CITY OF NAPLES
STORMWATER MASTER PLAN UPDATE

"90% DRAFT REPORT"

Prepared for:

City of Naples
380 Riverside Circle
Naples, Florida 34102

Prepared by:

TETRA TECH
201 East Pine Street, Suite 1000
Orlando, Florida 32801

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CITY OF NAPLES
STORMWATER MASTER PLAN UPDATE

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EXECUTIVE SUMMARY

Past emphasis on stormwater master planning was based upon resolving flooding problems associated with quantity or timing of stormwater runoff. The various basin reports and master plan efforts have invested considerable time in evaluating existing conditions of infrastructure, future conditions, and alternatives to improve the level of service of the system. Although much work has been performed, especially in Basins 3, 5, and 6; there is much more analysis needed in other basins in the City. Water quality considerations have barely been studied in the City. Although more recent reports reflect the growing concern of the state, a local citizens to protect the water resources in the area, the actual amount of useful analysis of alternatives to improve water quality lags far behind the previous efforts in flood control. Most recently, Naples Bay has become a major area of interest. The Federal NPDES and TMDL programs have helped elevate the concern over protecting and restoring this significant local water resource. The most significant recent program to focus on this growing concern is the SWIM program administered by the State through the SFWMD. Although these three State and Federal programs are all coming together to integrate the many inter-related concerns, the fact remains that the bulk of the data, analyses, and retrofit construction activities have focused for years on improving flooding in the City of Naples. Unfortunately, the standards for elevating excess stormwater runoff have typically involved passing more pollutant carrying freshwater to the downstream receiving water bodies at a more efficient rate. Thus, the historic activities associated with improving flood control has degraded the quality of the receiving waters and adversely impacted ecological systems. Although the purpose of this report is to compile the existing stormwater data, alternative analyses, costs, and recommendations into one updated master plan, the new focus will attempt to balance the City's three (3) major areas of interest:

(1) Improving flood control (water quantity) within the City.
(2) Improving pollution control (water quality) within the City.
(3) Improving Naples Bay on a regional level.

SECTION 1

INTRODUCTION

1.1 INTRODUCTION

The City of Naples is an area of rapid growth and development that was historically situated between the Gulf of Mexico and the Gordon River at Naples Bay. Much of the early development that created the City of Naples did not properly consider the flood potential and the natural resources of the estuaries and low lying areas that made up this coastal region. The Naples area was characterized by:

- Very low topography;
- Limited freeboard in the wetlands and lakes;
- Heavy rainfall patterns (Geographic positioning subject to receiving frequent tropical storms and hurricanes.) and;
- High tidal activity.

These characteristics result in situations that cause flooding. In some cases, runoff waters exceed the capabilities of the original canals, ditches and culverts to convey the stormwater. In addition, the lack of understanding of how high tidal surges could rise above mean sea level led to roadways and building structures constructed lower than the elevation of frequent water surges. These historic deficiencies have led to frequent flooding throughout the City. The over drainage of high ground water from off-site Collier County and the introduction of urbanization pollutants from both the City and surrounding Collier County has resulted in a significant decline in the viability of Naples Bay to continue as an important regional estuary.

As the City of Naples continued to develop, water quantity problems (flooding) were first recognized and targeted for corrective activities. Water quantity problems (flooding) continued to be identified causing the City to undertake many studies over the years to attempt to address these complex issues. Numerous basin studies and master plans have been commissioned over the years to attempt to find solutions to the problems and prevent more from occurring. More recently, water quality (pollution) concerns have become an additional area of interest, yet the existing studies do not adequately address pollution concerns except at the project mitigation level. The studies have attempted to maintain status quo when additional water is directed to Naples Bay instead of actually providing a net gain in pollution reduction to Naples Bay

On December 13, 2004, the City staff provided the status of the Stormwater Master Plan Update to the City Council in a City Council Workshop. The presentation recognized the need to have all the previous work efforts performed by an assortment of consultants and staff members (from 1981 to date) integrated into one comprehensive master plan. The report recommended that "prior efforts need to be integrated". The City staff at that time had a stormwater manager who began working on an updated Stormwater Master Plan. The draft report not completed, nor adopted.

On May 1, 2006 the City Staff reported to the Council that the goals of the Stormwater Master Plan Update should:

- Maintain existing systems.
- Replace system components as necessary – both increasing the water quality treatment and conveyance.
- Establish Level of Service goals for each Basin and use these goals in identifying deficiencies and future improvements.
- Design, permit, and construct improvements using a Basin by Basin approach.

Furthermore, it was recommended that the Updated Stormwater Master Plan recognize the following existing programs and attempt to integrate them in one document:

- Operation and Maintenance (O&M) Project Listing.
- 10-Year Capital Improvement Program (CIP).
- Naples Bay Water Quality Projects.
- User Fees and Bonding Capacity.
- Dedicated Grant Efforts.
- NPDES Program.
- TMDL Programs.

The staff recommended that a consultant be hired to "facilitate stormwater activities associated with the City of Naples." The **primary objective** presented to the Council was for a consultant to assist with the completion of the Stormwater Master Plan Update. The **secondary objective** described was to provide an evaluation of a rate analysis in efforts to provide a revenue stream in conjunction with the items outlined within the Stormwater Master Plan Update. On October 30, 2006, Tetra Tech (Tt) received a purchase order to complete the primary objective. In addition, the second objective would be "explored" through a "snapshot" analysis. The second objective should ultimately be accomplished once this report has been adopted by the City Council through a separately funded rate study that specifically accomplishes the analysis in a manner that measures up to industry standards and legal challenges. Section 8 discusses these issues in more detail.

The Scope of Services specifically contracted by the City is repeated below:

"The purpose of this scope of services is to compile all the existing data and historic stormwater master plan (SMP) information available for the City of Naples and create a framework for an updated SMP. However, the updated SMP will not be complete in terms of all of the hydrologic modeling, capital improvement assessments, and other such services that have been determined to be best spread out over the next few years. The SMP will however, identify all of those tasks that need to be completed including a time schedule and estimate of cost to complete those identified services.

The most comprehensive benefit to this updated SMP will be the complete compilation of the many related studies, engineering reports, previous master plans and other relevant data into one combined source data book on a City-wide basis. As we understand, this has never been done for the City. In addition, there will be an emphasis on projecting (based on the best information available) a first generation estimate of the operation and maintenance (O&M), renewal and replacement (R&R), and capital improvement projects (CIP) for long and short term budgeting purposes. These financial elements are necessary for the proper implementation of a stormwater utility. Many of these expenses have not been adequately identified or quantified on a City-wide basis in previous studies.

In addition, there are several new City-wide concerns that have not been addressed in previous studies because of the specific basin-by-basin basis by which the previous studies were implemented. This updated SMP will identify these other significant issues and programs (such as the NPDES program, TMDL expectations and impacts, ocean outfalls and unified level of service determinations)."

MAJOR ISSUES TO BE DISCUSSED:

In accordance with our meeting, we identified several major issues which should be addressed as major sections of the master plan framework.
Those sections include the following:

1. Future impact/effects of the TMDL program on the City of Naples and Naples Bay.
2. Status of the implementation of the NPDES program (including an update on the status of the existing annual report).
3. Assimilation of Capital Improvement Projects and data.
4. Creation of a Renewal and Replacement Program.
5. Assessment of floodplain management program and future needs.
6. Comparison of estimated funding needs versus existing stormwater utility rates and grant provisions.
7. Assessment of a unified Level of Service (LOS) methodology including recommendations where the existing ordinances, codes or comprehensive plan should be adjusted accordingly.
8. Time schedule and projected costs (the framework) to implement a City-wide Master Plan.

SECTION 2

SOURCES OF DATA

The City and Consultant worked closely to locate the existing studies and reports available for the integrated update. We divided the sources of data relied upon into two (2) groups: existing drainage studies and master plans, and all other relevant data.

2.1 EXISTING DRAINAGE STUDIES AND STORMWATER MASTER PLANS

Tetra Tech reviewed dozens of existing drainage studies, stormwater master plans and other similar data sources to assess how much work has been performed to date to assimilate the useful data into one comprehensive integrated database and assess what technical work activities still need to be completed or updated. See Section 10 for more details of the reference materials used.

The Documents reviewed are as shown in Table 2.1 below:

Table 2.1 Summary of Existing Drainage Studies and Stormwater Master Plans

Year	Title of Document	Date Issued	By
1981	Stormwater Master Plan	01/01/81	CH2M Hill
1990	Phase 1 Stormwater Master Plan and Inventory	10/01/90	CDM
1996	Stormwater Management Program Ph 1 Master Plan	10/01/96	Naples staff
1996	Lantern Lake Drainage Area Study	06/01/96	HMA
1998	Basin VI Assessment Report	08/01/98	CDM
1999	Gordon River Extension Basin Study Phase III	09/01/99	Wilson Miller/CDM
2000	Lantern Lake Basin Drainage Study Update	09/01/00	HMA
2001	Interim Basin III Design Development Report	02/01/01	CDM
2002	Gordon River Extension Basin Study Phase IV	2002	Wilson Miller/CDM
2004	Basin V Stormwater System Improvement Plan Phase I: Basin Assessment and Conceptual Improvement Plan	06/04/04	CDM
2006	Draft Report Ph-1 Master Plan Stormwater Management Program	04/01/06	Naples staff

2.2 OTHER RELEVANT SOURCES

Key information sources included federal, state, and local environmental and regulatory agencies, as well as several special interest organizations. Some of these are listed briefly below:

- Federal Emergency Management Agency (FEMA)
- U.S. Geological Survey (USGS)
- National Oceanic and Atmospheric Administration (NOAA)
- South Florida Water Management District (SFWMD)
- Florida Department of Environmental Protection (FDEP)
- Big Cypress Basin Board
- Collier County
- City of Naples

In addition, numerous publications, textbooks, and other technical documents contributed to this Master Plan Update. A complete and comprehensive list of all sources of data and references used is provided in Section 10 of this report.

SECTION 3

COMPILATION OF DATA AND REORGANIZATION

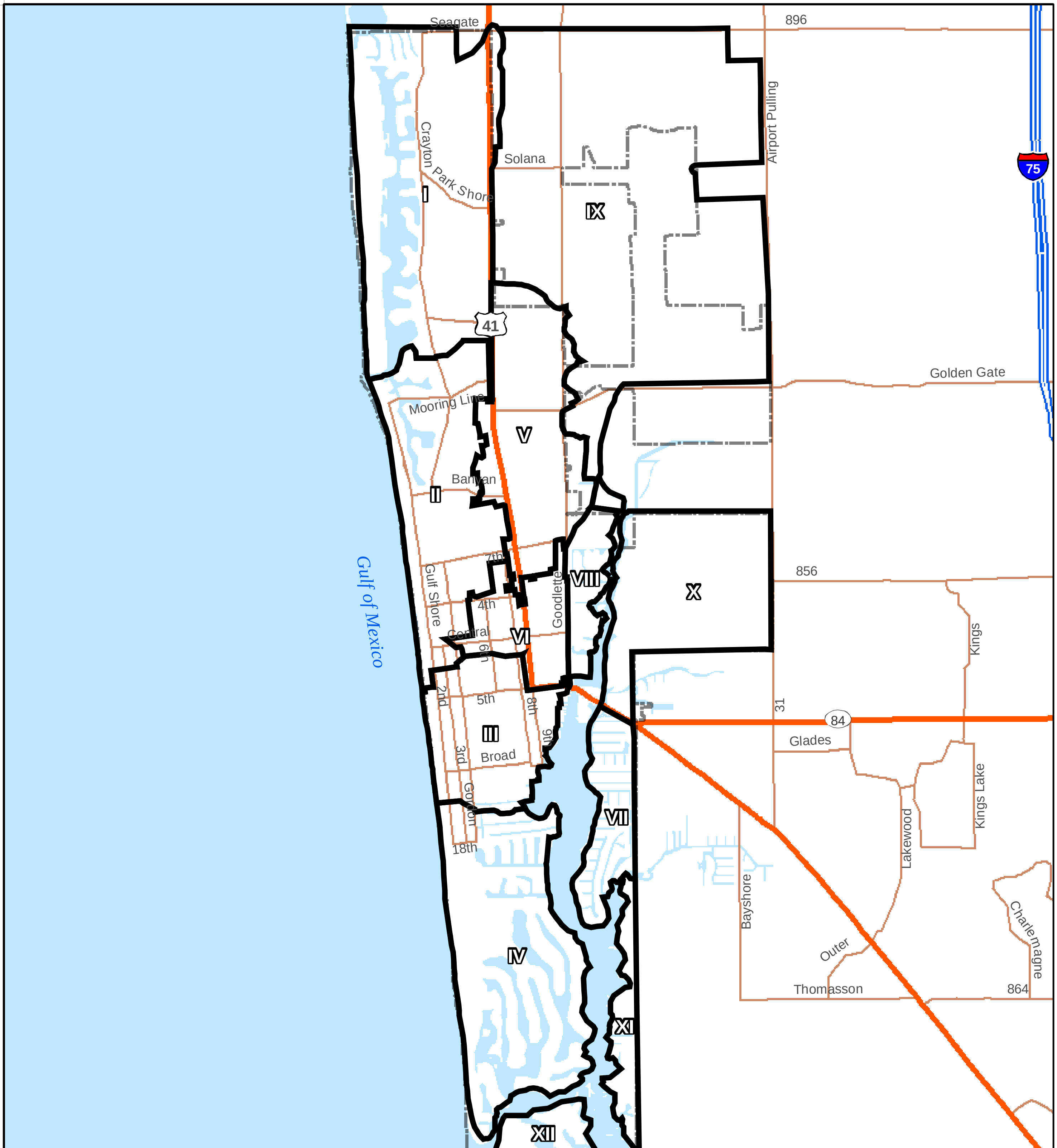
3.1 BASIN DELINEATION

Defining drainage basins is vital to determine the size of an area impacting a receiving water body, a retention area, or a drainage structure. CH2M Hill prepared the first master drainage report for the City in 1981. At that time, they identified 7 drainage basins (Reference # 10.13). These basins corresponded to the most significantly developed areas within the City of Naples.

Follow up work by other consultants utilized these original basins and defined the remaining lands within the City limits so that there were 12 drainage basins recognized in the CDM master drainage plan update in 1990 (Reference # 10.15). These same 12 basins are still used today, and continue to be designated by the original Roman Numerals given by CH2M Hill for consistency. In this updated report, we have used these basin designations to identify all problem areas, CIP projects and other initiatives with identification numbers that carry the drainage basin identification number as the first digit to help the user locate what hydrologic mapping unit of the City the work or project is effecting. <u>We recommend that the City continue to use this cataloging system from now on, as it was a tedious effort to reconcile and cross-reference all the data compiled without such a system in place.</u>

These basins have been shown and reproduced many times and in many reports but have never been rectified against recent aerials and placed into a useable Geographic Information System (GIS) database. The advantage of rectifying all the data and information by basins into this format is that special interest data queries can be viewed relative to other stormwater data collected. As part of this report all basins have been added to the GIS database, populated, and rectified to the most recent aerials. See Figure 3.1-1 for a map showing all 12 basins.

In addition, we found inconsistencies in the nomenclature and labeling of these basins between the reports which had to be corrected. For an example, the City's ACAD inventory maps labeled Basin "IX" where Basin "XI" was supposed to be located. In order to settle conflicts in nomenclature, we consulted the original reports by CH2M Hill (1981) for the original basins and the expanded basins described in the CDM report (1990). The original descriptions of the



LEGEND

City of Naples City Limits

City of Naples Basin Delineations

N

0 1 Miles

BASIN DELINEATION MAP
CITY OF NAPLES, FLORIDA
COLLIER COUNTY. FLORIDA

FIGURE 3.1-1

TT8.5X11P_EX250\GIS\NAPLES\030009016-SW\maps\report_1st\APF3.1-1.mxd [12-22-06 amm] geographical boundaries were used to delineate and correct discrepancies in basin area designations.

For convenience, we have republished the descriptions of each basin here from the 1990 CDM Report (Reference # 10.15). The major descriptions are as follows:

Basin I: The basin is bounded by the Gulf on the west, Seagate Drive on the north, U.S. 41 on the east and a line that extends from Doctors Pass through the Moorings Country Club to U.S. 41 on the south. The land is characterized primarily by residential development with commercial development along the U.S. 41 corridor and multi-family high-rise residential development in the Park Shore area. The basin's stormwater runoff is routed via a series of swales, inlets, pipes and detention lakes to outfall into Moorings Bay.

Basin II: The basin is bounded by the Gulf on the west, Basin I on the north, U.S. 41 and Basin V on the east and a line that runs from the intersection of 4th Avenue South and the beach northeasterly to the southeast corner of the Naples Beach Club golf course on the south. The land us is characterized primarily by residential development with commercial development along the U.S. 41 corridor and multi-family high-rise residential and hotel development along the Gulf beaches. The northern portion of the basin discharges its stormwater runoff via swales, inlets and pipes to Moorings Bay, while the south portion of the basin discharges its stormwater runoff via swales, inlets, pipes and detention lakes to the Gulf of Mexico.

Basin III: The basin is bounded by the Gulf on the west, Basin II and Basin VI on the north, Naples Bay on the east and a line running from Naples Pier southeasterly to Naples Bay on the south. The land use is characterized by primarily residential development with commercial development in the 5th Avenue South, 3rd Street South and Crayton Cove areas. Additionally, City Hall and the Fire Department are located in this basin. The basins stormwater runoff is routed via swales, inlets, pipes and one detention lake to the Broad Avenue South Stormwater Pump Station for discharge into Naples Bay.

Basin IV: The basin is bounded by the Gulf on the west, Basin III on the north and Naples Bay on the east and south. The land use is characterized by the Port Royal and Aqualane Shores residential developments. The basin's stormwater runoff is routed via swales, inlets and pipes to the canals of the basin which flow to Naples Bay. There is a stormwater pump station located on Lantern Lane in Port Royal.

Basin V: The basin is bounded by U.S. 41 and Basin II on the west, Creech Road on the north, Goodlette Road on the east and a line that runs from the intersection of U.S. 41 and 3rd Avenue North northeasterly to Goodlette Road on the south. The land is characterized by commercial development along the U.S. 41 corridor and the Coastland Mall area with residential development throughout the basin. The basin's stormwater runoff is routed via swales, inlets, pipes and several detention lakes to a storm sewer pipe system along the wet right-of-way of Goodlette Road. This system discharges to the Gordon River.

Basin VI: The basin is bounded by Basin II on the west, Basin V on the north, Goodlette Road on the east and Basin III on the south. The land use is characterized by primarily commercial development in the U.S. 41 corridor and downtown Naples area with residential development interspaced throughout. The majority of the basin's stormwater runoff is routed via swales, inlets and pipes to the Goodlette Road stormwater pump station near the Police Station. A portion of the basin's stormwater runoff is routed via swales, inlets and pipes to a ditch and pipe system along the west right-of-way of Goodlette Road. This system discharges to the Gordon River.

Basin VII: The basin is bounded by Naples Bay on the west, U.S. 41 on the north, Sandpiper Street on the east and Naples Bay on the south. The land use is characterized by the Royal Harbor residential development, some multi-family residential development in the north portion of the basin and some commercial development along the U.S. 41 corridor. The basin's stormwater runoff is routed via swales, inlets and pipes to the canals of the basin which flow to Naples Bay.

Basin VIII: The basin is bounded by Goodlette Road on the west, an east-west line that would be the westerly extension of the northern boundary of Naples Airport on the north and the Gordon River on the east and south. The land use is characterized by some residential development in the north portion of the basin with commercial development along the Goodlette Road corridor. The City Police Department, Utilities Department and the Goodlette Road stormwater pump station are within this basin. The basin's stormwater runoff is routed via swales, inlets and pipes to the Gordon River.

Basin IX: The basin is bounded by Goodlette Road on the west, the Gordon River and Airport Road on the east and Basin VIII on the south. This basin is the City's portion of the Collier County "Gordon River Extension Stormwater Basin" which extends well into the County. The land use is characterized by residential development, some commercial development along the Goodlette Road corridor and undeveloped land/preserve land. The basin's stormwater runoff is routed via swales and overland sheet flow to the Gordon River.

Basin X: The basin is bounded by the Gordon River on the west, the north boundary of Naples Airport on the north, Airport Road on the east and the south boundary of Naples Airport and U.S. 41 on the south. The land use is characterized primarily by Naples airport and some residential and commercial development. The basin's runoff is routed by swales, inlets, pipes and overland street flow to the Gordon River.

Basin XI: The basin is bounded by Naples Bay on the west, Basin VII on the north and the City limits on the east and south. The land is undeveloped except for Bayview Park. The basin's stormwater runoff is routed via overland sheet flow to Naples Bay.

Basin XII: The basin is the portion of Key Island within the City limits. The land is mostly undeveloped with some sparse residential development. The basins stormwater runoff is routed via overland sheet flow to Naples Bay and the Gulf of Mexico.

3.2 INVENTORY AND MAPPING

The second stormwater master plan of 1990 included an inventory of the drainage structures in Naples. This information was compiled into a CADD drawing which has been the basis of all drainage performance analysis and project development ever since. The CADD inventory does NOT overlay Collier County's aerials, GIS database, and property appraiser's parcel data, thus causing a problem in reviewing and updating the CIP/R&R projects, and comparing these projects to other current GIS data layers. As part of this Stormwater Master Plan Update, our GIS department manually corrected the stormwater drawings provided by the City of Naples and rectified the features to the 2005 Orthophotography (aerials) and GIS parcel data. This effort took several weeks. The GIS stormwater inventory improves the ability of the user to study the infrastructure system in relation to other datasets available in GIS, such as; planning data, flood zones, CIP projects, water, wastewater, and reuse systems. Now that this GIS database has been converted and rectified, we recommend the City assume responsibility to further build the database by using "as-built" plans of retrofit projects, new CIP projects, and new developments to keep an on going inventory of the stormwater assets of the City.

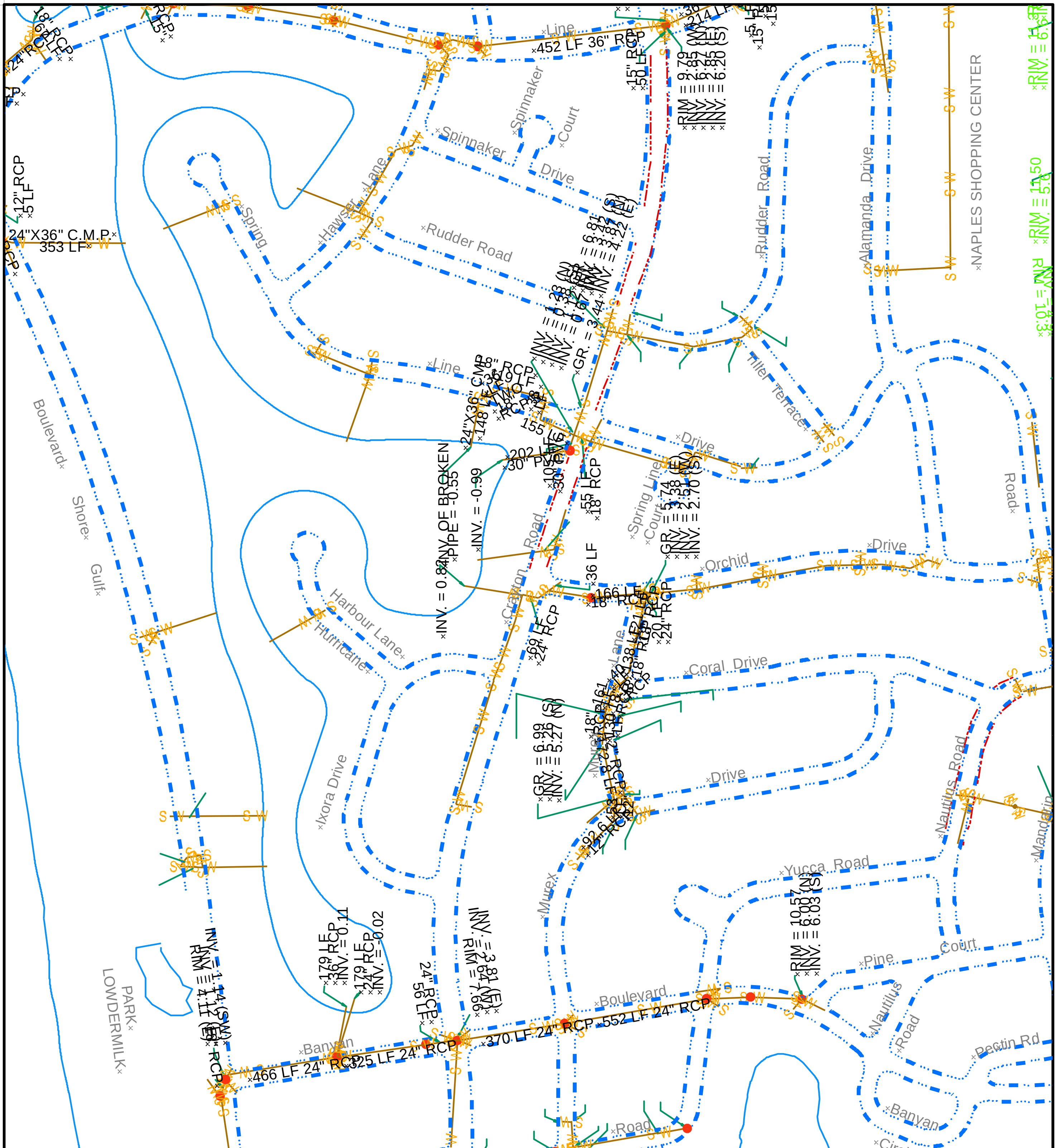
This information is not only critical to proper project planning and design, but can be useful in evaluating the value of the stormwater management assets for accounting purposes. Figure 3.2-1 provides an example of the previous inventory mapping from CADD. Figure 3.2-2 illustrates the GIS database conversion. The original CADD map is displaced to illustrate the spatial errors in relation to the GIS system. You can see from Figure 3.2-2 just how far off the right-of-way and water boundary lines were from the recent 2005 aerials. Note that the pipe work has been shifted into its correct context. Figure 3.2-3 provides the final rectified version.

3.2.1 CADD Map Limitations

The City's stormwater system CADD map has some limitations that will affect the accuracy of the GIS database in some areas. Approximately 75% of all catch basins and manholes within the system have no ground elevations or invert elevations provided, 24% of the pipe network has no pipe diameter information available. In certain areas, pipes, catch basins, and manholes are not present in the CADD map where they are clearly visible in the aerial imagery. Basin divides outside of Basins III, V, and VI are spatially inaccurate and should not be relied upon. Additionally, information within the inventory does not reflect any improvements or new developments since the creation of the CADD map. In summary, we recommend that this effort be completed as it is a very useful planning tool for the City. The level of accuracy of the material being converted, however, is not equivalent to the GPS/GIS inventory of the utility system components. It would be a major undertaking to use a GPS data collection device and update and inventory the entire system. The City budgeted $600,000 for this activity in their 2006 Draft 10-Year CIP Plan (see Reference #10.6), however this effort is obviously well beyond the scope of this master plan update.

3.2.2 Stormwater Inventory Rectification

Stormwater features from the CADD map were converted into a GIS inventory database. The stormwater features were rectified relative to their relation with the right-of-way in Collier County's GIS parcel base map and to 2005 6-inch Pixel high resolution orthophotography. The term 6-inch pixel resolution means that every pixel within the image represents 6 inches on the surface of the earth. This high resolution allows for higher accuracy rectification. Where available, stormwater features were moved over the actual visible location in the imagery. Details about individual features provided as annotation in CADD were populated into fields within the database. For example, rim and invert elevations for manholes are now available



Source: City of Naples Stormwater Inventory CADD Map

LEGEND

CADD FEATURES

- <all other values>
- STORMWATER MAIN
- MANHOLE
- RIGHT-OF-WAY
- UNDERDRAIN
- WATER"S EDGE

N

0 500 Feet

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Infrastructure Offices Throughout Florida
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ORIGINAL CADD
STORMWATER INVENTORY MAP
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE
3.2-1

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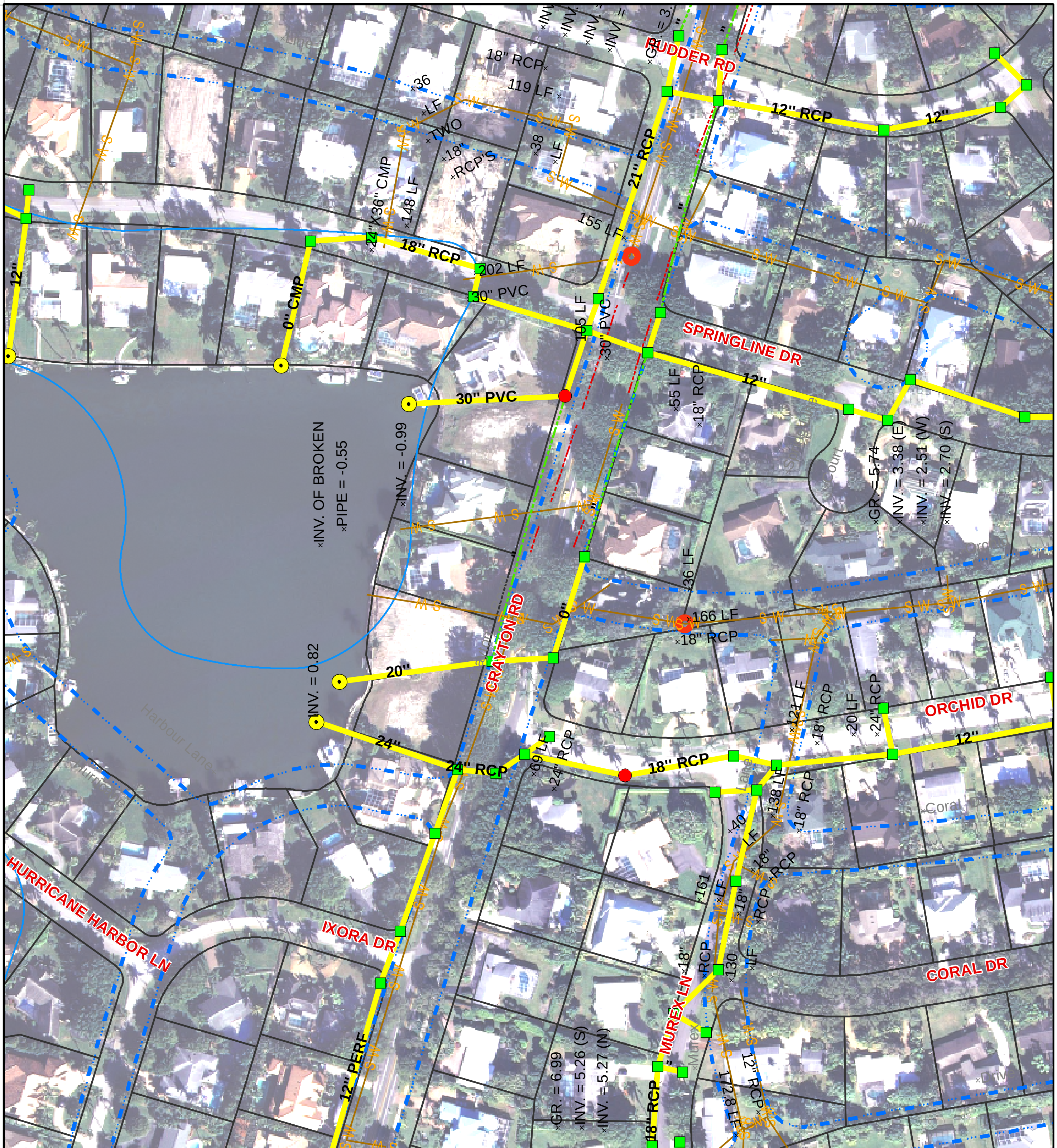

Source: Collier County 2006 Orthophotography

LEGEND

GIS RECTIFICATION

STORMWATER MAIN

UNDERDRAIN

Stormwater Manhole

Catch Basin

Outfall

N

0 200 Feet

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GIS STORMWATER DATABASE
RECTIFICATION MAP
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE
3.2-2

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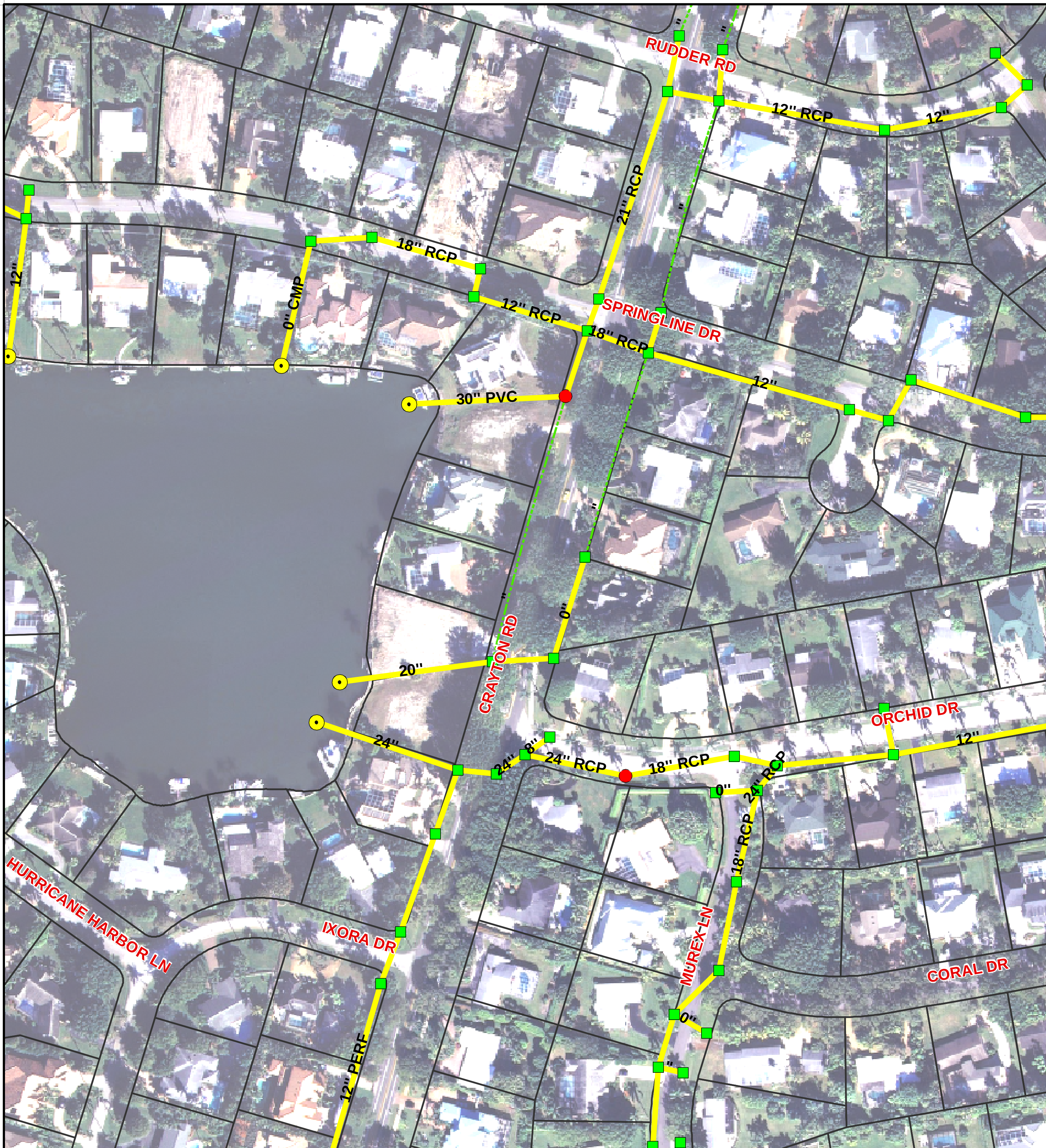

Source: Collier County 2006 Orthophotography

LEGEND

GIS RECTIFICATION

STORMWATER MAIN

UNDERDRAIN

Stormwater Manhole

Catch Basin

Outfall

N

0 200 Feet

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Infrastructure Offices Throughout Florida
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GIS STORMWATER DATABASE
FINAL PRODUCT MAP
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE
3.2-3

TT11X17PEW \\haiorlsfs4\fs4\GIS_proj\NAPLES\030009016-SW\maps\report_1st_APIN\F3.2-3.mxd [12-26-06 amm] within the GIS database. Survey drawings of stormwater structures for large portions of Gordon Road where also used for spatial reference.

To date, 68% of the City's stormwater inventory has been converted and rectified within Basins II, III, IV, V, and VI. The City previously funded detailed basin studies for Basins III, V, and VI. These reports provide detailed sub-basin delineations that differ from those contained within the original CADD system map. These delineations were also incorporated in the GIS database. Basins III, V, and VI represent 30% of the total stormwater system area. Maps reproduced from the database are spatially acceptable to a scale of 1 inch = 200 feet. Figure 3.2.2-1 illustrates the progress status of GIS Database.

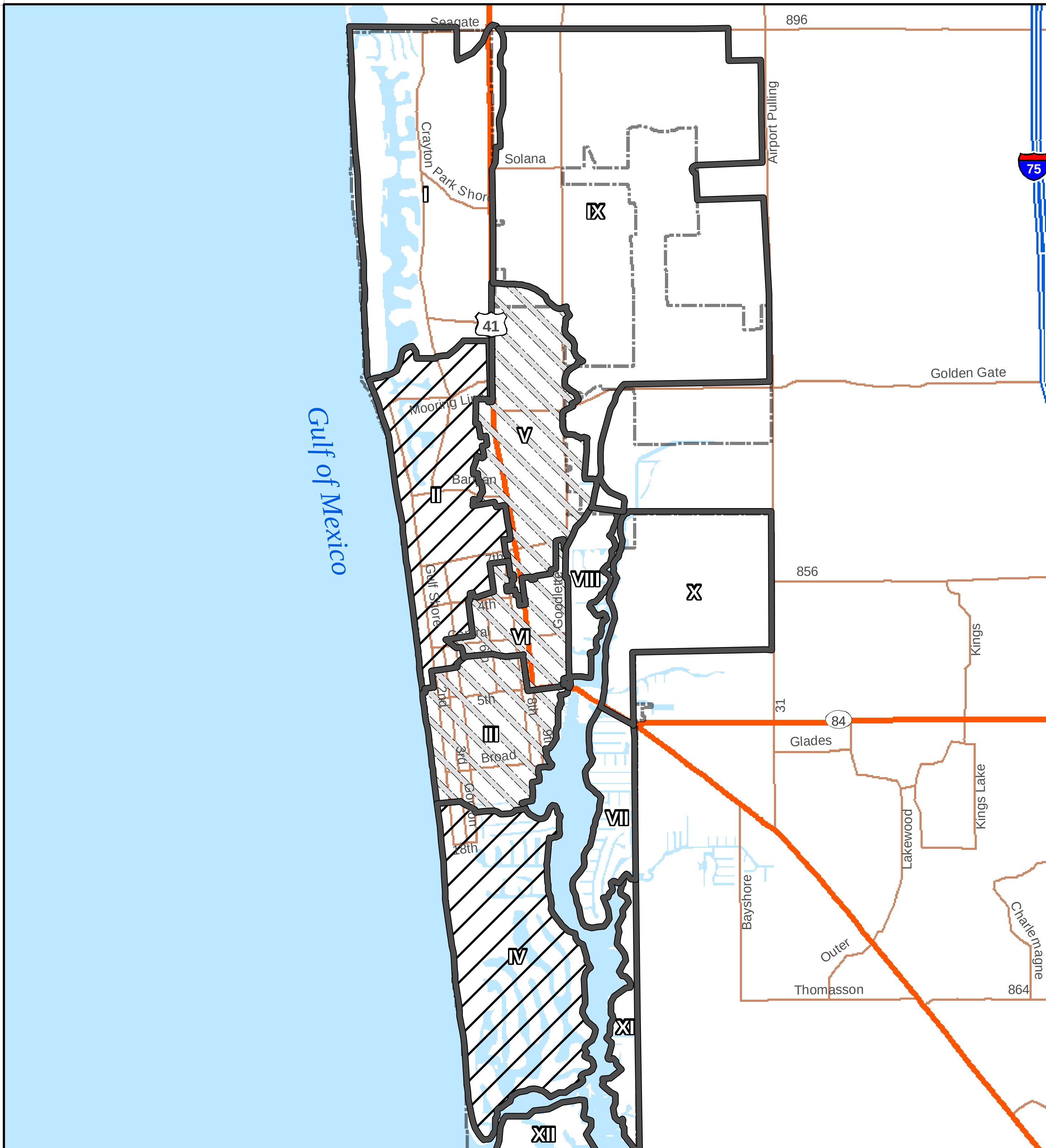
3.2.3 Deliverable

The City is furnished with a stormwater inventory GIS database on CD-ROM. The database is spatially consistent with Collier County's parcel data and 2005 aerial imagery at a plot scale of 1" = 200' for the features contained within Basins II, III, IV, V, and VI. Parcel data, street centerline, and FEMA flood zones are also provided. The 2005 orthophotography will not be included due to the extremely large file size.

3.2.4 Inventory and Mapping Recommendations

It is recommended that all future stormwater and CIP projects be updated into the GIS database. All available "as-built" drawings should be incorporated in the database as well. These as-builts should include both private projects that affect the public infrastructure, as well as public R&R and CIP projects that affect the inventory. A systematic process involving the City's Director of GIS will need to be developed since the data will come from various departments within the City. This database should be incorporated with other City wide GIS datasets in the future. The GIS database should be reviewed in areas where information is incomplete from the original CADD map, (e.g. areas where no invert elevations or pipe diameters exist). The following bullet points summarize our recommendations:

- Complete the conversion and rectification of all stormwater information (see Figure 3.2.2-1)
- Incorporate all future CIP/R&R projects into GIS database



LEGEND

City of Naples City Limits

STATUS

Basin Delineations Corrected, Stormwater System Converted, Stormwater System Rectified

Basin Delineations NOT Corrected, Stormwater System Converted, Stormwater System Rectified

Basin Delineations NOT Corrected, Stormwater System Converted, Stormwater System NOT Rectified

GIS DATABASE PROGRESS STATUS BY BASIN
CITY OF NAPLES, FLORIDA
COLLIER COUNTY. FLORIDA

FIGURE 3.2.2-1

TT8.5X11P_EX250\GIS\NAPLES\030009016-SW\maps\APF3.2.2-1.mxd [12-22-06 amm]

- Create a systematic process of updating information from the various Departments to the City's GIS Department
- Update GIS database with each specific drainage basin study commissioned since more accurate inventory records become available.

3.3 SUMMARY OF PROBLEM CHARACTERIZATIONS

In this section, we will characterize the known flooding and pollution problems and attempt to integrate it into the Updated Master Plan. Specific review of the project needs occurs in later sections.

3.3.1 Water Quantity (Flooding)

In order to successfully assess the flooding problems affecting the City, it is first important to understand the different types of flooding conditions that occur within the City. The original Stormwater Master Plan developed by the City Staff in 1996 attempted to educate the reader to some of the problems that the City was experiencing. These problems were described in Section 4 of that report. Upon review of the City's various problems, we offer a reorganization of those flooding characteristics that might better facilitate a comprehensive understanding of the problems challenging the City of Naples. Table 3.3.1 summarizes the types of flooding conditions experienced in Naples.

As one can see, the problems that the City has experienced fall into one of ten (10) problem categories based on the original 1996 descriptions. We consider, however, that the original 8 problems types are best described in one of 7 categories described in more detail in Section 5.2. The categories used in Section 5.2 are based upon the **cause** of the flooding whereas the City's 1996 categories were a mixture of causes and symptoms. Also, we have provided a categorization crosswalk for the flooding problems to financial grouping. In Table 3.3.1-1, we have linked each flooding problem into one of three (3) basic financial categories:

- Capital
- R&R
- Maintenance

These financial categories are discussed in more detail in Section 8 of the report.

Of the technical categories given in Table 3.3.1-1, the most problematic is the tailwater backups due to tidal influences. When storm surge or significant high tide events occur, the downstream water bodies that the City of Naples depends upon for outfalls reach elevations above sea level that prevent the surface drainage of excess runoff from the City. This occurs when the Gulf of Mexico and Naples Bay are high in elevation. Unfortunately, the original builders of much of the City of Naples constructed streets and buildings too low relative to mean sea level. Much construction occurred with a lack of understanding of how often the downstream outfalls would rise up and prevent surface water discharge from being conveyed out of flooded areas. The early City streets and buildings should have been constructed higher since we cannot lower the oceans and bays during tidal extremes.

Table 3.3.1-1 Summary of Types of Flooding Conditions Experienced in Naples

2007 Tetra Tech I.D. #	1996 Naples Prob. I.D. #	Problem Resolved by Financial Group Type	Simple Problem Description	Description & Category as described in Naples SMP Update 1996 (Ref #10.10)	Extent and Significance of Problem
1	I	Capital	Tail water/Tidal (See Section 5.2.1)	Backups	Most Significant because of periodic tidal conditions
2	II	R&R	R&R deficiency (See Section 5.2.4)	Deterioration of culverts	Typical in certain locations
3	III	Capital / R&R	Groundwater (See Section 5.2.7)	Deterioration of roadway systems (saturated sub-bases)	Not significant in normal years but significant in unusually high tidal conditions
4	IV	Capital	Inadequate primary/ secondary conveyance of inlet infrastructure (See Sections 5.2.3 & 5.2.5)	Local street flooding	Somewhat significant
5	IV	Capital	Lack of primary/ secondary conveyance of inlet infrastructure (See Sections 5.2.3 & 5.2.5)	Local street flooding	Somewhat significant
6	V	Maintenance	O&M Deficiencies Outfall blockage (See Section 5.2.6)	Shoreline outfall failure	No longer significant
7	V	Capital	Outfall capacity primary conveyance infrastructure	Shoreline outfall failure	Significant in certain locations
8	VI	Capital / R&R / Maint.	Swale deterioration & Inadequacy (Primary R&R, see Section 5.2.4)	Swale deterioration	Very Significant
9	VII	Capital	Groundwater (See Section 5.2.7)	Swale deterioration	Significant in certain locations
10	VIII	Maintenance	Clogged secondary systems (See Section 5.2.6)	Clogged storm liner	No longer significant

The only way to remove flood water from rainfall excess under high tailwater conditions is to pump the excess floodwaters back out to Naples Bay and place gate structures in the system to stop the sea from rushing back into the pumped system. This is inherently a dangerous technique in that it lowers the flood waters below the elevations outside the gates. In such situations, there is always the pressure of the higher water levels in the ocean and bay to seek a way back. The levees collapsing in New Orleans during Hurricane Katrina demonstrates an extreme scenario when the head differential corrects this imbalance. The techniques are further complicated by the costs of the equipment to pump the water against grade and the newer laws pertaining to untreated discharges of stormwater for flood control to sensitive downstream waters such as the Gulf of Mexico and Naples Bay.

Further complications arise when the public does not understand how some of these flooding categories overlap. For instance, there may be flooding in the street because a drainage inlet is inadequate for the storm event that it was intended to serve. This is a condition that can occur when development has preceded beyond the original design intentions. Installing a larger inlet and pipe system may correct this deficiency as a capital upgrade. If, however, the pipe system discharges to a tidally influenced water body at an elevation where the inlet has insufficient topographic relief (hydraulic head), the ability of the newly constructed infrastructure may still be limited to rain events that occur only when the tailwater (tidal conditions) are low enough. The newly constructed inlet and pipe may be just as ineffective as the previous system during times of high tailwater. The expectations of the public must be tempered during such conditions as the Level of Service (LOS) of the flooding area was "improved" (the frequency of flooding decreased), while the problem was not "eliminated" because it was subjected to multiple categories of flooding problems.

3.3.2 Water Quality (Pollution)

The water quality issues in the City can be characterized several ways. One way would be to discuss pollution parameters in terms of typical NPDES criteria (such as the water quality analysis in the Drainage Basin III Report). Since the City is not subject to the Phase I NPDES criteria, we do not propose to characterize water quality in this manner for this Update. Another popular characterization of water quality favored in the NPDES program divides pollutants into "point source" and "non-point sources". This manner in characterizing pollutants is well documented and an integral part of the NPDES program requirements. More is discussed on the NPDES program in Section 7.1.

Another way of organizing the key water quality issues is based on the TMDL program and those parameters that make water bodies "impaired". At this current time, however, there are few water quality parameters on the FDEP's radar screen for the City's key water bodies, thus, that method of organization might miss other important considerations.

Since there is so much attention and concern on the long term viability and health of Naples Bay, we suggested characterizing water quality in terms of a few key pollutants that:

- Typically lead to the degradation of state waters;
- Are near the threshold parameters affecting Naples Bay;
- Are currently easily documented in existing studies or data; or
- The introduction of abnormal quantities of freshwater into the estuary by upstream drainage ditches and canals.

Thus, the focus in this Master Plan Update is on those water quality parameters of primary concern. We selected a metal of concern that has been documented well, two nutrient parameters, and something that would be indicative of suspension and turbidity. The pollution parameters that we selected to narrow our focus in this update are:

- Total Nitrogen
- Total Phosphorus
- Total Suspended Solids
- Copper

There are many other parameters of concern that are not well documented, or are not as easy to compare at this time. Since it is beyond the scope of this update to analyze all of the water quality data, we will present this general characterization. Note, however, that in Sections 6.3 and 6.4, we compile and summarize the range of parameters that have been studied to date.

In addition, we will look at any information quantifying the timing and volume of freshwater into the Naples receiving waters since the saline concentration is a vital factor in the health of estuarine systems.

3.4 SUMMARY OF EXISTING IDENTIFIED PROJECTS AND NEEDS

Summarizing the existing identified projects and need from the various reports and studies performed for the City has been an arduous task. There has not been a consistent identification system to track the progress of projects and many problem areas overlap with other problem areas. Further complicating matters, we could find no system of tracking which problem areas had been studied and compiled into specific capital improvement project categories with set funding established. In each case we reviewed, the actual recommended alternative for the Basin Study Reports was not implemented as described in the reports. Comparisons between the various lists, reports, and funding summaries that we were provided to review revealed inconsistencies between the dollar amounts and scope of projects to be performed with little or no explanation of what the discrepancy was.

At first, we attempted to prepare a summary listing of all of the known problem areas in the City by compiling the existing lists that were prepared for by the previous City staff and consultants in a number of drainage reports and stormwater master plans (see Reference Nos. 10.7, 10.8, 10.11, 10.13, and 10.14). We found that problem areas often expanded into other problem areas, thus making categorization of these areas very difficult. Furthermore, many problem areas have been partially fixed by various City initiatives. In no case could we find where partial fixed problems were reanalyzed to see what actual LOS would be provided. We recommend that project modifications to the alternatives studied in the original Basin Reports (III and VI in particular) be reanalyzed to determine their effective LOS. This should be performed using the original CDM models, but with the unified LOS comparison criteria suggested herein.

Another complicating factor is that the drainage basins have been studied primarily on a basin by basin basis whereby major basin capital improvement projects have been created with the intention of dealing with basin-wide problems all at one time. Tetra Tech met with various members of City staff in attempt to reconcile the status of all the known problem areas. Ultimately, we conceded that it would be more productive at this time to deal with the tracking of problem areas through drainage basin studies on a basin by basin approach. Regardless, Table 3.4-1 documents an integrated compilation of the problem area descriptions we located from various reports into one summary table. The specific status of each incremental listing, however, has not been accurately confirmed. We caution that use of the table should be limited to background historical information.

Table 3.4-2 gives our initial listing of the remaining stormwater management projects and expenditures identified in the various studies and reports and integrated into one comprehensive list for analysis. Many of these costs are from former reports and CIP upgrades by staff. We will adjust the costs to today's dollars and modify the costs to reflect today's project conditions when the information to do so is available. Later in Section 8 of this report, we will attempt to analyze the most significant projects and rank the projects based on cost and benefit considerations. The ultimate deliverable will be a methodology and reorganization of the projects by ranking priority and other timing considerations into an updated stormwater management capital improvement program. This list will be utilized to help study the stormwater funding in Section 8 of this report.

Table 3.4-1 List of Reported Problem Areas By Naples Drainage Basins Areas and Source

Problem ID #	Problem Location by Streets	Sources & Reference #'s								Status of Problem (According to Naples Staff Dec. 2006)	Subjective Priority (Naples Staff Dec. 2006)
		CH2MH 1981 (10.13)	CDM 1990 (10.15)	Naples 1996 (10.10)	City Staff 1998/ CDM 1998 (10.7)	City Staff 2000/ CDM 2001 (10.11)	WM/CDM 2002 (10.14)	CDM 2005 (10.8)	City Staff 2007		
III-1	8th St S from 3rd Ave S heading North		X							Not Fixed	Not Critical
III-2	Gulf Shore Blvd (12th Ave S to North of 6th Ave S)		X			X			X	Not Fixed	Moderate
III-3	10th St S from 10th Ave S to North of 6th Ave S		X	X					X	Partially	Moderate
III-4	9th St S from 6th Ave S heading North			X					X	Not Fixed	Moderate
III-5	9th St S from 6th Ave S to 10th Ave S		X	X						Not Fixed	Not Critical
III-6	10th Ave S from 9th St S to 11th St S		X							Fixed	N/A
III-7	13th Ave S from 4th St S to 7th St S		X			X			X	Not Fixed	Moderate
III-8	5th Ave S from 3rd St S to 7th St S			X		X			X	**Not Fixed**	**Critical**
III-9	5th Ave S from 7th St S to 9th St S					X			X	Not Fixed	Moderate
III-10	4th Ave S from 6th St S to 7th St S					X			X	Not Fixed	Moderate
VI-1	10th St from 3rd Ave S to 5th Ave S	X	X	X	X					Partially	Not Critical
VI-2	10th St from 3rd Ave S to 5th Ave N		X	X	X					Partially	Not Critical
VI-3	5th Ave N from 10th St N to 11th St N	X								Not a Problem	N/A
VI-4	9th St N (SR 45 US 41) and Central Ave	X								Partially	Not Critical
VI-5	8th St N from 2nd Ave N to 3rd Ave S		X						X	Not Fixed	Moderate
VI-6	Central Ave from 7th St N to 8th St N		X							Not Fixed	Not Critical
VI-7	Central Ave from 8th St N to Tamiami Trl		X	X						Not Fixed	Not Critical
VI-8	Central Ave from Tamiami Trl to 10th St N		X	X	X					Not Fixed	Not Critical
VI-9	Central Ave from 10th St N to Goodlette Frank Rd.			X	X				X	Not Fixed	Moderate
VI-10	5th Ave S and Tamiami Trail				X					Not Fixed	Not Critical
V-1	U/S end of Fleishman Blvd crossing						X				
V-2	22nd Ave. Culver Crossing; U/S and D/S ends						X				

Table 3.4-1 List of Reported Problem Areas By Naples Drainage Basins Areas and Source

Problem ID #	Problem Location by Streets	Sources & Reference #'s								Status of Problem (According to Naples Staff Dec. 2006)	Subjective Priority (Naples Staff Dec. 2006)
		CH2MH 1981 (10.13)	CDM 1990 (10.15)	Naples 1996 (10.10)	City Staff 1998/ CDM 1998 (10.7)	City Staff 2000/ CDM 2001 (10.11)	WM/CDM 2002 (10.14)	CDM 2005 (10.8)	City Staff 2007		
V-3	Golden Gate Parkway (BV35045)							X			
V-4	12th Street North (BV12020)							X			
V-5	Golden Gate Parkway (BV35050)							X			
V-6	Golden Gate Parkway (BV35030)							X			
V-7	Int. of 7th Ave. N. and 12th St. N. (BV12030)							X			
V-8	15th Ave. N. (BV23011)							X			
V-9	Int. of Diana Ave. and 10th St. N. (BV43040)							X			
V-10	D/S end of 14th Ave. N. crossing (BV23015)							X			
V-11	Diana Ave., D/S of 10th St. N. (BV43035)							X			
V-12	Int. of 22nd Ave. N. and 11th St. N. (BV43020)							X			
V-13	Corner of 15th Ave. N. and 12th St. N. (BV23010)							X			
V-14	Int. of 12th St. N. and 14th Ave. N. (BV23030)							X			
V-15	Int. of Diana Ave. and 13th St. N. (BV44045)							X			
V-16	Int. of 14th St. N. and 26th Ave. N. (BV44050)							X			
V-17	Int. of 8th Ave. n. and 12th St. N. (BV11010)							X			
V-18	U/S end of crossing at 10th Ave. N. and 13th St. N.							X			
XI-1	South portion of Goodlette Frank Rd. Ditch						X				

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
1.1		**Master Planning and Design**	**Primary Conveyance System Analysis & Modeling (Specific Basin Studies)**	**Basins III, V, and VI completed. Need to complete others using one consistent methodology and LOS rating.**	**Naples 2006 #10.6**	**See Breakout Below**			
1.1.1	I	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 1	Not initiated	#10.6 and Tt 2007	$ 150,000	2006	$ 150,000	
1.1.2	II	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 2	Not initiated	#10.6 and Tt 2007	$ 200,000	2006	$ 200,000	
1.1.3	III	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 3	**Completed**	#10.6 and Tt 2007	$ -	2006	$ -	
1.1.4	IV	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 4	Not initiated	#10.6 and Tt 2007	$ 150,000	2006	$ 150,000	
1.1.5	V	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 5	**Completed**	#10.6 and Tt 2007	$ -	2006	$ -	
1.1.6	VI	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 6	**Completed**	#10.6 and Tt 2007	$ -	2006	$ -	
1.1.7	VII	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 7	Not initiated	#10.6 and Tt 2007	$ 150,000	2006	$ 150,000	
1.1.8	VIII	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 8	Not initiated	#10.6 and Tt 2007	$ 160,000	2006	$ 160,000	
1.1.9	IX	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 9	Not initiated	#10.6 and Tt 2007	$ 80,000	2006	$ 80,000	
1.1.10	X	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 10	Not initiated	#10.6 and Tt 2007	$ 80,000	2006	$ 80,000	
1.1.11	XI	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 11	Not initiated	#10.6 and Tt 2007	$ 40,000	2006	$ 40,000	
1.1.12	XII	Master Planning and Design	Primary Conveyance System Analysis & Modeling Basin 12	Not Needed - Not Applicable	#10.6 and Tt 2007	$ -	2006	$ -	**$ 1,010,000**
1.2	all	Master Planning and Design	5 and 10 year CIP Refinement	Refining CIP List and Ranking @ Yr 1,5,10	Tetra Tech 2007	$ 18,000	2006	$ 18,000	
1.3	TBD	Master Planning and Design	Secondary Conveyance System Analysis/Modeling	Major SWMM modeling too coarse of tool to adequately identify capacity issues of inlet spacing, throat capacity, and minor pipe size issues. Recommend other modeling techniques in most problematic areas.	Tetra Tech 2007	$ 50,000	2006	$ 50,000	
1.4	TBD	Master Planning and Design	Naples Bay Basin Management Plan	Phase I - Preliminary Engineering and Environmental (Not awarded) Contribution to Regional Efforts and SWIM Program	Naples 2006 #10.6 Staff 2007	$ 250,000	2006	$ 250,000	

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
1.5	II	Master Planning and Design	Beach Management Plan for Removal of Ten Stormwater Outfalls	Preliminary engineering and environmental, final engineering and permitting or could be integrated with item 1.1.2	Naples 2006 #10.6 Staff 2007	$ 380,000	2006	$ 380,000	
1.6	TBD	Master Planning and Design	Lake Water Quality Management Plan	Phase 1 - Preliminary engineering and environmental analysis without specific design plans & permits. This will evaluate on a citywide basis, opportunities to maximize pollutant reduction for discharges to Naples Bay by retrofitting, expanding, or altering existing wet detention areas and lakes.	Naples 2006 #10.6 and staff 2007	$ 225,000	2006	$ 225,000	
1.7.2	all	Master Planning and Design	Citywide Stormwater Master Plan Ph-2 GIS Completion & Comp Plan Adjustment	Phase 2 completion of GIS conversion with some additional detail in scheduling upcoming design projects, based on grant funding, and prioritization developed in Phase 1.Includes Comp Plan and LOS Modification Implementation	Naples 2006 #10.6	$ 38,700	2006	$ 38,700	
1.7.3	all	Master Planning and Design	Rate Study	Update Rate Study to implement a raise in stormwater fees to accomplish the goals of the Stormwater Master Plan Update.	Tetra Tech 2007	$ 88,000	2006	$ 88,000	
1.8	TBD	Master Planning and Design	Stormwater Drainage GIS Inventory, Inspection & Evaluation (asset management)	Verify inventory begun back in 1990 & update to most recent conditions. This will provide data useful for GASBY34 & make the storm system compatible in GIS to the other utilities	Naples 2006 #10.6	$ 600,000	2006	$ 600,000	$ 1,649,700
2.1	all	Capital Purchases	Purchase Vacuum Truck for Stormwater System Maintenance	A truck will be purchased in 2007, therefore this is needed as a replacement vehicle in 5 years, or in 2012	Naples 2006	$ 330,000	2006	$ 330,000	
2.2	all	Capital Purchases	Purchase Street Sweeper for NPDES Phase II Water Quality Control Measure	A truck will be purchased in 2007, therefore this is needed as a replacement vehicle in 5 years, or in 2012	Naples 2006	$ 290,000	2006	$ 290,000	$ 620,000
3.1	I	CIP Implementation	Unidentified Stormwater Projects in Basin 1	TBD but based on prioritization should be in **first** 5 years (<2012)	TBD	TBD			
3.2	II	CIP Implementation	Unidentified Stormwater Projects in Basin 2	TBD but based on prioritization should be in **first** 5 years (<2012)	TBD	TBD			

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
3.3	**III**	**CIP Implementation**	**Stormwater Projects in Basin 3**	**Based on existing report**	**CDM 2001 #10.11**	**See Breakout Below**			
3.3.1	III	CIP Implementation	Construction of Stormwater Projects in Basin 3 - Phase 1 Improvements	Phase 1 of the Program - loosely follows Alt. #3, but with modifications, and covers 65% basin area. Does not include PS improvements. Design plans and permits completed by City staff. Original cost estimate by CDM - $6,800,000.	CDM 2001 #10.11	$ 3,770,000	2001	$ 4,606,940	
3.3.2	III	CIP Implementation	Design & Permitting of Stormwater Projects in Basin 3 - Phase 2	Phase 2 of the Program to complete the Alternative #3 Recommendation. Design and permitting.	TBV	$ 182,700	2006	$ 182,700	
3.3.3	III	CIP Implementation	Construction of Stormwater Projects in Basin 3 - Phase 2 Improvements	Construction of Phase 2. Estimated cost not verified. Needs to be adjusted once design is completed.	TBV	$ 2,030,000	2001	$ 2,480,660	
3.3.4	III	CIP Implementation	Construction of Stormwater Projects in Basin 3 - Phase 3 PS and Treatment	Upgraded Pump Station and Water Quality Mitigation Projects ($1,000,000 for the PS and $2,000,000 for the mitigation based on 2001 CDM Report)	TBV	$ 3,000,000	2001	$ 3,666,000	**$ 10,936,300**
3.4	IV	CIP Implementation	Unidentified Stormwater Projects in Basin 4	TBD but based on prioritization should be in second 5 years (>2012)	TBD	TBD			
3.5	**V**	**CIP Implementation**	**Stormwater Projects in Basin 5**	**Based on existing report - TBD but should be in first 5 years. Cost includes design, permitting, and contingencies.**	**CDM 2005 #10.8**	**See Breakout Below**			
3.5.1	V	CIP Implementation	Add new pipe along 10th Ave. No. & 15th Ave. No.	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 926,900	2005	$ 963,049	
3.5.2	V	CIP Implementation	Add Parallel Storm Sewer Along 10th Street North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 454,480	2005	$ 472,205	
3.5.3	V	CIP Implementation	Add Parallel Pipe, Outfall from 6th Avenue North Pond	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 110,630	2005	$ 114,945	
3.5.4	V	CIP Implementation	Add Parallel Pipe along 8th Avenue North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 376,740	2005	$ 391,433	
3.5.5	V	CIP Implementation	Detention Improvements at 13th Street North Pond	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 44,850	2005	$ 46,599	
3.5.6	V	CIP Implementation	Pipe & detention improvements along 10th Avenue North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 412,620	2005	$ 428,712	
3.5.7	V	CIP Implementation	Add parallel pipe along 11th Street North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 128,570	2005	$ 133,584	

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
3.5.8	V	CIP Implementation	Add new pipe along 11th Street North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 263,120	2005	$ 273,382	
3.5.9	V	CIP Implementation	Add parallel pipe along 14th Avenue North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 91,195	2005	$ 94,752	
3.5.10	V	CIP Implementation	Pipe improvements along 12th Street North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 1,856,790	2005	$ 1,929,205	
3.5.11	V	CIP Implementation	Detention improvements at 15th Avenue North Pond	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 29,900	2005	$ 31,066	
3.5.12	V	CIP Implementation	Conveyance improvements adjacent to the mall	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 1,312,610	2005	$ 1,363,802	
3.5.13	V	CIP Implementation	Pipe improvements along Golden Gate Parkway	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 2,526,550	2005	$ 2,625,085	
3.5.14	V	CIP Implementation	Add parallel pipe along Golden Gate Parkway	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 421,590	2005	$ 438,032	
3.5.15	V	CIP Implementation	Pipe & detention improvements along Diana Ave / 10th Street N	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 4,323,540	2005	$ 4,492,158	
3.5.16	V	CIP Implementation	Replace existing pipe under Golden Gate Parkway	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 651,820	2005	$ 677,241	
3.5.17	V	CIP Implementation	Pipe improvements along Royal Palm Drive	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 754,975	2005	$ 784,419	
3.5.18	V	CIP Implementation	Add parallel pipe along Diana Avenue	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 254,150	2005	$ 264,062	
3.5.19	V	CIP Implementation	Replace existing pipe along 26th Avenue North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 168,935	2005	$ 175,523	
3.5.20	V	CIP Implementation	Pipe improvements along 28th Avenue North	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 1,532,375	2005	$ 1,592,138	
3.5.21	V	CIP Implementation	Add parallel pipe, outfall from 28th Avenue North Pond	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 61,295	2005	$ 63,686	
3.5.22	V	CIP Implementation	Add parallel pipe, outfall from 14th Street North Pond	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 134,550	2005	$ 139,797	

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
3.5.23	V	CIP Implementation	Weir modifications adjacent to Reach 03	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 22,975	2005	$ 23,871	
3.5.24	V	CIP Implementation	Replace existing pipe under Goodlette-Frank Road	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 420,095	2005	$ 436,479	
3.5.25	V	CIP Implementation	Widen existing channel sections along Reach 03	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 444,015	2005	$ 461,332	
3.5.26	V	CIP Implementation	Construct 27-acre SWMF along Reach 03	Based on Report recommendations and LOS recommendations as of 2005	CDM 2005 #10.8	$ 3,369,730	2005	$ 3,501,149	**$ 21,917,705**
3.6	VI	CIP Implementation	Stormwater Projects in Basin 6	TBD but based on prioritization should be in **first** 5 years (<2012)	CDM 1998 #10.7	$ 3,125,000	1998	$ 4,090,625	**$ 4,090,625**
3.7	VII	CIP Implementation	Stormwater design and permitting projects in Basin 7	TBD but based on prioritization should be in second 5 years (>2012)	Tetra Tech	TBD	2005		
3.8	VIII	CIP Implementation	Stormwater design and permitting projects in Basin 8	TBD but based on prioritization should be in **first** 5 years (<2012)	Tetra Tech	TBD	2005		
3.9	IX	CIP Implementation	Stormwater design and permitting projects in Basin 9	TBD but based on prioritization should be in second 5 years (>2012)	Tetra Tech	TBD	2005		
3.10	X	CIP Implementation	Stormwater design and permitting projects in Basin 10	TBD but based on prioritization should be in second 5 years (>2012)	Tetra Tech	TBD	2005		
3.11	XI	CIP Implementation	Stormwater design and permitting projects in Basin 11	TBD but based on prioritization should be in second 5 years (>2012)	Tetra Tech	TBD	2005		
3.12	XII	CIP Implementation	Stormwater design and permitting projects in Basin 12	TBD but based on prioritization should be in second 5 years (>2012)	Tetra Tech	$ -	2005	$ -	
3.13		**CIP Implementation**	**Stormwater Projects in Gordon River Extension**		**CDM/WM 2002 #10.14**	**See Breakout Below**			
3.13.1	VIII & XI	CIP Implementation	Gordon River Improvements (Alternative 1 with all 22 improvements)	Cost includes design, permitting, and contingencies	CDM/WM 2002 #10.14	$ 7,063,000	2002	$ 8,517,978	$ 8,517,978
4.1	all	R&R Implementation	Water quality swale & stormwater drainage facility reconstruction	10-year projection based on $195,000/year average	Naples 2006	$ 1,950,000	2006	$ 1,950,000	

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
4.2	all	R&R Implementation	Reconstruct drainage inlets (safety, lost capacity, & filter	10-year projection based on $220,500/year average	Naples 2006	$ 2,205,000	2006	$ 2,205,000	
4.3	all	R&R Implementation	Citywide storm sewer system repair & replacement projects	10-year projection based on $100,000/year average	Naples 2006	$ 1,000,000	2006	$ 1,000,000	
4.4	all	R&R Implementation	Outfall storm drain pipe slip lining & replacement	10-year projection based on $200,000/year average	Naples 2006	$ 2,000,000	2006	$ 2,000,000	
4.5	VII	R&R Implementation	Royal Harbor Water Quality Swales (Elimination of paved point discharge outfall swales)	Under a current grant application for $60,000. Assumes $103,500/year average City contribution	Naples 2006	$ 1,035,000	2006	$ 1,035,000	$ 8,190,000
5.1	all	O&M Implementation	Survey/log actual flood complaints	City's current annual budget for items 5.1 through 5.4 consists of approximately $250k in staff salary plus benefits = $350k. Over ten years = $3.5M. Plus materials and equipment assume total at $4M. Items 5.1 through 5.4 are assumed to use the budget in the following percentages, respectively (10%, 35%, 40%, and 15%)	Staff 2007	$ 400,000	2007	$ 400,000	
5.2	all	O&M Implementation	Inspection and cleaning structures and culverts		Staff 2007	$ 1,400,000	2007	$ 1,400,000	
5.3	all	O&M Implementation	maintenance of canals and ditches		Staff 2007	$ 1,600,000	2007	$ 1,600,000	
5.4	all	O&M Implementation	retention ponds and water bodies		Staff 2007	$ 600,000	2007	$ 600,000	
5.5	TBD	O&M Implementation	Maintenance of Pump Stations and force mains	Annual ongoing program $20,000/year salary and benefit. Plus materials and equipment, assume $30k total. Over ten years use $300k	Staff 2007	$ 300,000	2007	$ 300,000	
6.2		O&M Implementation	TMDL Programs	Annual water sampling program - Natural Resources (Staff + Lab)	Staff 2007	$ 250,000	2007	$ 250,000	
6.3		O&M Implementation	NPDES Programs	illicit discharge detection and elimination, construction site runoff control (Staff + Lab)	Staff 2007	$ 150,000	2007	$ 150,000	
5.6	all	O&M Implementation	Pollution prevention and good housekeeping. NPDES Phase II Stormwater Public Education & Public Outreach Control Measure			$ 100,000	2006	$ 100,000	$ 4,800,000
6.1		**Special Water Quality Initiatives**	**SWIM Programs**			**See Breakout Below**			
6.1.1		Special Water Quality Initiatives	Stormwater Management - Broad Ave. Linear Park & Filter Marsh	CDM under contract and managed by Construction Management	SFWMD 2006 #10.19	$ 4,200,000	2007	$ 4,200,000	
6.1.2	III	Special Water Quality Initiatives	Cove Pump Station / Naples bay Outfall Detention Water Quality Basin	Conceptually discussed in Basin III Report, not under preliminary engineering at this time	Naples 2006 #10.6	$ 1,800,000	2006	$ 1,800,000	

Table 3.4-2 10 Year Integrated Stormwater Management Program Summary

ID #	City Basin	Category	Description of Program or Purchase	Status of Program or Purchase	Cost Reference Source	Opinion of Probable Cost $	Year of Cost	Adjusted Opinion of Cost $	Subtotal $
6.1.3		Special Water Quality Initiatives	Stormwater Management - Goodlette Frank Road Water Quality Greenway	Needs verification	Naples 2006 #10.6	$ 2,600,000	2006	$ 2,600,000	$ 8,600,000
					TOTALS	$ 65,135,400		$ 70,332,308	

Notes:

1 The costs provided for this inventory listing are as presented from various reports based on the dates provided and as cited herein. Cost for construction and professional fees have been adjusted at the average annual rates as published by ENR. See values listed below.

2 TBD - To Be Determined. TBV - To Be Verified. Typically no cost estimate will be given when either of these acronyms are shown. If a cost estimate is provided next to one of these acronyms then, consider the value to be an order of magnitude value that should be adjusted when better information is available. In these instances, the estimated order of magnitude value shown is to act as a numerical place holder.

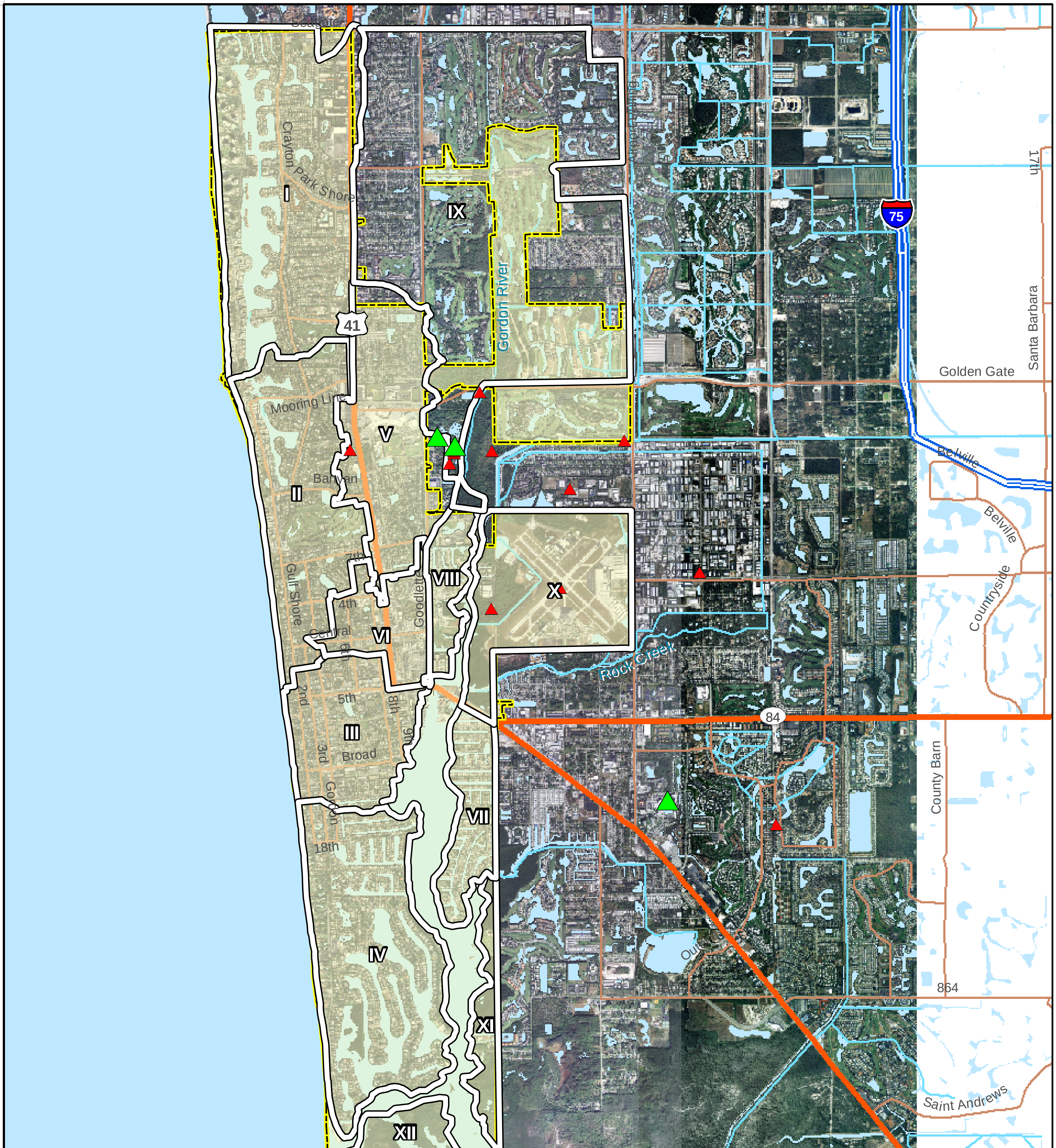
1996	1.416
1997	1.330
1998	1.309
1999	1.279
2000	1.246
2001	1.222
2002	1.206
2003	1.183
2004	1.097
2005	1.039
2006	1.000
2007	1.000

In general, we have identified the most significant projects and/or project needs as follows:

- Completion of individual drainage basin studies.
- Construction and implementation of CIP projects for Basin III.
- Construction and implementation of CIP projects for Basin V.
- Re-evaluation of LOS for Basin VI and (if needed), construction and implementation of additional CIP projects for Basin VI.
- City-wide wet detention treatment retrofit master plan.
- City-wide swale restoration program (R&R activities as well as CIP).
- Basin to gulf outfall culvert relocation and/or modification study.
- Participation in various Naples Bay off-site freshwater diversion projects.
- Participation in Naples Bay ecological and environmental restoration initiatives and the SWIM Program.
- Participation in City-wide retrofit water quality treatment initiatives (such as, the filter marshes and Naples Bay Treatment Facility.
- Completion of CADD/GIS inventory conversion.
- Construction and implementation of the Gordon River Extension CIP projects.

3.5 HYDROLOGIC DATA

Hydrologic data has also been compiled from various reports and sources. We have compared the various reports available to determine where rainfall data has been collected for use in the various hydrologic studies affecting the City. This rainfall data has been used, for instance, to calibrate various models and assess the Level of Service (LOS) provided by drainage facilities and structures. Figure 3.5-1 provides a layer of data giving the location of the most commonly used rainfall gathering and recording stations as cited in the various reports used to date. Most of these stations provide very detailed rainfall information but only during limited periods of time.



Source: SFWMD DBHYDRO database, Collier County 2005 Aerials

LEGEND

City of Naples City Limits

Basins I - XII

SFWMD Rain Monitoring Stations

Active

Inactive

N

0 1 Miles

TETRA TECH HAI
Infrastructure Offices Throughout Florida
Orlando • Fort Myers

SFWMD RAIN MONITORING STATIONS
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE 3.5-1

TT8.5X11P_EX250\G\SIS\NAPLES\03000 9016-SWmaps\report_1st\APIF3.5-1.mxd [12-29-06 bam]

3.5.1 NOAA Rainfall Data

We have included with this Master Plan Update the National Oceanic and Atmospheric Administration (NOAA) rainfall data. Historically that data was collected at an unnamed rainfall data collection station, located at 26°10′N Latitude and 81°43′W. Starting in 2002 they also began collecting data at the Naples Municipal Airport. We show both for an easy reference. Note that the data exists for the years 1985 through 2006 and there are several years where the annual sets are missing data. Annual totals are not available in those select years where data is missing. See Table 3.5.1-1.

The average rainfall of the complete record years shows an annual expectation of **54.9** inches per year in Naples. The highest recorded rainfall was 74.6 inches in 2003 and the lowest total was 34.2 inches in 1996. Although the typical rainy season months of the summer (June through September) normally have 8 to 9 inches of rainfall, there have been a few record months that have inundated the City with over 20 inches of rain in one month.

Table 3.5.1-1 Summary of Naples NOAA Rainfall Data from 1985 to 2006

							Rainy Season							
Year	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	Naples	0.83	0.90	1.55	2.41	0.71	6.77	21.49	5.30	9.78	5.28	2.66	0.89	58.57
1986	Naples	1.75	1.94	2.44	0.80	4.98	9.46	3.79	7.77	7.61	5.24	2.11	3.14	51.03
1987	Naples	2.13	2.19	8.12	0.14	8.34	7.50	6.54	5.77	3.63	7.06	6.60	0.19	58.21
1988	Naples	1.08	0.99	2.58	0.16	1.30	2.31	8.66	9.55	6.25	0.84	1.70	0.35	35.77
1989	Naples	0.84	0.09	1.40	4.55	0.91	10.86	11.48	9.37	10.07	4.59	0.32	2.37	56.85
1990	Naples	0.09	2.21	0.84	2.77	4.62	10.17	5.69	2.17	7.39	5.13	1.06	0.07	42.21
1991	Naples	9.40	2.11	1.86	2.92	10.70	MD*	14.15	MD*	MD*	MD*	MD*	0.37	N/A
1992	Naples	0.49	3.69	2.65	2.55	0.91	10.94	7.90	9.22	8.27	0.69	0.57	0.06	47.94
1993	Naples	7.66	3.93	2.13	2.25	2.97	6.71	9.19	11.72	3.57	6.87	0.52	0.59	58.11
1994	Naples	1.56	1.67	1.11	1.21	0.93	10.86	11.30	7.49	9.46	3.79	2.54	3.58	55.50
1995	Naples	4.35	1.74	0.75	3.48	3.98	10.38	MD*	MD*	10.90	15.98	0.59	MD*	N/A
1996	Naples	2.10	0.01	1.72	1.71	6.20	2.74	2.60	5.56	3.58	7.40	0.26	0.30	34.18
1997	Naples	1.04	0.36	4.04	7.73	4.52	8.42	6.36	4.23	3.36	2.30	3.85	6.28	52.49
1998	Naples	1.52	6.09	2.52	0.66	3.92	5.43	7.58	6.18	11.57	4.34	6.63	1.75	58.19
1999	Naples	1.52	1.15	0.70	0.37	5.10	9.81	9.15	5.96	13.64	1.94	2.17	0.41	51.92
2000	Naples	0.72	MD*	1.21	1.35	1.83	5.81	5.68	10.79	9.95	0.25	0.21	1.01	38.81
2001	Naples	1.06	0.01	1.59	0.30	MD*	6.94	12.45	11.71	20.84	6.24	0.20	2.76	64.10
2002	Naples MAPR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.28	2.05	3.19	2.70	N/A
	Naples	3.42	1.94	1.44	2.43	4.49	11.87	7.87	9.30	12.96	2.14	4.18	2.84	64.88
2003	Naples MAPR	2.45	0.79	4.90	4.34	3.38	11.71	8.93	9.92	17.22	1.28	4.08	2.12	71.12
	Naples	3.00	1.07	3.03	2.78	5.27	11.12	11.19	13.43	16.45	1.11	3.21	2.97	74.63

Table 3.5.1-1 (Continued) Summary of Naples NOAA Rainfall Data from 1985 to 2006

							Rainy Season							
Year	**Location**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
2004	Naples MAPR	3.16	3.54	0.14	2.78	0.64	5.18	7.61	9.78	3.22	1.82	1.02	1.28	40.17
	Naples	3.14	3.67	0.08	1.53	2.47	9.95	10.90	12.80	5.33	2.79	0.96	2.11	55.73
2005	Naples MAPR	0.71	0.99	5.22	1.61	1.46	21.06	6.27	4.60	5.49	13.74	2.08	0.17	63.40
	Naples	1.38	1.02	5.92	1.75	0.98	20.51	9.08	7.47	9.14	5.34	2.98	0.49	66.06
2006	Naples MAPR	0.56	3.21	0.08	0.00	MD*	MD*	MD*	MD*	MD*	MD*	MD*	MD*	N/A
	Naples	0.27	0.80	0.05	0.00	MD*	MD*	MD*	MD*	MD*	MD*	MD*	MD*	N/A
1985-2005 Avg.	-	2.31	1.83	2.41	2.19	3.50	9.41	8.95	8.19	9.21	4.51	2.24	1.62	54.85
NOAA Record High:	-	9.40	6.09	8.12	7.73	10.70	21.06	21.49	13.43	20.84	15.98	6.63	6.28	74.63
NOAA Record Low:	-	0.09	0.01	0.05	0.00	0.64	2.31	2.60	2.17	3.22	0.25	0.20	0.06	34.18

3.5.2 Other Rainfall Data

Rainfall data also has been provided for numerous design documents at varying return frequencies. One should be careful in that the anticipated rainfall depths for various storm events have typically increased as more data becomes available. Thus, the older rainfall references tend to provide lower estimates. We have reviewed numerous sources. (See Reference # 10.1, 10.2, 10.3, 10.24, 10.25, and 10.26). Newer publications such as SFWMD (TNP 03/06/06) 86-6 should be used over older sets when the desired storm event is available. Table 3.5.2-1 summarized many storm events where data was found and the most recent report providing the data (when available).

Table 3.5.2-1 Comparison of Rainfall to LOS Storm Event

LOS Storm Event - Equivalent Rainfall					
Return Frequency Storm (yrs) and Duration (hrs)					
Storm Event	**Rainfall (in)**	**Storm Event**	**Rainfall (in)**	**Storm Event**	**Rainfall (in)**
1 Yr - 1 Hr	2	5 Yr-1 Hr	2.9	100 Yr - 1 Hr	4.7 (ref. 10.2)
1 Yr - 24 Hr	3.8	5 Yr-24 Hr	6.6	100 Yr - 24 Hr	12
1 yr - 72 Hr	Unknown	5 Yr-72Hr	7.7 (ref. 10.3)	100 Yr - 72 Hr	13.2 (ref. 10.3)
2 Yr - 1 Hr	2.4 (ref. 10.2)	10 Yr-1 Hr	3.2		
2 Yr - 24 Hr	4.7	10 Yr-24 Hr	8		
2 Yr - 72Hr	5.8 (ref. 10.3)	10 Yr-72 Hr	8.8 (ref. 10.3)		
3 Yr - 1 Hr	Unknown	25 Yr-1 Hr	3.7		
3 Yr - 24 Hr	5.2	25 Yr-24 Hr	9.2		
3 yr - 72 Hr	Unknown	25 Yr-72 Hr	10 (ref. 10.3)		

❖ Source of Data: All rainfall amounts interpolated for the Naples area from Reference #10.1 and #10.15 (which uses #10.24, 10.25, and 10.26), except as noted above from Reference #10.2 and 10.3.

3.5.3 Tidal Data

Tidal information has been gathered and studied intensively in various studies by CDM to date (See Reference # 10.7, 10.8, 10.10 & 10.11). Table 3.5.3-1 below provides a useful summary of the results presented in various reports.

Table 3.5.3-1 Summary of High Tide Elevations

Stillwell Elevation (NGVD)	Return Frequency (Years)
2.7	1/12 (average month)
3.2	1
4.1	10
4.9	25
5.0	Highest Observed Tide (12/21/1972)

SECTION 4

ASSESSMENT OF LEVEL OF SERVICE METHODOLOGY

4.1 SUMMARY OF EXISTING STUDIES

The City hired consultants to analyze the Level of Service (LOS) in the existing drainage infrastructure several times in the past sixteen (16) years. Unfortunately, there has been differing methods used to measure and evaluate LOS. The problem with these inconsistencies is that capital budgets should be based on recommendations that compare equitable remediation. The cost benefit ratios of these decisions should be based upon consistent improvement expectations.

For example, one report may recommend a solution to improve the flooding at an intersection by lowering the anticipated flood elevation in the street by six inches based on a 2-year/24-hour duration storm. Whereas, another report may recommend similar improvements provide the public with complete flood reduction at an intersection based on a storm event that occurs once every 10 years. The amount of rainfall occurring in each of these scenarios is quite different. The public will receive two very different levels of service – a solution that allows the problem to reoccur once every 2-years versus once every 10-years. Ironically, although the problem occurs five times more often in the 2-year scenario, the actual rainfall increase in examining the 10-year case is less than double. Thus, the ten year design LOS treats a little less than twice the amount of rainfall but reduces the return interval of the flooding by five times.

Costs of projects often increase dramatically as the LOS provided by the improvements increases. Thus, there is an optimum cost to benefit for each retrofit solution. Often with the tailwater-tidal caused flooding problems, the costs to retrofit higher LOS have cost to benefit ratios that are prohibitive.

Table 4.1-1 gives a summary of the LOS determinations provided in each of the reports examined and summarized in this Stormwater Master Plan Update. Previously, Table 3.5.2-1 provided an estimation of how these different LOS standards relate to actual rainfall amounts.

Table 4.1-1 Summary of LOS Determinations Made Based on Storm Event Criteria

Year	Study or Master Plan Information Source	Project Description	Duration Storm Return Frequency Storm (yrs)						
			1	2	3	5	10	25	100
1990	CDM 1990 (Ref # 10.15)	Performed a preliminary LOS analysis for Basin III	24 hr		24 hr	24 hr	24 hr		
1996	Naples 1996 (Ref # 10.10)	Introduced ABCD rating system and suggested Comp Plan storm performance criteria exceeding actual performance in Old Naples for new development				1 hr			24 hr
1998	CDM 1998 (Ref # 10.7)	Analyzed LOS Basin VI		24 hr		24 hr	24 hr	24 hr	24 hr
2001	CDM 2001 (Ref # 10.11)	Analyzed LOS Basin III		24 hr		24 hr	24 hr	24 hr	24 hr
2002	WM/CDM 2002 (Ref # 10.14)	Analyzed LOS of Gordon River				24 hr	72 hr	72 hr	72 hr
2004	CDM 2004 (Ref # 10.8)	Analyzed LOS Basin V.				24 hr	72 hr	72 hr	72 hr
2006	Naples 2006 (Ref # 10.6)	Master Plan Update describes Adopted Comp Plan requirements.				1 hr			24 hr

4.2 EXISTING REQUIREMENTS

The actual requirements for performing a LOS determination is typically guided by the City's Adopted Comprehensive Plan which provides goals and objectives for establishing what public performance is acceptable for a drainage infrastructure service. Many Comprehensive Plans are focused on the criteria that "new development" and new pubic infrastructure projects should meet and are not often in line with what a City can actually provide in older areas of the City that were constructed before they understand the physiographic, topographic, and hydrologic constraints of their community. It appears that the City of Naples attempted to lower the bar on the LOS determinations to goals that were more in keeping with what could be provided. Although the original Comprehensive Plan was reported to be based on providing a LOS rating of "C", based on 25-year/72-hour storm (see Reference # 10.10 Table 6.3.1 for history). The actual adopted Comprehensive Plan from January 21, 1998 gives the following LOS expectations:

4.2.1 Water Quantity (Flood Control)

All development, redevelopment, and primary drainage systems (roadways, yard drainage, stormwater pump stations and drainage trunk lines) are to be designed to meet the acceptable LOS standard during a **5-year/1-hour storm event**. In the case of protecting building structures, the flood protection criteria is based on keeping a building free from flooding during a **100-year storm event**. The duration of the storm was not specified in the Comprehensive Plan but is presumed to be the 24 hour duration in keeping with typical state and federal practices.

We also note that CDM researched this topic extensively and presented their recommendations to the City Council on February 24, 1992 (see Reference #10.33). They recommended the LOS standard be the 5-year/24-hour storm event.

4.2.2 Water Quality (Pollution Abatement)

Construction projects (development or redevelopment) are required to meet a LOS for water quality that essentially references the pollution abatement standards set forth in the SFWMD Basis of Review Manual (see Reference 10.17) which matches the rainfall treatment volume to the selected Best Management Practice (BMP) technique utilized (such as wet detention, dry detention, and retention). The criteria in the Adopted Comprehensive Plan is written with minimal detail while trying to follow the intent of SFWMD criteria. For convenience, we have provided the additional detail that SFWMD provides in their rule.

Retention, detention, or both retention and detention in the overall system, including swales, lakes, canals, greenways, etc., shall be provided for one of the three following criteria of equivalent combinations thereof:

Wet detention volume shall be provided for the first inch of runoff from the developed project, or the total runoff of 2.5 inches times the percentage of imperviousness, whichever is greater.

Dry detention volume shall be provided equal to 75 percent of the above amounts computed for wet detention.

Retention volume shall be provided equal to 50 percent of the above amounts computed for wet detention. Retention volume included in the flood protection calculations requires a guarantee of the long-term operation and maintenance of system bleed-down ability. Examples of such guarantee include evidence of excellent soil percolation rates, such as coastal ridge sands, or an operations entity which specifically reserves funds for operation, maintenance and replacement (example: Orange County MSTU).

Systems with inlets in grassed areas are credited with up to 0.2 inches of the required wet detention amount for the contributing areas. Full credit is based no a ratio of 10:1 impervious area (paved or building area) to pervious area (i.e. the grassed area) with proportionately less credit granted for greater ratios. In addition, commercial and industrial land uses are required to provide as a minimum, at least 0.5 inch of dry retention of treatment in order to ensure a higher presumption of pollution reduction since those land uses typically generate the most pollutant loads.

4.2.3 Summary of Past Recommendations

According to our review of the City's 1996 Stormwater Master Plan (Reference # 10.10) and the Draft 2006 Stormwater Master Plan Draft (Reference # 10.6), both prepared by the City, the City has proposed a number of revisions to the LOS criteria as summarized in Table 4.2.3-1 with the existing criteria below:

Table 4.2.3-1 Summary of Past LOS Criteria Recommendations

Agency	Roadway Drainage	Roadway Centerline	Swales	Drainage System and Outfalls	Flood Protection Structures	Water Quality
Existing Comprehensive Plan (1996) (From Ref # 10.10)	25 Yr., 72 Hr.; LOS C	25 Yr./ 72 Hr.; LOS C	None	None	Not Listed	Wet Detention 1st. 1" or 2.5" X % Imp. Dry Detention Wet Det. X 75%, 1" Min. Retention Wet Det. X 50%, 1" Min.
Proposed LOS for analysis (1992) Ref. # 10.33	--	5 Yr./ 24 Hr.	--	--	--	Same
Proposed Comprehensive Plan Revision (1996) (From Ref # 10.10)	10 Yr./ 24 Hr. (new development) 5 Yr., 24 Hr. (vested)	25 Yr./ 72 Hr.	Refer to Water Quality Criteria	25 Yr./ 72 Hr.	100 Yr./ 72 Hr.	Same
Existing Comprehensive Plan (Adopted 1998) (From Ref # 10.5)	5 Yr./ 1 Hr.	N/A	None Given	5 Yr./ 1 Hr.	100 Yr.	Same
Proposed Comprehensive Plan Revision from Draft Report 2006 (From Ref # 10.6)	See Tables 6.3.1 and 6.5.1 of the original City Draft Report (Missing in the copy provided to us).					No Changes Proposed

4.3 RECOMMENDED RECONCILIATION AND IMPLEMENTATION

In this section, we provide our recommended reconciliation of the LOS methodologies and the steps necessary to implement those recommendations.

4.3.1 Reconciliation of Methodologies

In review of the various LOS storm events used in the exiting drainage studies, it appears that none of the evaluations performed to date are actually in accordance with the City's Adopted Comprehensive Plan Criteria. Although each drainage basin evaluation and master plan modeled the 5-year storm, none modeled the actual duration of 1-hour specified in the Comprehensive Plan. They all used 24 hours which is a more severe event in terms of total rainfall. We note however, that the 2.9 inches of rain in the 5-year/1-hour storm is still a very intense storm since all the rainfall is in only 1 hour. The limitation on this event is that it does not consider total volume impacts from longer durations. Notice in Table 3.5.2-1 that the rainfall from a 5-year/24-hour event is more than double the 5-year/1-hour storm. In addition, it appears that most evaluations were based on trying to accomplish a far better LOS than the 5-year/1-hour. As a result, we see alternatives selected based on performance of the improvements in 5-year, 10-year, and 25-year return frequency storm events of varying durations from 24-hours to 72-hours.

We also note that the City staff attempted to create a tiered LOS approach to stormwater management based upon the recommendations of the 2006 Draft Master Plan and previous methodology prior to 1996. The tiered approach is an excellent method since it allows the specification of both the most practical **storm event** (5-year/24-hour, 25-year/72-hour, etc.) for a particular infrastructure facility (local roadway, collector roadway, retention pond, culvert, inlet, etc.) and a **rating class** for the actual services being provided (i.e. A, B, C, D, or F). The City staff also recognized the need to further separate LOS standards for new development from existing vested systems which are inherently problematic.

Considering the methodology differences above and the amount of funds required to improve flooding conditions in the older areas of the City, it is clear that a consistent LOS criteria for comparing the effectiveness of retrofit improvements needs to be set at a useable level. "New development" can, however, be expected to uphold a higher level of performance than retrofit projects since they have the benefit of knowing what the problematic hydrologic conditions are. For an example, houses in a subdivision already constructed six (6) feet below the predicted 100-year flood elevation are not easily modified to meet today's acceptable LOS standard for protecting the finished floors of those structures. A new subdivision, however, can construct the new roads, utilities, and homes and the correct elevations by using fill and other flood proofing techniques. Therefore, we recommend the following LOS standards separate into the categories as shown in Table 4.3.

Table 4.3 Recommended LOS Criteria for City of Naples Stormwater Management Systems

Public Street Criteria				
LOS	Storm Event / Description of LOS	Approximate Rainfall Depth (in.) (See Table 4.1-2)	New Construction Goals	"Retrofit" Minimum Goals
A	25 Year / 24 Hour; No Flooding at Crown	9.2	Arterial	-
B	10 Year / 24 Hour; No Flooding at Crown	8.0	Collector	Arterial
C	5 Year / 24 Hour; No Flooding at Crown	6.6	Local Road	Collector
D	2 Year / 24 Hour; No Flooding at Crown	4.7	Unacceptable	Local Road
E	1 Year / 24 Hour; No Flooding at Crown	3.8		Unacceptable
F	Chronic Failure	2.5		

Building Criteria				
LOS	Storm Event / Description of LOS	Approximate Rainfall Depth (in.) (See Table 3.5.2-1)	New Construction Goals	"Retrofit" Minimum Goals
A	At -or- Greater than 100 Yr. / 72 Hr. -or- 12" above 100 Yr. / 24 Hr. (1 Foot Freeboard)	13.2	Goal met	Goal met
B	At -or- 12" above 100 Yr. / 24 Hr. (Encroaching Freeboard)	12.0	Unacceptable	
C	FFE At or Above 25 Yr. / 24 Hr.	9.2		Unacceptable
D	FFE At or Above 10 Yr. / 24 Hr.	8.0		
E	FFE At or Above 5 Yr. / 24 Hr.	6.6		
F	Repetitive Failure	5.0		

Water Quality Criteria			
LOS	Storm Event / Description of LOS	New Construction Goals	"Retrofit" Minimum Goals
A	Exceeds SFWMD criteria for BMP -or- meets OFW Class II Waters - Presumed Treatment Efficiency = 95%	Goal for Class II Waters / OFW	Goal: Best that can be achieved
B	Meets 100% SFWMD criteria for BMP Class III Waters - Presumed Treatment Efficiency = 85%	Goal for Class III Waters	
C	Meets 75% SFWMD criteria for BMP Class III Waters - Presumed Treatment Efficiency = 75%	Unacceptable	
D	Meets 50% SFWMD criteria for BMP Class III Waters - Presumed Treatment Efficiency = 50%		Unacceptable
E	Meets 25% SFWMD criteria for BMP Class III Waters - Presumed Treatment Efficiency = 30%		
F	Meets 0% SFWMD criteria for BMP Class III Waters - Presumed Treatment Efficiency = 0%		

<table>
<tr><th colspan="4">Stormwater Management Facilities</th></tr>
<tr><td colspan="4">Facilities include: Retention Swales, Wet Detention Lakes, Retention Ponds, and Dry Detention Ponds</td></tr>
<tr><th>LOS</th><th>Storm Event / Description of LOS</th><th>New Construction Goals</th><th>"Retrofit" Minimum Goals</th></tr>
<tr><td>A</td><td>Meets pre-developed peak rate with post-developed outflow hydrograph for 25-year/24-hour storm with 1-ft. freeboard or 25-year/72-hour storm with no freeboard</td><td>Goal</td><td rowspan="2">Goal: best that can be achieved</td></tr>
<tr><td>B</td><td>Meets pre-developed peak rate with post-developed outflow hydrograph for 10-year/24-hour storm with 1-ft. freeboard or 10-year/72-hour storm with no freeboard</td><td rowspan="5">Unacceptable</td></tr>
<tr><td>C</td><td>Meets pre-developed peak rate with post-developed outflow hydrograph for 5-year/24-hour storm with 1-ft. freeboard or 5-year/72-hour storm with no freeboard</td><td rowspan="4">Unacceptable</td></tr>
<tr><td>D</td><td>Attenuation provided by less than 5-year storm but more than incidental pollution abatement volume</td></tr>
<tr><td>E</td><td>Attenuation provided by pollution abatement volume only.</td></tr>
<tr><td>F</td><td>No attenuation provided</td></tr>
</table>

We note, however, that retrofit goals are not always obtainable. This is particularly true with existing homes built too low in the FEMA coastal surge floodplain. It is impossible to meet the Finished Floor flooding goal of an existing structure situated five feet below the flood. We recommend that problematic homes be handled separately form the Basin Studies and pursue FEMA grant money for flood proofing, elevation, reconstruction, or demolition. There are numerous grants and programs for such problematic structures. These problem structures will be discussed in more detail in Section 5.4.

4.3.2 Implementation

Numerous times, staff and/or consultants have recommended revisions to the Comprehensive Plan and/or Development Codes to improve the City's Stormwater Management. In Section 7.4, we will discuss our recommended modifications. The implementation of these modifications is normally performed by Development Services with technical input from the Public Works staff. Since many of the recommendations have been suggested in the past but not implemented, we recommend that the LOS modifications become a priority for implementation as part of the Stormwater Master Plan Update.

SECTION 5

ASSESSMENT OF WATER QUANTITY ISSUES (FLOODING)

In this section we assess: the status of protecting the public from flooding first by examining the FEMA flood plain program; then by reviewing the types of flooding problems in the City; followed by a review of the actual hydraulic modeling of various storm events within the drainage basins of the City. The worst structural flooding problem areas will be discussed as the final section.

5.1 FEMA FLOODPLAIN EVALUATION AND ISSUES

The City of Naples is covered by federal floodplain mapping by the Federal Emergency Management Agency (FEMA) in a series of maps referred to as (Federal Insurance Relief Maps (FIRMs). The exact panels that cover the entire city limits are listed as follows:

- 12021C0379G 11/17/2005
- 12021C0383G 11/17/2005
- 12021C0385G 11/17/2005
- 12021C0387G 11/17/2005
- 12021C0391G 11/17/2005
- 12021C0392G 11/17/2005
- 12021C0393G 11/17/2005
- 12021C0394G 11/17/2005
- 12021C0581G 11/17/2005
- 12021C0583G 11/17/2005

The latest panels that cover the City were modified and made effective as the date **November 17, 2005**. Upon review of these panels we note that nearly the entire City is affected by floodplains. Because the City is a coastal community in an area of rapid development activity, all of the City limits have been studied in some detailed manner establishing base flood elevations throughout the entire City limits.

It should be noted when we discuss the potential depth of "floodplain" flooding relative to an area, and/or the band of base flood elevations provided on the FIRM panel, that these comparisons are based on the following:

1. Relative differences in natural ground elevations and flood elevations. Thus, if a building structure or a lot has been raised above the historic grade, it is protected by as much fill as was imported to raise the structure above the floodplain.

2. The assumptions are based on broad topographic interpretations, not site specific data.

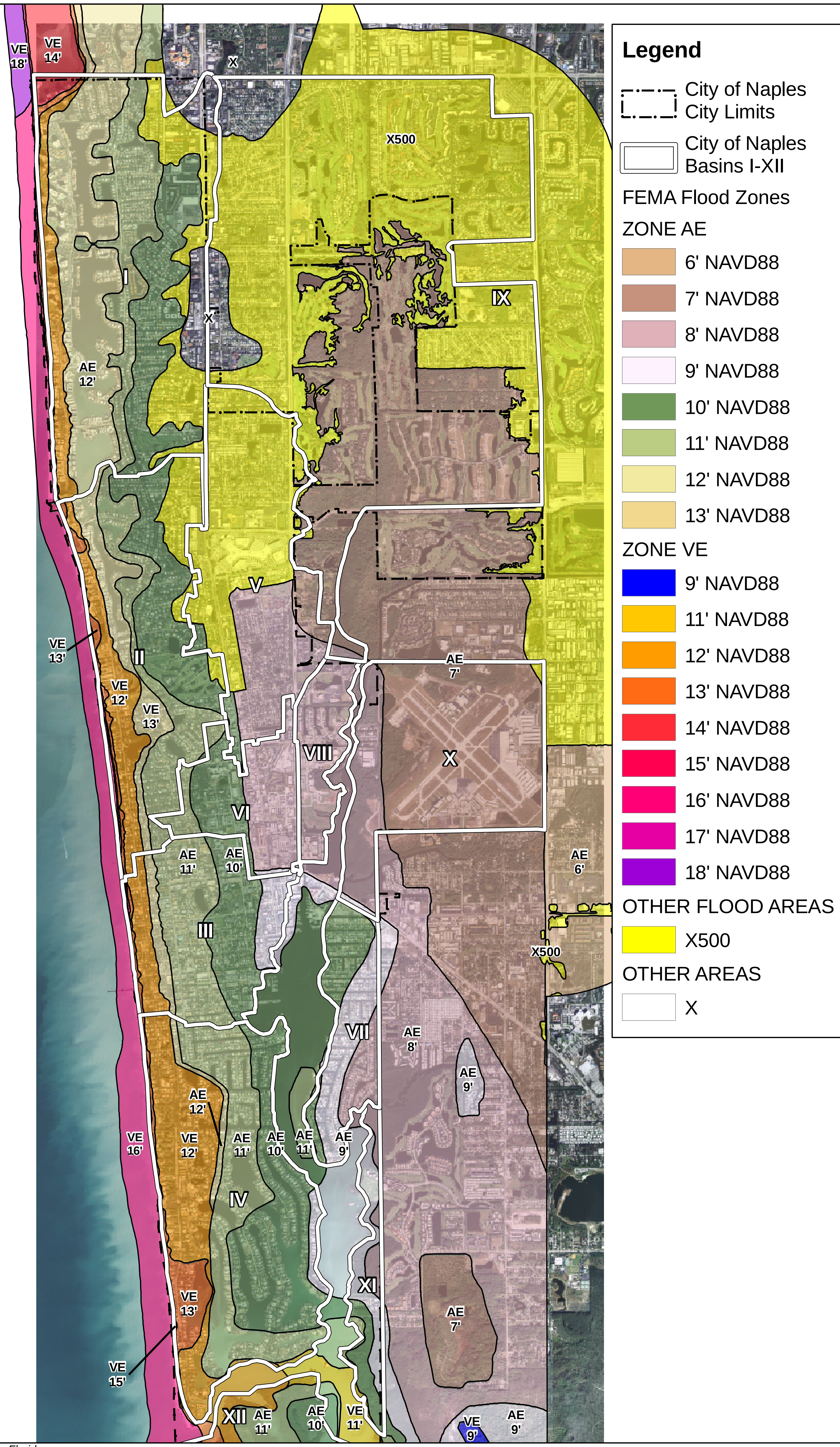
3. The floodplain elevations are based on FEMA approved modeling of a theoretical 100-year design storm event, not an actual event that occurred.

Thus, the generalizations discussed in this section are for overall understanding of floodplain management, not for specific analysis of any given area. The information has been compiled and one convenient Figure for reference and added to the overall GIS database for future use. See Figure 5.1-1.

5.1.1 Coastal Floodplains (VE)

A significant floodplain zone covering all of the western most portions of the City is the coastal flood designation where a velocity hazard is expected (wave action). These zones are shown as "VE" zones. Specific anticipated flood elevations are provided based on a storm event with an expected return frequency of 100 years. This is the floodplain that is caused by the tropical storm surge that occurs from hurricanes or other large tropical storms.

FEMA recognizes that the coastal floodplain affecting the coast of Naples is anticipated to produce a surge elevation of sixteen (16) feet above mean seal level (MSL). Just north of the City limits, FEMA predicts a tidal surge elevation of an even higher potential, with the maps showing a VE zone of 18' MSL. The primary foredune that runs along the coastline of Naples is inadequate in height to protect the City from tropical storm surge since the dune only reaches elevations in the magnitude of five (5) feet above sea level. In some coastal communities on the east coast, the primary foredune actually prevents the surge from penetrating deep into the upland territory of the community. In the case of Naples, the surge drives eastward affecting



Source: FEMA FLOOD DATA 2005; Naples, Florida

N

0 3,200 Feet

TETRA TECH HAI
Infrastructure Offices Throughout Florida
Orlando • Fort Myers

SUMMARY OF FEMA FLOODPLAIN ZONES AND DESGINATIONS
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE 5.1-1

TT11X17PEW_\\haiorlsfs4\fs4\GIS_proj\N\NAPLES\030009016-SW\maps\report_1st_BPQF5.1-1.mxd [12-26-06 amm] much property with velocity hazards. Since the elevation of the land is very low near the beach, the flooding depth (over natural ground) during the storm event is greater than ten feet deep and as high as 14 feet on the beach.

The small dune does, however, cause the wave action to lose energy rapidly as it extends inward and the flood elevations decrease rapidly. There are a very thin band of flood zones with anticipated base flood elevations just east of the VE=16 Zone. This band provides a drop in base flood elevations from elevation 15 down to 13 (three feet drop), and the width of the entire band that they occupy is no more than about 200 feet wide (corresponding to the wave action over the foredune area). This band is completely west of Gulf Shore Blvd. The lone exception is in the area of the western most bay off of Gordon Pass (Drainage Basin IV) which is predicted to layout a widened VE=13 band encompassing the finger bay at that specific location. Since most of the City in this areas is at elevation 3 to 8, one would expect that the depth of flooding (over natural ground) to continue to be as deep as 5 to 10 feet within this band.

East of this series of thin VE bands begins a series of wider wave action bands where the tidal surge head is more slowly dissipated over a larger land mass area. The first VE contour, VE=12 averages over 800 feet wide and varies in width from 400 to 2000 feet wide. This band, in general, occupies the area of Gulf Shore Blvd. The next band to the east predicts where the energy of the tidal surge decreases to an extent where the flooding is no longer associated with velocity hazards. The next bands to the east are downrated to "AE" zones which are discussed in the next sub-section in more detail.

There is only one other area in the City limits that has a VE zone designation and that is the area south of Naples Bay and Gordon Pass that becomes the mouth of Dollar Bay. Here the Zone VE energy decreases once again to a base flood elevation of 11 feet MSL. This is the lowest floodplain contour in the City Limits that contains a velocity hazard and it does not "band" adjacent to the other VE contours. The depth of flooding above natural ground in these last few VE bands would vary from about 3 to 8 feet deep in a 100-year return frequency storm event.

5.1.2 Riverine and Tributary Floodplains (Zone AE)

Adjacent to the VE zones are the "AE" zones which are those floodplains that are not specifically associated with the tidal surge and velocity hazards and can be found in palustrine, lacustrine, and riparian floodplain areas throughout the State of Florida. Like the velocity hazards Zones in Naples, all of the Floodplain Zone “A” areas have been studied in sufficient detail to have specific base flood elevations established and thus, have the specific designation “AE”. There are no areas in the City limits with an unstudied designation of Zone “A” which indicates that a level of floodplain analysis in the City has been well studied.

The most problematic Zone AE areas are those bands associated with the VE zones to the west. Here the energy of the VE bands has dissipated to a point where wave activity is no longer predicted to be an issue, but the surge of water into the inlets, bays, and tributaries, still reaches elevations substantially higher than mean sea level. The first few base flood elevations begin as additional bands adjacent to the VE bands but directly to the east. These bands begin at elevation 12 MSL and extend down to elevation 10 feet above sea level. East of these bands are the AE Zones where the floodplain establishes base flood elevations over broad areas and inflict much shallower flooding on the City. The lowest floodplain contour is the AE=6 which is found just east of, and adjacent to the airport.

It is interesting to note that the first AE band (AE=12) is found adjacent to the VE=12 band and runs along the first block east of Gulf Shore Blvd. (2nd Street South) and into the northern bays that drain out through Doctors Pass. Essentially all of Compass Cove, Bowline Bay, Mooring Bay, Outer Doctor Bay, Inner Doctor Bay, and Venetian Bay, all are subjected to the AE=12 Zone. As a result the band is much wider in this area (Drainage basin I) than down in Drainage Basins II, III, and IV. The band is only around 100 feet wide in Basin IV and grows to approximately 300 wide in Basin III. Basin II begins the Compass Cove area and the band begins to fluctuate from 200 feet wide to 1000 feet wide. In Drainage Basin I, the AE=12 band widens out from 1500 to 2000 feet wide. The depth of flooding in this most serious AE zone would be expected to be in the order of 4 to 9 feet deep.

The next two bands (AE=11 and AE=10) are very wide and encompass much of the western City limits east of 2nd and 3rd Street South. This flood zone encumbers much of Drainage Basins I, II, III and IV, and VI. These are the last of the deep flooding areas (based on natural ground). One would expect that the flooding depth above natural ground (unfilled grade) would be in the order of 1 foot to no more than 7 feet above sea level, with the majority of the depth being in the 2 to 5 foot depth range.

East of this last organized band of base flood elevations the flooding contours spread out into wide meandering areas that decrease from elevation 9 MSL down to 7MSL. The bulk of Naples

Bay contains the AE=10 and AE=9 base flood elevation. Basins VII, VIII, and IX contain primarily the AE=9 and AE=8 base flood elevations. The airport is the majority of Basin X, and is almost entirely comprised of the AE=7 contour, thus being subjected to the lowest base flood elevations in the City.

There are only two drainage basins in the City that fair better than the airport area in terms of their base flood elevations; Basins V and XI. These two basins only have portions in the AE=8 and AE=7 floodplain areas. A significant amount of each of these two basins contains areas outside of the predicted 100-year floodplain. By definition all of these areas are expected to flood deeper than 1 foot, however, it is unlikely that there are areas that can flood higher than 5 feet in any of these areas and the most likely flood depths would be around 2 to 3 feet above natural ground.

5.1.3 Other Flood Areas and Non-flood Areas (Zone X)

Zone "X" is the best rating one can have on a FEMA FIRM Panel. There are two designations that apply to the City of Naples: Zone "X500 and Zone "X". Zone X500 are those areas that are subjected to floodplain flooding in less often occurring storm events at the 500 year return frequency or higher; or, the depth of flooding is so inconsequential during the 100 year storm event that the maps show the area as a 500 year floodplain. The maps describe these areas as follows: Areas of the 500 year flood, or areas of the 100 year flood where the average flood depths are thought to be less than and average of less than one (1) foot; or with drainage areas less than one (1) square mile (640 acres); or areas protected by levees from the 500 year flood.

In reviewing the mapping for Naples, it appears that the designation for these areas of the City was based primarily on the criteria that the 100 year flooding depth is predicted to be under one foot of average depth. Thus, the residents in these areas are still subject to potential flooding in these areas. Homes that are in an area where the flood depth is 1-foot instead of 2-feet are not necessarily better off. Once flood waters enter the physical home structure destroying flooring and drywall, there is typically not a lot of difference in the damage claim whether the water depth over the carpet was 6 inches deep or 18 inches deep. This Zone X500 makes up nearly all of the remaining City limits and is primarily found in the northern reaches of the City in Drainage Basins I, II, V, and XI.

There is one last designation in the City Zone "X". This zone is allotted to those areas that are determined to be outside of the 500 year floodplain and are thus, non-floodplain areas for purposes of determining flood insurance needs. Theoretically, a storm event so severe that it only occurs once every 600 years could potentially flood these areas as well, but for purposes of requiring flood insurance, these areas are considered non-risk. Rarely do residents pay for insurance in these areas. We like to point out, however, that flooding is not always causes by floodplain type flooding. Homes sometimes flood due to blockages in lines (maintenance related), capacity related or other factors that are not simulated by a 100-year flood analysis. Thus, homes are able to purchase flood insurance regardless of where they are situated relative to the FIRM panels if they wish to pay for flood protection.

There are only two tiny sections of land that are designated outside of the floodplains in the City of Naples. Both of these areas are in Drainage Basin I, in the northern most sections of the City. There is a relatively high ridge that runs along the historic Tamiami Trail (US 41). The ridge begins just north of where US 41 crosses the Gordon River and proceeds north beyond City limits. The ridge ranges from around elevation 10 to over elevation 20. The two high areas of the ridge that are within City limits is the areas where Park Shore Dr. intersects with US 41 and then up in the northeast City limits where Seagate Dr. intersects with US 41. Both of these Zone "X' areas are approximately 15 feet above sea level and the predicted floodplain bands in the surrounding area are no higher than elevation 10 (on the west side).

5.2 TYPES OF FLOODING

It is important to understand the different types of conditions cause flooding. In Section 3.3.1 of this report, we discussed why flooding problem characterization is important especially when trying to educate the public on the expectations of level of service and performance for a particular retrofit project alternative. Table 3.3.1-1 helped align and integrate the various flooding problems into groups based on the financial activities necessary to resolve those flooding problems. In this section, we will describe in more detail some of the technical categories of flooding.

5.2.1 Tailwater and Tidal Issues

Tailwater and tidal flooding problems occur when the receiving water bodies' water elevation is so high relative to the upstream drainage facilities, that there is essentially no energy (driving head) to convey the stormwater out through the culvert into the receiving water body. In some instances, the tailwater elevation exceeds the top of grate and inlet throat elevations of the upstream drainage collection facilities causing the downstream water body to flow backward into the streets and adjacent properties. Usually tailwater/tidal flooding is a temporary condition caused by a periodic rising of the water in the receiving body which is higher than the drainage system design anticipated or allowed for.

Tailwater flooding can occur any time that a stormwater management conveyance design improperly disregards the periodic high water fluctuations in the receiving water body or is based on faulty data. In coastal communities, such as Naples, this condition is most commonly associated with unusual high tide events in the Gulf of Mexico or Naples Bay, the Moorings Bay system, or any of the tidally influenced channels or canals. Mean sea level is assumed to be elevation 0. Typical tide variations are in the order of 2-feet ±. On an annual basis, Naples Bay will reach a high tide elevation of approximately 3.2 (Reference #10.11, 10.7, 10.8, and 10.14) . High tide events have been measured as high as, however, 5-feet above sea level. Although such extreme peaks in high tide are very uncommon, there are numerous streets and drainage systems constructed in the City of Naples at elevations 12 to 18-inches below that record high tide elevation. As a result, very high tide events have been known to back water through the drainage system and flood streets and parking areas. Even when the high tide elevation is below that necessary to back up into the streets, just the presence of an above-average high tide in these systems has such a minor difference in head, that the conveyance cannot effectively occur until the high tide recedes. Thus, in these areas of the City, the actual performance and efficiency of the existing infrastructure may be directly tied to the timing of tidal events occurring simultaneously with rainfall events.

Another extreme variation of this type of flooding is tropical storm surge flooding which was discussed in detail in Section 5.1. This is an unusual situation where the tropical cyclonic storm activity surges the Gulf of Mexico to an elevation dangerously above normal high tide fluctuations. It is not uncommon during Category 5 hurricanes for tidal surge elevation along the Gulf of Mexico to range up to 15 to 20-feet above sea level. Obviously, during such extreme tailwater conditions, no stormwater discharge out of the City is possible and in fact most of the City is under water. Lesser category hurricane events, however, can still whip up tropical storm surges in the range of 5 to 15-feet above sea level which is still far greater than the highest elevation events caused by gravitational forces. Tailwater problems associated with tropical storm surge are often unresolvable by typical CIP projects. Whereas, high tailwater problems associated with tide events can often be cured with one-way flap gates (also referred to as tidal flap gates), surge usually rises up and above all containment berms and structures rendering such devices useless.

5.2.2 Primary Conveyance Issues (Canals, Ditches and Major Culverts)

If tailwater conditions are properly considered during design, primary conveyance facilities (canals, ditches, and major culvert lines) should be able to flow stormwater runoff effectively away from property and right-of-way and discharge the excess water to the receiving water bodies. When primary conveyance facilities are not properly designed/constructed for the intended design storm event, the discharge capacity structures can be exceeded and cause flooding. Examples of such flooding would include man-made ditches and canals where the cross sectional area is not large enough to handle the intended design storm event, and culverts that are too small to handle the quantity of flow from the storm event.

Sometimes this inadequacy of the primary conveyance facility is a result of the design storm event selected for the facility. For instance, if a culvert was designed to handle a 10-year/24-hour return frequency storm event and the system receives a 100-year/24-hour storm event, the additional rainfall runoff will exceed the design capacity of the culvert and cause flooding upstream. Resolving this type of problem involves a capital expenditure since the corrective solution involves replacing the existing infrastructure with facilities that can handle additional capacity or improve the level of service provided by increasing the design storm event.

Another common cause of flooding in primary conveyance facilities is when peacemealing of retrofit drainage projects with time forces additional drainage basin areas into the primary conveyance facility including lands that were never intended to drain into the existing facility. In many older facilities, the primary conveyance facilities were often sized by intuition and not to a certain LOS performance expectation.

5.2.3 Secondary/Tertiary Conveyance Issues (Ditches, Swales and Minor Culverts)

The problems associated with secondary and tertiary facilities are identical to those described in the previous section for primary conveyance facilities. The secondary and tertiary conveyance facilities are those cross culverts, smaller ditches, swales and other conveyance facilities that bring sub-basins and minor tributary areas to the main primary collection and conveyance infrastructure system. The main difference between the problems with secondary/tertiary systems and those of the primary conveyance facilities is that the primary conveyance deficiencies are much more problematic in that their inadequacy provides a backwater flooding condition into the secondary/tertiary conveyance facilities. In other words, the secondary and tertiary infrastructure system may be adequately sized to handle their intended subcomponent flows, however, they are discharging into a primary infrastructure system which is inadequate and the backwater conditions from the downstream primary system overwhelms secondary/ tertiary systems. It is important to separate which system is actually causing the backwater flooding as enlarging the secondary system may not alleviate flooding caused by the primary facilities.

Examples of secondary/tertiary conveyance facilities that are inadequately sized include: roadway cross culvert, swale, or commercial parking drain that is sized too small for the intended design storm event. Often secondary and/or tertiary facilities extend onto private property which can further complicate the corrective actions necessary when the system is analyzed as a whole because of legal access and maintenance issues.

5.2.4 Renewal and Replacement (R&R) Deficiencies

Another category of flooding occurs when an existing facility deteriorates to a point where it can no longer supply the conveyance capacity that it was originally designed and constructed to provide. This type of flooding is often difficult to ascertain and categorize properly as it often disguises itself as a maintenance problem or a capital capacity deficiency. An R&R deficiency is a problem where the corrective measures involve the renewal or replacement of the existing facility to restore the original capacity of the system and level of service. An example of an R&R deficiency would be an outfall culvert which performed properly for 30-years but became so deteriorated by salt water that the facility collapsed due to the migration of soil into the corroded steel pipes. The renewal of this existing culvert by slip lining, for example, could restore the original capacity of the culvert without upgrading the level of service or future potential expansion of service effectively extending the life of the infrastructure. Replacing this culvert with a new culvert of the same size, capacity and design performance would do the same. Both of these corrective actions to the flooding problem described above would be considered renewal and/or replacement.

5.2.5 Inlet and Structure Inadequacies (Throat Capacity & Spacing)

Inlet and structure inadequacy is an interesting flooding problem associated with the intake structures within primary and secondary/tertiary conveyance facilities. Usually these flooding problems are found on the terminal locations of secondary and tertiary conveyance facilities. This type of flooding occurs when the inlets themselves are either spaced inadequately to collect the water efficiently or the throat capacity (or grate capacity) is inadequate to efficiently collect the surface runoff. The calculations necessary in design to properly size and space inlet structures along public roadways are different activities to that of conveyance line sizing. One is not considering the backup of the hydraulic grade line in this type of design activity. One is ensuring that the water can get into the pipe system quick enough. It is possible to have a pipe system which is effectively passing the flow once it enters the conveyance system, but the inlet structures above are simply too few and far between to fill the culverts to capacity.

As a result, many public entities require specific design guidelines in the analysis and sizing determination of inlets including their spacing. In many areas of Florida, the inlets are to be sized to collect stormwater during a 10-year return frequency storm event without causing a spread of water pooling at the inlet throat or specifying that the inlet spread does not exceed the height of the roadway crown elevation. If the conveyance facilities (culverts) are sized properly, flooding due to inlet and structure deficiency is a very temporary condition. It is most likely experienced during high intensity short duration storms as opposed to heavy rainfall storms. For instance, a system of inlets may adequately be able to collect the stormwater runoff from 9-inches of rainfall falling in 24-hours (essentially the 25-year/24-hour storm event) without causing any street flooding as long as the rainfall was distributed moderately throughout the day without any significant high intensity downpours. If, on the other hand, a high intensity downpour (such as 4-inches of rain in one hour) fell upon the same system of inlets, there is a high probability the inlet capacity would be exceeded and flooding would occur. Inlets are thus normally designed for storm events based on intensity duration curves instead of rainfall return frequency storm events. The 5-year/1-hour storm currently required in the Comprehensive Plan is a reasonable LOS/design standard for inlet design.

Retrofit solutions to this type of flooding are usually relatively simple as they involve modifications at the edge of roadways at curb lines. Unfortunately, most modeling techniques used by consultants to analyze flooding do not incorporate techniques and modeling scenarios that are designed to identify this particular type of flooding. As a result, comprehensive regional drainage basin studies using hydraulic grade line performance simulations may fail to recognize and/or correct this particular flooding problem. The funding category of this problem type can be either capital, R&R, or O&M. If the existing system was simply sized improperly to handle the LOS of the conveyance system, then the replacement of these structures is a capacity upgrade or service upgrade. If the facility deteriorated to a point where it can no longer perform to its original design specifications, it is an R&R project. Maintenance can involve activities as simple as unclogging the debris from the inlet grates, removing sediment trapped inside of the catch basins, or replacing steel grate or manhole covers that have been destroyed by salt corrosion.

5.2.6 Operation and Maintenance Deficiencies

Operation and Maintenance (O&M) deficiencies are the easiest typically to diagnose and resolve in stormwater management plans. These are problems where maintenance to stormwater management facilities described above have not been performed adequately enough to maintain the desired level of service. The removal of sand, debris and other objects from culverts, inlets, and outfall structures are all examples of routine maintenance activities. Removing vegetation obstructing the flow in a channel is another example of a typical maintenance function. The maintenance activity should restore the intended level of service, not improve it. Improving the level of service through "maintenance activities" may need to be reevaluated as a capital expenditure if the capacity or level of service is increased in a regional system. Consider for an example, the "maintenance dredging" of a primary canal facility. If the dredging activity simply removes the sediment buildup along the bottom of the conveyance way, the activity could be considered maintenance. If however, the conveyance cross section of the canal-way was enlarged by deepening the facility or widening the facility, the maintenance activity should be considered a capital expenditure. We also note that most of the regulatory exemptions for "maintenance" have very specific language about restoring the primary conveyance facility to its "original design cross section". Increasing the conveyance capacity of such facility triggers significant regulatory considerations.

5.2.7 Groundwater Flooding

Groundwater flooding occurs whenever the surficial aquifer fills enough of the void spaces in the soil to encroach upon stormwater management facilities (and/or roadway bases) so that the effectiveness of the system is diminished. Often groundwater flooding problems occur during unusual high rainfall periods where the seasonal high water table exceeds the expectations of prior geotechnical investigations and design assumptions. In coastal communities such as Naples, however, groundwater intrusion may be exacerbated by tidal fluctuations. Historically, drainage systems to lower high groundwater conditions were implemented throughout the State of Florida making lowland areas developable by converting wetlands into uplands. With today's more stringent regulations regarding wetland protection and the state being more sensitive to protecting our groundwater resources, such over-drainage practices and retrofit activities are typically not available. On a limited basis, infiltration systems (such as underdrain) can be permitted. Underdrain controls pesky high groundwater fluctuations that adversely impact roadway bases and swales. Modern development regulations and proper geotechnical practices however, should guard today's development activities from additional groundwater flooding problems.

5.3 ASSESSMENT OF KNOWN PROBLEM AREAS

In the following section, Tetra Tech evaluated the detailed modeling results of the drainage basin studies performed for Basins III, V, and VI provided by the City for our review. The methodologies and assumption, although similar, contained differences that required standardization in order to assimilate the CIP recommendations and integrate them into the Master Plan Update. We will summarize the results and recommendations of each of these studies briefly and then provide an assessment of the benefits of the alternatives relative to their projected CIP costs.

5.3.1 Drainage Basin III Conclusions and Recommendations

The following is a brief recap of the conclusions and recommendations sections of the CDM report (Reference # 10.11). We have included some comments relative to our attempt to normalize all of the reports into this updated format.

- Computer modeling results of this report indicated that alternatives became cost prohibitive retrofitting storm events larger than the 5-year/24-hour return interval. While increased pipe sizes were insufficient to provide flood relief for the 2-year/24-hour storm event, increased pumping capacity was determined to be necessary for larger storms above the 5-year/24-hour return interval. We recommend that we re-evaluate the options to provide a more consistent LOS to that offered in other Basins.

Four Alternatives were analyzed:

- *Alternative One* essentially returned the existing system to the design capacity through maintenance, replacement of damaged culverts, and improvements to the pumping station to eliminate clogging by debris. Pump capacity was not increased for this alternative. The permitting considerations for the proposed improvements were determined to be much more complex when the pump station capacity is increased over existing conditions because the increased volumes of water affect water quality considerations. The estimated cost of Alternative One was **$1.13M**. (in 2001 $)

- *Alternative Two* consisted of piping and pump station improvements that would produce no more than 2-inches of roadway flooding on the streets during a 2-year/24-hour storm event (5-inches of rain in 24-hours). These improvements were determined to be insufficient to eliminate building structure flooding in certain areas of Basin III where the finished floor elevations were essentially the same elevation as the crown of the existing roadways. While the depth and duration of flooding would be reduced, it would not be eliminated. The pump capacity remains the same as for Alternative One and therefore the permitting of this Alternative would be relatively straight forward. The improvements were estimated to cost approximately. **$3.42M** (in 2001 $)

- *Alternative Three* consisted of similar improvements to the piping and pump facilities as Alternative Two; however, the improvements associated with Alternative Three were designed to maintain flood waters at least 2-inches *below* the road crown under the 2-year/24-hour design storm with one exception (the intersection of 9th Avenue South and 10th Street South). The crown of the roadway at that junction is physically incapable of correction in that the existing intersection is at the same elevation as the tailwater conditions modeled for Naples Bay. As with Alternative Two, the pump capacity remains the same as it currently exists; therefore permitting would be relatively straight forward. The estimate of cost for Alternative Three was **$6.73M**. (in 2001 $)

- *Alternative Four* provided 2-inches of free board during a flooding event (dry roadway conditions) for a larger design storm event than that modeled in the previous alternatives. The 5-year/24-hour storm was used for model simulation (5.8 inches of rainfall in 24-hours). Increasing the size of culverts alone, however, was not able to meet the level of service specified in this Alternative for that design storm event; and thus, increased pumping capacity was required to achieve the results. As a result, additional flows to Naples Bay are necessary and permitting would be significantly more difficult for this Alternative, likely requiring water quality treatment considerations. The cost estimated for this Alternative was **$8.42M**. (in 2001 $)

In the final recommendations, CDM recommends *Alternative Three* as being the most cost-effective solution to the flooding problems. One of the main reasons for the selection of this alternative is that the permitting would not be abnormally difficult since there is no change in peak discharge or total volume of floodwater conveyed into Naples Bay. The pollutant loading would be nearly identical to existing conditions.

5.3.2 Assessment of Basin III Recommendations

Tetra Tech reviewed the specific results of the existing conditions model performed by CDM in the Basin III report. In addition, we analyzed the effectiveness of each of the Alternatives to quantify and categorize the benefits in a consistent and integrated manner in order to compare with other city-wide capital expenditures. The purpose of this analysis was to organize the proposed Capital Improvements Projects (CIP) within the City's library of potential projects and perform an objective ranking of all of these projects for purposes of determining the timing and funding of the CIP projects.

During this assessment, it was noted that the model analyzed the flooding conditions at 61 separate junction nodes spread out through drainage Basin III (essentially inlets where the hydraulic grade line could be measured against existing ground conditions). CDM modeled both the existing and buildout conditions (future) for its baseline comparison model. In order to evaluate the potential harm to public safety, health and welfare, the report examined flooding conditions relative to roadway crown elevations and building structure finished floor elevations (FFEs). Four (4) alternatives were modeled to evaluate effectiveness of proposed improvements.

In order to place this comparative analysis into perspective, Tetra Tech utilized Table 4.3 of this report, (our recommended reconciliation on how to measure level of service (LOS) for various structures and infrastructure facilities within the City). We selected a LOS "C" for roadway retrofit projects for this comparison since it is the first LOS rating, which in our opinion, provides an acceptable condition in terms of resolving a flooding problem area. In the case of the roadway crown comparisons, a LOS "C" or less implies that flooding will <u>not occur at the crown of the roadway</u> during a 5-year/24-hour storm event or less (approximately 6.6 inches of rainfall).

In the case of building structure flooding, we selected a LOS of "B" meaning the FFE would be protected from flooding from a 100-year storm. A LOS of "B" does not provide the typical 1-foot of freeboard that is normally desired when using the 100-year/24-hour storm, but it is reasonable for retrofitting homes in troublesome areas since the homes are still above the standard 100-year elevation.

In the existing condition, the model indicated that 7 out of 61 (11.5%) of the junction nodes experienced a level of service below "C" relative to roadway crown flooding; and 2 out of 61 (3.3%) for FFE flooding. Expanding the land use intensity to "future conditions" increased the flooding conditions to 11 out of 61 junctions (18%) for roadway crown flooding; while 2 out of 61 (3.3%) junction nodes continued to flood finished floor elevations.

Table 5.3.2-1 below summarizes how the various Alternatives actually improve conditions in the Basin relative to the overall projected cost for the improvements.

Table 5.3.2-1 Evaluating Cost Benefit Effectiveness for Basin III Improvements

		Roadways/Buildings not operating at the LOS specified below.					
Condition	Net Δ in Peak Stage	Roadways LOS "C" or Less		Buildings LOS "B" or Less		Estimated Cost of Improvement (1)	Estimated Cost of Improvement (2)
Existing	N/A	7 / 61	11.5%	2 / 61	3.3%	N/A	N/A
Future	N/A	11 / 61	18.0%	2 / 61	3.3%	N/A	N/A
Alt - 1	0.0	11 / 61	18.0%	2 / 61	3.3%	$1.31M	Not Provided
Alt - 2	0.0	11 / 61	18.0%	2 / 61	3.3%	$3.24M	Not Provided
Alt - 3	0.0	6 / 61	9.8%	2 / 61	3.3%	$6.73M	Not Provided
Alt - 4	-0.19	1 / 61	1.6%	1 / 61	1.6%	$8.42M	Not Provided

Notes: (1) The report provides a cost for CIP with Renewal and Replacement (R&R) of older infrastructure which is the value given in the first column.

(2) If parallel pipes are installed leaving older infrastructure in place, the cost is given in the second column.

(3) Building LOS condition of "B" was used since the model only gave results for the 100 year / 24 hour storm event.

(4) All costs are from original report and represent 2001 dollars.

As one can see from this table, Alternatives one through three shows no net decrease in peak stages due to the improvements. In other words, there was no additional change in peak flow or volume of water discharged to Naples Bay. Essentially, the model balanced the stormwater runoff by increasing the flooding in some junction nodes while reducing it in "more critical" areas. Alternative Two raises or lowers the flooding on average between -0.2 to +0.2 feet. Alternative Three has more aggressive fluctuations in the balancing act with a typical range on the order of -0.4 to +0.3 feet, whereas the fourth alternative (which increases discharge to Naples Bay) indicated a variation of flooding fluctuation from -0.5 to +0.2 at most of the junction nodes. The net effect of the balancing act for alternative four was a -0.19 foot average decrease in flood stage during the 100-year/24-hour storm event.

Despite all of these improvement alternatives, it is interesting to note that Alternative Two did not actually reduce roadway flooding from the future buildout condition (using our unified LOS comparison – LOS "C"). The building structure flooding did not reduce either for LOS "B". Alternative Three did at least reduce the street flooding at 5 locations but left 6 that continued to flood. The junction nodes with building flooding did not improve at all. Thus, the $3.2M to $6.7M worth of improvements modeled in Alternative Two and Three were relatively ineffective relative to the "unified" LOS criteria used. Accepting a lower standard of LOS would recognize higher benefits, but then would place us back to the inconsistencies in measuring benefits that we are trying to correct by integrating a City-wide Master Plan Update.

Furthermore, an examination of Table 7-1 of the Basin III report (Reference # 10.11) showed that both Alternative Two and Alternative Three improved the roadway crown flooding level of service from 2-year or less to 5-year in general; however in a couple of basins, the existing 5-year level of service was actually decreased to a 2-year level of service. Considering that the vast majority of the other junction nodes are performing at the 25-year or better level of service, the net increase in service is not all that significant for either of these alternatives. We note that 34 out of the 61 junction nodes (58%) in the existing system were meeting a LOS "A" by providing flood relief for storm events with a return frequency of the 25-year/24-hour storm or greater. We recognize, however, that Alternative Three increases the overall level of service of all the junction nodes in Basin III by increasing the amount of junction nodes served by a LOS "A" to 38 out of 61 (61%). This benefit, however, is only a 3% increase and at the highest measurement level. Providing local roadways with a high end level of service equal to, or better than, the 25-year to 100-year storm event is not the typical practice in South Florida and would be considered excessive service. In most communities, a LOS preventing flooding from occurring within local streets in a 10-year storm is considered very good. The important goal is to relieve the flooding of more routine storm events such as the 2-year return frequency.

Only Alternative Four truly provided significant relief from the routine storm events by decreasing the anticipated roadway flooding down to 1 junction node out of 61 (1.6%). This remaining troublesome junction cannot realistically be retrofitted; therefore, the success of the project utilizing Alternative Four is very high. The problem with Alternative Four is that by increasing the discharge to Naples Bay, water quality and fresh water contribution considerations would enter into the permitting equation and complicate the process. In addition, the project cost in construction would increase from $6.7M to $8.4M. (in 2001 $)

The most important consideration in evaluating the effectiveness and benefits of the alternatives of this report comes from a recognition of how tailwater was modeled in this analysis. In the report, it is explained that there were several tidal and floodplain considerations examined prior to modeling. Table 5.3.2-2 lists those considerations.

Table 5.3.2-2 High Tide and Tidal/Coastal Surge Tailwater Considerations (For Basins III, V, & VI)

High Tide Events (All Basins)	
Stillwater Elevation (NGVD)	Return Frequency (Years)
3.2	1
4.1	10
4.9	25
5.0	Highest Observed 12/21/1972

Tidal/Coastal Surge Events (Tropical Storm Surge)		
Basin	Flood Elevation FEMA FIRM Panels	Return Frequency (Years)
III	Range 10-12 NGVD	100
V	8 NGVD (or None)	100
VI	Range 8 – 11 NGVD	100

It is important to recognize the difference between **high tide stillwell** elevations and **tropical storm surge** elevations as presented in the table described. High tide stillwell elevations are periods where unusual high tide elevations are measured due to gravitational forces relating to the relative positions of the sun, moon and earth to each other. There is no storm event necessarily associated with these activities. The highest observed high tide elevation provided (5.0 NGVD) is likely near nature's physical limit to how high the tide can rise due to these periodic gravitational fluctuations. The storm surge elevations, however, are due to barometric pressure differences in tropical cyclonic storm activity. During these storms, the difference in pressure between the storm disturbance boundary may lift the ocean water 10 to 20 feet above sea level (tropical storm surge). According to the FEMA flood maps (see Figure 5.1-1) anticipated storm surge elevation should reach elevations as high as 12 feet above sea level on the western boundary of Basin III diminishing to 10-feet above sea level on the eastern side of Basin III.

CDM recognized that these high tide and storm surge constraints effectively stymies the ability to model level of service improvements when the tailwater conditions are high. Thus, their model assumes relatively low tailwater conditions. In other words, all of the analyses performed in the Basin III Study assume that during the storm events modeled, the tailwater conditions in the receiving water bodies do not exceed more than a one-year return frequency high tide (elevation 3.2 NGVD). Although this assumption is not unrealistic, it may be more likely that a 2-year/24-hour storm event strikes the City of Naples during a 10-year high tide than it is that a 100-year/24-hour storm strikes the City on a one-year high tide cycle. Thus, the actual effectiveness of the LOS improvements may be overstated for smaller design storm return frequencies that are limited to analysis based only on the one-year high tide tailwater conditions. Table 5.3.2-3 compares the actual tailwater modeling assumptions used in each of the Basin Studies integrated into the Stormwater Master Plan Update.

Table 5.3.2-3 Comparison of Actual Tidal/Tailwater Conditions Used in Basin Modeling

Basin Report	Tailwater (Stillwell)	Year of Report	Approximate Occurrence Equivalent Frequency
III	3.2 NGVD	2001	1 Year
V	3.5 NGVD	2005	4-5 Years
VI	4.0 NGVD	1998	8-9 Years

To illustrate just how significant tailwater flooding alone could affect, (and does affect) Basin III, thus invalidating to some extent the effectiveness of the proposed improvements, consider the following facts about Basin III:

- The roadway crown elevations are listed in the report as varying from elevation 3.2 to 9.5 NGVD.
- Based on Table 5.3.2-2, we note that the 10-year high tide elevation is expected to reach an elevation of 4.1 NGVD. It appears that 10 out of 61 of the junction nodes modeled are at or below this high tide elevation (16.4%), meaning that even with all of these improvements in place, there will be times where the high tide fluctuations alone will cause street flooding since the model assumes that the tide will remain constant at 3.2 during the modeled storm events.
- The highest tide observed was at elevation 5.0.
- Note that 31 out of 61 of the junction nodes (51%) are at or below this high tide elevation, (5.0), meaning that even if the City spends $8.42M (2001 $) on Alternative Four to provide flood protection from various return frequency storm events, there will be times when nature floods more than half of the intersections due to extreme high tides alone (with no rainfall).

An analysis of the effective LOS improvements to the finished floor of structures was also investigated. We note that all of the finished floor elevations varied from 4.4 to 10.8 within Basin III according to the CDM Study. If the 100-year storm surge strikes the City, all of the minimum building elevations at the 61 junction nodes would be submerged by flood water with the exception of 3 nodes. In regard to high tide events, 6 out of 61 of the junction nodes (9.8%) contain minimum building elevations that are 4.9 feet above sea level or lower (equivalent to the 25-year tidal still well elevation). The same 6 nodes flood out the record high tide elevation = 5.0 (See Table 5.3.2-4 for a summary of this data). When ranking these basin projects for CIP consideration, these costs to benefit considerations will be factored into our analysis.

Upon review of this report and comparing it to the recommendations of other reports and more recent studies, <u>Tetra Tech recommends that the City upgrade the alternative to Number 4, or a modification of Number 3 that utilizes additional pump capacity. The additional costs are not significantly higher that Alternative 3, especially when compared to more recent Basin studies.</u>

Table 5.3.2-4 Summary of Tidal/Tailwater Induced Flooding on Roadway and Nodes

Basin	Roadway Crown Range	Total Junction Nodes Roadway	10-Year High Tide Tailwater	Junction Nodes Flooded TW_{10}	% of Roadway Nodes Flooded	Highest Recorded Tide Tailwater	Nodes Flooded TW_H	% of Roadway Nodes Flooded
III	3.2-9.5	61	4.1	10	16%	5.0	31	51%
V	7.2-12.9	142	4.1	0	0%	5.0	0	0%
VI	4.4-10.3	43	4.1	0	0%	5.0	5	12%

Table 5.3.2-5 Summary of Tropical Storm Surge and Tailwater Induced Flooding on Building Nodes

Basin	Finished Floor Elevation Range	Total Junction Nodes Min FFE	FEMA 100 YR. Surge Elevation	Junction Nodes Flooded by Surge	% of Building Nodes Flooded	Highest Recorded Tide Tailwater	% of Building Nodes Flooded
III	4.4-10.8	61	10-12	58	95%	5.0	9.8
V	7.0-13.8	55	8	8	15%	5.0	0
VI	5.2-11.7	43	8-12	Indeterminate	Most	5.0	0

5.3.3 Drainage Basin V Conclusions and Recommendations

The following is a brief recap of the Conclusions and Recommendations Section of the report for Basin V (Reference # 10.8). The existing system stormwater level of service (LOS) throughout the basin was evaluated, and locations that did not achieve the desired LOS were grouped into problem areas. Three conceptual improvement alternatives were developed to address the defined problem areas and meet a range of property and structure flooding LOS goals, including:

- *Alternative 1* represents a combination of County and City improvements developed to address flooding problems in the Gordon River Extension System. Improvement projects were developed to provide a LOS with maximum 6-inch overtopping of the road crown for the 25-year/72-hour design storm event. This far exceeds the LOS expectations found acceptable in the Basin III Report.
- *Alternative 2* represents City improvements developed to address the problem areas in the Basin V primary stormwater master system. The target LOS was to provide no

overtopping of the road crown for the 25-year/72-hour design storm event. This was provided to CDM as the current LOS for new development in the City. This alternative is still well above the LOS expectations in any previous studies. The desired LOS was achieved in most locations; however, there was a concern that such a relatively high level of service would be cost-prohibitive considering City funding sources.

- *Alternative 3* represents a refined set of retrofit LOS criteria that are consistent with similar coastal Florida communities. Alternative 3 improvements were developed to achieve the various LOS criteria for several design storm events, including a maximum 6-inch overtopping of the road crown for the 25-year/72-hour design storm event as well as up to 3-inches for the 10-year/72-hour storm, up to 9-inches for the 100-year/72-hour storm, and all storm event flood stages below known building elevations. This alternative provides 8.3 acre-feet of water quality treatment volume, meets the pre-development peak discharge rate, and meets the pre-development runoff volume requirement. The 8.3 acre-feet of retrofit wet detention water quality treatment volume would be used to support the Environmental Resource Permit (ERP) process.

CDM recommended that the City proceed with a conceptual ERP for the Alternative 3 improvement projects with a phased approach to implementation as follows:

- Acquisition of lands and easement necessary to construct and maintain the conveyance improvements and detention facilities;
- Modification of the existing detention facilities (lakes) per the improvements described;
- Investigate the feasibility of the additional detention facilities recommended to meet the water quality treatment volume requirements, located at the Conservancy and Jungle Larry's properties; and
- Implement the remaining conveyance improvements in Alternative 3 as appropriate and as permitted.

5.3.4 Assessment of Basin V Recommendations

Tetra Tech also reviewed the specific results of the existing conditions model performed by CDM in the Basin V report. In addition, we analyzed the effectiveness of each of the Alternatives was analyzed and categorized in a consistent and integrated manner in order to compare with other city-wide capital expenditures. The purpose of this analysis was to organize the proposed Capital Improvements Projects (CIP) within the City's library of capital projects and perform an objective ranking of all of these projects for purposes of determining the timing and funding of the CIP projects.

During this assessment, it was noted that the model analyzed the flooding conditions at 172 separate junction nodes spread throughout drainage Basin V. CDM did not model both the existing and buildout conditions (future) for their baseline comparison model as was done in the Basin III and VI models. In order to evaluate the potential harm to public safety, health and welfare, the report examined the flooding conditions relative to roadway crown elevations and building structure finished floor elevations (FFEs). Three (3) alternatives were modeled to evaluate effectiveness of proposed improvements.

In order to place this comparative analysis into perspective, Tetra Tech utilized Table 4.3 of this report, which recommends how to measure level of service for various structures and infrastructure facilities within the City. We again selected a level of service "C" for roadway retrofit projects for this comparison to be consistent. In the case of the roadway crown comparisons, a LOS of "C" or less implies that flooding will not occur at the crown of the roadway during a 5-year/24-hour storm event or less. We saw previously in Section 5.3.2 that this was a difficult LOS standard to meet in Basin III. Conditions in Basin V, however, were much more favorable to this standard. We also note that only Alternative 3 provides a LOS that is more in line with the other Reports in terms of consistency.

In the case of building structure flooding, we were only given data based on a storm event that would favor selecting a LOS of "A" instead of the "B" used in our Basin III comparison; meaning the FFE would be protected from flooding from a 100-year/72 hour storm or have at least 1-foot freeboard above a 100-year/24-hour storm. However, since the 100-year/72-hour storm is more intense than the 100-year/24-hour storm event and no junction nodes contained minimum building FFE's that flooded, one can infer that all of the data can be converted to the LOS "B" criteria with no flooding in order to be consistent in our comparisons.

In the existing condition, the model gave 50 out of 142 (35%) of the junction nodes experiencing a LOS below "C" with roadway crown flooding; and as mentioned earlier, 0 out of 61 (0.0%) for FFE flooding. Future conditions were not provided in this particular study.

Table 5.3.4-1 below summarizes how the various Alternatives actually improve conditions in the Basin relative to the overall cost for the improvements.

Table 5.3.4-1 Evaluating Cost Benefit Effectiveness for Basin V Improvements

	Roadways/Buildings not operating at the LOS specified below.					
Condition	Roadways LOS "C"		Buildings LOS "B"		Estimated Cost of Improvement (1)	Estimated Cost of Improvement (2)
Existing	50 / 142	35.%	0 / 55	0%	Not Provided	Not Provided
Future	Not Provided	N/A	Not Provided	N/A	Not Provided	Not Provided
Alt - 1	46 / 142	32.4%	0 / 55	0%	Not Provided	Not Provided
Alt - 2	5 / 142	3.5%	0 / 55	0%	Not Provided	Not Provided
Alt - 3	8 / 142	5.6%	0 / 55	0%	$21.09M	$17.79M

Notes:
(1) The report provides a cost for CIP with R&R of older infrastructure which is the value given in the first column.
(2) If parallel pipes are installed leaving older infrastructure in the place, the cost is given in the second column.
(3) Building LOS condition of "B" was used even though the model only gave results for the more intense 100-year / 72-hour storm event. The data inferred that the results for the less intense, 100-year/24-hour storm event, would be applicable as shown.
(4) The costs provided, herein, are from the original report and represent 2005 dollars.

Unlike the analysis performed for Basin III, all of the alternatives studied in Basin V caused a net decrease in peak stage due to the improvements. In other words, additional volume of water has to be discharged to Naples Bay in order to reduce flooding. As a result, water quality improvements to mitigate the increased pollutant load were conceptually studied by providing additional capacity in existing lakes.

Alternatives Two and Three significantly reduced the roadway flooding at the junction nodes (using the LOS "C" comparison). Alternate Three was selected by the City during draft report review, therefore, no opinions of probable cost were provided for the other alternatives. Thus, the decision of cost is based on whether the City wishes to replace existing inadequate information at this time (essentially performing R&R) or limit the CIP expenses by installing parallel pipes and utilizing the existing conveyance of the older, existing system. We recommend spending the money now to perform R&R by avoiding the parallel pipes. The 16% savings is small compared to the cost of having to replace the older system shortly hereafter by tearing up the R/W again.

The report explained that there were several tidal and floodplain considerations examined prior to modeling. Table 5.3.2-2 listed those considerations. According to the FEMA flood maps (see Figure 5.1-1) very little of anticipated storm surge should reach Basin V. Only the 8-foot flood contour reaches the western side of Basin V; the remainder is above the 100-year floodplain.

CDM recognized that high tide and tropical storm surge constraints could effectively reduce the ability to model LOS improvements when the tailwater conditions are high. However in this model, they assumed a relatively higher tailwater conditions than in Basin III. All of the analyses performed in the Basin V Study assume that during the storm events modeled, the tailwater conditions do not exceed more than a four to five year return frequency high tide event (3.5 NGVD). Table 5.3.2-3 compares the actual tailwater modeling assumptions used in each of the Basin Studies.

To illustrate how tailwater flooding could affect Basin V, we considered the following:

- The roadway crown elevations are listed as varying from elevation 7.2 to 12.9 NGVD.
- Based on Table 5.3.2-2 above, we note that the 10-year high tide elevation is expected to reach an elevation of 4.1 NGVD. It appears that none of the 142 of the roadway crown junction nodes are at or below this high tide elevation (16.4%), meaning that street flooding will not occur in Basin V due to tides alone since the highest tide observed was at elevation 5.0.

An analysis of the effective LOS improvements to the finished floor of structures was also investigated. We note that all of the finished floor elevations varied from 7.8 to 13.8 within Basin V according to the CDM Study. If the 100-year storm surge impacts the City, only 8 of the minimum building elevations at the 55 building junction nodes would be submerged in flood water. In regard to high tide events, none of the 55 junction nodes (0.0%) contain minimum building elevations that would flood (see previous Tables 5.3.2-4 and 5.3.2-5). When ranking these basin projects for CIP consideration, these costs to benefit considerations will be factored into our analysis.

Currently, the biggest challenge to the implementation to this project is that the funding available falls very short of needs recommended. Currently, the City, through grants and matching, have $250,000 allocated to Basin V Improvements. With over $21,000,000 estimated by CDM (in 2005 $) to implement the entire program, the phasing of this project must be identified carefully.

In addition, the 8.3 ac-ft of treatment volume conceptually identified in the report is far short of that needed. On page 6-5 of the report, it is noted that 43.6 ac-ft is needed; thus, there is a 35.3 ac-ft shortfall. We recommend that an integrated phasing plan be developed that matches realistic funding opportunities to a few related sub-basins. Bonding the improvements and retiring the debt service through the stormwater utility is also an option. Before that can be accomplished, however, the significant deficit in water quality treatment must also be resolved. Currently, the conceptual water quality program developed for Basin V only provides for 8.3 ac-ft of the 43.6 ac-ft required (or 19%). Thus, the first fully funded phases is currently limited to approximately $4M of the $21M in recommended capital improvements.

5.3.5 Drainage Basin VI Conclusions and Recommendations

The following is a brief recap of the conclusion and recommendations provided in the Report for Basin VI (Reference #10.7).

Based on the evaluations presented in this report, the preferred option was also Alternative 3. Only Alternatives 3 and 4 met the desired level of service requirements throughout Drainage Basin VI. Alternative 3 was the most cost-effective of the two. However, Alternative 3 represented a basin-wide goal for road flooding protection (a 10-year level of service). With the available planning level cost estimates, cost trade-offs could be investigated for site-specific improvement projects. That is, level of service requirements could be phased in order to balance the degree of flooding protection against the cost of implementation.

In addition, CDM made the following recommendations:

- Proceed with improvements to remediate flooding problems identified on 10th Street particularly at the intersection of 10th Street/4th Avenue North and at 10th Street/Central Avenue. The report presented a two-phased approach to implement these improvements. The estimated cost was $600,000 for Phase One, and $550,000 for Phase Two.
- Obtain topographical mapping of the City, since it would provide valuable information for understanding the stormwater system and identifying problem areas.
- Install a recording rain gage and flow monitor for future basin evaluations. Their primary use would be for model calibration, which can lead to greater reliability and public acceptance of modeling results.

- Coordinate a public information program to explain to citizens the trade-offs between costly improvement alternatives versus shallow, frequent but short duration ponding.
- Inventory custom-built inlets within the study area. Constrictive inlets that are suspected of contributing to localized flooding problems should be replaced with FDOT standard inlet types.

A meeting was held with the SFWMD to discuss permitting requirements for basin piping improvements. The SFWMD will require demonstration of an improvement in water quality for construction of basin improvements.

The only vacant site available for a stormwater pond was determined to be property owned by the City; however, there are restrictions on the property that require its use for a government facility. Thus, there was no property found in this study available to provide stormwater detention. Potential water quality projects discussed at the SFWMD meeting included a discharge channel detention pond, improvements to the pump station baffle boxes in the basin and a spreader swale. Water quality requirements will need to be established at a pre-application meeting with the SFWMD.

Use of the discharge channel as a detention pond was identified as a potential water quality improvement. This would require construction of a weir in the channel near the wastewater treatment facility. This project was discussed with the SFWMD. SFWMD noted that the project would be difficult to permit due to the presence of mangroves and submerged lands. SFWMD stated that detention facilities are not an acceptable use for submerged lands. The delineation of submerged lands would need to be determined in order to better evaluate the permittability and feasibility of this potential water quality project.

The proposed pump station design included several features to improve the water quality of the stormwater discharged into the Gordon River. The existing wetwell was much smaller than the proposed wetwell. The proposed wetwell was designed to reduce velocity to less than 2-feet per second to allow solids and grit to settle in the wetwell. Thus, water quality will be improved by increased sedimentation in the wetwell.

A mechanically-cleaned screen was also proposed to provide a significant water quality benefit. The screen will remove material larger than one inch.

Table 5.3.5-1 summarizes the effectiveness and projected costs by CDM for their alternatives investigated (in 1998 $):

Table 5.3.5-1 Summary of Alternatives for Basin VI

	Projected Cost Range		Level of Service Provided	Pump Station Improvements
Alternative #	Parallel	Replacement		
• Alternative 2	$1,425,400	$1,874,900	5-year / 24-hour	Yes
• Alternative 3	$1,974,300	$3,125,000	10-year / 24-hour	Yes
• Alternative 4	$2,371,500	$4,004,800	25-year / 24-hour	Yes
• Alternative 5	$2,555,500	$6,236,500	5-year / 24-hour	No

CDM clarified in their summary that the pump station cost was not included in the project costs presented above and that the "replacement" referred to replacing the existing pipes with new pipes. Parallel referred to using existing pipes and adding new parallel pipes.

5.3.6 Assessment of Basin VI Recommendations

Finally, Tetra Tech reviewed the specific results of the existing conditions model performed by CDM in the Basin VI report. In addition, we analyzed the effectiveness of each of the Alternatives to quantify and categorize the benefits in a consistent and integrated manner in order to compare with other city-wide capital expenditures. The purpose of this analysis was to organize the proposed Capital Improvements Projects (CIP) within the City's library of projects and perform an objective ranking of all of these projects for purposes of determining the timing and funding of the CIP projects.

During this assessment, it was noted that the model analyzed the flooding conditions at 43 separate junction nodes spread out through drainage Basin VI. CDM modeled both the existing and buildout conditions (future) for its baseline comparison model. In order to evaluate the potential harm to public safety, health and welfare, the report examined the flooding conditions relative to roadway crown elevations and building structure finished floor elevations (FFEs). Five (5) alternatives were modeled to evaluate effectiveness of proposed improvements.

In order to place this comparative analysis into perspective, Tetra Tech again utilized Table 4.3 of this report. To be consistent, we selected a level of service "C" for roadway retrofit projects. In the case of building structure flooding, we were once again able to select a LOS of "B" meaning the FFE would be protected from flooding from a 100-year storm.

In the existing condition, the model indicated that 12 out of 43 (27.9%) of the junction nodes experienced a level of service below "C" with roadway crown flooding, and 9 out of 43 (20.9%) for FFE flooding. Expanding the land use intensity to "future conditions" increased the flooding conditions to 13 out of 43 junctions (30.2%) for roadway crown flooding, and 10 out of 43 (23.3%) building junction nodes.

Table 5.3.6-1 below summarizes how the various Alternatives actually improve conditions in the Basin relative to the overall cost for the improvements. Note that the costs provided in this table are 1998 dollars.

Table 5.3.6-1 Evaluating Cost Benefit Effectiveness for Basin VI Improvements

	Roadways/Buildings not operating at the LOS specified below.					
Condition	Roadways LOS "C"		Buildings LOS "B"		Estimated Cost of Improvement (1)	Estimated Cost of Improvement (2)
Existing	12 / 43	27.9%	9 / 43	20.9%	N/A	N/A
Future	13 / 43	30.2%	10 / 43	23.3%	N/A	N/A
Alt - 1	Maintenance	Only	Maintenance	Only	Not Provided	Not Provided
Alt - 2	0 / 43	0%	6 / 43	13.9%	$1.87M	$1.43M
Alt - 3	0 / 43	0%	5 / 43	11.6%	$3.13M	$1.97M
Alt - 4	0 / 43	0%	4 / 43	9.3%	$4.00M	$2.37M
Alt - 5	2 / 43	4.65%	4 / 43	9.3%	$6.34M	$2.56M

Notes:
(1) The report provides a cost for CIP with R&R of older infrastructure which is the value given in the first column.
(2) If parallel pipes are installed leaving older infrastructure in the place, the cost is given in the second column.
(3) Building LOS condition of "B" was used since the model only gave results for the 100-year / 24-hour storm event.
(4) The costs provided herein are from the original report and represent dollars from 1998.

As with Basin V, all of the differences in peak stages summarize to a net decrease in flood stages meaning more water is discharged faster to Naples Bay in order to reduce flooding. The balancing act of increasing some flood stages at some nodes in favor of decreasing flood stages in the majority of nodes provided an overall improvement in LOS. The overall volume of water discharging to Naples Bay, however, does increase. This project was completed before the other Basin studies. The TMDL program was not as advanced in 1998 as it is today. The demonstration in water quality improvements today will be more difficult to permit.

Alternative One was simply a maintenance alternative and did not affect any LOS. All of the alternatives in this particular study reduced the future buildout flooding at the roadway junction nodes (using the LOS "C") and the building structure flooding (LOS "B") significantly.

In the report, it is explained that there were several tidal and floodplain considerations examined prior to modeling. Table 5.3.2-2 listed those considerations. According to the FEMA flood maps (see Figure 5.1-1) anticipated storm surge elevations could reach elevations as high as 11 feet above sea level on the western boundary of Basin VI diminishing to 8-feet above sea level on the eastern side of Basin IV.

CDM recognized that high tide and tropical storm surge could effectively constrain the ability to model LOS improvements when the tailwater conditions are high. Thus, the model assumes low tailwater conditions. However, unlike the models for Basin III and V, the consultant selected a more conservative value for tailwater. In other words, all of the analyses performed in the Basin VI Study assume that during the storm events modeled, the tailwater conditions do not exceed more than an eight to nine year return frequency high tide. Table 5.3.2-3 compared the actual tailwater modeling assumptions used in each of the Basin Studies.

To illustrate how the tailwater flooding could affect Basin VI, we considered the following:

- The roadway crown elevations are listed as varying from elevation 4.2 to 10.3 NGVD.
- Based on Table 5.3.2-2 above, we note that the 10-year high tide elevation is expected to reach an elevation of 4.1 NGVD. It appears that none of 43 roadway crown junction nodes are at, or below, this high tide elevation (0.0%),
- Since that the highest tide observed was at elevation 5.0, there would be 5 junction nodes that flood street crowns due to tide alone (11.6%).
- Thus, even if the City spends $2 to $6 million on the alternatives presented to provide flood protection from various return frequency storm events, there will be times where nature will still flood nearly 12% of the junction nodes due to high tides alone (and possibly with no rainfall at all).

An analysis of the effective LOS improvements to the finished floor of structures was also investigated. We note that all of the finished floor elevations varied from 5.2 to 11.7 within Basin VI according to the CDM Study. If the 100-year tidal surge strikes the City, most of the minimum building elevations at the 43 building junction nodes would be submerged in flood water since the surge reaches elevations between 8 and 11. In regard to high tide events, all of the junction nodes are above the minimum building elevations so that no structures should flood because of tide events alone (see Table 5.3.2-4 and 5.3.2-5 for summary). When ranking these basin projects for CIP consideration, these costs to benefit considerations will be factored into our analysis.

Shortly after this report was issued, the City did implement Basin VI improvements to both the pump station, and the primary conveyance facilities to the pump station. We have not been able to verify if the actual Alternative 3 recommendations were actually followed. Until this verification has been completed, we will assume that the City modified the improvements based on available funding at the time. <u>We recommend completing the verification of construction activities to determine if the flood protection provided eliminates this Basin from needing further construction improvements</u>.

5.4 ASSESSMENT OF WORST STRUCTURAL PROBLEM AREAS

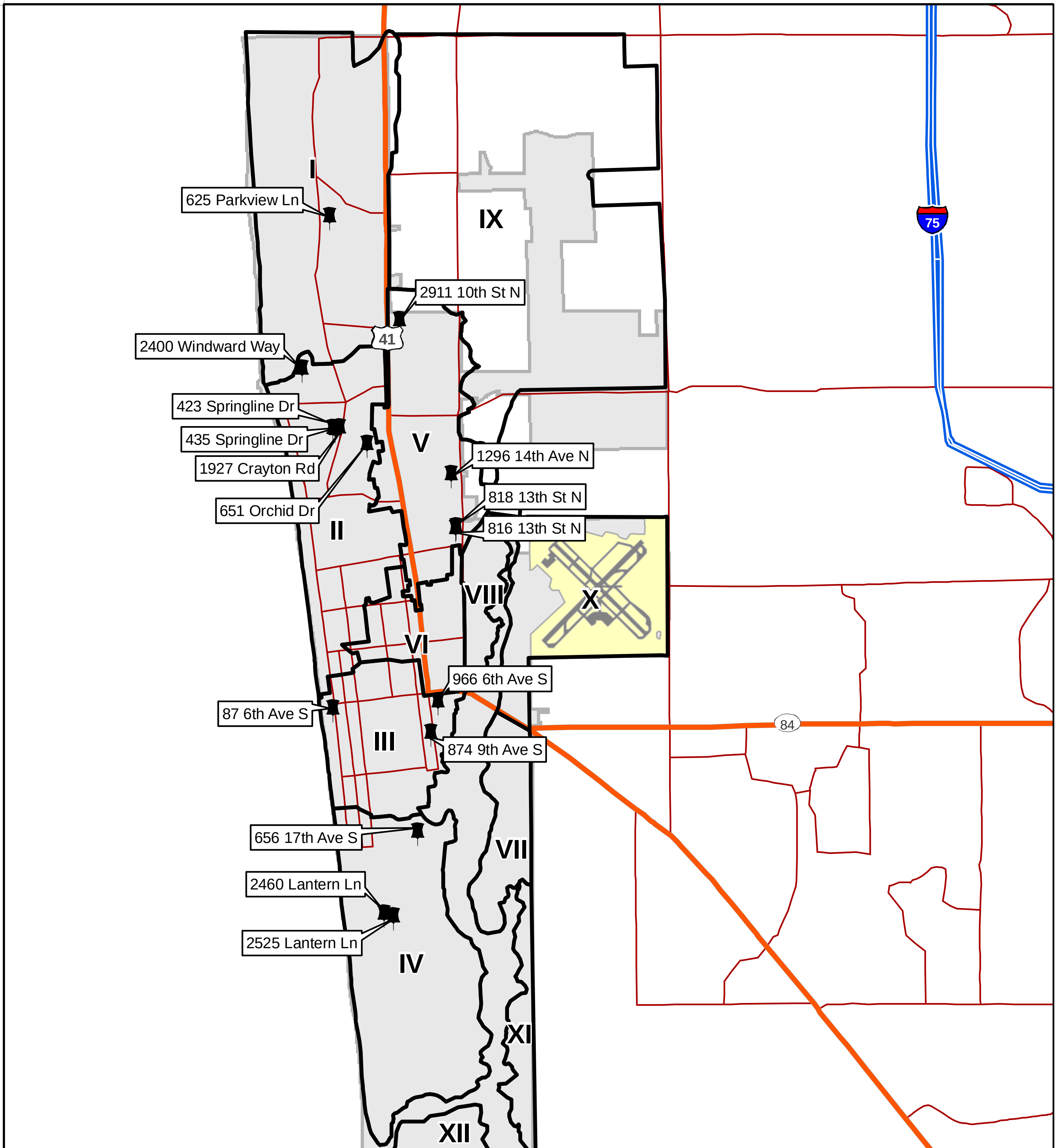
Table 5.4 summarizes some of the major structural flooding problem areas in the City of Naples. As indicated in the table, Basin II has the greatest number of repetitive loss structures. **Repetitive loss structures** are building structures that have been subjected to insurance claims due to flooding at least twice in ten (10) years, with claims in excess of $1,000. (See Figure 5.4-1 for locations of these structures relative to the drainage basins). Throughout most of Drainage Basin II, the losses are relatively recent. Some of the losses reported in other drainage basins date back to the mid 1980s. One structure of interest (Structure V-1) experienced flooding dating back to 1987, and though mitigated in 2003 and scheduled to be taken off of the list of repetitive loss properties, flooded again anyway in 2005.

This table was compiled for this Master Stormwater Plan Update by interviewing City staff, checking the previous master plans, and checking FEMA records. The source of information is given as a reference number with the Structure ID Number.

Table 5.4 Summary of Known Building Structures with History of Flooding

Struct. ID #/ Service	Structure Location	Flood Insur.	Owner	Dates of Losses	Total FEMA Payments to 04/30/2006	Repetitive Loss Property	Mitigated
I-1 (10.28)	11000 Gulf Shore Dr.	Yes	Assumed Condominium Building	08/21/2004 09/14/2001	$495,981.82	Yes	Collier County
I-2 (10.6)	625 Parkview Lane		Gerry Storch	2005	Unknown		
II-1 (10.6)	1927 Crayton Rd.		Marta Suarez	2003	Unknown		
II-2 (10.28 & 10.6)	2400 Windward Way	Yes	Gerald Wachowitcz	10/24/2005 06/10/2005	$128,975.87	Yes	No
II-3 (10.28)	435 Springline Dr.	Yes	Donald Wayne & Arnold	09/26/2003 09/29/2001	$ 13,738.96	Yes	Demolished in 2004
II-4 (10.28)	651 Orchid Dr.	Yes	Paul T Kane	09/29/2003 08/25/1995	$ 3,742.13	Yes	No
II-5 (10.28)	423 Springline Dr.	Yes	James & Beth Starnes	10/24/2005 08/13/2004	$102,076.26	Yes	No
III-1 (10.6)	87 6th Ave. So.		Toni Tuttle	Unknown			
III-2 (10.28 & 10.6)	874-876 9th Ave. So.	Yes	Mark Borelli / Karen Van Arsdale	06/12/2005 09/20/1999	$ 13,345.66	Yes	No
IV-1 (10.28 & 10.6)	2460 Lantern Lane	Yes	Steve & Lindsey Smith	10/24/2005 06/12/2005 08/24/1995	$ 73,362.86	Yes	No
IV-2 (10.28)	A56 17th Ave. So.	Yes	John G Wolf	3/13/1993 11/23/1998 12/31/1986	$ 34,050.53	Yes	No longer repetitive loss property
IV-3 (10.28)	2525 Lantern Ln.	Yes	GBD KKD Partners LP	09/29/2003 09/29/2001 09/20/1999	$ 80,294.05	Yes	No
V-1 (10.28)	816 13th St. No.	SDF	Gregory Cabiness	6/9/2005 09/29/2003 08/24/1995 05/15/1987	$ 21,084.38	Yes	Mitigated 10/7/03
V-2 (10.28)	818 13th St. No.	No	Raymond Jr & F Dulaney	9/21/1999 08/24/1995	$ 3,494.05	Yes	Mitigated 10/7/03
V-3 (10.28)	1296 14th Ave. No.	Yes	Karen M Emigh-Saldana	06/24/2003 08/24/1995	$ 3,850.79	Yes	Elevated in 2005
VI-1 (10.28)	990 4th Ave. So.	No	Deborah A Cox	9/20/1999 08/24/1995	$ 6,887.90	Yes	No
I / V (10.6)	2911 10th St No.		Ed Dotter	2005	Unknown		
III / IV (10.6)	966 6th Av. So.		Beth Bedtelyon	2005	Unknown		

Note: The payments shown above from FEMA insurance claims. They do not reflect payments or project costs by the City of Naples.



Source: City of Naples, FL

LEGEND

City of Naples

City Limits

Basins I - XII

Approximate Location of Flooding Incident Report for Building Structure

N

0 1 Miles

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FLOOD INCIDENT REPORT LOCATIONS MAP
STORMWATER MASTER PLAN
CITY OF NAPLES, FLORIDA

FIGURE
5.4-1

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SECTION 6

ASSESSMENT OF WATER QUALITY (POLLUTION IMPACTS)

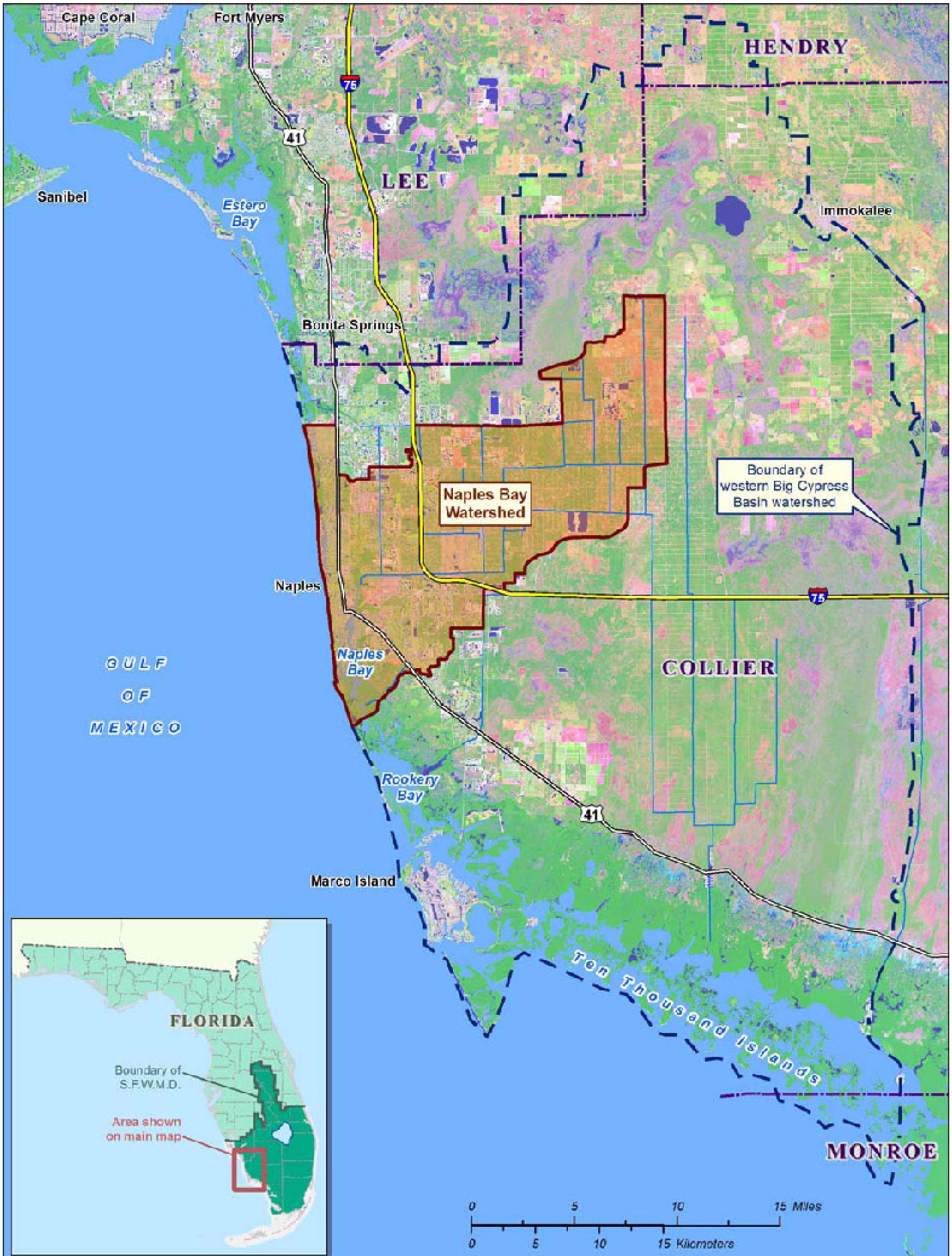
6.1 RECEIVING WATERS CONSIDERATIONS

The Gulf of Mexico is the final receiving water body for all surface water runoff generated by the City of Naples. The drainage basins that make up the City, however, all discharge into one of the three (3) immediate receiving water bodies: (1) Naples Bay; (2) Gulf of Mexico directly; or (3) the Moorings Bay finger canals that all discharge through Doctor's Pass to the Gulf of Mexico. The Moorings Bay area is a tidally influenced bay that has been dredged and reworked significantly by man to provide harbored boat access to the Gulf of Mexico. Naples Bay was historically a vital estuarine resource connecting to the Gulf of Mexico. An estuary is a semi-enclosed body of water where fresh water from the land, usually from a river, meets salt water from the sea. As the waters meet and mix, the salt content of the water gradually goes from zero parts of salt per thousand (ppt) at the rivers head to full strength seawater (usually 32-38 ppt) at the ocean inlet. The area in between, called the mixing zone, has a salt content that varies with tide, season, depth and distance from the sea or river.

Mixing of fresh and salt water, create unique habitats. It is these habitats that make estuaries so ecologically productive. Many marine organisms rely on having just the right salinity at just the right time to ensure survival of their young. The ability to physically tolerate a range of salinity allows some organisms to live and compete for resources where others cannot. For these reasons, estuaries are commonly referred to as nursery grounds because juvenile fish, shrimp, and crab prefer lower salinity environments.

6.1.1 <u>Naples Bay</u>

The Naples Bay Watershed (NBW) encompasses approximately 13% of the drainage area within the Big Cypress Basin (1,200 square miles). The NBW, as defined by the SFWMD, comprises 32 sub-basins. The NBW is wholly contained within Collier County. The NBW is also wholly encompassed by the western Big Cypress Basin (BCB) watershed. See Figure 6.1.1-1.



Source: SFWMD Naples Bay SWIM Plan, Draft January 2007

LEGEND

N

N.T.S.

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BIG CYPRESS BASIN & NAPLES BAY WATERSHED
STORMWATER MASTER PLAN
CITY OF NAPLES, FLORIDA

FIGURE
6.1.1-1

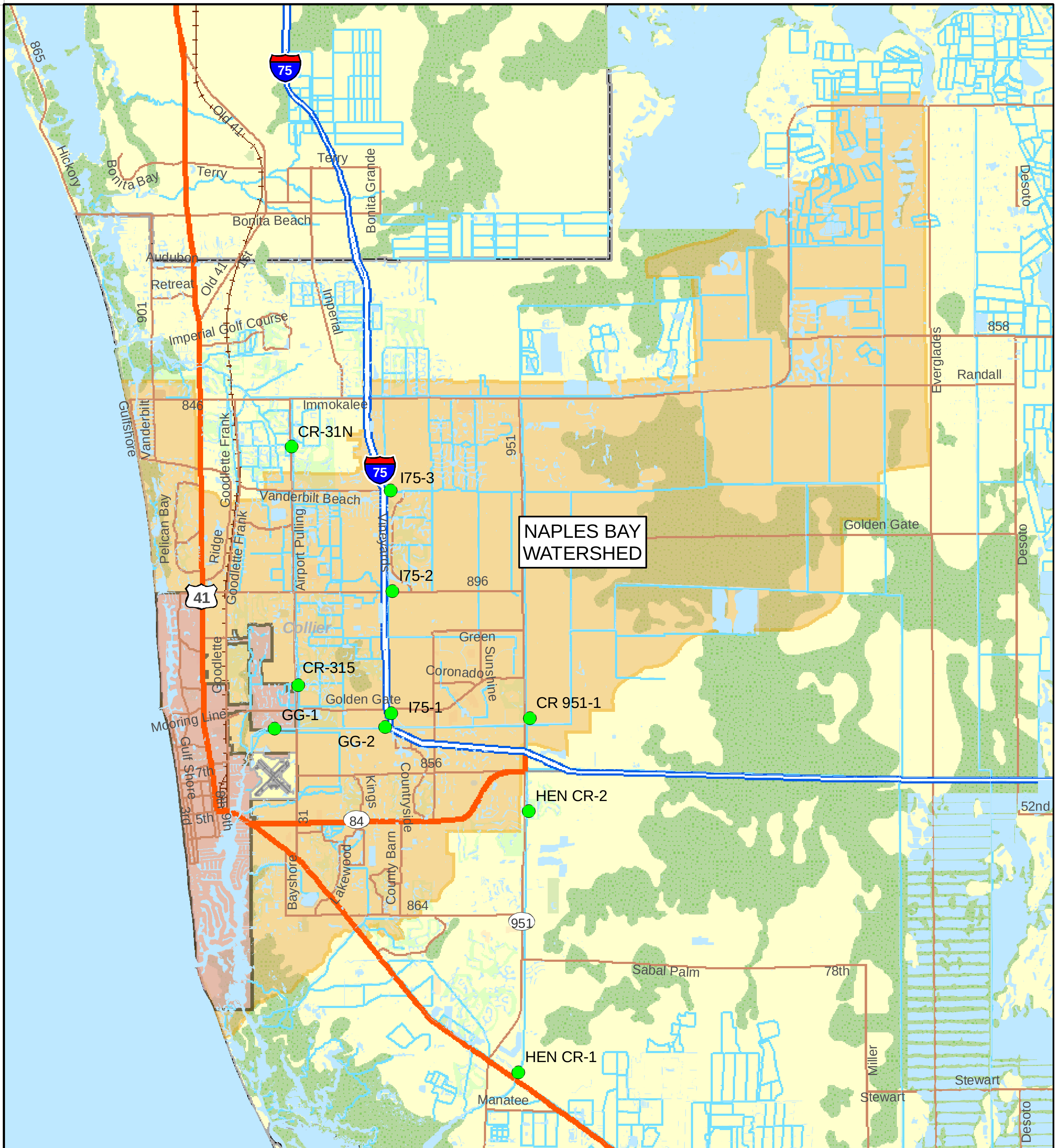
The major hydrologic feature in the NBW is Naples Bay, a relatively narrow and shallow estuary ranging in width from 100 to 1500 feet, and in depth from 1 to 23 feet (Reference #10.18 and 10.19). The majority of the Bay is less than five (5) feet deep with a navigational channel between 7 and 14 feet deep. It is formed by the confluence of the Gordon River and other small tributaries that empty into the Gulf of Mexico through Gordon Pass. 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 results of 60 years of canal drainage, agricultural activities and urban development activities have: reduced water clarity; increased concentrations of contaminants and nutrients; increased fresh water; and reduced dissolved oxygen levels in the NBW. The Watershed now collects surface water input from approximately 120 to 160 square miles, over a tenfold increase from the historic drainage condition (Reference #10.19). Although the text continuously gives 120 square miles for the watershed area, our evaluation of the GIS sub-basins indicates that the 160 figure is the correct value. The City of Naples consists of approximately 14.5 square miles of the overall watershed. Thus, the City of Naples only accounts for around 9.0% of the watershed.

In actuality, the contribution of surface water to Naples Bay from the City is less by land area than that shown in the SFWMD SWIM reports. A closer examination of Drainage Basins I and II in the City of Naples (3.9 acres) reveals that these two (2) areas drain directly to the Gulf of Mexico or out through Doctors Pass. As a result, the modified **Contributing Area** of the City drainage to Naples Bay is 10.6 acres shown in Figures 6.1.1-2 and 6.1.1-3. Adjusting the ratio of net contributing runoff from the City from the net watershed area provides an estimate of how much of the City actually contributes to the drainage area affecting Naples Bay. It appears that 6.8% is a reasonable estimate based upon actual surface areas.

$$\frac{\text{Net Contributing Areas}}{\text{Net Watershed Area}} = \frac{14.5 - 3.9}{160 - 3.9} = \frac{10.6}{156.1} = 6.8\%$$

Today, large quantities of freshwater discharge through the large network of flood control canals and ditches. These point discharges disrupt the natural salinity fluctuations and shock the aquatic biota in the Bay. Naples Bay no longer exhibits the natural salt variations of a protected estuarine bay. Much of Naples Bay displays characteristics of a lower saline system. Extensive areas of mangroves and salt marsh have been replaced by canals, seawalls and bulkheads.



LEGEND

City of Naples City Limits (14.5 Square Miles)

Naples Bay Watershed (160 Square Miles)

Approximate Location of Major BCB Control Structures within Vicinity of Naples

N

0 3 Miles

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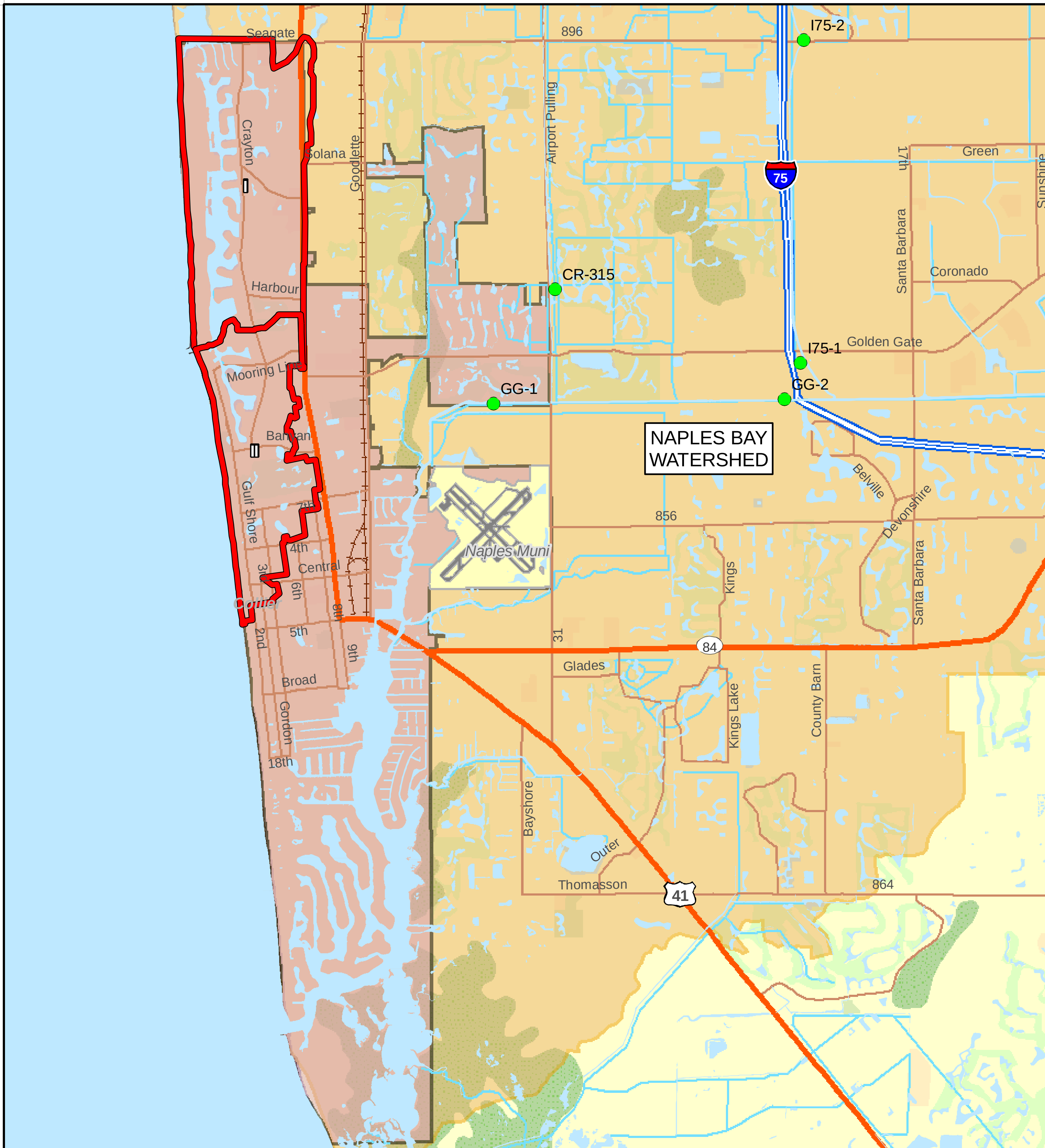
NAPLES BAY WATERSHED
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE
6.1.1-2



LEGEND

City of Naples City Limits (14.5 Square Miles)

Naples Bay Watershed (160 Square Miles)

City of Naples Basins Iand II Stormwater Outfalls into the Gulf of Mexico

Approximate Location of Major BCB Control Structures within Vicinity of Naples

N

0 6,000 Feet

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STORMWATER OUTFALLS TO THE GULF OF MEXICO
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE 6.1.1-3

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 also been altered by urban infrastructure changing the historic flowways to Naples 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, contributing to the declines in sea grass beds, and harmful impacts to all levels of flora and fauna in the aquatic ecosystem.

In 1977, the Big Cypress Basin (BCB) Board was created to evaluate the water resources of the Basin, develop water management plans, and address the broad objectives of conservation, preservation and enhancement of the water resources of the region. In 1979, Collier County, SFWMD and the BCB Board agreed to transfer the operation and maintenance responsibilities of 20 water control structures to the BCB Board. An agreement in 1986 extended the Basin's role to cover the entire primary drainage system in the County. In accordance with this agreement, 106 miles of primary canal segments were adopted in phases as "Works of the Basin." The BCB Board presently has responsibility for operation, maintenance, and providing planning and capital improvements to 169 miles of primary canals and 46 water control structures. (Ref. #10.37) See Figures 6.1.1-2 and 6.1.1-3 for the locations of the closest water control structures to the City of Naples. Presently, the BCB collects continuous data on rainfall, evaporation, surface and groundwater levels, storm flow, and water quality. The BCB's monitoring network includes 106 stations that is processed for storage and retrieved at the District's Hydrological and Water Quality Database. (DBHYDRO). (Reference # 10.37) Further details of the activities of the BCB can be found on the SFWMD Web site at **http://www.sfwmd.gov**. An index of all research and monitoring activities is publically accessible at **http://ocean.floridamarine.org/bcb**.

Of the 106 Hydrologic Monitoring Stations that BCB maintains, only about seven are of immediate interest to the City of Naples because of their location. Table 6.1.1-1 below summarizes those stations.

Table 6.1.1-1 Summary of BCB Hydrologic Monitoring Stations in Naples Area

Station I.D.#	Site Name	Station Name	Parameters Measured											
			Stage	Headwater	Tailwater	Rainfall	Gates	Wells	Water Quality	Evaporation	Temperature	Wind Speed	Supervisory Control	Telemetry
37	GOLDW1	Golden Gate Weir #1@CR31	X						X					X
38	GOLDW2	Golden Gate Weir #2		X										X
42	Gordon	Gordon River		X	X									
43	Haldem	Haldeman Creek		X	X									X
49	I75W1	I-75 Weir #1		X	X									X
63	NAP31	CR31 South		X	X									X
64	NAPCON	The Conservancy				X								X

The locations of major control structures of BCB are shown on Figures 6.1.1-2 and 6.1.1-3. The monitoring stations described above are not shown on these figures, although their approximate location can be deduced from the station name above and using the major control structure location that is shown on the figures.

The Golden Gate system of canals tends to be aligned along section and half section boundaries in north-south or east-west patterns. There are eleven major canals within the Naples Bay Watershed including, Golden Gate Main Canal, Orange Tree Canal, Corkscrew Canal, Curry Canal, Cypress Canal, CR 951 Canal, Green Canal, Harvey Canal, 1-75 Canal, Airport Road Canal. 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 (Reference #10.19).

According to the data discussed in the SFWMD SWIM Plan (Reference # 10.19), average salinities at the US 41 Bridge range from 0 to 10 practical salinity units (PSU) in the wet season and occasionally approach 35 PSU (the salinity of the open Gulf) in the dry season. Data from various compiled reports by Taylor Engineering, however, indicate that the 75 percentile for Salinity in Naples Bay is 35.6 south of the US 41 Bridge and 30.7 north of the US 41 Bridge.

(Reference # 10.23). 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.

Stratification problems appear 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 (Reference #10.19).

A study of the Florida Bay (Reference #10.20) indicated a similar disruption in salinity fluctuation regimes due to upland overdrainage and the addition of more freshwater to the system. In that report, Florida Bay's salinity was reported to be affected by water management for flood protection, urban development and agriculture. In a very general sense, northeast Florida Bay is now reported to be more fresh, with salinities from zero to low 20's ppt. Salinities in the central and western parts of the Bay range between 20-35 ppt.

Restoration activities must consider the effects of salinity with the seagrass flora desired. Lowered salinities in Florida Bay, for instance, would lead to a diverse environment of shoal grass, manatee grass and turtle-grass beds. However, if resource management focuses on recreating the Bay's once lush turtle-grass beds present prior to seagrass dieoff, then a tropical lagoon environment with higher salinity would be required (Reference # 10.20). We recommend that sea grass restoration efforts underway by City staff be carefully coordinated since certain species prefer specific salinities. If the BCB is successful in diverting more freshwater away from Naples Bay, the salinity regimes may shift affecting where certain sea grass beds may be most adaptive.

With significant impacts to the watershed rapidly compiling, the Basin Board has undertaken efforts to reduce the surge of freshwater into Naples Bay by numerous water control projects. In addition, many federal, state, and local governments and regulatory agencies along with concerned citizen groups and environmental organizations have formed cooperative partnerships to provide funding, technical support, or political support to initiatives in the area to improve the conditions of the natural resource. Some of these interested parties include: The Naples City Council, South Florida Water Management District, The Conservancy of SW Florida, Collier County environmental Advisory board, Florida Wildlife Federation, and Collier County Board of County Commissioners, US Department of the Interior, US Army Corps of Engineers, US Environmental Protection Agency, Florida Department of Environmental Protection, Florida

Fish and wildlife Conservation Commission, the National Audubon Society, and others. These organizations have shown a strong interest in funding projects and supporting projects that:

- Reduce freshwater discharges into the Bay;
- Reduce pollutant loading into the Bay;
- Re-establish historic vegetative communities in the Bay;
- Restore or provide improved habitat for aquatic biota in the Bay

Some of the most significant Projects that have been identified to help Naples Bay from a water quality improvement standpoint are described in the following section.

6.1.2 Significant Water Quality Project Initiatives for Naples Bay

There are a number of projects detailed in the recent SFWMD SWIM Plan Report (Reference # 10.19) and in the 5-year plan by the SFWMD Big Cypress Basin (Reference # 10.37). The SWIM Plan reports a need to spend over $100 million in projects that may improve the Naples Bay Watershed. With the evolution of urban and agricultural development, the traditional surface water flow patterns in the western Collier County region have undergone drastic changes. Historic flowways have been virtually eliminated, and drainage canals, in many cases, have resulted in haphazard transfer of runoff from one basin to another with too much water in one area and too little in another. Some of the impacts may be minimized or reversed by restoring and reassembling the historic surface water flow characteristics of the region.

The Basin Board has been conducting a comprehensive evaluation of the surface water flow characteristics of the western Collier County region as a singular watershed system under the Big Cypress Basin Watershed Management Plan (BCBWMP). This plan develops a set of regional routing models as a tool for evaluating alternatives for improved water management strategies.

The first two phases of this project consisting of the development of a hydrologic-hydraulic model and ecologic assessment methodology have been completed. An assessment of the hydrologic-hydraulic capacities of BCB facilities has been performed and conceptual alternatives have been evaluated. A preliminary flood control plan has been formulated following comparative evaluation of alternatives. Continued efforts in the BCBWMP will involve the application of an integrated surface and groundwater model presently being utilized as a comprehensive modeling tool to evaluate the entire realm of watershed processes.

This regional watershed management model is being applied to develop several basin-scale plans for formulation of preliminary engineering design of the capital projects outlined in this five year plan. The following projects will comprise the thrust of Watershed Management planning activities during the 2006-2010 planning cycle.

The following projects describe briefly some of the key initiatives identified by the SWIM Plan and BCB Five Year Plan that the City is involved with (or may be involved with):

- Broad Avenue South Linear and Water Quality Park – The City of Naples is the sponsor for this project which will consist of several ponds and swales and a filter marsh. Stormwater will enter into a proposed filter marsh before entering into Naples Bay. A feasibility study is currently being carried out by CDM but was not available for review at the time of this writing. The benefits of this project include improvement of water quality, decrease of flooding issues, preservation of urban open space and opportunities for education about stormwater and water quality.

- Lakes to Bay Goodlette-Frank Conservancy Filter Marsh System - A series of stormwater lakes located in downtown Naples that currently are not connected to each other will connect to Naples Bay through ditches and swales as part of this project. In addition, a filter marsh is proposed to receive stormwater before it enters Naples Bay. The City of Naples is the responsible entity for this project. The main objectives of this project are to minimize flooding problems, improve water quality, properly size outfall pipes and maximize retention.

- Gordon River Water Quality Park - The Gordon River Water Quality Park project involves a series of interconnected multiple-depth ponds, polishing marshes and wetlands that will function as a natural filtration system and improve the water quality of the Gordon River and Naples Bay. The County has built a pond site there now for the current expansion of Goodlette-Frank Road. The responsible entities for this project are Collier County, SFWMD/Big Cypress Basin and the City of Naples. These project partners have hired CH2MHill as the consultant firm for the treatment pond project. Contact Tom Spriggs, PhD, at 813-874-6522.

- Golden Gate Canal Outfall Improvements - The Golden Gate Canal Outfall Improvements project proposes the diversion of water from the Golden Gate Main Canal into the SR 951 canal, construction of a filter marsh near the outfall of the Golden Gate Main Canal at the

Gordon River and implementation of Aquifer Storage and Recovery (ASR) technology. Collier County, SFWMD/Big Cypress Basin and City of Naples are the responsible partners for this project. This project will decrease the amount of freshwater that enters the Gordon River and improve water quality.

- East Naples Bay Swale Restoration Improvements – The City of Naples proposes the replacement of various concrete swales outfalls located along the shore of Naples Bay with vegetated swales in order to decrease the velocity of runoff at these outfalls and improve water quality.

- Gateway Triangle Stormwater Management – This stormwater infrastructure retrofit project for the Gateway Triangle area includes the installation of outlet control and backflow prevention valves at some outfall points along the Bay. This project is proposed by Collier County and will help to reduce flooding problems in Gate Triangle area and decrease pollutant and nutrients loading to Naples Bay. The County contact for the project is Shane Cox at 239-659-5792.

- Modification of Golden Gate Canal Weir #2- SFWMD/Big Cypress Basin and Collier County are the sponsors of this project that proposes raising the weir crest of the Golden Gate Canal Weir #2 and modification of the gates in order to provide the appropriate flood protection and improve water quality which has been deteriorated as a result of population growth and changes in impervious area. This project is part of the Big Cypress Basin Watershed Management Plan (BCBWMP). The modified structure will enhance flood protection from the "flash flooding" and create conservation storage capacities. Construction of the $4,200 ,000 project was scheduled to start in late fiscal year 2006.

- Modification of I-75 Canal Weir #1 – This project consist of the modification of the I-75 Canal by raising weir crests and changing gates to reach the adequate flood control for this fast-growing urbanized area and decrease the amount of freshwater discharging into Naples Bay. Collier County is the responsible entity for this project.

It should be noted that some of these projects will be funded in part or in whole by the City of Naples, whereas others will be funded by other public entities. The overall effectiveness of each project in terms of reducing freshwater surges, removal of pollutants, and/or flood control (as a benefit) should be summarized relative to the overall costs of implementing these projects. Table 6.1.2-1 attempts to organize this information for the City for future funding and implementation considerations.

TABLE 6.1.2-1

Water Quality Project Initiatives for Naples Bay

City CIP ID #	Brief Title	Entity(ies) Responsible	Benefits Summarized	Anticipated Costs
6.1.1	Broad Avenue South Linear and Water Quality Park	City of Naples	Improvement of water quality, decrease of flooding issues, presentation of urban open space and opportunities for education	$4,200,000 (Ref. #10.19)
N/A	Lakes to Bay Goodlette-Frank Conservancy Filter Marsh System	City of Naples	Minimize flooding problems, improvement of water quality, properly sized outfall pipes and maximization of retention	TBD (Ref. #10.19)
N/A	Gordon River Water Quality Park	Collier County	Water quality improvement, decrease of flooding impacts, education/outreach opportunities.	$11,980,000 (Ref. #10.19)
N/A	Golden Gate Canal Outfall Improvements	SFWMD/ Big Cypress Basin	Decrease of amount of freshwater entering the Gordon River, improvement of water quality, wetland enhancement	TBD (Ref. #10.40)
TBD	East Naples Bay Swale Restoration Improvements	City of Naples	Slow stormwater runoff at outfall points and water quality improvement	TBD (Ref. #10.40)
N/A	Gateway Triangle Stormwater Management	Collier County	Reduction of flooding problems in Gate Triangle area and decrease of pollutant and nutrients loading to Naples Bay	$6,000,000 (Ref. #10.19)
N/A	Modification of Golden Gate Canal Weir #2	SFWMD/ Big Cypress Basin	Water quality improvement and decrease of flooding impacts	$4,200,000 (Ref. #10.19)
N/A	Modification of I-75 Canal Weir #1	Collier County	Water quality improvement, increased flood protection and wetland enhancement	$2,000,000 (Ref. #10.40)
6.1.2	Cove Pump Station/Naples Bay Outfall Detention Water Quality Basin	City of Naples	This project was conceptually discussed in Basin III report, it is not under preliminary engineering at this time.	$1,800,000 (Ref. #10.6)

We also note that the Big Cypress Basin has several projects described in their current Five Year Plan that also affect the City of Naples in terms of the restoration of Naples Bay even though the City may not currently be a direct participant. These two (2) programs will ultimately help divert some of the excess freshwater away from Naples Bay and are described briefly as follows:

- **Golden Gate Canal/Henderson Creek Diversion Plan** – The historic flowways of Henderson Creek have been disrupted by nearly 50 years of road and drainage development. One of the key objectives of the BCBWMP is to restore this important flowway to reduce flooding and minimize adverse impacts to the estuaries. Accordingly, the BCBWMP recommended implementation of a diversion canal to connect Golden Gate Main Canal and Henderson Creek across I-75. The objective of this project is to divert a portion of the Golden Gate Canal flows to restore the historic flowways of the Henderson Creek Basin and to reduce flooding along the urbanized areas of Golden Gate Main Canal. It will additionally reduce voluminous freshwater shock load to the Naples Bay estuary. The Basin staff is coordinating with a land developer to implement the diversion through a series of lakes for eventual connection to the upper reaches of Henderson Creek. The construction and land acquisition cost of the project is estimated at $2,500,000 and scheduled for implementation in 2007.

- **Estuarine Hydrodynamics and Water Quality Evaluation and Planning** – The bays and estuaries along the coast are the receiving fresh waters from the Big Cypress Basin's primary canal system. To understand the impact of the current management practices and future alternatives, it is necessary to simulate the hydrodynamics of the system and relate the water management practices to the water quality and biological characteristics of the estuaries. The first project in this endeavor will involve development of a hydrodynamic and water quality model for the Naples Bay estuary. A comprehensive review of the available data and construction of a simple model for the estuary was performed in 2005. These efforts also included collection of bathymetric data for the Bay. A comprehensive model will be developed to track the impact of changes in freshwater and nutrient loads on the estuary. This modeling project may be used to develop a watershed management plan to meet the Total Maximum Daily Load (TMDL) requirements.

6.1.3 Gulf of Mexico

Rapid urbanization along the southwest coast of Florida has lead to an increase in the amount of nitrates and phosphates flowing into the gulf, causing an alarming number of algal blooms. Frequent red tides deplete dissolved oxygen in water making it unable to sustain marine life and can cause major respiratory problems in humans and their pets. The declining health of the gulf not only threatens the major fishing industries supported by the gulf, but also the health of surrounding residents.

For these reasons, direct stormwater outfalls into the gulf are no longer permitted by the State of Florida. Naples currently drains untreated stormwater directly into the gulf through nine (9) outfalls. The Florida Department of Environmental Protection (FDEP) would like to see those outfalls removed. In order to encourage this activity, the FDEP has warned the City staff and Collier County that no more permits for beach sand renourishment will be granted without a plan for the removal of the outfalls. These outfalls are part of the existing drainage system for Drainage Basin II, and therefore, removing them will create capacity and conveyance issues, which may increase flooding impacts. A potential solution is to connect the outfalls to a manifold system and pump the untreated stormwater into the lake surrounded by East Palm Circle and West Palm Circle and/or the lake located south of North Lake Drive and north of South Lake Drive in order to provide treatment to the stormwater before discharge. Another alternative discussed was diverting the "first flush" of runoff to wastewater treatment plant and using the filtration and chlorination treatment train to produce additional reuse water. We recommend that a specific study be commissioned to evaluate alternatives to remove the beach outfalls including the most practical manner to treat the pollutants.

6.1.4 Moorings Bay

The Moorings Bay System is a grouping of boating channels, bays, and man-made canals that provides the most altered and engineered shoreline in the City of Naples. The interconnected water bodies are made up of Moorings Bay, Outer Doctor's Bay, Inner Doctor's Bay, and Venetian Bay. The system flows out through Doctor's Pass to the south, but is hydraulically connected to Outer Clam Bay north of the City limits, which empties out into the Gulf of Mexico through Clam's Pass. This system of waterways makes up most of Basin I and the north section of Basin II. The extreme traffic of boats, dredged channels, and hard seawalls makes this area the most significantly altered estuarine habitat. It should be noted that so much attention has been placed on Naples Bay that the Moorings Bay area is virtually unmentioned in all of the reports compiled for this master plan. Unlike Naples Bay which receives the majority of its freshwater impacts and pollutant runoff from Collier County, these important waters are entirely within the City of Naples and their impacts are attributed to City land uses. We recommend that this area be studied separately by the City since it does not appear to be covered in the current Big Cypress Basin initiatives focused on Naples Bay and its watershed.

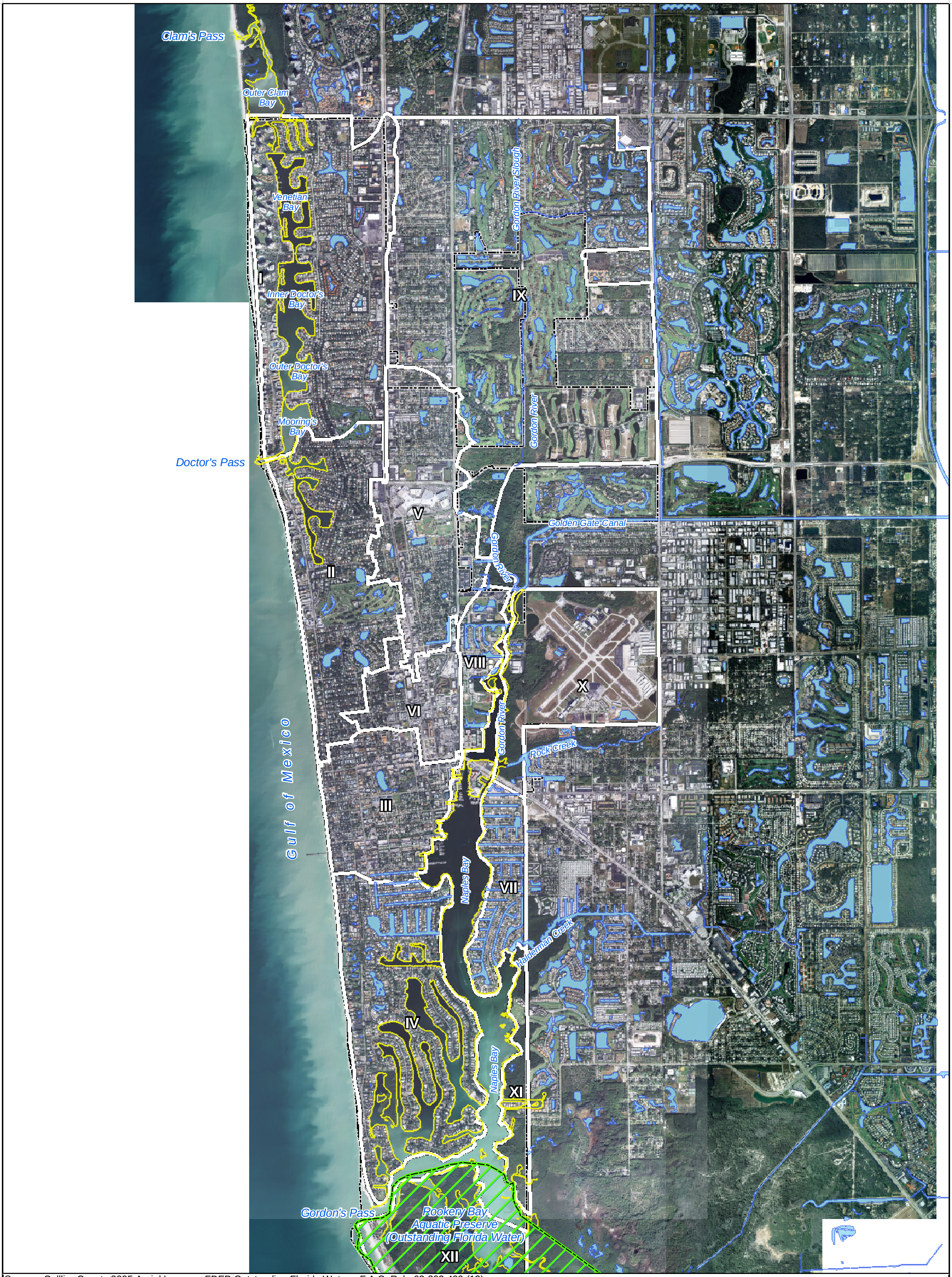
6.1.5 Special State Designations

Most surface waters of the State of Florida are classified as Class III - Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife, except for certain waters which are described in the Florida Administrative Code (FAC) Rule 62-302.400(12). Class I is reserved for waters that are used for sources of raw water for treatment to drinking standards whereas Class II is reserved for waters where shellfish propagation and harvesting deserve special protection. The City of Naples contains waters with both Class II and Class III designations. A water body may be designated as an Outstanding Florida Water or an Outstanding National Resource Water in addition to being classified as Class I, Class II, or Class III.

The following listed water bodies in the City of Naples are classified as Class II according to FAC Rule 62-302.400(12):

- Connecting Waterways - From Wiggins Pass south to Outer Doctors Bay.
- Outer Clam Bay.
- Inner and Outer Doctors Bay.
- Tidal Bays and Passes.
- Naples Bay and south and easterly through Rookery Bay.
- Figure 6.1.5-1 shows our interpretation of FAC 62-302.400(12) in regard to the Class II, Class III and OFW water bodies with the City of Naples and vicinity.

FDEP Surface Water Classification Boundary Areas GIS Data indicates that Bowline Bay, Compass Cove, Hurricane Harbor and Gordon River from US-41 to the confluence of the Gordon River and the Golden Gate Canal listed are Class II water bodies.



Source: Colllier County 2005 Aerial Imagery, FDEP Outstanding Florida Waters, F.A.C. Rule 62-302.400 (12)

N

0 3,500 Feet

LEGEND

City of Naples City Limits

Basins I-XI

Outstanding Florida Water Body, State Aquatic Preserve, National Estuarine Research Reserve

FDEP Surface Water Body Classification

Class II Water Body

Class III Water Body

TETRA TECH HAI
Infrastructure Offices Throughout Florida
Orlando • Fort Myers

SURFACE WATER BODY CLASSIFICATION AND OUTSTANDING FLORIDA WATERS MAP
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE 6.1.5-1

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030009016-SW\maps\report_1st_BPIF6.1.mxd [12-26-06 amm]

Rookery Bay is the only OFW located in the City of Naples listed in FAC Rule 62-302.400(12). Normally waters with these special designations are provided special considerations in regards to pollutant reduction goals. We recommend the City revisit their development regulations and investigate whether a higher level of treatment should be considered in the City. More will be discussed on this in Section 7.4. The next section will provide the technical framework for that discussion.

6.2 BEST MANAGEMENT PRACTICES (BMPs)

Under the following sections, we will briefly discuss some of the common Best Management Practices (BMPs) utilized for water quality treatment. It should be noted that there are extensive detailed write-ups in the numerous drainage basin studies and master plans already performed for the City by various consultants which more than adequately describe these techniques. Thus, we only offer a brief summary of each for purposes of keeping the information integrated in this Stormwater Master Plan Update. For more detailed and specific reading on each of these stormwater management treatment techniques, we recommend several publications that discuss the BMP effectiveness (see Reference No.10.38, 10.16 and 10.17).

6.2.1 Wet Detention Provisions

Wet detention systems are permanently wet ponds which are designed to slowly release the detention volume over a 24 to 72-hour period through an outlet structure. Wet detention ponds are designed to maintain a permanent pool of water, which generally is maintained at the seasonal high groundwater level. The control structure generally includes a drawdown device, such an orifice or a small weir, set at the normal water level.

Removal efficiencies in this type of systems are primarily a result of residence time. Residence time is equal to the detention volume divided by the outflow rate. The longer the residence time, the higher the removal efficiency. Important pollutant removal processes which occur within the permanent pool include: uptake of nutrients by algae, adsorption of nutrients and heavy metals onto bottom sediments, biological oxidation of organic materials, and sedimentation. The storage capacity of the permanent pool must be large enough to detain the untreated runoff long enough for the treatment process described above to take place.

6.2.2 Dry Retention / Detention Ponds

Dry detention systems are dry storage areas which are designed to store a defined quantity of runoff and slowly release the collected runoff through an outlet structure to adjacent surface waters. After drawdown of the stored runoff is completed, the storage basin does not hold any water thus the system is normally "dry." These ponds are on-line ponds in which the detention volumes are slowly released in 2-3 days primarily by a control structure rather than by percolation. The principal pollutant mechanism is the settling action to the bottom of the pond. The same consideration of groundwater levels as dry retention ponds must be observed (Reference # 10.16, #10.17).

A retention system is defined as a storage area designed to store a defined amount of runoff, allowing it to percolate through permeable soils and into the shallow ground water aquifer. Soil permeability and the water table must be such that the retention system can percolate the desired runoff volume within a specified time following as storm event. These ponds, unlike the dry detention ponds are not made to discharge collected runoff. Retention systems provide significant removal of many different stormwater pollutants, including: suspended solids, oxygen demanding materials, heavy metals, bacteria, some varieties of pesticides, and nutrients such as phosphorus (Reference # 10.16).

6.2.3 Swale Provisions

Swales are shallow vegetated channels used to convey stormwater where pollutants are removed by filtration through grass and infiltration through soil. They usually require shallow slopes and soils that drain at least moderately well. Grassed swale designs have achieved mixed performance in pollutant removal efficiency. Runoff waters are typically not detained long enough to effectively remove very fine suspended solids, and swales are generally unable to remove significant amounts of dissolved nutrients. Moderate removal rates have been reported for suspended solids and metals. Deeper swales that can retain the entire FAC treatment volume can act like a linear retention pond and provide much higher removal rates.

Grassed swales are sometimes modified to provide water quality filtration and treatment through the use of bio-retention areas in the swale, although their primary use is for stormwater conveyance. They can provide sufficient control under light and moderate runoff conditions, with the correct stabilization, but their ability to control large storms is limited. Enhanced grassed swales, or bio-filters, utilize check dams, bio-retention areas, and/or wide depressions to increase runoff storage and promote settling and treatment of more pollutants.

6.2.4 Exfiltration – Filtration Provisions

There are basically two forms of filtration systems utilized with common BMPs. One form involves the process of **exfiltration** while the other involves the process of **infiltration**. There are numerous forms of exfiltration devices whereby the stormwater is disposed of directly into the ground by placing hydraulic head pressure on a permeable distribution facility and forcing the stormwater into the void spaces in the surrounding soil. These systems are highly efficient in treating water quality since they do not allow discharges to downstream water bodies if they are designed correctly. They typically consist of slotted culverts, perforated pipes, gravel trenches, and specialized corrugated plastic distribution galleries that are wrapped with special filter fabrics to prevent the fine soil materials from entering into the distribution system and clogging the perforations.

The ability of these systems to operate is dependent upon their use in soils where the groundwater table remains below the exfiltration system allowing the hydraulic pressure to force collected water through the native soils. Silty soils, organic soils and clayey soils do not lend themselves to the proper operation of these systems. Often exfiltration pipes and galleries work very well in coastal communities when placed in relic dune systems where the water table is low and the sands have high percolation rates. Unfortunately, in the Naples area, the coastal dune sands are in very low lying topographic areas where the available distance to the high groundwater table does not leave sufficient room for such systems. In general, the City of Naples is not a community physiographically located suitable for this technique.

Infiltration practices are those systems where the hydraulic pressure of high water table is forced through perforations into a collection distribution pipe which then discharges the water to a lower tailwater condition. Underdrains typify this type of BMP practice. Underdrains are used extensively in communities that have high water tables and where exfiltration practices are not feasible. Underdrains allow the vertical recovery of stormwater management areas where the native soils do not, by themselves, evacuate the design treatment volume in sufficient time to allow the pond to be available for the next storm event.

If there is sufficient filtering media between the pond and the underdrain distribution pipe, the pollutant removal efficiency of such systems can be fairly high. When underdrain systems do not operate properly or where there is insufficient filtering media, the system simply short circuits the infiltration capabilities of the soil and the soluble pollutants are collected by the underdrain system and discharged downstream. As a result, dry retention facilities that use underdrains as a mechanism to ensure recovery, are referred to as "detention with filtration" systems. In order to be referred to as "retention", all of the stormwater must be disposed of by percolation, evaporation or transpiration. Collecting the stormwater in an infiltration pipe (underdrain) and discharging it to a downstream water body is, in effect, a form of detention.

There were other filtration BMPs that are used in the United States but not commonly in the State of Florida. These are systems where the stormwater discharge is deliberately routed to a sand filter system recollected and discharged much in the way of the filtration systems utilized in water/wastewater treatment facilities.

6.2.5 Biological Provisions

Biological treatment systems are often employed as part of water quality treatment train because of the relatively high potential for vegetative masses to remove nutrients. Stormwater wetland treatment areas, filter marshes, and algal filter devices are all examples of such BMP techniques that can be employed. When an array of pollutant constituents needs to be removed, vegetative uptake of nutrients is best employed with other BMP Practices such as filtration and/or physical settling. Vegetative buffer strips and swale facilities are effective because they provide both the vegetative nutrient uptake as well as filtering and percolation capabilities. Likewise, wetlands and littoral zones in wet detention facilities and wetland treatment areas improve the pollutant removal efficiencies of the permanent pool are in combined treatment facilities. This is one reason why the state allows a littoral zone creation in a wet detention pond to substitute for a portion of the required residence time in the permanent pool.

In specific instances, where the pollutants to be removed are a focused reduction on nutrients; there are newer technologies being employed whereby stormwater is cycled through a system of cells of algal mats (or other vegetative materials) that can uptake the nutrients and then be harvested and disposed. Such systems tend to be difficult to implement because of land use issues, maintenance costs, and disposal options available.

6.2.6 Mechanical Provisions

There are number of mechanical pollution treatment and/or settling devices that are employed as part of the BMP options. Most of these alternatives, however, provide very poor pollutant removal efficiency. Examples of such devices are baffle box settling chambers, and the wide selection of centrifugal separators. Most of these systems are efficient at removing either floatable organics and oils, or large particles and suspended solids. They are thus most commonly used as a pretreatment device in a pollutant water quality treatment train. These devices are also expensive and require significant maintenance to remove the debris and sediments collected.

6.2.7 Chemical Provisions

Chemical treatment facilities are becoming more popular in the State of Florida especially in the treatment of lakes with high tropic states due to nutrients. In particular, alum treatment is highly effective in removing phosphorous and does a very respectable job of capturing nitrogen as well. There are significant environmental considerations when using alum treatment because of pH changes and buildup of flocculent material on the bottom of the water bodies. The chemical and maintenance costs of this treatment technology is also substantial. These systems are most typically utilized in small lakes and freshwater wet detention facilities. They are not used in tidal systems where substantial mixing zones are present. There are also products available that utilize polymers to cause particles to coagulate and settle.

6.3 WATER QUALITY SAMPLING PROGRAM

In this section of the report, Tetra Tech attempts to quantify the various water quality sampling programs that have been initiated in the City of Naples and surrounding area. In particular, the attention paid to Naples Bay is emphasized in this section. It is beyond the scope of this Stormwater Master Plan Update to reproduce all of the data that has been collected to date nor to analyze all of that data. We do in this section however, attempt to organize the sampling of water quality data in the area, locate where the data was collected, and what parameters were sampled.

6.3.1 Past Sampling Programs

There are numerous water quality sampling programs that have been initiated for the Naples Bay and surrounding area since 1957. Most of the data that we located were sampled from 1989 to date. Past sampling programs were initiated by the City of Naples, Collier County, South Florida Water Management District, Big Cypress Basin Board, Florida Department of Environmental Protection, Conservancy of Southwest Florida, and Florida International University. Table 6.3.1-1 provides a partial listing of many of these past sampling programs. The table lists the public entities that managed the programs as well as the parameters that they measured (if known). Databases earlier than 1989 were not included in this table, however, additional information on these databases can be obtained from the 2005 Taylor Study (see Reference #10.23). Figure 6.3.1-1 attempts to overlay the locations of the various sampling programs described in Table 6.3.1-1. Table 6.3.1-2 provides a description and location for the water quality sampling stations. Note that the table includes the information for the current City of Naples Sampling Program which was taken over from the FDEP in 2006.

This information must be discussed separately from the past sampling programs because the data was obtained after South Florida Water Management District (SFWMD) commissioned evaluation of the Naples Bay Water Quality and Hydrologic Data Report by Taylor Engineering dated June 2005 (Reference #10.23).

Table 6.3.1-1 Water Quality Sampling Programs in Naples Bay

Parameter	Entity Responsible for Program and Sampling Period					
	Collier County (1989-1996)	Collier County/ SFWMD and BCB (1998-2006)	FDEP (2005)	City of Naples (1993-1999)	City of Naples (2005)	FIU (1999-2005)
Alkalinity	Sampled	Sampled	Sampled		Sampled	
Calcium	Sampled	Sampled	Sampled		Sampled	
Chloride	Sampled	Sampled	Sampled		Sampled	
Fluoride	Sampled	Sampled				
Total Hardness	Sampled	Sampled	Sampled		Sampled	
Magnesium		Sampled	Sampled		Sampled	
Salinity	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
Sulfate	Sampled	Sampled	Sampled		Sampled	
Arsenic	Sampled	Sampled	Sampled	Sampled	Sampled	
Cadmium	Sampled	Sampled	Sampled	Sampled	Sampled	
Chromium	Sampled	Sampled		Sampled		
Copper	Sampled	Sampled	Sampled	Sampled	Sampled	
Iron	Sampled	Sampled	Sampled		Sampled	
Mercury				Sampled		
Selenium				Sampled		
Tin				Sampled		
Lead	Sampled	Sampled	Sampled	Sampled	Sampled	
Zinc	Sampled	Sampled	Sampled	Sampled	Sampled	
BOD	Sampled				Sampled	
Chlorophyll a	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
Diss. Oxygen	Sampled	Sampled	Sampled	Sampled	Sampled	Sampled
DO Saturation			Sampled	Sampled	Sampled	
Fecal Coliform	Sampled	Sampled	Sampled	Sampled	Sampled	
Total Coliform	Sampled	Sampled	Sampled	Sampled	Sampled	
Pheophytin	Sampled	Sampled	Sampled		Sampled	
TOC	Sampled	Sampled	Sampled		Sampled	Sampled

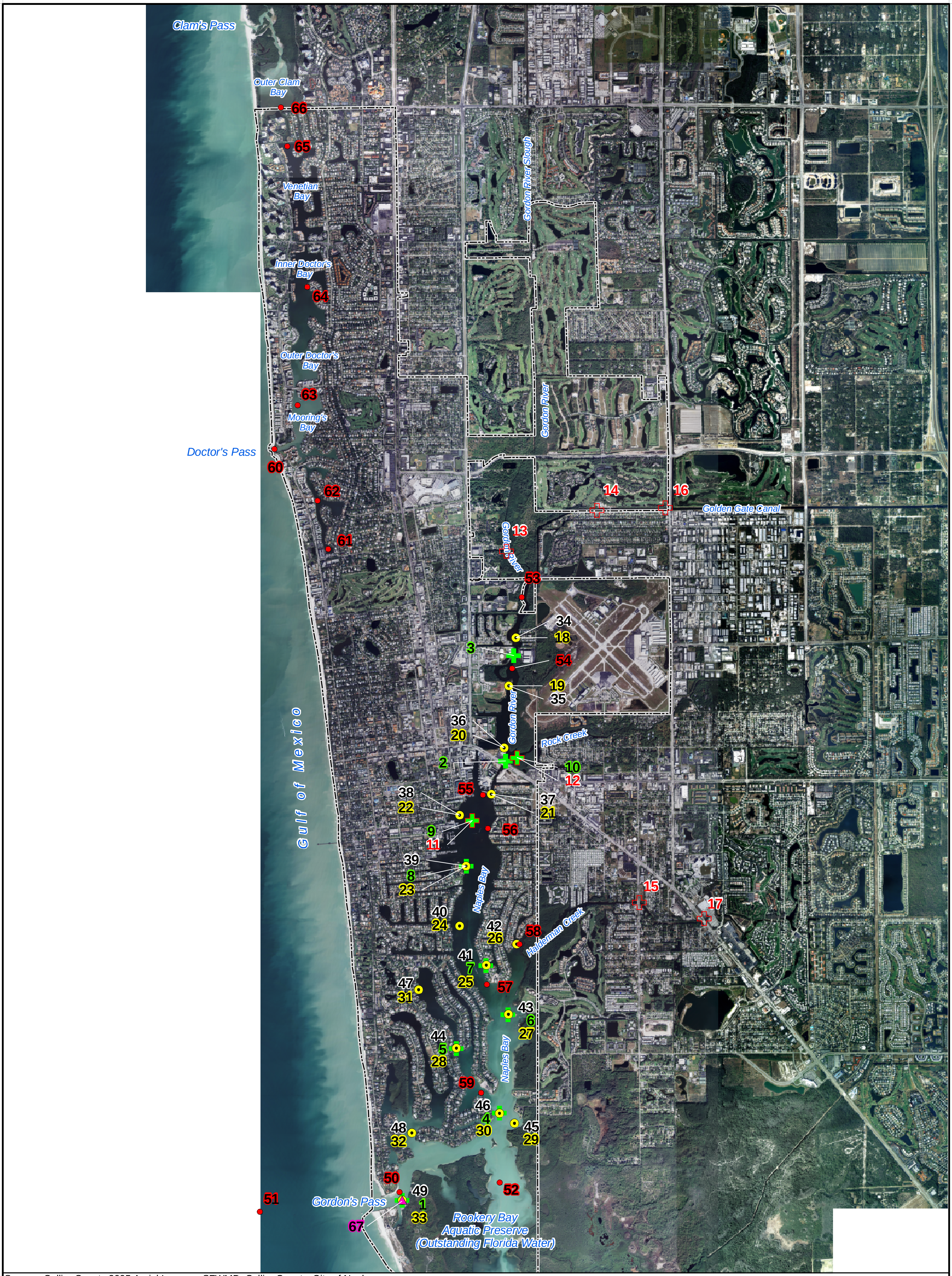
Table 6.3.1-1 Water Quality Sampling Programs in Naples Bay

Parameter	Entity Responsible for Program and Sampling Period					
	Collier County	Collier County/ SFWMD and BCB	FDEP	City of Naples	City of Naples	FIU
Silicate	Sampled	Sampled				Sampled
TDS		Sampled				
TSS	Sampled	Sampled	Sampled		Sampled	
Turbidity	Sampled	Sampled	Sampled		Sampled	Sampled
Diss. Inorganic N		Sampled				
Ammonia	Sampled	Sampled	Sampled		Sampled	
Ammonium		Sampled				Sampled
Nitrite	Sampled	Sampled	Sampled		Sampled	Sampled
Nitrate	Sampled	Sampled	Sampled		Sampled	Sampled
Nitrite+Nitrate		Sampled	Sampled		Sampled	
TKN	Sampled	Sampled	Sampled		Sampled	
TON		Sampled				Sampled
Total N		Sampled	Sampled		Sampled	
Alkaline Phosphatase Activity						Sampled
Soluble Reactive Phosphate						Sampled
Ortho phosphorus		Sampled				
Ortho phosphate	Sampled		Sampled		Sampled	
Total Phosphorus	Sampled	Sampled	Sampled		Sampled	Sampled
TN:TP						Sampled
Oil & Grease				Sampled		
Misc. Pesticides & Org. Comp.*				Sampled		
pH	Sampled	Sampled	Sampled	Sampled	Sampled	
Color	Sampled	Sampled	Sampled		Sampled	
Secchi depth	Sampled	Sampled	Sampled		Sampled	
Specific Conductivity	Sampled	Sampled	Sampled	Sampled	Sampled	
Staff gauge		Sampled				
Temperature	Sampled	Sampled	Sampled		Sampled	Sampled

* For a complete list of compounds sampled contact City of Naples Natural Resources Department for the data spreadsheets. Approximately 21 different compounds (including diazinon malathion,etc) were sampled.

Table 6.3.1-2 Description and Location of the Water Quality Sampling Stations

Tt ID	STATION	EST	INL	DESCRIPTION	Y_DD	X_DD	MONITORED BY	PERIOD	CODE	Tt Comment
1	GORD10	NBY		Gordon Pass at Marker 6FA	26.093	-81.79858	Collier County	1989 - 1996	A	
2	GORD60	NBY		Gordon River at US 41 bridge near Boat Haven	26.14058	-81.78652	Collier County	1989 - 1996	A	
3	GORD70	NBY		Gordon River opposite City of Naples Wastewater Treatment Plant outfall	26.15198	-81.78562	Collier County	1989 - 1996	A	
4	NBAY20	NBY		Naples Bay at Channel Marker 21	26.10253	-81.78702	Collier County	1989 - 1996	A	
5	NBAY22	NBY		Naples Bay at entrance to Treasure Cove	26.10948	-81.79221	Collier County	1989 - 1996	A	
6	NBAY24	NBY		Naples Bay at Marker 24	26.11317	-81.78604	Collier County	1989 - 1996	A	
7	NBAY41	NBY		Naples Bay at mouth of canal entering Royal Harbor	26.11847	-81.78875	Collier County	1989 - 1996	A	
8	NBAY50	NBY		Naples Bay at Marker 31	26.12919	-81.79116	Collier County	1989 - 1996	A	
9	BC1	NBY		Channel marker 38 in Naples Bay	26.13412	-81.79046	Collier County	1989 - 1996	A	Same Location as Tt_ID 11
10	BC2	WD6		Just inside the mouth of Rock Creek	26.14094	-81.78513	Collier County	1989 - 1996	A	Same Location as Tt_ID 12
11	BC1	NBY		Channel marker 38 in Naples Bay	26.13412	-81.79046	Collier County, SFWMD, BCB	1998 - 2006	B	Same Location as Tt_ID 9
12	BC2	WD6		Just inside the mouth of Rock Creek	26.14094	-81.78513	Collier County, SFWMD, BCB	1998 - 2006	B	Same Location as Tt_ID 10
13	BC3	GRE		Gordon River Ext, at mouth of Canal leading to Main Post Office	26.16328	-81.78654	Collier County, SFWMD, BCB	1998 - 2006	B	
14	BC4	MGG		Downstream of Wier in Main Golden Gate Canal across Bear's Paw Country Club	26.16777	-81.77574	Collier County, SFWMD, BCB	1998 - 2006	B	
15	BC5	WD6		Bridge at Intersection of Haldemann Creek and Bayshore Dr.	26.12536	-81.77037	Collier County, SFWMD, BCB	1998 - 2006	B	
16	GGCAT31		MGG	Bridge at Intersection of Airport Rd. and Golden Gate Canal	26.16806	-81.76754	Collier County, SFWMD, BCB	1998 - 2006	B	
17	HALDCRK		WD6	Upstream of Amil Gate at intersection of US 41 and Haldermann Creek	26.1237	-81.76263	Collier County, SFWMD, BCB	1998 - 2006	B	
18	GORDPT			Gordon River near Port Ave.	26.1539	-81.7854	City of Naples	2006	C-1	Same Location as Tt_ID 34
19	GORDPK			Just South of WWTP outfall, adjacent to Pulling Park	26.1487	-81.7862	City of Naples	2006	C-1	Same Location as Tt_ID 35
20	GORDJOE			Gordon River just N. of US 41 bridge near Joe's Crab Shack	26.1420	-81.7867	City of Naples	2006	C-1	Same Location as Tt_ID 36
21	NBAYCC			Entrance to Curlew Canal	26.1370	-81.7882	City of Naples	2006	C-1	Same Location as Tt_ID 37
22	NBAYNL			Naples Landing	26.1347	-81.7920	City of Naples	2006	C-1	Same Location as Tt_ID 38
23	NBAY33			Naples Bay at Marker 33	26.1292	-81.7912	City of Naples	2006	C-1	Same Location as Tt_ID 39
24	NBAY29			Naples Bay, west of marker 29 and south of Egret Channel	26.1227	-81.7919	City of Naples	2006	C-1	Same Location as Tt_ID 40
25	NBAYKF			Naples Bay at mouth of canal entering Kingfish Rd Canal	26.1185	-81.7887	City of Naples	2006	C-1	Same Location as Tt_ID 41
26	NBAYHC			Haldeman Creek	26.1208	-81.7851	City of Naples	2006	C-1	Same Location as Tt_ID 42
27	NBAYWS			Naples Bay near Marker 24, Windstar dock/shoal	26.1132	-81.7860	City of Naples	2006	C-1	Same Location as Tt_ID 43
28	NBAYTC			Naples Bay at entrance to Treasure Cove	26.1095	-81.7922	City of Naples	2006	C-1	Same Location as Tt_ID 44
29	NBAYBV			BayView Park	26.1014	-81.7852	City of Naples	2006	C-1	Same Location as Tt_ID 45
30	NBAY21			Naples Bay at Channel Marker 21	26.1025	-81.7870	City of Naples	2006	C-1	Same Location as Tt_ID 46
31	NBAYLLO			Morgan's Cove by Lantern Lake Outfall	26.1158	-81.7968	City of Naples	2006	C-1	Same Location as Tt_ID 47
32	NBAY13			Just inside of Doubloon Bay, Port Royal	26.1003	-81.7975	City of Naples	2006	C-1	Same Location as Tt_ID 48
33	GPASS6			Just inside Gordon's Pass at Marker 6	26.0930	-81.7986	City of Naples	2006	C-1	Same Location as Tt_ID 49
34	GORDPT			Gordon River near Port Ave.	26.1539	-81.7854	FDEP	2005	C-2	Same Location as Tt_ID 18
35	GORDPK			Just South of WWTP outfall, adjacent to Pulling Park	26.1487	-81.7862	FDEP	2005	C-2	Same Location as Tt_ID 19
36	GORDJOE			Gordon River just N. of US 41 bridge near Joe's Crab Shack	26.1420	-81.7867	FDEP	2005	C-2	Same Location as Tt_ID 20
37	NBAYCC			Entrance to Curlew Canal	26.1370	-81.7882	FDEP	2005	C-2	Same Location as Tt_ID 21
38	NBAYNL			Naples Landing	26.1347	-81.7920	FDEP	2005	C-2	Same Location as Tt_ID 22
39	NBAY33			Naples Bay at Marker 33	26.1292	-81.7912	FDEP	2005	C-2	Same Location as Tt_ID 23
40	NBAY29			Naples Bay, west of marker 29 and south of Egret Channel	26.1227	-81.7919	FDEP	2005	C-2	Same Location as Tt_ID 24
41	NBAYKF			Naples Bay at mouth of canal entering Kingfish Rd Canal	26.1185	-81.7887	FDEP	2005	C-2	Same Location as Tt_ID 25
42	NBAYHC			Haldeman Creek	26.1208	-81.7851	FDEP	2005	C-2	Same Location as Tt_ID 26
43	NBAYWS			Naples Bay near Marker 24, Windstar dock/shoal	26.1132	-81.7860	FDEP	2005	C-2	Same Location as Tt_ID 27
44	NBAYTC			Naples Bay at entrance to Treasure Cove	26.1095	-81.7922	FDEP	2005	C-2	Same Location as Tt_ID 28
45	NBAYBV			BayView Park	26.1014	-81.7852	FDEP	2005	C-2	Same Location as Tt_ID 29
46	NBAY21			Naples Bay at Channel Marker 21	26.1025	-81.7870	FDEP	2005	C-2	Same Location as Tt_ID 30
47	NBAYLLO			Morgan's Cove by Lantern Lake Outfall	26.1158	-81.7968	FDEP	2005	C-2	Same Location as Tt_ID 31
48	NBAY13			Just inside of Doubloon Bay, Port Royal	26.1003	-81.7975	FDEP	2005	C-2	Same Location as Tt_ID 32
49	GPASS6			Just inside Gordon's Pass at Marker 6	26.0930	-81.7986	FDEP	2005	C-2	Same Location as Tt_ID 33
50	9			Gordon Pass	26.0939	-81.7989	City of Naples	1993 - 1999	D	
51	10			Gulf of Mexico	26.0917	-81.8156	City of Naples	1993 - 1999	D	
52	8			Dollar Bay	26.095	-81.7869	City of Naples	1993 - 1999	D	
53	1			Gordon River/GGC	26.1583	-81.7847	City of Naples	1993 - 1999	D	
54	2			Gordon River/WWTP	26.1506	-81.7858	City of Naples	1993 - 1999	D	
55	3			Naples Bay/South of NSYC	26.1369	-81.7892	City of Naples	1993 - 1999	D	
56	4			Naples Bay/ City Dock	26.1333	-81.7886	City of Naples	1993 - 1999	D	
57	5			Naples Bay/ Royal Harbor	26.1164	-81.7886	City of Naples	1993 - 1999	D	
58	6			Haldeman Creek	26.1208	-81.7847	City of Naples	1993 - 1999	D	
59	7			Naples Bay/ South Point YC.	26.1047	-81.7892	City of Naples	1993 - 1999	D	
60	11			Doctor's Pass	26.1742	-81.8144	City of Naples	1993 - 1999	D	
61	12			Hurricane Harbor	26.1531	-81.8081	City of Naples	1993 - 1999	D	
62	13			Hurricane Harbor	26.1686	-81.8092	City of Naples	1993 - 1999	D	
63	14			Mooring's Bay	26.1789	-81.8117	City of Naples	1993 - 1999	D	
64	15			Venetian Bay	26.1917	-81.8106	City of Naples	1993 - 1999	D	
65	16			Venetian Bay	26.2069	-81.8131	City of Naples	1993 - 1999	D	
66	17			Outer Clam Bay	26.2111	-81.8139	City of Naples	1993 - 1999	D	
67	464			ROOK, Dollar Bay, G73	26.0930	-81.7986	FIU	1999 - 2005	E	



Source: Collier County 2005 Aerial Imagery, SFWMD, Collier County, City of Naples

LEGEND

N

0 3,500 Feet

City of Naples City Limits

Sampling Entity, (Sampling Period)

- FDEP, (2005)
- City of Naples, (2006)
- City of Naples, (1993 - 1999)
- Collier County, SFWMD, BCB, (1998 - 2006)
- Collier County, (1989 - 1996)
- FIU, (1999 - 2005)

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WATER QUALITY SAMPLING STATIONS
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE 6.3.1-1

TT8.5X11P_EX250\\GIS\N\NAPLES\030009016-SW\maps \report_1st\BPIF6.3.1-1.mxd [12-22-06 amm]

6.3.2 SFWMD 2005 Naples Bay Water Quality Database

SFWMD contracted Taylor Engineering to compile a database of long-term water quality data for Naples Bay and adjacent tributary sampling stations. Upon completion of the database, the data was evaluated for their usefulness in accessing current conditions, trends, and water quality model setup and calibration. Trends in water quality data is discussed in their report. A snapshot of their findings is summarized herein. Water quality samples from 1957 to 2003 came from 155 stations throughout Naples Bay and tributaries. Data summarizing the water quality conditions in the Bay area came from 150 of the 155 stations representing several general locations. The four (4) general areas summarized were as follows:

(1) Lower Naples Bay (all stations south of US 41 Bridge in Naples Bay excluding tributaries).

(2) Upper Naples Bay (all stations above US 41 Bridge excluding tributaries).

(3) Tributary locations (Lely Canal, Haldeman Creek, Rock Creek, Gordon River and Golden Gate Canal).

(4) Gulf of Mexico.

Water quality data from 53 stations sampled between 1999 and 2003 provided the basis for an assessment of "current conditions". Water quality conditions of concern in the four general areas include both chemical and biological parameters. Dissolved oxygen, nitrogen, phosphorous, copper, iron, lead and zinc often exceed state water quality standards in more than 10% of the sample sets developed from the data for all samples in a location (see Reference 10.23). Chlorophyll *a.* concentrations and fecal coliform counts were often elevated relative to state and/or typical regional estuary values.

Upon review of the specific locations of the sampling stations relative to the four (4) general locations described above, the data used to build the water quality database consisted of the following:

- Lower Naples Bay – 49 stations
- Upper Naples Bay – 12 stations
- Tributaries – 133 stations
  - Gordon River Extension – 6 stations (adjacent to the weir)

- Gordon River Extension Watershed – 21 stations
- Golden Gate Canal – 7 stations (adjacent to the weir)
- Golden Gate Canal Watershed – 41 stations
- Rock Creek – 4 stations
- Haldeman Creek – 7 stations
- Lely Canal – 4 stations

- Gulf of Mexico – 5 stations

6.3.3 Current City of Naples Sampling Program

The City of Naples took over the water quality sampling program initiated by the FDEP in February 2006. The water quality samples taken by the City today are in the exact same locations of the 16 sampling locations initiated by the FDEP February 2005. The program is currently administered by Katie Fuhr of the City of Naples and the results are submitted to the FDEP, where they are uploaded to the State STORET system.

6.3.4 Water Quality Measurement Criteria

In the SFWMD 2005 Naples Bay water quality database creation, Taylor Engineering defined numeric water quality criteria based on Class III Marine Waters from Chapter 62-302.530 of the Florida Administrative Code (F.A.C.). In addition, new trend criteria identified in a recent (2003) report from Charlotte Harbor and the Indian River Lagoon provided insight into current conditions. We note, however, that much of the Naples Bay area is classified as Class II Marine Waters. We have thus attempted to summarize the various water quality thresholds for analytical comparison in Table 6.3.4-1. The threshold value for copper provided by the Taylor Report had to be corrected since it was different than the value published in FAC 62-302.530.

6.4 RESULTS IN SAMPLING DATA

The summaries of current water conditions in Naples Bay area are presented in the following subsections. Tables 6.4-1 and 6.4-2 compile the information obtained from the analysis performed by Taylor Engineering for SFWMD in 2005 (Reference # 10.23). Figure 6.4-1 shows the delineation of the analyzed areas. Note we have provided not only the State's maximum thresholds from FAC 62-302.530 and FAC 62-302.553, but also some typical values by

Table 6.3.4-1 Summary of Commonly Used Water Quality Threshold Criteria

Parameter	Unit	Maximum Value (MV)	Typical Value (TV) @ 75 %	Source(s)	Comment
Aluminum	mg/L	1.5	0.8	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Arsenic	µg/L	50	3.5	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Fecal Coliforms	# 100ml	200 monthly average 400 max. in 10% of samples or 800 max. in one day	25	MV:(1)/TV:(3)	Class III Marine Waters
		Median of 14 w/max. 10% of samples exc. 43, nor 800 max on any one day	N/A	MV:(1)	Class II Waters
Total Coliforms	# 100 ml	1000 monthly avg., 1000 max. in 20% of the samples, 2400 maximum at any time	322	MV:(1)/TV:(3)	Class III Marine Waters
		70 max. median, max. 10% of the samples to exceed 230	N/A	MV:(1)	Class II Waters
Cadmium	µg/L	9.3	2	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Chromium (hexavalent)	µg/L	50	N/A	MV:(1)	Class III Marine Waters and Class II Waters
Copper	µg/L	3.7	7.5	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Dissolved Oxygen	mg/L	4 (min.), 5 (min. avg. in 24 hrs.)	7.6	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
		5 (min.)	N/A	MV:(1)	Class III Fresh Water Upstream of Weirs
Iron	mg/L	0.3	0.5	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Lead	µg/L	8.5	1.8	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Phosphorus	mg/L	0.1	0.2	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Turbidity	NTU	29 above background	N/A	MV:(1)	Class III Marine Waters and Class II Waters
		2.6	7.3	MV:(2)/TV:(3)	not to exceed value for Indian River Lagoon
Zinc	µg/L	86	13	MV:(1)/TV:(3)	Class III Marine Waters and Class II Waters
Chlorophyl a	µg/L	11 max. annual mean for any year, or 50% max. increase of annual mean for 2 consecutive years	11.8	MV:(4)	Estuaries or estuary segments
		3.1	12	MV:(2)/TV:(3)	not to exceed value for Indian River Lagoon
Total Suspended Solids	mg/L	none	26.5	TV:(3)	Estuaries

Notes about sources:
(1) FAC 62-302.530
(2) Reference # 10.23
(3) Reference # 10.27
(4) FAC 62-302.353

Table 6.4-1 CURRENT WATER QUALITY CONDITIONS FOR NAPLES BAY AREA

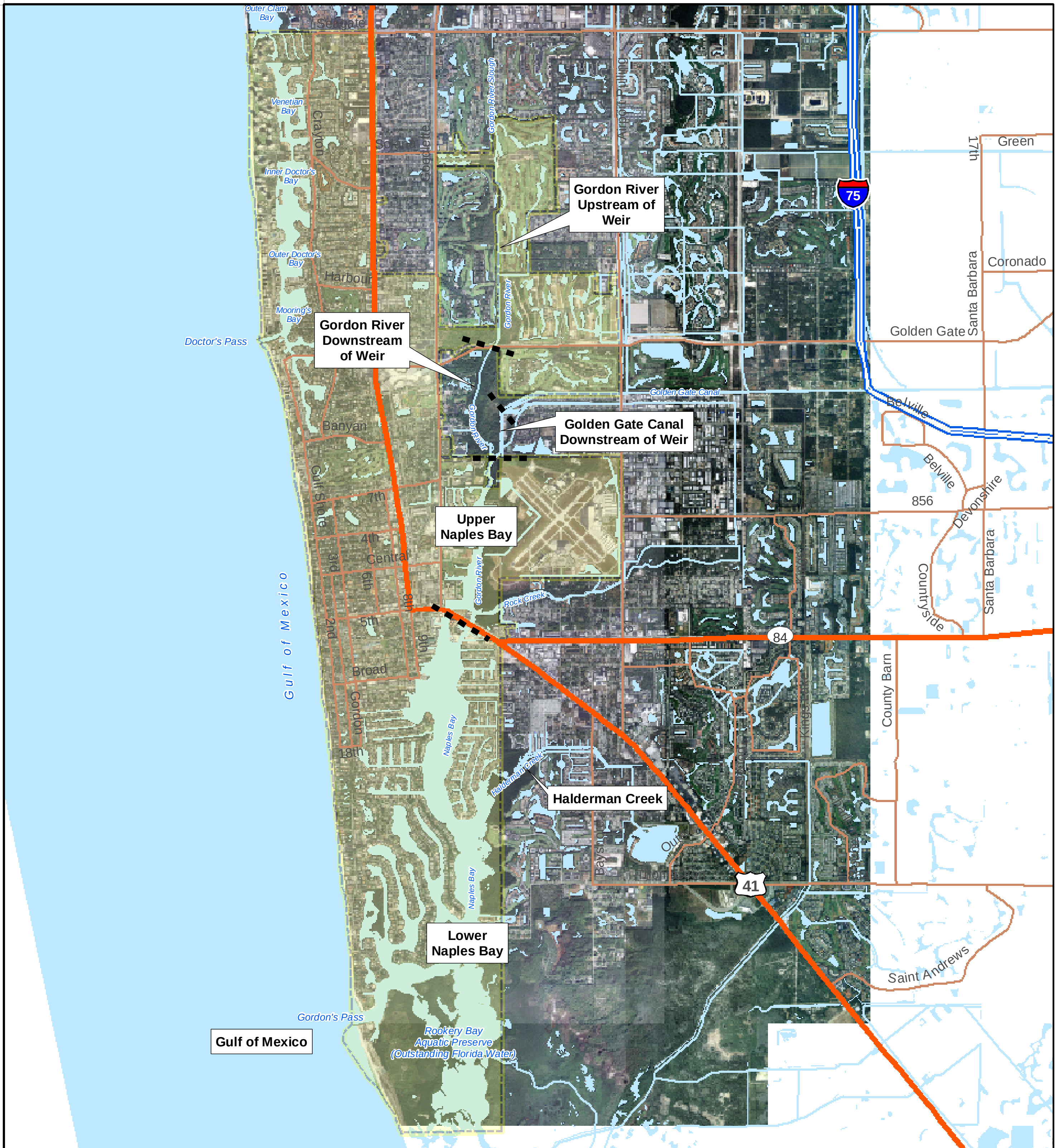
Parameter	Threshold Used (1)	Gulf of Mexico		Lower Naples Bay		Upper Naples Bay		Haldeman Creek	
		75%	Comment	75%	Comment	75%	Comment	75%	Comment
Salinity (%)	-	36.3	Typical	35.6	Typical	30.7	Little low	32.6	Ok
DO marine (mg/L)	4(1)/7.6(2)	6.9	Good (2.1 % FAC exc)	6.7	Good (16% FAC exc)	6.2	Ok (11% FAC exc)	5.2	Fair (45% FAC exc)
DO freshwater (mg/L)	5(1)	N/A	-	N/A	-	N/A	-	N/A	-
Total Phosphorus (mg/L)	0.1(1)/0.2(2)	0.04	Good (0% FAC exc)	0.05	Good (2% FAC exc)	0.09	Fair (18% FAC exc)	0.04	Good (0% FAC exc)
Total Nitrogen (mg/L)	0.6(3)	0.3	Good	0.4	Typical-Good	0.9	Fair	0.8	Fair
Chlorophyl a (mg/L)	11(1)/11.8(2)	3.6	Typical	8	Ok	11.7	Fair (exc typ. estuaries)	11	Fair
Fecal Coliforms (CFU/100ml)	800(1)/25(2)	12	Good (1% FAC exc)	130	Fair (4% FAC exc)	220	Poor (8% FAC exc)	420	Poor (6% FAC exc)
TSS (mg/L)	26.5(2)	43	Ok	18.2	Ok	12.2	Ok	13.2	Ok
Copper (µg/L)	3.7(1)/7.5(2)	5	Little high (85% FAC exc)	5	Little high (67% FAC exc)	5	Little High (63% FAC exc)	8.4	Poor (79% FAC exc)
Iron (mg/L)	0.3(1)/0.5(2)	N/A	-	0.5	Mildy over (but 90% FAC exc)	0.5	Mildy over (80% FAC exc)	0.4	Mildy over (83% FAC exc)
Lead (µg/L)	8.5(1)/1.8(2)	23	Poor (67% FAC exc)	13	Poor (36% FAC exc)	6	Ok (17% FAC exc)	N/A	-
Zinc (µg/L)	86(1)/13(2)	5	Excellent (0% FAC exc)	10	Good (0% FAC exc)	15	Ok (0% FAC exc)	30	Acceptable (0% FAC exc)
Turbidity (NTU)	2.6(3)/7.3(2)	3.3	Ok	5	Ok	3.4	Ok	3.6	Ok

Notes: (1) All thresholds are maximum allowed from FAC 62-302.530 or FAC 62-302.353 unless otherwise noted.
(2) 75 percentile used as typical (above average) value from Reference # 10.27 for additional comparison or when no other criteria available.
(3) Taylor Engineering values provided in Reference # 10.23 gave a 25 percentile of a typical estuary at 0.40 mg/L and a not to exceed value of 0.69 mg/L for another estuary. We used 0.6 as an estimated 75 percentile value. Turbidity showed 2.2 for 25% and 2.84 as not to exceed value, thus, 2.6 was estimated as a 75 percentile which is much lower than that given in Reference # 10.27.

Table 6.4-2 CURRENT WATER QUALITY CONDITIONS FOR NAPLES BAY AREA

Parameter	Threshold Used (1)	Gordon River Downstream of Weir # 951		Gordon River Upstream of Weir # 951		Golden Gate Canal Downstream of Weir	
		75%	Comment	75%	Comment	75%	Comment
Salinity (%)	-	22.9	High fresh water flows	NM	-	19.1	Very High Freshwater
DO marine (mg/L)	4(1)/7.6(2)	3.2	Poor (89% FAC exc)	N/A	-	N/A	-
DO freshwater (mg/L)	5(1)	N/A	-	3.5	Poor (100% FAC exc)	6.6	Ok (17.9 % FAC exc)
Total Phosphorus (mg/L)	0.1(1)/0.2(2)	0.13	Poor (50% FAC exc)	0.06	Good (0% FAC exc)	0.04	Good (0% FAC exc)
Total Nitrogen (mg/L)	0.6(3)	1.1	Fair	1.5	High	0.8	Fair
Chlorophyl a (mg/L)	11(1)/11.8(2)	8.5	Ok	28	Poor (60% FAC exc)	5.9	Ok
Fecal Coliforms (CFU/100ml)	800(1)/25(2)	180	Fair (5% FAC exc)	N/A	-	69	Ok (2% FAC exc)
Total Suspended Solids (mg/L)	26.5(2)	1	Good	N/A	-	4	Ok
Copper (μg/L)	3.7(1)/7.5(2)	2.2	Acceptable (17% FAC exc)	13	Poor (85% FAC exc)	0.8	Good (0% FAC exc)
Iron (mg/L)	0.3(1)/0.5(2)	0.3	Ok (20% FAC exc)	N/A	-	5	Poor (44% FAC exc)
Lead (μg/L)	8.5(1)/1.8(2)	0.5	Excellent (0% FAC exc)	10	Poor (70% FAC exc)	0.5	Excellent (0% FAC exc)
Zinc (μg/L)	86(1)/13(2)	40	Acceptable (0% FAC exc)	6.8	Excellent (0% FAC exc)	20	Ok (0% FAC exc)
Turbidity (NTU)	2.6(3)/7.3(2)	1.9	Good	N/A	-	2.9	Ok

Notes: (1) All thresholds are maximum allowed from FAC 62-302.530 or FAC 62-302.353 unless otherwise noted.
(2) 75 percentile used as typical (above average) value from Reference # 10.27 for additional comparison or when no other criteria available.
(3) Taylor Engineering values provided in Reference # 10.23 gave a 25 percentile of a typical estuary at 0.40 mg/L and a not to exceed value of 0.69 mg/L for another estuary. We used 0.6 as an estimated 75 percentile value. Turbididy showed 2.2 for 25% and 2.84 as not to exceed value, thus, 2.6 was estimated as a 75 percentile which is much lower than that given in Reference # 10.27.



Source: SFWMD DBHYDRO database, Collier County 2005 Aerials

LEGEND

City of Naples City Limits

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0 6,000 Feet

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WATER QUALITY CONDITION REGIONS
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE 6.4-1

percentile and/or maximum values provided in other reports for additional comparison (Reference # 10.23 & #10.27). The highlighted areas on Tables 6.4-1 and 6.4-2 emphasize those parameters that are providing "current condition" results of concern frequently enough that we recommend these values be monitored carefully.

6.4.1 SFWMD 2005 – Data Results for Lower Naples Bay

The southern portion of Naples Bay showed typically near marine salinity conditions. The lower bay data exceeded maximum allowed water quality values from FAC 62-302.530 or FAC 62-302.353 for dissolved oxygen, total phosphorus, chlorophyll *a*, fecal coliforms, copper, iron and lead. Lower Bay lead value at the 75th percentile was very high (13 μg/L) in comparison with the 8.5 μg/L maximum allowed by the state and the 1.8 μg/L typical value for this parameter.

6.4.2 SFWMD 2005 – Data Results for Upper Naples Bay

The salinity in the upper Naples Bay is a little low relative to the lower bay. Dissolved oxygen, total nitrogen, total phosphorus, and lead exceedances were infrequent, but present. The 75 percentile value for chlorophyll *a* exceeds maximum allowed value from FAC 62-302.530 and it is very close to the 75 percentile typical value for Florida's estuaries. The fecal coliform counts exceeded standards more frequently than in the lower bay and the value at the 75th percentile of 220 CFU/100 ml is much higher than the typical value of 25 CFU/100 ml.

6.4.3. SFWMD 2005 – Data Results for Haldeman Creek

Salinity levels in Haldeman Creek are close to marine conditions. The water showed exceedance for dissolved oxygen and iron; however, the 75th percentile for iron is just mildly over the maximum allowed value and the 75% of the samples had 5.2 mg/L or higher values for dissolved oxygen. Copper values exceeded frequently the maximum allowed value. The 75th percentile value for fecal coliform had only 6% of exceedance but the 75th percentile value was 420 CFU/100 ml, which is very high when compared with the 25 CFU/100 ml values typical of estuaries.

6.4.4. SFWMD 2005 – Data Results for Gulf of Mexico

Salinity presented typical marine values. Lead concentrations exceeded the state water quality standard in 67% of the samples and the 75th percentile value of 23 µg/L is very high relative to the maximum allowed value. Copper had an 85% of exceedance and its 75th percentile value was a little high compared with the maximum allowed value.

6.4.5. SFWMD 2005 – Data Results for Gordon River Downstream of Weir

Gordon River Downstream of the weir showed low concentrations of dissolved oxygen, having a very high percentage of exceedance (89%) for this parameter. Half of the samples exceeded the allowed values for total phosphorus. Iron, cooper and fecal coliforms also exceeded the maximum values but not frequently.

6.4.6. SFWMD 2005 – Data Results for Gordon River Upstream of Weir

Water quality in the Gordon River above the weir showed a 100% of exceedance for dissolved oxygen. Total nitrogen concentration was high. Chlorophyll *a*, copper, and lead also presented high percentages of exceedance from the maximum allowed values, suggesting that this area is impaired with respect to these parameters.

6.4.7. SFWMD 2005 – Data Results for Golden Gate Canal downstream of Weir

Golden Gate Canal presented the best water quality conditions among the areas analyzed in the upper mouth of Naples Bay. Most of the parameters did not have exceedance or had infrequent exceedances. The only parameter with a high percentage of exceedance was iron. The 75th percentile value for iron was very high (5 mg/L) compared with the maximum allowed (0.3 mg/L).

6.5 ANALYTICAL WATER QUALITY MODELING RESULTS

Although the City has quite a few stormwater master plans and specific basin studies in their library, a review of these reports indicated that only one report actually attempted to analytically model the existing water quality of an area of the City and predict how various alternatives might improve the water quality of the discharges to the receiving waters of Naples. In the CDM

Drainage Report for Basin III, they used their Watershed Management Model (WMM) to develop loading estimates from various land use in Naples Basin III. This model has not been used for any other of the City's Drainage Basins to date. In order to better advise the City with regard to water quality improvement options and expenditures on a City-wide basis, Tt evaluated the method used in the Basin III report and see we could extrapolate the results to project expectations applicable to other basins for conceptual master planning purposes.

6.5.1 Basin III WMM Model

The core calculations of the WMM model used by CDM in Basin III were based on the common practice of accepting the premise that the concentration averaged over a storm event of pollutants in stormwater runoff is characteristic for each type of land use. This practice continues to be popular since it is very expensive to sample locally and there is normally limited data available.

The Basin III WMM model provided annual pollutant load estimates for each sub-basin. The twelve pollutant loads required by EPA MS4 NPDES permits (from the Phase I program Cities) were used in the model. By doing so, the model was trying to synchronize the results with potential future requirements of the NPDES Program. At this time, however, those parameters are not required to be monitored by the state. We checked with Sarah Jozwiak of the State's NPDES Program and verified that there are no plans by the FDEP to require these parameters be tested by Phase II cities in the future. There was a time in the early part of this decade, that the uncertainty of the NPDES Program, led some communities to set up programs figuring that full parameter monitoring would eventually be required. The water quality parameters that were used in the Basin III report were pollutant loading estimates including the following:

- five-day biochemical oxygen demand (BOD_5)
- chemical oxygen demand (COD)
- total suspended solids (TSS)
- total dissolved solids (TDS)
- total phosphorus (TP)
- dissolved phosphorus (DP)
- total Kjeldahl nitrogen (TKN)
- nitrate/nitrite ($N0_3/N0_2$)
- lead (Pb)
- copper (Cu)

- zinc (Zn)
- cadmium (Cd).

Total nitrogen (TN) can be also calculated as the sum of TKN and NO_3/NO_2 nitrogen. Today, many water quality programs look at "nutrients". Often the parameters of total phosphorus TP, total nitrogen TN and chlorophyll are used to observe the trends in total nutrients. There is usually pollutant removal efficiencies published for these parameters (especially TN and TP) when others are not readily available.

The rationale of the WMM model methodology selected for Basin III was that the results may be used for relative comparisons of land use changes, BMP changes, and changes to point source loadings. Annual and seasonal watershed event mean concentration (EMC) estimates could also be derived (as required by the Phase I NPDES permitting process), if the City is eventually placed under similar requirements.

WMM incorporates a land use approach to estimate annual and seasonal nonpoint source loads from direct runoff based upon the EMCs and runoff volumes. The WMM model, however, also allows for several features that were deemed inapplicable by CDM in their analysis of the City of Naples. The following summarizes some of the features of the WMM model and whether those features were deemed applicable to Naples:

- WMM estimates annual and seasonal runoff pollution loads and concentrations for nutrients, heavy metals, oxygen demand and sediment based upon EMCs, land use, percent impervious, and annual rainfall (used)

- WMM estimates annual and seasonal runoff pollution load reduction due to partial or full scale implementation of up to five types of onsite or BMPs

- WMM applies a delivery ratio to account for reduction in runoff pollution load due to instream sedimentation processes during transport through the watershed (not applicable)

- WMM estimates stream base flow contributions to the annual pollution load (not applicable)

- WMM estimates point source loads for comparison with relative magnitude of nonpoint pollution loads (not applicable)

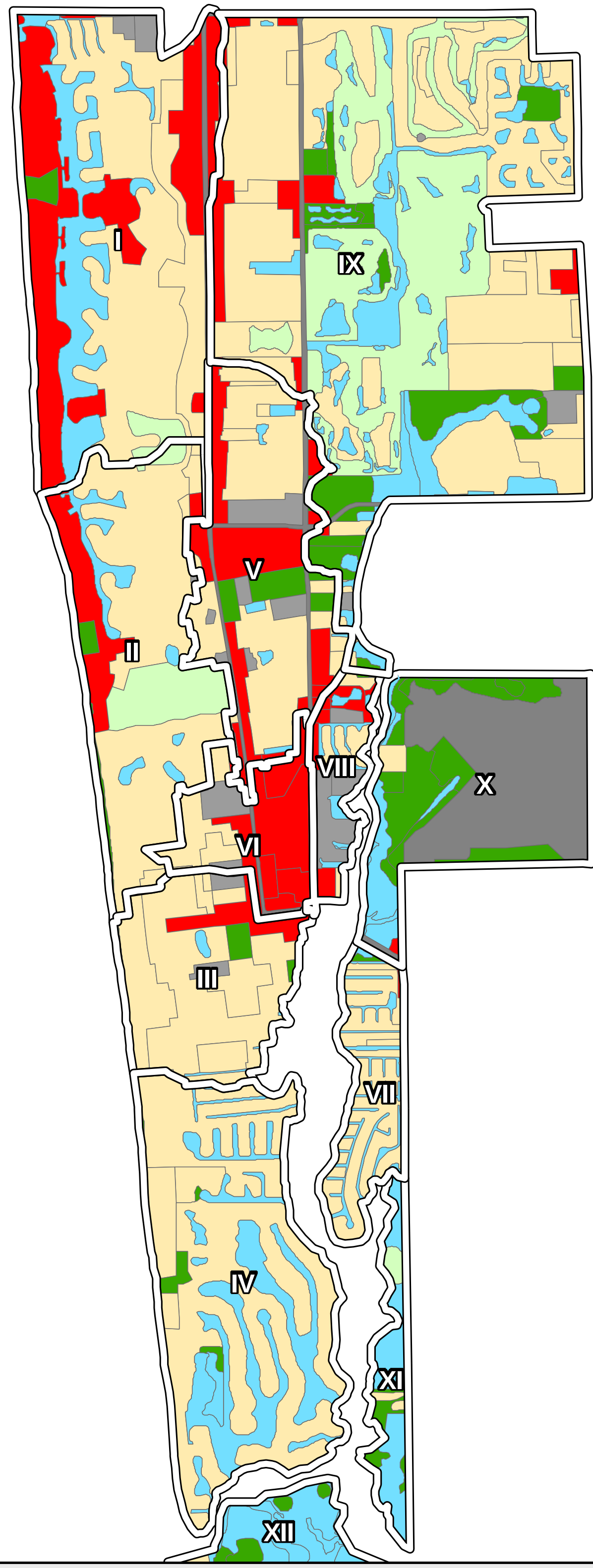
- WMM estimates pollution loads from failing septic tanks (not applicable)

In summary, the WMM model provided a basis for planning level evaluations of the long-term nonpoint pollution loads and the relative benefits of nonpoint pollution management strategies to reduce these loads for Naples Basin III. In order to perform these functions, the model evaluated each sub-basin individually. WMM was used to evaluate a few alternative management strategies (combinations of non-structural and structural controls) in order to formulate a stormwater management plan for improving the water quality of Basin III. We note, however, that the improvements available in these options were not presented in terms of some overall load reduction goal. In other words, the recommendations quantified an improvement of water quality without placing that improvement into context with the overall loads still affecting the receiving water body. As part of this Master Stormwater Management Update, we will attempt to integrate these results with the rest of the City and specifically with the receiving water body of most significant concern (Naples Bay).

6.5.2 Event Mean Concentration (EMC) and Land Use

Table 6.5.2-1 summarizes the percent land uses for each basin. (See Figure 6.5.2-1) Some of the Planning Department land use categories were combined for simplicity when general hydrologic and/or EMC values were similar enough to combine. The Directly Connected Impervious Area (DCIA) values used in the Basin III report were also used to be consistent and are summarized on Table 6.5.2-1.

CDM obtained existing land use conditions from SFWMD's land use plan (1995) in GIS format, aerial photographs, and performed field reconnaissance in Basin III. Although Basin III is almost entirely built out, the future land uses were estimated based on the City's 2005 land use zoning plan, obtained from the City's GIS department. The land use characteristic, which most affects the amount of runoff (and therefore the pollutant loading), is the degree of impervious land cover. Since the basin and sub-basin divides required some adjustment when rectified to the new aerial bases (See Section 3.2), the specific land use areas used in the Basin III Report did not match exactly with the new database. For purposes of this city-wide integration, the differences do not affect the overall results.



Source: Collier County 2001 Land Use

LEGEND

Basins I - XII

Land Use 2001

- Commercial/Industrial
- Golf Courses
- Institutional
- Open Space
- Residential
- Transportation
- Water/Wetland

N

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GENERAL LAND USES BY BASIN
CITY OF NAPLES, FLORIDA
COLLIER COUNTY, FLORIDA

FIGURE
6.5.2-1

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During a storm event, the concentration of pollutants in the runoff varies considerably over time. For example, the concentration of oily substances on roadways are highest during the first part of the storm, and then decline quickly when the bulk of the material is washed off. This is known as the *"first-flush"*. However, the concentration in the first-flush runoff is not representative of the entire storm. In order to estimate the loading from a storm, the flow-weighted average concentration is needed. Known as EMC, the flow-weighted concentration is derived as the average of total loading divided by total runoff for a series of storm events (Reference # 10.11).

While some deviations exist, EMCs for similar land uses are typically transferable throughout major regions of the United States with similar rainfall characteristics, especially for relative comparisons. This is possible because the characteristics of the urban land use categories tend to be similar. Since the data is so sparse in Florida, it is common to use EMCs in this manner. To be consistent, we recommend applying the EMCs analyzed for use in this report to extrapolations to other basins in the City until which time better EMC data becomes available in the state. Then the loading rates can be adjusted city wide if necessary at that time. Table 6.5.2-2 summarizes the EMC values used for the four (4) water quality parameters selected for a city-wide preliminary analysis. We selected the widely published and sampled parameters TN, TP, and TSS to perform our preliminary City-wide analysis and added one common metal (copper) since recent studies show it is metal that also needs to be monitored carefully in Naples Bay.

Table 6.5.2-1 Percentage of Land Use by Drainage Basin

Basin	Tetra Tech GIS Adj. Areas (ac)	Open Space	Resident. (all)	Institut.	Comm. / Industr.	Water/ Wetland	Golf	Transp.	Total
I	1514.4	1%	46%	1%	31%	16%	2%	3%	100%
II	916.8	3%	63%	1%	12%	7%	14%	0%	100%
III	570.5	4%	81%	3%	9%	3%	0%	0%	100%
IV	1173.9	3%	70%	0%	0%	27%	0%	0%	100%
V	803.4	7%	48%	8%	27%	3%	1%	7%	100%
VI	316.2	0%	27%	11%	56%	0%	0%	6%	100%
VII	296.8	2%	76%	0%	1%	21%	0%	0%	100%
VIII	194.2	1%	22%	36%	21%	18%	0%	2%	100%
IX	2990.2	8%	49%	1%	4%	14%	24%	2%	102%
X	800.9	26%	2%	0%	1%	11%	0%	60%	100%
XI	178.6	13%	4%	0%	0%	74%	9%	0%	100%
Total	**9,756**								
	DCIA (1)	1%	30%	50%	75%	25%	1%	50%	

Table 6.5.2-2	EMC Values for Key Pollutants Reviewed						
	Open Space	Resident. (all)	Institut.	Comm. / Industr.	Water/ Wetland	Golf	Transp.
TP	0.22	0.30	0.30	0.21	0.02	1.00	0.10
TSS	40.2	50.9	50.9	48.7	5	20	150
TN	1.24	1.50	1.50	1.36	1.10	2.50	1.20
Copper	0.00	0.01	0.02	0.02	0.00		

Notes: (1) Source of DCIA assumptions from Reference # 10.11
(2) Source of EMC values taken from Reference # 10.11 and 10.8 and/or estimated from Reference # 1029 and #10.34

6.5.3 Other Hydrological Model Considerations

Monthly rainfall totals were obtained from the National Climatic Data Center (NCDC) for the Naples airport for the period 1948-1996. The average annual rainfall used was **53.3 inches**. The average annual rainfall given on Table 3.5.1-1 was 54.8 inches. We recommend, however, using 55 inches to be conservative or 53.3 inches to be consistent for future comparisons.

CDM considered no natural conveyance, therefore base flow was not considered significant to the annual pollutant loading. There were no point source discharges in Basin III, and the entire watershed is served by a central sewer system. None of these modules were used in the WMM model.

6.5.4 Best Management Practices (BMPs) for Pollutant Load Reduction

Common forms of structural stormwater treatment (BMPs) include structural facilities, such as treatment swales, wet detention basins, retention, and dry detention basins. These structures provide varying pollutant removal efficiencies. The effectiveness of a given BMP depends on the type and size of facility and type of pollutant. For convenience, we have provided the summary table of BMP effectiveness from the Basin III Report. We have also updated the table with some effectiveness values from some other recent publications (Reference #10.16). See Table 6.5.4-1.

In the case of a dry retention facility, a properly designed structure will "treat" approximately 90 percent or better of the average annual runoff by diverting the runoff from storms under 1 inch and allowing this volume to infiltrate into the ground, or evapo-transpirate into the air.

In contrast to retention systems that prevent the runoff volume from discharging downstream, wet detention basins are designed to delay the movement of stormwater. In doing so, pollutants are removed in the facility. Wet detention systems are designed to retain a permanent pool of water at all times. Runoff increases this volume temporarily, but a bleed down structure allows the pond to return to the pre-runoff stage after the event. This type of BMP typically has far less pollutant removal efficiency for each parameter than dry retention. As one can see from Table 6.5.4-1, the pollutant removal efficiencies of TN, TP, TSS and copper are typically around 30%, 55%, 90%, and 70% respectively (based on Reference # 10.11).

A swale can be designed to function as a retention system (no outfalls) or as a detention system where the discharge of runoff is temporarily detained providing time for particulate pollutants to settle. In Basin III, as well as most of the City, most of the swales have been connected to drainage inlets and other culverted systems where they function more as detention systems than retention. Thus, the values for swales used were 30%, 40%, 80% and 55% for TN, TP, TSS, and copper, respectively. See Table 6.5.4-1.

In order to ascertain the extent of swale treatment in Basin III, 100 percent of that basin was surveyed by CDM during the study for swales. Lot-by-lot counts were converted to GIS coverage and associated by sub-basin. The results were unique to Basin III and were given in the Basin III report. Of the 42 sub-basins field observed, the range of values varied from 0% to 67% with the mean value being just under 16% of the homes with swales. CDM defined a "swale" as a grassed flow path, 6-12" deep, with the geometric ratios specified in FAC 62-25 (3:1 sideslope, etc.). They determined only about 100 homes in Basin III had proper swales. They further assumed that each house with a swale in the front right-of-way had 100 linear feet (LF) of sideyard swale for a 200 LF average per home with a swale.

Table 6.5.4-1 Removal Efficiencies for Potential BMPs

Parameter	CDM Reference # 10.1				
	Dry Retention	Wet Detention	Swale	Dry Detention	Inlet Devices
BOD_5	90%	30%	30%	25%	0%
COD	90%	30%	30%	25%	0%
TSS	90%	90%	80%	85%	85%
TDS	90%	40%	10%	0%	0%
Total P	90%	55%	40%	25%	35%
Dissolved P	90%	40%	10%	0%	0%
TKN	90%	30%	20%	15%	20%
$NO_2 + NO_3$ - N	90%	30%	15%	0%	40%
TN	90%	30%	18%	12%	30%
Lead	90%	80%	75%	75%	75%
Copper	90%	70%	50%	55%	50%
Zinc	90%	50%	50%	45%	35%
Cadmium	90%	80%	65%	75%	60%

Parameter	ASCE Reference # 10.15				
	Dry Retention	Wet Detention	Swale	Dry Detention	Inlet Devices
BOD_5	90%	67%		40%	
COD	90%				
TSS	90%	75%	70%	70%	80%
TDS	90%				
Total P	90%		30%	25%	96%
Dissolved P	90%				
TKN	90%	37%			
$NO_2 + NO_3$ - N	90%	80%			
TN	90%	26%	25%	15%	96%
Lead	90%	77%	50%	60%	
Copper	90%	59%	40%	35%	
Zinc	90%		50%	70%	
Cadmium	90%				

Tetra Tech drove representative roadways in all of the basins, including Basin III, and found that a lack of consistent swale maintenance makes evaluating swales difficult. Many swales have filled in with sediment as St. Augustine sod has built-up to a degree where the swale geometry is essentially non-existent and no longer meets the swale definition of FAC 62-25. We recommend that an ongoing swale restoration program be initiated as part of a repair and replacement program. More on this will be discussed in Section 6.6. We also note that underdrains in the swales are significantly more efficient in reducing pollutant loads than using inlets as bottom drains. Thus, we recommend underdrains as the preferred recovery method when the swales are not able to percolate sufficiently on their own. This technique will increase the pollutant removal efficiency over those swales with ditch bottom inlets at low points.

In lieu of determining each sub-basin individually, one might use the basin-wide average as a reasonable "typical" value for estimating the order of magnitude of swale coverage in the City of Naples. In order to test this, assumption, Tetra Tech conducted a brief field verification to see how the CDM results in Basin III might apply in other basins in order to extrapolate results on an integrated city-wide basis. The results of this field investigation is given in Section 6.6.

Given the constraints of the locality, CDM recommended that the City focus their primary efforts in Basin III at non-structural BMPs. It was recommended that the City continue with the street-sweeping program and implement the educational and non-structural components of the NPDES Phase II stormwater program. (Reference # 10.11)

6.5.5 Three Alternatives Evaluated

Three (3) structural BMPs were evaluated for Basin III. The first was a widespread swale restoration program for all residences. The study determined that this would extend the existing treatment volume for 1.0 acre-ft (10,730 linear feet times 4 ft^2 cross section area) to 5.5 acre-ft. (Reference # 10.11). In order for this alternative to be applicable, the study presumes that the City Council would authorize an effort to tear up all residential front yards in Basin III (within City right-of-way) and re-grade all of the front yards without regard to special circumstances. Often retrofitting swales in a built-out community, like Basin III, is limited by existing landscaping, hardscaping, and grading in the right of way. In some areas, the space simply can not be used. As a result, we would expect that a fraction of the 100% assumption is actually politically and technically feasible (See Section 6.6).

The second alternative evaluated in the Basin III Report was the construction of a detention area in Naples Bay downstream of the present pumps. The State of Florida dedicated 2.25 acres east of Broad Avenue South to the City of Naples for municipal purposes.

The third structural BMP evaluated was a linear wet detention facility (3.4 acres), constructed in the City's right-of-way along Broad Avenue South. The cost of this alternative was deemed prohibitively high because it required a second pump station. As a general rule in Florida, 90 percent of the individual storm events are 1 inch or less. Thus, a design, which will treat the runoff from a 1-inch storm, will treat 90 percent of the events likely to occur. Since the linear detention or outfall detention would receive all of the runoff that currently discharges through the pumps, these capture rates reflect watershed-wide capture efficiency. The pollutant removal efficiencies are similar for detention swales and wet detention facilities.

The results of the WMM analyses for the present land use and existing swale coverage were summarized in Tables for existing land use and existing BMPs for an average year. The existing swales were the only BMPs modeled in the Basin III Report. CDM then used the model to predict loading if the swales were retrofit to all residences in Basin III. Retrofitting all existing homes with swales was determined to remove 4-5 times more pollutants than that are currently being removed by the existing swales. Table 6.5.5-1 in this Stormwater Master Plan Update conveniently summarizes the most relevant information of the pollutant loading calculations made in the Basin III Report specifically related to *existing conditions.* We added some columns that would allow for comparative analysis later as we were interested in seeing what could be integrated and/or extrapolated to other areas of the City.

The results of the existing conditions model suggested the following:

(1) **TN** – If we calculate the TN from the results of the TKN and NO2-NO3, we see little pollution removal potential. The existing swales are predicted to remove only 64 pounds of the annual TN per year from the theoretical generation of 3,644 pounds of TN. That reduction is only a mere 1.7%. The swale retrofits assumed to 100% coverage of the residential land use in Basin III only reduces the load by 287 pounds per year or 8%.

(2) **TP** – The existing swale load reduction yields 3.9% (decreases the 432 pounds per year by only 17 pounds). Forcing 100% swale coverage only increases the total reduction of TP to 74 pounds per year, or an 18% annual reduction.

Table 6.5.5-1 Pollutant Loading (lb/yr) for Existing Conditions in Drainage Basin III

Parameter	Existing Land Use if No Swales Existed	Existing Land Use with Existing Swales	lbs/yr Removed by Existing Swales	Existing Land Use with 100% Swale Coverage	lbs/yr Removed by 100% Swale Coverage	Percent of Existing Load Removed by 100% Swale
BOD	30,369	29,517	852	25,841	3,676	12%
Cd	1.1	1.0	0.1	0.7	0.3	30%
COD	149,322	145,682	3,640	130,004	15,678	11%
Cu	21	20	1	16	4	20%
DP	329	325	4	311	14	4%
NO23	656	647	9	605	42	6%
TKN	2,988	2,933	55	2,688	245	8%
TN	**3,644**	**3,580**	**64**	**3,293**	**287**	**8%**
TDS	**214,934**	**212,732**	**2,202**	**203,252**	**9,480**	**4%**
Pb	8	7	1	5	2	25%
TP	**432**	**415**	**17**	**341**	**74**	**18%**
TSS	**6,459**	**6,166**	**293**	**5,571**	**595**	**10%**
Zn	117	112	6	93	18	17%

Table 6.5.5-2 Pollutant Loading (lb/yr) for Future Conditions in Drainage Basin III

Parameter	Future Land Use with Existing Swales	Additional Loading Due to Buildout	Percent Increase Over Existing Conditions	Future Land Use with 100% Swale Coverage	lbs/yr Removed by 100% Swale Coverage	Percent of Future Load Removed by 100% Swale
BOD	36,417	6,900	23%	34,836	1,581	4.3%
Cd	0.9	-0.1	-9%	0.8	0.1	9.8%
COD	191,782	46,100	32%	185,067	6,715	3.5%
Cu	20	0	0%	18	2	8.9%
DP	348	23	7%	335	13	3.7%
NO2/3	697	50	8%	680	17	2.4%
TKN	3,127	194	7%	3,022	105	3.4%
TN	**3,824**	**244**	**14%**	**3,702**	**122**	**3.3%**
TDS	**212,955**	**223**	**0%**	**208,895**	**4,060**	**1.9%**
Pb	9	2	20%	8	1	9.9%
TP	**457**	**42**	**10%**	**423**	**34**	**7.4%**
TSS	**9,844**	**3,678**	**60%**	**9,131**	**713**	**7.2%**
Zn	139	27	25%	132	7	5.0%

Notes:
(1) TN = NO2+NO3
(2) This data is condensed and reproduced from reference number 10.11

(3) **TSS** – The model shows poor results even for suspended solids. When one considers that TSS is traditionally one of the easiest constituent pollutants to be removed and retrofitting all the swales in the Basin only gets a 10% annual reduction, this removal rate is also disappointing.

(4) **Copper** – The model shows a 1 lb./year reduction from 21 lbs./year (or 4.8%). The removal increases to 20% if 100 year swales could be retrofitted.

The pollutant loading, which would be expected from future land use and only the existing swale coverage, was given in the Basin III report. This scenario assumed that the 2005 land use changes will occur, but not additional BMPs implemented. CDM then used the model to predict the expected loading results for future land use conditions and with 100% swale coverage of all residential land use. The results indicate that total residential swale construction will only remove only about 2-10 percent of the future loads. Table 6.5.5-2 in this Stormwater Master Plan Update conveniently summarizes the pollutant loading calculations made in the Basin III Report specifically related to *future predicted land use conditions*.

The future land use analysis suggested the following results:

(1) **TN** – The swale retrofits to 100% of the land use in Basin III only reduces the load approximately 3%.

(2) **TP** – The swale retrofits to 100% of the land use in Basin III only reduces the load approximately 7%.

(3) **TSS** – With 100% swales the total load removed is approximately 7%.

(4) **Copper** –With 100% swales, the total load removed is approximately 9%.

The reason for the low removal efficiency in the future condition is due to the increase in projected load due to additional buildout. In Table 6.5.5-2, note that the load due to future build-out increases for all but one water quality parameter (Cadmium). Most parameters increase from 6% to 24%. TN, TP, TSS, and Copper increased by 7%, 10%, 60% and 0%, respectively.

The final WMM scenario evaluated consisted of the future land use with existing residential swale coverage and the proposed outfall detention facility in Naples Bay. The construction of the outfall detention in Naples Bay was as effective at removing pollutants as 100 percent swale coverage on all existing and future residential land use. Of course, obtaining all the treatment in one location reduces the political and geographical complexity immensely. Constructing berms in Naples Bay is not without it's permitting difficulties as you are in effect, slicing off a portion of a valuable estuary, to convert it into a pollution treatment pond.

The Basin III WMM modeling concluded that future land use changes, although moderate, will result in increased pollutant loadings to Naples Bay. A fully implemented swale program for existing and new residences could help mitigate these increases, but is incapable of fully controlling the increase. A small detention system at the outfall could provide equivalent annual average treatment despite the fact that only a small fraction of the storms could be fully treated.

6.6 SWALE RESTORATION AND RETROFITS

CDM concluded that the structural BMPs in Basin III were largely restricted to isolated residential swales covering about 15 percent of the residences. An aggressive swale construction program of the existing residential areas could remove 3-5 times more pollutants than are being removed by the existing swales. Although we support and recommend a swale retrofit program, the aggressiveness of the 100% assumption will not pass the political ramifications when one considers how poorly ineffective the program is overall in terms of total reduction of pollutants and how much disruption to existing residences would be anticipated. We recommend a swale retrofitting program that is limited in scope to those areas that can be retrofitted with minimal right of way damage and restoration requirements.

6.6.1 Tetra Tech Swale Investigation

Tetra Tech performed a window survey of the major developed basins in Naples on December 28 and 29, 2006. We estimated that we surveyed 90% to 100% of the roadways in Basins II, III, V, and VI; and 60% to 75% of Basins I and IV. We did not investigate more than 10% of Basins VII through XII because they were not significant areas of swale development needed for our City-wide projections. Our investigation can be summarized by the following observations:

- Grass types greatly affect the long-term maintenance and functioning of existing swales. Bahia and Bermuda do not tend to build up over the curbs, flumes, and driveways as readily as healthy St. Augustine. Healthy St. Augustine requires regrading and replanting after 8-15 years.
- Many areas have the vestiges of the original swale construction (or intent), but are no longer functioning. R&R is needed in many areas.
- Paved swales should be replaced with grass or other stable vegetation.
- The swales use inlets to drain instead of complete percolation and evapo-transpiration, thus, the systems act more as "detention" than "retention". Raising inlet tops would provide more treatment volume, but could exacerbate flooding conditions. Underdrains will provide a higher pollutant removal efficiency than using ditch bottom inlets.

Tetra Tech spent a significant amount of time evaluating the constraints in restoring, refurbishing, or retrofitting additional swale treatment. The goal to provide additional swale treatment volume for water quality improvement is typically on inexpensive and relatively efficient retrofit method. The Basin III report assumed the City could get 100% swale coverage on all residential structures (Reference # 10.11). This assumption appears too aggressive for not only Basin III but the entire City for a number of reasons summarized below:

- <u>Sidewalk</u> – Space between the sidewalk and the edge of pavement is insufficient in many locations.
- <u>Curbing</u> – Curbing precludes swale drainage as a general rule. Miami curb can be retrofitted with flume bi-pass structures more readily than Type "F" curb or other non-mountable type curbs. Removing and/or retrofitting curbs are very expensive relative to non-curbed sections of roadway.
- <u>Grading</u> – Existing grading in many areas presented constraints where the ground was not flat enough to grade a swale.
- <u>New Home Non-Uniformity</u> – Many new homes are being constructed 3 to 5 feet higher than older existing structures. In some cases, the new home, itself, is set high to avoid the floodplain and the front setback to the street is minimal. The resulting front yard slope to the street is too high and too steep to allow a swale. In other cases, new and old homes sit adjacent to each other with each new home site forming an obstruction in the potential swale flow path. The paradox is that the large homes constructed today are elevated high enough to protect the residents from flooding but by doing so, preclude proper swale development and thus, do not provide their fair share of water quality treatment. Older structures at grade

provide water quality treatment opportunities (through swales), but are subject to tidal and tailwater flooding.

- Commercial Conflicts – In commercial areas, the amount of driveways, parking spaces, and other hard obstructions leave no effective grass area for excavation.
- Landscaping – Numerous right-of-ways contain mature palm trees, ficus trees, and other landscape material that would be very difficult to transplant. The removal of some of these plants would destroy the character of the boulevard look that currently exists on many streets.

6.6.2 Swale Investigation Summary

Table 6.6.2-1 provides a summary of the parameters necessary to develop a simple estimate of the runoff of each basin using a form of the rational method. The annual rainfall from the Basin III report and DCIA values were used to determine an approximation of the runoff characteristics. Each annual runoff volume is given in acre-feet. Using Basin III as our field calibration (approximately 15% swale area coverage of homes), we estimated the equivalent coverage of the other ten drainage basins. The estimated percent swale coverage has been adjusted in the adjacent column entitled "Effective Area w/Coverage" which adjusts the effective coverage area to reflect the amount of residential area actually available in the basin from Table 6.5.2-1. These results are given on Table 6.6.2-1.

Table 6.6.2-1 Estimated Annual Runoff Volume and Swale Coverage

Basin	Annual Precip (in)	Runoff Coefficient	Tetra Tech GIS Adj. Areas (ac)	Volume (ac-ft)	% Swale Coverage	Effective Area w/ Coverage	Max. Est. Coverage Possible	Effective Area w/ Coverage
I	53	0.43	1,514.4	2,881	5%	2%	20%	10%
II	53	0.30	916.8	1,228	50%	32%	55%	35%
III	53	0.33	570.5	840	15%	12%	50%	41%
IV	53	0.28	1,173.9	1,440	5%	4%	20%	14%
V	53	0.43	803.4	1,523	30%	17%	40%	22%
VI	53	0.59	316.2	820	15%	5%	25%	8%
VII	53	0.29	296.8	378	30%	23%	60%	46%
VIII	53	0.46	194.2	393	5%	1%	10%	2%
IX	53	0.23	2,990.2	3,040	20%	10%	30%	15%
X	53	0.34	800.9	1,215	0%	0%	0%	0%
XI	53	0.20	178.6	157	1%	0%	2%	0%

As a result of the investigation, we note that even in the most aggressive swale retrofit program (100% coverage), the net reduction in pollutants is not substantial. This is partly due to the lower treatment efficiency of the swales in Naples because of their high water table and inlet structures conveying water away preventing true retention through percolation and evapo-transpiration. In addition, the amount of volume available is too small in most for the swales to effectively treat the amount of runoff generated within the basins.

Most importantly, however, the physical limitations and constraints on the retrofit opportunities show that a more realistic expectation of the maximum swale retrofit projects is in the range of 20% to 60%, not 100%. Very difficult political decisions could make many of these projects undesirable. For instance, consider a street where on one side has higher graded lots providing a vertical separation between the sidewalk and edge of pavement where a swale can not be constructed. This often occurs if the homes are newer and above the flood plain. On the other side of the roadway the homes are at grade and, thus, can physically accommodate a swale but have substantial landscaping. Imagine notifying the residents on the lower side of the street that they all get to have their front yard landscaping torn up to do their part for the community, but the newer, higher elevated houses do not get inconvenienced because they graded their lots so that a swale can not be retrofitted.

Swale retrofitting in residential areas is a reasonable activity in select areas throughout the City and should be considered when it makes sense. The important point to understand is how limited the activity is in terms of ultimate effectiveness. Table 6.6.2-2 gives the estimated pollutant load generation for TN, TP, TSS, and copper for all of the City basins providing that there were no swales. Table 6.6.2-3 estimates the pollution removal effectiveness for the same four (4) parameters based on: (1) the estimate of actual swale coverage today; and (2) an estimate of a realistic maximum swale retrofit program on a City-wide basis. With only retrofit swale treatment, the total load removal will be limited to under 10% and other alternatives are needed to meet water quality treatment needs. Swale retrofits should be seen as having only a minor role in the overall program.

Table 6.6.2-2 Estimated Pollutant Loading by Basin (if no treatment)
Theoretical Condition (if no swales were present)

Phosphorous (lbs/yr)									
Basin	Annual Runoff Vol. (ac-ft)	Open Space	Resident. (all)	Institut.	Comm. / Industr.	Water/ Wetland	Golf	Transp.	TOTAL loading (lbs/yr)
I	2881	17	1,081	23	510	25	157	23	1,813
II	1228	22	631	10	84	5	467	0	1,218
III	840	20	555	21	43	1	0	0	640
IV	1440	26	822	0	0	21	0	0	869
V	1523	64	596	99	235	2	24	29	1,020
VI	820	0	180	74	262	0	0	13	516
VII	378	5	234	0	2	4	0	0	245
VIII	393	2	71	115	47	4	0	2	239
IX	3040	145	1,214	25	69	23	1,983	17	3,460
X	1215	189	20	0	7	7	0	198	223
XI	157	12	5	0	0	6	38	0	62
Total		**502**	**5,408**	**367**	**1,259**	**99**	**2,669**	**283**	**10,305**

Total Suspended Solids (lb/yr)									
Basin	Annual Runoff Vol. (ac-ft)	Open Space	Resident. (all)	Institut.	Comm. / Industr.	Water/ Wetland	Golf	Transp.	TOTAL loading (lbs/yr)
I	2881	3,148	183,347	3,986	118,220	6,265	3,132	35,238	318,097
II	1228	4,024	106,992	1,698	19,499	1,168	9,342	0	142,723
III	840	3,671	94,126	3,486	10,006	342	0	0	111,633
IV	1440	4,720	139,459	0	0	5,284	0	0	149,464
V	1523	11,645	101,101	16,850	54,411	533	478	44,019	185,018
VI	820	0	30,618	12,474	60,758	47	0	20,051	103,896
VII	378	825	39,716	0	500	1,078	0	0	42,120
VIII	393	430	11,970	19,588	10,932	962	0	3,207	43,882
IX	3040	26,570	206,059	4,205	16,094	5,783	39,657	24,786	298,369
X	1215	34,524	3,363	0	1,609	1,817	0	297,275	41,311
XI	157	2,232	870	0	0	1,580	769	0	5,451
Total		**91,789**	**917,622**	**62,287**	**292,029**	**24,859**	**53,378**	**424,576**	**1,441,964**

Table 6.6.2-2 Continued Estimated Pollutant Loading by Basin (if no treatment)
Theoretical Condition (if no swales were present)

Total Nitrogen (lb/yr)									
Basin	Annual Runoff Vol. (ac-ft)	Open Space	Resident. (all)	Institut.	Comm. / Industr.	Water/ Wetland	Golf	Transp.	TOTAL loading (lbs/yr)
I	2881	97	7,204	157	4,418	1,629	392	282	14,178
II	1228	124	4,204	67	729	304	1,168	0	6,595
III	840	113	3,698	137	374	89	0	0	4,412
IV	1440	146	5,480	0	0	1,374	0	0	6,999
V	1523	359	3,973	662	2,033	139	60	352	7,578
VI	820	0	1,203	490	2,271	12	0	160	4,136
VII	378	25	1,561	0	19	280	0	0	1,885
VIII	393	13	470	770	409	250	0	26	1,938
IX	3040	820	8,097	165	601	1,504	4,957	198	16,342
X	1215	1,065	132	0	60	472	0	2,378	4,108
XI	157	69	34	0	0	411	96	0	610
Total		**2,831**	**36,056**	**2,447**	**10,914**	**6,463**	**6,672**	**3,397**	**68,780**

Total Copper (lb/yr)									
Basin	Annual Runoff Vol. (ac-ft)	Open Space	Resident. (all)	Institut.	Comm. / Industr.	Water/ Wetland	Golf	Transp.	TOTAL loading (lbs/yr)
I	2881	0	36	2	49	0	0	7	93
II	1228	0	21	1	8	0	0	0	30
III	840	0	18	1	4	0	0	0	24
IV	1440	0	27	0	0	0	0	0	27
V	1523	0	20	7	22	0	0	9	58
VI	820	0	6	5	25	0	0	4	40
VII	378	0	8	0	0	0	0	0	8
VIII	393	0	2	8	4	0	0	1	15
IX	3040	0	40	2	7	0	0	5	54
X	1215	0	1	0	1	0	0	59	61
XI	157	0	0	0	0	0	0	0	0
Total		**0**	**180**	**24**	**120**	**0**	**0**	**85**	**410**

Table 6.6.2-3 Estimated Pollutant Loading by Basin (if existing swale treatment)

	Phosphorous (lbs/yr)							
	Existing Condition				Improved Condition			
Basin	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction
I	2%	18	1795	1%	10%	70	1,742	4%
II	32%	154	1065	13%	35%	148	1,071	14%
III	12%	31	609	5%	41%	99	541	16%
IV	4%	12	857	1%	14%	48	821	6%
V	17%	67	952	7%	22%	84	936	9%
VI	5%	10	506	2%	8%	17	499	3%
VII	23%	22	223	9%	46%	41	204	18%
VIII	1%	1	238	0%	2%	2	237	1%
IX	10%	141	3319	4%	15%	203	3,257	6%
X	0%	0	223	0%	0%	0	223	0%
XI	0%	0	62	0%	0%	0	62	0%
Totals		**457**	**9,849**	**4%**		**711**	**9,594**	**7%**

	Total Suspended Solids (lb/yr)							
	Existing Condition				Improved Condition			
Basin	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction
I	2%	6,235	311,863	2%	10%	24,450	293,647	8%
II	32%	35,966	106,757	25%	35%	29,593	113,130	28%
III	12%	10,851	100,782	10%	41%	32,653	78,979	32%
IV	4%	4,185	145,279	3%	14%	16,271	133,193	11%
V	17%	24,463	160,555	13%	22%	28,305	156,713	18%
VI	5%	4,114	99,782	4%	8%	6,586	97,311	7%
VII	23%	7,683	34,437	18%	46%	12,563	29,557	36%
VIII	1%	421	43,461	1%	2%	834	43,048	2%
IX	10%	24,347	274,022	8%	15%	33,540	264,829	12%
X	0%	0	41,311	0%	0%	0	41,311	0%
XI	0%	2	5,449	0%	0%	3	5,447	0%
Totals		**118,266**	**1,323,697**	**8%**		**184,799**	**1,257,165**	**14%**

Table 6.6.2-3 Continued Estimated Pollutant Loading by Basin (if existing swale treatment)

Total Nitrogen (lb/yr)								
	Existing Condition				Improved Condition			
Basin	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction
I	2%	63	14,116	0%	10%	249	13,929	2%
II	32%	374	6,221	6%	35%	388	6,207	6%
III	12%	96	4,315	2%	41%	315	4,097	7%
IV	4%	44	6,955	1%	14%	175	6,824	3%
V	17%	225	7,352	3%	22%	292	7,286	4%
VI	5%	37	4,100	1%	8%	61	4,076	1%
VII	23%	77	1,808	4%	46%	148	1,737	8%
VIII	1%	4	1,933	0%	2%	8	1,929	0%
IX	10%	300	16,042	2%	15%	442	15,900	3%
X	0%	0	4,108	0%	0%	0	4,108	0%
XI	0%	0	610	0%	0%	0	610	0%
Totals		**1,221**	**67,559**	**2%**		**2,078**	**66,702**	**3%**

Total Copper (lb/yr)								
	Existing Condition				Improved Condition			
Basin	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction	Effective Area w/ Coverage	Pollutant Removed (lbs/yr)	Loading (lbs/yr)	Percent Reduction
I	2%	0.4	92.8	0%	10%	1.6	91.5	2%
II	32%	1.7	28.0	6%	35%	1.7	27.9	6%
III	12%	0.5	23.4	2%	41%	1.7	22.3	7%
IV	4%	0.2	27.2	1%	14%	0.7	26.7	3%
V	17%	1.7	55.9	3%	22%	2.2	55.4	4%
VI	5%	0.4	39.5	1%	8%	0.6	39.3	1%
VII	23%	0.3	7.7	4%	46%	0.6	7.4	8%
VIII	1%	0.0	15.1	0%	2%	0.1	15.1	0%
IX	10%	1.0	52.7	2%	15%	1.5	52.3	3%
X	0%	0.0	60.8	0%	0%	0.0	60.8	0%
XI	0%	0.0	0.2	0%	0%	0.0	0.2	0%
Totals		**6**	**403**	**2%**		**11**	**399**	**3%**

Note on Table 6.6.2-3 that the estimated removal of the four (4) parameters on an integrated City-wide basis would only be approximately:

	Existing Condition	Improved Condition
• TP	4%	7%
• TSS	8%	14%
• TN	2%	3%
• Copper	2%	3%

There appears to be more opportunities in the basins to restore the swales to their original volumes (R&R) than to develop new swale systems (CIP). Thus, in regards to using swales for City-wide treatment, we recommend the following:

(1) Establish a basin-wide swale restoration program under an R&R program.

(2) Consider providing some minor swale creation projects on a basin-wide basis, in limited areas where it makes sense physically and politically and organize it as part of a limited CIP Program.

(3) Any swale restoration projects that create new water quality treatment volumes (like removing a paved swale and replacing with grass) should be "banked" and the treatment credits accounted for to apply against retrofit water quality projects (to alleviate flooding) within the same basin.

(4) Explore an ordinance that attempts to ensure that mega-homes provide their fair share of treatment, either through: requiring swale area; exfiltration in front slope fall areas; or on-site retention.

SECTION 7

ASSESSMENT OF FUTURE REGULATORY ISSUES

7.1 NPDES PROGRAM

NPDES is an acronym for the National Pollutant Discharge Elimination System. The purpose of the NPDES program is to protect waters of the States from pollution. The Clean Water Act of 1972 established the NPDES program. The Environmental Protection Agency (EPA) was tasked with developing the Federal NPDES program as a result. Permitting was implemented in 1990.

The permit requirements were broken into two phases, Phase I and Phase II. Phase I requirements went into effect in 1990 and were designed to cover large municipalities (population > 100,000), industrial activities, and construction sites that disturbed 5 acres or more. Phase I permitting was regulated by EPA. Phase II permit requirements went into effect in 1999. The Phase II program was designed to cover municipalities not regulated under the phase I program, and construction sites that disturb between 1 and 5 acres. In October of 2000, the EPA authorized the Florida Department of Environmental Protection (FDEP) to implement and maintain the NPDES permitting requirements in the State of Florida.

The City of Naples is currently permitted under Phase II of the program through FDEP, permit number **FLR04E080**. The original permit was approved in November 2003 with a detailed pollution prevention management plan that the City is required to implement. The permit is an ongoing process that requires various action items to be performed in different permit years along with annual reporting of the implementation of these actions. One important action item that the City appears to be performing over and above current NPDES regulations for Phase II is their water quality sampling and monitoring. The original sampling procedure and locations were described in a report by Camp Dresser & McKee (CDM) titled "City of Naples Monitoring Program Review" (Reference #10.39). The report was not dated, but was written prior to October 2000 due to permit requirement descriptions that do not include FDEP as the regulatory authority over the program. Since 2005, the City has undertaken a different water quality sampling program. More on both of these programs were discussed and summarized in Section 6.3 and Section 6.4.

Tetra Tech researched the files provided to us by the City and ascertained that the Year 1 Annual report was submitted to FDEP and accepted as complete, with minor recommendations for future reporting. This information is detailed in the Year 1 Annual Report Inspection letter dated November 28, 2005 from the FDEP. The City also underwent an inspection of the program in December 2005. From the letter dated December 19, 2005 from FDEP it was determined that the implementation of the permit at the time was adequate. There was a follow up letter to the City dated December 22, 2005 regarding an incorrect version of the report. It appears that the inspection was considered satisfactory. Nonetheless, that is an assumption without verifying the complete inspection reports which were not available at the time of the writing of this particular section (December 2006).

The City lost a staff member that implemented the NPDES program in early 2006. As a result, the City's Year 2 Annual Report that was due to FDEP on May 16, 2006 was not submitted. As of late December 2006, FDEP still had not received the required annual report. Therefore, the City is delinquent in reporting the mandatory requirements of the permit, and possibly in the implementation of various items as well. Tetra Tech informed the City of this delinquency in a letter dated November 28, 2006. We recommend the City take immediate action to bring this annual NPDES report into compliance.

City Staff and Tetra Tech are working together currently to obtain the applicable permit data in order to complete the report, and submit the annual report to FDEP.

7.2 TMDL AND IMPAIRED WATER PROGRAM

In 1972, the US Government enacted Section 303d of the Clean Water Act with the intent to mandate that States would determine which water bodies were impaired (not meeting State water quality standards) and to set priorities for determining what the Total Maximum Daily Load (TMDL) that a water body could stand. TMDLs establish the maximum amount of pollutants a water body can assimilate without exceeding water quality standards. A specific TMDL for each pollutant was to be determined for each water body listed. The Environmental Protection Agency (EPA) was to approve or disapprove the State submissions and act in lieu of the State if it disapproved a State's submission.

After approximately thirty years, over 40% of the assessed water bodies still did not meet the water quality standards set for them. The TMDLs were not even set to determine the amount of a pollutant that a water body could receive and still meet the water quality standards. As a result, a number of legal actions occurred in 37 states and the EPA was placed under a court order/consent decree to ensure TMDLs were established. Florida was one such state.

Thus, in 1992, new regulations were instituted that included a scope of state lists, a methodology to develop the list of "impaired waters", and more definition as what components make up a TMDL. Priorities and schedules were set in the State. Additional interpretive guidance was provided in 1997. This led to the formation of a specific schedule based on geographic watersheds. Today, the TMDL program as it affects Naples in Florida can be summarized as follows:

- Florida is divided into 6 Watershed Districts
- FDEP South District is comprised of 5 Basin Groups (BGs)
- Group 1 Basin, "**Everglades West Coast**" has 3 planning units (PUs)
- The 3 planning units locally are: Estero bay, Southwest Coast, and Inner Drainage Area (east Collier County)
- **Naples is located in Southwest Coast PU** (904 sq mi. and 44 water bodies)
- Water bodies are defined by the EPA as a stream, estuary, coastal, or lake system
- Each year the FDEP assesses water bodies in the Basin Groups
- A Watershed Management Program is being developed in each Basin

The City of Naples was grouped into the geographic region known as **Everglades West Coast Planning Unit.** Planning units comprise a group of smaller assessment units referred to as WBIDs, for water body identification. Nine of the 41 WBIDs in the Southwest Coast Planning Unit occur within the Naples Bay Basin. (Reference #10.19). The Everglades West Coast Planning Unit has been following the schedule provided for that region. The plan involves five phases of required activities in order to comply with the TMDL program. Those phases are as follows:

- Phase 1 – Watershed Evaluation
- Phase 2 – Strategic Monitoring
- Phase 3 – Developing and Adopting TMDLs
- Phase 4 – Developing Watershed Management Plans
- Phase 5 – Implementing Watershed Management Plans

In November of 2001, the Basin Status Report was issued for the Everglades West Coast Group 1. The report listed potentially impaired water bodies in the geographic region. Gordon River and Naples Bay were declared as "potentially impaired." The Conservancy of Southwest Florida petitioned to have Naples Bay included as an "impaired water body". The verified list of impaired waters was released in July of 2002. The FDEP submitted the Verified List to the EPA in October of 2002 which published an updated impaired waters master list showing seven water body identifications (WBIDs) or waterbody segments occurring on either the Planning or Verified List in the Naples Basin Watershed (NBW). WBIDs on the planning list will undergo Impaired Water Rule assessments to ascertain if TMDLs are needed and receive a new listing in the fall of 2007 after further monitoring is conducted. The projected year for TMDL development of all necessary WBIDs in the Naples Bay Basin is 2008.

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).

7.2.1 Results of the Phase 2 Assessment Report for Group 1

According to information provided in the 303(d) lists, the primary parameter of concern in the Naples Bay area is dissolved oxygen (DO). Henderson Creek WBID is mis-named. The WBID is not related to Henderson Creek, but rather is a portion of the Golden Gate Canal System (Reference # 10.19).

Table 7.2.1-1 below provides the FDEP 303(d) Waterbodies Status (compiled from the Updated Master List October 2002), and the Amended Verified and De-lists Lists (March 2003) for the Naples Bay Watershed.

Table 7.2.1-1 FDEP 303(d) Waterbody Status for NBW

WBID	Water Body Name	Proposed	Parameter	Priority
3259C	Gordon River	Planning List	DO	Low
		Planning List	Total Coliforms	Low
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	
3259G	Naples Bay	Planning List	DO	Low
		Planning List	Nutrients (chlorophyll)	Low
3259H	Henderson Creek Canal	Planning List	DO	

In September of 2003, the FDEP issued a Phase 2 Assessment Report which included the status of water bodies in Naples. The findings of that report included the following for the Southwest Coast Group 1:

- Only 7 out of 44 water bodies were designated as "impaired"
- Only 1 water body was actually in the City of Naples since WBID is mislabeled.
- Gordon River Canal is listed as "**impaired**" for D.O and is thus, on the Verified List.
- Gordon River is listed as "**potentially impaired**" for D.O. and total Coliforms and is thus, only on the Planning List.
- Naples Bay is listed as "**potentially impaired**" for nutrients (by way of chlorophyll *a*) and D.O. is thus only on the Planning List.
- None of the listings were given "High Priority." Only the Gordon River received a "medium" priority. All others in Naples were given "Low Priority."

7.2.2 Status of Schedule

The water quality data collection has been occurring now for several years. In Naples Bay for instance 446 samples were taken from 1996 to 2001. The data is being collected by both Collier County and the City of Naples and provided to the FDEP. It is anticipated that the data collected with be used to model the bay in 2007. Development of the TMDLs for Naples Bay will follow thereafter. Thus, the current schedule for Group 1 is as follows:

- 2006 Strategic water quality monitoring to produce the "Verified List"
- 2007-2008 TMDL modeling and development
- 2008-2009 Develop the Basin Management Action Plan (BMAP)
- 2009 Implement the BMAP

7.2.3 What does this mean for Naples Bay?

There are many parameters that can trip a threshold allowing a water body to receive the "impaired" status. Common parameters that trip the threshold include high nutrients, low dissolved oxygen, high suspended solids, high bacteria, or high heavy metals. None of these monitored water quality parameters have yet to show sufficient evidence from the State's perspective that the current water quality has deteriorated to the standards necessary to enact special rules on this water body. It is interesting to note that the list of specific parameters do not include salinity. Taylor and SFWMD have been very interested in salinity because of how it affects the ecological systems in the estuaries (References # 10.23 and #10.19). We recommend measuring salinity at the water quality sampling locations that are measuring background estuarine conditions.

Currently the only parameter of concern listed by the FDEP for Naples Bay is Chlorophyll *a*. Naples Bay has other reasons to be a water body of concern, however such as its Class II designation by the State and it becoming part of a SWIM Plan this year. The City was informed that the FDEP will not place Naples Bay on the impaired list if "reasonable assurance" through projects are implemented by the City to improve the water quality. With the chlorophyll *a* in question, Naples Bay may be potentially impaired, attributable to nutrients. We recommend that the continued monitoring of nitrogen, phosphorus and Chlorophyll *a* continue. We also noted in Section 6.4 that there were some concerns with periodic surges in fecal coliforms and lead. Interestingly, the results shown on Table 6.5-1 suggest that the periodic spikes in lead concentrations are coming from the Gulf of Mexico which suggests that not all of the treatment of pollutants should be directed at the runoff generated from within the City of Naples drainage basins and upstream freshwater streams from outside the City. Tidal introductions of pollutants from the Gulf are much more problematic to deal with. Not only are the lead values in the Gulf exceeding State thresholds 67% of the time, but the 75 percentile at 23 mg/L is significantly above the 1.8 mg/L reported as the typical 75 percentile for Florida estuaries (Reference #

10.27). The values provided in that reference were intended for estuaries not the Gulf of Mexico; however, the discrepancy is still a cause for alarm and monitoring since it would affect the values of lead entering Naples Bay as well. The high concentration of lead from Gordon River upstream of the Weir may also be a contributing factor.

In general, the three upper section discharge locations into Naples Bay summarized in Table 6.4-2 indicate that the Gordon River upstream of the Weir may be a source of significant concentrations of pollutants to Naples Bay. Not only are lead concentrations high from upstream of this weir, but also copper, TN, and Chlorophyll *a*. Low values of DO discharge from this location as well, with 100% exceedance of State Standards. Copper exceeds State thresholds 85% of the time and the 75 percentile is 13 mg/L. Chlorophyll *a* exceeds State Standards 60% of the time and the 75 percentile value of 28 is more than twice the typical 75 percentile values provided (Reference # 10.27). We recommend the City reassess their water quality monitoring program in general. The current practice of measuring the water quality in the waterbody does not help isolate specific strategic "hot spots" where the City may be contributing loads of special concern. Once a polluted discharge has mixed with Naples Bay, you can not tell where the pollutant originated. Some select monitoring locations located at major outfalls, might allow a more cost-effective effort to target the most troublesome discharges.

7.3 NAPLES BAY UNDER THE STATE'S SWIM ACT

In recognition of the need to place additional emphasis on the restoration, protection and management of the surface water resources of the State, the Florida Legislature, through the Surface Water Improvement and Management (SWIM) Act of 1987, directed the State's water management districts to "design and implement plans and programs for the improvement and management of surface water" (Section 373.451, Florida Statutes). The SWIM legislation requires the water management districts to protect the ecological, aesthetic, recreational, and economic value of the State's surface water bodies, keeping in mind that water quality degradation is frequently caused by point and non-point source pollution, and that degraded water quality can cause both direct and indirect losses of aquatic habitats.

The South Florida Water Management District (SFWMD) ranked Naples Bay as a Tier 2 waterbody on the SFWMD priority list approved in 2001. In 2003, the development of a SWIM plan for Naples Bay was authorized by the SFWMD Governing Board (Reference # 10.19).

In preparation for development of the Naples Bay SWIM Plan, a Naples Bay SWIM Reconnaissance Report was authorized in 2005 (Reference # 10.18). The objective of the Reconnaissance Report 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 was to provide a meaningful resource for the development of the Naples Bay SWIM Plan.

To develop the Naples Bay SWIM Plan, the Reconnaissance Report was used as the primary resource by a team of SFWMD staff members and an outside consultant to develop a draft Plan. Input on the draft Plan was solicited for, and provided by government and agency stakeholders and other interested parties, through a workshop held in the vicinity of Naples Bay. On October 27, 2006, the Draft SWIM Plan was issued and current draft report available at the time of this Stormwater Master Plan Update. That draft indicates an intent to have the SWIM Report issued in January of 2007.

Water management goals and objectives of the Naples Bay SWIM plan (Reference # 10.19) includes the following:

- Protect and improve surface water quality
- Preserve and restore, where appropriate, native ecosystems along with their water resource related functions
- Maintain the integrity and functions of water resources and related natural systems
- Improve degraded water resources and related natural systems to a more natural functionality

We summarize herein, three key sections of the SWIM Plan Report (Reference # 10.19) by first providing the plan's initiatives, strategies, action steps and funding.

7.3.1 Naples Bay SWIM Plan Initiatives

The Naples Bay SWIM Plan focuses on the following four primary initiatives:

Initiative 1 — *Water Quality*

- Water quality and flow monitoring
- Water quality modeling.

Initiative 2 — *Stormwater Quantity*

- Identify inflows from canals and stormwater conduits, including non-point discharges.
- Identify mechanisms to reduce excess flows and restore more natural timing and quantity of freshwater inflows to the Bay.

Initiative 3 — *Watershed Master Planning and Implementation*

- Watershed Master Planning -
  Evaluate the existing stormwater management infrastructure and practices in the geographic area and identification of problem areas, with detailed remedial actions derived using hydrologic models simulating responses on volumes and timing of flow rates under a range of climatic conditions.
- Implementation -
  Assist local governments in coordinating their plan implementation and construction of those projects through a prioritized stormwater retrofit program. The dual focus is on areas built prior to adoption of stormwater management regulations (1984), and areas with identified impaired waters. A key tool for implementation is solicitation of available federal and state funding and identification of other partnering opportunities.

Initiative 4 — *Habitat Assessment, Protection and Restoration*

- Strategies to develop maps to identify areas for habitat protection and restoration in the NBW.
- Additional data collection efforts for parameters such as benthic organism diversity, submerged aquatic vegetation distribution, and shellfish areas
- Evaluate and analyze data to identify opportunities for habitat restoration.

7.3.2 Naples Bay SWIM Plan Strategies and Action Steps

A number of strategies and associated action steps were developed to fulfill these initiatives. The strategies for each initiative are listed as follows:

Water Quality Initiative

- Strategy: Evaluate the existing water quality monitoring network to determine its ability to detect change.
- Strategy: Hydrologic and hydrodynamic water quality modeling

Water Quantity Initiative

- Strategy: Improve the timing of freshwater flows into Naples Bay

Watershed Master Planning and Implementation

- Strategy: Evaluate existing stormwater master plans
- Strategy: Assist in the development of local Stormwater Master Plans and implementation schedules
- Strategy: Partner with local governments to implement Stormwater Master Plans

Habitat Assessment, Protection, and Restoration Initiative

- Strategy: Provide habitat assessment, protection and restoration

7.3.3 Naples Bay SWIM Plan Funding

The successful implementation of this plan will require staff resources and dedicated funding along with financial commitment by local governments in the watershed. To accomplish all of the action steps in the ambitious endeavor, it was estimated that full implementation of the NBW SWIM Plan will cost $6.31 million over the next five years (Reference # 10.19). Table 7.3.3-1 shows funding estimates by initiative.

Table 7.3.3-1 Funding Estimates by Initiative from the SFWMD SWIM Plan

Initiative	Year 1	Year 2	Year 3	Year 4	Year 5
Water Quality	$75K	$90K	$75K	$75K	$75K
Water Quantity	$25K	$60K	$30K	$25K	$25K
Watershed Master Planning and Implementation	$1,050K	$1,150K	$1,120K	$1,120K	$1,120K
Habitat Assessment, Protection, and Restoration	$50K	$50K	$30K	$30K	$30K
Totals	**$1,200K**	**$1,350K**	**$1,255K**	**$1,250K**	**$1,250K**

7.4 CITY'S STORMWATER MANAGEMENT REGULATION PROGRAM

Tetra Tech reviewed the City's Land Development Codes (LDCs) and Ordinances as provided by the City to evaluate the stormwater management regulations. Chapter 30 (Public Works), 44 (LDC) and 52 (Reserve Protection Standards) were all reviewed for the purpose of determining whether modifications to the codes should be considered.

7.4.1 Review of Existing Comprehensive Plan

The Comprehensive Plan outlines LOS criteria for evaluation of Stormwater Management Systems but the criteria is inappropriate for design analysis and alternatives evaluation. In addition, there is no consideration given to retrofit design activities versus new design activities. Most specifically, however, the Plan does not appear to set the direction for the City to create its own stormwater management regulations and thresholds to address their unique needs and local concerns. We recommend that the Comprehensive Plan make provisions for expanded LOS evaluation, minimum thresholds of applicability, new construction versus retrofit, and expanded water quality considerations in their next revision and that the codes follow these goals. More specific direction will be provided in subsection 7.4.2.

7.4.2 Review of Existing Stormwater Management Codes

Article VI of Chapter 30 is the section on "Stormwater Management". This entire section deals with the establishment of the stormwater utility from an administration and financial perspective. It does not deal with LOS or engineering design standards.

Chapter 44 is primarily the General Provisions of the LDC. The most significant section is the Definitions. This section has never been modified to include the normal terms and definitions used in Stormwater Management Codes and subsections. Noticeably missing terms included: Best Management Practice (BMP), retention, detention, wet detention, design storm event, pollution abatement (water quality calculations), peak attenuation (water quantity considerations for flood control), etc. A definition of "LOS" and "swale" was present, however, they were not written with stormwater management specifically in mind. We recommend using the State's definition for swale, which gives very specific geometric and performance criteria as part of the definition. We further recommend that an entire stormwater management definition section be created.

Article IV Water Resources of the Chapter 52 (Resource Protection Standards) was the last section of Codes and Ordinances provided to Tetra Tech for review. This section contains much language relating to boating, mooring, waterways, dredging, seawalls, boat slips, and related topics; but again, does not specifically deal with stormwater management regulations and LOS performance criteria.

Unless some specific sections of the code were not omitted for our review inadvertently, we found little that relates to stormwater management practices. It appears the City lacks a typical stormwater management section in their codes, since they rely heavily on the SFWMD permitting activities to ensure compliance. Since SFWMD Regulations are not intended to regulate small drainage impacts, most cities contain their own thresholds that are more finite than those imposed by the local Water Management District. These codes typically fall into one of three categories:

- Pollution abatement (water quality considerations)
- Peak attenuation (water quantity considerations)
- Floodplain compensation (mitigation, floodplain encroachment)

SFWMD codes for pollution abatement follow essentially the State's recommendations regarding BMP Practices. The City's LOS criteria provided in the adopted Comprehensive Plan already establishes and follows the SFWMD criteria closely. The consideration missing is a specific threshold for the City to require water quality treatment design for new impervious surfaces.

Peak attenuation is well defined in SFWMD regulations but not in the City Codes or Comprehensive Plan. According to subsection 40E-4.0415(1)(b), F.A.C., the thresholds for requiring a permit with SFWMD is not concerned with new impervious cover unless it exceeds 1 acre (43,560 sq. ft.) where as, SJRWMD has a threshold of 9,000 sq. ft. (and 4,000 sq. ft. if vehicular impervious). The thresholds for notice and permit requirements with FDEP indicates that a permit will be required if new impervious surface exceeds 2 acres (62-25.030(1)(b), F.A.C.). Many cities have adopted a threshold requiring stormwater management for commercial impervious projects exceeding 500 to 10,000 sq. ft. Some communities set lower thresholds for water quality considerations than for water quantity. The actual design storm events should follow the LOS guidelines in the Comprehensive Plan. As discussed in Section 4 of this report, the LOS methodology and Comprehensive Plan should be modified.

The floodplain ordinance applicable to the City is based on typical FEMA templates. There is currently no compensation storage policy required by City Codes. Since the predominant problem with floodplain encroachment in the City is flooding due to tidal surge (tropical storm surge) and high tide events (not floodplain displacement), we do not favor nor recommend a compensatory storage code written specifically for the City. Such compensation storage practices would not be effective in preventing flooding in this particular geographic location where specific tailwater issues cause most of the flooding.

In summary, we recommend creating specific Stormwater Management Codes and thresholds to address the City of Naples specific concerns and needs. Although drafting these codes is beyond the scope of services, we outline the recommendation for those changes shown in Table 7.4.2-1 below:

Table 7.4.2-1 Recommended Stormwater Management Code Elements

Section of Code	Current Status	Proposed Creation/Modification
Definitions	Very few	Create specific section relevant to stormwater management.
Pollution Abatement	Comprehensive Plan LOS defaulting with SFWMD criteria.	Adapt to Stormwater Management Codes and establish threshold criteria for commercial impervious area at least above 5,000 to 10,000 sq. ft. to capture what SFWMD regulations do not cover.
Peak Attenuation	Comprehensive Plan LOS only. Does not apply to smaller projects and residential.	Modify Comprehensive Plan as recommended in Section 4.3.1. Create Stormwater Management Codes for new construction and retrofit construction. Thresholds for attenuation at above 10,000 sq. ft. to 1 acre. Let SFWMD criteria dictate and perform for sites over 1 acre.
Floodplain Compensation	None required	No provisions recommended at this time.

7.4.3 Mega-Home Construction

The City is currently undergoing a period of expansion where there are numerous large footprint homes (locally referred to as "Mega-homes") being constructed. In many of those cases, the home is constructed on an assemblage of lots at bare minimum setbacks. Because these mega-homes are typically found on the Bay, Gulf or access to major water bodies, these buildings are typically subjected to the very worse FEMA floodplain zones (See Figure # 5.1-1) and are elevated significantly above land surface. The resulting disparity between these mega-homes and their existing neighbors often creates stormwater management problems such as:

- Inability to create roadside swales for water quality treatment
- Direct untreated discharge from highly fertilized and landscaped lawns into sensitive receiving waters
- Significant increase in impervious area causing direct runoff onto the lower neighbor resulting in nuisance flooding.

Most communities follow the standards established under FAC 62-25 which essentially exempts most single family structures from requiring a stormwater permit. According to FAC 62-25.030 "Exemptions", the State does not require permits from residential structures that are:

- Designed to accommodate only one single family dwelling unit, duplex, triplex or quadruplex, provided the single unit, duplex, triplex or quadruplex is not part of a larger common plan of development or sale;
- Designed to serve single family residential projects, including duplexes, triplexes or quadruplexes, of less than 10 acres total land area and which have less than 2 acres impervious surface.

Obviously, the second part of this code sets the current minimum bar for "mega-home" thresholds at the State's level. This threshold is not recommended for Naples as most large impact homes are built on much smaller land areas and do not provide 2 acres of impervious surface. According to Bob Marsh, Plans Reviewer at the City, there is no maximum percent impervious area on single family homes, but there are "livable space ratios." In order to ensure that there is not a continuous generation of unabated residential pollutants, we recommend establishing a maximum percentage of impervious area for each residential construction project to guarantee a reasonable area to be set aside for trees, grasses and landscaping to filter and percolate stormwater runoff prior to discharge to receiving waters. In addition, the City may wish to consider residential structures that generate more than say 20, 000 sq. ft. of impervious area as "mega-homes". We suggest requiring such projects to either meet the standard water quality treatment criteria required of commercial development or some other standard BMP practice utilizing buffer strips, side and front yard swales, or exfiltration depending upon specific site conditions.

SECTION 8

ASSESSMENT OF FINANCING ISSUES AND OPPORTUNITIES

8.1 RANKING PROJECTS

Ranking projects requires an objective procedure and methodology to determine which projects should be initiated ahead of others. In communities where no ranking procedure has been established, difficulties arise in the implementation of projects. In some communities, the projects funded first are those where residents make the most noise. Such strategies of funding where a public group or individual speaks the loudest causes dissatisfaction among the public when more important projects are delayed in favor of less important projects. In addition, projects often need to be constructed in coordination with other projects in order to maximize the benefits or to prevent repetitive construction activities. For an example, the City would not want to tear up a public street to install a retrofit drainage pipe, repair the street, then come back and tear up the same street a year later to construct a new water line. Often Public Works and Public Utility CIP projects need to be coordinated to ensure that the most logical sequencing occurs.

In review of the existing Stormwater Master Plans and reports prepared for the City, we could find no evidence that a ranking system has previously been initiated. There are several iterations of a modified list of CIP projects, but no ranking of the projects in terms of benefits and annual budgets to fit into the 5-year plan. With the State expressing more interest in how municipalities calculate, manage and report their 5-year CIPs, the creation of a CIP Ranking Methodology and updating the Five Year Plan has become increasingly important (Reference #10.36). As part of this Stormwater Master Plan Update we propose to create such methodologies.

We propose two (2) methodologies for ranking expenditures in this report. The first is aimed at establishing a ranking of problem areas by drainage basin. This approach will help guide big picture spending by identifying which areas in the City need the most focused attention. The second approach will rank the actual identified CIP projects by a cost to benefit approach. This method narrows the focus significantly looking at individual project expenditures within the drainage basins. Both methods should prove useful to the City depending upon the type of decision they are attempting to rank.

8.1.1 Ranking of Problem Areas by Drainage Basins

We selected some of the most relevant data compiled in this Stormwater Master Plan Update and re-organized the results into a ranking comparison table. Table 8.1.1-1 borrows the results from various tables throughout this text as referenced. The data is organized into two (2) basic considerations:

- Water Quantity Considerations (Flooding)
- Water Quality Considerations (Pollution)

We calculated relative ratios and percentages of the number of junction nodes and/or homes flooded per area to determine which drainage basins have the worst flooding problems. We chose four (4) separate comparisons to evaluate flooding:

- Tailwater flooding from the record high tide event
- Roadway flooding by storm events for a LOS "C"
- Building flooding by storm events for a LOS "B"
- Actual reported home flooding (above FFE)

The first three (3) considerations on Basin III, V, and VI have been studied extensively. We recommend completing the Basin studies and using the data from those studies to update/finish the rankings accordingly. The comparison of flooding at sub-basin nodes from the SWIM model was an easy and useful way to make consistent comparisons. We recommend that approach be maintained on the subsequent Basin studies. Table 8.1.1 will help guide which basins should be studied next.

Table 8.1.1-1 does not attempt to normalize columns of data where ratios are missing. Values that have not been studied to date simply are assigned no normalized value. The incentive to collect additional data in these basins is that Basins III, V, and VI have more points in water quantity (flooding) considerations because they have been studied in the most detail (and were arguably considered the tope three basins historically). Table 8.1.1-1 indicates the following basins have the worst conditions as summarized:

- Tailwater/tidal flooding - Basin III (so far)
- Roadway flooding potential - Basin V (so far)
- Building flooding potential - Basin VI (so far)
- Actual FFE structure flooding - Basins II and III (complete)

Table 8.1.1-1 Ranking Problem Areas by Drainage Basin

			Water Quantity Considerations (Flooding)														Water Quality Considerations (Pollution)					
			# of Relevant Junct. Nodes		Tailwater flooding from Record High Tide			Roadway Flooding by Storm Event for LOS C			Building Flooding by Storm Event for LOS B			Actual Homes w/ FFE Flooding		Pollutant Loading Potential – If No Swales					
City Basin ID #	Basin Area (acres)	Basin Area (sq.mi.)	Road	Homes	# Junct. Nodes Flooding	Flooding Failures/ Junction	Flooding Failures/ Sq. Mile	# Junct. Nodes Flooding	Flooding Failures/ Junction	Flooding Failures/ Sq. Mile	# Junct. Nodes Flooding	Flooding Failures/ Junction	Flooding Failures/ Sq. Mile	# of Homes	Flooded Homes/ Sq. Mile	TN (Lbs/Yr)	Lbs/ Acre	TP (Lbs/Yr)	Lbs/ Acre	TSS (Tons/ Year)	Tons / Sq.Mi
-	Table 6.5.2-1	-	From Table(s) 5.3.(2,4,6)-1		Table 5.3.2-4	-	-	From Table(s) 5.3.(2,4,6)-1		-	From Table(s) 5.3.(2,4,6)-1		-	Table 5.4	-	Table 6.6.2-2		Table 6.6.2-2		Table 6.6.2-2	
I	1,514	2.37												1	0.4	14,178	9.4	1,813	1.2	159	67.2
II	917	1.43												5	**3.5**	6,595	7.2	1,218	1.3	71	49.8
III	571	0.89	61	61	31	**51%**	34.78	11	18%	12.34	2	3%	2.24	3	3.4	4,412	7.7	640	1.1	56	62.6
IV	1,174	1.83												3	1.6	6,999	6.0	869	0.7	75	40.7
V	803	1.26	142	55	0	0%	0.00	50	**35%**	39.83	0	0%	0.00	4	3.2	7,578	9.4	1,020	1.3	93	73.7
VI	316	0.49	43	43	5	12%	10.12	13	30%	26.31	10	**23%**	20.24	0	0.0	4,136	**13.1**	516	**1.6**	52	**105.2**
VII	297	0.46												0	0.0	1,885	6.4	245	0.8	21	45.4
VIII	194	0.30												0	0.0	1,938	10.0	239	1.2	22	72.3
IX	2,990	4.67												0	0.0	16,342	5.5	3,460	1.2	149	31.9
X	801	1.25												0	0.0	4,108	5.1	223	0.3	21	16.5
XI	179	0.28												0	0.0	610	3.4	62	0.3	3	9.8

City Basin ID #	Basin Area (acres)	Basin Area (sq.mi.)	Tailwater Flooding Potential		Roadway Flooding Potential		Building Flooding Potential		Actual FFE Flooding Potential		TN Pollution Potential		TP Pollution Potential		TSS Pollution Potential		Normalized Ranking Based on Water Quantity		Normalized Ranking Based on Water Quality	
-	Table 6.5.2-1	-	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual	Normal	∑Normal (Actual)	Normal	∑Normal (Actual)	Normal
I	1,514	2.37							0.4	1.0	9.4	2.7	1.2	4.3	67.2	6.9	1.0	1.0	13.9	**4.3**
II	917	1.43							3.5	**8.7**	7.2	2.1	1.3	4.8	49.8	5.1	8.7	8.7	12.0	**3.7**
III	571	0.89	34.8	**3.4**	12.3	1.0	2.2	1.0	3.4	8.5	7.7	2.3	1.1	4.0	62.6	6.4	13.9	13.9	12.7	**3.9**
IV	1,174	1.83							1.6	4.0	6.0	1.7	0.7	2.7	40.7	4.2	4.0	4.0	8.6	**2.6**
V	803	1.26	0.0	0.0	39.8	**3.2**	0.0	0.0	3.2	8.0	9.4	2.8	1.3	4.6	73.7	7.5	11.2	11.2	14.9	**4.6**
VI	316	0.49	10.1	1.0	26.3	2.1	20.2	**9.0**	0.0	0.0	13.1	3.8	1.6	**5.9**	105.2	10.8	12.2	12.2	20.5	**6.3**
VII	297	0.46							0.0	0.0	6.4	1.9	0.8	3.0	45.4	4.7			9.5	**2.9**
VIII	194	0.30							0.0	0.0	10.0	2.9	1.2	4.4	72.3	7.4			14.8	**4.5**
IX	2,990	4.67							0.0	0.0	5.5	1.6	1.2	4.2	31.9	3.3			9.0	**2.8**
X	801	1.25							0.0	0.0	5.1	1.5	0.3	1.0	16.5	1.7			4.2	**1.3**
XI	179	0.28							0.0	0.0	3.4	1.0	0.3	1.2	9.8	1.0			3.2	**1.0**

Unlike the water quantity (flooding considerations), all of the basins (except XII) were studied at least at a conceptual level in order to complete the ranking matrix. Basin XII was not studied since it is an off-site wetland area in Naples Bay that has no real bearing on any of the financial decisions of the City at this time.

Table 8.1.1-1 indicates the following basins have the highest pollutant loading potential for the parameters considered as summarized below:

- TN (lbs/ac/yr) Basin VI (followed by VIII & then V)
- TP (lbs/ac/yr) Basin VI (followed by II & then V)
- TSS (lbs/ac/yr) Basin VI (followed by V & then VIII)

If one ranked all the basins on **water quality alone**, then re-normalized the results, we find the five (5) basins of highest concern (in terms of generating pollutant load) in the following order:

- #1 Basin VI (6.3 points) Studied thoroughly relative to flooding
- #2 Basin V (4.6 points) Studied thoroughly relative to flooding
- #3 Basin VIII (4.5 points) Completely unstudied to date
- #4 Basin I (4.3 points) Completely unstudied to date
- #5 Basin III (3.9 points) Studied thoroughly in both water quantity & quality

Based on the more limited, **water quantity alone**, we would rank the five (5) basins of highest concern (in terms of various flooding considerations) in the following order:

- #1 Basin VI (12.2 points) Studied thoroughly in terms of both water quantity and quality
- #2 Basin III (13.9 points) Studied thoroughly in terms of flooding
- #3 Basin II (8.7 points) Studied thoroughly in terms of flooding
- #4 Basin V (11.2 points) Completely unstudied to date
- #5 Basin IV (4.0 points) Completely unstudied to date

Since normalization of data was incomplete, we had to rank these using some subjectivity considering complicated issues such as:

- Although Basin VI is ranked highest in potential building flooding (of the basins studied in detail), it is the only major developed basin with no actual reported residential structure flooding (see Table 5.4).
- Although Basin III is ranked highest (currently) in tidal/tailwater flooding and second worse in actual homes flooded, tailwater flooding is the most unpractical type of flooding to correct.
- Basin II, although currently unstudied, is known to have one of the most significant unsolved issues with direct drainage outfalls to the Gulf as well as the highest ranked actual home flooding per acre.

Obviously, if one considers both water quality and water quantity, Basin VI shows up as the basin of most significant concern. <u>Thus, we recommend that the City use Table 8.1.1-1 to rank overall importance of each basin with the following order</u>:

- #1 Basin VI
- #2 Basin III
- #3 Basin V
- #4 Basin II
- #5 Basin VIII or I

Basin VI improvements have been completed. As discussed earlier, the reason why this basin is shown ranked high is that we have not been able to corroborate what actual projects were funded and constructed. It may be the actual projects did not follow the recommendations of the Basin Study and there may still be some flooding potential. It is clear, however, that the improvements did <u>not</u> include Basin-wide BMPs to reduce actual pollutant loading to Naples Bay, thus, the water quality ranking shown above will likely remain. We suspect, however, the water quantity ranking of Basin VI will be reduce once a more thorough verification of projects implemented is properly completed. <u>We recommend that the actual projects implemented for Basin VI be compared to the final recommendations of the Basin VI Report and an updated LOS model simulation be performed (if necessary) to ensure that the modified LOS being provided can be ascertained.</u>

As better data becomes available, the ranking table should be adjusted and reissued accordingly. Since Basin II is the next highest ranked basin that has not been studied, we would encourage the City to allocate funds for a basin-wide study for this basin as the next highest priority. We would schedule Basin II ahead of Basins I and VIII, accordingly.

8.1.2 Ranking of CIP Projects

The methodology most widely accepted for ranking CIP projects is a cost to benefit ratio approach. In order to determine the ratio, each CIP project must have an Engineer's Opinion of Probable Cost (EOOPC) and some manner in which to determine the effective gain in benefit by implementing the selected CIP alternative. There have been many studies performed for the City of Naples where specific problem areas were evaluated and existing conditions where quantified in terms of LOS. Specific alternatives were also evaluated by computer simulations of the effect of modifying the existing drainage system components and then re-evaluating the LOS under the new conditions. In most cases, the study included an EOOPC that is currently available. Thus, with the EOOPCs available, the remaining effort is to determine a consistent and objective manner to evaluate the increase in benefit for all the known CIP projects, and then place them into a consistent Cost/Benefit Model to rank the projects.

Quantifying the change in benefit in terms of dollars is difficult at best. In most instances, communities with similar goals have chosen to place the relative change in benefit into a quantifiable number using various ranking criteria based upon a LOS methodology.

Thus, the basic equations for this will be:

$$\text{Benefit to Cost ratio} = (\text{Change in benefit}) \div \text{EOOPC (\$M)}$$

8.1.3 Expanded LOS Approach

Evaluating the Level of Service (LOS) in an objective, comprehensive manner is a convenient way to compare the various stormwater management issues and alternatives. The difficulty is that most stormwater managers include a multitude of parameters to be "objective" in their ranking but typical Comprehensive Plans have a simple – one parameter way of establishing the LOS of a drainage system. Only measuring one common flooding parameter in terms of LOS may be limiting. Also, problems may have very different ratings if one considers other potentially relevant factors such as:

- How long has this problem been reported but still not fixed?
- How many citizens are actually being inconvenienced by each problem?
- Which problem has the most cost associated with the resolution?
- Which problem is easier to permit and begin construction?
- Does either problem need to be fixed in association with another project?
- Are their other factors that should be considered like septic tank failure, or the pooling of water is providing habitat for mosquito breeding?

As a result, many communities "expand" their LOS considerations for purposes of ranking projects using some of these other considerations. We recommend that the ranking of CIP projects be based on an Expanded CIP evaluation approach.

8.1.4 Selected Ranking Parameters

Table 8.1.4-1 below provides our recommended approach to ranking CIP Projects for the City of Naples using an expanded LOS approach. Note that the current rating of LOS based on the Comprehensive Plan Methodology is included as one of the parameters and points given accordingly. In addition to the existing LOS by the Comprehensive Plan criteria, we add the following for consideration:

1. **Potential Harm to Public Safety, Health, and Welfare Due to Water Quantity (Flooding)** – How the extent of flooding can affect public safety, health, and welfare are considered in this section. Specific examples of the potential magnitudes of harm are provided in Table 8.1.4-1, in order to establish a numerical rating varying from 0 to 50 points. In this section, the rating is determined based on how much impact to the public the quantity of floodwater may cause.

2. **Potential Harm to Public Safety, Health, and Welfare Due to Water Quality (Pollution Abatement)** - The extent of pollutants generated and not adequately treated are considered in this section. Specific examples of the magnitudes of harm are provided in Table 8.1.4-1 in order to establish a numerical rating varying from 0 to 50 points. In

this section the potential harm to the public due to pollutants is considered on the downstream user, receiving water body, or effected neighbor.

3. **Existing LOS -** The last consideration proposed in the ranking format is to acknowledge the existing LOS of the deficient system by means of the Comprehensive Plan Approach and any derived analysis from pervious reports for the drainage system in question. In most cases, the City has already hired a consultant to evaluate the LOS performance increase for several alternatives and provided an Engineers Opinion of Probable Cost (EOOPC) for each of those alternatives. Thus, much of this data already exists. Although the Comprehensive Plan provides a mechanism for evaluating LOS based on both water quality and quantity considerations, most of the evaluations performed to date were based on flooding (water quantity) alone. The complicating issue, however, is that most of the analyses were based on varying interpretations of how the acceptable LOS Condition would be measured. Tetra Tech attempted to reconcile these discrepancies by the recommended modifications to LOS evaluation and performance provided in Table 4.3. We propose to use that table to evaluate the change in level of service in a uniform manner.

   For systems that have not had the alternatives formally evaluated, then the increase in LOS will not be available. In such instances we propose to simply assume that the "post-condition improvements" which will not improve the LOS. This assumption will, by default, provide fewer points where the City has not commissioned a formal evaluation of LOS improvements prior to spending the money, than those projects that have been evaluated. This may act as an incentive to have the remaining projects evaluated in terms of LOS improvement as well.

Table 8.1.4-1 Recommended Prioritization Methodology for Ranking CIP Projects

A. Potential Harm to Public Safety, Health, and Welfare due to Tidal/Tailwater Flooding From the record high tide TW_H= 5.0

Points Awarded	Percent of Modeling Nodes with Tailwater Flooding - Roadway Nodes	Points Awarded	Percent of Modeling Nodes with Tailwater Flooding - Building Nodes
0-5	0-20%	0-5	0-20%
6-10	21-40%	6-10	21-40%
11-15	41-60%	11-15	41-60%
16-20	61-80%	16-20	61-80%
21-25	81-100%	21-25	81-100%

B. Potential Harm to Public Safety, Health, and Welfare due to Water Quality (Pollution)

Points Awarded	Percentage of basin without treating commercial stormwater to 85% presumptive criteria (or residential land use not receiving effective swale treatment)
0-10	0-20%
11-20	21-40%
21-30	41-60%
31-40	61-80%
41-50	81-100%

C. LOS (Based on Evaluation Using Proposed Comprehensive Plan Modified Criteria)

Points Awarded	LOS Rating Based on Roadway and Building Criteria. See Table 4.3		
	Individual CIP Project if Roadway or Building is:	If failure to meet Basin-wide average of Roadway LOS = "C" is:	If failure to meet Basin-wide Average of Building LOS = "B" is:
0-5	**A**	0-5%	0-5%
6-10	**B**	6-10%	6-10%
11-20	**C**	11-20%	11-20%
21-35	**D**	21-35%	21-35%
36-49	**E**	36-50%	36-50%
50 max	**F**	51-100%	51-100%
	See Note (1)	See Note (2)	See Note (2)

Notes:

(1) Projects that are small (sub-basin sized) can be evaluated on a "per project basis" by the LOS performance of that modeling node or project area. Use column two above.

(2) Projects that are implemented on a large scale (or basin-wide) will have varying degrees of success during the LOS evaluations, thus use columns three and four to evaluate the percentage of modeling nodes (or sub-basins) that <u>fail</u> to meet the threshold LOS criteria recommended in Table 4.3.

8.1.5 Assignment of Expanded Level of Service (ELOS)

Total scores are added up to determine the Expanded Level of Service (ELOS) for purposes of ranking the CIP Projects. Table 8.1.5-1 below provides the classification for each. Projects that lack data properly to evaluate criteria in any of the columns can not be expressed in these terms since the table below assumes that there is data for each ranking evaluation criteria. In the event that there are missing evaluation criteria, then "N/A" for "Not Applicable" should be used.

Table 8.1.5-1 Expanded Level of Service Assignment (for 100 Point Maximum)

Cumulative Score	ELOS	Description
0-10 points	A	Excellent
11-35 points	B	Above Average
36-60 points	C	Average/Acceptable
61-90 points	D	Below Average
91-120 points	E	Significantly Deficient
121-200 points	F	Non-Functional

8.1.6 Evaluating the Draft CIP List for Existing and Proposed Conditions

The CIP projects identified during the Stormwater Master Plan Update have been discussed to some degree or another in previous sections of this report (References # 10.7, 10.8, 10.11, 10.14, 10.19, 10.13 and 10.15). Many other capital expenses have been loosely described from time to time in various inter-department memos, informal reports, and draft master plans provided to Tetra Tech as part of this assignment. These items have been compiled along with other projects originating during this Stormwater Master Plan Update in order to create a **Draft CIP Project List**. (See Table 8.1.6-1). Note this table is a condensed summary of Table 3.4-2 removing all O&M expenses and R&R programs since they are not ranked on "project" basis as described herein. Also, all project markers (places holding future expense categories when the costs are currently unknown) have been removed.

Table 8.1.6-1 10 Year Integrated Stormwater Management CIP List

ID #	City Basin	CIP Category	Description of Program or Purchase	Status of Program or Purchase	Opinion of Probable Cost $	Initial Recom. Year to Implement
1.1.1	I	Master Planning	Primary Conveyance Modeling Basin 1	Not initiated	$ 150,000	1-2
1.1.2	II	Master Planning	Primary Conveyance Modeling Basin 2	Not initiated	$ 200,000	1-2
1.1.4	IV	Master Planning	Primary Conveyance Modeling Basin 4	Not initiated	$ 150,000	3-5
1.1.7	VII	Master Planning	Primary Conveyance Modeling Basin 7	Not initiated	$ 150,000	3-5
1.1.8	VIII	Master Planning	Primary Conveyance Modeling Basin 8	Not initiated	$ 160,000	3-5
1.1.9	IX	Master Planning	Primary Conveyance Modeling Basin 9	Not initiated	$ 80,000	6-10
1.1.10	X	Master Planning	Primary Conveyance Modeling Basin 10	Not initiated	$ 80,000	6-10
1.1.11	XI	Master Planning	Primary Conveyance Modeling Basin 11	Not initiated	$ 40,000	6-10
1.2	all	Master Planning	5 and 10 year CIP Refinement	Refining CIP List and Ranking @ Yr 1,5,10	$ 18,000	3-5, 6-10
1.3	TBD	Master Planning and Design	Secondary Conveyance System Analysis/Modeling	Identify capacity issues of inlet spacing, throat capacity, and minor pipe size issues.	$ 50,000	1-2
1.4	TBD	Master Planning and Design	Naples Bay Basin Management Plan	Preliminary Engineering and Environmental Contribution to Regional Efforts	$ 250,000	annual
1.5	II	Master Planning and Design	Beach Management Plan for Removal of Ten Stormwater Outfalls	Preliminary engineering and environmental, final engineering and permitting	$ 380,000	1-2
1.6	TBD	Master Planning and Design	Lake Water Quality Management Plan	Evaluate opportunities to maximize pollutant reduction for discharges to Naples Bay by retrofitting, expanding, or altering existing wet detention areas and lakes.	$ 225,000	3-5
1.7.2	all	Master Planning and Design	Stormwater Master Plan Ph-2 GIS Completion & Comp Plan Adjustment	Proposal submitted	$ 38,700	1-2
1.7.3	all	Master Planning and Design	Rate Study	Update Rate Study to implement a raise in stormwater fees to accomplish the goals of the Stormwater Master Plan Update.	$ 88,000	1-2
1.8	TBD	Master Planning and Design	Stormwater GIS Inventory, Inspection & Evaluation (asset management)	Verify inventory begun back in 1990 & update to most recent conditions.	$ 600,000	6-10
2.1	all	Capital Purchases	Purchase Vacuum Truck for Stormwater System Maintenance	Replacement vehicle in 5 years, or in 2012	$ 330,000	6-10
2.2	all	Capital Purchases	Purchase Street Sweeper for NPDES Phase II Water Quality Control Measure	Replacement vehicle in 5 years, or in 2012	$ 290,000	6-10
3.3.1	III	CIP Implementation	Construction of Stormwater Projects in Basin 3 - Phase 1 Improvements	Phase 1 covers 65% basin area. Design plans and permits completed by City staff.	$ 4,606,940	1-2

Table 8.1.6-1 10 Year Integrated Stormwater Management CIP List

ID #	City Basin	CIP Category	Description of Program or Purchase	Status of Program or Purchase	Opinion of Probable Cost $	Initial Recom. Year to Implement
3.3.2	III	CIP Implementation	Design & Permitting of Stormwater Projects in Basin 3 - Phase 2	Phase 2 of the Program to complete the Alternative #3 Recommendation. Design and permitting.	$ 182,700	1-2
3.3.3	III	CIP Implementation	Construction of Stormwater Projects in Basin 3 - Phase 2 Improvements	Construction of Phase 2. Estimated cost not verified. Needs to be adjusted once design is completed.	$ 2,480,660	1-2
3.3.4	III	CIP Implementation	Construction of Stormwater Projects in Basin 3 - Phase 3 PS and Treatment	Upgraded Pump Station and Water Quality Mitigation Projects ($1M for PS and $2M for mitigation based on 2001CDM Report)	$ 3,666,000	3-5
3.5	V	CIP Implementation	Stormwater Projects in Basin 5	Based on existing report - TBD but should be in first 5 years. Cost includes design, permitting, and contingencies.	$ 21,917,705	1-2,3-5
3.6	VI	CIP Implementation	Stormwater Projects in Basin 6	TBD but based on prioritization should be in **first** 5 years (<2012)	$ 4,090,625	3-5
3.13		CIP Implementation	Stormwater Projects in Gordon River Extension	Cost includes design, permitting, and contingencies	$ 8,517,978	6-10
6.1.1	III	Special Water Quality Initiatives	Stormwater Management - Broad Ave. Linear Park & Filter Marsh	CDM under contract and managed by Construction Management	$ 4,200,000	1-2
6.1.2	III	Special Water Quality Initiatives	Cove Pump Station / Naples bay Outfall Detention Water Quality Basin	Not under contract	$ 1,800,000	3-5
6.1.3		Special Water Quality Initiatives	Stormwater Management - Goodlette Frank Road Water Quality Greenway	Needs verification	$ 2,600,000	6-10
6.2		Special Water Quality Initiatives	TMDL Programs	Annual water sampling program - Natural Resources		
6.3		Special Water Quality Initiatives	NPDES Programs	illicit discharge detection and elimination, construction site runoff control		
					$ 57,342,308	

In Table 8.1.6-2 below, we began ranking the CIP projects based upon their existing condition. Only those projects where sufficient information to rank the projects were evaluated in terms of the categories listed below. In some instances, we re-ranked the alterations from the basin studies using the updated LOS methodology since like-for-like comparisons are now possible. Table 8.1.6-3 performs the same analysis for the proposed condition after improvements. The point valves provided in each table were those suggested in the guidelines provided previously in Table 8.1.4-1.

Note most line items from the draft CIP list (Table 8.1.6-1) are not recommended for "project-basis ranking." Reasons for not ranking these projects at this time include:

- Insufficient before/after improvement data;
- Operation and Maintenance expenses (O&M) and most renewal and replacement (R&R) programs are on-going and therefore, not ranked on a "project-basis";
- Some items are necessary predecessors to later tasks and must be done first (i.e. completing the Master Plan Update);
- Individual sub-basin projects cannot be analyzed separately (in incremental phases) without exploring what the net benefits are to performing only partial construction activities (such as Items 3.5.1 through 3.5.26 on Table 3.4-2).

The worksheets have been assembled in Tables 8.1.6-2, 8.1.6-3, and 8.1.7-1 so that project ranking can occur at a later date when the additional information or analysis has been completed for each section of the CIP list.

Table 8.1.6-2 Existing Conditions (or Future Unmitigated Buildout When Known)

ID	Basin	Project and Description of Recommended Alternative	Tidal Flooding (Road & Build)	Pollution	Roadway LOS "C"	Building LOS "B"	Cumulative Score (0-200)	ELOS
		Maximum Score	50	50	50	50	200	
1.1.1	I	Modeling Basin 1	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.2	II	Modeling Basin 2	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.3	III	Alt. #2 if selected	15	40	18	3	76	D
1.1.3	III	Alt. #3 if constructed as modeled	15	40	18	3	76	D
1.1.3	III	Alt. #3 if constructed as funded	15	40	18	3	76	D
1.1.3	III	Alt. #4 if constructed and funded	15	40	18	3	76	D
1.1.4	IV	Modeling Basin 4	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.5	V	Alt #1	0	35	35	0	70	D
1.1.5	V	Alt #2	0	35	35	0	70	D
1.1.5	V	Alt #3	0	35	35	0	70	D
1.1.7	VII	Modeling Basin 7	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.8	VIII	Modeling Basin 8	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.9	IX	Modeling Basin 9	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.10	X	Modeling Basin 10	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.11	XI	Modeling Basin 11	Ranking of Basin Planning Studies by Basin-wide Approach					
1.2	all	5 and 10 year CIP Refinement	Item required every 5 years. No ranking necessary					
1.3	TBD	Secondary Conveyance System Analysis/Modeling	No ranking recommended. No data to compare to.					
1.4	TBD	Naples Bay Basin Mgt. Plan	No ranking. Regional initiative, no data to compare to.					
1.5	II	Beach Management Plan for Removal of Ten Stormwater Outfalls	No data available for ranking. Study should be a high priority.					
1.6	TBD	Lake Water Quality Mgt. Plan	No data available for ranking. Study should be a high priority.					
1.7.2	all	Stormwater Master Plan Ph-2 GIS Completion & Additional Services	Ranking is immediate since the master Plan Update is the guiding document for the plan					
1.7.3	all	Rate Study	Ranking should be Immediate in order to fund improvements					
1.8	TBD	Stormwater GIS Inventory, Inspection & Evaluation	Ranking will be based on GASB 34 assest mgt. and accounting needs					
2.1	all	Purchase Vacuum Truck for Stormwater System Maintenance	Not applicable - Do not rank capital purchases. Timing based on service life.					
2.2	all	Purchase Street Sweeper for NPDES Phase II Measure	Not applicable - Do not rank capital purchases. Timing based on service life.					
3.1	I	Unidentified Projects in Basin 1						
3.2	II	Unidentified Projects in Basin 2						
3.3.1	III	Construction of Projects in Basin 3 - Phase 1 Improvements	15	43	12	3	73	D

ID	Basin	Project and Description of Recommended Alternative	Tidal Flooding (Road & Build)	Pollution	Roadway LOS "C"	Building LOS "B"	Cumulative Score (0-200)	ELOS
Table 8.1.6-2 Existing Conditions (or Future Unmitigated Buildout When Known)								
		Maximum Score	50	50	50	50	200	
3.3.2	III	Design and Permitting of Stormwater Projects in Basin 3 - Phase 2						
3.3.3	III	Construction of Projects in Basin 3 - Phase 2 Improvements						
3.3.4	III	Construction of Projects in Basin 3 - Phase 3 PS and Treatment						
3.4	IV	Unidentified Projects in Basin 4						
3.6	VI	Stormwater Projects in Basin 6						
3.7	VII	Unidentified Projects in Basin 7						
3.8	VIII	Unidentified Projects in Basin 8						
3.9	IX	Unidentified Projects in Basin 9						
3.10	X	Unidentified Projects in Basin 10						
3.11	XI	Unidentified Projects in Basin 11						
3.13	VIII & XI	(Alternative 1 with all 22 improvements) Gordon River Ext.						
6.1.1		Stormwater Management - Broad Ave. Linear Park & Filter Marsh						
6.1.2		Cove PS / Naples Bay Outfall Water Quality Basin						
6.1.3		Goodlette Frank Road Water Quality Greeway						

ID	Project and Description of Recommended Alternative	Tidal Flooding (Road & Build)	Pollution	Roadway LOS "C"	Building LOS "B"	Cumulative Score (0-200)	ELOS
	8.1.6-3 Proposed Conditions (After Improvements)						
	Maximum Score	50	50	50	50	150	
1.1.1	Modeling Basin 1	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.2	Modeling Basin 2	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.3	Alt. #2 if selected	15	40	18	3	76	D
1.1.3	Alt. #3 if constructed as modeled	15	40	10	3	68	D
1.1.3	Alt. #3 if constructed as funded	unknown	unknown	unknown	unknown	unknown	unknown
1.1.3	Alt. #4 if constructed and funded	15	40	2	2	59	C
1.1.4	Modeling Basin 4	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.5	Alt #1	0	33	32	0	65	D
1.1.5	Alt #2	0	33	4	0	37	C
1.1.5	Alt #3	0	33	6	0	39	C
1.1.7	Modeling Basin 7	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.8	Modeling Basin 8	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.9	Modeling Basin 9	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.10	Modeling Basin 10	Ranking of Basin Planning Studies by Basin-wide Approach					
1.1.11	Modeling Basin 11	Ranking of Basin Planning Studies by Basin-wide Approach					
1.2	5 and 10 year CIP Refinement	Item required every 5 years. No ranking necessary					
1.3	Secondary Conveyance System Analysis/Modeling	No ranking recommended. No data to compare to.					
1.4	Naples Bay Basin Mgt. Plan	No ranking. Regional initiative, no data to compare to.					
1.5	Beach Management Plan for Removal of Ten Stormwater Outfalls	No data available for ranking. Study should be a high priority.					
1.6	Lake Water Quality Mgt. Plan	No data available for ranking. Study should be a high priority.					
1.7.2	Stormwater Master Plan Ph-2 GIS Completion & Additional Services	Ranking is immediate since the master Plan Update is the guiding document for the plan					
1.7.3	Rate Study	Ranking should be Immediate in order to fund improvements					
1.8	Stormwater GIS Inventory, Inspection & Evaluation	Ranking will be based on GASB 34 assest mgt. and accounting needs					
2.1	Purchase Vacuum Truck for Stormwater System Maintenance	Not applicable - Do not rank capital purchases. Timing based on service life.					
2.2	Purchase Street Sweeper for NPDES Phase II Measure	Not applicable - Do not rank capital purchases. Timing based on service life.					
3.1	Unidentified Projects in Basin 1						
3.2	Unidentified Projects in Basin 2						
3.3.1	Construction of Projects in Basin 3 - Phase 1 Improvements	15	43	10	3	71	D

ID	Project and Description of Recommended Alternative	Tidal Flooding (Road & Build)	Pollution	Roadway LOS "C"	Building LOS "B"	Cumulative Score (0-200)	ELOS
8.1.6-3 Proposed Conditions (After Improvements)							
	Maximum Score	50	50	50	50	150	
3.3.2	Design and Permitting of Stormwater Projects in Basin 3 - Phase 2						
3.3.3	Construction of Projects in Basin 3 - Phase 2 Improvements						
3.3.4	Construction of Projects in Basin 3 - Phase 3 PS and Treatment						
3.4	Unidentified Projects in Basin 4						
3.6	Stormwater Projects in Basin 6						
3.7	Unidentified Projects in Basin 7						
3.8	Unidentified Projects in Basin 8						
3.9	Unidentified Projects in Basin 9						
3.1	Unidentified Projects in Basin 10						
3.11	Unidentified Projects in Basin 11						
3.13	(Alternative 1 with all 22 improvements) Gordon River Ext.						
6.1.1	Stormwater Management - Broad Ave. Linear Park & Filter Marsh						
6.1.2	Cove PS / Naples Bay Outfall Water Quality Basin						
6.1.3	Goodlette Frank Road Water Quality Greeway						

8.1.7 Final Ranking List Based on Benefit to Cost Ratio

The difference in benefit scores determined from the point distribution analysis demonstrated on Tables 8.1.6-2 and 8.1.6-3 were calculated and provided as "Net Score" on Table 8.1.7-1 below. The Engineer's Opinion of Probable Cost (when known) was provided in the next column so that a benefit to cost ratio could be determined. The costs used were the original cost estimates adjusted for inflation. The average index of construction inflation was provided by the Engineering News Record (ENR).

The benefit (Net Score) was then divided by the adjusted estimated cost (in millions) to create a benefit to cost ratio as described in Section 8.1.2.

Table 8.1.7-1 Final Ranking List Based on Benefit to Cost Ratio

ID	Project and Description of Recommended Alternative	Net Score	Adjusted 2007 Estimated Cost	Benefit to Cost Ratio
	Maximum Score			
1.1.1	Modeling Basin 1	0	$150,000	N/A
1.1.2	Modeling Basin 2	0	$200,000	N/A
1.1.3	Alt. #2 if selected	0	$3,240,000	0.0
1.1.3	Alt. #3 if constructed as modeled	8	$6,730,000	1.2
1.1.3	Alt. #3 if constructed as funded	8	$3,770,000	unknown
1.1.3	Alt. #4 if constructed and funded	17	$8,420,000	2.0
1.1.4	Modeling Basin 4	0	$150,000	N/A
1.1.5	Alt #1	5	unknown	
1.1.5	Alt #2	33	unknown	
1.1.5	Alt #3	31	$21,090,000	1.5
1.1.7	Modeling Basin 7	0	$150,000	N/A
1.1.8	Modeling Basin 8	0	$160,000	N/A
1.1.9	Modeling Basin 9	0	$80,000	N/A
1.1.10	Modeling Basin 10	0	$80,000	N/A
1.1.11	Modeling Basin 11	0	$40,000	N/A
1.2	5 and 10 year CIP Refinement		$18,000	N/A
1.3	Secondary Conveyance System Analysis/Modeling		$50,000	N/A
1.4	Naples Bay Basin Mgt. Plan		$250,000	N/A
1.5	Beach Management Plan for Removal of Ten Stormwater		$380,000	N/A
1.6	Lake Water Quality Mgt. Plan		$225,000	N/A
1.7.2	Stormwater Master Plan Ph-2 GIS Completion & Additional Services		$38,700	N/A
1.7.3	Rate Study		$88,000	N/A
1.8	Stormwater GIS Inventory, Inspection & Evaluation		$600,000	N/A
2.1	Purchase Vacuum Truck for Stormwater System Maintenance		$330,000	N/A
2.2	Purchase Street Sweeper for NPDES Phase II Measure		$290,000	N/A
3.1	Unidentified Projects in Basin 1		TBD	
3.2	Unidentified Projects in Basin 2		TBD	
3.3.1	Construction of Projects in Basin 3 - Phase 1 Improvements		$4,606,940	0.0

Table 8.1.7-1 Final Ranking List Based on Benefit to Cost Ratio

ID	Project and Description of Recommended Alternative	Net Score	Adjusted 2007 Estimated Cost	Benefit to Cost Ratio
	Maximum Score			
3.3.2	Design and Permitting of Stormwater Projects in Basin 3 -		$182,700	0.0
3.3.3	Construction of Projects in Basin 3 - Phase 2 Improvements		$2,480,660	0.0
3.3.4	Construction of Projects in Basin 3 - Phase 3 PS and Treatment		$3,666,000	0.0
3.4	Unidentified Projects in Basin 4		TBD	
3.6	Stormwater Projects in Basin 6		$4,090,625	
3.7	Unidentified Projects in Basin 7		TBD	
3.8	Unidentified Projects in Basin 8		TBD	
3.9	Unidentified Projects in Basin 9		TBD	
3.1	Unidentified Projects in Basin 10		TBD	
3.11	Unidentified Projects in Basin 11		TBD	
3.13	(Alternative 1 with all 22 improvements) Gordon River Ext.		$8,517,978	
6.1.1	Stormwater Management - Broad Ave. Linear Park & Filter Marsh		$4,200,000	
6.1.2	Cove PS / Naples Bay Outfall Water Quality Basin		$1,800,000	
6.1.3	Goodlette Frank Road Water Quality Greeway		$2,600,000	

8.2 EXISTING FINANCING

Implementation of the CIP proposed in Section 3 (see Table 3.4-2) must not only meet the operating needs of the City but also must be financially feasible. The purpose of this section is to review the City's stormwater utility and develop the projected cash flows showing the proposed CIP in relation to financial performance. The cash flow statement is a ten year projection of the stormwater utility's financial performance based on revenue and expense projections discussed below.

8.2.1 Existing Revenue Requirements

The City currently maintains an annual Operating and Maintenance (O&M) Budget for the Stormwater Utility and a budget for annual capital improvement expenses. The O&M Budget is prepared annually by the Public Works and Finance Departments to be included in the City's master budget. The Budget is provided on a detailed, line-item basis and includes all anticipated O&M cash expenditures of the system. **Figure 8.2.1-1** details the Stormwater Utility Budget as provided by the City. Table 8.2.1-1 summarizes the City's current stormwater O&M budget.

FIGURE 8.2.1-1
THE CITY OF NAPLES
STORMWATER PROFORMA
Fiscal Year 2007 Budget and Adjustments

Line	Description	FY 2007 Budget
	O&M EXPENSES	
	PERSONAL SERVICES	
10-20	REGULAR SALARIES & WAGES	$ 244,680
10-30	OTHER SALARIES	-
10-40	OVERTIME	4,000
25-01	FICA	18,418
25-03	RETIREMENT CONTRIBUTIONS	24,395
25-04	LIFE/HEALTH INSURANCE	49,905
25-07	EMPLOYEE ALLOWANCES	420
	TOTAL PERSONAL SERVICES	$ 341,818
	OPERATING EXPENSES	
30-00	OPERATING EXPENDITURES	$ 2,500
30-01	CITY ADMINISTRATION	125,000
30-05	COUNTY LANDFILL	25,000
30-07	SMALL TOOLS	1,000
30-40	CONSTRUCTION MANAGEMENT FEE	82,600
30-00	PROFESSIONAL SERVICES	75,000
31-01	PROFESSIONAL SERVICES	25,000
31-04	OTHER CONTRACTUAL SERVICES	50,000
32-10	OUTSIDE COUNSEL	-
38-01	PAYMENTS IN LIEU OF TAXES	-
40-00	TRAINING & TRAVEL COSTS	2,300
40-03	SAFETY	500
41-01	TELEPHONE	290
42-02	POSTAGE & FREIGHT	200
42-10	EQUIP.SERVICES - REPAIRS	60,000
42-11	EQUIP. SERVICES - FUEL	12,600
43-01	ELECTRICITY	33,000
43-02	WATER, SEWER, GARBAGE	-
44-02	EQUIPMENT RENTAL	1,000
45-22	SELF INS. PROPERTY DAMAGE	12,069
46-00	REPAIR AND MAINTENANCE	2,400
46-04	EQUIP. MAINTENANCE	1,500
46-08	LAKE MAINTENANCE	10,000
46-12	ROAD REPAIRS	12,000
47-06	PRINTING & BINDING	500
49-02	INFORMATION SERVICES	22,630
51-00	OFFICE SUPPLIES	500
52-00	OPERATING SUPPLIES	25,000
52-02	FUEL	7,000
52-07	UNIFORMS	1,300
52-09	OTHER CLOTHING	700
54-01	MEMBERSHIPS	500
59-00	DEPRECIATION	-
	TOTAL OPERATING EXPENSES	$ 592,089
	NON-OPERATING EXPENSES	
60-30	IMPROVEMENTS O/T BUILDING	$ 3,450,000
60-40	MACHINERY & EQUIPMENT	21,600
60-70	VEHICLE	58,000
70-11	PRINCIPAL	244,194
70-12	INTEREST	93,429
	TOTAL NON OPERATING EXPENSES	$ 3,867,223
		$ 4,801,130

Table 8.2.1-1

Fiscal Year 2006/07 Stormwater Utility Operating Budget	
Description	**Budgeted Cost**
Personal Expenses	$341,818
Operating Expenses	592,098
Subtotal O&M	$933,907
Other Expenses (Debt Service)	
State Revolving Loan – Principal	$244,194
State Revolving Loan – Interest	93,429
Subtotal Debt Service	$337,623
Total Expenses	**$ 1,271,530**

In addition, the City's existing adopted budget for annual Capital Improvement expenses for fiscal year 2006/07 is $3,539,000. The budget consists of capital equipment purchases, "City-wide drainage maintenance", master planning, cove pump station improvements, limited construction projects in Basins III and V, and a few other related items. It is important to note that the projects and dollar values in the budgeted Capital Improvements do not match closely to the needs developed herein and shown on Table 3.4-2 or 8.1.6-1.

8.2.2 Existing Revenue Sources

In order to pay for the Utilities revenue requirements, the Utility currently has two primary sources of income; and a few minor sources as well.

- User Fees
- Grants – Specific Capital Projects only.

In addition, the City has, as of the beginning of FY 2006/07, a total of $2,192,170 in utility reserve funds accumulated from prior years. Other minor sources of revenue include: interest income, auction proceeds, and CRA transfer (totaling only $56,548).

Table 8.2.2-1 below summarizes the expected revenues for FY 2007.

Table 8.2.2-1

Fiscal Year 2007
Expected Revenues

Revenue Category	Revenue
Stormwater Fees	$2,256,900
Grants	$1,075,000
Interest Income	$40,000
Auction Proceeds	$2,000
CRA Transfer – 10th St. Stormwater	$14,548

8.2.3 User Fees

Those elements of the system for the collection, treatment and disposal of Stormwater are of benefit and provide services to all property within the city, including property not presently served by the storm elements of the system. Ordinance 06-11496 Section 30-335 provides that the City council shall require that adequate revenues are generated to provide for a balanced operating budget by at least annually setting sufficient levels of Stormwater management utility fees.

According to Ordinance 06-11496, the city currently imposes a Stormwater user fee on all property within the city as follows:

1. *Single-family residential.* All developed single-family residential property shall be charged a monthly fee of $4.00, billed on a bi-monthly basis. Guesthouses shall be billed as an additional single-family unit.

2. *Multifamily residential.* Any developed multifamily residential property shall be charged a monthly fee of $4.00, per each residential unit, billed on a bi-monthly basis.

3. *Commercial.* All developed commercial property shall be charged based on the rate of $4.00 to this Code per average residential unit (ARU) of impervious structure per month, billed on a bi-monthly basis.

The City defines an ARU as the average impervious area of residential developed property per dwelling unit located within the City and is established by the city council as 1,934 square feet. For the purposes of property classification, the Ordinance requires all property within the incorporated City limits to be classified into one of the following classes:

1. Residential developed property.
2. Nonresidential developed property.
3. Vacant improved property.
4. Undisturbed parcel.

The utility fee for residential developed property shall be the ARU rate multiplied by the number of individual dwelling units existing on the property. The utility fee for nonresidential developed property shall be the ARU rate multiplied by the numerical factor obtained by dividing the total impervious area of a nonresidential developed property by 1 ARU. The minimum utility fee for any nonresidential developed property shall be equal to 1 ARU.

The computation of the utility fee for multi-story buildings, multi-story parking garages or other elevated surfaces and structures shall be calculated as per the footprint of the structure only. Multiple story structures shall be calculated as if they were only ground-level structures. The utility fee for unoccupied developed property shall be based upon the category and classification as if the property were occupied. Undisturbed parcels and vacant property shall be exempt from the utility fee, provided they are not served by a water meter. Where served by a water meter, the utility fee shall be based upon a comparison of impervious area with the categories of property classifications shown in this section.

At the time of this study, the City had budgeted a rate increase of $2.00 for each property class in the coming fiscal year. No official rate study has been performed at this time. The City anticipates $1,506,900 in revenue for fiscal year 2006/07 from their existing user fees. If the rate increase comes in this fiscal year, an additional $750,000 will be expected generating a total of $2,256,900 on an annual basis. A rate increase effective for the remainder of FY 2007 will generate substantially less than this value since it will be implemented no better than mid year.

8.2.4 Grants

Many of the City's stormwater capital projects receive funding from various grant activities. Grant funds are an excellent means of implementing capital projects while reducing the impact on the Utility's funds. However, grant funds are typically restricted to a particular project or type of project. The City is very active in seeking and receiving funding from a number of state, federal, and local organizations. Some of these organizations include:

- Big Cypress Basin Board
- South Florida Water Management District
- Florida Department of Environmental Regulation
- Federal Emergency Management Agency
- Collier County
- Department of Community Affairs

A number of grants have been approved this year including:

Big Cypress Basin Board

$350,000	for Drainage Basin III Improvements
$100,000	for Drainage Basin V Improvements
$ 60,000	for Elimination of Royal Harbor Concrete Swales in Basin VII.

The City is actively pursuing many other grants from other agencies. The following projects are pending:

SFWMD

$350,000	for the Stormwater management water quality project at Broad Avenue (filter marsh and linear park)
$350,000	for the Naples Bay Outfall Treatment Project
$300,000	for the Goodlette Road Water quality greenway project

FDEP

$1,507,500 for basin III water quality and flood control mitigation improvements. This includes upgrades to the Cove Pump Station.

Table 8.2.4-1 summarizes the grants pending and available for the City's Stormwater projects.

Table 8.2.4-1 Summary of Grants for Stormwater Management Projects

Type of Grant	Basin	Project Associated with Grant	Grant Sponsor	Total Amount $ Attempted	City's Match % of Grant	Spons. Match % of Grant
SRF Grant				$3M		
Hazard Mitigation Grant Program	III	CIP # 06V14 (Basin III - Phase I)	FEMA	$271,882.62	25%	75%
SB444-(SWIM) Surface Water Improvement & Management	V & III	Basin III Works, Basin V Works & Elimination of Royal Harbor Concrete Swales	SFWMD	$350,000 (Basin III), $100,000 (Basin V), and $60,000 (Swales). Total = $510,000	50%	50%
Water Quality improvement/ Water Restoration Grant Program	III	Stormwater Basin III Water Quality and flood mitigation	Community Budget Issue Request (CBIR)	$1,650,000.00	50%	50%
Water Quality improvement/ Water Restoration Grant Program	V	Stormwater Basin V Water Quality and flood mitigation	Community Budget Issue Request (CBIR)	$587,500.00	50%	50%
SFWMD Local Government Agreement		Storm System Repair & Maintenance Program - Specific Projects to be Designated	Big Cypress Basin	Cooperative Agreement for $200,000 & Naples Stormwater Improvements for $100,000 (Total $300,000)	50%	50%
Western Collier Partners for Restoration- Legislative Appropriation	III	Stormwater Management - Broad Avenue Linear Park and Filter Marsh	SFWMD	$195,000.00	50%	50%
Western Collier Partners for Restoration- Legislative Appropriation		Stormwater Management - Naples Bay Outfall Treatment Project	SFWMD	$350,000.00	50%	50%
Western Collier Partners for Restoration- Legislative Appropriation		Stormwater Management - Goodlette Frank Road Water Quality Greenway	SFWMD	$300,000.00	50%	50%
State and Tribal Assistance (STAG) Grant	III	Stormwater Drainage Basin III Water Quality & Flood Mitigation Improvements - Cove Pump Station Upgrade Project	Collier County Delegation / FDEP	$2,250,000 ($742,500 by City & $1,507,500 by Feds)	50%	50%

Type of Grant	Basin	Project Associated with Grant	Grant Sponsor	Total Amount $ Attempted	City's Match % of Grant	Spons. Match % of Grant
SFWMD Local Government Agreement		Reclaimed Water Expansion	Big Cypress Basin	$460,000.00		
SFWMD Local Government Agreement		Golden Gate Main (for alternative irrigation water)	Big Cypress Basin	$100,000.00		
FEMA Hazard and Mitigation Grant Program		City of Naples Stormwater Management Basin III (phase I) Drainage Improvements	Dept. of Community Affairs & FEMA			
FEMA Hazard and Mitigation Grant Program		Stormwater Management Master Plan Improvements (Including NPDES)	FEMA	$6.8 Million Basin III; $5-8 Million Basin V; $3.2 Million Basin VI; Exceeds $15 Million.		
FEMA Hazard and Mitigation Grant Program		Pump Station Mechanical Screening Systems, etc.	FEMA	$800,000.00		
FEMA Hazard and Mitigation Grant Program		Goodlette-Frank Road Canal Drainage Improvements	FEMA	$200,000.00		
FEMA Hazard and Mitigation Grant Program		Goodlette-Frank Road / Golden Gate Parkway Flood Drainage	FEMA	$450,000.00		

8.2.5 Other Sources

In order to meet the budgeted capital needs, the City will begin to use utility reserves accumulated from previous years. However, with the large capital needs of the system, relying on reserves as a primary source of funding will quickly diminish the Utilities net assets.

8.3 PROGRAM FUNDING NEEDS

Projects performed by the City are divided into three categories as defined below:

- Operation and Maintenance Projects (O&M)
- Renewal and Replacement Projects (R & R)
- Capital Improvement Projects (CIP)

Classifying projects into these three categories is not always easy. It is common to find technical staff grouping such activities into these categories based on technical issues without considering the financial relevancy of doing so. Capital Investments are projects that increase the value of the City's balance sheet. Capital *expansions* and *upgrades* do this as well as R & R. Capital

expansion projects increase the capacity of an infrastructure system so that more customers can be served, whereas capital **upgrades** increase the LOS provided to the existing customers.

In renewal and replacement, the existing assets are refurbished so that they can remain in service and continue to have a useful life. Often the depreciated value of the asset is reset to reflect the new life (similar to giving an automobile a new engine). In contrast, Operation and Maintenance activities are provided continuously to make sure that the infrastructure continues to perform as designed. One may renew or replace an asset after fifteen years, but the maintenance of infrastructure should occur long before it needs R & R.

To illustrate these three principles with a public swale in the City R/W, we offer the following analogy. If there are no swales in a subdivision and the City wishes to provide water quality treatment or conveyance to new customers in a subdivision, they may construct swales and cross drains under the existing driveways. This is an example of a new Capital Improvement. The periodic mowing of the swales and cleaning out of clogged cross drains is an O&M activity. However, in fifteen years those swales may be so filled with sediment and elevated by the organic build-up that the swale no longer functions with a defined flow path. Regrading and re-sodding the swales is an R&R project. This year, the City performed swale re-grading, underdrain installation, and new pipe placements on Murex Lane. This project was described as an O&M project. But since the construction activity actually refurbished the original function of an existing swale conveyance service, and improved the LOS to the citizens (by providing underdrains), the project probably would best be classified as an R&R or Capital Project (depending upon whether the LOS was actually improved).

8.3.1 O&M Requirements

Operating and maintenance expenses are primarily those ongoing costs required to manage and operate the Stormwater utility a day-to-day basis while maintaining a dependable level of service. A properly developed O&M program reduces the risk of water quality problems and extends the life span of the infrastructure. Such O&M activities relate to the infrastructure in the ground (such as cleaning debris from a culvert) or the equipment used to accomplish O&M activities (such as keeping a backhoe serviceable). The estimated O&M requirements are generally a function of a budgetary process and are directly related to the level of service provided to customers of the Stormwater system. As such, these costs are most commonly recovered through the monthly user rates applied to system customers.

In the process of developing the Master Plan, Tt along with City staff have reviewed O&M needs and presented anticipated costs in the 10 Year Integrated Stormwater Management Program Summary (**Table 3.4.2-1, ID# 5.1-5.7**). These costs include personnel salary requirements, materials and equipment, and annual increases built in. **Table 8.3.1-1** summarizes the City's O&M requirements as presented in the Master Plan:

Table 8.3.1-1

Annual O&M Requirements

O&M Function	Annual Cost
Survey/log actual flood complaints	$40,000
Inspection and cleaning structures and culverts	$140,000
Maintenance of canals and ditches	$160,000
Retention ponds and water bodies	$60,000
Maintenance of Pump Stations and force mains	$30,000
TMDL Programs	$25,000
NPDES Program	$15,000
Pollution prevention and good housekeeping; and NPDES Phase II Stormwater Public Education & Public Outreach Control Measure	$10,000
Total Annual Cost	**$480,000**

The total annual O&M requirements is estimated to be $480,000. By way of comparison, the adopted O&M budget for FY 2006/07 is $933,907. On the surface, this would indicate that the O&M requirements of the stormwater utility is sufficiently funded, however, through the course of the Master Plan, it was determined that the Budget O&M also includes funds that serves as a Renewal and Replacement function as discussed below.

8.3.2 Renewal & Replacement

As part of maintaining a satisfactory level of service, Renewal and Replacement (R&R) is a necessary ongoing part of the Utility. Existing Stormwater infrastructure must be maintained or replaced as it ages and this process must be funded by the operations of the Stormwater utility. Currently, the City labels many projects as "maintenance" and budgeted within the O&M budget that should be re-classified as Renewal & Replacement and budgeted separately. Typically, an R&R account is funded annually by operations and set aside specifically for R&R projects. Currently, the City only has one fund dedicated to all Stormwater O&M, R&R, and Capital projects. It is recommended that the City develop separate R&R and capital sub accounts to allow for better tracking. The Master Plan has identified the R&R needs of the City and is detailed in the 10-Year Integrated Stormwater Management Program Summary (**Table 3.4-2, ID# 4.1-4.5**). **Table 8.3.2-1** summarizes the City's R&R requirements as presented in the Master Plan:

Table 8.3.2-1

10-Year Renewal & Replacement Projects Summary

R&R Project	Project Cost
Water quality swale & Stormwater drainage facility reconstruction	$1,950,000
Reconstruct drainage inlets (safety, lost capacity, and filter)	2,205,000
City-wide storm sewer system repair & replacement projects	1,000,000
Outfall storm drain pipe slip lining & replacement	2,000,000
Royal Harbor Water Quality Swales (Elimination of paved point discharge outfall swales)	1,035,000
Total R&R Program Cost	**$8,190,000**
Annualized over 10-Years	**$819,000**

The City's Renewal and Replacement (R&R) program currently consists of a process of identifying and completing numerous renewal and replacement concerns as they arise. Examples of projects completed in the first 6 months of FY 2006 included:

- Swale restoration with grading, and underdrains, and bubble up structures along Galleon Drive.
- Swale restoration with grading, and underdrains, and inlet structures along Curlew Avenue.
- Re-graded swales, installed catch basins, and 2,000 LF of pipe to improve drainage along 1st, 2nd, and 3rd Avenues. (This was listed as an O&M project by the City but may have

improved the LOS and thus be considered a Capital Project, although we have only upgraded it to an R&R Project).

- Outfall pipe repair and gate installation at 17th Avenue.
- Re-constructing an inlet lid on Windward Way to prevent debris form entering the catch basin and reducing the O&M necessary to keep the structure free from debris.
- Removed and replaced ineffective valley gutter and created a gutter that restored drainage to remove surface ponding at Cuddy Court.

Thus the combined R&R and O&M expectations are annualized as $1,299,000 which is greater than the $933,907 FY 2006/07 budget which included work activities that would normally be classified as both O&M and R&R.

8.3.3 Capital Requirements

While the R&R expenses are for the service of existing capital assets, Capital expenses are those that are apportioned to the expansion and improvement of the utility systems' physical assets. As with the R&R expenses, the City currently funds its Capital projects on a cash-needs basis from the Stormwater Utility Fund. It is recommended that the City develop a separate sub account for Capital projects funded by operations.

This Master Plan defines the City's 10-year Capital Improvement needs and associated costs. Table 3.4-2 details the CIP and financial requirements as determined by Tt and City staff. **Table 8.3.3-1** summarizes the 10 year CIP and its associated costs.

Table 8.3.3-1

10 Year CIP and Costs	
Category	**Estimated Cost**
Master Planning and Design	$2,659,700
Capital Purchases	620,000
CIP Implementation (as currently identified projects)	45,462,608
Special Water Quality Initiatives	8,600,000
Total 10 Year CIP Cost	**$57,342,308**

It should be noted, however, that the "identified" CIP project includes work from Basin studies III, V, and VI and the Gordon River Study. We anticipate CIP projects will be identified when the Basin Reports for I, II, IV, VII, VIII, IX, X, and XI are completed as well. There are no projections for these improvements in the plan at all at this time except for incidental R&R work in Basin IV as part of swale restoration efforts. Thus, CIP Implementation may be significantly understated for long term planning purposes.

The Master Plan has detailed the needs of the system and the priority of the Capital Improvement projects that must be undertaken. **Table 8.3.3-2** summarizes the cost of the CIP arranged by priority. The values were taken from Table 8.1.6-1

Table 8.3.3-2

10 Year CIP and Costs

Priority	Estimated Cost - Rounded		
	Period (years)	Total Cost during Priority Period	Average Annual Cost during Period
Immediate (within 2 yrs.)	2	$19,427,000	$ 9,713,500
3-5 years	3	$25,243,330	$ 8,414,443
6-10 years	5	$12,671,978	$ 2,534,396*
Total		**$57,342,308**	

*Note: The values for years 6 through 10 are understated until the addition of CIP for unidentified basins are available.

8.4 CASH FLOW ANALYSIS

Using the City's current operating budget and expected revenues, Tetra Tech has assembled cash flow projections for the next five years. These projections do not take into account Capital Improvement expenditures or Renewal and Replacement. **Table 8-4** shows the pro-forma cash flows. Expenses are escalated using appropriate inflationary adjustments.

Table 8-4

Projected Cash Flows

Category	2007	2008	2009	2010	2011
Total Revenues (not including grants)	$1,546,900	$1,548,900	$1,551,000	$1,553,205	$1,555,520
Total O&M Expenses	933,907	960,090	987,390	1,015,820	1,045,440
Operating Balance	$612,993	$588,810	$563,610	$537,385	$510,080
Debt Service	$337,623	$337,620	$337,620	$337,620	$337,620
Balance Net of Debt Service	$275,370	$251,190	$225,990	$199,765	$172,460
Annual R&R	$819,000	$819,000	$819,000	$819,000	$819,000
Net Balance available for CIP	$(543,630)	$(567,810)	$(593,010)	$(619,235)	$(646,540)

These cash flows demonstrate that after operating expenditures, little cash is available to fund R&R and the CIP. With immediate needs of the CIP being at approximately $19,000,000 over the next two years, additional funding or restructuring of the Utility revenues will be required.

There are, however, a few options that can be implemented. The first, and most necessary would be to re-structure and revise the current rates and keep the current pay-as-you-go capital funding method. However, it is important to recognize that even as the planned rate increase comes online, cash shortages still occur. Second, the City can choose to issue debt secured by system revenue to pay for the CIP over a long-term period. In either case, the current stormwater utility rates will require an adjustment.

8.5 FINANCIAL FINDINGS AND RECOMMENDATIONS

The Stormwater Utility was implemented in 1993 and since its inception has been an effective means of paying for the O&M, R&R and capital requirements of the City's stormwater facilities.

However, changes in the City's customer base, new regulatory requirements and the updated CIP presented herein necessitates that the rates of the utility be reevaluated. Based on the review of the stormwater utility and the CIP requirements presented in this Master Plan, Tt has the following recommendations:

1. Conduct a Comprehensive Stormwater Utility Rate Study with the following goals:

    a. Reconcile the differences in the identified needs from Tables 3.4-2 and the actual budget.
    b. Re-evaluate the definition of an ARU as defined in the City Ordinance.
    c. Consider restructuring the residential rate class into a tiered system to allow for more equitable recovery of costs.
    d. Reevaluate the City's stormwater fee credit policy.
    e. Establish new rates to meet the cost requirements, goals and policies of the stormwater utility.

2. Establish separate sub accounts within the stormwater utility fund to tract the cost of R&R costs, restricted grant funds, funds set aside for CIP projects.

3. Consider shifting the funding method for capital projects from the current "pay-as-you-go" method to debt funding to offset the magnitude of potential rate increases.

SECTION 9

RECOMMENDATIONS

9.1 RECOMMENDED ACTIONS AND IMPLEMENTATIONS

The following is a summary of the actions and implementations we recommend for the City of Naples Stormwater Master Plan Upgrade. The recommendations have been grouped by section from which they were generated for the benefit of the reader. We recognize that some of these recommendations are for "General Reference" [GR] and others require "Immediate Action" [IA] or "Near Term Action" [NTA]. These designations are included with each recommendation for your use as follows:

Section 3 - Compilation of Data and Reorganization

1. Use the original CH2M Hill cataloging system based on master drainage basins to identify all project works. It was a tedious effort to reconcile and cross-reference data compiled without a consistent labeling system in place for all stormwater work. [GR]

2. Document all future stormwater construction projects by "as-built" drawings and place into the GIS database. These as-builts should include both private projects that affect the public infrastructure, as well as public R&R and CIP projects that affect the City inventory. A systematic process involving the City's Director of GIS will need to be developed since the data will come from various departments within the City. [GR]

3. Commission the completion, conversion, and rectification of all stormwater information from ACAD to GIS database. A proposal has already been submitted to accomplish this. [IA]

4. Update the GIS database with each specific drainage basin study commissioned since more accurate inventory records become available as a result of those work products. [GR]

Section 4 - Assessment of Level of Service Methodology

5. Separate and adopt the LOS Standards into the categories shown in Table 4.3 of this report and modify the Comprehensive Plan and Development Codes to be consistent. [IA]

6. Separate problematic homes from the basin studies and pursue FEMA grant money for flooding proofing, elevation, reconstruction, or demolition. See Table 5.4 for know problem structures. [GR]

Section 5 - Assessment of Water Quantity Issues (Flooding)

7. Use the existing 5-year/1-hour storm criterion currently in the Comprehensive Plan as a reasonable LOS/design standard for inlet design and spacing but not pipe design. [GR]

8. Re-evaluate the Basin alternatives outlined in Reports III, V and VI prior to funding and construction phased projects to provide a consistent LOS to that offered in other Basins. Use the original SWMM model with unified LOS criteria. [IA]

9. Consider upgrading to Alternative #4 of the Basin II Drainage Study, (or a modification of Alternative #3) that utilizes additional pump capacity. [NTA]

10. Select the alternative in the Basin V improvement recommendations that performs R&R by avoiding constructing the parallel pipes. The 16% savings is small compared to the cost of having to replace the older system shortly hereafter and in parallel to the new system. [GR]

11. Study the water quality shortfall identified in the CDM report for Basin V. On page 6-5 of the CDM report, it is noted that 43.6 ac-ft is needed to implement Alternative #3 ($22M) and only 8.3 ac-ft of treatment was found; thus, there is a 35.3 ac-ft shortfall. [NTA]

12. Develop an integrated phasing plan for Basin V that matches realistic funding opportunities to a few related sub-basins. Bonding the improvements and retiring the debt

service through the stormwater utility is also an option. Before that can be accomplished, however, the significant deficit in water quality treatment must also be resolved. [IA]

13. Verify that the construction activities in Basin VI provide flood protection meeting an appropriate LOS; thus eliminating this Basin from requiring further construction improvements. [IA]

Section 6 - Assessment of Water Quality Issues (Pollution Impacts)

14. Coordinate sea grass restoration efforts carefully since certain species prefer specific salinities. If the BCB is successful in diverting more freshwater away from Naples Bay, the salinity regimes may shift as to where certain sea grass beds may be most adaptive. [GR]

15. Commission a specific feasibility study to evaluate alternatives to remove the beach outfalls. This effort should begin in the next 2-years and could be combined with a Basin II study or can be handled separately as previously budgeted. It could also be handled as a stormwater to reclaimed water feasibility activity if the City continues to investigate combined stormwater/reuse as an option. [NTA]

16. Include Moorings Bay System as a water body of concern, or study separately by the City since it is not covered by the current Big Cypress Basin initiatives focused on Naples Bay and its watershed. [GR]

17. Re-visit the City's development regulations and consider a higher level of treatment in the City because of Class II impacts and place more emphasis on improving pollutant removal efficiency during construction of stormwater facilities, rather than retrofitting after the fact. [GR]

18. Ensure the monitoring of the highlighted areas on Tables 6.4-1 and 6.4-2 which emphasize some parameters that have been frequently providing results of concern. [GR]

19. Use a consistent template for future Basin reports. The City can elect to use variable LOS standards to measure success on a "basin-by-basin" basis; however, the analysis between basins should be comparable. The values and parameters include: [GR]

a. Apply the EMCs used in this report and extrapolate to other basins in the City until which time better EMC data becomes available in the State.
b. Use the 53.3 inches of rainfall for average annual total.
c. Use tailwater from Table 5.3.2-2 to correspond to the design item event used in the LOS analysis.
d. Perform "future" condition modeling along with "existing" conditions.
e. Use Table 4.3 for LOS comparison between alternatives. See tables 5.3.2-1 through 5.3.2-6, 5.3.4-1, and 5.3.6-1.
f. Analyze as a minimum the following storms: 5 yr/24 hr, 10 yr/24 hr., 25 yr./24 hr, 100 yr./24 hr, and 100 yr./72 hr.
g. Create sub-basins from the hydrologic mapping units within the Basin Studies.
h. Turn all surveyed structure information, or updated "as-builts" to the GIS Department.
i. Presume flooding to be abated by additional discharge to Naples Bay, and thus, water quality treatment must be part of any Basin Study.
j. Assume replacing older infrastructure (R&R) when applicable as an option with the recommended capital upgrades.
k. Provide a nodal analysis of existing conditions (like provided herein) based on tropical surge flooding, tidal flooding, etc. as shown in Tables 5.3.2-1 through 5.3.2-6, in addition to the primary conveyance analysis, so that full evaluation of the frequency of flooding can be considered.

20. Establish an on-going basin-wide swale restoration program initiated as part of a renewal and replacement program budget. [GR]

21. Provide some minor swale creation projects on a basin-wide basis, in the limited areas where it makes sense physically and politically to create swales. Organize the costs as part of a limited CIP Program. [GR]

22. Document and "bank" any swale restoration projects that create new water quality treatment volumes (like removing a paved swale and replacing with grass). The treatment credits should be applied against retrofit water quality projects (to alleviate flooding) within the same basin. This may be important in Basin IV. [IA]

23. Use underdrains as a preferred recovery method when swales are not able to percolate sufficiently on their own. This technique will increase the pollutant removal efficiency over those swales with ditch bottom inlets at low points. [GR]

Section 7 - Assessment of Future Regulatory Issues

24. Complete and submit the City's NPDES Year 2 Annual Report that was due to FDEP on May 16, 2006. [IA]

25. Ensure measuring salinity at all of the water quality sampling locations that are measuring background estuarine conditions. [GR]

26. Prioritize and continue to monitor nitrogen, phosphorus, Chlorophyll *a*, copper, lead, and salinity. [GR]

27. Re-assess the water quality monitoring program in general. The current practice of measuring the water quality only in the waterbody does not help isolate specific strategic "hot spots" where the City may be contributing loads of special concern. Some select monitoring locations located at major outfalls, might allow a more cost-effective effort to target the most troublesome discharges. The Phase 2 services include a deliverable that will help identify preferred locations to add those monitoring stations. [GR]

28. Create a stormwater management definition section in the City's Code. [GR]

29. Modify the Comprehensive Plan to make provisions to address local needs and unique problems. Do not rely so wholly on SFWMD which has a regional obligation. Create specific Stormwater Management Codes and thresholds to address the City of Naples specific concerns and needs. [NTA]

30. Establish a maximum impervious area by percentage for each residential land use to guarantee that some reasonable area will be set aside for trees, grasses and landscaping to filter and percolate stormwater runoff prior to discharge to receiving waters. Consider residential structures that generate more than 20,000 sq. ft. of impervious as "mega-homes" and require them to either meet the standard water quality treatment criteria required of commercial development or some other Standard BMP Practice utilizing

buffer strips, side and front yard swales, or exfiltration depending upon specific site conditions. Do not rely on current SFWMD and FDEP thresholds as being effective enough to address the concerns of Naples. [IA]

Section 8 - Assessment of Financing Issues and Opportunities

31. Complete the Basin studies and updating/finishing the rankings accordingly. [IA] and [NTA]

32. Use Table 8.1.1-1 to rank overall importance of each basin. Based on the existing information available, we would currently adopt the following order of importance: [IA]

    - #1 Basin VI (depending upon effectiveness of recent improvements the ranking of this Basin will change).
    - #2 Basin III
    - #3 Basin V
    - #4 Basin II
    - #5 Basin VIII or I

33. Re-rank and reissue the basin table to guide project schedules and funding as better data becomes available. [GR]

34. Allocate funds for a basin-wide study of Basin II as the next highest priority. We would schedule Basin II ahead of Basins I and VIII, accordingly. [IA]

35. Rank CIP projects and alternatives based on an Expanded CIP evaluation approach provided herein, when the data is available in order to assist decisions on what alternative gives the best benefit ratio, or to determine order of construction and/or funding. [GR]

36. Use Table 8.1.4-1 in order to perform CIP project ranking. [GR]

37. Develop separate R&R and capital sub accounts to allow for better tracking of expenses to budgets. [GR]

38. Develop a separate sub account for Capital projects funded by operations since the City currently funds its Capital projects on a cash-needs basis from the Stormwater Utility Fund. [GR]

39. Conduct a Comprehensive Stormwater Utility Rate Study with the following goals: [IA]
    a. Re-evaluate the definition of an ARU as defined in the City Ordinance.
    b. Consider restructuring the residential rate class into a tiered system to allow for more equitable recovery of costs.
    c. Re-evaluate the City's stormwater fee credit policy.
    d. Establish new rates to meet the cost requirements, goals and policies of the stormwater utility.
    e. Reconcile the differences in the identified needs between Table 3.4-2 and the actual budget.

40. Establish separate sub accounts within the stormwater utility fund to tract the cost of R&R costs, restricted grant funds, funds set aside for CIP projects. [GR]

41. Consider shifting the funding method for capital projects from the current "pay-as-you-go" method to debt funding to offset the magnitude of potential rate increases. [GR]

9.2 ESTIMATED SCHEDULES AND PHASING

Once more, Basin Reports with comparative alternatives and the effects of "phasing" Basin projects have been properly assessed, then additional ranking of the projects can be performed. In the meantime, the coarser "Basin-wide" approach can continue to direct the schedule of where and how the City directs spending. In Table 8.1.6-1, we provided our recommendation as to what timeframe during the 10-year program that various expenses and projects should be realized. These values should be re-evaluated annually with each fiscal year budgeting process. We note, however, that the rate study recommended herein will significantly align and re-evaluate in more detail the most effective timing of the projects from a financial perspective. The snapshot analysis, herein, of the current funding and stormwater utility operation does, however, provide some useful guidance at this juncture as to what projects should occur based on the following windows:

- Immediate (within the next two years)

- Soon (within the next three to five years)
- Following (within the next six to ten years).

Refer to Table 8.1.6-1 for identification of these projects to these schedules, and to Table 8.3.3-2 for the estimated cost regimes on an annualized basis.

SECTION 10

REFERENCES AND MATERIALS USED/CITED

10.1 Rainfall Frequency Atlas for Alabama, Florida, Georgia, and South Carolina (for durations from 30 minutes to 24 hours and return periods from 1 to 100 years) Technical Paper Number 40. Weather Bureau, USDA-Soil Conservation Service, Ft. Worth, Texas. Dated **1973**.

10.2 Technical Memorandum Hydro 35 (5 to 60-Minutes Precipitation Frequency for Eastern and Central United States). NOAA's National Weather Service. Dated **1977**.

10.3 Technical Paper 49, Two-to- Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. Miller et al. Dated **1964**.

10.4 Total Precipitation and Departures from Normal (Inches) Per Station (Florida). National Oceanic & Atmospheric Administration. Dated **2002**.

10.5 City of Naples Adopted Comprehensive Plan (Ordinance Number 98-8165). Dated January 21, **1998**.

10.6 April 2006 Update Report of the October 1996 Draft Report Phase I - Master Plan Stormwater Management Program. Vlad A. Ryziw P.E., PMP, Senior Civil Engineer. Dated April 7, **2006**.

10.7 City of Naples Basin VI Assessment Report. Camp Dresser & McKee (CDM). Dated August **1998**.

10.8 City of Naples Basin V Stormwater System Improvement Plan, Phase I: Basin Assessment and Conceptual Improvement Plan Draft Report. Camp Dresser & McKee. Dated May **2005**.

10.9 Assessment of Stormwater Volumes and Impacts on Water Quality in Naples Bay, Collier County, Florida (Draft report); Prepared for Southwest Florida Regional Planning Council. The Conservancy, Inc., Norris Marine Research Center. Dated August **1983**.

10.10 Stormwater Management Program Phase I Master Plan. City of Naples. Dated October **1996**.

10.11 City of Naples Interim Basin III Final Design Development Report. Camp Dresser & McKee (CDM). Dated February **2001**.

10.12 Naples Bay Surface Water Improvement & Management (SWIM) Plan Reconnaissance Draft Report. Debra Childs Woithe, Inc. & Sherry Brandt-Williams, Ph.D. Dated May **2005**.

10.13 Citywide Drainage Study. CH2M Hill. Dated January **1981**.

10.14 Gordon River Extension Basin Study - Phase IV. Wilson Miller and Camp Dresser & McKee (CDM). Dated **2002**.

10.15 City of Naples Stormwater Management Program Phase I Inventory. Camp Dresser & McKee (CDM). Dated September **1990**.

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10.17 Basis of Review for Environmental Resource Applications within the South Florida Water Management District (Water Quality Criteria). South Florida Water Management District (SFWMD). Amended date February 12, **2006**.

10.18 Naples Bay Surface Water Improvement & Management (SWIM) Plan Reconnaissance Report. Debra Childs Woithe, Inc. & Sherry Brandt-Williams, PhD (SFWMD). Dated February **2006**.

10.19 Naples Bay Surface Water Improvement & Management (SWIM) Plan Report. South Florida Water Management District (SFWMD). Dated October 27, **2006** (Release date January 2007).

10.20 The Florida Bay Education Project: Defining Florida Bay. Christine Rapozo (University of Florida/Monroe County Cooperative Extension). Date last updated March 21, **2001**.

10.21 City Council Workshop - Stormwater System Update. (Slide Presentation) The City of Naples. Dated October 2, **2006**.

10.22 City Council Workshop - Naples Bay Restoration - Water Quality, Rip Rap, and Stormwater Retention Ponds (Presentation Slides). The City of Naples. Dated October 2, **2006**.

10.23 Evaluation of Naples Bay H2O Quality and Hydrologic Data. Taylor Engineering, Inc. for SFWMD. Dated June **2005**.

10.24 Rainfall Averages and Selected Extremes for Central and South Florida, **1983**, SFWMD Technical Publication 83-2.

10.25 Frequency Analysis of SFWMD Rainfall, **1986**, SFWMD Technical Publication 86-6.

10.26 Frequency Analysis of Rainfall Maximums for Central and South Florida, **1981**, SFWMD Technical Publication #81-3.

10.27 Typical Water Quality Values for Florida's Lakes, Streams and Estuaries. FDEP Watershed Assessment Section. Joe Hand. October **2004**.

10.28 FEMA Repetitive Loss Properties Spreadsheet from Serena Jonnet, City of Naples, August 23, **2006**.

10.29 Evaluation of Water Quality Stormwater Regulations for the Lake Apopka Basin, ERD and SJRWMD.

10.30 City Council Workshop – Update on Total Maximum Daily Load Program. (Slide Presentation). The City of Naples. November 29, **2004**.

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10.35 Pollutant Removal Efficiencies for Typical Stormwater Management Systems in Florida, Environmental Research & Design, Inc. (ERD), Table 2. Harvey H. Harper, **1995**.

10.36 A Guide to the Annual Update of the Capital Improvements Element, Florida Department of Community Affairs, August 16, **2006.**

10.37 Five Year Plan 2006-2010, Big Cypress Basin. South Florida Water Management District. April 27, **2006.**

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10.39 City of Naples Monitoring Program Review CDM Report, **2000.**

10.40 Naples Bay Initiative: A Series of Projects Supporting the Restoration of Naples Bay. The City of Naples, 2006.