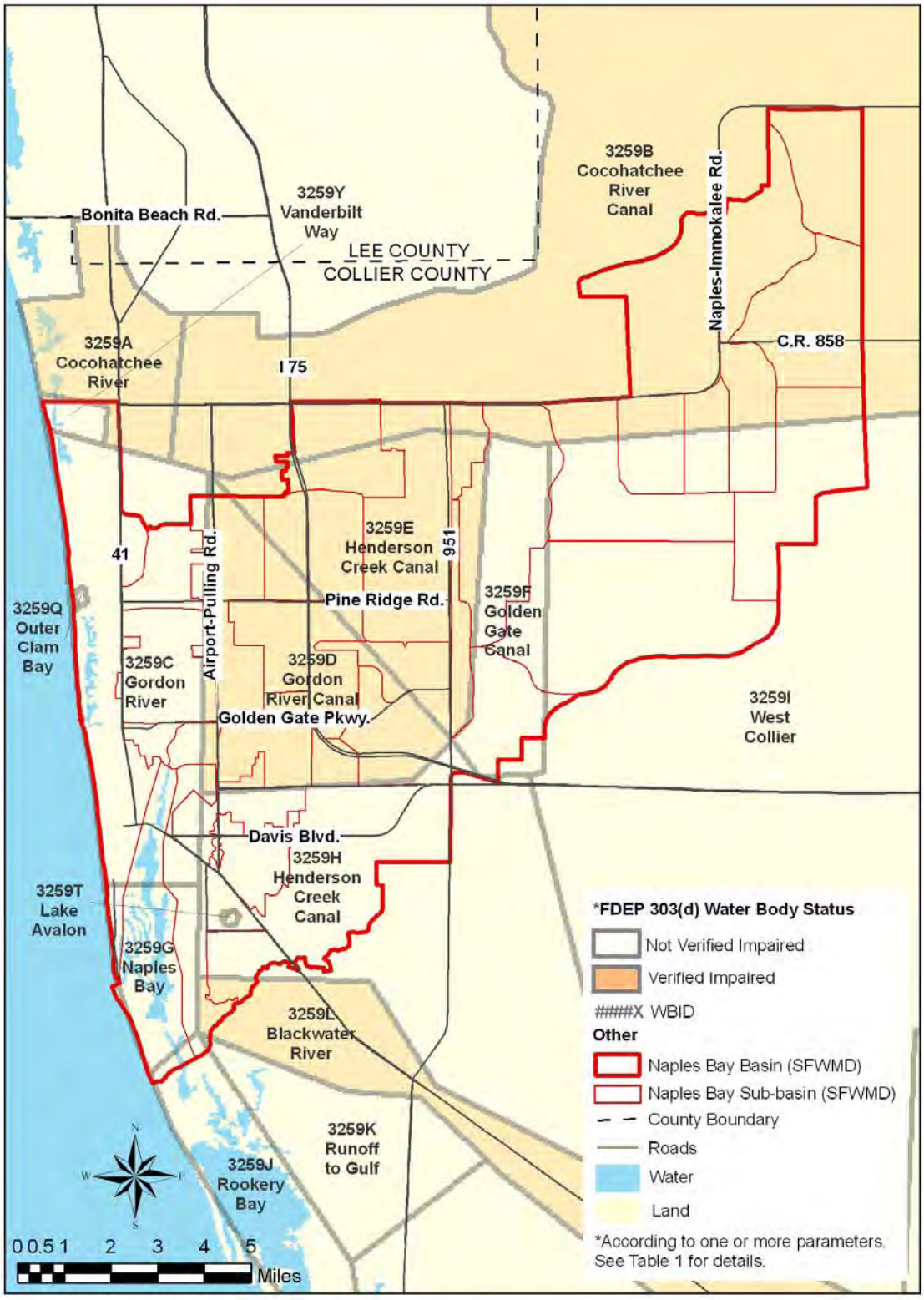

Figure 2. FDEP 303(d) WBID and Verified Impaired Waterbody Status (data source: FDEP, 2005).

GOVERNMENT UNITS WITH JURISDICTION

Governmental units that have jurisdiction over Naples Bay and its drainage basin include Federal and State agencies and the SFWMD. The Basin also lies entirely within Collier County and the boundaries of the Southwest Florida Regional Planning Council (SWFRPC). The City of Naples is located entirely within the Study Area, as is the Pelican Bay Municipal Service Taxing Benefit Unit (MSTBU). Special Districts within the Study Area that are relevant to surface water improvement and management are listed below (Table 2). The function of the Special District, year established, local government with authority over the district, and Florida Statute that governs their operation are included. A Special District is identified as independent if no other governmental entities have control over their budget or governing board membership. The information in Table 2 is from the Florida Department of Community Affairs (FDCA) Special District Information Program Official List of Special Districts On-Line. None of the special districts within the Study Area are included in the SFWMD GIS data set, and, while some of their geographic boundaries are apparent, they are not readily available for mapping.

PARTICIPANTS AND CONTRIBUTORS

SFWMD requested participation in this project from government agency representatives with expertise in the subject matter and Study Area. A half-day working group meeting was held March 1, 2005 to identify available information, data and their sources that should be included in the Reconnaissance Report. All issues and sources of information discussed at workshop were considered in the development of this Reconnaissance Report. Many other organizations and individuals were contacted for information and to follow up on leads discussed at the workshop. A second half-day working group meeting was held June 1, 2005 to review and receive comments on the draft report. Additional information, suggested clarifications and corrections were incorporated into the final report as appropriate. The seventy-two working group participants and other contributors to the project are acknowledged on the following page.

The information gathering process was initiated in February 2005, and accelerated following the March meeting. Input from the twenty participants of the first meeting was recorded. Between meetings, information was gathered and reviewed with many suggestions and leads followed through phone and/or email communication. A comprehensive set of notes from these discussions was maintained. All information (data, studies, projects, etc.) was logged into a spreadsheet designed to track and manage the information. The tracking matrix was maintained and updated throughout the project, with fields for item name, source, contact person, description, comments, status, format, reviewer name and review status. The spreadsheet contained over 200 records at the time of project completion. All information, both digital and paper, was organized and stored for use in the review process and for delivery with the final report. Information from

the fifteen participants of the second working group meeting was recorded on tape. The tracking matrix and notes were updated as additional information was gathered and reviewed for the final report.

Table 2. Special Districts within the Study Area.

District	Function	Local Gov. Authority	Year Established	Independent	Statutory Authority
City of Naples Airport Authority	Airport/Aviation	City of Naples	1969	No	Ch. 332, F.S.
Collier County Airport Authority	Airport/Aviation	Collier County	1993	No	Ch. 332, F.S.
Cedar Hammock Community Development District	Community Development	Collier County	1999	Yes	Ch. 190, F.S.
Heritage Greens Community Development District 2	Community Development	Collier County	1993	Yes	Ch. 190, F.S.
Lely Community Development District	Community Development	Collier County	1990	Yes	Ch. 190, F.S.
Naples Heritage Community Development District	Community Development	Collier County	1996	Yes	Ch. 190, F.S.
Pelican Marsh Community Development District	Community Development	Collier County	1993	Yes	Ch. 190, F.S.
Pine Air Lakes Community Development District	Community Development	Collier County	1994	Yes	Ch. 190, F.S.
Collier County Community Redevelopment Agency	Community Redevelopment	Collier County	2000	No	Ch. 163, Part III, F.S.
East Naples Bay Special Taxing District	Environmental Protection & Navigation	City of Naples	1987	No	Section 165.041(2).F.S.
Moorings Bay Special Taxing District	Environmental Protection & Navigation	City of Naples	1987	No	Section 165.041(2).F.S.
Collier County Industrial Development Authority	Industrial Development	Collier County	1978	No	Ch. 159, Part III, F.S.
Collier Mosquito Control District	Mosquito Control	Collier County	1950	Yes	Ch. 582, F.S.
Collier Soil & Water Conservation District	Soil & Water Conservation	Collier County	1984	Yes	Ch. 582, F.S.
Collier County Water-Sewer District	Water & Sewer	Collier County	1978	No	Ch. 153.53, F.S.
Immokalee Water & Sewer District	Water & Sewer	Collier County	1978	Yes	Ch. 153.53, F.S.
Big Cypress Stewardship District	Water Control	Collier County	2004	Yes	Section 298.01, F.S.

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2 HISTORY OF THE BASIN

BEFORE 1860

The southwest coast of Florida was under water until about 5000 years ago. The gentle ridges and embayments conducive to mangrove island formation are remnants of several different long-term sea rises that created shorelines at seven different levels within the Pleistocene era, and are now referred to as terraces. The two lowest levels, Talbot and Pamlico, are evident in Collier County. These elevations were estimated to be 25 to 42 feet above sea level in the mid-20th century for the Talbot terrace and 20 to 25 feet above sea level for the Pamlico. All of the Study Area is part of the Pamlico terrace, with the potential exception of the extreme northeast corner which may lie on the Talbot terrace.

Earliest documented human settlements, the Calusa Indians, date from 2500 years ago. The Spanish attempted to colonize the area in the early 1500s, but met with fierce resistance from the Calusas. After 40 years of fighting and disease introduction the Calusa population was gone, and no permanent Spanish settlements remained. In 1821 when the U.S. acquired Florida from Spain, there were about 5000 Seminoles living in the Collier County area. In 1855, these native-Americans had been driven further east into the Big Cypress and Everglades areas.

The early Naples Bay Basin was characterized by surface water sheet-flow, with historic vegetation communities corresponding with the Basin's flat topography (Figure 3, Southwest Florida Pre-Development Vegetation Map). The vast majority of the Basin (75%) was covered with Mesic or Hydric Flatwoods. Cypress and other swamp forests were primarily in the eastern portion of the basin and covered less than 10% each. Xeric hammock communities were near the coast along the coastal ridge now occupied by US41. Mangrove swamps fringed the coast and much of Naples Bay. Freshwater lakes were largely absent from the landscape. (Deuver et al. 2001, Wanless et al. 1994, Scholl 1964, McCoy 1962, 1954 Collier County soil maps SCCS)

1860 TO 1930

Roger Gordon and Joe Wiggins arrived in Naples in the late 1860's. Although the river in this study was named after Gordon and passes were named after each, they did not stay. The first permanent settlers were John and Madison Weeks, taking residence along the Gordon River in 1876. In 1886, over 3,000 acres between the Gulf of Mexico and what came to be known as Naples Bay was purchased by a group of Tallahassee businessmen calling themselves the Naples Town Improvement Company.

In 1887, the Naples Town Improvement Company was reorganized by General John S. Williams and Walter N. Haldeman, prominent Kentucky men, into the Naples Company with ambitious plans for Naples development. One of the Gordon River's tributaries is named after Haldeman. The Naples

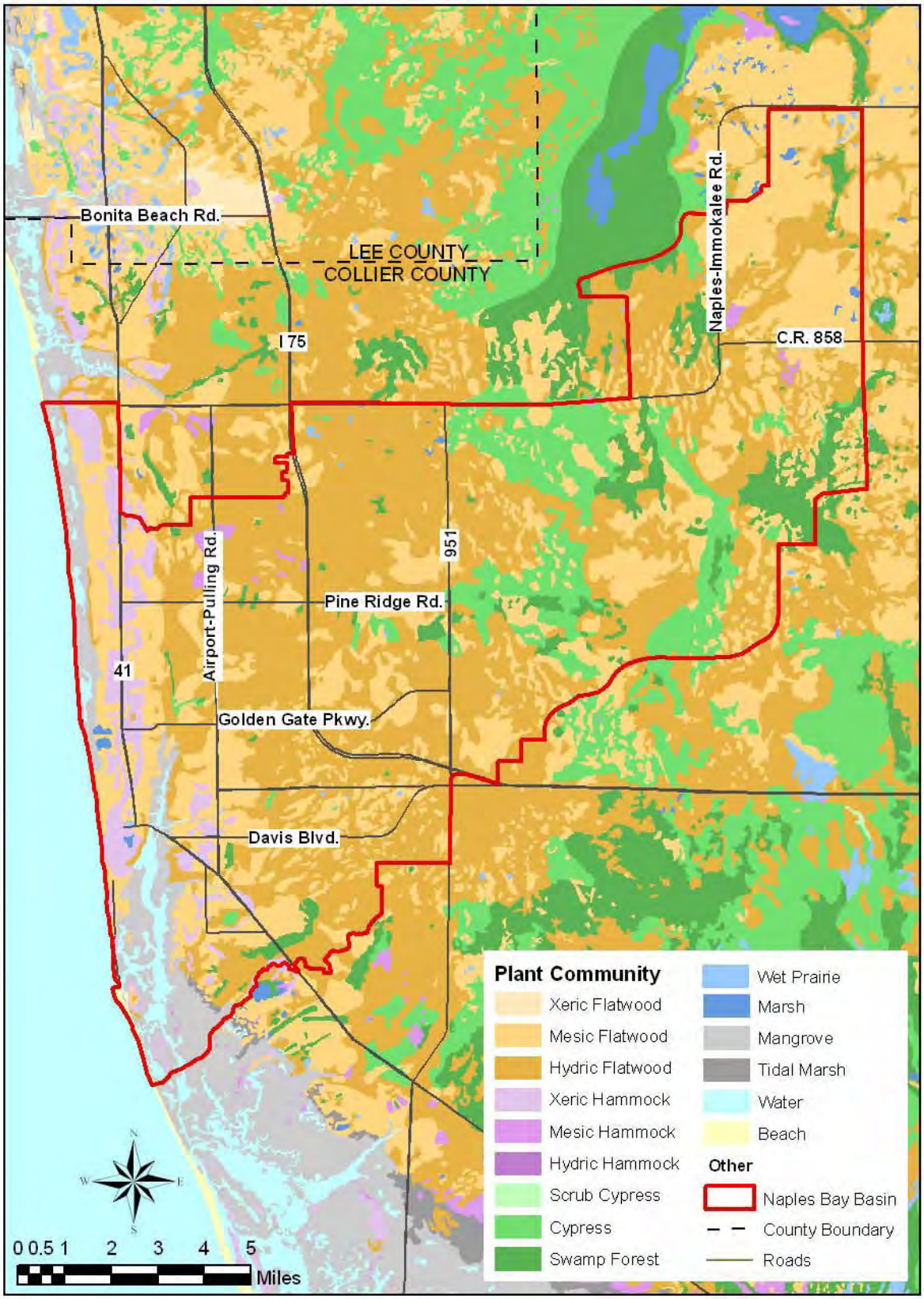

Figure 3. Pre-Development Vegetation **(Data source: SFWMD, Southwest Florida Predevelopment Vegetation Map, 2002).**

Hotel (Figure 4) and a 600 foot pier were built in 1888. By 1890, the Naples Company was bankrupt and the Naples Bay area remained isolated and sparsely settled for the next 40 years.

The Tamiami Trail, built to connect Miami with Tampa, was completed in Collier County in 1928, and was largely funded by Barron Collier. Based on the promise of completion of this road, the area to the west of Dade, Hardy and Monroe and south of Lee counties was accepted as the 62nd Florida county and named after Collier in 1923. The first train delivered tourists in 1927 to the depot that is now an historic building on 10th Street and 5th Avenue South. The county population was about 1200 and Naples had less than 400 residents. The building of the Tamiami Trail and the railroad were the first major impediments to surface water, overland flow in this area. (Baum 1973, Tebeau 1957)

Figure 4. Naples Hotel in downtown Naples circa 1906 (State Library & Archives of Florida).

1930 TO PRESENT

In 1930, a protected channel, 3-feet deep and 40-feet wide, was dredged from Naples Bay to Marco Island. In 1940, the federal government completed the channel, 6-feet deep and-70 feet wide, from the southern boundary of Naples to the Big Marco Pass, a total of 10 miles. In 1945, the federal government relocated the channel east of Hurricane Pass due to storm damage. Landscape characteristics of the area between Naples and Gordon Pass at the time can be seen in Figure 5. Today vessels must leave a sheltered bay channel at Wiggins Pass, travel in the Gulf, then re-enter a sheltered channel at Gordon Pass. The dredged channels and other shoreline changes can be seen in the nautical charts and aerial photographs in Figures 6 through 9.

Figure 5. Road from Naples to Gordon Pass circa 1935 (State Library & Archives of Florida).

A U.S. Army Air Field was constructed at the Naples Airport in 1943 (Figure 10), and

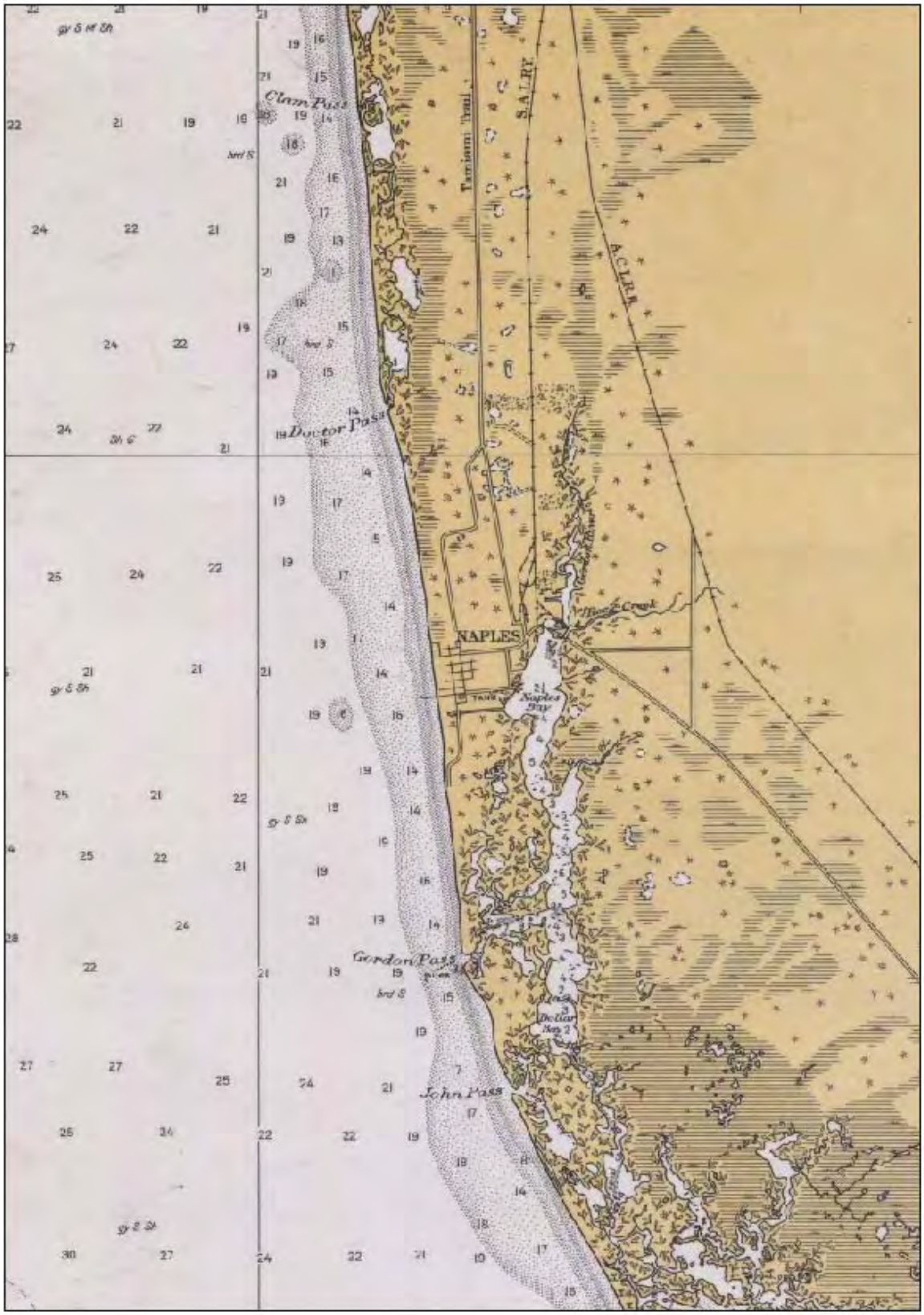

Figure 6. Nautical chart of Naples Bay, Dollar Bay and the Gulf of Mexico in 1931 (US Coast and Geodetic Survey, 1931).

Figure 7. Nautical chart of Naples Bay, Dollar Bay and Gulf of Mexico in 1984 (NOAA-NOS, 1984).

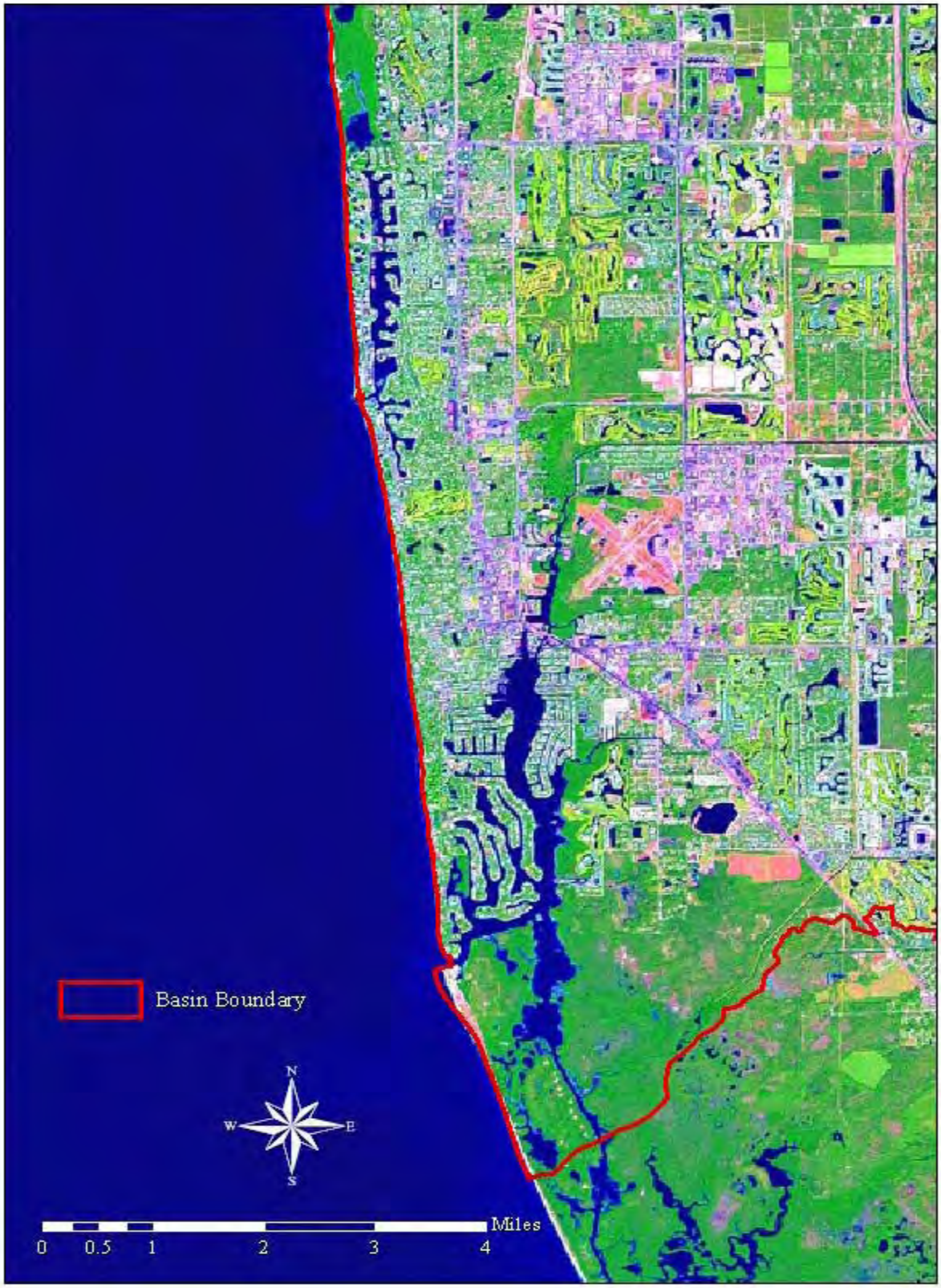

Figure 8. 2000 Satellite image, Naples Bay, Dollar Bay, and the Gulf of Mexico (data source: SFWMD).

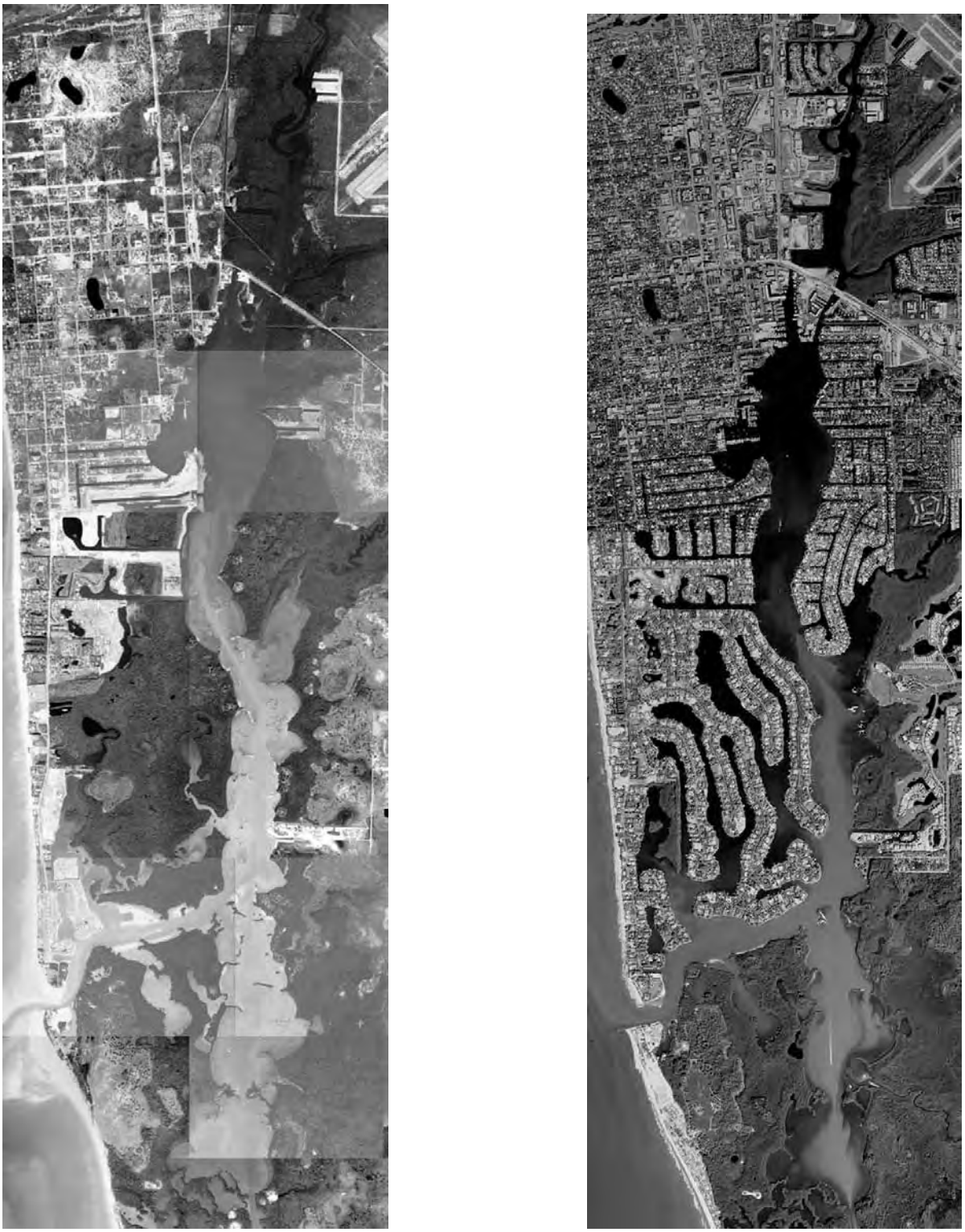

Figure 9. Naples Bay and Gordon Pass in 1953 (left) and 1999 (right) (RBNERR, source: USGS).

by 1944 there were over 200 soldiers stationed in Naples, almost doubling the population. By 1953, the airport was conveyed to the city and county, a bank had been built and residents had funded several parks and civic improvements. Port Royal and Aqualane Shores were the first developments to dredge canals and create waterfront property. A hospital, expanded water treatment plant, schools and businesses were built at the same time, and by 1960 the population count was almost 5000.

Figure 10. Clearing on the site of Naples Airport circa 1935 (State Library & Archives of Florida).

Construction of the City of Naples drainage system began in the 1940s in "Old Naples", with additional construction in the 50's and 60's as Ridge Lakes and Coquina Sands subdivisions were built. The Cove and Public Works Pumping Stations were added in the mid-1960s. Drainage systems were added for the Moorings, Port Royal and Royal Harbor in the late 60's and early 70's with the Lantern Lane station located in Port Royal. During the same time period, many small lakes were constructed to deal with drainage issues, further altering the natural system in an area where lakes were notably absent.

Hurricane Donna passed directly over Naples in 1960, destroying the pier and causing extensive inland damage. The influx of insurance and disaster funding stimulated growth, and Naples became the fastest growing city in the nation. Meanwhile, the Gulf American Corp. began development of 113,000 acres of pine and cypress forests in the county's interior – Golden Gate Estates. Gulf American dug 180 miles of canals, some of them 19-feet deep, and built 800 miles of roads. The southern portion is now Picayune Strand and is slated for restoration. Historic drainage of this mostly undeveloped area was south through the Faka-Union Canal. However, the northern section of Golden Gates Estates is developed and drainage currently enters the Gordon River through the Golden Gate Canal; effectively increasing the original Naples Bay watershed from about 10 square miles to over 100. Collier County's population continued to rise exponentially, passing the quarter million mark in 2000. The burden on infrastructure increases by almost 100,000 people every winter (Figure 11).

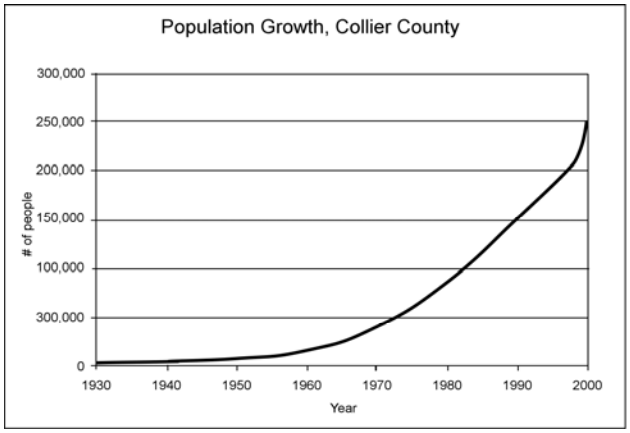

Figure 11. Population Growth in Collier County, 1930 – 2000 (Collier County 2001 Demographic and Economic Profile U.S. Bureau of the Census, 1930-1990-2000 Collier County Comprehensive Planning Section July 2000).

In 1970, the Naples City Council conducted a small water quality survey of Naples Bay. The results led to three City of Naples sewage system expansions in order to reduce the amount of sewage entering the Bay. In 1972, when the Naples Bay Study was begun by The Conservancy of Southwest Florida (the Conservancy), there were 117 residential canals in the Naples Bay complex. Some canals were in the City where adjacent residences had central sewer systems, but many were in the county where septic tanks were used for sewage treatment. In 1979, Port Royal and Aqualane Shores Phase 2 dedicated their canals to the City. Oyster Bay, Golden Shores and Royal Harbor developments retained their canals as private property.

In early 1988, plans were announced to purchase and develop the northern end of Key Island (Figure 12) which is the southern land mass bordering Gordon Pass. While the Conservancy opposed this plan, the Naples City Council did allow the 42 single-family homes. In 1993, 2,300 acres of Key Island became part of RBNERR, including those portions along Gordon Pass.

Figure 12. Gordon Pass and Key Island.

The result of 60 years of canal drainage, agricultural activities and urban development activities has been reduced water clarity, increased concentrations of contaminants and nutrients, and reduced dissolved oxygen levels in the Bay. The Bay once received drainage from about 10 square miles, but with the construction of the Golden Gate Canal system it receives surface water input form approximately 120 square miles. Extensive areas of mangroves and salt marsh have been replaced by canals, seawalls and bulkheads. Development activities in the watershed have altered the volume, quality, timing and mixing characteristics of freshwater flows reaching Naples Bay. Natural tributaries - Gordon River, Rock Creek, and Haldeman Creek - have been altered by urban infrastructure that have significantly changed the historic flowways to the Bay and impacted its biology. Seasonal influxes of fresh water from the Golden Gate Canal system have altered the natural salinity regime of the bay, resulting in declines in seagrass beds, and harmful impacts to all levels of flora and fauna in the aquatic ecosystem. (Tebeau 1957, Baum 1973, Naples Bay Study 1979, Collier County Comprehensive Planning Section 2000, City of Naples Engineering Division 1996)

3 GEOGRAPHIC ANALYSIS

This section describes the Naples Bay Basin primarily through maps using data available in GIS format. Spatial data available for the Study Area were compiled, reviewed and documented. The spatial data used to create the maps in the report were provided on DVD in ESRI compatible GIS format, with available metadata.

The Naples Bay Basin (as defined by the SFWMD for the purposes of this Reconnaissance Report and upcoming SWIM Plan) forms the boundary of the Study Area. There are 32 sub-basins within the Naples Bay Basin. Collier County, the City of Naples, FDEP and other organizations have different delineations for the basins and sub-basins within the Study Area (Figure 13). This is a basin boundary for planning purposes only and may change as more information becomes available from local drainage assessments and refined topographical efforts. The various reports, studies, etc. within this report may use the terms basin, sub-basin and watershed differently, as their geographic scopes differ.

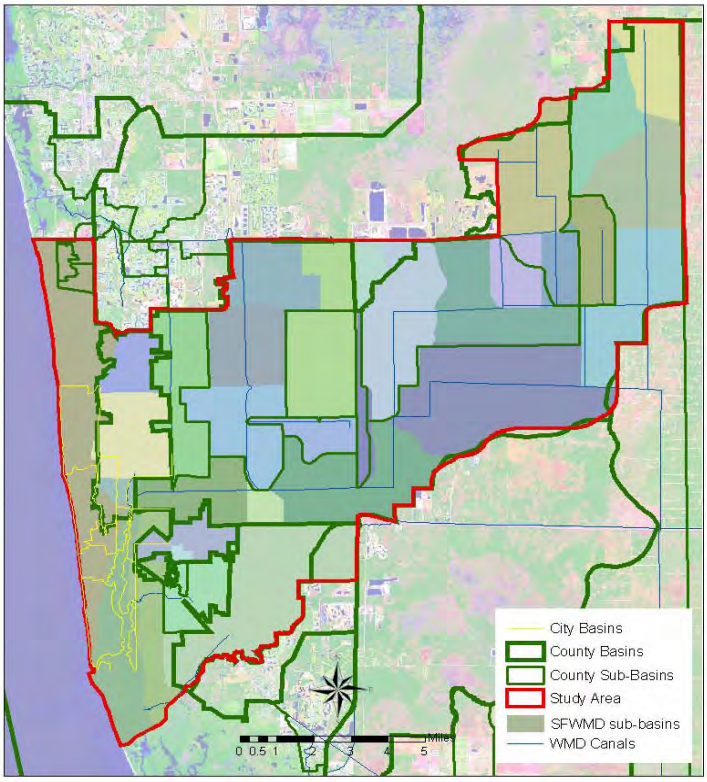

Figure 13. County, City and SFWMD basins and sub-basins (data sources: SFWMD, Collier County).

ESTUARIES

Naples Bay is a relatively narrow and shallow estuary ranging in width from 100 to 1500 feet, and in depth from 1 to 23 feet. The majority of the Bay is less than 5 feet deep with a navigational channel between 7 and 14 feet deep. The finger canals on the western side of the Bay are the system's deepest components. As part of the "Evaluation of Naples Bay Water Quality and Hydrologic Data" (Taylor, 2005), a detailed bathymetric survey of Naples Bay was completed (Figure 14). Data were collected from a hydrographic survey vessel with onboard geophysical sensors. From the 2004-2005 field data, one-half foot bathymetric contours were processed into a combination of 5 ft and 25 ft cells in raster GIS data sets.

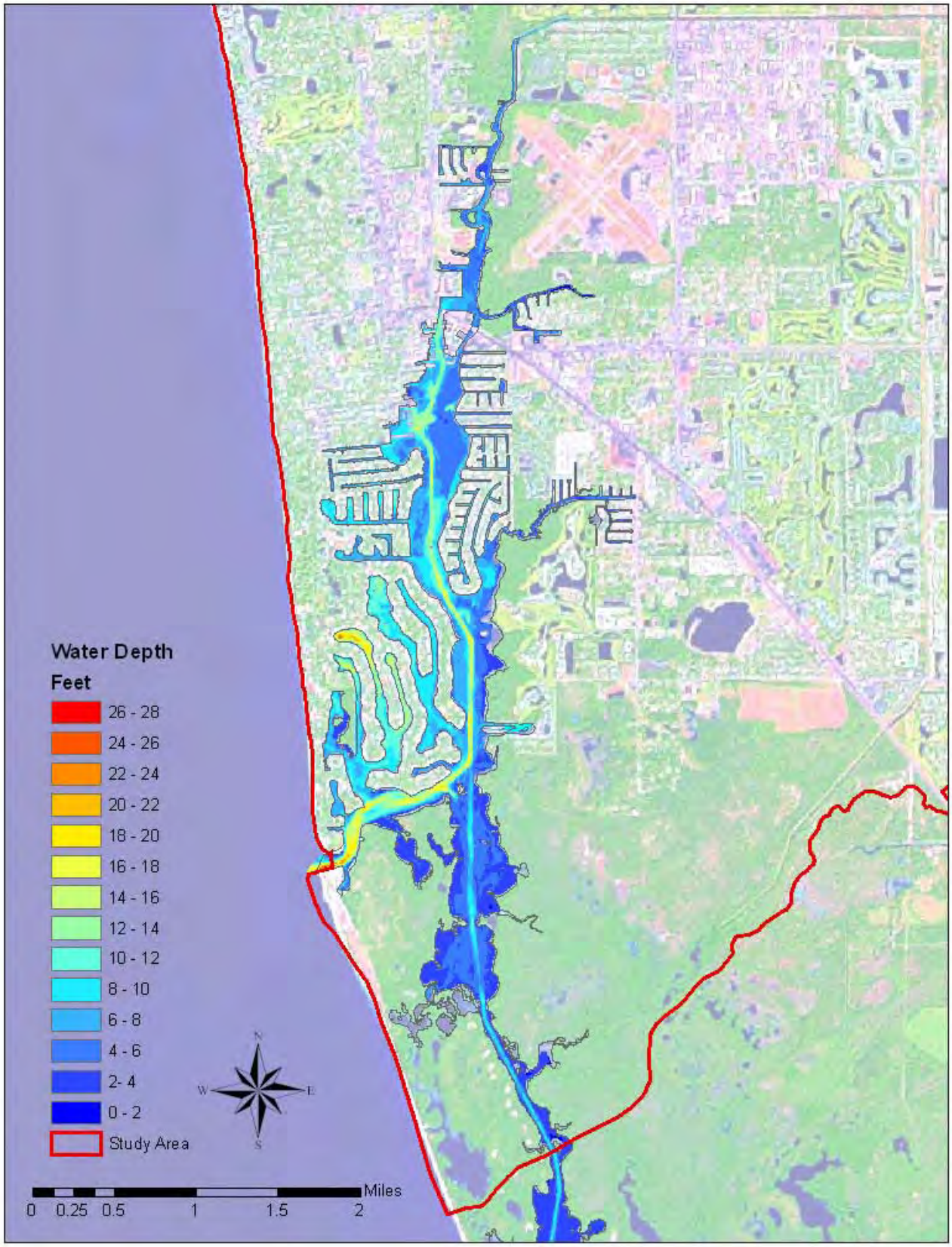

Figure 14. Bathymetry of Naples Bay and Dollar Bay (data source: SFWMD, 2005).

Substrates in the Bay and its canals are muddy, permeable sediments. Certain areas also have high organic content. Several dredged channels are maintained and marked for navigation throughout the Study Area. A dredged channel through Gordon Pass extends to the top of Naples Bay, and south through Dollar Bay to Marco Island. Doctor's Pass allows access to Venetian Bay from the Gulf of Mexico. There are several marine facilities, including marinas, boat ramps, hotels, resorts, and other establishments within the Study Area.

Tidal exchange occurs through Gordon Pass at the southern end of the Bay. Average daily tide range at Gordon Pass is 2.1 feet. The highest tides occur every two weeks during the "spring tides" at full and new moons. Spring tide ranges average 2.8 feet at Gordon Pass. Tidal ranges increase slightly moving north from Gordon Pass to the US 41 Bridge in downtown Naples as a result of amplification caused by the elongated shape of Naples Bay. Tidal ranges decrease in the Gordon River north of the bridge because tidal flow is limited by the constricted shape of Naples Bay in the vicinity of the bridge.

Salinities in Naples Bay vary both seasonally (wet season and dry season) and daily (incoming and outgoing tides). Average salinities at the US 41 Bridge range from 0 to 10 PSU in the wet season and occasionally approach 35 PSU (the salinity of the open Gulf) in the dry season. Salinity at the Gulf of Mexico near Gordon Pass is typically 35 PSU. The largest range in daily salinity is most often seen in the area of Naples Bay off Bayview Park. Low salinity surface layers move into this area during outgoing tides. Incoming tides force the low salinity waters north and inhibit the discharge of tributaries like Haldeman Creek.

During the wet season, the deeper portions of northern Naples Bay become stratified and form layers of different salinity water. Low salinity water flowing out of the Golden Gate Canal and other tributaries flows over the denser, high salinity bay waters. The result is a series of horizontal layers with increasing salinities from bay surface to bottom. In the northern Bay, these layers often do not mix. Since oxygen is produced in the upper layers, this lack of mixing results in low oxygen concentrations in the bottom layers. The Bay once received drainage from about 10 square miles, but with the construction of the Golden Gate Canal system it receives surface water input from approximately 120 square miles. Stratification problems are believed to have increased with both the increased freshwater flow and with the construction of deep, dead end canals. Stratification is less of a problem in the lower Bay where horizontal mixing from tidal currents is greater (Simpson et al., 1979).

TOPOGRAPHY, FLOOD ZONES, SOILS

In general, ground elevation increases gradually from Naples Bay and the coast towards the northeast portion of the Basin (Figure 15). The lowest areas of the Naples Bay Basin are the mangrove forests and the Bay at sea-level in the Basin's southwest corner. The highest elevations in the Basin are approximately 20 ft NGVD in the far northeastern corner near Immokalee. The majority of the Basin has elevations of 10 ft or less with a slow rise to the northeast. Elevations above 15 ft do not occur until north

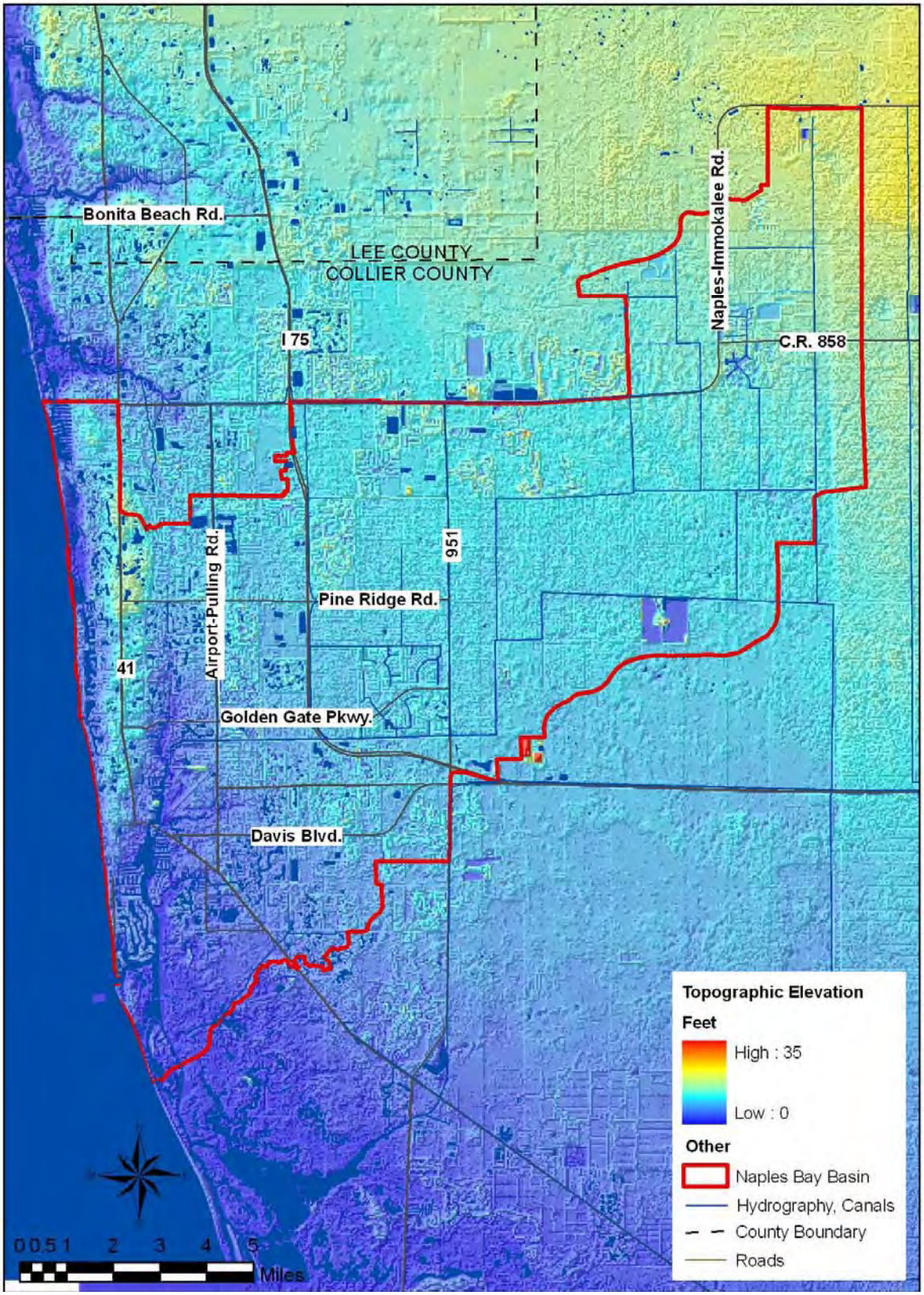

Figure 15. Topographic Elevation **(data source: SFWMD, Revised Elevation for the Southwest Florida Feasibility Study Area, 2004).**

of Oil Well Road (CR858). An exception is found along the US41 corridor within a mile of the coast. This road follows a north-south oriented coastal ridge with elevations between 10 ft and 15 ft.

Areas within the FEMA flood zone extend between roughly 3,000 and 15,000 ft. inshore (Figure 16). Revisions made to the Flood Insurance Rate Maps (FIRM) by FEMA, as shown in this report, will be effective November 17th, 2005. A large portion of the Basin is covered by hydric soils (Figure 17). Though much of the Basin can be characterized as a mosaic of hydric and upland soils, the coastal ridge in the western edge of the Basin is dominated by upland soils. A revision to the Collier County soils map is being done by USDA NRCS to correct for a 100-foot line offset in the GIS data that has been identified. The revised soil map reflecting the positional shift should be available in the near future.

LAND USE/LAND COVER

SFWMD current and future land use/land cover maps used in this Reconnaissance Report were created using FLUCCS (Figures 18, 19) to support CERP efforts in Southwest Florida. Their 1995-base SFWMD land use/land cover was updated to 2000-base conditions using the 2000-aerial photography and other sources. Partial updates were made for 2004 conditions. Future land use/land cover for 2025 and 2050 were developed from county future plans, other GIS data, and local expert knowledge. Other sources of current and future land use are available; however they are not as well suited for Naples Bay SWIM purposes. Collier County has a FLUCCS map updated by Wilson Miller, Inc. using 2001 aerial photography. Unfortunately, the map covers only the western portion of the County. The SFWMD 2000 FLUCCS map, developed as part of its District-wide, 5-year mapping program, was not available in time to meet CERP modeling needs. The Southwest 2000 FLUCCS, updated for SFWMD by URS, remains the preferred data set for CERP. A compiled, generalized future land use map is available from the SWFRPC and local governments have their own future land uses maps, however they do not use FLUCCS, and therefore do not allow direct comparison from one time period to the other. Land use/land cover acreages for the Basin for each of the three time periods are summarized in Table 3.

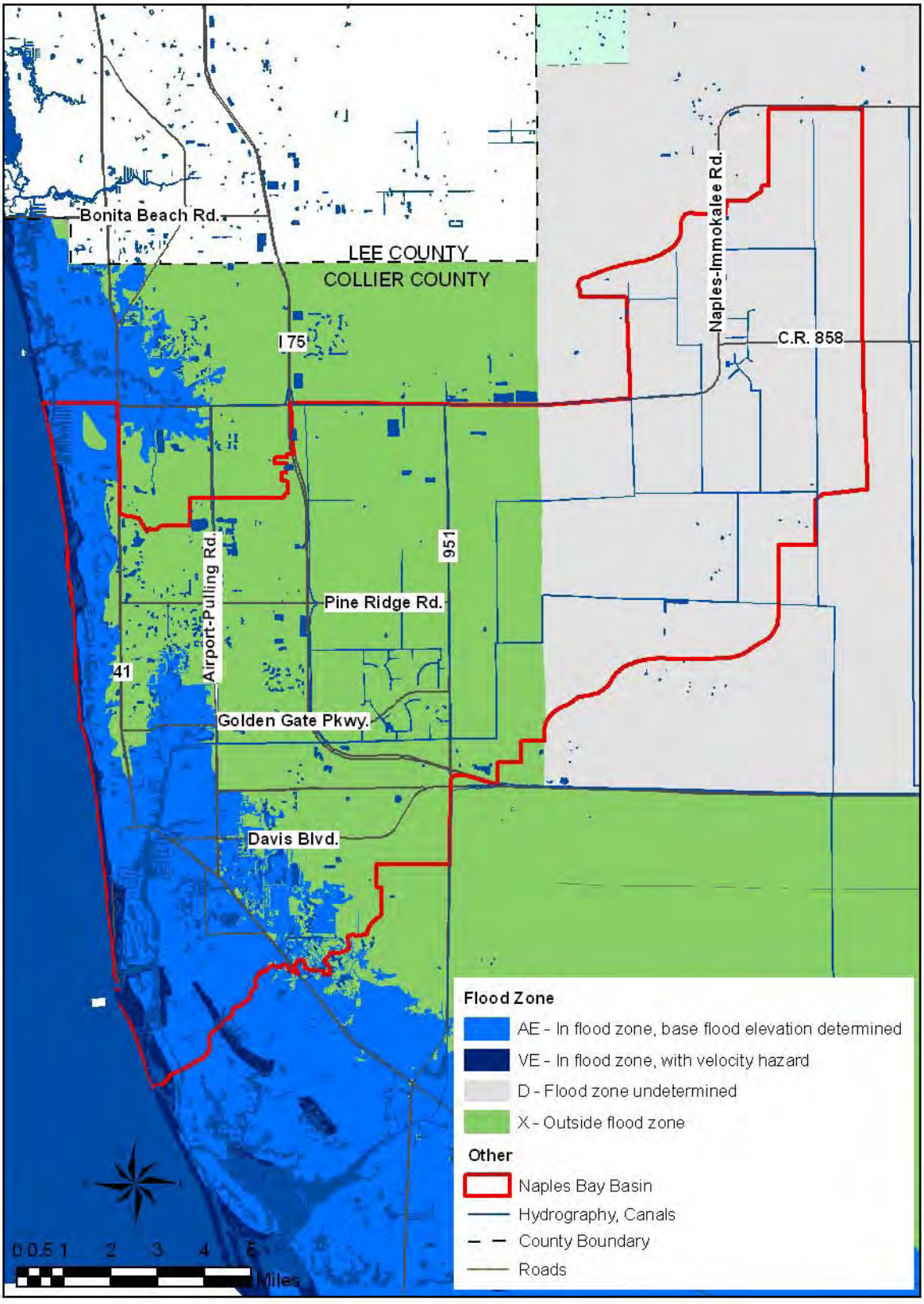

Figure 16. Flood Zones **(data sources: Collier County/ FEMA Flood Insurance Rate Map (FIRM), to be adopted November 2005).**

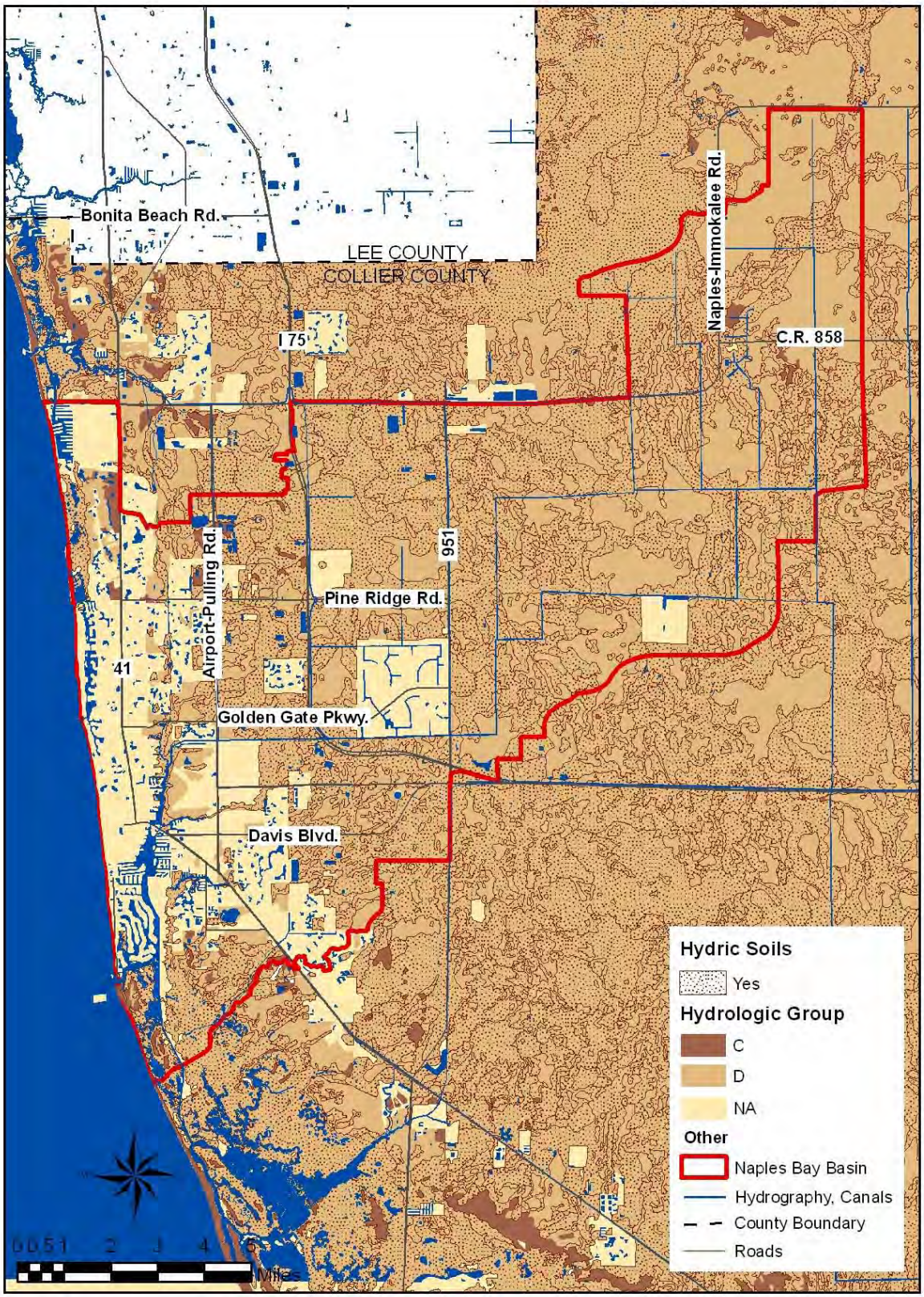

Figure 17. Hydric Soils and Hydrologic Soil Group (data source: USDA NRCS Soil Survey Geographic Database (SSURGO), 1995).

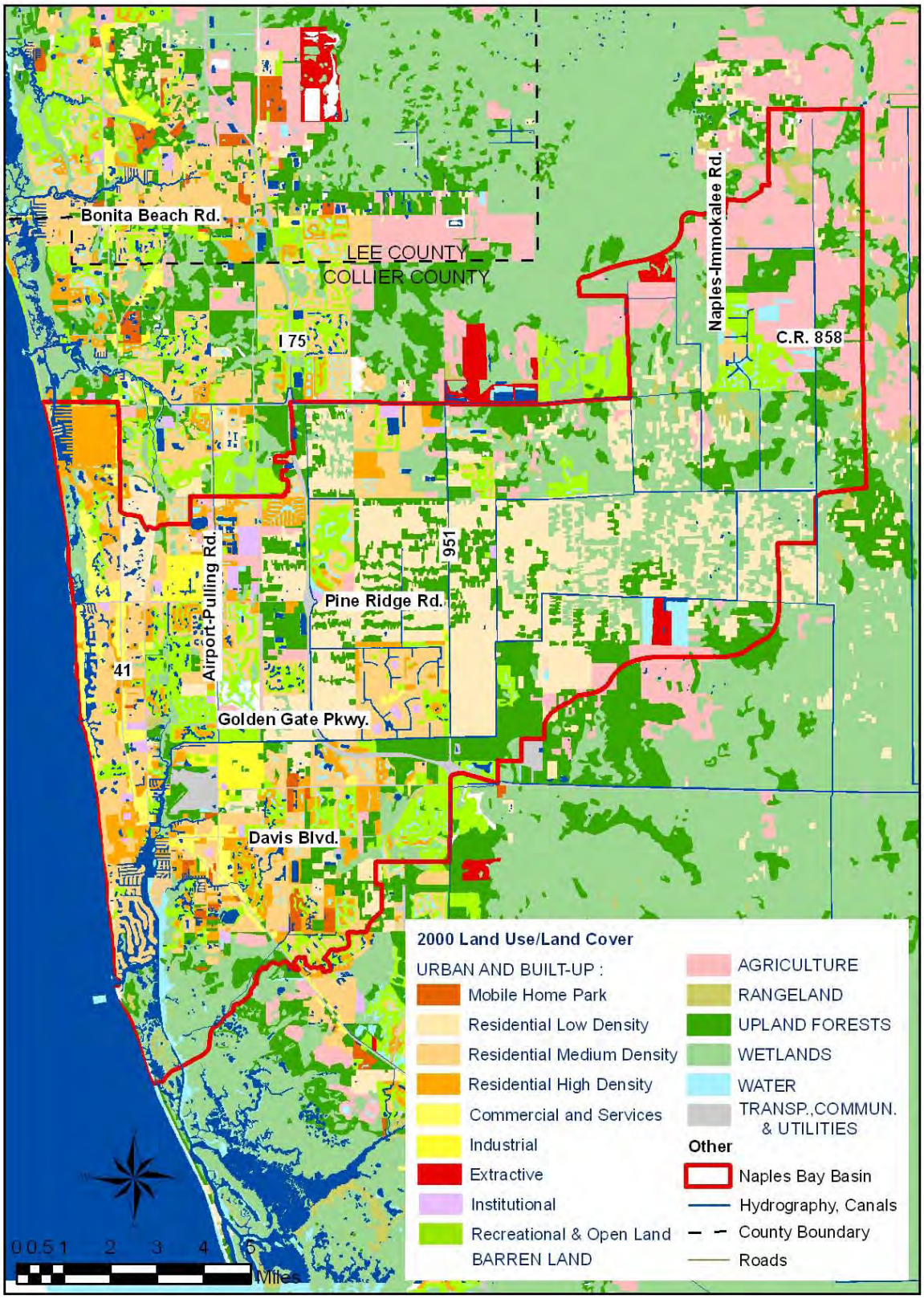

Figure 18. Current Land Use/Land Cover (FLUCCS) **(data source: SFWMD, 2000 Update for Land Use/Land Cover for Southwest Florida, 2004).**

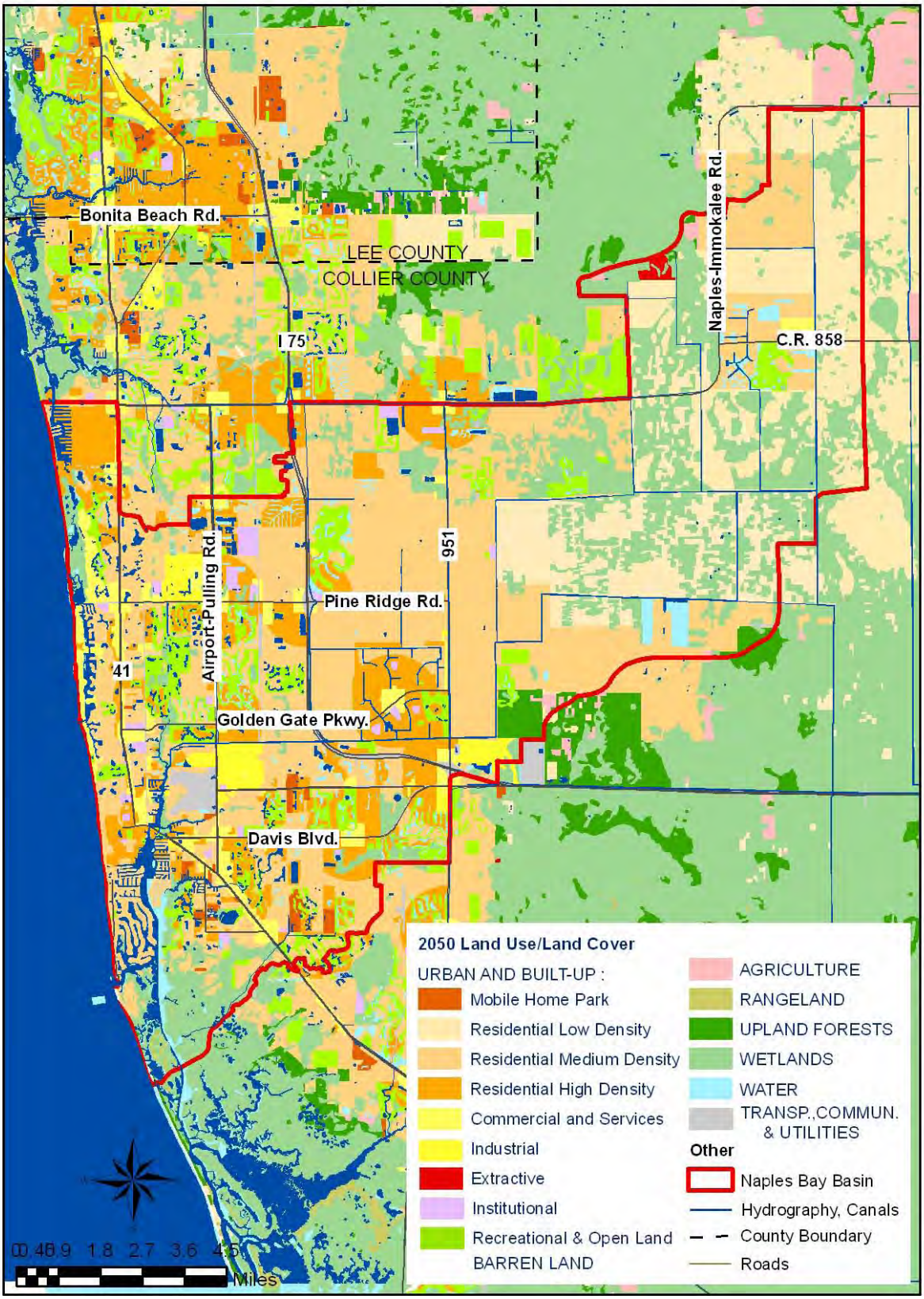

Figure 19. Future Land Use/Land Cover (FLUCCS) **(data source: SFWMD, Spatial Distribution of Land Use/Land Cover for Southwest Florida Feasibility Study Area, 2004).**

Table 3. 2004, 2025, and 2050 Land Use/Land Cover in the Basin.

Land Use/Land Cover	2004	2025	2050
Mobile Home Park	464	464	464
Low Density Residential	19,151	33,213	15,359
Medium Density Residential	12,081	18,023	36,122
High Density Residential	6,223	10,948	10,794
Commercial and Services	2,583	3,469	3,996
Industrial	1,205	1,711	1,764
Extractive	413	144	144
Institutional	890	890	890
Recreational	5,621	5,880	5,880
Open Land	2,251	0	0
Agriculture	8,507	905	233
Rangeland	1,278	70	70
Upland Forest	15,539	893	893
Water	4,938	4,938	4,938
Wetland	18,667	18,667	18,667
Barren Land (Beaches, Sand)	448	43	43
Transportation, Communication & Utilities	2,567	2,568	2,568
Sum	**102,826**	**102,826**	**102,826**

The decrease in low density residential uses is attributed to the increase in medium and high density residential uses. The general rules followed for modeling future land use distribution assumed no development of areas designated as the wetland by the wetland FLUCCS code. Since the wetland distribution is according to FLUCCS, it does not reflect changes that might occur due to wetland fill permits or mitigation.

The five most common categories which comprise 73% of the current land use in the Study Area are listed below:

- Low density residential = 19%
- Wetland = 18%
- Upland forest = 15%
- Medium density residential = 12%
- Agriculture and Rangeland = 9%

The US41 corridor from North Naples to Belle Meade occupies the Basin's western edge. This corridor is the most heavily developed area in the Basin. It is almost entirely medium and high density residential together with commercial land uses. The only exception is a large area of mangrove forest south and east of Naples Bay. The majority of the Basin's agricultural lands are located in the higher elevation areas north of Oil Well Road and east of Immokalee road in the Basin's northeastern corner.

Significant changes are projected for the distribution of land use/land cover in the Basin between the current conditions and 2050. The largest projected future land uses (by percentage of basin area) are listed below:

- Medium density residential = 35%
- Wetland = 18%
- Low density residential = 15%
- High density residential = 10%
- Recreational = 6%

Upland forest and agricultural/rangeland are each projected to occupy less than 1% of the Basin in 2050. The 2050 land use projections place almost all of the high density residential and commercial land west of CR951. The eastern portion of the Basin will be a mosaic of wetlands and low density residential development with several large blocks of medium density residential and a small amount of commercial development.

SUB-BASIN AND DRAINAGE CHARACTERISTICS

Canals and other drainage barriers and conveyances have altered the historic patterns in the Naples Bay Basin to the extent that the basin is now best described in terms of these features. The canals tend to be aligned along section and half section boundaries in north-south or east-west patterns (Figure 20). There are eleven major canals within the Naples Bay Basin.

- Golden Gate Main Canal
- Orange Tree Canal
- Corkscrew Canal
- Curry Canal
- Cypress Canal
- CR 951 Canal
- Green Canal
- Harvey Canal
- I-75 Canal
- Airport Road Canal
- Lely Canal

A primary and secondary canal system forms a major public surface water/stormwater network in Collier County. A sample of the high resolution, detailed drainage maps depicting that system in the Naples Bay vicinity is in Figure 21. The West Collier and East Collier maps are

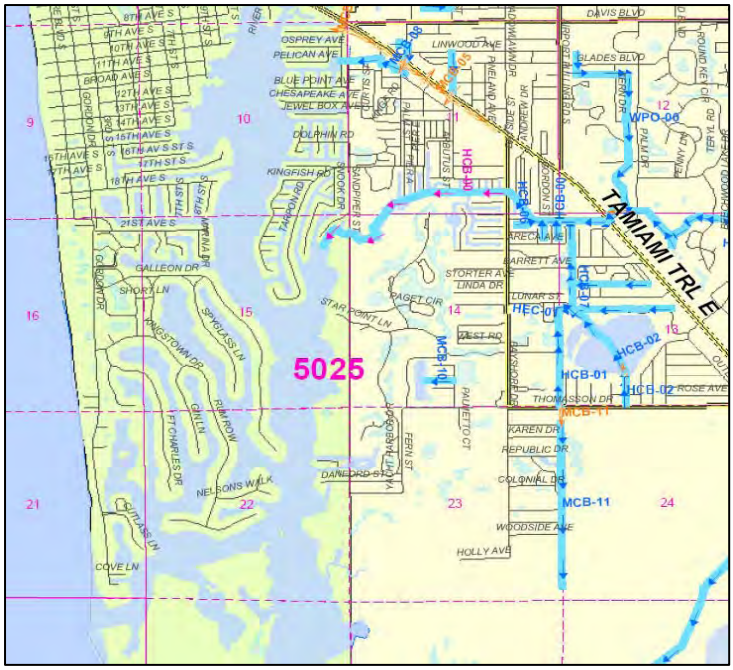

Figure 21. A portion of the Collier County Primary and Secondary Drainage Map, Naples Bay vicinity (Collier County).

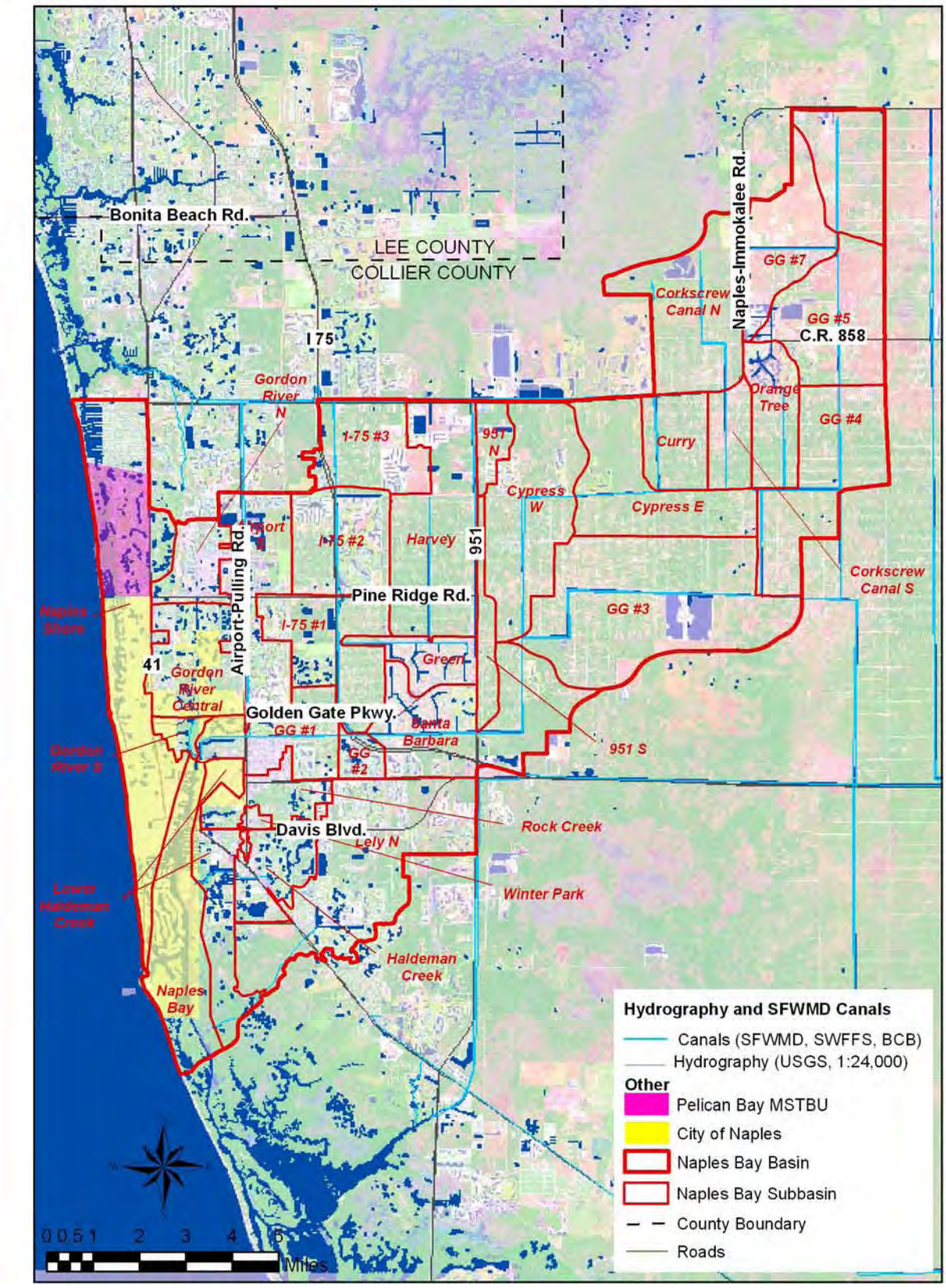

Figure 20. Naples Bay Basins, Sub-basins, Canals and Hydrography (data source: SFWMD 2005).

designed for large format plotting and viewing. The County's extensive stormwater management system is displayed using their draft stormwater management GIS data in Figure 22. SFWMD canals and structures are in Figure 23. GIS data sources available from SFWMD for canals and control structures vary slightly. All sources are shown in Figure 23. They are referred to in the GIS data as SFWMD Canals, Big Cypress Basin Canals, and SWFFS Canals. SWFFS data were developed for regional models and are subject to revisions. BCB data were used in MIKE SHE models. See GIS metadata for additional information. The City of Naples has Master Drainage AutoCad maps that document pipes, inlets, manholes, and other conveyance features that are not shown here.

The 32 sub-basins in the Naples Bay Basin (Table 4) are generally named for the conveyance features within them (Figures 24 and 25). The acreage of each sub-basin is listed below. The minimum sub-basin size is 225 acres, the maximum is 8,820 acres, and the mean is 3,213 acres.

Table 4. Sub-basins of the Naples Bay Basin.

Sub-basin name	Area (acres)		Sub-basin name	Area (acres)
951 N	781		Gordon River N	1,474
951 S	967		Gordon River S	456
Airport S	3,481		Green	1,358
Corkscrew Canal N	4,579		Haldeman Creek	1,970
Corkscrew Canal S	1,348		Harvey	5,324
Curry	1,863		I-75 #1	3,485
Cypress E	4,341		I-75 #2	3,102
Cypress W	4,953		I-75 #3	2,760
GG #1	2,585		Lely N	7,404
GG #2	621		Lower Haldeman Creek	2,665
GG #3	8,820		Naples Bay	3,893
GG #4	4,699		Naples Shore	8,075
GG #5	4,049		Orange Tree	2,076
GG #6	2,702		Rock Creek	1,569
GG #7	2,952		Santa Barbara	5,244
Gordon River Central	3,006		Winter Park	225
			Sum	**102,826**

The Big Cypress Basin Watershed Management Plan identifies several "flood control problem areas" within the Study Area. Flood control problem areas are defined as areas where at least one of the following items occurs during the design storm event (using land use and cover that was current at the time of the study):

- The maximum flood elevations exceed the canal bank elevation
- The maximum flood elevation is within 1.5 feet of the canal bank elevation
- Water velocities exceed 2.5 feet per second, creating a potential for erosion
- Structures within the canal do not meet District right of way criteria

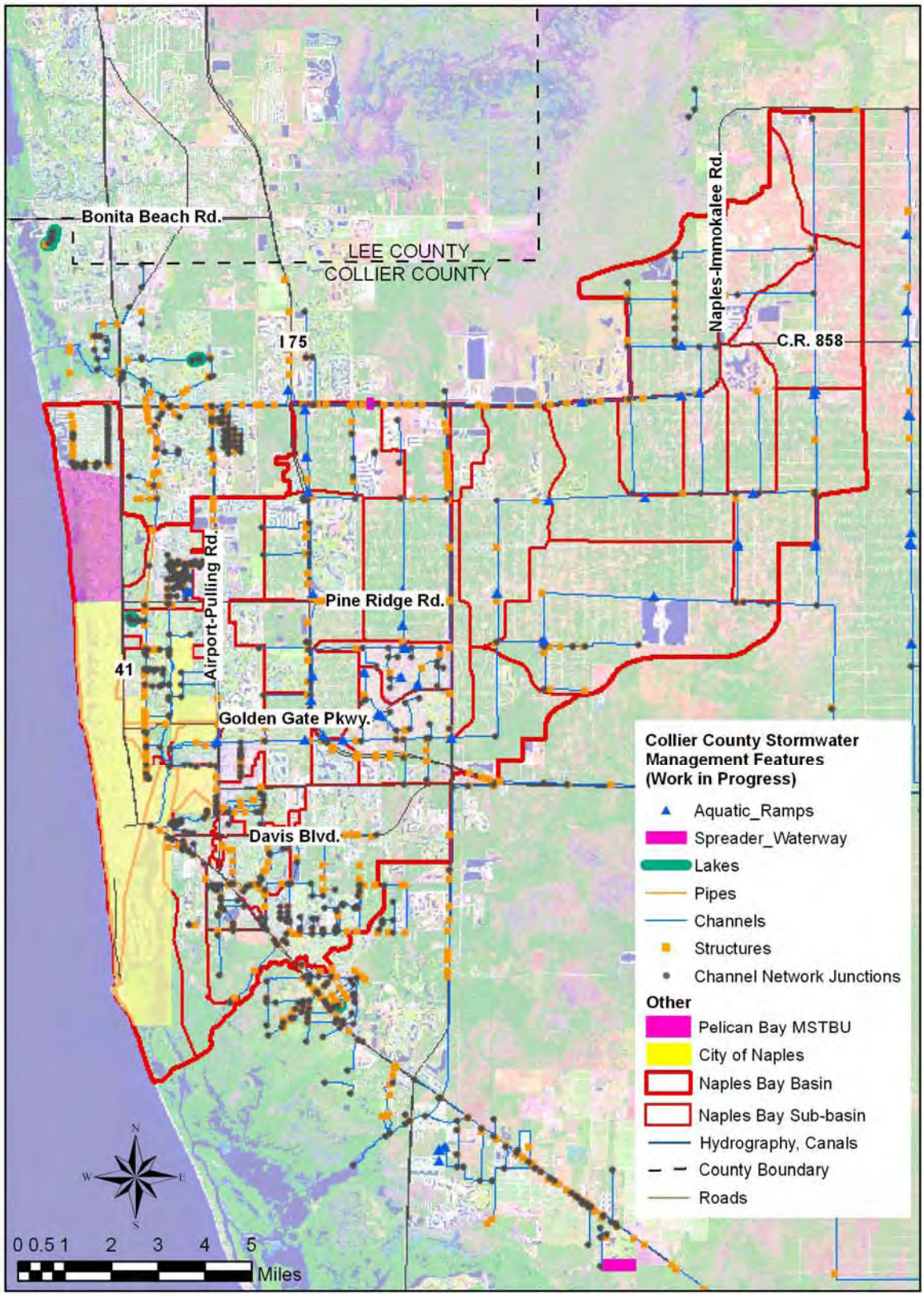

Figure 22. Collier County Stormwater Management Features (data source: Collier County, Work in Progress, 2005).

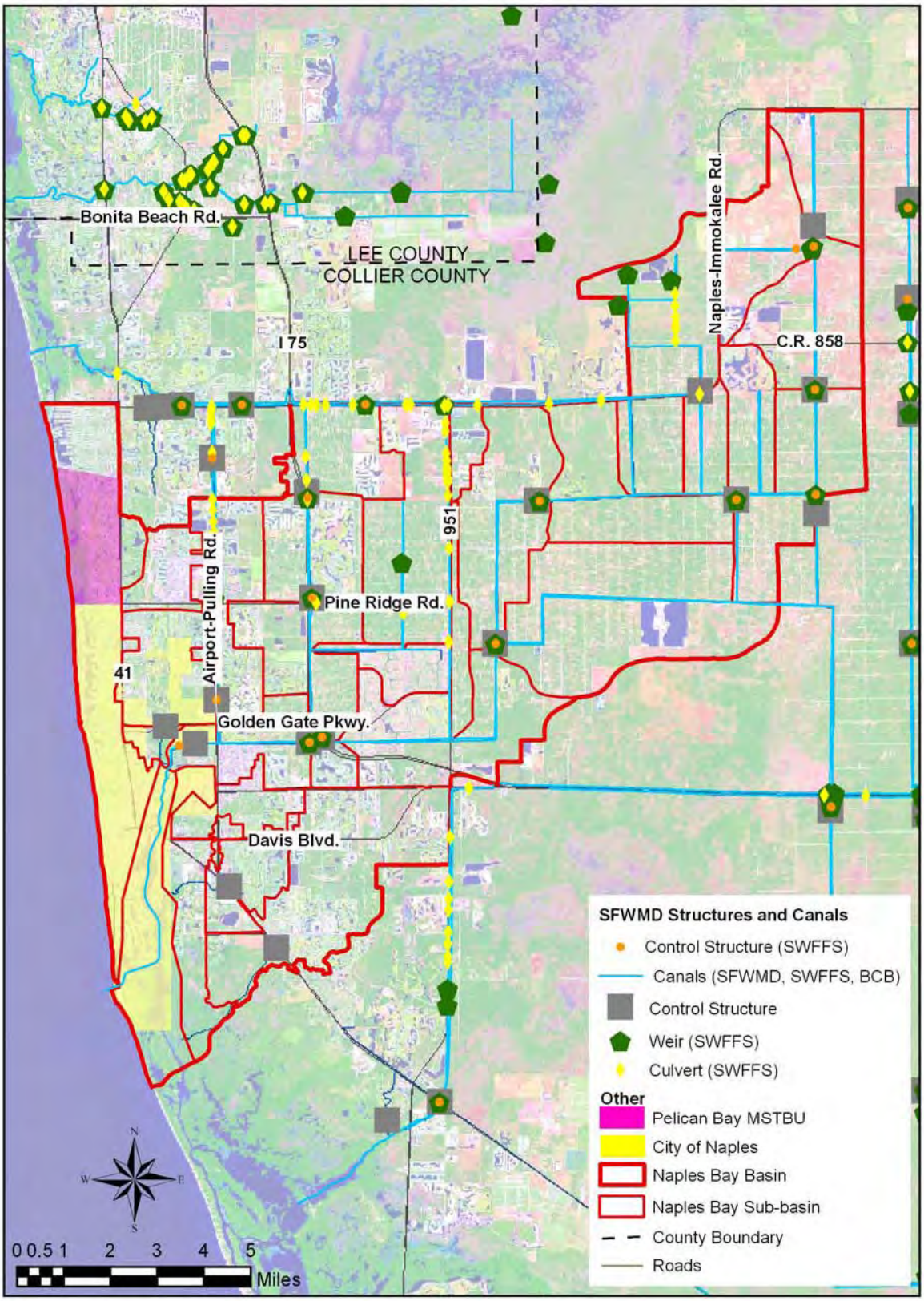

Figure 23. SFWMD Canals and Structures (**data source: SFWMD, 2002 - 2004, SWFFS area data were developed for regional model and are subject to revision. BCB data were used in the MIKE SHE model).**

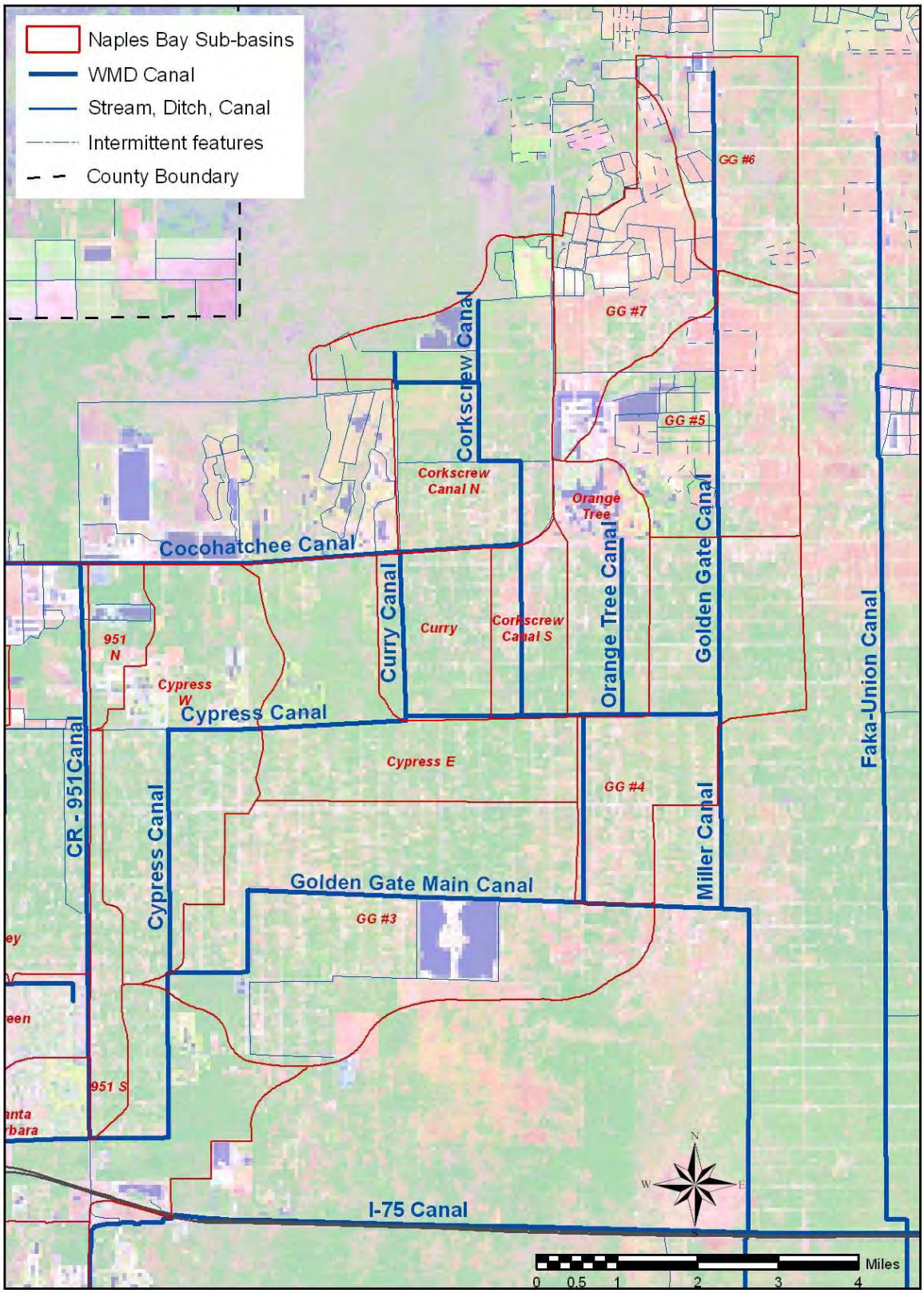

Figure 24. Canals and sub-basins in the eastern portion of Naples Bay Basin (data sources: SFWMD, 2005).

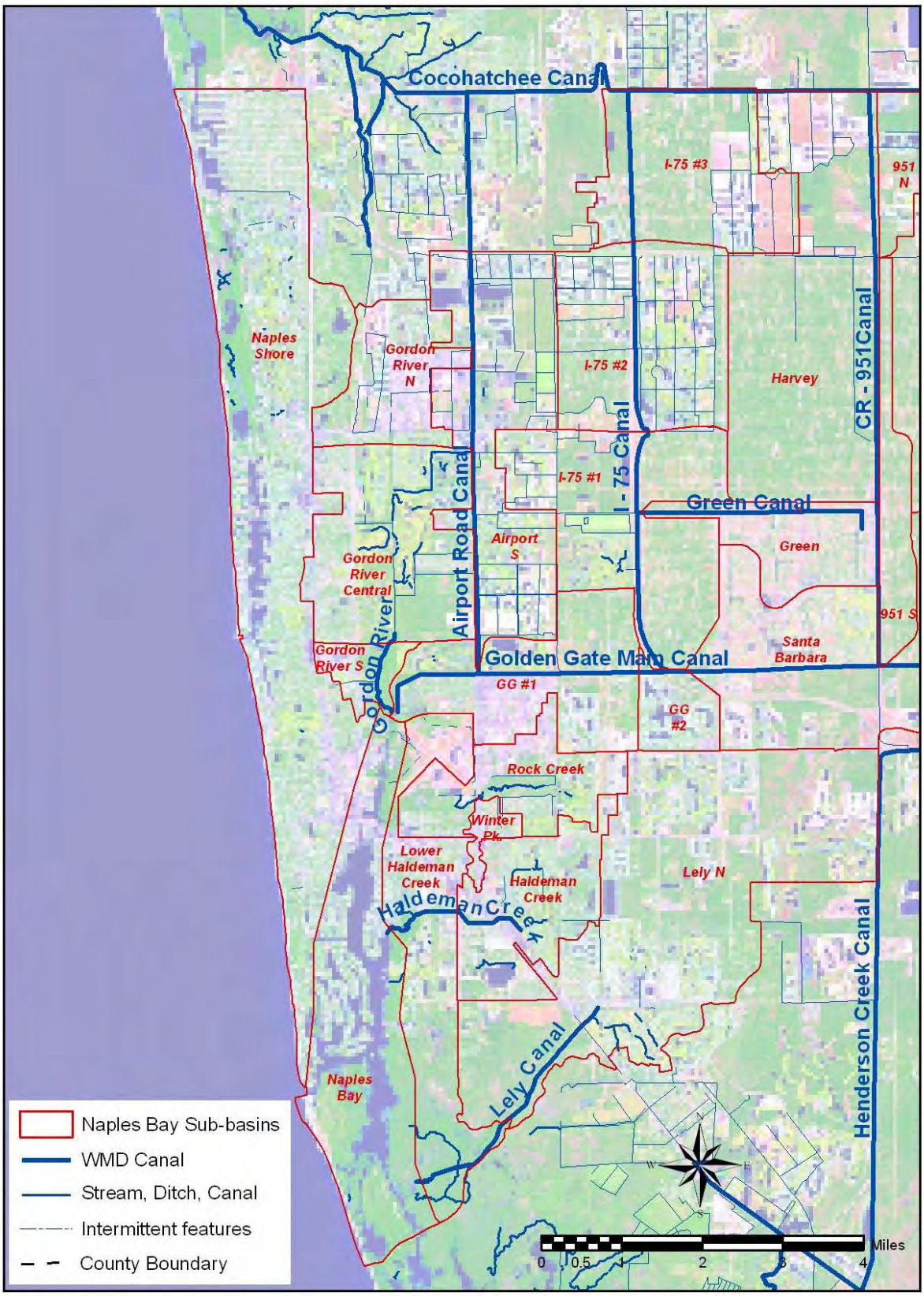

Figure 25. Canals and sub-basins in the western portion of Naples Bay Basin (data sources: SFWMD, 2005).

Based on these criteria, approximately 29% of the 163 total miles of canals in the Big Cypress Basin (or 47.6 miles) are located in flood control problem areas having inadequate flood control for the design storm events. The design storm events are the 25-year, 3-day storm event in urban areas and the 10-year, 3-day storm event in rural areas.

The Golden Gate Main, Orange Tree, Corkscrew, and Curry Canals all originate in the northeastern corner of the Naples Bay Basin (Figure 24). These canals run north-south and are located a little more than a mile apart. The Golden Gate Main Canal is by far the longest of the four. Originating on the south side of Immokalee Road southeast of Corkscrew Swamp, this canal drains an area that was historically mesic flatwoods. Sub-basins in this area are Golden Gate #7, Golden Gate #5, and Golden Gate #4. These sub-basins (particularly #7) are currently dominated by agriculture and wetlands. The vast majority of the almost 10,000 acres of agricultural land and rangelands in the Naples Bay Basin are found in these sub-basins. The District's 2050 future land analysis projects almost all non-wetland areas in the sub-basins will be low or medium density residential.

The Golden Gate Main Canal is approximately 27 miles long with an outfall near the opposite end of the Basin in the Gordon River, just north of the Naples Airport (Figure 25). There is a significant control structure located just above the canal's outfall. Many of the other canals in the Basin drain into the Golden Gate Main Canal along its route in the eastern and southeastern boundaries of the Naples Bay Basin. As such the canal is thought to be particularly susceptible to flood capacity issues resulting from land use changes. The Big Cypress Basin classifies 43% of this canal as flood control problem areas.

The Orange Tree Canal is a short canal immediately west of the Golden Gate Canal. The canal begins east of Immokalee Road and empties into the eastern portion of the Cypress Canal. The Orange Tree Canal drains the Orange Tree sub-basin, an area that was historically mesic and hydric flatwoods. The sub-basin currently contains a mix of low density residential, agriculture/rangelands, and wetlands. The 2050 land use projects this area to be predominantly low density residential uses and wetlands.

The Corkscrew Canal is located west of the Orange Tree Canal. The Corkscrew Canal has its origins north of Immokalee Road near a large rock mine and the southern end of the Corkscrew Swamp. At the southern end of its six mile course, the canal empties into the Cypress Canal. The Corkscrew Canal drains one sub-basin on the north and one on the south side of Immokalee Road. The current land use in these areas is largely wetlands and agriculture, with some low density residential and smaller amounts of upland and rangeland. Future land use is projected to be almost entirely low density residential uses and wetlands. The Big Cypress Basin classifies 37% of this canal as flood control problem areas.

The Curry Canal is the westernmost of the four canals in the northeastern Gordon River Basin. It is another short canal and drains a small sub-basin immediately south of Immokalee Road. The canal is named for the Curry Island, an historic vegetation feature located among the wetlands that dominate this portion of the Basin. The Curry sub-basin contains a large percentage of wetlands and forested areas along with low density residential uses, much of which is centered on the Rock Road corridor. Curry

Canal has its outfall in the Cypress Canal. Current land uses and land cover are primarily low density residential and wetland with small amounts of upland forest, agriculture and rangeland. Future land use and land cover are projected to be wetland and low density residential, with a small amount of medium density residential.

The Cypress Canal is an 8-mile long canal that receives flow from the Orange Tree, Corkscrew, and Curry Canals. The Cypress runs east-west at the same latitude as Vanderbilt Beach Road from the Orange Tree Canal to the intersection of Vanderbilt Beach Extension and Massey Street. Cypress Canal then follows a north-south course until it reaches its outfall in the Golden Gate Main Canal east of Green Boulevard. Cypress Canal drains two, large sub-basins, Cypress East and Cypress West. These areas were historically a mosaic of flatwoods and cypress. The southern portions of these basins are more heavily developed and primarily low density residential with some upland and wetland forests. The northern portions of the basins still contain large areas of wetlands, as well as natural uplands, agriculture, and low density residential uses. The 2050 land use projections show the basins as medium and low density residential uses with scattered wetlands.

The County Road 951 (CR951) Canal follows a north-south course down the middle of the Naples Bay Basin (Figures 24 and 25). The canal is a little over seven miles long and was originally excavated to provide fill for the adjacent roadbed. Despite its original purpose, the CR951 canal now serves as a conveyance structure. It originates at the intersection of Immokalee Road and CR951 on the northern boundary of the Basin. Its outfall is where CR951 crosses the Golden Gate Main Canal just north of I-75. It drains two very narrow basins on the east side of CR951, 951 North and 951 South. The current 951 South basin land-use is predominantly low density residential with some Upland Forest. Future land use is projected to be medium density residential. The 951 North basin is currently low density residential and upland forest with some wetland and agriculture. Future land use is projected to be medium and high density residential with some wetland and commercial land use. The Big Cypress Basin Board classifies 35% of this canal as flood control problem areas.

The Green Canal is a short canal that runs east-west just south of Green Boulevard. It drains the Green sub-basin that is dominated by the developed hub of the Golden Gate area. The canal originates just west of CR951 and empties into the I-75 Canal just south of Green Boulevard. Current land use is predominantly medium density residential with a small amount of commercial. Future land use is projected to be high density residential and commercial.

The Harvey Canal is a north-south conveyance less than a mile west of CR951. The canal originates on the south side of Vanderbilt Beach Road and empties into the Green Canal two miles to the south. The Harvey Canal drains a sub-basin that was historically hydric flatwoods with smaller areas of cypress and mesic flatwoods. The current land use of low density residential with scattered patches of upland forest is enabled by drainage from area canals. Future land use within the Basin is projected to be entirely medium density residential.

The I-75 Canal is a north-south conveyance that follows I-75 from roughly Immokalee Road to its junction and outfall with the Golden Gate Main Canal. It drains sub-basins I-75 #1, #2, and #3. The Airport Road Canal is located two miles west of I-75 on the eastern edge of Airport Pulling Road. This canal also follows a north-south course from Immokalee Road to the Golden Gate Main Canal. These two canals drain basins with similar land uses. Low and medium density residential uses dominate the current land use. Medium and high density residential uses are projected to dominate in 2050, with a decrease in upland forest and low density residential.

The Lely Canal is the exception to the rule of north-south and east-west canals running along section and quarter section boundaries. This canal runs southwest from the Lely area to the coast and has an outfall in the vicinity of Dollar Bay. This drainage area of this canal can be characterized by a mixture of different land uses and land cover. Future land uses are projected to be increasingly medium and high density residential as well as commercial. Much of the residential development in this basin in fairly recent, but the canal predates this development.

Haldeman Creek is a short, channelized creek that empties into Naples Bay between the Golden Gate Canal and Lely Canal. Haldeman Creek drains basins that contain a large proportion of residential and commercial land uses.

SPECIES AND HABITAT

The species richness index was developed by FFWCC in order to assess habitat conservation needs of rare and imperiled wildlife in Florida (Cox and Kautz. 2000). The index represents the number of species identified as having potential habitat at a given location. Potential habitat was modeled for 130 focal species. Index values range from 0 (representing no species) to 26 (the maximum number of species in one location) in the state of Florida. Within the Naples Bay Basin, values range from 0 to 15 (Figure 26). Species richness is greater in and around the natural areas that boarder the study, and these areas are largely held in conservation. The index is a useful planning resource when considering habitat and species, though other data, both observed and modeled, for individual and for multiple species are available.

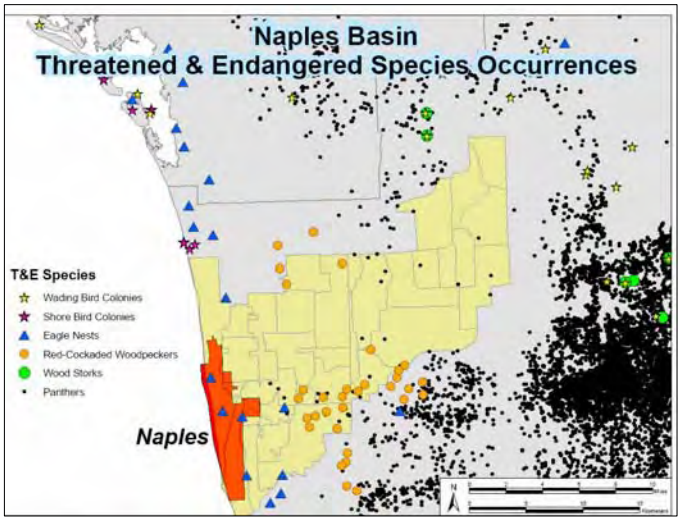

Figure 27. FWCS Threatened and Endangered Species (FWS).

Threatened and endangered species identified and mapped by the FWS (Figure 27) indicate that several Eagle nests are

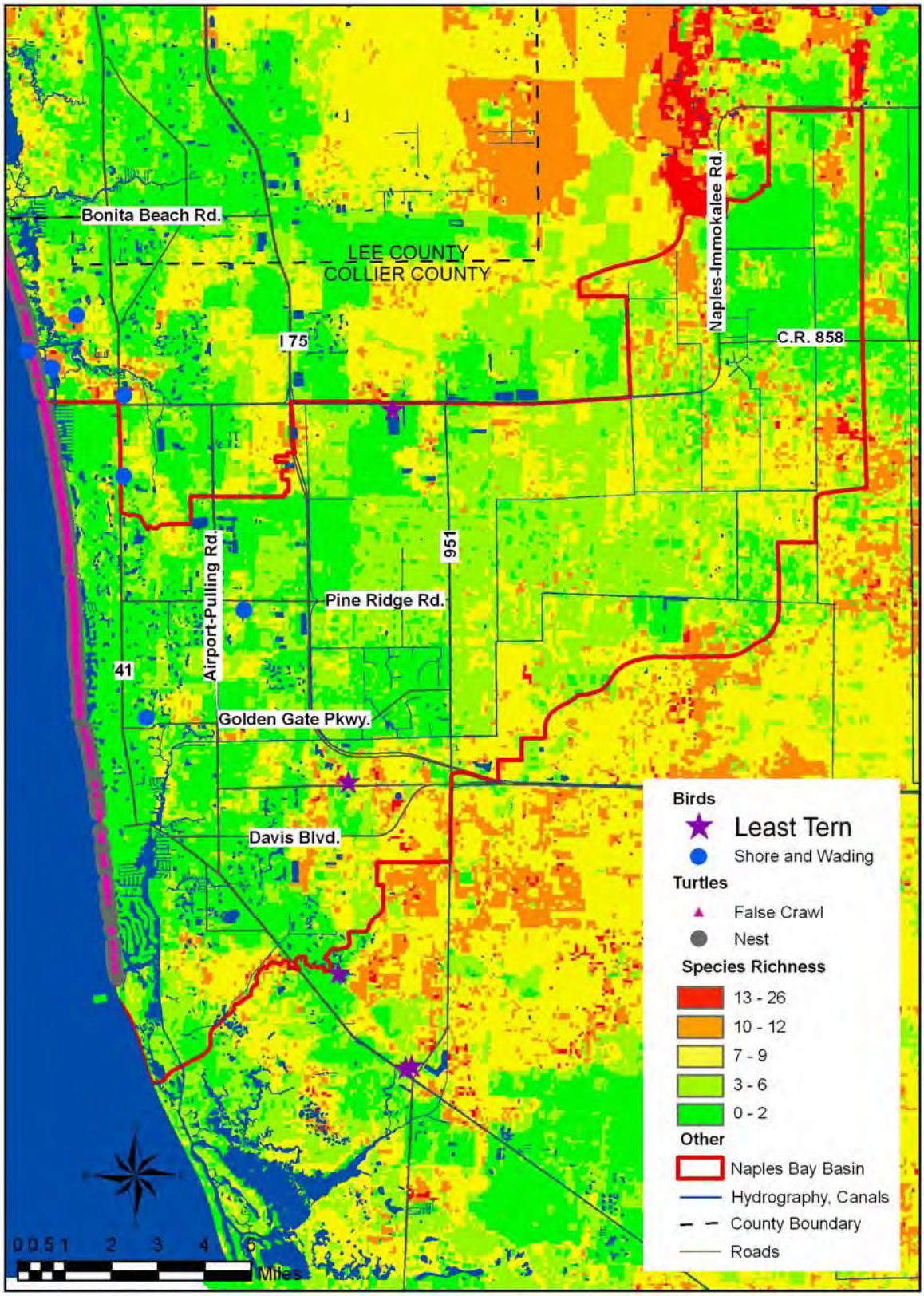

Figure 26. Species Richness and Selected Species (data sources: FFWCC Species Richness Index, 2000, Collier County selected species, 2004).

present along the coast. Panthers and Red-Cockaded Woodpeckers are present in and around the Corkscrew Swamp and Picayune Strand, and near the northern and southern boarders in the central portion of the Study Area. It should be noted that not all State-listed species are included on the FWC map, and that data represent a wide range of dates (from 1970 to 2004, with some dates uncertain). Additional data for shore and wading birds (FFWCC), Least Terns (Collier County), and sea turtles (Collier County) are shown in Figure 26. It should also be noted that the several wading bird colonies shown on the map may under-represent those actually present. Sea turtle nests and false crawls are prolific along the beaches. The Statewide Nesting Beach Survey program (SNBS) GIS data, however, does not indicate that any of the three species of sea turtles surveyed are active on beaches within the Study Area. The loggerhead (Caretta caretta), the green turtle (Chelonia mydas), and the leatherback (Dermochelys coriacea), regularly nest on Florida's beaches and are listed as either Threatened or Endangered under the Endangered Species Act.

The West Indian Manatee, a marine mammal on the endangered species lists, uses Naples Bay habitat. According to the FFWCC GIS data (FFWCC, 2004), three manatees were observed during synoptic surveys between 1994 and 2001. Synoptic surveys are a tool used for estimating the size of the population. The two day aerial surveys cover all of the manatee's wintering habitats in Florida and southeast Georgia between 1976 and 2004. There were 55 manatee deaths reported within the Study Area between 1974 and 2004.

Repeated anecdotal assertions indicate that seagrasses were present in the Bay prior to canal dredging and mangrove removal. The BCB Science Plan contains a proposal to document existing locations, and a project being funded by the SFWMD to document the Naples Bay historic habitat (Conservancy, in Progress) including GIS mapping of benthic communities.

The use of Naples Beach by coastal water birds has been documented and reported based on over 30 years of biweekly census data in "Coastal Water Bird Beach Utilization Naples Florida" (Below, 2004). The census was initiated between Doctors and Gordon Pass, then focused on two areas that are heavily used by birds: the structures present at 3rd Avenue North and one kilometer north of 32nd Avenue South. Those areas are used for roosting and feeding.

The latest available document listing Florida's Endangered Species, Threatened Species, and Species of Special Concern (FFWCC, 2004) consolidates the official state and federal species lists. The Multi-Species Recovery Plan for South Florida was prepared by the U.S. Fish and Wildlife Service as part of the South Florida Ecosystem Restoration Initiative (US Fish and Wildlife Service, 1999). The Plan identifies the recovery needs of 68 threatened and endangered species and 23 natural communities. The plan includes habitat requirements and limiting factors, recovery objectives and criteria, both habitat and species level recovery actions needed, estimated costs of recovery implementation, and the targeted date of recovery for each species (USACOE and SFWMD, 2002). As part of the SWFFS effort, a SWFFS Species Update is being prepared. The SWFFS's Feasibility Scoping Meeting critical habitat designation

(FSM) document will include current information (status, critical habitat designation, recovery recommendations) on federally listed species occurring within the boundaries of the SWFFS. The SWFFS Species Update final draft is anticipated late 2005. (Daryl Thomas, USFWS, personal communication).

Southwest Florida Coastal Conservation Corridor (SWFCCC) Plan (The Nature Conservancy, In Preparation) is a landscape scale conservation planning project that intends to enhance cooperative planning between public and private land acquisition entities. The goal is to establish a multi-jurisdictional partnership to identify, create, and manage a conservation corridor system from Dixie to Monroe County. Products of the project are to include a series of maps showing opportunities for landscape-scale connection along with a comprehensive GIS database and an interactive internet map server. Principal partners are The Nature Conservancy, US Fish & Wildlife Service, FDEP and the FFWCC. The project is being done in coordination with the Southwest Florida Regional Wildlife Habitat Plan, the Southwest Florida Feasibility Study (SWFFS), Comprehensive Everglades Restoration Plan (CERP), and the South Florida Ecosystem Restoration Task Force, and the Multi-species Recovery Plan/ Multi-Species Ecosystem Recovery Implementation Team. The plan is expected to be available on the Nature Conservancy website in 2005 and can be found through: http://nature.org/wherewework/northamerica/states/florida/

In 1992, a mangrove die-off was documented in Clam Bay at the northern, coastal portion of the Basin (Figure 28). Water quality, sediment, biological and hydrographic studies were conducted for Clam Bay and the Parkshore subdivision between 1975 and 1977, along with recommendation and evaluations of over-water structures. Findings indicated parameters within normal ranges (USEPA, 1975, USEPA 1977). Ongoing water quality monitoring efforts by Collier County Environmental Services and Pelican Bay Services District did not indicate the presence of excessive chemicals or nutrient in concentrations high enough to solely cause the mangrove mortality. Rather, the monitoring suggested that the death of the mangroves was attributable to excessive freshwater input to the system from the adjacent, developed uplands and inadequate drainage/tidal exchange through increasingly constricted channels. As a result, water became elevated and stagnated above the pneumatophores of the black mangrove for lethally long periods of time. In 1998, one joint coastal permit was issued to Collier County-Pelican Bay Services Division to restore and manage the Clam Bay Natural Resource Protection Area based on the Clam Bay Restoration and Management Plan (CBRMP) (Brown et al., 1998) over the life of a ten year permit. This plan included dredging, water quality,

Figure 28. Clam Bay mangrove die-off area (Turrell & Associates).

hydrographic and biological monitoring. The Conservancy also has studies focused on the Clam Bay mangrove die-off. Related documents are summarized in Appendix A2.

PUBLICLY OWNED/CONSERVATION LANDS

Existing and proposed publicly owned land and conservation areas were investigated and mapped (Figure 29) using the best available data. The significant areas are described below. The Naples Bay Basin is surrounded by or partially contains several major conservation areas, and additional acquisitions are proposed. Additional smaller public/conservation lands, less than 300 acres, are proposed within the Basin, primarily by the Conservation Collier Land Acquisition Program, which is further described in Chapter 4 under Programs. Many small access and conservation easements are also present within the Study Area. Existing and proposed conservation lands and easements within the Basin total 3,440 acres, approximately 3% of the Basin. Of those lands, 2,650 acres or 2.6% are existing lands, and 790 acres, or 0.8%, are proposed. As described in Chapter 4 under Projects, land in Northern Golden Gates Estates has been proposed for acquisition for a Regional Off-site Mitigation Area (ROMA) as well.

There are 45 SFWMD Conservation Easements acquired through the regulation permitting process scattered throughout the Study Area. Together they total 950 acres and less than 1% of Study Area. Other than for Naples Municipal Airport, they are primarily associated with residential developments and golf courses. Three Access Easements (ingress/egress) owned by the SFWMD are located in the southern portion of the Basin, the largest being the Lely Canal and structure, another at the Golden Gate Canal, and a very small parcel along I-75 between Green Boulevard and Golden Gate Parkway.

Corkscrew Regional Ecosystem Watershed (CREW) is a 60,000-acre project in Lee and Collier counties, consisting of Corkscrew Swamp Sanctuary, Corkscrew Marsh, Camp Keais Strand, Flint Pen Strand, and Bird Rookery Swamp. Existing (200 acres) and proposed (540 acres) portions of CREW extend into the northeast portion of the Basin. CREW lands are dominated by cypress forest, low pine flatwoods, hardwood hammocks, marshes, mixed swamps, and ponds. This system provides habitat which supports at least 65 species of plants and 12 species of animals listed by the state as endangered or threatened (USACOE and SFWMD, 2002). CREW surrounds Audubon's Corkscrew Swamp Sanctuary and conveys water to it and other conservation lands.

The Rookery Bay National Estuarine Research Reserve (RBNERR) area is 110,600 acres of primarily estuarine habitats including mangroves, salt marshes, estuarine bay and associated mudflats, oyster bars, and seagrass beds. There are some areas of freshwater marsh, cypress swamps, coastal strand, scrub, pine flatwoods, and cabbage palm/oak hammock. The northwestern tip of the Reserve, 1,460 acres, lies within the southwest tip of the Basin. RBNERR comprises 1.4% of the Naples Bay Basin.

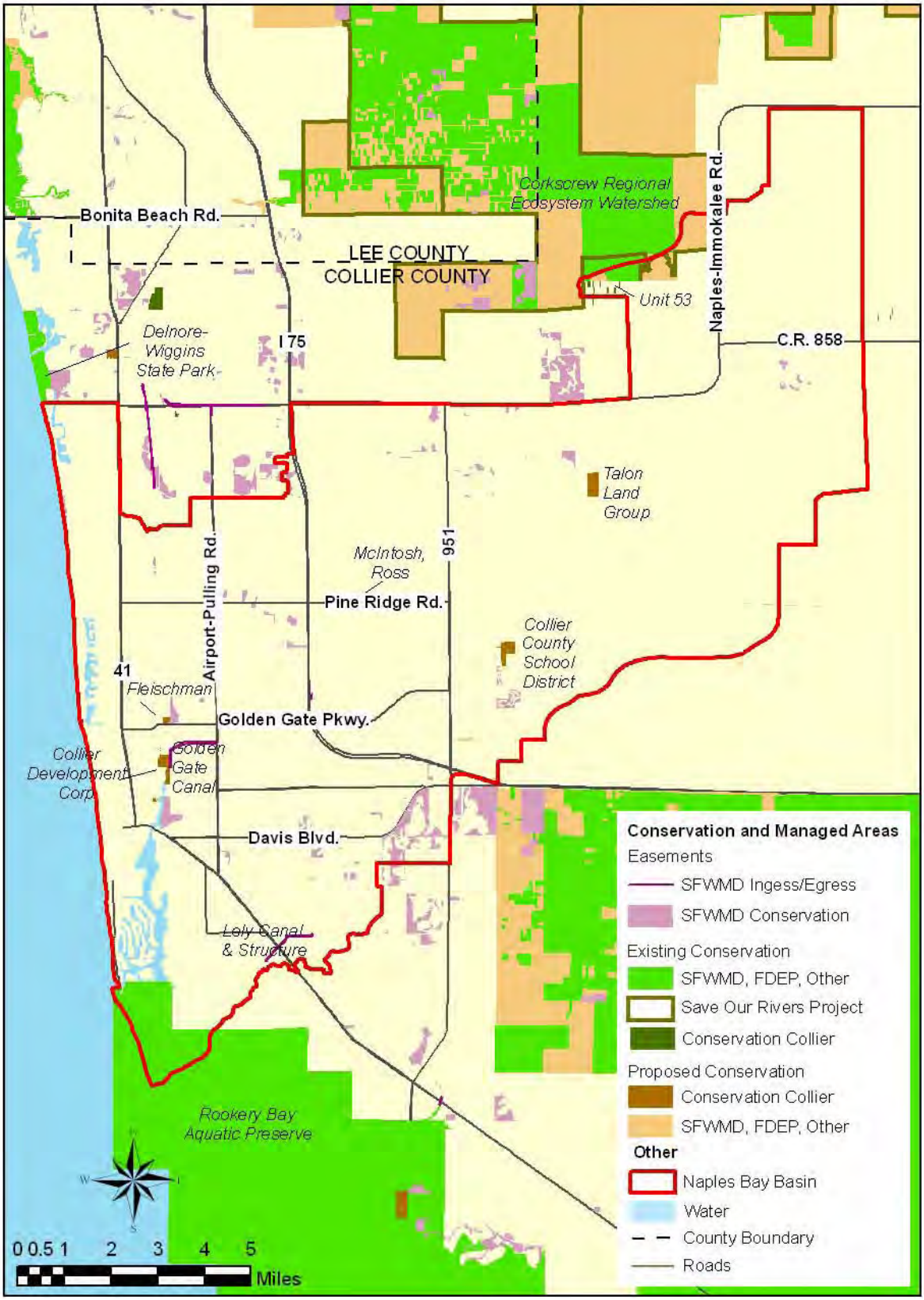

Figure29. Existing and Proposed Conservation Lands and Easements (data sources: SFWMD, Conservation Collier, Florida Natural Areas Inventory (FNAI), 2005).

Conservation Collier has purchased portions of two multi-parcel projects, and solicitations for purchase are ongoing. The first multi-parcel project is the Red Maple Swamp Preserve (comprised of the entire North Golden Gate Estates Unit 53), a seasonal wetland located south of CREW lands and just west Study Area. In this project, 30 out of a total of 285 acres have been purchased. In the second multi-parcel project, called Winchester Head (a 200-acre cypress and marsh wetland immediately east of the Study Area), less than 10 of the 141 acres within the project boundary have been purchased.

Other conservation acquisition activities within the Study Area include several potential purchases along the Gordon River. Conservation Collier will partner with County Stormwater and Transportation Departments to purchase 13 acres of a 52-acre parcel on the NE corner of Goodlette-Frank Road and Golden Gate Parkway, where Florida Community Trust is involved in a grant partnership for the Gordon River Water Quality Park. Conservation Collier is seeking to purchase approximately 100 acres due south of the Gordon River Water Quality Park along the Gordon River to provide recreational trails and canoe access to the Gordon River. Farther south, also along the Gordon River, the program is in the process of making an offer on 49 acres which will help connect with others to create an envisioned Gordon River Greenway stretching from Golden Gate Parkway on the north to the Gordon River Bridge and U.S. 41 to the south. Property reports and maps are available on the Conservation Collier website at: http://www.colliergov.net/natresources/conservationcollier/index.cfm.

AQUIFER

The principle source of drinking water in southwest Collier County is the surficial aquifer, also known as the Chokoloskee Aquifer. It is recharged primarily by rainfall (Jarosewich and Wagner 1985, Jakob 1983). Most of this formation is underlain by the Tamiami Formation, a thin, highly permeable layer with the top exposed in some areas. The Hawthorne Formation, present in north Collier County, is absent in most of the Study Area, but may be present in the northeast corner. The Floridian Aquifer lies beneath the Tamiami in southwest Collier County and extends out into the coastal shelf. The top of this formation is about 400 ft below surface at the coast. Since the pieziometric head is about 200 feet throughout south Florida, recharge of this aquifer does not occur outside of the central Florida ridge (McCoy 1962).

SANITARY SEWER SERVICE

The County Sewer Service area extends slightly more than halfway across the western portion of the Basin (Figure 30). More information about the existing and future conditions of sanitary sewers can be found in Collier County Growth Management Plan Sanitary Sewer Sub-Element, included in digital format with this Reconnaissance Report. The Sewer Sub-Element was last amended September 2003.

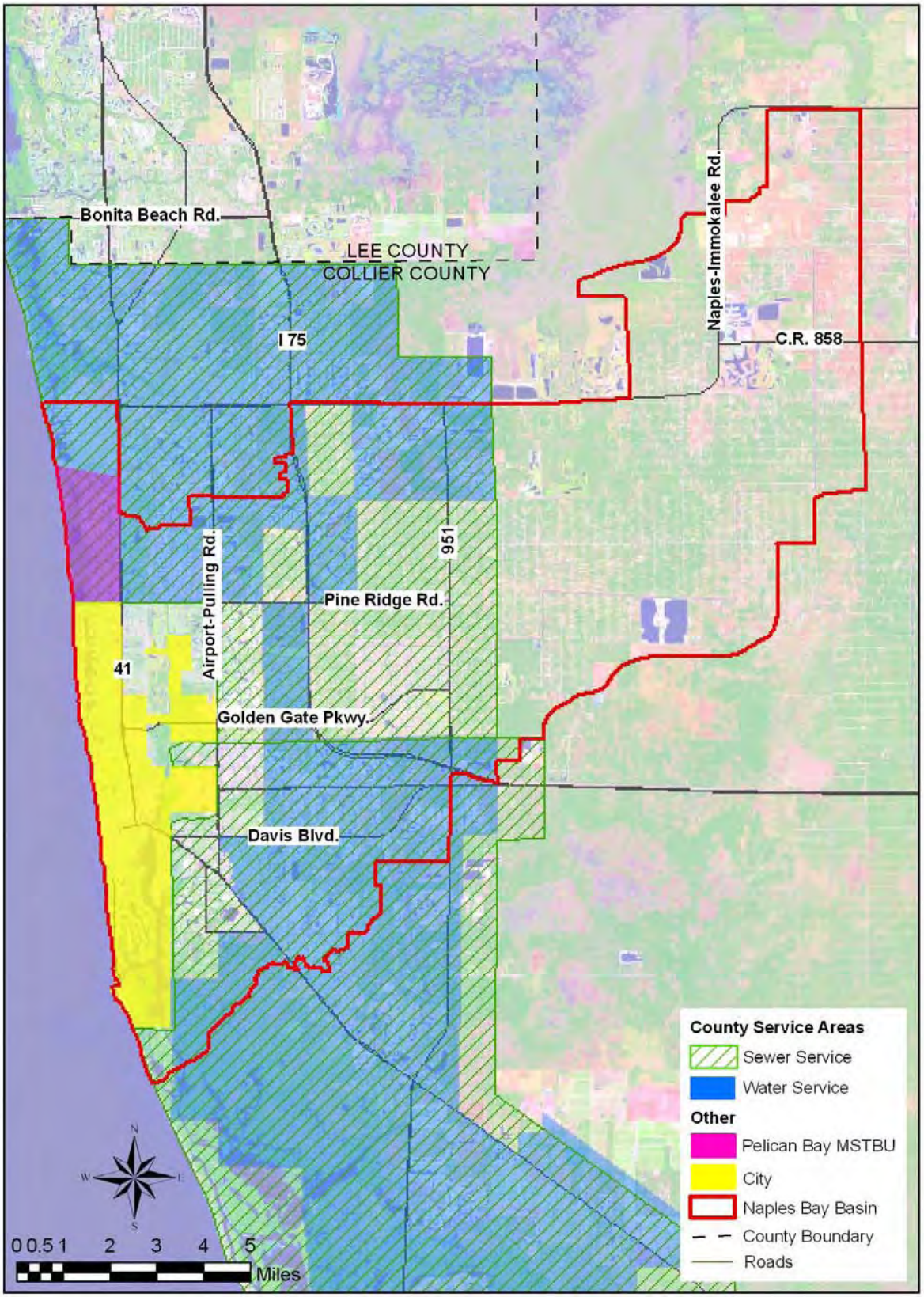

Figure 30. Collier County Sewer and Water Service Area (data source: Collier County, 2005).

4 INFORMATION REVIEW

Over the past 35 years, substantial research, monitoring, studies, and plans have been done that address water quality, hydrology, and ecosystems in the area. The "Naples Bay Study", completed in 1979, identified problems affecting the Bay and provided a number of recommendations. Many organizations, both government and citizen based, have focused their efforts on studying, restoring and managing the system. CERP has undertaken comprehensive restoration and preservation of water resources in Central and South Florida. To date, however, CERP actions taken specific to the Naples Bay basin are limited to Program Management Plans for Feasibility Studies, compilation and evaluation of water quality data, and water quality strategy development by a Water Quality Sub-team. Other governmental entities including Collier County, the City of Naples, SFWMD, and Rookery Bay National Estuarine Research Reserve actively support efforts to improve the Bay, as do several non-government support groups.

Summaries of data sets, studies, plans, projects and programs that are pertinent to surface water resource management are presented in this Chapter with some more detailed information provided in Appendix A. Within each section of the Chapter, the information is presented in chronologic order, with the most recent information first. Other sources considered for this report but not summarized here are included in the References Cited Section.

Information focused on habitat and species was included in the Geographic Analysis Section. A summary of four canal studies completed between 1972 and 1980 is given in Appendix A4. Water quality data that are collected by groups such as the Conservancy of Southwest Florida and Bay Watch, but not analyzed by certified laboratories are not reviewed here. Those data are covered in more detailed reviews, such as the Tetra Tech Report, summarized below.

The BCB Library Catalog was reviewed for inclusion of pertinent bibliographic sources. The catalog is in spreadsheet format, approximately 50 pages, and can be searched by key word. A compilation in progress, the BCB – Estero Bay Regional Research Database was searched as well (http://ocean.floridamarine.org/bcb). The database is a collection and documentation of data that can be queried on-line using a traditional database interface, or using an interactive mapping interface. A list of projects for a given geographic area or keyword can be retrieved, along with project details. A list of ecological projects and research scientists maintained by SFWMD staff (Tomma Barnes, SFWMD, personal communication) was also reviewed.

CURRENT DATA

Preferred Water Quality Data

As a result of the SWFFS, the Water Quality Sub-Team was formed and the report, Compilation, Evaluation and Archiving of Existing Water Quality Data for Southwest Florida (Tetra Tech and Janicki, 2004), was produced with a 'preferred' Access dataset containing about 2 million records. SFWMD identified and improved some problems with the database (Darren Rumbold, SFWMD, personal communication). Data gaps have been addressed and future sampling plans discussed as a cooperative effort among the City of Naples, Collier County, FDEP, and SFWMD staff. Additional funding sources and means of sampling have been sought.

Since the Tetra Tech and Janicki report was completed in mid 2004, re-sampling of historic sites has been performed and new sampling sites and parameters have been added, though new data are still provisional. Starting January 2005, one site was added in the Bay and other sites were added near the mouth of the Bay. BOD has been added to all County sampling sites (Rhonda Watkins, Collier County, personal communication, Karen Bickford, FDEP, personal communication). Strategies and recommendations of the Water Quality Sub-committee are described in this report. "Evaluation of Naples Bay Water Quality and Hydrologic Data" (Taylor Engineering, Inc., 2005), completed June 2005, further evaluated the preferred Access dataset for Naples Bay. These two recently completed reports provide a succinct and complete evaluation of water quality monitoring in the Naples Bay Basin.

Collier County, SFWMD, FDEP (DBHYDRO and STORET)

Since 1998, the Collier County Pollution Control and Prevention Department has collected and analyzed monthly water samples in the Bay and surrounding tributaries under contract with the South Florida Water Management District and the Big Cypress Basin. The station locations are shown in Figure 31. Samples are analyzed for the following parameters:

Monthly Parameters

Calcium	Fecal Coliform	pH	Total Nitrogen
Chlorophyll	Total Hardness	Phaeophytin	Total Organic Carbon
Color	Magnesium	Salinity	Total Organic Nitrogen
Diss. Inorganic Nitrogen	Ammonia	Secchi depth	Total Coliform
Diss. Oxygen	Ammonium	Total Kjeldahl Nitrogen	Total Depth
Specific Conductivity	Nitrite	Ortho-phosphorus	Total Phosphorus
Staff gauge	Nitrate	Turbidity	Total Suspended Solids
Total Diss. Solids	Nitrite+Nitrate	Temperature	BOD (as of Jan. 2005)

Additional Quarterly Parameters

Alkalinity	Chloride	Fluoride	Silicate
Arsenic	Chromium	Iron	Sulfate
Cadmium	Copper	Lead	Zinc

FDEP collects additional data that are available through STORET, including the surface water data of the Integrated Water Resource Monitoring Network (IWRM) Program (Figures 32 and 33). Water quality monitoring conducted by Collier County for SFWMD are loaded into DBHYDRO, SFWMD's online environmental database, which stores hydrologic, meteorologic, hydrogeologic and water quality data (http://www.sfwmd.gov/org/ema/dbhydro/index.html).

DBHYDRO data are also loaded into the FDEP database, STORET, and are available for download at (http://STORET.DEP.STATE.FL.US/). STORET is adatabase administered by the USEPA, the acronym being derived from STOrage and RETreival. STORET is a primary data source used to create the National Water Quality Inventory Report to Congress (305(b) report), which evaluates the status of water quality in the nation every two years. Data from STORET are also used to determine if a water body fails water quality standards and requires the development of Total Maximum Daily Loads (TMDLs). Due to inherent time delays in collecting, processing and

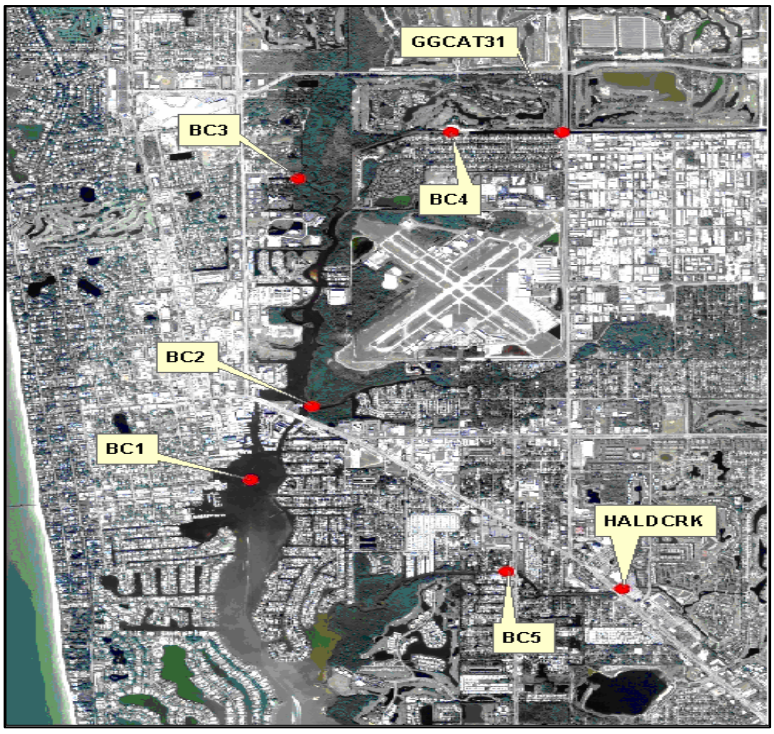

Figure 31. Current Collier County surface water monitoring locations (Collier County Pollution Control and Prevention Department).

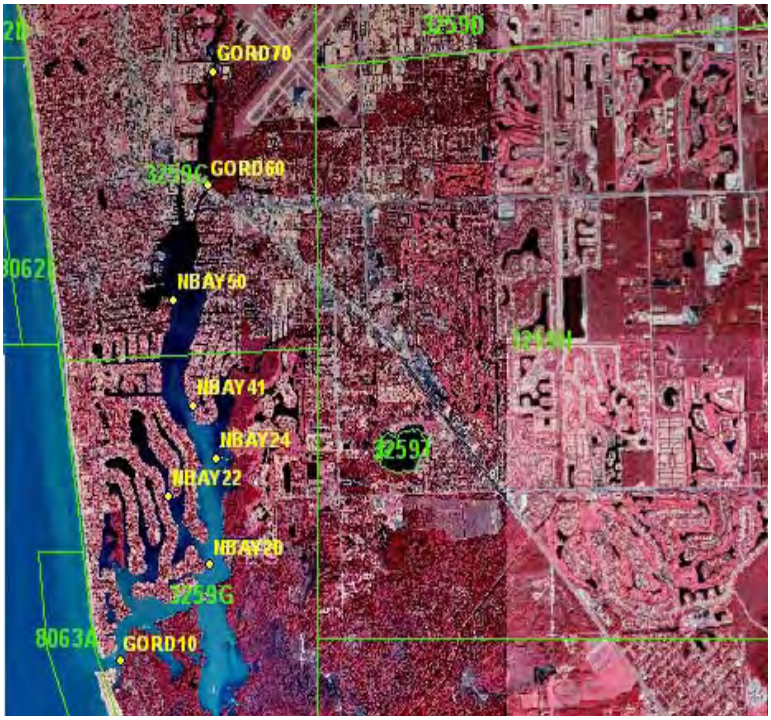

Figure 32. FDEP Current Sampling Stations (FDEP).

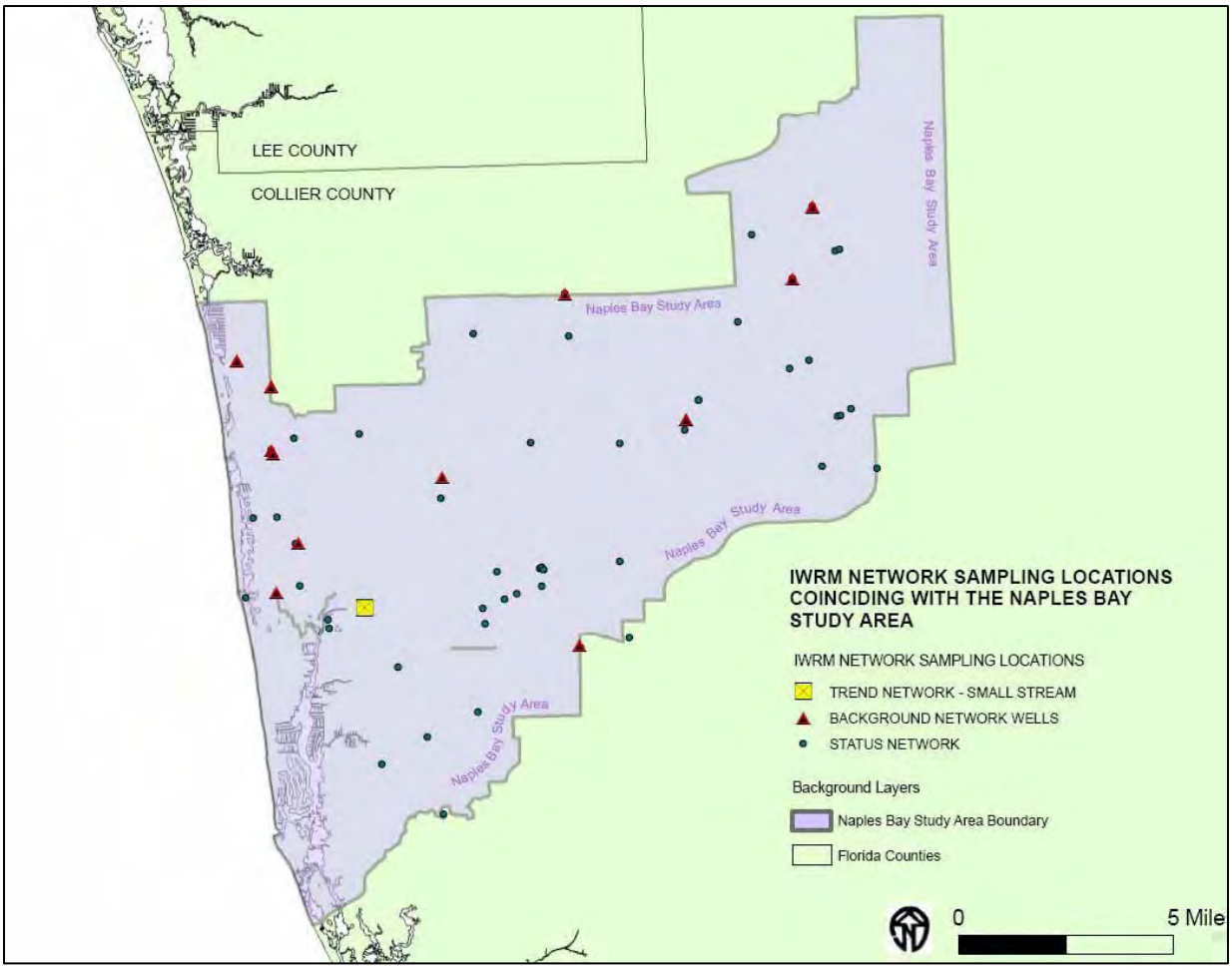

Figure 33. FDEP IWRM Network Sampling Locations.

incorporating data into databases, STORET and DBHYDRO are said to be up to 1 year behind on the inclusion of data from the County's water quality sampling program. Also as a result of inherent time delays in collecting, processing and incorporating data in databases, flow and stage data handled by the SFWMD are roughly one month behind in DBYHDRO (Rhonda Watkins, Collier County, personal communication, Andy Potts, SFWMD, personal communication). SFWMD and FDEP monitoring stations locations in GIS data sets are shown in Figure 34 and 35. It should be noted that not all stations shown on the map are currently being sampled. The locations of the sampling sites might also differ from those shown on the maps due to error in data collection and processing.

FFWCC

FFWCC has sampling locations for the phytoplankton that causes red tide near the shoreline of Study Area and about 5 miles offshore (Figure 35). As of May 2005, only one sample, taken at Clam Pass, indicated a presence of Karenia brevis (less than 1001 cells per liter, 04/25/2005). The sample locations offshore from Clam Pass and from the southern tip of the Study Area report up to a 'medium' amount of

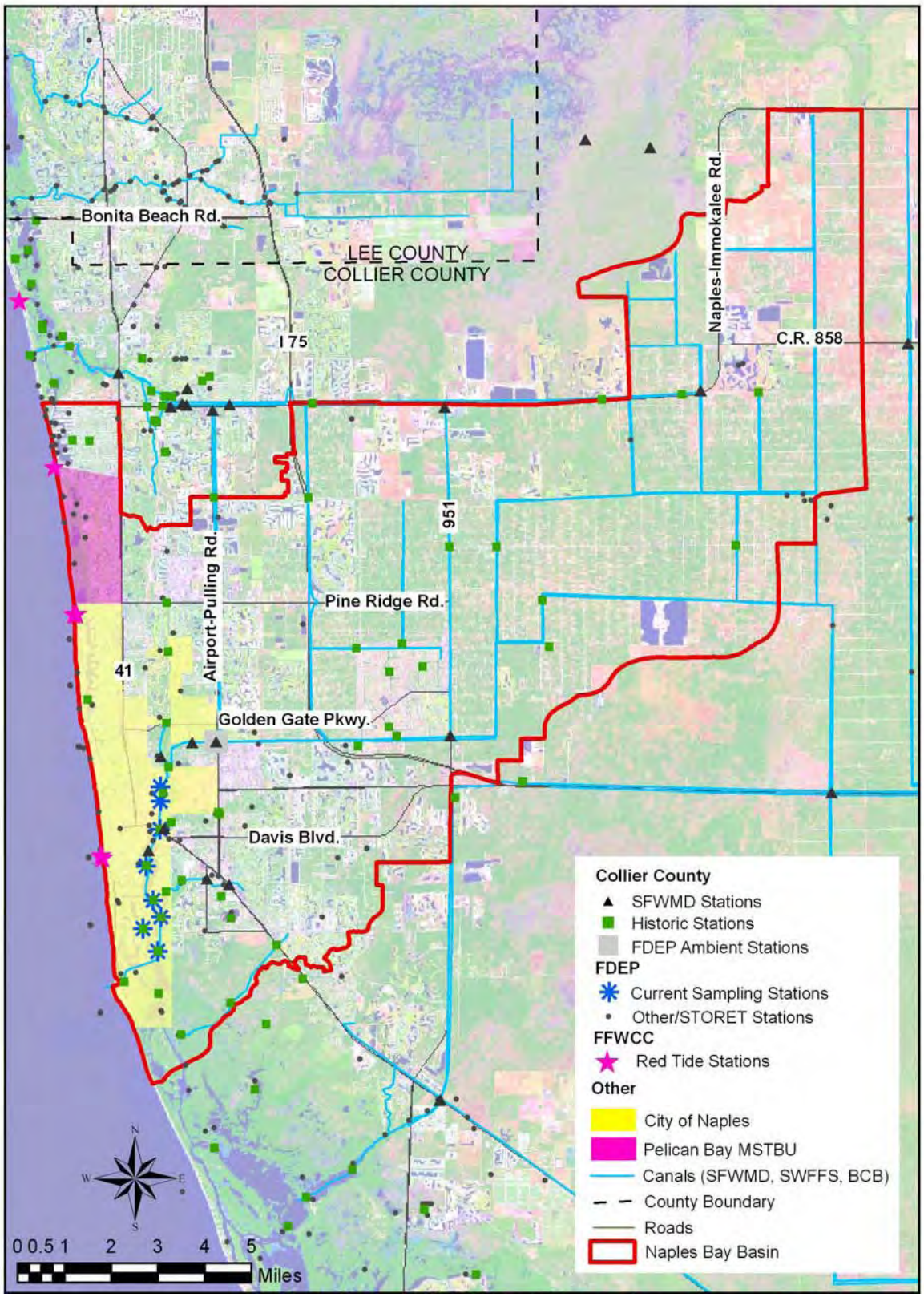

Figure 34. Collier County, FDEP and FFWCC Water Quality Monitoring Stations (data sources: Collier County, FDEP, FFWCC, 2005).

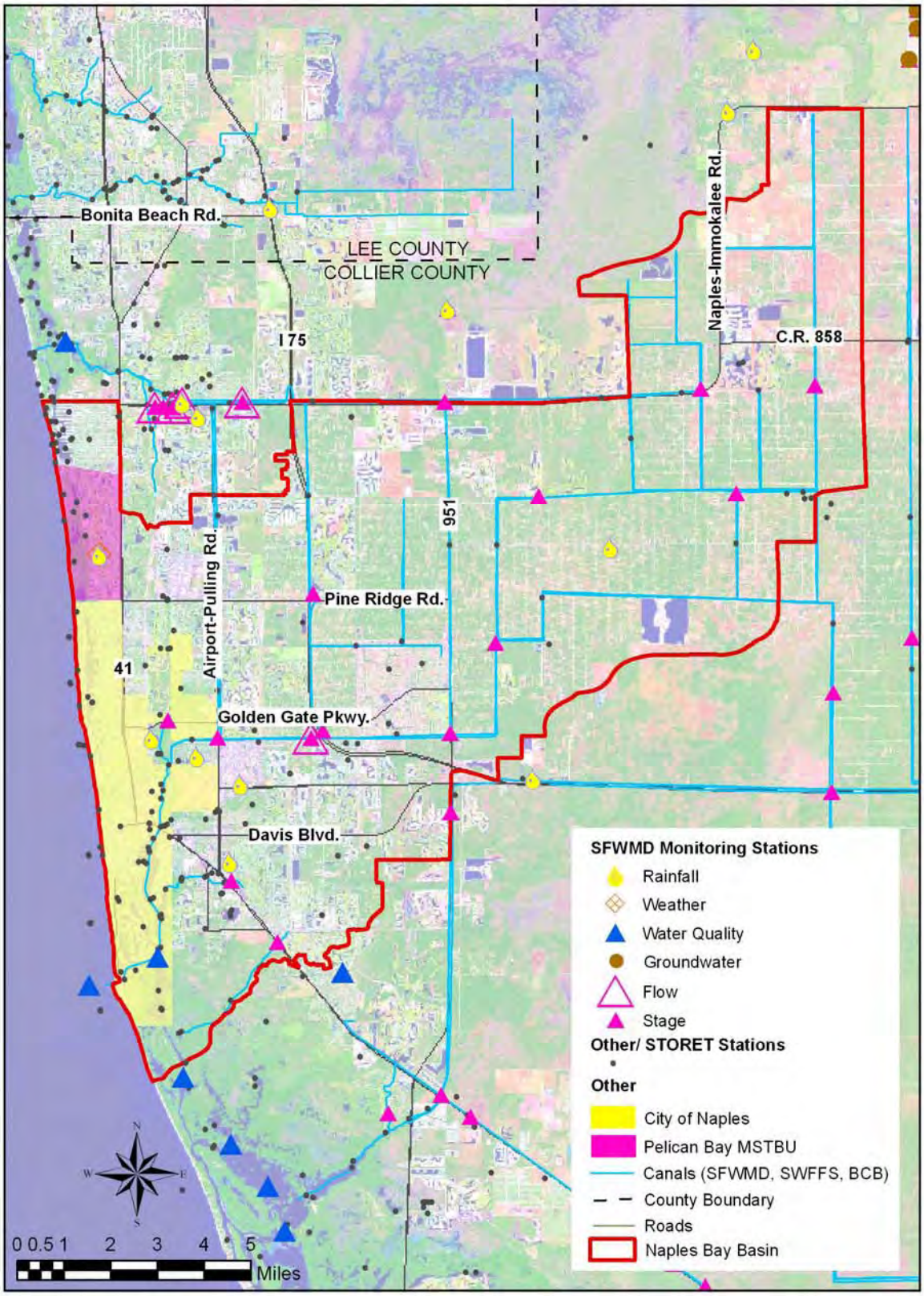

Figure 35. SFWMD Monitoring Stations (data sources: SFWMD, FDEP 2005).

the algae (1,000,000 cells per liter) during October and November 2004. Data are available for viewing, interactive mapping and download at http://ocean.floridamarine.org/mrgis/viewer.htm.

Petroleum Storage Tanks and Hazardous Waste

Petroleum storage tank facilities within the Naples Bay Basin are regulated by the Florida Department of Environmental Protection due to the potential for groundwater contamination. The facilities identified in Figure 36 and Appendix A5, are regulated petroleum storage tank facilities, which include above ground storage tanks greater than 550 gallons in volume, and underground storage tanks greater than 110 gallons in volume. Also identified are petroleum storage tank facilities with confirmed discharges. These confirmed discharges may be caused by leaks or corrosion in the tank system, equipment failure, and operator error (i.e. overfilling of tank). Cleanup of contamination is required to be completed by the property owner under the supervision of FDEP.

Hazardous waste generators within the Naples Bay Basin are regulated by the Florida Department of Environmental Protection due to the potential threat they pose to human health and natural resources. The facilities identified in Figure 36 and Appendix A5 include small quantity generators, conditionally exempt small quantity generators of hazardous waste, and non-handlers (used oil generator). The designation of small quantity generator includes facilities that generate between 100 kg – 1,000 kg of hazardous waste per month. Conditionally exempt small quantity generators of hazardous waste generate up to 100 kg of hazardous waste per month or less than 1 kg of acute hazardous waste. Acute hazardous wastes are substances that have been found to pose significant, irreversible harm to human health, such as arsenic and cyanide compounds. All small quantity and conditionally exempt small quantity generators of hazardous waste, as well as non-handlers (used oil generating facilities) are required to ensure proper disposal of their wastes through pick up by a licensed hauler for its eventual proper disposal or storage. The Basin has no large quantity generators, nor any treatment, disposal, or storage sites.

Wastewater

Wastewater generating facilities within the Basin are permitted by the FDEP. These facilities include domestic wastewater treatment facilities and industrial wastewater facilities (Figure 37 and Appendix A5). A number of these facilities are required to obtain a National Pollution Discharge Elimination System (NPDES) permit, administered through the FDEP, while some are not and are regulated solely under Florida Statutes.

The domestic wastewater treatment plants generate secondarily treated wastewater that may be permitted to be disposed of in many ways including: surface water discharge; deep well injection; re-use (treated to a higher standard); intermittent surface water discharge; or a combination of these. Intermittent surface water discharge generally means the wastewater is contained within an isolated pond

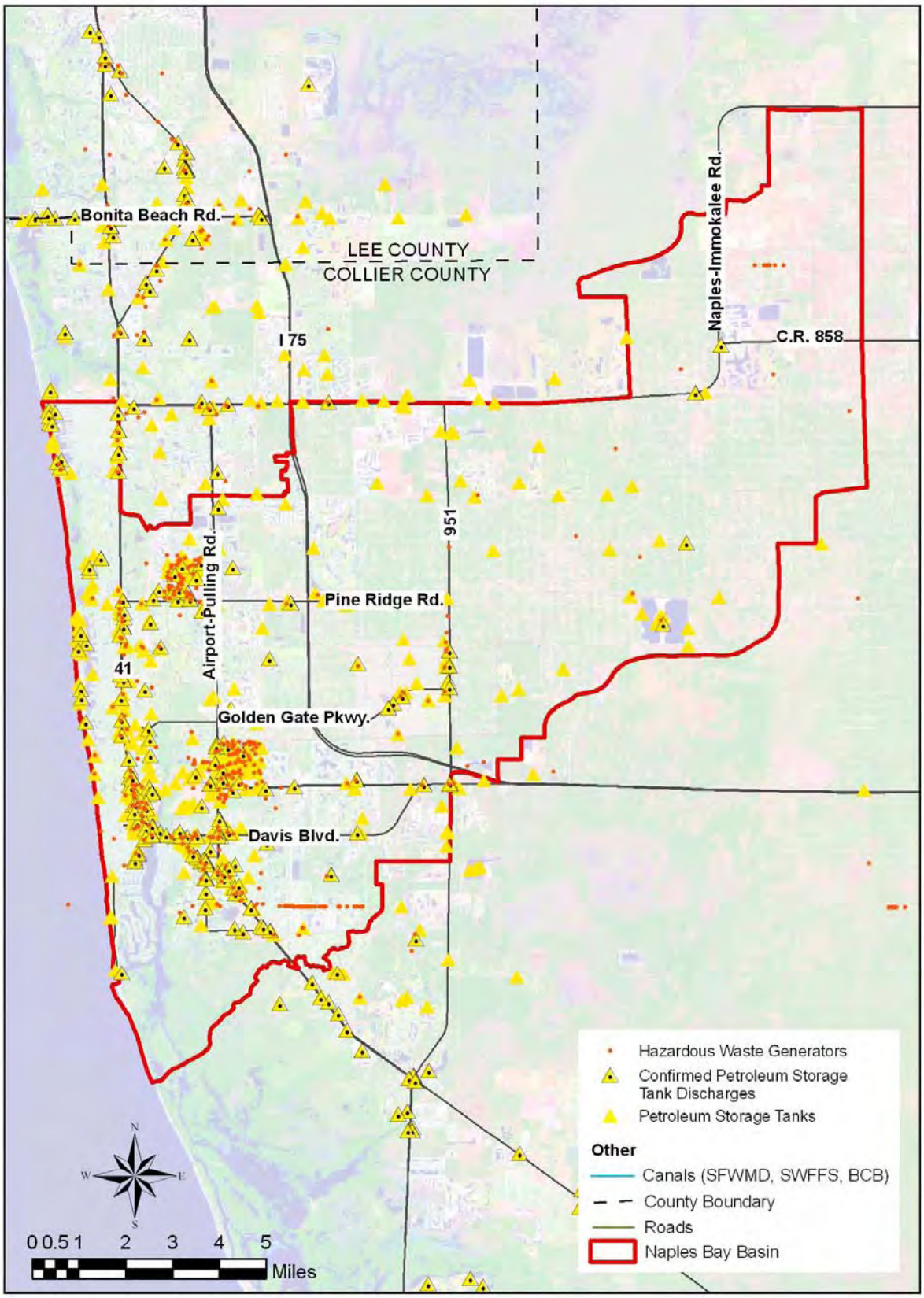

Figure 36. Petroleum Storage Tanks and Hazardous Waste Generators (data source: FDEP, Petroleum Contamination (PCT) and Statewide Coverage for Compliance and Enforcement Tracking of Hazardous Waste (CHAZ), August, 2005).

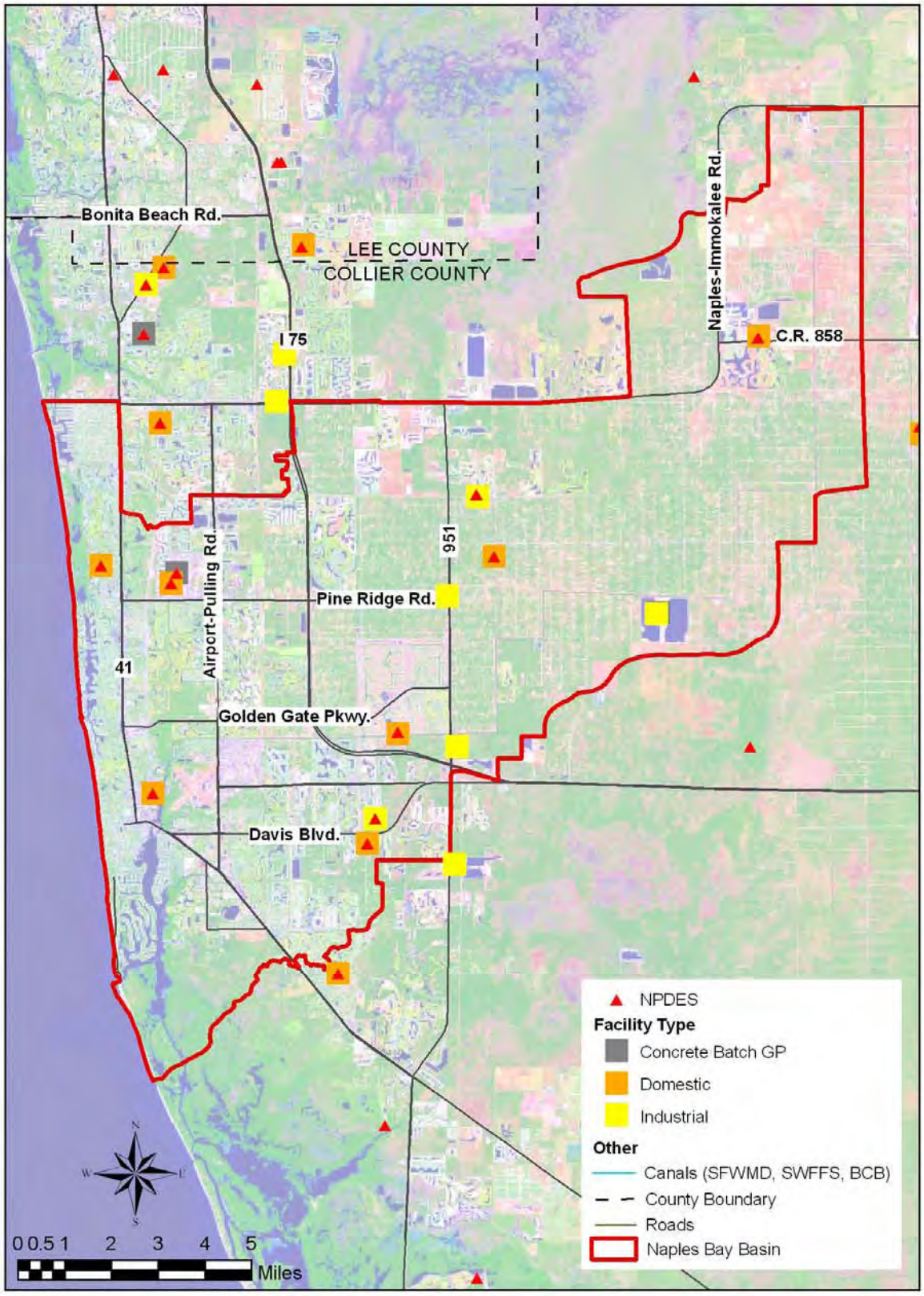

Figure 37. Wasterwater Facilities **(data source: FDEP, Statewide Coverage of Wastewater Facility Regulation (WAFR), August 2005).**

and only reaches surface waters of the state through ground water seepage and transmission, or during a significant storm event.

The industrial wastewater permits in the Study Area are for facilities such as concrete batch plant, reverse osmosis plants, an agricultural processing operation (tomatoes), and primarily discharge to groundwater through percolation ponds or deep well injection. Other types of discharge that occur to a lesser extent are: surface water discharge, and re-use. The wastewater discharged from concrete batch plants have elevated total suspended solids (TSS) generated from water runoff within the site. The wastewater discharged from reverse osmosis plants is high in total dissolved solids (TDS).

The main contributor of secondarily treated wastewater to surface waters in the Study Area is the City of Naples Wastewater Treatment Plant, which is permitted to discharge approximately 2.4 mgd (annual average daily flow) to the Gordon River, with the remainder of its wastewater being disposed of through re-use.

The Department of Environmental Protection through agreements with the Environmental Protection Agency, is working toward eliminating as many surface water discharges as possible, and has made considerable progress with this in the past several years.

STUDIES

Coastal Bays and Barrier Islands Ecological Conceptual Model

Thomas, D. and D. Rumbold,. Unpublished. Coastal Bays and Barrier Islands Ecological Conceptual Model, US Fish and Wildlife Service. Vero Beach, Florida. Unpublished working paper.

While this draft report is for planning purposes only and is not to be cited or quoted, it is being referred to here with permission from its authors. The modeling effort is being lead by Daryl Thomas, USFWS, and Darren Rumbold, SFWMD. The conceptual model includes Naples Bay, Estero Bay, and Rookery Bay. Baseline conditions are described, covering water quality and parameters of concern, as are habitat alteration and loss, and human use. It also addresses the following:

- External drivers: climatic cycles and meteorological events, sea level rise, water management, urban, industrial and agricultural development
- Ecological stressors/chemical or physical changes: altered hydrology and freshwater inflow, changes in water quality and increased contaminants, toxicants
- Ecological attributes/biological indicators: community structure and function of algal bloom, benthic, wading and shore birds, fisheries, submerged aquatic vegetation, bivalve, mangroves, as well as the manatee population abundance, distribution, and health
- Ecological effects/response: mangroves, manatees, fisheries, oysters, SAV and plankton, water quality
- Hydrologic performance measures: adopted from the SWFFS
- Ecological performance measures: adopted from the SWFFS

- Water quality performance measures: evaluation measures and assessment measurers are currently being developed by the SWFFS Water Quality Sub-team (see SWFFS Water Quality Strategy Document in Modeling and Plans section).

Evaluation of Naples Bay Water Quality and Hydrologic Data.

Taylor Engineering, Inc. 2005. Evaluation of Naples Bay Water Quality and Hydrologic Data. Prepared for South Florida Water Management District. Fort Myers, FL.

Taylor Engineering used the Southwest Florida Feasibility Study ACCESS database framework to compile water quality data for Naples Bay and adjacent tributaries (Lely Canal, Haldeman Creek, Rock Creek, Gordon River, and Golden Gate Canal). Data were compiled from 1957 to 2003 for 150 of the 155 stations representing several locations with the Naples Bay Basin and the Gulf of Mexico. Most of the samples were taken after 1985, though the data record became more consistent after 1999.

Water quality conditions of concern within the Naples Bay Basin included both chemical and biological parameters. Dissolved oxygen, nitrogen, phosphorus, copper, iron, lead, and zinc exceeded state water quality standards in more than 10% of the sample sets and nutrient parameters also frequently exceeded nutrient criteria defined for Class III waters. Chlorophyll-a concentrations and fecal coliform counts were often elevated relative to the state or regional estuary criteria. Lower Naples Bay is occasionally less saline than normal, and dissolved oxygen concentrations have decreased slightly from 1957 to 2003. Nitrogen has decreased since 1990. Upper Naples Bay did not exhibit the same change in nitrogen concentrations but total phosphorus has decreased since 1990. Dissolved oxygen standards were often not met. The less frequently sampled tributaries provide less data for examination.

This study also had a goal of assessing the quality of data and to determine their utility in calibrating a water quality and hydrodynamic model for Naples Bay. The study concludes that existing data would allow limited model calibration, but an intensive calibration effort would require collection of more complete data.

Compilation, Evaluation, and Archiving of Existing Water Quality Data for Southwest Florida.

Tetra Tech, Inc. and Janicki Environmental, Inc. 2004. Compilation, Evaluation, and Archiving of Existing Water Quality Data for Southwest Florida. Department of the Army, Jacksonville District Corps of Engineers. Jacksonville, Florida. Contract No. DACW 17-02-D-0009.

This report is an extensive listing of water quality data available as of early 2004 throughout the entire Southwest Florida region. Each set of data is evaluated for quality and details about the sampling frequency and parameters tested are provided. The location of the data is also provided, with a large percentage in the DBHYDRO database. The data were used to identify areas for potential concern and gaps in important information. Three basins from the Tetra Tech study are incorporated either completely or partially in the Naples Bay Study Area: Basins 284, 302, and 306 (Figure 38).

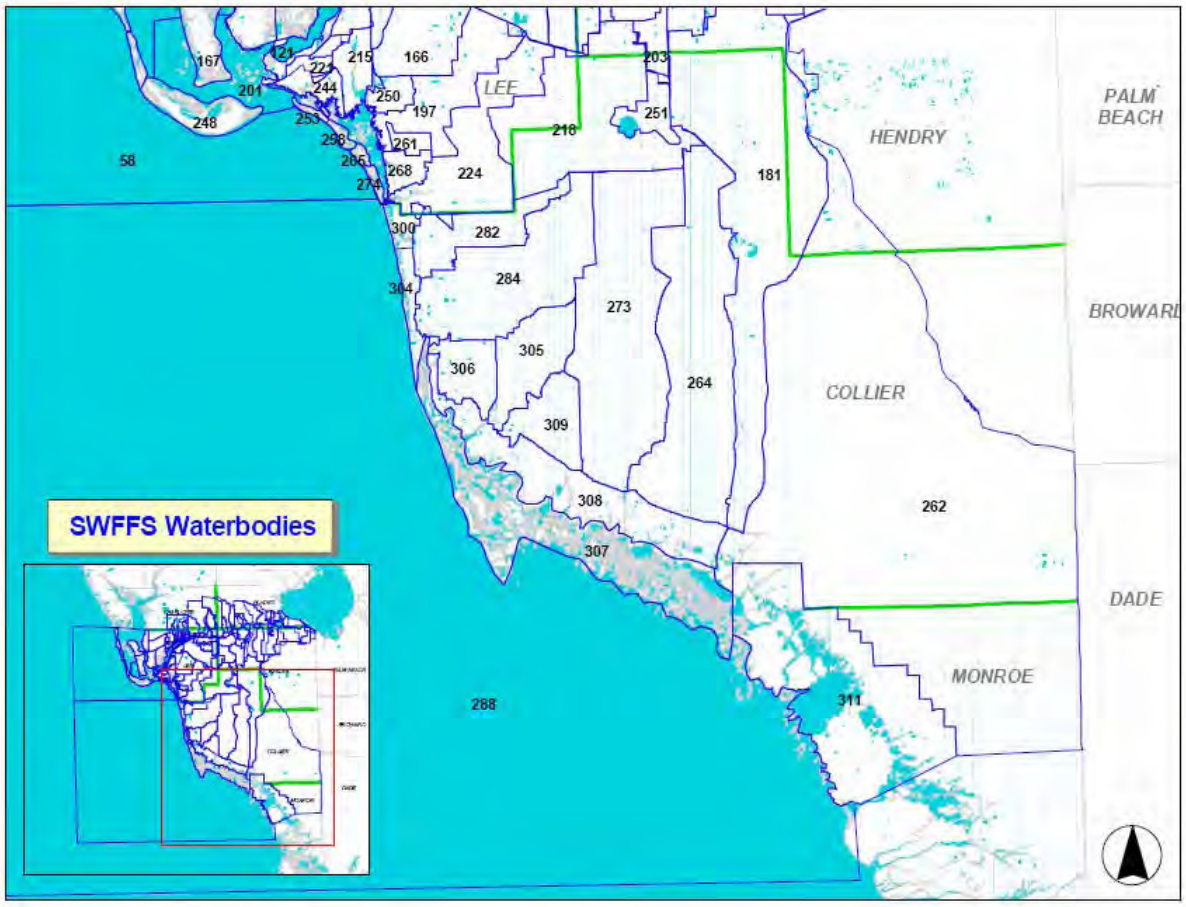

Figure 38 Basins from the Tetra Tech Study (Tetra Tech and Janicki, 2004).

The term 'verified concern' was used to indicate that state standards were not being met, and the number of times a measure exceeded limits was in excess of the allowable occurrences. The term 'potential concern' meant that the number of times a measure exceeded limits was close to the allowable occurrences. Basin 284 is identified as having waters of verified concern in the following areas: conductance, dissolved oxygen, fecal coliforms, excess iron and nutrients, total coliforms and unionized ammonium. Basin 304 is identified as having waters of verified concern in the following areas: fecal coliforms, excess nutrients and total coliforms. Basin 306 is identified as having waters of verified concern in the following areas: conductance, dissolved oxygen, fecal coliforms, excess iron and total coliforms and is identified as having waters of potential concern related to unionized ammonium.

Data gaps in water quality parameters have also been identified in these three basins. Areas with insufficient data for these basins as defined by the Tetra Tech study are conductance, dissolved oxygen, fecal coliform, iron, total coliforms and unionized ammonium. Specifically, Basin 284 has no recorded data for mercury. Basin 304 has no recorded data for endrin, antimony, or thallium. Basin 306 has no

data for mirex, radioactivity, bromoform, methylene chloride, carbon tetrachloride, flourene, hexachlorobutadiene, PCPs or trichloroethylene.

There are 23 monitoring efforts included in the Tetra Tech study that have at least one sampling site within the Naples Bay Basin or the near offshore waters. Four additional monitoring efforts that pertain to the area were not included because either 1) the source is an unverified lab or 2) data were only available in hard copy. A summary of these monitoring efforts, including sampling parameters, dates and location, is presented in Appendix A6.

Effects Of Increased Urban And Agricultural Landuse On The Anthropogenic Loading To Southwest Florida Estuaries

Gardinali, P., Y. Cai, R. Jaffe and J. Boyer. 2002. Effects of Increased Urban And Agricultural Landuse On The Anthropogenic Loading To Southwest Florida Estuaries. Final Report Prepared for Environmental Services Division, Pollution Control Department, Collier County, Florida Grant # 579901900. SERC TECHNICAL REPORT T-191 Revision 1

The purpose of this study was to assess 104 common organic contaminants and metals in surficial sediments along the coast of Collier County (see Appendix A7 for complete list). Eight sites were sampled in the Naples Bay Basin. Testing was conducted twice – May-June 2001 and December 2002. Sample site's (Figure 39) were chosen from low energy depositional areas with a high accumulation of fine particles so that low concentration levels would still be possible to detect using protocols from NOAA's Status and Trends Program as described in NOAA Technical Memorandum NOS/ORCA/CMBAD 130 (Lauenstein and Cantillo, 1998). Results from this test were compared to testing completed by Grabe in the early 90s (1996, 1993, 1990).

The Naples Bay station near the US-41 Bridge (CC04) had PAH concentrations exceeding more than half of the Threshold Effects Levels (TEL) for individual PAH groups present. The most likely source for this sites PAH loading was determined to be from vehicular and boat traffic. Five of the sample sites exceeded TELs for several other contaminants: Naples Bay/Gordon River at the US-41 Bridge (CC04), just north of the bridge (CCX04), Wiggins Pass (CC05), mid Naples Bay (CCX06) and the north end of Keewaydin Island (CC465). Specific contaminants for these sites are presented in Appendix A7.

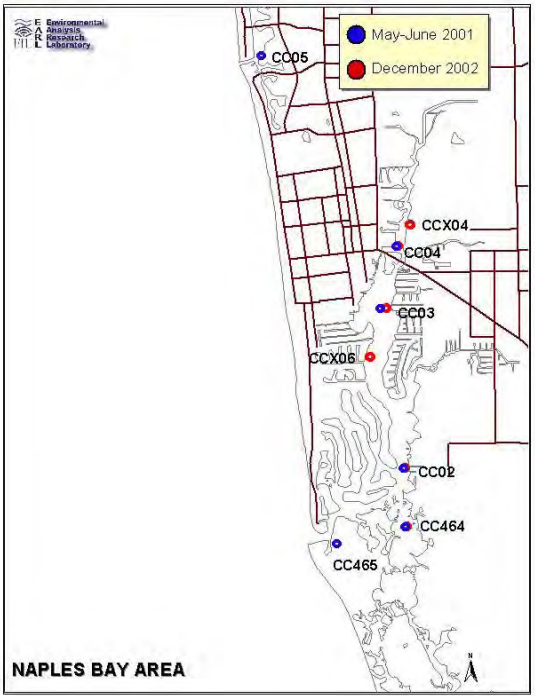

Figure 39. FIU Sediment contaminant sample sites for Collier County in 2001-2002 (FIU website).

A more intensive site specific survey was recommended for Naples Bay and the Gordon River area

and proposed locations for testing were provided. Additional details about contents for this report are listed in Appendix A7.

Effects of Water Control Structures on Estuaries.

Savarese, M., L.P. Tedeso, M.S. Shirley, G.Filippelli, S.M. Bush, H.E. Stoffel. 2002. Restoring Estuarine Habitat Quality: Effects of Alternative Types of Water Control Structures on Freshwater Inflow, the Distribution of Non-point Source Pollutants, and the Dispersal of Non-Indigenous Species. National Oceanographic and Atmospheric Administration. Washington, D.C.

The purpose of the study was to investigate the relative influences that three different weir designs and water release practices have upon estuarine habitats. Three Collier County systems were studied; the Faka-Union, Henderson Creek, and the Cocohatchee River, with the unmanaged Blackwater River used as a control comparison. Estuarine habitat quality upstream and downstream from each water control structure was evaluated by 1) monitoring sedimentological changes; 2) measuring the concentration of trace, minor, and major metal and organochlorine contaminates in sediments; 3) estimating the abundance and size distribution of salinity-sensitive macroinvertebrates; 4) estimating the abundance of exotic fish; and 5) comparing water quality (principally salinity, dissolved oxygen, and primary productivity as measured by chlorophyll concentration). Methods used and resulting data are presented in detail. It was concluded that it is the "simple design and lack of dynamic control of water release that is potentially detrimental to estuarine health". The timing and rate of salinity change should be controlled such that "pulses of freshwater are avoided" and biological organisms are able to accommodate the change. Results will influence design modifications for the fixed-crest weir retrofit planned at the headwaters of Henderson Creek to improve the timing and quantity of freshwater to Rookery Bay. Long term monitoring is planned by the Reserve for design evaluation. This study provides input for designing modifications to existing canal control structures or new canal control structures throughout the Naples Bay Basin.

Environmental Impact Statement On Improving the Regulatory Process in Southwest Florida, Lee and Collier Counties, Florida.

U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service and U.S. Environmental Protection Agency, 2000. Environmental Impact Statement on Improving the Regulatory Process in Southwest Florida, Lee and Collier Counties, Florida. USACOE. Jacksonville, Florida. Revised 2005.

This EIS for Southwest Florida was primarily prepared to propose new procedures for permitting wetland impacts. These procedures were designed to provide a more holistic approach to permitting, reviewing all of the natural resources in a watershed with specific criteria dependent upon overall condition. Ecological parameters such as species management and landscape configuration were the primary focus, but water quality was also considered. Early data collected in USEPA and FDEP studies were analyzed for the entire area, and the areas relevant to the Naples Bay Study Area are summarized below.

Historical STORET water quality data from 1980-1989 was used to summarize conditions for the Golden Gate Canal. Values and interpretations in the EIS are listed below.

- Relatively low turbidity (3.5-4.3 NTUs)
- Low TSS (2-3 mg/L)
- Higher color content than average (50-99 PCUs)
- Neutral pH
- Low to moderate levels of DO (4.8-6.0 mg/L)
- Conductivity higher than average (572-650 micromhos)
- BOD exceeded State standards (2.4 mg/L at one canal sample location)
- Chlorophyll a higher than average (19 mg/L)
- Fecal coliform bacteria lower than average (55 MPN/100 ml)
- TN and TP lower than average (0.81-1.07 and 0.02- 0.03 mg/L respectively)
- WQI ranged from 36 to 40, an indication of "good" water quality

Another compilation of water quality data from all available organizations within the Study Area was completed and WQIs were calculated by decade (1970-1979, 1980-1989, and 1990-1998) and approximate 55.5, 59.4, and 60.0, respectively for the Golden Gates Canal Basin indicating an increasing degradation in water quality. DO, BOD and fecal coliform were determined to be the cause of the degradation.

STORET data from 1989 was also used to describe water quality for Naples Bay.

- Near average turbidity (3.6-4.5 NTU/NTUs)
- Slightly better than average color (40-80)
- Low DO observed at two sample locations (4.5 to 6.0 mg/L)
- Low Chlorophyll a, (6-7 mg/L)
- TN exceeded screening levels (1.31 mg/L)
- TP exceeded screening levels (0.10 mg/L)

Very little historical or current water-quality data were available for the Lely Area, formerly known as Water Management District 6 Basin; however, an appendix in the report provides a summary of the water quality from the STORET database by decade. No overall summary was included for this basin, but records indicate low DO (average 5.1 mg/L), BOD exceeding screening level in 1990-1998 summary (3.56 mg/L), and fecal coliforms exceeding screening levels since 1980 (average of 710 MPN/100 ml). The majority of this EIS dealt with ecological issues of concern, and is therefore more fully summarized in Section 6 of this reconnaissance report. Details for relevant information can be found in Appendix A8.

Five future landscapes (called "Ensembles") were created that suggested different locations of development and different criteria for the permitting of developments and were used to propose an alternative procedure for reviewing wetland permits. The EIS proposed a set of standardized natural resource criteria be used in reviewing permit applications in Southwest Florida, called the Permit Review Criteria (Appendix H of the EIS). Anticipated future uses where a project may have a high potential for adverse effect were shown on the companion Natural Resources Overlay Map. Each application would then be evaluated using the criteria and evaluations suggested in the EIS applicable to the important resources found in that area.

The sub-area pertinent to the Naples Bay Study Area is included in "Zoom C" defined to the west by the Gulf of Mexico and to the east by the Faka-Union Canal, Miller Boulevard, Winchester Strand, and Big Corkscrew Island.

The Corps determined that seventeen listed fauna occurred in the Study Area that could be most affected by the proposed new procedures for permitting wetland impacts, although there were 23 species in Southwest Florida on the USFWS list and 45 on the FFWCC list. These species included the American crocodile, Eastern indigo snake, Florida scrub-jay, bald eagle, wood stork, red-cockaded woodpecker, piping plover, Audubon's crested caracara, Everglades snail kite, Florida panther, West Indian manatee, and the Loggerhead, Hawksbill, Green, Leatherback, and Kemp's Ridley Sea Turtles.

An Integrated Surface Water Quality Monitoring Program for the South Florida Coastal Waters

Jones. R. and J. Boyer. 2000. An Integrated Surface Water Quality Monitoring Program for the South Florida Coastal Waters. Southeast Environmental Research Center, Florida International University. Miami, Florida.

The Integrated Surface Water Quality Monitoring Program is a long term annual water quality (nutrient) sampling program with a grid of sites throughout coastal waters in south Florida. There are two sites in the Naples Bay Study Area: one in Naples Bay at Gordon Pass (Site 464) and one in the Gulf of Mexico just west of Gordon Pass (Site 465). These sites have been sampled since 1999 and annual reports issued since 2000. Data and annual reports through 2004 are available at http://serc.fiu.edu/wqmnetwork/SFWMD-CD/index.htm.

This program monitors 12 components monthly: salinity, temperature, dissolved oxygen, ammonium, nitrate, total phosphorus, soluble reactive phosphate, chlorophyll a, alkaline phosphatase, total organic carbon, total organic nitrogen and turbidity. Summary reports combine the results from both Naples sites, but the raw data are also available for each individual site (Figures 40 and 41). Details for the 2000 report and the website are provided in Appendix A9.

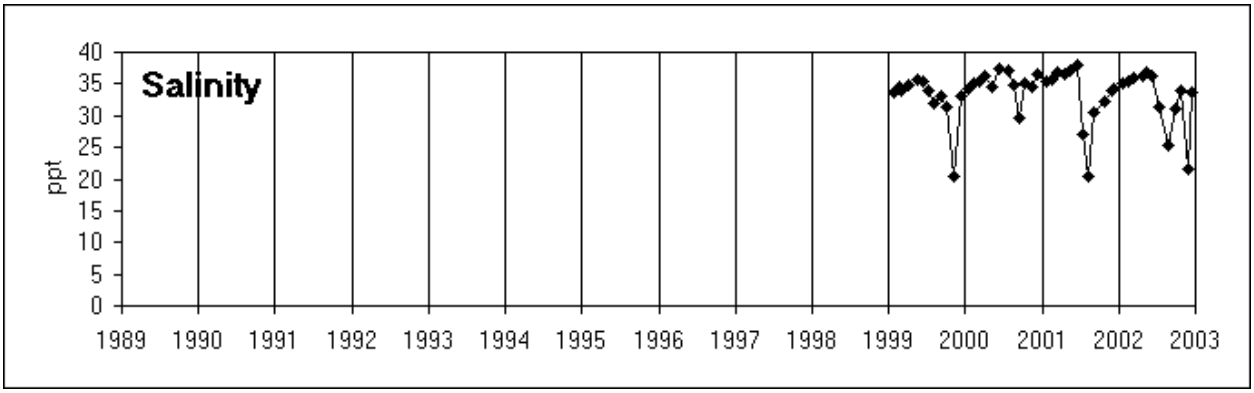

Figure 40. Salinity graph for data available for one of the sampling sites within the Naples Bay Study Area Site 464 to the east of Gordon Pass (FIU website).

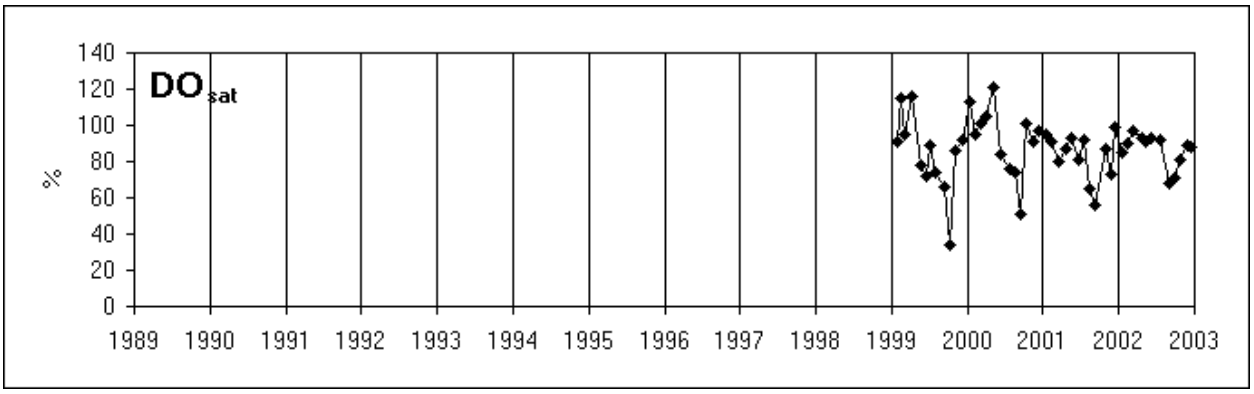

Figure 41. Dissolved oxygen graph for data available for one of the sampling sites within the Naples Bay Study Area – Site 464 to the east of Gordon Pass (FIU website).

Data from this study show no statistically significant trends in dissolved oxygen or nutrient concentrations within the water column for the two sites within Naples Bay between 1999 and 2005. However, both sites exhibit a small decline in DO, almost no change in nitrogen, a decline in TP and high seasonal variability in chlorophyll concentrations.

Big Cypress Basin Water Quality Monitoring Report: 1979 – 1988

Grabe, S. 1989. Big Cypress Basin Water Quality Monitoring Network Report: 1979 – 1988. Big Cypress Basin Board South Florida Water Management District. West Palm Beach, Florida.

This study presents water quality monitoring completed between the Naples Bay Study and work included in the Tetra Tech compilation. It is specific to Collier County and has four sites of interest to the Naples Bay Study Area: Gordon River above the Golden Gate Canal (GGC), GGC at Airport-Pulling Road, GGC at CR951, and the upper Lely Canal (Table 5). Parameters evaluated include nutrients and bacteria (monthly) and metals (biannually). The report focuses on statistical analysis of variance between overall annual averages for the entire area sampled. The report's appendix provides data by station, however, it is averaged over the entire sampling period (January 1979 – September 1988), and therefore neither trends nor seasonal variance can be reviewed. A brief summary of results relevant to the Naples Bay area is provided in Table 5.

Table 5. Brief summary of water quality data for four stations, means for 1979-1988.

Parameter measured	GGC at Airport-Pulling	GGC at CR951	Gordon River	Lely Canal
Temp, C	24.9	25.1	24.0	26.1
DO, mg/l	5.1	4.6	3.0	6.6
Conductivity, umhos/cm	572.2	547.8	1957.5	1389.7
pH	7.4	7.4	7.4	7.6
TKN, mg/l	1.1	1.0	1.2	1.1
TP, mg/l	0.03	0.02	0.07	0.03
Turbidity, NTU	4.4	4.7	3.5	3.7
Fe, mg/l	0.78	1.03	0.18	0.46
TSS, mg/l	3.6	6.7	4.9	4.3
NO3, mg/l	0.07	0.04	0.11	0.02
NO2, mg/l	0.007	0.005	0.010	0.005
NH4, mg/l	0.05	0.04	0.07	0.04
OPO4, mg/l	0.011	0.009	0.033	0.005
Cl, mg/l	39.1	26.0	638.0	611.6
SO4, mg/l	35.0	31.9	139.3	115.8
Color	84.9	98.6	57.2	49.1
Ca, mg/l	102.7	99.8	99.7	104.5
Mg, mg/l	4.2	3.4	19.5	18.1
Na, mg/l	20.3	12.4	150.7	125.7
K, mg/l	1.2	0.7	6.9	4.5
As, ug/l	7.2	6.6	11.2	8.1
Cd, ug/l	0.70	0.61	0.45	1.65
Cu, ug/l	4.8	2.3	4.0	3.4
Hg, ug/l	0.81	0.76	0.91	0.87
Pb, ug/l	2.6	3.3	3.4	4.3
Zn, ug/l	49.2	45.8	33.1	23.2
CaCO3, alk, mg/l	219.1	223.3	206.7	206.9
Chl a, ug/l	3.7	5.2	2.4	17.4
Fecal, max, #/100 ml	28	16	205	219
Strep, max, #/100 ml	10900	2880	370	64
Total coliform, max, #/100 ml	10	26	62	18

Naples Bay Study

Simpson, B., R. Aaron, J. Betz, D. Hicks. J. van der Kreeke, B. Yokel, 1979. The Naples Bay Study. The Collier County Conservancy. Naples, Florida.

This report presents detailed field studies evaluating the condition of Naples Bay and the effect of the residential canals connected to the Bay. Most of the sampling spanned a year between November 1976 and November 1977 with some follow-up bacterial work from September 1977 through February 1978. This body of work summarized: legislation; the currents and flows in both the Bay and canals; construction details for residential canals; bacterial, physical and chemical conditions in water

and sediment; and the benthic, midwater and surface fauna present. Methods are well documented and results, including statistical analysis, are extensive, presented in both tabular and graphical formats (Figure 42).

A total of 24 sites were chosen spanning from Gordon Pass at the southern boundary up to the Golden Gate Canal Dam at the northern boundary. Two additional sites in Dollar Bay were chosen as reference sites. Twelve of the locations are in residential canals, one is in Gordon Pass, four are in Naples Bay, three are in Haldeman Creek, two are in Rock Creek, one is in the Gordon River and the last is at the Golden Gate Dam. In addition, a schematic drawing of the waste water collection and drainage system in 1977 is provided in Appendix F of the Naples Bay Study.

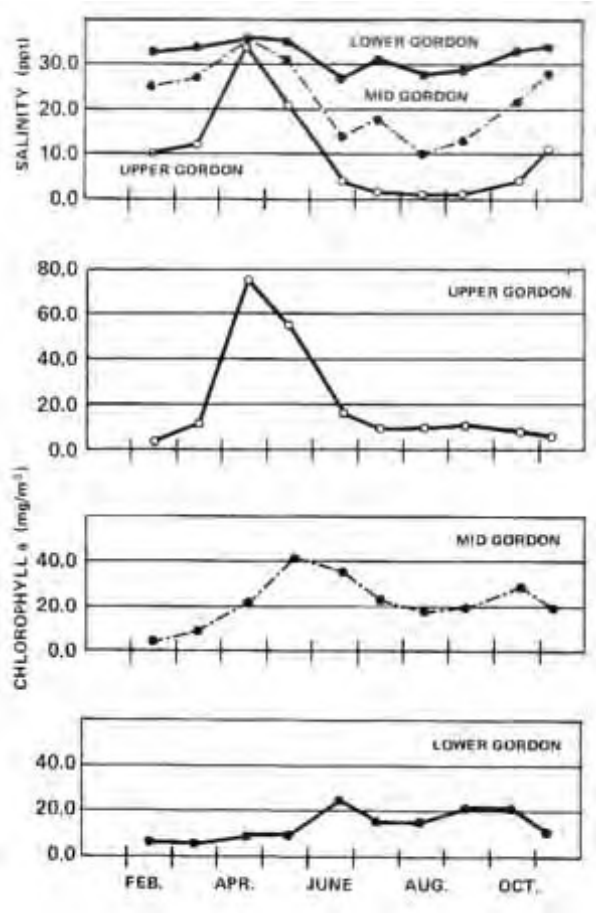

Figure 42. An example of water quality data presented graphically in the Naples Bay Study (Simpson et al. 1979).

A legal analysis of federal, state and local regulations related to water quality, construction, ownership and management, and permitting is included, although much of this legislation has been modified since. The study concluded that the canals in Naples Bay were constructed on highly permeable soil without lining and using drag lines and suction, two of them deep enough to breach the shallow aquifer. A silting study was not done; a study on similar canal in Marco Island was used as reference (Wanless, 1994).

Street runoff and storm water drainage were main nitrogen sources, while the Naples sewage treatment facility was identified as the primary phosphorus source. Freshwater drainage from Golden Gate was considered a low nutrient runoff input and acted as a diluting agent during otherwise high nutrient input periods, curbing algal bloom persistence in Naples Bay. However, Golden Gate runoff was the primary source of organic matter loading.

Overall respiration was greater than productivity in Naples Bay throughout the year, except April and May. This coincided with the driest part of the sample year and periods of only slight salinity stratification. In general dissolved oxygen less than 4 ppm occurred for prolonged periods in the dead-end canals. Low DO occurred in the Bay and river during periods of high freshwater input leading to severe salinity stratification. Respiration was about 30% greater in canals than the Bay, overall.

In the upper Study Area near the outfall from the sewage treatment plants, 35 to 65% of collected samples exceeded state fecal coliform standards. Urban runoff was the main cause of bacteria in the lower reaches with fewer exceedance violations than the upper reaches. Mean fecal coliform values at 5 stations tested prior to this study (1970) were significantly higher in the 1977 testing in this study, as much as 10 times higher at three sites. Three of the sampling sites did not meet the body contact limit during any of the eight sampling times, three sites met the limit once, and only one of the sites met the limit for six out of eight samples. The Naples Land Yacht Harbor was the most polluted with coliform.

Excess freshwater discharge eliminated or displaced a high percentage of typical fauna communities from June to October. Because of this, Gordon River exhibited lower catch and occurrence of recurrent benthic groups and animal diversity than the control area in Dollar Bay. The Naples Bay canals had lower diversity than Naples Bay but slightly higher catch results, but were still below Dollar Bay results for the same measures. Loss of benthic species in the canals appeared to be due to salinity stratification and reduced flushing leading to low DO in the deeper portions of the canals.

The graphs in Figure 42 represent typical graphical presentations of data in the report. Details about the format of the report and the location of different data are presented in Appendix A10.

The study demonstrated that the main source of freshwater in the system was from the Golden Gate Canal with as much as 1500 cfs during September, 1977, while the combined contributions of Halderman Creek, Rock Creek and Gordon River were estimated to be 100 cfs. Dye studies were conducted to determine the flushing times in eight canals typical of other canals in the area. A hydrography model for Naples Bay was simulated with tidal ranges and current magnitudes accurately predicted, but with a 30 to 60 minute time lag in flooding results. In addition, a schematic drawing of the waste water collection and drainage system in 1977 is provided in Appendix F of The Naples Bay Study. Details about the format of the report and the location of different data are presented in Appendix A10.

MODELING AND PLANS

SWFFS Water Quality Strategy Document

SWFFS. 2003. SWFFS Water Quality Strategy Document. Southwest Florida Feasibility Study Water Quality Sub-team. USACE, Jacksonville, Florida.

Within the context of the Comprehensive Integrated Water Quality Feasibility Study, (CIWQFS), objectives were developed by the WQ Sub-team to ensure that the SWFFS fulfills its role in restoring water quality. This plan outlines recommendations made by the Southwest Florida Feasibility Study Water Quality (WQ) Sub-team as a basis for further discussion of water quality guidelines for alternatives evaluation. Given the limited information available, a process for developing a stratified or tiered approach for evaluation of the incremental benefits and costs in comparing alternatives was developed. Below is a much simplified version of this process which is subject to re-evaluation:

- Compile all available WQ data into a single preferred data set (this was achieved through the Tetra-Tech report and its associated Access dataset)
- If needed for alternatives analysis, formulate a plan with the goal of achieving the necessary level of WQ
- Where a proposed alternative has a hydrologic focus:
  - Assess alternative for potential adverse WQ impacts
  - Identify and quantify possible WQ improvements, including credits to Environmental Quality (EQ) account
  - Optimize the proposed alternative to take full advantage of opportunities for WQ improvement
  - Develop a multipurpose alternative that achieves WQ restoration targets
- Review other WQ initiatives within the Study Area (e.g., CERP Projects such as C43 Basin Storage Reservoir (BSR) and ASR Pilot; TMDLs; SWIM Plans) to assess consistency or conflict. To this end, the Sub-team is currently reviewing regional plans and studies for findings and recommendations on WQ needs.

Two sets of performance measures were developed; 1) assessment measures, used for real responses and 2) evaluation measures, which predict the performance of a given alternative (Tables 6 and 7). This document focuses on the rationale for selecting evaluation measures and the development of water quality goals. The use of evaluation measures will be constrained by the availability of modeling tools, including data.

Table 6. Assessment WQ Performance Measures for SWFFS.

Assessment Performance Measure	Target
Dissolved Oxygen (DO)	Project/indicator region specific
Specific Conductance	Project/indicator region specific
Salinity	Project/indicator region specific
Turbidity/ TSS / Color	Maintain or reduce to levels that support healthy flora and fauna.
Photosynthetically Active radiation (PAR) / secchi disc depth	Maintain or increase to levels that support healthy flora and fauna.
Chlorophyll a (Chl *a*)	Maintain or reduce to levels that support healthy flora and fauna.
Total Nitrogen / Ammonia Nitrogen / Total Kjeldahl Nitrogen / Nitrate / Nitrite / Dissolved inorganic nitrogen	Maintain or reduce loads and concentrations to support healthy flora and fauna.
Total Phosphorus / Orthophosphate/soluble reactive phosphorus	Maintain or reduce loads and concentrations to support healthy flora and fauna.
Chloride	Project/indicator region specific
Sulfate	Project/indicator region specific
Silica	Project/indicator region specific
Pesticides	Project/indicator region specific
Trace Metals	Project/indicator region specific

The performance measures were developed through WQ Sub-team meetings, review of others' performance measure-related information, and previous assessments within the study boundary. They are scientifically based and the result of applying research findings, literature information, and best professional judgment. Atmospheric loading and metals are intended to be included as well. Salinity as a restoration target and ecological assessment performance measures (secondary response variables such as

SAV and fish) will be discussed in the SWFFS. An evaluation protocol that recognized the uniqueness and diversity of the study was culled from multiple guidelines and approaches. It addresses: concentrations within water quality treatment areas, concentrations within receiving waters, and downstream loading to "waters to be restored", and concentrations in 'waters to be restored".

Given that SWIM plans and TMDLs have not been established within the Study Area, if pollutant load reduction targets follow the FDEP load reduction and abatement assessment for the C-43 basin are deemed appropriate by the Sub-team, they may be adopted. Other tools that may be used to set load reduction targets are the Estero Water Quality model (DHI under contract to Lee County) and other regional plans and studies.

Table 7. SWFFS WQ Sub-Team Evaluation Performance Measures.

Evaluation Performance Measures
Dissolved Oxygen (DO)
Salinity (PSU, see hydrologic targets)
Turbidity / TSS
Photosynthetically Active radiation (PAR) / Color
Chlorophyll *a* (Chl-*a*)
Total Nitrogen (TN)
Dissolved inorganic nitrogen (DIN)
Soluble Reactive Phosphorus (SRP)
Total Phosphorus (TP)

The type of model used to forecast a systems response is considered. Pending the development of TMDLs, the Sub-team recommends alternatives evaluation be based, in part, on the reduction in annual nutrient loads as a percentage of current loading. The debate over load or concentration as a management objective is described.

It is recommended that an evaluation measure be developed for specific waterbody types in "waters to be restored" that addresses target concentrations for a typical dry season. The frequency, duration, and magnitude that a constituent exceeds target concentrations should be minimized.

City of Naples Basin V Stormwater System Improvement Plan Phase I: Basin Assessment and Conceptual Improvement Plan

Camp, Dresser and McKee. 2004. Basin V Stormwater System Improvement Plan Phase I: Basin Assessment and Conceptual Improvement Plan. Draft Interim Report. City of Naples. Naples, Florida.

This report is the first of three phases in an effort to document the current Basin V storm water system, recommend alternatives and provide design for these alternatives. The second and third phases (preliminary and final designs) were not authorized at the time of this draft. The Study Area was approximately bounded by Goodlette-Frank Road to the east, US 41 to the west, Ridge Street to the north and 6th Avenue North to the south. The first phase presented in this report included data compilation and evaluation using data provided by the City of Naples, and resulted in maps and identification of additional surveys required for complete assessment. Water quantity models were also simulated, similar to models

from the *Gordon River Basin Extension Modeling* (Wilson Miller, 2001) and using the same modeling parameters, but further delineated into a larger number of smaller hydrologic units and with additional junction nodes and conduits. The model was calibrated for four significant rain events: late September 2003, Tropical Storm Floyd in September 1999, early October 1995, and Tropical Storm Jerry in August 1995.

Overall, the model was determined to provide a reasonable match to actual events with predicted peak stages within 0.1 ft across the entire basin, and simulation results were used to determine the Level of Service provided for all units and junctions in the modeled area. Level of Surface (LOS) was divided into four classes defined by amount of flooding protection with A as the highest level of protection (no flooding in roads, yards or buildings) and D as the lowest level of protection (extensive road and building flooding predicted). For a 5 year/24-hr event, 64% of the Basin received Class A protection and 10% received Class D LOS. Results for all junction points are listed in Table 5-1 of the CDM draft. The Existing System LOS Evaluation-Comparison to Reported Flooding Problems (Table 5-3, CDM draft) and other details of this report are in Appendix A11.

The Southwest Florida Feasibility Study (SWFFS)

U.S. Army Corps of Engineers and South Florida Water Management District, 2002. Central and Southern Florida Project Management Plan: Southwest Florida Feasibility Study. USACOE. Jacksonville, Florida.

The SWFFS is one of a series of feasibility studies recommended in the Comprehensive Everglades Restoration Plan (CERP). The project boundary corresponds to the SFWMD Lower West Coast Water Supply Plan (LWCWSP) planning area. This includes most of Collier County, including Naples and Golden Gates Estates. The Project Management Plan (PMP) for the SWFFS is complete. Preliminary alternatives have been formulated and analytical methods and tools have been determined.

"The purpose of the study is to determine the feasibility of making structural, non-structural, and operational modifications and improvements in the region in the interest of environmental quality, water supply, and other purposes. The SWFFS will develop a comprehensive regional plan of action to address the health of aquatic and upland ecosystems; the quantity, quality, timing, and distribution of water flows; agricultural, environmental, and urban water supply; the sustainability of economic and natural resources; flood protection; fish and wildlife; biological diversity; and natural habitat." (USACE and SFWMD, 2002)

An inventory of public concerns, developed during several public workshops is listed in the PMP. Planning objectives include:

- Conserve and protect water resources to ensure sustainability of economic and natural resources.
- Ensure availability of ground and surface water supplies for agricultural, environmental, and urban uses.
- Improve and protect quality, heterogeneity, and natural biodiversity in freshwater, upland, estuarine, and marine ecosystems.

- Improve quantity, quality, timing, and distribution of freshwater flows to estuaries and wetlands.
- Protect and improve water quality conditions within the Study Area.
- Protect and recover listed species.
- Reduce flood damages within the Study Area.

A brief description of the general types of structural and non-structural features that may be used to formulate alternatives is given. They are:

- Surface water storage
- Improve Water Deliveries to Estuaries
- Aquifer Storage and Recovery
- Stormwater Treatment Areas
- Reestablish Sheetflow
- Reuse Wastewater
- Conservation
- Land Acquisition
- Rehydration of Wetlands
- Operational Measures

Big Cypress Basin Integrated Hydrologic-Hydraulic Model

DHI Inc. 2002. Big Cypress Basin Integrated Hydrologic-Hydraulic Model. South Florida Water Management District. West Palm Beach, Florida.

This BCB project explored the value of an integrated MIKE SHE/MIKE11 model for the western Big Cypress Basin for assessment of the impact of various water management strategies on flood dynamics, wetland hydro-periods and water supply. The primary objective was to model flood levels, peak flows and wetland hydro-period. The main scenario was the model of the hydrologic restoration of the Southern Golden Gates Estates wetland, which is peripheral to the Naples Bay Study Area. However, two other water management scenarios were tested that either directly or indirectly affect Naples Bay: a canal extension from Golden Gate Main to Henderson Creek with the intention of diverting water to Henderson Creek and flow diversion from Corkscrew Canal to Golden Gate Main.

The Big Cypress Basin model was determined capable of simulating historic records of water levels and flows in the BCB watershed from 1990-1995 within predefined target criteria. However, the scenario related to diversion of GGC wet season flow to Henderson Creek showed that the new channel with chosen channel and structure geometry would not have the intended effect. Diversion from Corkscrew Canal to Golden Gate Main resulted in considerably increased flow. Since Golden Gate Canal water is now drained into Naples Bay, this diversion without the Henderson Creek diversion working properly would result in additional excess freshwater input to Naples Bay. Details of this report are summarized in Appendix A12.

Five Year Plan -- 2002-2006 For The Big Cypress Basin of The South Florida Water Management District

BCB-SFWMD. 2002. Five Year Plan -- 2002-2006 For The Big Cypress Basin of The South Florida Water Management District. Big Cypress Basin Board South Florida Water Management District. West Palm Beach, Florida.

This report provides details related to the canals and control structures considered to be under the control of the BCB in an agreement with Collier County extending through 2011. Information about proposed capital improvements and projects related to improved data acquisition is provided in tables on pages 18, 22, 23 and 51 with maps of locations on pages 15 and 52. Sites of interest to the Naples Bay Study Area include modernization of the meteorological station at The Conservancy and the surface water hydrological data stations on the Golden Gate Canal, Haldeman Creek, Corkscrew Canal, Cypress Canal, Gordon River and the I-75 canal. A meta-database of research and monitoring activities at these sites is publicly accessible at: http://library.fgcu.edu/big_cypress. Most of these stations should already be in place.

Capital improvements relevant to Naples Bay include a retrofit to Golden Gate #1 and Airport Road South weirs and improvements to Corkscrew and Golden Gate canals. The Plan has considered one water management strategy to divert a portion of the peak flows from the Golden Gate Canal to the Henderson Creek Canal. The implementation of this plan will involve construction of a diversion channel that will convey flow from the Golden Gate Main Canal segment east of CR 951 through a culvert under I-75, southward to the Henderson Creek Canal. The Corkscrew Canal and its side ditches including the Curry Canal comprise a network of poorly drained canals that provide an interbasin transfer of water from the Corkscrew-Cocohatchee Basin to Golden Gate Canal Basin. In FY02, additional drainage improvement work, including replacement of six culverts, was coordinated with Collier County. This drainage network currently affects Naples Bay through drainage of the Golden Gate Canal (GGC). However, with completion of the extension between the GGC and the CR951 canal, much of this extra water will be diverted to Henderson Creek. Much of this work should have already started, with completion after 2006. The diversion of water may decrease the effective size of the Naples Bay Basin. The management plan also proposes the development of a hydrodynamic and water quality model for the estuary to track the impact of changes in freshwater and nutrient loads on the estuary.

BCB Region Science Plan

Rookery Bay National Estuarine Research Reserve and Florida Department of Environmental Protection. 2002. Region Science Plan: Big Cypress Basin - Estero Bay, Southwest Florida. Rookery Bay National Estuarine Research Reserve. Naples, Florida.

The Region Science Plan for Big Cypress Basin Southwest Florida is a compendium of individual project recommendations for studies, monitoring or improvements related to biodiversity, water quality and hydrogeology and recommended efforts to improve information management. These projects were submitted by several state and federal agencies in an effort to identify data gaps and to prioritize funding needs with individual forms supplying an estimated cost, problem statement and project synopsis. The

report is still in draft form. Most of the suggestions were generic to the entire BCB region, but several applied to the Naples Bay Study Area. These projects are summarized in Table 8 and represent potential data gaps or opportunities for future work. Some of these projects have already been implemented. Notes from the initial effort in 1997 are also included in this report (BCB Science Plan: Issues Characterization Workshop) but are not summarized here.

Table 8. Projects from the Region Science Plan for BCB Southwest Florida of potential relevance to Naples Bay SWIM plan.

Project category and title	Project number
Biodiversity: BCB region land acquisition map; Impacts of canal/lake management activities on fish and wildlife in the BCB; Review of cumulative and secondary impacts in the BCB; BMPs for fish and wildlife conservation on agricultural operations	1, 5, 7, 8, 21
Water quality: Evaluation of regional historical water quality data; minimum flow requirements for estuaries in the BCB; Regional groundwater constituent survey; Ambient stormwater monitoring and evaluation; Bioassays to assess impact of agricultural chemicals in freshwater habitats	31, 32, 33, 34, 35, 38
Hydrogeology: Development of BCB region/subregion water budget	42, 43, 44, 45, 49, 53, 50, 52
Information management: Summary reports on state of the BCB region; GIS map component from the BCB Database; BCB Water Quality Monitoring Consortium	57, 58, 59, 60

Gordon River Extension Basin Study, Phase IV

Wilson Miller and Camp, Dresser & McKee. 2001. Gordon River Extension Basin Study, Phase IV, Preliminary Technical Memorandum. Collier County Stormwater Management Department. Naples, Florida.

The goal of this modeling study was to identify regional alternatives to improve flood protection, surface water quality and groundwater recharge. This report covers Phase IV of a seven phase project. Phases I through III covered data collection in existing drainage along main channels. Phase IV modeled existing conditions and three alternatives, and includes extensive detail about water quality and hydrology, existing and modeled results. Two storm events were modeled: 25 and 100 year events, both for 72 hours (Figure 43).

The area covered in the modeling was divided into eight reaches beginning at the northwest corner of Pine Ridge Industrial Park and ending at the tidal outfall of the Gordon River. The reaches also include the Goodlette-Frank road ditch, and tributaries through and next to four golf courses. The graphics on the following pages illustrate the eight reaches modeled, and the problem areas identified for a 25 year, 3 day event (Figure 44).

The water quality component used a model developed for USEPA (EPA-841-R-92-002) based on concentrations typical for the aggregated land use categories and evaluated 12 pollutants: BOD_5, COD, TSS, TDS, TP DP, TKN, NO2+NO3, Pb, Cu, Zn and Cd. There is no attempt to compare water quality model results to actual data, and comparisons to established PELs and TELs are not offered. Predicted pollutant loads are provided for each reach evaluated.

The water quantity component of the simulation used EPA models RUNOFF and EXTRAN for hydraulic components and typical infiltration and overland flow equations for sheet flow. An extensive inventory of channel parameters and hydrological properties for the hydrological units modeled was presented. Further, a summary of tidal stillwater elevations was provided along with a review of a 1986 FEMA flood insurance study and a listing of identified flood areas as of May 2001.

Model results were a reasonable match in 9 out of 12 locations and for overall timing. Simulation of a 25 year, 3 day design storm event identified 13 areas of flooding and a 100 year, 3 day storm event found three additional areas of flooding. A more detailed summary of this report's water quantity contents is listed in Appendix A13.

Big Cypress Basin Watershed Management Plan: Hydrologic Hydraulic Assessment for Golden Gate Canal Watershed Improvements Phase I – Retrofit of Golden Gate Canal Weir Number 1

BCB-SFWMD. 2001. Big Cypress Basin Watershed Management Plan: Hydrologic Hydraulic Assessment for Golden Gate Canal Watershed Improvements Phase I – Retrofit of Golden Gate Canal Weir Number 1. Big Cypress Basin Board South Florida Water Management District. West Palm Beach, Florida.

Between 1985 and 2001, BCB modified ten water control structures in the Golden Gate Main Canal for better management of water supply. Despite these modifications, excessive freshwater was still being discharged into Naples Bay. This report provides recommendations for installation of an automated, gated spillway with three hinged crest gates. Differences in operating protocols are provided in Table 3 on page 24 of the plan with modeled results of peak flows on pages 27 through 33. This capital improvement is included in the BCB five year management plan covered in the Five Year Plan (BCB-SFWMD, 2002).

Big Cypress Basin Watershed Management Plan, Flood Control Element

BCB-SFWMD. 2000. Big Cypress Basin Watershed Management Plan, Flood Control Element. 06/25/01 Draft. Big Cypress Basin Board South Florida Water Management District. West Palm Beach, Florida.

This study presents simulations of design storms to identify flood problems and assesses alternatives for development of a regional plan addressing flooding, water supply and environmental impacts. Simulation showed that 11.8 miles out of 27 miles of the Golden Gate Canal and 2.5 of 7.2 miles of the CR951 canal were considered flood control problems, and one alternative for management was to divert aportion of the Golden Gate Canal (GGC) flow into the Henderson Creek basin (Figure 45). Other alternatives also considered were channel and structural modifications to the canal west of CR951 and to CR951 Canal and aquifer storage and recovery (ASR) of GGC wet season overflow. Diversion of Corkscrew Canal flows into the GGC was considered but not recommended.

Figure 43. Map of eight reaches included in stormwater modeling in the Gordon River Basin Extension.

44. Map of 25-year, 3 day storm event problem areas in the Gordon River Basin.

The RUNOFF block of the SWMM model was used to simulate the rainfall-runoff and the upper zone ground water processes, and the interaction between ground and surface water for eight basins, including two in the Naples Bay Study Area – District 6 and Golden Gate Canal. Three design storms (25, 50, and 100-year 3-day) were selected for the simulation. Details of this report are summarized in Appendix A14.

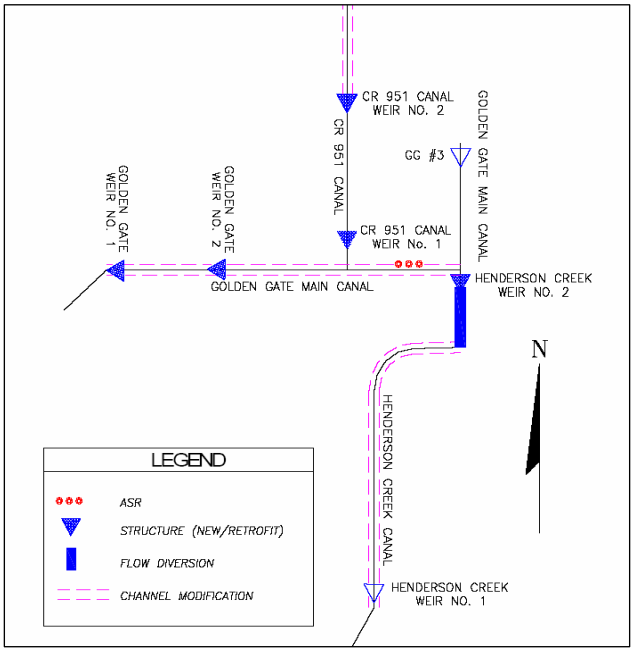

Figure 45. Big Cypress Basin retrofit examples (BCB-SFWMD, 2000).

South Lee County Watershed Plan

Johnson Engineering. 1999. South Lee County Watershed Plan. South Florida Water Management District. West Palm Beach, Florida.

Though not within the Study Area, the South Lee County Watershed Plan includes the Corkscrew Watershed, adjacent to the Naples Bay Basin. There is potential for water exchange in northeastern Naples Bay Basin through the Corkscrew Canal. This connection was greater prior to Immokalee Road and its canals, and should decrease more in the future when levees are repaired through other BCB projects.

> "[The report] addresses flooding problems associated with development in southern Lee and northern Collier counties. Flooding of the residential areas in both the Imperial and the Cocohatchee watersheds occurred once in 1992, twice in 1995, and to a lesser degree in each subsequent year, with 1999 having the greatest impact to the residential area since 1995. Due to the relatively flat terrain, the slightest deviation in surface elevation is enough to shift runoff. Because of man-made alterations such as ditches, dikes, U.S. Interstate 75, and farm roads, historic delineations of the various contributing areas have been significantly altered. As sheetflow meanders southwest, it is collected by a series of natural and man-made channels converging into several main rivers and creeks: the Estero River, Halfway Creek, Spring Creek, Imperial River, Cocohatchee River, Corkscrew Canal, and Camp Keais Strand.
>
> As a part of the study, a hydrologic/hydraulic model, an ecological assessment, and problem identification and evaluation of existing hydrologic-hydraulic conditions in the Estero Bay Watershed were completed. As a result of the analysis performed for the South Lee County Watershed Plan it was determined that sheetflow has been substantially altered and cumulative effects of seemingly small hydrologic diversions have changed the direction of flow from basin to basin within the watershed. Lowlying areas in the southwestern portion of Lee County are

now subject to inundation from stormwater runoff generated miles away. The plan identifies flow way restoration and improvements that can be made to protect the capacity of historic outfalls within the watershed."

USACOE and SFWMD (2002)

Central and Southern Florida Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (PEIS)

U.S. Army Corps of Engineers and South Florida Water Management District, 1999. Central and Southern Florida Project Comprehensive Review Study: Final Integrated Feasibility Report and Programmatic Environmental Impact Statement. USACOE. Jacksonville, Florida.

"This report recommends a comprehensive plan for the restoration, protection, and preservation of the water resources of central and southern Florida, including the Everglades. It identifies and discusses the plan's proposed project features [over 60], its beneficial effects and potential impacts on existing resources."

However, water resources problems and opportunities in southwest Florida were determined to require studies beyond the scope of The Central and Southern Florida Project Comprehensive Review Study, also know as the "Restudy". Therefore, a feasibility study for Southwest Florida was recommended to investigate the region's hydrologic and ecological restoration needs. The Restudy only assessed water resource issues in southwest Florida as they relate to the Caloosahatchee Basin. Other watersheds in southwest Florida have not been studied in a comprehensive fashion.

City of Naples Basin VI Assessment Report

Camp, Dresser and McKee. 1998. Basin VI Assessment Report. City of Naples. Naples, Florida.

Assessment of sub-basins within Basin VI was completed using models similar to the Basin V Stormwater System Improvement Plan Phase I: Basin Assessment and Conceptual Improvement Plan (CDM draft, 2004). Basin VI, the Central Avenue – 10th Street drainage basin, was identified in the City of Naples Stormwater Management Plan (1996) as a major drainage problem area. Five alternatives were evaluated: one to maintain existing system except relocating and upgrading the pump station, and the other four with different levels of service provided by replacing or paralleling undersized pipes. A range of costs is offered for each alternative. The alternative offering a 10-year, 24-hour level of service was recommended as the most cost effective. Other recommendations include improved topographical mapping, flow monitors and recording rain gauges, replacing poorly built custom inlets with standardized FDOT inlets and restricting the placement of loose yard waste at the curb for pickup.

City of Naples Interim Basin III Design Development Report

Camp, Dresser and McKee. 2001. Interim Basin III Design Development Report. City of Naples. Naples, Florida.

Modeling of Basin III was completed with the same objectives and background as Basin VI. Basin III drainage problems were identified on 5th Avenue South and 9th and 10th Streets from 5th Avenue to 10th Avenue South. Four alternatives were evaluated: returning existing system to design capacity through maintenance; improve pipes and pumping capacity; improve piping but not pumping; even larger pipes and pump. The improved piping with no increase in pumping capacity is recommended as the most cost effective and involves no change in peak discharge or total volume discharge into Naples Bay.

City of Naples Stormwater Management Program - Phase 1 Master Plan Draft Report

City of Naples Engineering Division 1996. Stormwater Management Program - Phase 1 Master Plan Draft Report. City of Naples. Naples, Florida.

The purpose of this report was to recommend a financially feasible stormwater management plan for the City of Naples following a 100-yr storm event in August 1995 that flooded virtually all sections of the city. Previously, in February 1980 and October 1990, drainage studies were completed making recommendations for capital improvements, some of which were partially implemented, and development of a stormwater utility which in 1996 was generating $859,000 per year. The objective of the study was to address both quantity and quality of surface water in the City and the approach recommended is to upgrade existing deficient areas to a reasonable level of service while implementing quality control during all future construction projects, both public and private.

This report summarizes the 1980 study by stating that some of the $5,000,000 in drainage improvements were implemented but that recommendations for lake monitoring had not been implemented and that control of aquatic weeds was implemented in limited fashion. The 1990 study included an inventory of existing stormwater facilities and the data from this report was the basis of this 1996 study using modeling techniques recommended in the 1990 report. The 1995 storm event was summarized as a worst case scenario with complete saturation from recent rain events and exceptionally high tides coinciding with a 100-yr rain event. The report points out that despite extensive flooding throughout the city, all of the water had drained within six hours following recession of the high tide and that in fact the system with a few exceptions was effective, but limited, in terms of level of service for a major storm event. Water quantity problems encountered in the 1995 storm event are characterized in Chapter 4 by location with details concerning cause and status of fixes and monitoring at the time of the report. Characterization of water quality issues is narrative without specific data. Recommendations focus on use of retention ponds. Stormwater problems throughout the community were identified and characterized as follows:

Back-up of major systems caused severe flooding and property damage
Deterioration and physical failure of existing facilities caused depression or roadway failure
Saturated sub-bases caused deterioration of roadway
Under-design and lack of drainage facilities caused local street flooding

Shoreline outfalls failed or were blocked from Naples Beach to 3rd Avenue South.
Swale deterioration caused local flooding
Perched water tables saturated swales
Clogged storm lines reduced capacity

In describing the existing drainage system, the report states that 50% of residential and commercial areas have swales or ditches and the other 50% are served by a network of gravity sewers with pipes ranging from 8 to 72 inches and some elliptical pipes and box culverts. However, most of the pipe was 25 to 30 years old and corroded and swales have in many cases been altered through siltation, landscaping and plant growth. There were 25 lakes considered part of the City's drainage e system with three more that were not connected to the storm sewer system. It was recommended that modifications to these lakes be evaluated for further retention area. Twelve basins were identified and boundaries are defined with pictures of the drainage facilities in 1996. Models to determine level of service were simulated for five different design storms with results summarized by conduit number.

The following 23 recommendations were made. Six are general recommendations, 8 relate to water quantity, and 9 relate to water quality. The projected probable cost in 1996 dollars was $10,140,000. Costs are itemized by capital projects and an analysis of revenue and annualized costs is provided.

General

1. Adopt a Mater Plan and its implementation program which address both water quality and water quantity.
2. Adopt a target level of service – Goal.
3. Implement a long term Capital Improvement Projects Program to construct the remedial facilities needed to meet adopted level of service – Goal.
4. Monitor and integrate Federal, State and local regulatory requirements into the stormwater program.
5. Develop a Public Information Program to develop citizen support for stormwater management.
6. Develop and adopt appropriate ordinances requiring stormwater management on all new construction, expansions and reconstruction to whatever degree possible.

Water Quantity

7. Encourage and pursue inter-governmental cooperation with Collier County and the SFWMD to authorize and implement the Gordon River Drainage Basin Study including water quantity impacts on the eastern edge of the City for those watersheds that drain to the Goodlette-Frank Road drainage canal.
8. Pursue intergovernmental cooperation with Collier County relative to maintaining existing and developing new outfalls to the Gordon River from the Goodlette-Frank Road ditch to offset diversion of water from the northern section of Goodlette-Frank Road.
9. Develop a strong public information program to inform the public and encourage citizen support of a stormwater quantity program with particular emphasis on stormwater retention in swales, lakes or other areas yet to be determined.
10. Develop a comprehensive program of major system inspection and maintenance, particularly in areas of landscaped easements to maintain designed capacity of existing systems
11. Implement comprehensive program of rehabilitation of existing systems including replacement of corrugated metal pipe during opportune circumstances (resurfacing projects, etc.)
12. Implement a City wide swale restoration program as it relates to providing drainage on streets with no curb and gutter
13. Develop and implement a program of lake evaluation to determine feasibility of expanding capacity for storage and improvement of water quality

14. On a prioritized basis, model major drainage basins to determine:
    - Overall system deficiency
    - Sport deficiencies within the system that can be feasibly improved
    - Utilization of lake systems in the drainage basin
    - Opportunity to provide additional retention via available open space or swale system improvement

Water Quality

15. Develop public information programs to inform public and encourage citizen support of Stormwater Quality Management Program
16. Encourage and pursue inter-governmental cooperation for the implementation of a Gordon River extension study, including aspects of water quality, impact on the eastern edge of the City of Naples, and the pollutant impacts on Naples Bay.
17. Implement ordinances requiring stormwater management for all new construction including single family homes and to establish a threshold based on the percentage of remodeling of existing structures.
18. Continue the water quality monitoring program, instituted in 1993, for Moorings Bay, Naples Bay, Gordon River, and the City's lake system to establish a base line to measure stormwater related pollution and to determine if solutions are effective.
19. Conduct studies to determine feasibility of increasing retention capacities of lakes serving the stormwater management system
20. Adapt a policy of encouraging water retention on all public works projects including evaluation of open areas for acceptable water retention
21. Develop a program of swale restoration throughout the community including designed inlet thresholds to accommodate limited ponding
22. Adopt engineering design policies encouraging exfiltration systems as part of stormwater facilities
23. Fund and implement a lake and bay quality program including pollution loading and vegetative aquatic growth

Gordon River Watershed Study.

CH2MHill. 1980. The Gordon River Watershed Study. Big Cypress Basin Board South Florida Water Management District. West Palm Beach, Florida. Project No. NA11977.D0.

The project is limited to the scope of services for Phase I of the Gordon River Watershed Study, the study of existing conditions. Included is a summary of the hydrology of 25 and 100-year rainfall events. Twenty-five and 100-year flood plains and water surface profiles were determined, as were the economic impacts of flooding on existing and potential development. The Study Area follows roughly the current sub-basins referred to as Gordon River North, Gordon River Central, Gordon River South and Airport South, though is it bounded on its east portion by Airport Road and the Golden Gate Canals.

PROJECTS

Collier County Capital Improvement Projects

Projects for the Collier County stormwater fiscal years 2004 -2005, 2005-2006, and 2006-2007 that are within the study and provide a water quality benefit are listed in Table 9 and shown in Figure 46.

Table 9. Collier County Stormwater Management projects within the Study Area for fiscal years 2004-2005, 2005-2006, and 2006-2007 (http://www.co.collier.fl.us/stormwater/capImprovement _pages/current.html).

SFWMD Sub-basin Name	County ID	County Fiscal Year	County Project Name
Santa Barbara	515012	05-06 and 06-07	Australian Pine Removal
Gordon River Central	510056	04-05 and 05-06	Westlake Outfall Improvements
Gordon River Central	510054	04-05 and 05-06	Twin Lakes Inner-connect
Gordon River Central	510055	04-05 and 05-06	Goodlette Frank Culvert Improvement
Gordon River Central	510053	04-05 and 05-06	Gordon River Water Quality Park
Rock Creek	514092	04-05 and 05-06	North Road Culvert Improvements-Rock Creek
Lely North	511072	04-05 and 05-06	Avalon School Ditch Improvements
Lower Haldeman Creek	518032	04-05 and 05-06	Gateway Triangle Drainage Improvements
Lely N	511012	04-05, 05-06, 06-07	Lely Area Stormwater Improvement Project
County-wide	510012	04-05 and 05-06	Stormwater Master Plan Update

City of Naples Ten Year Stormwater Funding Plan

The following 16 projects are listed on the BCB Ten-Year Grant Funding Plan for Selected Stormwater Management Projects, submitted to the BCB May 2005 by The City of Naples Public Works Department. Projects total $41,435,000 and include management plans, control measures, maintenance, improvements, reconstruction, removals, asset management, and public education.

- Street Sweeper for NPDES Phase II Water Quality Control Measure
- Stormwater Drainage Basin III Water Quality & Flood Mitigation Improvements
- Stormwater Drainage Basin V Water Quality & Flood Mitigation Improvements
- Stormwater Drainage Basin VI Water Quality & Flood Mitigation Improvements
- Naples Bay Basin Management Plan (Phase I Prelim. Eng'rg. & Environmental)
- Beach Management Plan For Removal of Ten Stormwater Outfalls (Prelim. Eng'rg.)
- Lake Water Quality Management Plan (Phase I Prelim. Eng'rg. & Environmental)
- NPDES Phase II Stormwater Public Education & Public Outreach Control Measure
- Royal Harbor Water Quality (Elimination of Point Discharge Concrete Swale Outfalls)
- Water Quality Swale & Stormwater Drainage Facility Reconstruction
- Outfall Storm Drain Pipe Inspection, Cleaning, Lining & Replacement
- Citywide Storm Sewer System Repair & Maintenance Program
- Stormwater Drainage Inventory, Inspection & Evaluation (Asset Management)
- Citywide Stormwater Master Plan (12 Basins Excluding Basins III, V and VI)
- Vacuum Truck For Stormwater System Maintenance
- Reconstruct Drainage Inlets (Safety, Capacity & Water Quality Inserts)

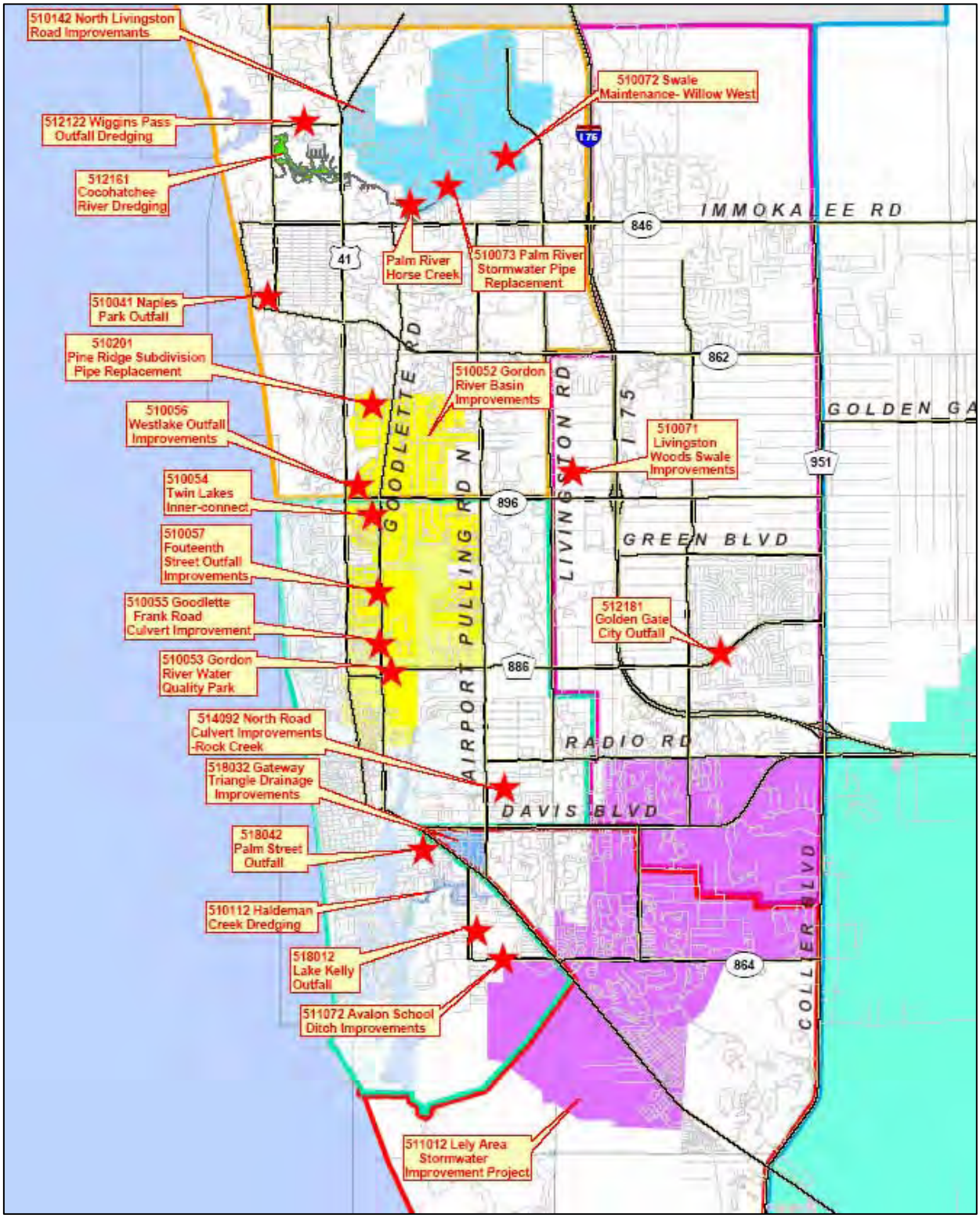

Figure 46. Collier County Stormwater Division capital improvement projects (Collier County).

Golden Gate Canal/Henderson Creek Water Transfer

A BCB project to transfer water from the Golden Gate Canal into Henderson Creek is in progress and expected to be complete in 2007. The diversion will reduce flow from Naples Bay to Rookery Bay. It is described in further detail in the Modeling and Plans section above.

Gordon River Water Quality Park

The Gordon River Water Quality Park Project (Figure 47) is a 50 acre natural water quality treatment facility designed to provide flooding relief and tertiary treatment of stormwater runoff from the Gordon River Extension Basin. The proposed passive park site is on the northeast corner of Goodlette-Frank Road and Golden Gate Parkway. The constructed, interconnected, multi-depth ponds, polishing marshes, and wetlands will serve as a filtration system while the trails, fishing piers, educational facilities, landscaping and hardscaping will benefit park users. The Collier County website states that this facility will allow the County the potential option of a future Aquifer Storage and Recovery System (ASR) within the park for landscape irrigation use.

Figure 47. Gordon River Water Quality Park Conceptual Master Plan.

Lely Area Stormwater Improvement Project (LASIP)

The southwest corner of the LASIP project is within the Study Area (Figure 48). The project boundary includes most of the Lely North sub-basin, referred to as the Lely Canal Basin on county maps, as well as the Lely Manor Basin, which is outside of the Naples Bay Basin. "The proposed Lely Area Stormwater Improvement Project consists of improvements to an existing drainage system for an 11,100± acre East Naples area, which formed the major portions of the former Water Management District 6 area. The project area currently has two (2) outfall systems consisting of the Lely Main Canal and a system of farm ditches and dikes associated with portions of the easterly half of the project, which drains the Lely Manor area. The project area is therefore divided into two (2) basins. The westerly most basin is known as the Lely Canal Basin and the easterly most basin is known as the Lely Manor Basin. The Lely Area currently has some water management improvements implemented; it generally suffers from the lack of a comprehensive outfall system and design.

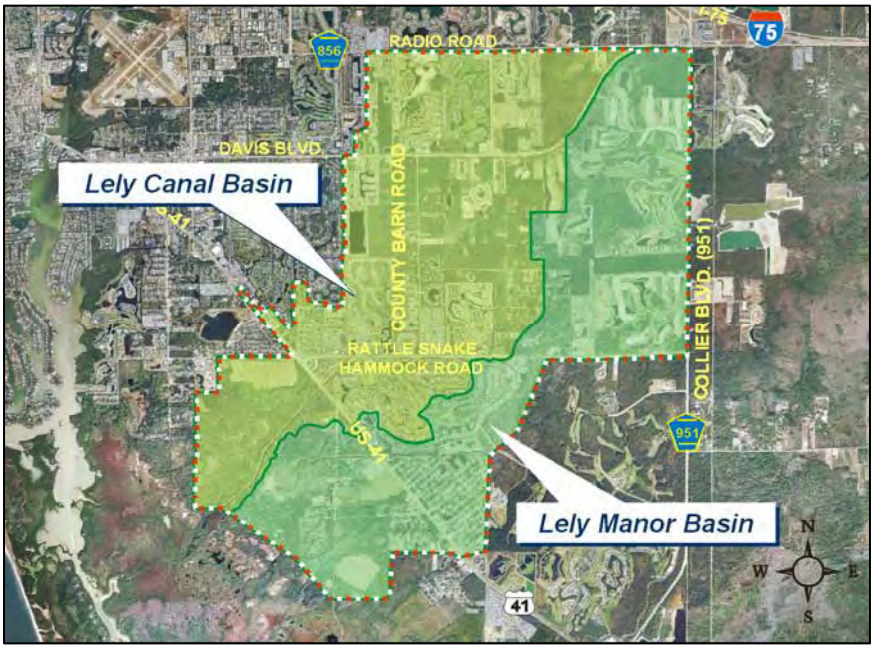

Figure 48. Lely Area Stormwater Improvement Project (Collier County website).

Land use within the Basin consists of a combination of modern developments that have improved water management systems consistent with current design requirements and best management practices as well as older existing neighborhoods that were developed before water management systems were required. The latter areas provide little if any water quality improvements for stormwater runoff.

The purpose of the project is to lower the flood elevations and to reduce the duration of peak stages while providing as much water quality improvement and groundwater recharge as possible. Careful design of the project has avoided wetland impacts where possible and minimized unavoidable wetland impacts to the maximum extent practicable, while still meeting the overall project purpose. The project will undertake the following construction activities:

- Widen and deepen existing canals.
- Construct new channels.
- Construct new control structures and culvert systems.
- Improve several existing control structures.

- Install new flood control gates.
- Construct spreader lakes and berms at outfalls.
- Construct a pump station to rehydrate existing wetlands.

An ERP from the SFWMD was issued on October 14, 2004. (Gerald Kurtz , Collier County personal communication). The Collier County Stormwater Department received approval from the USACE for the associated dredge and fill activities. Total estimated construction costs are approximately $45,000,000. Construction is planned to commence in January 2006, with one phase to be completed each year for six or seven years.

Westlake Outfall Improvements and the Twin Lakes Interconnect

These projects will consist of conveyance pipes and water control structures that will connect stormwater lakes in the Westlake and Twin Lakes subdivisions in the Gordon River basin to the Goodlette-Frank Canal. SFWMD expects these projects to result in tangible improvements to flood mitigation and stormwater quality in the Gordon River basin. In support of the Naples Bay Watershed Initiative, an agreement was written April 2005 to provide state appropriated funding support from the SFWMD to Collier County.

Gordon River Greenway

The Southwest Florida Land Preservation Trust is working with support from the Collier County Commissioners and the Naples City Council to fulfill their mission to facilitate public and private interest and involvement in creating and preserving a Gordon River Greenway for public use, recreation, water resource protection and habitat preservation. The Greenway is a continuous public right-of-way along the Gordon River with both a bikeway and walking path that will stretch from the Golden Gate Parkway to US 41 South. It will include two bridges, and will connect other parks, including the Gordon River Water Quality Park, trails, and the Naples Bay waterfront. A section on the Naples Airport property is complete, and work is in progress to obtain easements to construct other sections. A master planning process for the Greenway has been started.

Northern Golden Gates Estates Regional Offsite Mitigation Area (ROMA)

> "A ROMA is intended to provide a low-cost mechanism for landowners to compensate for permitted wetland impacts resulting from residential construction. The ROMA for North Golden Gate Estates was proposed by the Collier Soil and Water Conservation District (CSWCD) and is in the initial review stages by the Florida Department of Environmental Protection (FDEP). If approved, the ROMA will include a legal agreement or memorandum of agreement (MOA), between the FDEP and the CSWCD, which will then be allowed to acquire land or conservation easements from willing sellers only in North Golden Gate Estates to restore wetlands".
>
> FDEP Website

The proposed plan involves the acquisition of lots or conservation easements on lots concentrated in the platted area of North Golden Gate Estates, north of I-75 and south of 10th Avenue. Once an appreciable portion of property is acquired, then an enhancement plan would be initiated. Enhancement is proposed through exotic species eradication and long-term management. It is also hoped that the hydrology could be improved by adding culverts. The MOA and Mitigation Plan are available on the internet (http://www.dep.state.fl.us/south/ERP/Golden%20Gate%20ROMA.htm).

Beach Re-nourishment

Several major City/County beach re-nourishment projects are to begin November 2005 and be completed early 2006. Approximately 625,000 cubic yards of sand are planned for re-nourishment of Naples Beach, Vanderbilt Beach and Parkshore. No direct impacts to existing Bay, marsh or estuary are anticipated. FDEP permit requirements include one acre of artificial reef to offset potential impacts of beach re-nourishment activities to benthic hard bottom habitat. (Gary McAlpin, Collier County, personal communication).

Transportation

The 2004/2005 – 2008/2009 Collier County Transportation Improvement Program (TIP) (available at http://www.colliermpo.com) includes prioritized, financially feasible projects for all modes of travel. Projects identified in the TIP are consistent with the Metropolitan Planning Organization's (MPO) 2025 Long Range Transportation Plan as well as other organizations' plans.

Figure 49 provides an overview of project locations, types, and the FDOT project number and year. Project phases that receive funding become part of the FDOT's Five-Year Work Program (Figure 50).

The Tentative Work Program was adopted July 1, 2005. Major construction projects listed in the District One Tentative Work Program FY 2005/06 – 2009/2010 for the Study Area and their FDOT project numbers follow:

175 From Golden Gate Parkway to S of Bonita Bch. Rd. Add lanes and reconstruct. 4063133 FY10
175 Overpass at Immokalee Rd. New Road Construction. 4189371 FY09
SR 84 (Davis Boulevard) from Santa Barbara Blvd. to CR 951. Add lanes and reconstruct. 1954162 FY10

There is potential for stormwater treatment within the Study Area through Joint Use Stormwater Management Agreements with FDOT. Joint use agreements have been made between FDOT and Collier and Lee Counties.

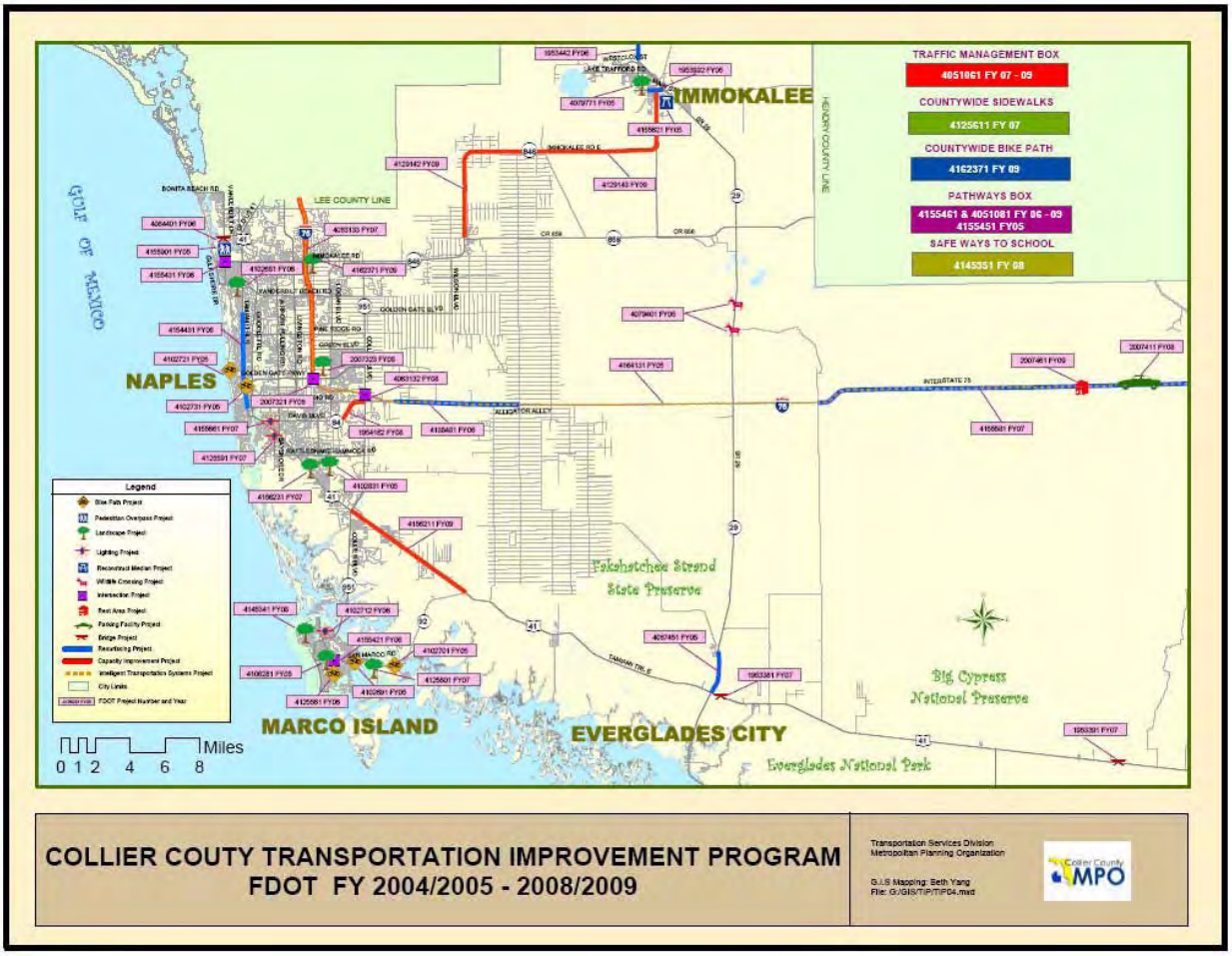

Figure 49. Collier County Transportation Improvement Program.

Figure 50. Collier County Five Year Work Program.

PROGRAMS

Background

Many programs or organizations have set out to improve the conditions of Naples Bay. The following summary was taken from Bauer (2003).

1988 - The Naples Bay Task Force was established by Area Chamber of Commerce, resulting in the Bay Management Organization, which provided the Naples these recommendations in 1990:

- Carrying out a hydrographic study of Naples Bay (how much water goes where),
- Establishing a stormwater utility,
- Expanding the dredging and maintenance of residential canals,
- Replacing vertical seawalls with rip rap,
- Developing a Golden Gate Basin Management Plan, and
- Improving stormwater management through source control BMPs.

1997 - The Naples City Council established the Naples Project Committee, with the following recommendations.

- Marine vessels be better controlled and
- Water quality be improved by
    - removing debris,
    - aerating canals,
    - preparing a bathymetric chart of the Bay,
    - restoring mangroves,
    - creating artificial habitats in the Bay,
    - connecting dead end canals,
    - implementing a stormwater master plan, and
    - educating citizens.

Recommendations made by these groups that have been carried out:

- The Golden Gate discharge rate has been slowed by improvements in the canal system
- The wastewater treatment plant has been upgraded to tertiary treatment capabilities
- Former package and septic systems have been connected to a central sewer system
- Stormwater management is ongoing
- Depth changes in some canals have been corrected
- Vessel speed controls are in place
- All septic tanks in Naples proper have been eliminated

2002 - City, state, and local governments, environmental groups and the private sector came together unofficially and identified:

- Stratification of the water column in the Bay proper and in canals is affecting oxygen levels, salinity, and the movement of food for aquatic organisms.
- Stormwater runoff is still negatively impacting the Bay, and
- Loss of intertidal habitat has occurred due to changes in the shoreline (mangroves, sea grasses, oyster reefs)

Shortly thereafter the SFWMD sought funding to implement the following projects, listed in priority order assigned by group above.

1. Mapping and Modeling of Naples Bay to determine where and how fresh water flows through the Bay *combined with* a new proposal to identify areas most impacted by fresh/salt water stratification.
2. Development of a Gordon River Basin Stormwater Management Master Plan to determine where structures and other practices should occur.
3. Modification of Golden Gate Canal Weir #2.
4. Modification of I-75 Canal Weir #1.
5. Documentation of the historic distribution of submerged aquatic vegetation, oyster reefs, and mangroves, followed by restoration of the habitats in these locations.
6. Development of a Gateway Triangle Stormwater Management Plan.

2003 - RBNERR held a Coastal Management Training Workshop for Collier County officials. The Collier County BCC passed a resolution requesting SWIM designation; the Naples City Council passes similar resolution. RBNERR, FDEP, and NOAA partnerships established to provide support.

Non-governmental organizations that have established public support and funding for the Naples Bay area:

- Conservancy of Southwest Florida
- Southwest Florida Watershed Council
- BCB Coordination Team
- Collier Audubon Society

NPDES (MS4) Municipal Separate Storm Sewer System Permits

In October 2000, EPA authorized the Florida Department of Environmental Protection (FDEP) to implement the NPDES stormwater permitting program in the State of Florida. The NPDES stormwater program regulates point source discharges of stormwater into surface waters of the State of Florida from certain municipal, industrial and construction activities. A municipal separate storm sewer system (MS4) is a publicly-owned conveyance or system of conveyances (i.e., ditches, curbs, catch basins, underground pipes, etc.) that is designed for the discharge of stormwater to surface waters of the State. Under Phase II, the program regulates discharges from certain MS4s not regulated under Phase I, and that meet designation criteria set forth in Chapter 62-624, F.A.C. Regulated MS4 operators must obtain an NPDES stormwater permit and implement a comprehensive stormwater management program to reduce the contamination of stormwater runoff and prohibit illicit discharges to the MS4. (FDEP website, http://www.dep.state.fl.us/water/stormwater/npdes/MS4_5.htm)

Collier County received an NPDES Phase II Stormwater Permit for its stormwater collection system July 28, 2003. Conditions of the permit require the County to have a stormwater quality program that reasonably attempts to prevent pollution from entering the stormwater collection system. The City of Naples and the Pelican Marsh Community Development District (CDD) were also required to obtain

NPDES MS4 permits in 2003. Copies of the County and City MS4 permits are in Appendix A15 and A16.

Collier County Stormwater Management Master Planning and Regulation.

The County wide Stormwater Master Plan prepared in 1988 was used to develop the Drainage Sub-Element of the County's Growth Management Plan, which was prepared to meet the requirements of Chapter 163, Florida Statutes and Chapter 9J-5, Florida Administrative Code. The document proposes a plan, through goals, objectives, and policies, to implement the County wide Stormwater Management Plan that provides an acceptable level of service for stormwater controls and environmental management objectives. The Big Cypress Basin Watershed Plan, a master planning process initiated in 1996, is being developed in cooperation with the City of Naples and Collier County at a much greater level of detail by incorporating detailed surveying, field data measurements, and computer modeling for preparing detailed basin and sub-basin stormwater management/environmental resources studies.

The latest amendment to the Drainage Sub-Element, included in Appendix A17, was May 9, 2000. The County further restricts the rate of discharge in some sub-basins via Ordinance 2001-27, which is included in Appendix A18. Areas of post-development discharge regulation are seen in Figure 51. The Ordinance also has a provision to correct problematic surface water run-off from single family residential lots.

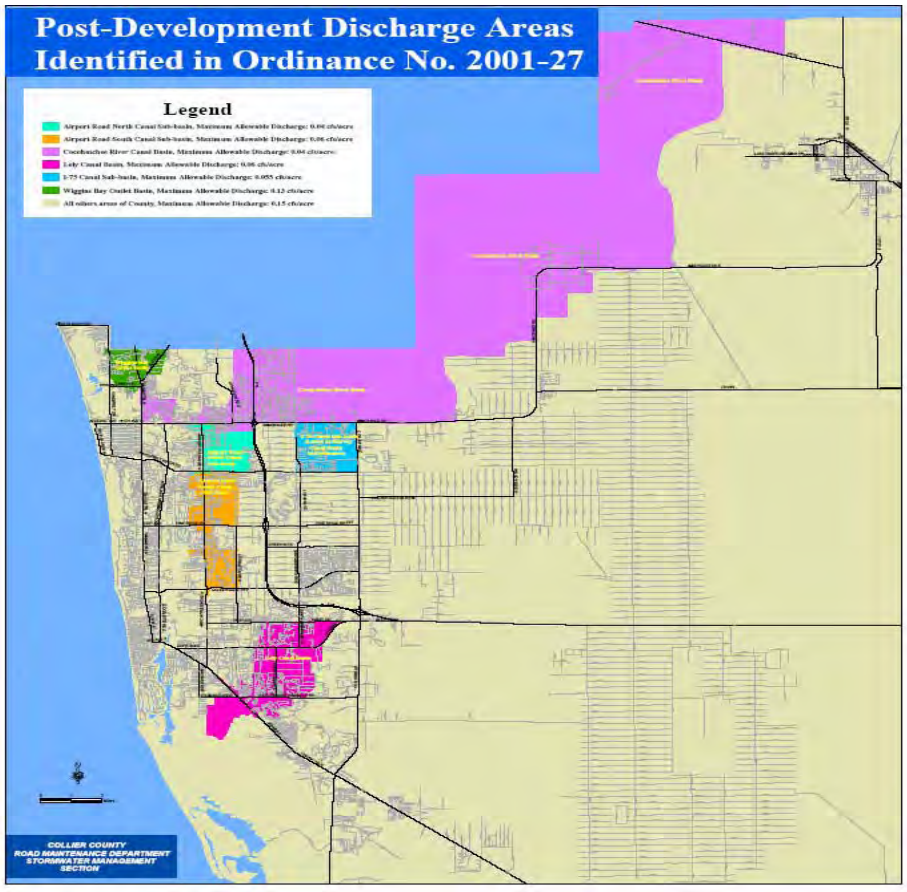

Figure 51. Post-development discharge areas (Collier County).

Collier County Transfer of Development Right (TDR) Program

The TDR program was adopted by ordinance February 2004. The intention is to direct development away from environmentally sensitive lands in the Rural Fringe Mixed Use (RFMU) District. The RFMU occurs in two places within the Study Area, both are East of County Road 951. Both sending and receiving areas are present. The two locations are 1) South and East of Naples-Immokalee Rd, and 2) the vicinity of Sub-basin GGE #3, along the southern border of the Basin (Figure 52). Owners of sensitive "sending lands" can sell their residential development rights yet maintain limited permitted and conditional uses, as provided for in Collier County's Land Development Code (LDC), Sub-Sections 2.03.08 and 2.03.07. Credits from RFMU can be transferred into the less sensitive "receiving lands" (Urban Residential Fringe and RFMU District Receiving Lands) as provided in Section 2.6.39.4 and 2.6.39.5 of the LDC. TDR credits must be issued and recorded by Collier County in the public records. A registry for interested buyers and sellers has been created by the County. The program is more thoroughly explained at http://www.co.collier.fl.us/compplanning/tdr/TDRFAQs.htm.

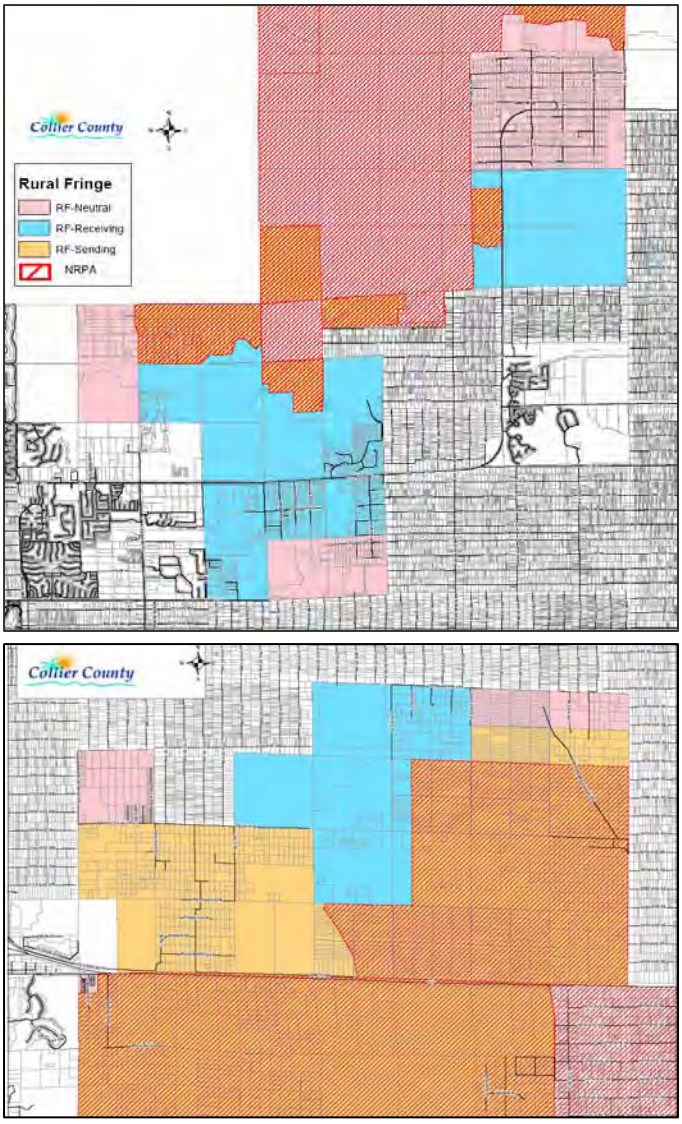

Figure 52. RFMU Sending and Receiving Lands.

Southwest Florida Resource Conservation & Development Council (RD&CD), Inc.

The non-profit organization established in 2002 consists of members from Charlotte, Collier, Glades, Hendry and Lee counties. The RC&DC was created to assist local communities in meeting their objectives of land conservation, water management, community development and land management. Their mission is to "preserve and enhance the natural resources of the area, promote economic stability and improve the quality of life for the residents of the area."

The Fiscal Year 2005 October 1, 2004 to September 30, 2005 – Annual Work Plan includes a planned project for Collier County Hard Clam Aquaculture. In anticipation of the Department of Agriculture and Consumer Services signing clam leases in approved areas of Collier County, assistance is planned for prospective clam growers. The work plan states that grants will be needed for surveying the leases and training individuals in clam aquaculture production and underwater diving (http://www.swfrpc.org/rcdc.htm).

Rookery Bay National Estuarine Research Reserve (RBNERR)

The RBNERR is a partnership program between NOAA and the FDEP. The Reserve is partially contained within the southern tip of the Naples Bay Study Area and is involved in research and monitoring, resource management, education and outreach, coastal training, and a volunteer program. "Collaborative research and monitoring efforts include analyzing the impacts of mosquito control aerial spraying, mangrove and oyster reef ecology, restoration ecology, estuarine fisheries, and nutrient cycling. Resource managers facilitate land acquisition, conduct habitat and hydrology restoration projects, eradicate and control invasive plants and animals, protect listed species, manage important habitats and wildlife and conduct prescribed fires to sustain native biodiversity." Incorporation of adjacent state-owned lands within the RBNERR boundary has been proposed to NOAA (http://www.rookerybay.org/). Other resource management activities, including the routing of water through canals such that freshwater flows may be reduced to Naples Bay and increased to Rookery Bay are covered in several documents in the Modeling and Plans section of this report.

Conservation Collier

The Conservation Collier Land Acquisition program targets lands with high natural resource value throughout Collier County from willing sellers. Properties need to support at least two of the following criteria to qualify: rare habitat, aquifer recharge, flood control, water quality protection, and listed species habitat. A Land Acquisition Advisory Committee, appointed by the Collier County Board of County Commissioners, reviews and recommends selected properties for approval by the County Commission. As of June 2005, 12 properties/projects totaling approximately 835 acres, including 2 large multi-parcel projects, have been approved for purchase.

Collier County Restoration Mapping

The Collier County Restoration Mapping database is being developed to identify environmental restoration projects for water quality, hydrology, and/or biodiversity. Representatives from Federal, State, County and local governments as well as organizations and individuals outside of government are being coordinated to identify potential and existing restoration projects. Projects are identified, described, and costed using a database created in Microsoft Access and outlined on USGS topographic

maps. The outlined polygons are then digitized into GIS coverages and spatially linked to the database. This effort will develop a product/tool that will be used in the alternative analysis and selection for the SWFFS. The database creation and GIS development follows similar restoration planning methodology used in Lee and Charlotte County that is currently being used for the SWFFS.

RECOMMENDATIONS

Naples Bay and its tributaries have been extensively monitored for water quality for the last 35 years. Its basins and drainage structures have been the basis for several intensive modeling efforts to determine the quantity and fate of storm water. Canal flow is well mapped and changes in volume monitored. Many concerns related to water quality and quantity improvement and management are identified in the items summarized in this report, as are data gaps and recommendations. However, several gaps exist in available data for the development of a SWIM plan.

Evaluation of Naples Bay Water Quality and Hydrologic Data

The SWFFS ACCESS database was recently evaluated for use in assessing current condition, trends, and water quality model setup and calibration for Naples Bay (Taylor Engineering, Inc. 2005). Taylor Engineering's recommendations are provided verbatim here for convenience.

Recommended Water Quality Data Collection

The insufficient water quality data from the present sampling program preclude calibration of the water quality model. Further, the data cannot support a process level water quality model that might simulate fluctuations in dissolved oxygen. However, the data should suffice for most of the necessary water quality model verification data for a two-dimensional model of the Bay. The data from present sampling programs would provide comparison information to evaluate errors in water quality model performance over the simulation period or periods. Additional water quality stations recommended for better water quality model (Figure 53) verification would include the following station locations:

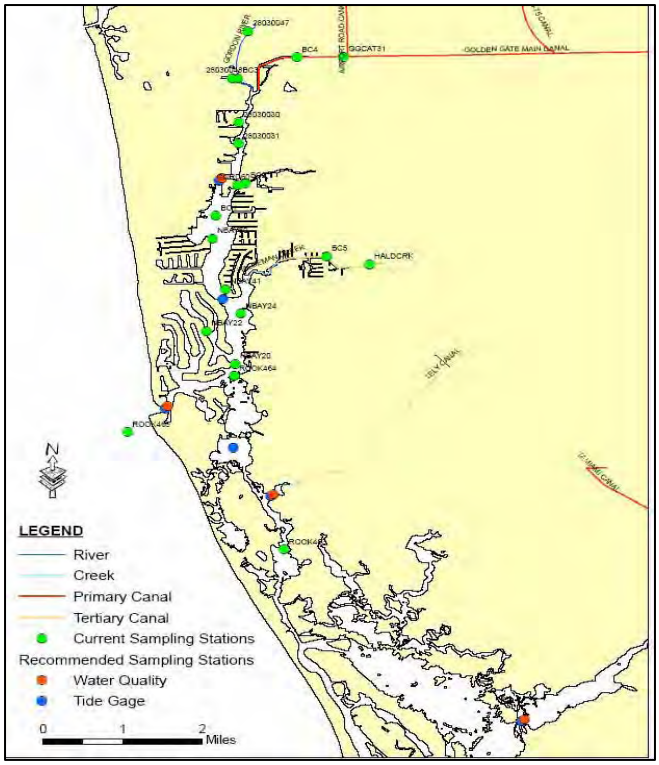

Figure 53. Current and recommended sampling stations (Taylor Engineering, Inc. 2005).

- Just inside Gordon Pass
- Within the main passages from residential canal areas on the west side of the Bay
- In the main body of the Bay south of Gordon Inlet
- In the Intracoastal Water Way at the mouth of Lely Canal
- At a constriction near the mouth of Henderson Creek

Summary of Recommendations

Taylor Engineering envisions the use of a two-dimensional model to simulate long-term water circulation and water quality dynamics. This class of model would likely provide sufficient capability to simulate ambient water quality conditions for management of the Bay to achieve and maintain Class III water quality standards. However, calibrating the model would require additional sampling and data collection. Additional long-term sampling stations would likely increase the ability to verify model performance, develop management plans, and monitor changes in the system.

Sufficient hydrologic data collected since 2000 from currently active hydrologic stations provide sufficient information for use in developing a limited calibrated water circulation model. Rainfall, flow at Golden Canal weir, and the Gordon River Extension weir, stage measurements from Haldeman Creek, Rock Creek, Lely Canal, Henderson Creek, and from gauges in the Gulf of Mexico would provide most of the data. Taylor Engineering recommends runoff modeling to provide stormwater flows from developed areas of the Basin, particularly the City of Naples.

Given the absence of tide gauges in Naples Bay, published tidal ranges would substitute for direct measurement to provide a limited calibration of the hydraulic model. The addition of several tide gauges would greatly improve hydraulic model calibration and verification capabilities.

Intensive 48-hour hydraulic and water quality parameter measurements during the dry and wet seasons would provide the ideal data sets for a detailed calibration of the hydraulic and water quality models.

Data from monthly sampling efforts in the Bay, augmented by data from recommended additions to the current sampling network, would provide verification data for the hydraulic and water quality model. The recommended sampling stations would suffice for verification of the model calibration and simulation period performance testing. The new stations would extend the monitored area south to Henderson Creek, potentially affected by proposed changes in the Naples Bay Basin canal drainage system.

Reconnaissance Observations

The following are recommendations based on what was observed during the synthesis of information for this Reconnaissance Report.

Additional data collection

While water quality and flow in general are being well sampled, a few basic pieces of information important for a complete understanding of surface water and its fate are missing in the Naples Bay area. Stream gauges are lacking in areas without control structures. More information on aquifers is needed in the study area rather than drawing inferences from the few cores completed in nearby areas, and in general a comprehensive summary of groundwater quality has not been completed. Testing for metals and pesticides has not been done consistently or in enough locations to draw sound conclusions. Further, distribution of residual organotin compounds should be conducted in areas of heavy boating activity/storage/repair activities.

Monitoring Station Representation

Update or create GIS layers for monitoring locations. The current SFWMD GIS layer does not reflect current SFWMD or County sampling stations (i.e. records in GIS layer and DBHydro database do not match). This will allow display of monitoring station locations, as well as spatial analysis and display of data. This could prove to be very effective as a quantitative analysis and/or planning tool. Ideally, a GIS layer with a unique identification for each station could be joined to a comprehensive water quality water quantity database. It would be useful to differentiate stations that are currently monitored versus historic stations. Additionally, the many stations in the STORET database that have no data available should be eliminated from the GIS layer. A significant effort would be necessary to reconcile differences and overlap between data sets.

Stormwater Treatment Systems Representation

Create GIS layer identifying stormwater treatment methods/systems. Various resources may be available with this information, though none are in GIS format. One resource is the regulatory related database which contains certified development information. Current ERP regulations call for stormwater BMPs. During permitting process, construction is certified to meet permit required standards. Certification information (project outfalls, CFS, pumps, etc) can be accessed through direct query, though information about location would have to be accessed indirectly using a permit number or other means (Steve Nagle, SFWMD, personal communication). Projects with regional significance have master drainage plans. Developments constructed prior to the ERP program are likely to have either inferior or absent stormwater treatment systems. Other, simpler means may prove to be effective as well, such as querying the property appraiser's spatial database for construction dates. A map of stormwater management systems would allow for the potential to target areas with inferior stormwater treatment methods and improvement projects.

Salinity modeling

The SFWMD is tentatively planning a salinity modeling project in partnership with the City of Naples. A recent nearby project that may be a useful resource is the USGS Estero Bay salinity patterns mapping (USGS, 2003). Fourteen salinity maps were created from monthly surface water and salinity data collected over an 18-month period. Surface water salinity maps were used to assess trends in freshwater inputs and saltwater movement within the estuary, and to evaluate water transport and residence time. Maps show seasonal variability, rivers of significance, and hydrologic barriers. Empirical salinity data collected within Naples Bay could be used to develop and/or verify planned salinity modeling efforts.

Working Group Meetings

Topics that were identified and discussed at the March working group meeting are characterized below:

Watershed boundaries, natural and artificial, may be disputed, as they vary according to conditions and can be influenced by water management decisions. The boundaries used in the study, however, are suitable for the purposes of developing surface water improvement and management plans and projects. Current modeling techniques used by the BCB are regional, integrate surface and groundwater, and are not constrained by specific boundaries.

The effects of altered hydrology on the structure and function of estuarine ecosystems in the region is well documented (Shirley et al. 2004; 2005). Performance measures to conserve natural biodiversity have been developed for other estuaries in the region (Popowski, 2003). It is recommended that the applicability of these performance measures and possibly other performance measures be developed early in the SWIM planning process to prioritize restoration activities and to assess the effectiveness of management actions. BCB management plans for water movement and storage should be formalized to include water levels maintained and quantities released such that the ecosystem needs are met. The term "Ecosystem Operating Plan" was suggested by workshop participants. It was suggested that consideration for the watershed management approach be given to the original water budget of the Basin, annualized water projections. It was stated that the effects of the inter-basin transfer of water should not be underestimated.

Additional storage of water to reduce drainage effects in Northern Golden Gates Estates is desirable yet limited by presence of septic systems and flood control issues. Drainage issues are being addressed by the Restudy Demands Committee and GGE Homeowners Association. Much of this area was developed before current permitting requirements were in place and lack sufficient stormwater treatment. Increased population density in this area negatively affects water resources due to an increase in the number of septic systems and amount of impervious surfaces.

Florida's Clean Marina and Florida Yards & Neighborhoods Program implementation should be strengthened within the Basin. The Clean Marina Program (CMP) educates, prevents degradation, and certifies businesses on a voluntary basis. CMP Clean Marina Designation indicates the business adheres to Marina Environmental Measures (MEMs). Florida Yards & Neighborhoods (FYN) educates and certifies home owners. Helpful concepts, tools and techniques for creating yards that use less irrigation, fertilizers, herbicides and pesticides resulting in improved stormwater runoff are provided. The FYN program also addresses shoreline management for waterfront homeowners.

Other issues include: I-75 Canal connections with the aquifer allows for loss of surface water; human waste and gray-water from live-aboard marinas and unregulated mooring fields; availability of land for stormwater treatment systems; exotic plants and animals with the potential to clog drainage systems and those with the potential to improve water quality aspects respectively.

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