Stormwater Master Plan Update
City of Naples

60% Deliverable

May 12, 2017

AECOM

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TAB 1

Executive Summary

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1. Executive Summary

This section of the report will summarize the purpose of the report, the analysis of the stormwater program, and the recommendations of the master plan. This section is intended to provide a neutral overview of the full document. This section will be completed at the 90% Deliverable to provide a comprehensive overview of the stormwater master plan.

This document is a 60% level of completion. Additional information and evaluation will be completed at the 90% Deliverable.

TAB 2

Introduction

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2. Introduction

The City of Naples, Florida (Naples or City) is the largest municipality in Collier County, Florida and lies on the southwest coast of Florida. It is bordered on the west by the Gulf of Mexico and on the east by East Naples along with several large developments outside the City limits. The City encompasses approximately 15.9 square miles in total area (exclusive of recent annexations) of which about 1.4 square miles, or 9%, of the City is comprised of bays, waterways, channels and other critically important surface water bodies. Currently, the U.S. Census Bureau estimates that the City's population is approximately 19,700 with several seasonal residents (over 33,000) that arrive during the winter months. The economy of Naples is largely based on tourism due to its proximity to the Everglades and Ten Thousand Islands, and there are several large waterbodies such as the Gulf of Mexico, Naples Bay, Dollar Bay, Mooring's Bay, and the Gordon River, which add to the desire of ecotourism.

Much of the early development that created Naples did not properly plan for the flood potential of the low lying areas that make up this coastal region or for natural resources of the estuaries. The City is characterized by its:

- Coastal environment
- Low topography
- Substantial build-out
- Ongoing redevelopment activities
- Heavy rainfall patterns
- High tidal activity, and
- High potential of storm surge above mean sea level along the gulf coast beaches on the City's western edge.

These characteristics cause some areas of the City to be more prone than others to nuisance and damaging flooding along with degradation of the quality of surface water bodies.

Multiple basin studies and master plans have been conducted over the years in an effort to assess and correct the City's stormwater deficiencies. Previous efforts have included hydrologic and hydraulic modeling in some of the City's basins to attempt to find solutions to the problems and prevent more from occurring. In addition, due to the increase in regulations affecting storm water discharges, the focus on water quality has been a major concern. Additional studies have been commissioned to help understand water quality concerns facing the City and provide potential treatment solutions as well as water quality monitoring programs. Previous efforts also included attempts to ensure that the City's Operation and Maintenance programs were optimized to assist in addressing water quality and quantity issues.

Stormwater runoff is an increasingly important resource that needs to be managed from both a water quantity and quality standpoint to protect public health and safety and to preserve the City's way of life in Southwest Florida. Drainage is an increasingly important subject and the management of it needs to be approached in a comprehensive matter. The development of this stormwater master plan gives the City the tools to record and evaluate current City stormwater management practices, allows the City to establish goals and provide a foundation for future policy decisions, and establishes capital improvement projects for the next 10 years taking into account existing and future practices in stormwater management.

2.1 Background

In 1996, a Stormwater Master Plan was prepared by City staff to outline a comprehensive program to identify and correct deficiencies in the existing systems to accommodate a practical level of service within available resources. In 1998, Camp, Dresser and McKee, Inc. (CDM) was hired to prepare an Assessment Report on Basin VI. In 2001, CDM was hired to prepare a Design Development Report for Basin III. In 2004, CDM was again hired to draft an Interim Report on Basin V. In February 2006, staff updated City Council on the status of the 1996 plan that included a $42,635,000 program for capital

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improvements, and an Operation and Maintenance (O&M) Management Plan. That overview included a finance plan to increase the revenue from the Stormwater Utility Fee.

Again in 2007, a Stormwater Master Plan update was performed by Tetra Tech that summarized past documents and efforts, outlined goals and objectives, and identified $78 million worth of projects and programs, many of which have been implemented in the past 10-years. A result of the master planning effort was the modification of the Stormwater Utility Fee ordinance to allow credits to be issued for properties with certified stormwater management systems, and the fee was raised from $4 per ERU to $10.40. A portion of the current master plan efforts involves the identification of the status of capital improvement projects identified in the 2007 plan.

2.2 Objective

The objective for this plan update is to develop a clear, comprehensive, and forward looking master plan (updated from April 2007) that encompasses Naples stormwater management program, presents a detailed investigation into key components of stormwater as it is related to the City, establishes goals and provides a foundation for future policy decisions. This Stormwater Master Plan Update will help the City guide its stormwater management program for the next 10 or more years.

2.3 Goals

The goals of this Stormwater Master Plan Update are: protection of the health, safety and welfare of City residents; protection of and improvement to the City's surface and ground water resources; protection of public and private property; protection and restoration of ecology, and planning wise and strategic investments into the storm water management system.

2.4 Components of the Stormwater Master Plan

As with the 2007 Master Plan Update, this master plan includes a continuation of the compilations of the many related studies, engineering reports, previous master plans and other relevant data into one combined source data book. In order to provide the City a comprehensive stormwater master plan that will effectively outline Naples' stormwater related needs for the next 10 years, the following components are included and are being evaluated in the plan:

1. Water Quantity (Flooding) - Identification of key water quantity issues and recommendations on solutions
2. Water Quality and Ecology - Address current and future water quality and ecology issues through the review of existing data, applicable regulatory standards, and evaluation of the City's monitoring program
3. Level of Service - Evaluation of the water quantity and quality level of service
4. Regulatory and Development Code Review - A thorough review of the City's regulatory and development codes as they relate to stormwater management
5. Climate Adaptation - Evaluation of mutually agreed upon local and regional sea level rise and resilience guidance documentation
6. Best Management Practices (BMP) Review - Review and expansion of the City's current literature on Best Management Practices and the applicability of each towards meeting the City's future stormwater goals
7. Operational Strategies - Provide guidance on how to enhance current operational strategies to assist the City in delivering stormwater protection services more economically, while better maintaining and reporting on current systems

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8. Capital Improvement Program - Identification of capital improvement needs and recommendations regarding future projects based on five year increments, for a 10 year duration

9. Funding - Evaluation of funding options through funding strategy services and an existing rate evaluation

10. Stormwater & Natural Resources Divisions – Review each division's goal and objectives

11. Public Involvement - Provide services to present and document public involvement during the Stormwater Master Plan process

TAB 3

Information and Data Collection

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3. Information and Data Collection

As part of this update to the 2007 Stormwater Master Plan, this plan continues the compilation of the many related studies, engineering reports, previous master plans, and other relevant data. A list of those documents is listed in a table provided in Appendix A along with a copy of the documents on a CD. Information and data collection includes the review of existing relevant drainage studies and master plans performed over several decades, as well as numerous reference materials from regulatory and governmental agencies and other technical sources. Data collection and review allows for a thorough understanding of the work that has been previously performed, work that is ongoing, and areas that need to be improved.

In addition to the documents that were collected and reviewed, other technical information was gathered which was specific to the City of Naples from other governmental agencies. This information includes hydrologic data such as rainfall data, tidal data, and groundwater data. Also, this section includes detailed descriptions of the characteristics of nine (9) of the twelve (12) basins that comprise of the City's watershed and an evaluation of the City's GIS system that is used to inventory the City's stormwater assets.

3.1 Sources of Data

3.1.1 Existing Drainage Studies and Stormwater Master Plans

As an update to the 2007 Stormwater Master Plan, Table 3-1 continues the list of existing drainage studies, stormwater master plans and other similar data sources used to assess and evaluate how the City has been managing stormwater infrastructure. The studies were examined first for relevancy to existing stormwater issues facing the City, then relevant documents were subsequently reviewed to provide a comprehensive understanding of the current state of the City's stormwater management system and areas that may be upgraded. Although sources are cited from the 2007 Stormwater Master Plan, this master plan continues from the conclusions of the previous master plan and concentrates on information occurring after the 2007 Stormwater Master Plan since the previous master plan already evaluated the information up to 2007.

In addition to drainage studies, the City has been concentrating its efforts in the evaluation of water quality since the 2007 Stormwater Master Plan. A more detailed assessment of the studies is located in Section 5 of this report.

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Table 3-1 Summary of Existing Drainage Studies and Stormwater Master Plans

Year	Title of Document	Date Issued	By
1981*	Stormwater Master Plan	1/1981	CH2M Hill
1990*	Phase 1 Stormwater Master Plan and Inventory	10/1990	CDM
1996*	Stormwater Management Program Phase 1 Master Plan	10/1996	Naples Staff
1996*	Lantern Lake Drainage Area Study	06/1996	HMA
1998*	Basin VI Assessment Report	08/1998	CDM
1999*	Gordon River Extension Basin Study Phase III	09/1999	Wilson Miller/CDM
2000*	Lantern Lake Basin Drainage Study Update	09/2000	HMA
2001*	Interim Basin III Design Development Report	02/2001	CDM
2002*	Gordon River Extension Basin Study Phase IV	2002	Wilson Miller/ CDM
2005*	Basin V Stormwater System Improvement Plan – Phase I: Basin Assessment and Conceptual Improvement Plan	11/2005	CDM
2006*	Draft Report Ph-1 Master Plan Stormwater Management Program	04/2006	Naples Staff
2007	City of Naples Stormwater Master Plan Update "90% Draft Report"	04/2007	Tetra Tech
2007	Feasibility Study for Basin III Stormwater Management System Improvements and Broad Avenue Linear Park DRAFT	08/2007	CDM
2009	Naples Beach Outfalls Conceptual Stormwater Management Analysis	11/2009	Gulfshore Engineering, Inc.
2012	Final Technical Memorandum on Beach Stormwater Outfall Hydrologic and Hydraulic Modeling for Existing Conditions	11/2012	AECOM
2013	Final Technical Memorandum on Beach Stormwater Outfall Alternatives Preliminary Assessment	04/2013	AECOM

* Listed in Previous Plan and not included in the CD in Appendix A

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3.1.2 Other Relevant Sources

Besides the City provided resources, additional key reference sources were obtained from several federal, state and local governmental agencies. Some of these agencies are referenced below with a more comprehensive list of information is included in Appendix A:

- Federal Emergency Management Agency (FEMA)
- U.S. Geological Survey (USGS)
- Nation 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

3.2 Hydrologic Data

When evaluating the level of service of stormwater management facilities and calibrating models, hydrologic data is essential in the design and assessment of stormwater management facilities. Hydrologic data consists of rainfall data, tidal data, and groundwater information.

3.2.1 Rainfall Data

The City of Naples receives an average annual rainfall of 49 inches. Over a 14.5 square mile area, the amount of rainfall that the City needs to manage in its stormwater management system is approximately 12 billion gallons or 38,000 acre-feet per year. Rainfall is where stormwater management begins. Without rainfall, there would be no need to manage the stormwater. The City of Naples is located in a coastal area where the rainy season begins in June and ends in October. This is when Naples receives the most rainfall. When designing stormwater management systems, the amount of rainfall is important in determining whether your system is meeting the desired level of service. Rainfall data is received from several sources. These sources include the National Oceanic and Atmospheric Administration (NOAA) and South Florida Water Management District (SFWMD). These sources are used for design and calibration of stormwater management systems.

3.2.1.1 NOAA Rainfall Data

National Oceanic and Atmospheric Administration (NOAA) precipitation data from 1985 to 2016 is summarized in Table 3-2. There are four (4) NOAA rainfall stations as shown in Figure 3-1, but the most complete record of rainfall information is from the Naples Municipal Airport Station USW00012897. This station began collecting data in March 2002 and the data is located in Appendix B. The NOAA Precipitation data prior to March 2002 was collected at an unnamed data collection station located at 26˚10' N Latitude and 81˚43' W Longitude. According to the data complied, the average monthly precipitation for the referenced time frame is approximately 4.2 inches with the average rainy season precipitation of approximately 7.3 inches per month. The maximum annual precipitation is 71.16 inches in 2003 and the minimum annual precipitation is 33.91 inches in 2009.

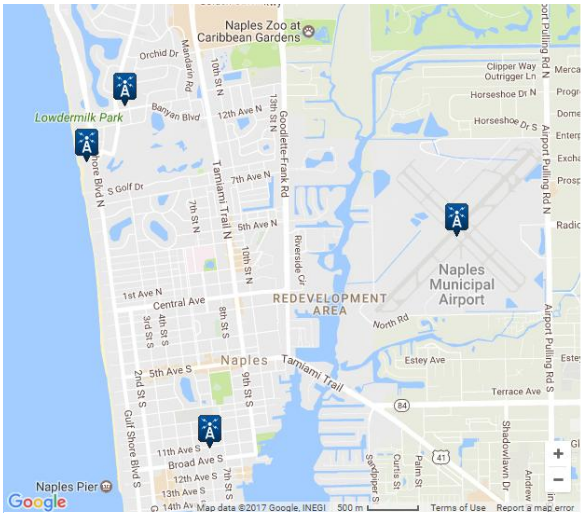

Figure 3-1 NOAA Rainfall Stations

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Table 3-2 NOAA Precipitation (inches) Data from 1985 to 2016

						Rainy Season							
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1985	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	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	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	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	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	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	9.40	2.11	1.86	2.92	10.70	MD*	14.15	MD*	MD*	MD*	MD*	0.37	N/A
1992	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	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	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	4.35	1.74	0.75	3.48	3.98	10.38	MD*	MD*	10.90	15.98	0.59	MD*	N/A
1996	2.10	0.01	1.72	1.71	6.20	2.74	2.60	5.56	3.58	7.40	0.26	0.3	34.18
1997	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	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	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	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	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**	3.42	1.94	1.19	2.36	5.16	13.19	6.60	7.56	11.28	2.06	3.19	2.70	60.65
2003	2.45	0.80	4.90	4.34	3.39	11.71	8.93	9.94	17.22	1.28	4.08	2.12	71.16
2004	3.15	3.54	0.14	2.78	0.64	5.18	7.61	9.79	3.22	1.83	1.02	1.29	40.19
2005	0.72	0.99	5.22	1.61	1.46	21.06	6.28	4.60	5.49	13.74	2.09	0.17	63.43
2006	0.56	3.21	0.08	0.00	2.74	10.33	12.17	11.61	7.50	1.15	0.41	0.45	50.21
2007	0.02	0.95	0.26	1.71	3.49	4.37	3.54	5.77	9.04	4.92	0.09	0.82	34.98
2008	0.69	1.51	0.74	5.91	0.34	9.46	9.83	10.00	4.28	4.60	0.33	0.60	48.29
2009	0.16	0.31	0.20	0.71	3.92	2.37	3.17	6.20	11.36	0.45	1.11	3.95	33.91
2010	1.65	1.06	2.85	4.68	1.58	9.69	7.77	7.13	6.12	0.52	0.59	1.00	44.64
2011	1.50	0.17	1.06	0.17	1.70	2.43	6.06	7.97	6.96	8.03	1.72	0.43	38.20
2012	0.17	3.21	1.00	2.47	2.46	4.51	4.29	10.95	3.78	3.18	0.12	1.78	37.92
2013	0.15	1.67	0.62	4.43	3.47	8.77	9.06	7.85	10.98	1.24	0.78	0.32	49.34
2014	2.39	0.77	1.90	1.80	1.97	8.19	6.95	13.89	10.08	1.43	1.05	0.25	50.67
2015	0.10	1.54	1.45	1.76	3.19	6.33	10.14	2.78	6.75	1.06	2.98	1.64	39.72
2016	7.54	1.16	0.45	0.47	2.48	4.91	6.31	10.72	5.57	4.60	0.00	0.35	44.56
Average	1.96	1.67	1.85	2.21	3.22	7.99	8.15	7.99	8.37	4.13	1.66	1.35	49.06
Maximum	9.40	6.09	8.12	7.73	10.70	21.06	21.49	13.89	20.84	15.98	6.63	6.28	71.16
Minimum	0.02	0.01	0.08	0.00	0.34	2.31	2.6	2.17	3.22	0.25	0.00	0.06	33.91

*"MD" is missing data and "N/A" is not applicable.
** Data in March 2002 and subsequent years collected from the Naples Municipal Airport Station.

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3.2.1.2 SFWMD Rainfall Data

In addition to the NOAA Precipitation Stations, South Florida Water Management District (SFWMD) also collects precipitation data at a number of rainfall stations shown on Figure 3-2. SFWMD rainfall data may be accessed by station ID at the following website: https://www.sfwmd.gov/weather-radar/rainfall-historical/sites-and-basins

This data along with the NOAA data is useful in the calibration of hydrologic and hydraulic modeling along with water quality modeling.

SFWMD also provides information concerning design storm events that are used in designing stormwater management systems. Common storm events used in the design of these systems are shown in Table 3-3.

Figure 3-2 SFWMD Rainfall Stations

Table 3-3 SFWMD Equivalent Rainfall for Return Frequency Storm (yrs) and Duration (time)

Storm Event	Rainfall (in)
5 Year, 1-Hour	2.8
3 Year, 1-Day	4.5
5 Year, 1-Day	5.5
10 Year, 1-Day	7.0
25 Year, 1-Day	8.0
100 Year, 1-Day	11.0
10 Year, 3-Day	9.5
25 Year, 3-Day	11.8
100 Year, 3-Day	15.0

3.2.1.3 NEXRAD Rain Grid

Next Generation Radar (NEXRAD) was deployed by the National Weather Service to determine quantities of rainfall by measuring the reflectivity of falling raindrops. NEXRAD is an attempt to improve upon conventional approaches to the collection of rainfall data that include localized methods such as rain gauges. Precipitation is estimated based on the reflectivity and rainfall relationship called Z-R. NEXRAD has the capability to measure reflectivity to a distance of 230 kilometers. NEXRAD Level II and Level III radar stations near Naples are located in Tampa, FL, Miami, FL and Key West, FL. NEXRAD rainfall data for Collier County for a 20 year period, earliest data is available in 1996, is shown below in Table 3-4. The average monthly precipitation for the referenced time frame is approximately 4.5 inches with the average monthly rainy season precipitation of approximately 9 inches per month. The maximum annual precipitation is 38.45 inches in 2001. NEXRAD data results differ substantially from NOAA data for some

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annual total while average monthly and average monthly rainy season average is similar. NEXRAD precipitation data can be accessed at the following website: http://apps.sfwmd.gov/nexrad2/nrdmain.action

Table 3-4 NEXRAD Rainfall Data for Collier County

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1996	0.47	0.33	2.51	0.96	6.50	9.18	4.82	6.46	4.12	4.61	0.24	0.44	40.62
1997	0.89	0.57	2.22	4.18	4.61	6.97	8.30	7.18	6.11	0.58	3.43	4.76	49.78
1998	1.40	4.37	3.98	0.16	2.75	4.38	7.02	7.96	7.36	4.12	7.99	1.67	53.16
1999	1.78	0.52	0.60	1.21	6.41	12.16	8.70	9.65	12.07	6.50	2.75	0.63	62.98
2000	0.73	0.23	2.35	2.53	2.35	9.11	10.21	9.81	11.53	4.24	0.08	0.15	53.32
2001	0.46	0.14	3.15	0.00	4.86	10.93	16.47	10.40	15.08	4.67	0.64	1.67	68.45
2002	0.44	2.08	0.76	1.10	2.39	11.41	6.32	5.82	6.14	2.17	2.33	3.03	43.99
2003	0.97	0.58	3.19	3.44	6.63	9.51	5.98	8.63	11.82	0.79	1.94	1.17	54.64
2004	3.29	2.98	0.19	2.50	1.11	8.83	10.17	10.95	7.48	1.40	0.56	1.10	50.56
2005	1.03	1.02	4.65	2.14	3.22	18.94	8.14	8.45	6.82	6.26	1.85	0.38	62.90
2006	0.34	2.72	0.50	1.09	3.55	8.40	9.32	10.00	8.35	1.12	1.56	1.82	48.77
2007	0.61	1.22	0.53	2.82	3.14	9.29	8.48	6.01	7.73	3.10	0.37	0.89	44.19
2008	0.76	4.87	1.94	3.96	1.53	11.19	11.36	15.93	8.26	3.59	0.27	0.83	64.50
2009	0.30	0.51	0.36	0.48	7.56	11.63	7.36	8.76	9.22	1.43	1.62	3.39	52.60
2010	2.14	2.69	5.63	4.51	3.39	6.92	6.45	11.98	6.74	0.85	1.41	1.07	53.78
2011	1.54	0.24	1.93	2.03	3.64	6.86	8.82	9.73	8.74	9.86	0.28	0.47	54.12
2012	0.10	1.43	1.81	3.25	5.30	6.33	5.99	9.63	7.23	5.93	0.04	2.81	49.83
2013	0.15	2.03	0.74	5.01	6.67	11.01	12.01	7.46	9.00	1.20	1.94	0.27	57.50
2014	2.98	0.86	2.10	2.33	2.88	8.64	8.26	8.29	8.69	1.69	2.41	0.37	49.50
2015	0.57	2.24	1.45	3.99	3.97	7.49	7.04	8.79	9.88	1.56	3.68	2.30	52.94
2016	10.24	2.19	1.04	1.23	6.28	10.42	8.23	10.44	7.39	2.74	0.06	0.33	60.58

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3.2.2 Tidal Data

For the City of Naples, there are two known stations. NOAA Station (ID 8725110) showed in Figure 3-3 and the Naples Bay North Station. Station 8725110 was established in March 4, 1965 and provides current data. The maximum water level was 3.11 feet MHHW on December 21, 1972, and the minimum water level was -2.48 feet MLLW in March 15, 1988, with a mean range of 2.01 feet and diurnal range of 2.87 feet. This station may be accessed at the following website: https://tidesandcurrents.noaa.gov/stationhome.html?id=8725110.

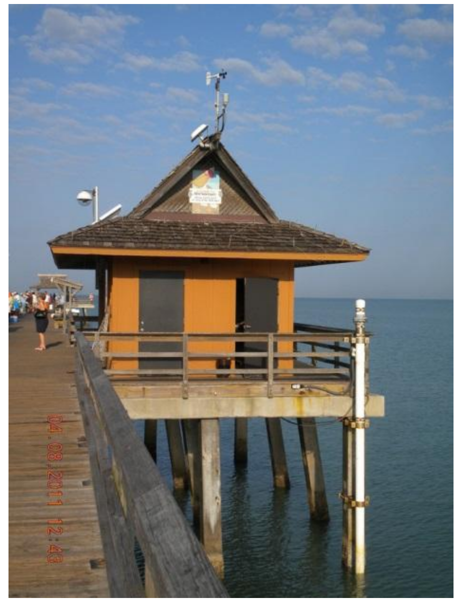

Figure 3-3 NOAA Station 8725110

The Naples Bay North Station was established in March 13, 1978, and then subsequently removed on April 10, 1981. The only historical information is the mean range of 1.97 feet and the Diurnal Range of 2.76 feet. Prior basin studies by CDM have extensively studied tidal information. The results of these studies were summarized in the previous master plan performed by TetraTech (2007) with a summary of high tide elevations and the associated return frequencies. Table 3-5 summarizes those results.

Table 3-5 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)

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3.2.3 Groundwater Data

The United States Geological Survey's (USGS) collects data from groundwater wells. There are five (5) active monitoring wells within Naples with periodic monitoring frequencies of at least one data point during the last 13 months. The USGS provides this data through their groundwater watch database. Each of the following Site Identification number contains a link to the groundwater monitoring station's USGS websites which contains statistics on each site's ground water levels as well as the number of years the sites has been monitored. The well identification numbers are as follows: 261200081483001, 261156081475801, 261018081484101, 261002081483701, and 260925081475101.

Also, there are two continuous monitoring wells, 261124081470301 and 261124081470101. These wells are located together on the east side of Goodlette-Frank Road N as shown in Figure 3-4. Site 261124081470301 is a 75 feet deep well, which is monitoring the "Tamiami Formation" local aquifer, and Site 261124081470101 is a 30 feet deep well, which is monitoring the "Nonartesian Sand Aquifer" (surficial aquifer system). By reviewing the data, the actual groundwater elevations appear to be 2 feet below existing ground elevation.

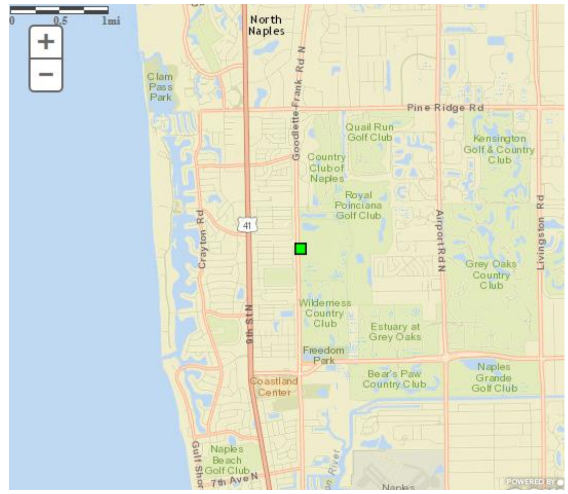

Figure 3-4 USGS Groundwater Well Location Map for Site No. 261124081470301

3.3 Basin Data

In order to assess and evaluate the City's stormwater management system, the City is delineated into drainage basins to determine the size of the area impacting a receiving water body, retention area, or drainage structure. During the 2007 Master Plan Update, Tetra Tech reconciled and defined the drainage basins. These basins are numbered with Roman Numerals in the 2007 report. Within this report, these basins are numbered with a standard numbering system.

The City comprises of approximately 16 square miles with approximately 2 square miles identified as major waterbodies for a total of 14.4 square miles, in which the City manages stormwater infrastructure. The City has been divided into twelve (12) drainage basins as shown in Figure 3-5. This section will further describe each drainage basin. For the purpose of this study, only Basins 1, 2, 3, 4, 5, 6, 7, 8, and 10 are being assessed and evaluated. Basins 9, 11, and 12 contain mostly developed private areas and conservation areas in which the City maintains little to no stormwater infrastructure. Each basin is characterized in the following sections with the following characteristics:

- General geography – to aid in the general location of the basin
- Topographic information – to aid in determining areas that may be prone to flooding due to low elevations and to give a generalize view of the storage the basin may contain
- Future land use and Zoning – to aid in the amount of runoff that a basin is producing that the City must manage
- Soil information – to aid in the amount of soil storage that a basin is providing thus reducing or increasing the amount of stormwater runoff
- Stormwater Infrastructure – to evaluate how the basin's stormwater management system is working.

Larger basin maps are provided in Appendix D along with soil survey information from the Natural Resource Conservation Services (NRCS) in Appendix E.

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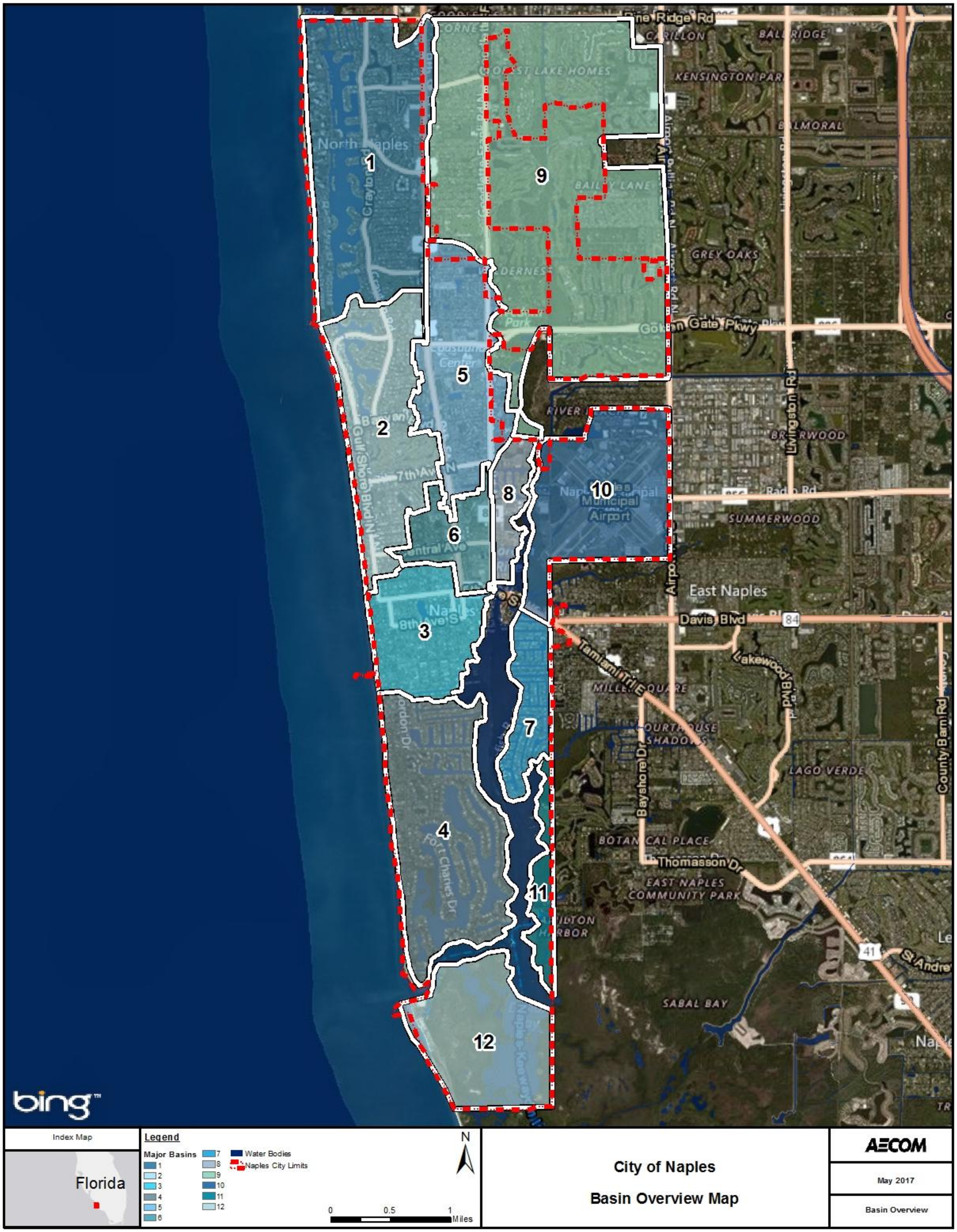
Figure 3-5 Overall Basin Location Map



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3.3.1 Basin 1

Basin 1 is bordered by the Gulf of Mexico on the west, Seagate Drive on the north, US 41 on the east, and from Doctors Pass through Moorings Country Club to US 41 on the south. Figure 3-6 shows the basin location. The neighborhood areas that are within this area include Seagate, Park West, Park West-Parkshore, Harbour Drive Gulf Shore-Parkshore, Parkshore, the north part of the Moorings, and Harbour Drive Gulf Shore-Moorings. Topography ranges between 18 feet NAVD to 1 feet NAVD where elevations are 13 feet NAVD to 18 feet NAVD on the east boundary by US 41 and where elevations are 6 feet NAVD to 1 feet NAVD on the west boundary by the Gulf of Mexico. The land use in the basin is predominantly residential development with some commercial development concentrated along US Highway 41 and high density, high-rise residential along the Gulf Beaches. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Commercial (Highway)
- Commercial (Limited)
- Institutional (Public, Semi Public)
- Recreation (Public, Semi Public, Private)
- Residential (High Density High Rise)
- Residential (High Density Mid Rise)
- Residential (High Density Tower)
- Residential (Low Density)
- Residential (Medium Density)

Zoning

- Highway Commercial
- Office
- Planned Development
- Public Service
- Single Family
- Multifamily

More than 50 percent of the land in Basin 1 consists of the Urban Land soil classification. The majority of the land along the Gulf of Mexico surrounding Gulf Shore Boulevard, consisting of one quarter of the land in the basin, is of the Urban Land-Aquenets Complex, Organic Substratum soils classification. The landforms associated with the soil classifications for these areas consist of marine terraces. Specific soils information for this basin is located in Appendix E.

Stormwater infrastructure in this basin is routed via swales, inlets, pipes and detention ponds into Venetian Bay, Inner Doctors Bay, Outer Doctors Bay, and Moorings Bay. There are also six (6) City maintained lakes within this basin, Devils Lake (consists of 2 Lakes), Swan Lake, Colonnade Lake, Hidden Lake, and Lake Suzanne.

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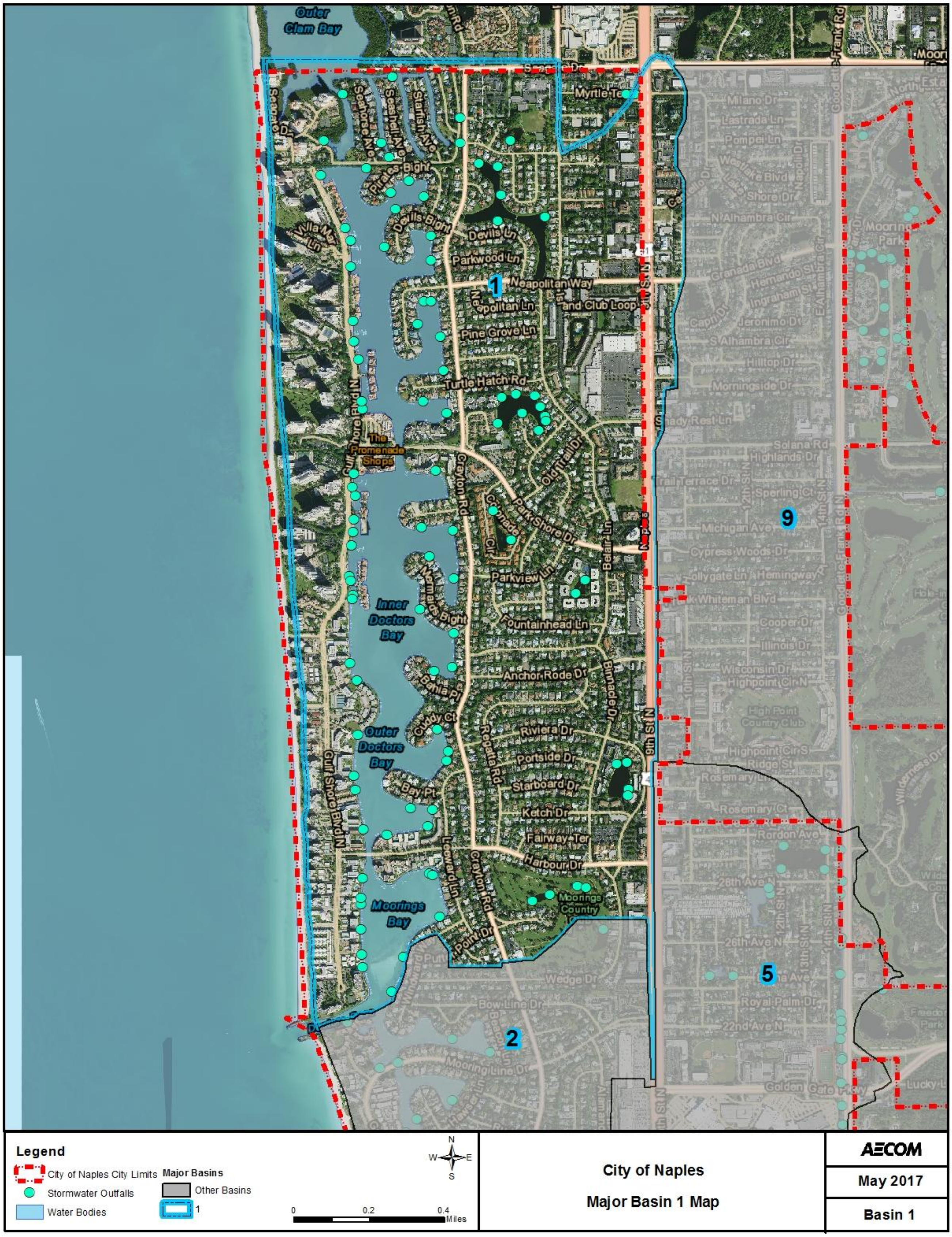
Figure 3-6 Basin 1 Location Map



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3.3.2 Basin 2

Basin 2 is bordered by the Gulf of Mexico on the west, Basin 1 on the north, US 41 and Basin 5 on the east, and Basin 3 south of 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. Figure 3-7 shows the basin location. The neighborhood areas that are within this area include Moorings, Coquina Sands, Naples Beach Golf Club, and Old Naples. Topography ranges from an elevation of 14 feet NAVD at US 41 to elevation 5 feet NAVD at Crayton Road and from elevation 9 feet NAVD on the dune system at the Gulf of Mexico to an elevation 2 to 3 feet NAVD at Gulf Shore Boulevard. Gulf Shore Boulevard appears to have the lowest elevations within the basin. The land use in the basin is predominately single family residential with commercial development concentrated along US highway 41 and high density residential along the Gulf coast beaches and the Naples Beach Golf Course. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Commercial (Highway)
- Commercial (Limited)
- Institutional (Public, Semi Public)
- Recreation (Public, Semi Public, Private)
- Residential (High Density, Low Rise Coquina Sands)
- Residential (High Density, Low Rise Moorings)
- Residential (High Density Mid Rise)
- Residential (Low Density)
- Residential (Medium Density)

Zoning

- Highway Commercial
- Planned Development
- Public Service
- Single Family
- Multifamily

More than 50 percent of the land in the basin consists of the Urban Land soil classification. The northern portion of the basin that runs near the Gulf of Mexico, consisting approximately 18% of the basin, is of the Urban Land-Aquenets Complex Organic Substratum soils classification. An additional 13% of the basin consists of Udorthents classification which is classified as somewhat poorly drained. The landforms associated with the soil classifications for these areas consist of marine terraces. Specific soils information for this basin is located in Appendix E.

Stormwater discharges in the northern portion of the basin are routed via a system of swales, inlets, and pipes to Moorings Bay. The southern portion of the basin discharges its storm water via a system of swales, inlets, pipes, and detentions lakes to the Gulf of Mexico via beach outlets. There are also five (5) City maintained lakes within this basin, Lowdermilk Lake, North Lake, South Lake, Alligator Lake, and Lake 7.

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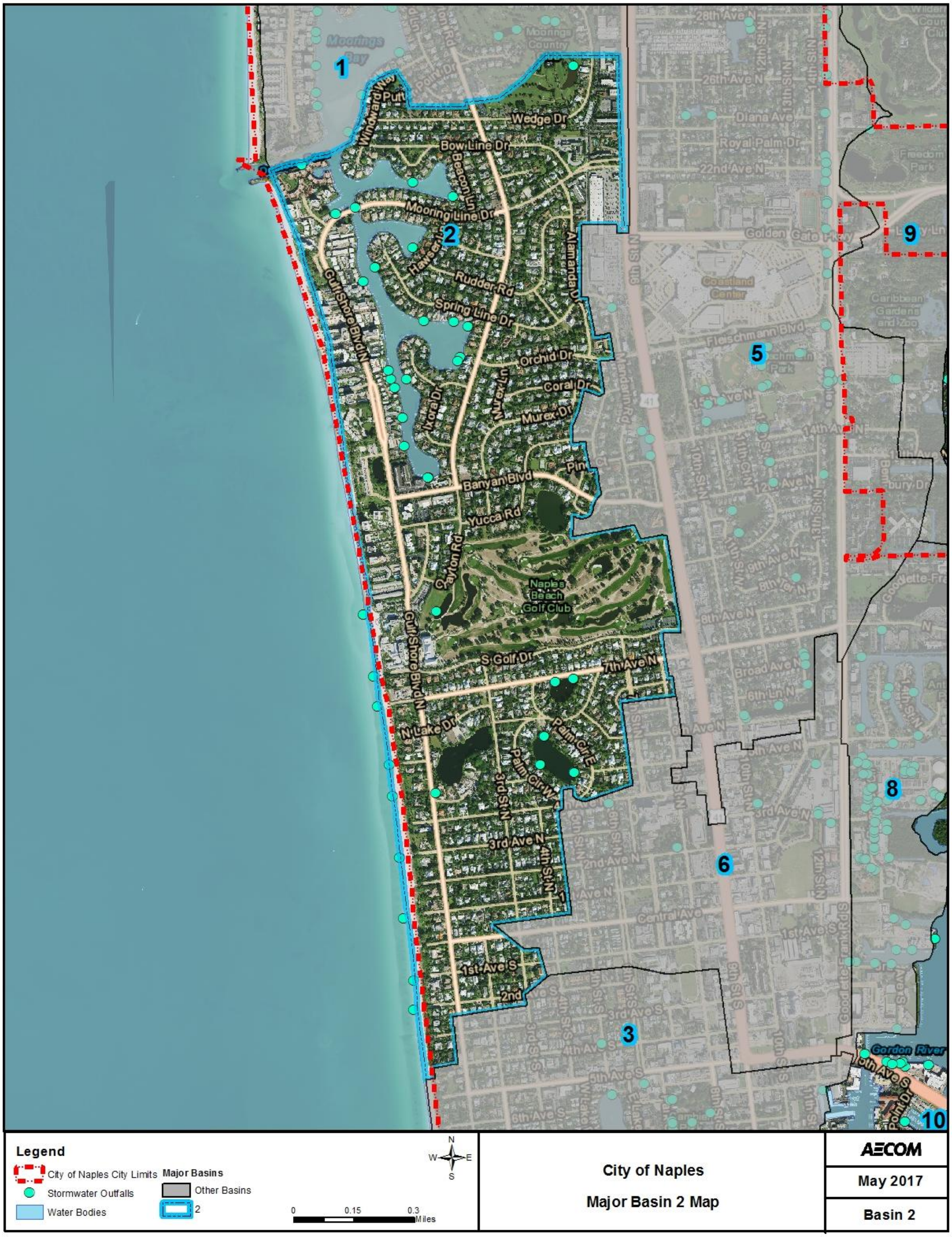
Figure 3-7 Basin 2 Location Map



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3.3.3 Basin 3

Basin 3 is bordered by the Gulf of Mexico on the west, Basins 2 and 4 on the north, Naples Bay on the east, and a line running from Naples Pier southeasterly to Naples Bay on the south (Basin 4). Figure 3-8 shows the basin location. The only identified neighborhood in this basin is Old Naples. It also includes three (3) overlay districts, the 3rd Street Overlay, the 5th Avenue Overlay, and the Community Redevelopment Area (CRA) District. Topography is at elevation 12 feet NAVD in the north part of the basin and slopes to the south and east to an elevation of 1 feet NAVD. On the west side of the basin there is a high dune ranging from 8 to 10 feet NAVD which slopes toward Gulf Shore Boulevard to an elevation of 1 to 2 feet NAVD. The area is relatively flat throughout the center of the basin. The land use in the basin predominantly consists of residential development with commercial development in the northeast portion of the basin and along 5th Avenue South and along 3rd Street South between Broad Avenue South and 14th Avenue South. In addition, City Hall and the Fire Department are located in this basin. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Commercial (Limited)
- Downtown Mixed Use
- Institutional (Public, Semi Public)
- Residential (Low Density)
- Residential (Medium Density)
- Waterfront (Mixed Use)

Zoning

- Retail Shopping
- Commercial Core
- General Commercial
- Waterfront Commercial
- Downtown
- Planned Development
- Public Service
- Single Family
- Multifamily

More than 96 percent of the land in the basin consists of the Urban Land soil classification. Specific soils information for this basin is located in Appendix E.

Stormwater runoff in the basin is routed by swales, inlets, pipes, and detention lakes (East Lake and Spring Lake), and then subsequently routed to the Cove Stormwater Pumping Station on Broad Avenue South and 9th Street South for discharge into Naples Bay.

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Figure 3-8 Basin 3 Location Map

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3.3.4 Basin 4

Basin 4 is bordered by the Gulf of Mexico on the west, Basin 3 on the north, and Naples Bay on the east and south. Figure 3-9 shows the basin location. The neighborhood areas that are within this area include Aqualane Shores and Port Royal. Topography ranges between 8 feet NAVD to 1 feet NAVD throughout the basin with a dune along the Gulf of Mexico that begins at 10 to 11 feet NAVD in elevation to an elevation of 1 to 2 feet NAVD along Gulf Shore Boulevard and Gordon Drive. The elevations appear to be relatively flat throughout the basin with high topography at the build pads to street elevations ranging from 1 feet NAVD to 5 feet NAVD. The land use in the basin is predominately single family residential development. The following lists the future land uses within this basin along with the zoning:

<u>Future Land Use</u>

- Beach Front Estates
- Conservation
- Institutional (Public, Semi Public)
- Recreation (Public, Semi Public, Private)
- Residential (Low Density)

<u>Zoning</u>

- Conservation
- Planned Development
- Public Service
- Single Family
- Multifamily

The majority of the area of the basin consists of Urban Land-Aquenets Complex Organic Substratum soils classification which consists of poorly drained soils with close to one quarter consisting of the Urban Land classification. In addition, 12 percent consisting of Urban land –Immokale e-Oldsmar, limestone substratum complex consisting of poorly drained. Specific soils information for this basin is located in Appendix E.

Storm water discharges in the basin are 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. There are also six (6) City maintained lakes within this basin, Lakes 12, 13, 25, and 28 and Lantern Lake and Half Moon Lake.

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Figure 3-9 Basin 4 Location Map

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3.3.5 Basin 5

Basin 5 is bordered on the west by US 41 and Basin 2, Creech Road on the north, Goodlette Road on the east and a line that runs from the intersection of US 41 and 3rd Avenue North northeasterly to Goodlette Road on the south. Figure 3-10 shows the basin location. The neighborhood areas that are within this area include Lake Park and Eagle Oak Ridge. In addition, part of the CRA District is within this basin. Topography in this basin generally slopes west to east with the higher elevations of 12 feet NAVD along US 41 and the lower elevations from 9 to 5 feet NAVD. There are also flatter areas between US 41 and Goodlette Road. The land use in the basin consists of commercial development along the US 41 corridor and the Coastland Mall area with residential development throughout the basin. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Commercial (Highway)
- Commercial (Limited)
- Downtown Mixed Use
- Institutional (Public, Semi Public)
- Recreation (Public, Semi Public, Private)
- Residential (Low Density)
- Residential (Medium Density)

Zoning

- General Commercial
- Downtown
- Highway Commercial
- Medical
- Planned Development
- Public Service
- Single Family
- Multifamily

More than 85 percent of the area of Basin 5 consists of the Urban Land soil classification which features the landform marine terraces with no associated drainage classification. Approximately 8 percent consists of Urban land-Immokalee-Oldsmar, limestone substratum complex which is poorly drained consisting of the landform flatwoods on marine terraces. Specific soils information for this basin is located in Appendix E.

The basin's stormwater runoff is routed via swales, inlets, pipes, and several detention lakes to a storm sewer pipe system along the west right-of-way of Goodlette Road. This system discharges to the Gordon River. There are also seven (7) City maintained lakes within this basin, Sun Lake, Thurner Lake, Lake 17, Mandarin Lake, Forrest Lake, Willow Lake, and Lake Manor.

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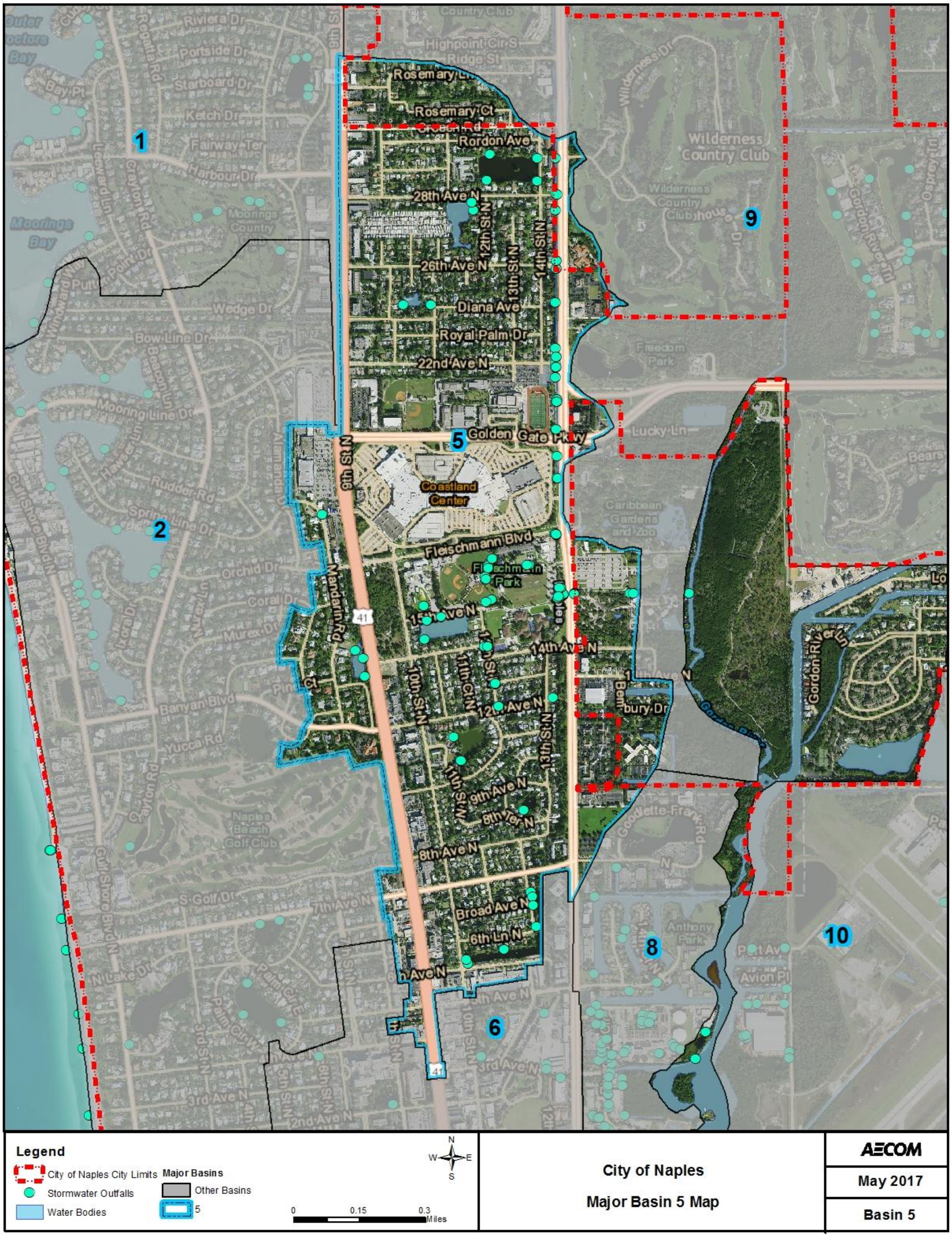
Figure 3-10 Basin 5 Location Map



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3.3.6 Basin 6

Basin 6 is bordered on the west by Basin 2, Basin 5 on the north, Basin 3 on the south, and Goodlette-Frank Road on the east. Figure 3-11 shows the basin location. The neighborhood areas that are within this area include Old Naples and River Park. In addition, portions of the CRA District are within this basin. Topography slopes north to south and west to east. The elevations range 12 feet NAVD from the north to 2 feet NAVD to the south and 10 feet NAVD from the west to 2 feet NAVD to the east. There are also areas within the basin that have relatively flat slopes. The land use in the basin consists of primarily commercial development in the US 41 corridor and downtown Naples area with residential development interspaced throughout. The following lists the future land uses within this basin along with the zoning:

<u>Future Land Use</u>

- Downtown Mixed Use
- Institutional (Public, Semi Public)
- Recreation (Public, Semi Public, Private)
- Residential (Low Density)
- Residential (Medium Density)
- Residential (Low Density)

<u>Zoning</u>

- General Commercial
- Downtown
- Medical
- Planned Development
- Public Service
- Single Family
- Multifamily

Basin 6 consists exclusively of the Urban Land soil classification which consists of the landform marine terraces with no associated drainage classification. Specific soils information for this basin is located in Appendix E.

The majority of stormwater runoff in the basin is conveyed via swales, inlets and pipes to the Goodlette Road (Public Works) 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 ultimately to the Gordon River. There is also one City maintained lake within the basin, NCH Lake.

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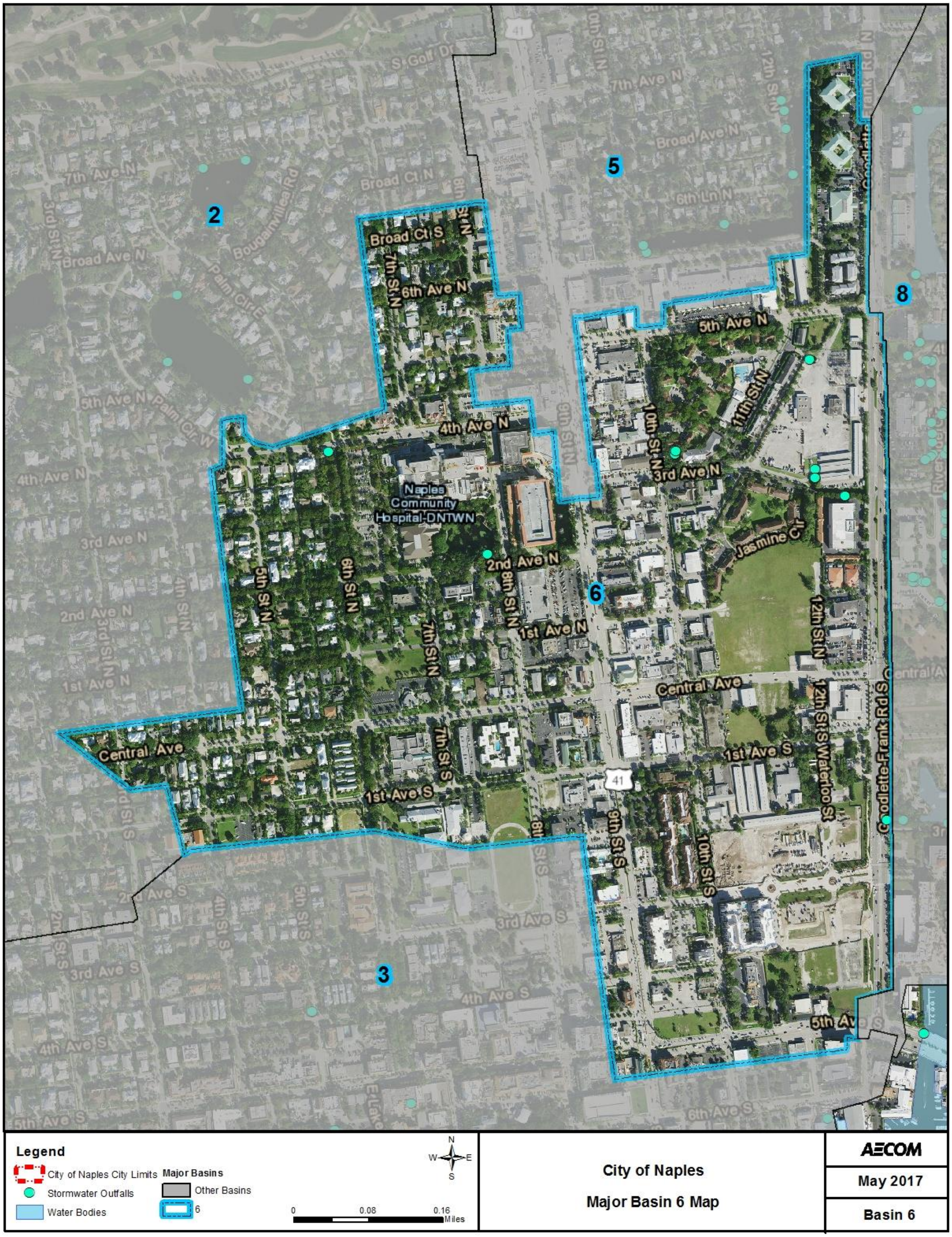
Figure 3-11 Basin 6 Location Map



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3.3.7 Basin 7

Basin 7 is bordered on the west by Naples Bay, US Highway 41 on the north, Naples Bay on the south, and Sandpiper Street on the east. Figure 3-12 shows the basin location. The neighborhood areas that are within this area include Oyster Bay and Royal Harbor. Topography is relatively flat with a high elevation of 7 feet NAVD to elevation 2 feet NAVD. Due to the many canals within the area topography slopes toward the canals. The land use in the basin is predominately single family residential with some multi-family residential dwellings and a small portion of commercial development in the north part of the basin along 5th Avenue South. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Residential (Low Density)
- Residential (Medium Density)
- Waterfront (Mixed Use)

Zoning

- Waterfront Commercial
- Planned Development
- Single Family
- Multifamily

More than 86 percent of the area in Basin 7 consists of the Urban Land-Aquenets complex, organic substratum soil classification which features the somewhat poorly drained drainage classification. Specific soils information for this basin is located in Appendix E.

Stormwater discharges in the basin are routed via a system of swales, inlets, pipes and canals which flow into Naples Bay.

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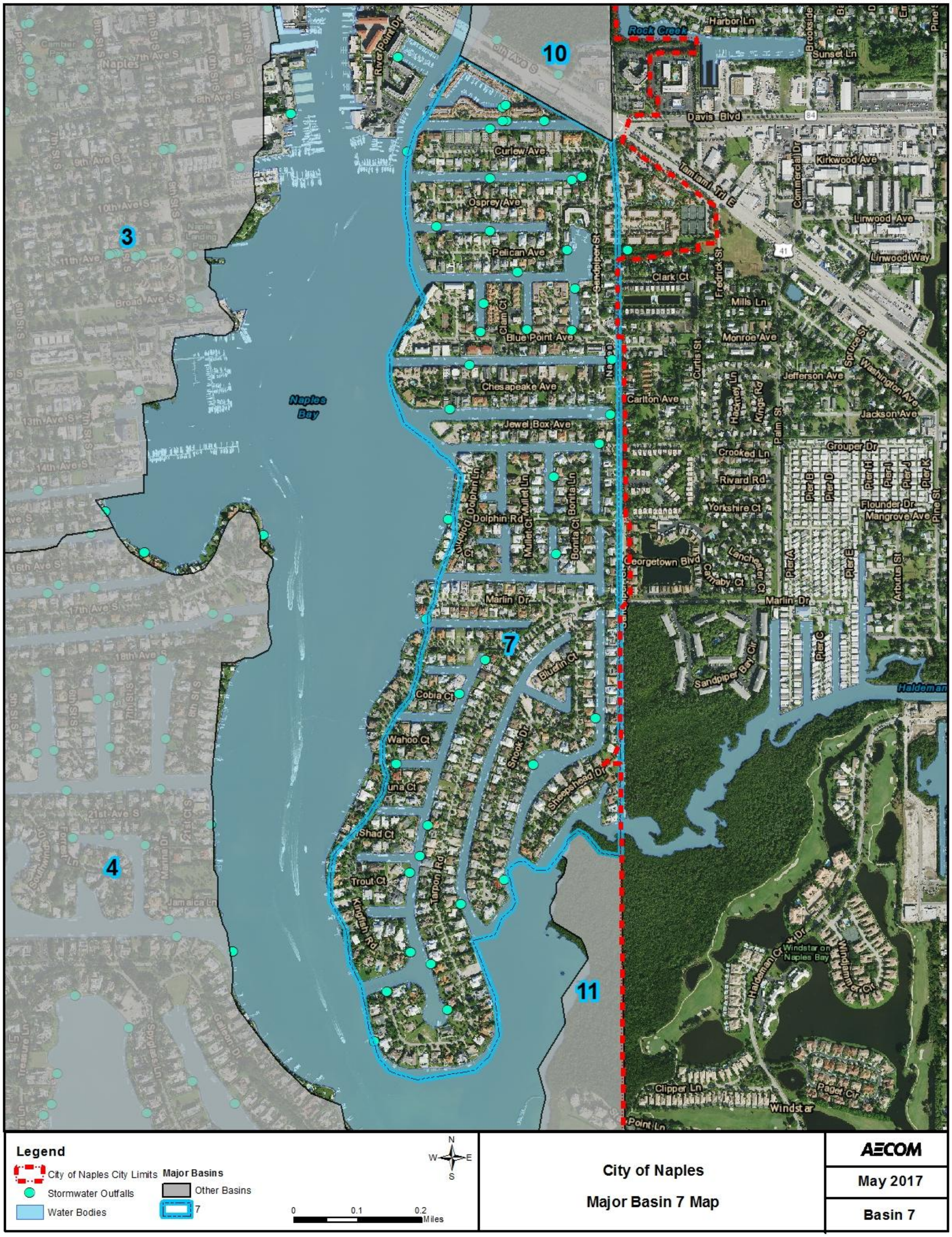
Figure 3-12 Basin 7 Location Map



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3.3.8 Basin 8

Basin 8 is bordered by Goodlette-Frank Road on the west, the Gordon River on the east and south, and an east-west line that would be the westerly extension of the northern boundary of Naples Airport on the north and Basin 5. Figure 3-13 shows the basin location. The neighborhood areas that are within this area include Old Naples and River Park. Topography slopes from Goodlette-Frank Road on the west to the Gordon River on the east with elevations from 6 feet NAVD to 1 feet NAVD. There are some relatively flat areas in the north basin where the topography is 3 feet NAVD from the west to 1 feet NAVD to the east. The land use in the basin consists of 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 (Public Works) Stormwater Pump Station are within the basin. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Conservation
- Downtown Mixed Use
- Institutional (Public, Semi Public)
- Recreation (Public, Semi Public, Private)
- Residential (Low Density)
- Residential (Medium Density)

Zoning

- Conservation
- General Commercial
- Waterfront Commercial
- Highway Commercial
- Planned Development
- Public Service
- Single Family
- Multifamily

The majority of the land in Basin 8 consists of the Urban Land-Aquenets complex, organic substratum soil classification which features soils that are classified as somewhat poorly drained. The remainder of Basin 8 consists of the Urban land-Immokalee-Oldsmar, limestone substratum complex and Urban Land classification with some uninhabited area in the Durbin and Wulfert mucks, frequently flooded classification. Specific soils information for this basin is located in Appendix E.

Storm water discharges in the basin are routed via a system of swales, inlets, and pipes to the Gordon River.

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Figure 3-13 Basin 8 Location Map

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3.3.9 Basin 9

Basin 9 is bordered by Goodlette Road on the west, the Gordon River and Airport Road on the east and Basin 8 on the south. This basin is the City's portion of the Collier County "Gordon River Extension Stormwater Basin" which extends will into the County. Figure 3-14 shows the basin location. The neighborhoods located within this basin are Moorings Park, Royal Poinciana Golf Club, Hole-in-the-Wall Golf Club, Estuary at Grey Oaks, Freedom Park, and the Bear's Paw Country Club. This basin is not being assessed or evaluated in this study, but the information is being provided to illustrate the City's entire limits for stormwater management.

The land use is characterized by residential development, some commercial development along the Goodlette Road corridor and undeveloped land/preserve land. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Commercial (Highway)
- Recreation (Public, Semi Public, Private)
- Residential (High Density High Rise)
- Residential (Low Density)
- Residential (Medium Density)
- Residential (Senior Living)

Zoning

- Highway Commercial
- Planned Development
- Public Service
- Transitional Conservation

The basin's stomwater runoff is routed via swales and overland sheet flow to the Gordon River.

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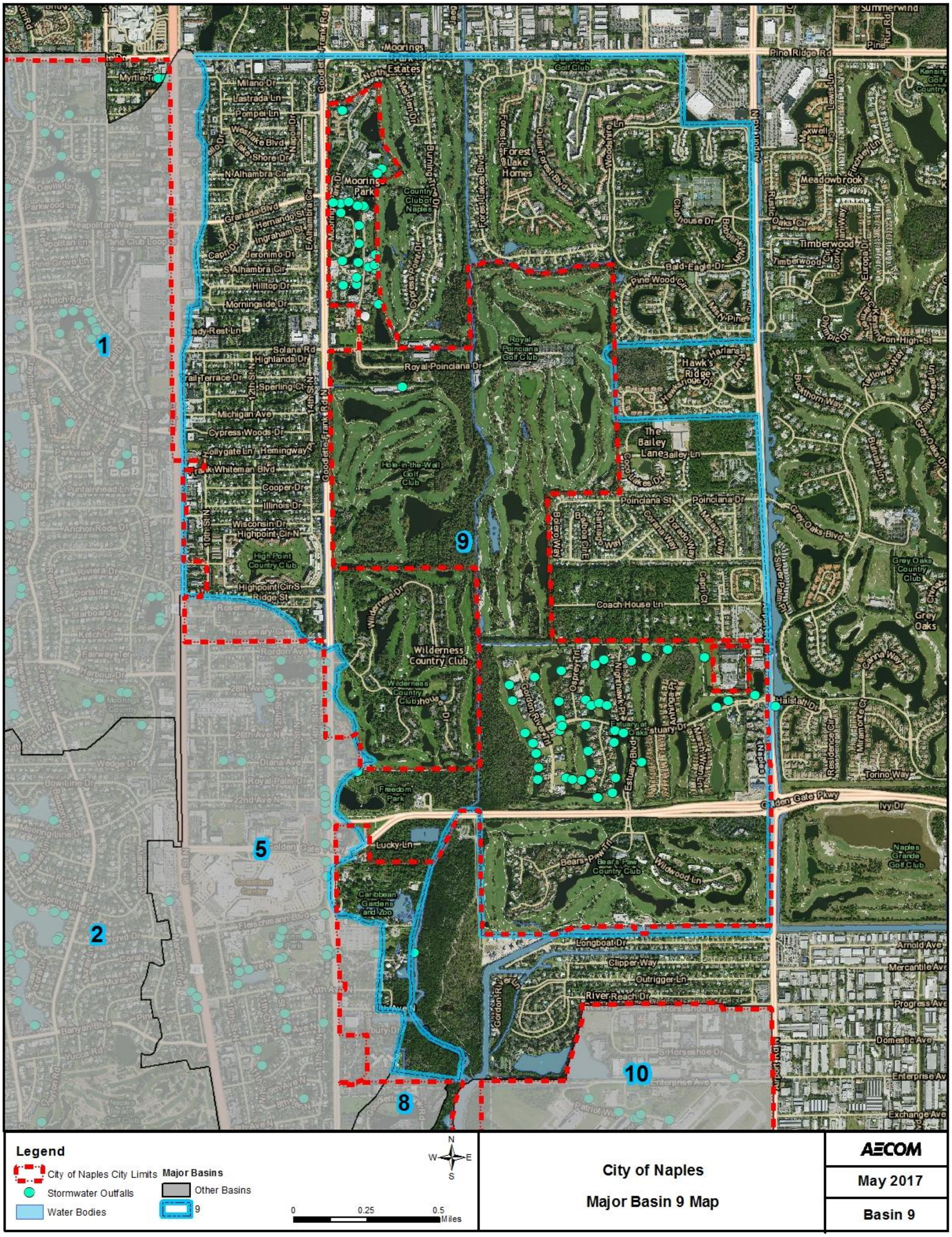
Figure 3-14 Basin 9 Location Map



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3.3.10 Basin 10

Basin 10 is bordered on the west by the Gordon River, the north boundary of Naples Airport on the north, Airport Road on the east, River Reach Drive on the north and North Road on the south. Topography within this basin slopes north to south from elevations 7 feet NAVD to 0 feet NAVD and east to west from elevations 6 feet NAVD to 0 feet NAVD. The Naples Municipal Airport is the majority landowner within this basin. There is also some residential and commercial development within the basin. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Airport
- Commercial (Business Park)
- Commercial (Limited)
- Conservation
- Residential (Low Density)
- Runway

Zoning

- Business Park
- Airport Commercial
- Planned Development
- Single Family

Approximately 44% of the land in the basin consists of Urban Land soils classification followed by the Immokalee find sand and Hallandale find sand classifications which are both classified as poorly drained on the east side of the basin. Specific soils information for this basin is located in Appendix E.

The basin's stormwater runoff is routed via swales, inlets, pipes, and overland street flow to the Gordon River.

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Figure 3-15 Basin 10 Location Map

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3.3.11 Basin 11

Basin 11 is bounded by Naples ay on the west, Basin 7 on the north and the City limits on the east and south. Figure 3-16 show the location map for this basin. This basin is not being assessed or evaluated in this study, but the information is being provided to illustrate the City's entire limits for stormwater management.

This area is mainly undeveloped with the exception of Bayview Park, portion of Windstar on Naples Bay, portion of Southpointe Yacht Club, and portion of Hamilton Harbor. The following lists the future land uses within this basin along with the zoning:

Future Land Use

- Conservation
- Recreation (Public, Semi Public, Private)
- Residential (Low Density)

Zoning

- Planned Development
- Public Service
- Single Family
- Transitional Conservation

The basin's stormwater runoff is routed via overland sheet flow to Naples Bay.

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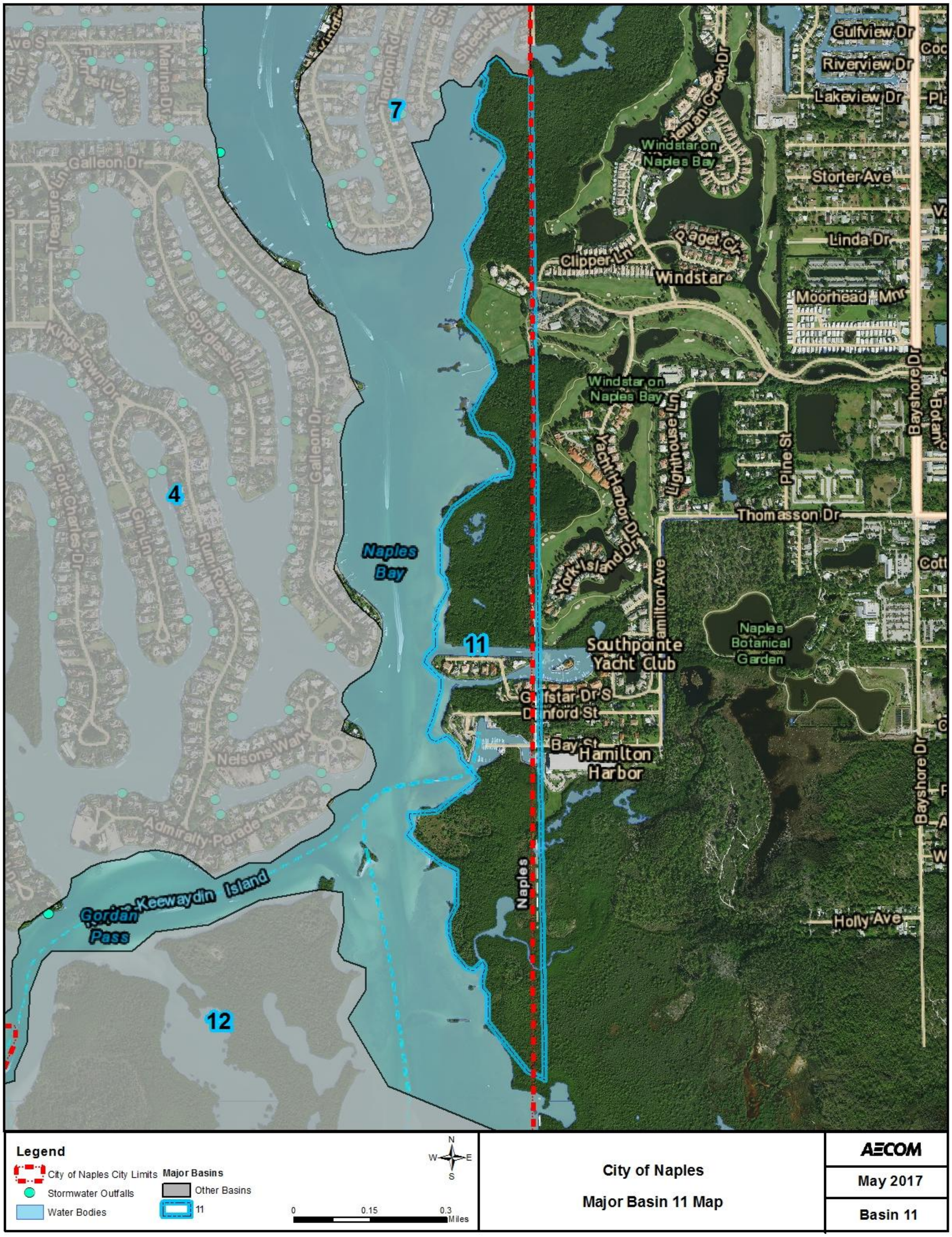
Figure 3-16 Basin 11 Location Map



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3.3.12 Basin 12

The basin is the portion of Key Island within the City limits. Figure 3-17 shows the location map for this basin. This basin is not being assessed or evaluated in this study, but the information is being provided to illustrate the City's entire limits for stormwater management.

The land is mostly undeveloped with some sparse residential development. The following lists the future land uses within this basin along with the zoning:

<u>Future Land Use</u>

- Conservation

<u>Zoning</u>

- Conservation
- Planned Development

The basins stormwater runoff is routed via overland sheet flow to Naples Bay and the Gulf of Mexico.

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Figure 3-17 Basin 12 Location Map

3.4 GIS Data

During the 2007 Stormwater Master Plan, Tetra Tech converted the City's Computer Aided Design (CAD) inventory into a Geographic Information System (GIS). Since this conversion, the City has been building and maintaining its stormwater infrastructure in GIS. The City has taken steps in inserting record drawings of stormwater infrastructure along with other important information into GIS. The GIS stormwater inventory improves the ability of the City to study the infrastructure system in relation to other datasets available in GIS, such as planning data, flood zones, capital improvement projects, water, wastewater, and reuse systems. 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.

The City currently has an operating GIS system and provides City of Naples GIS Maps for the public to access on its website. The following maps are currently provided on the GIS Website:

- FEMA DFIRM Flood Zones
- Wind Speed Risk Categories
- Naples Annexations
- Naples Future Land Use
- Naples Overlay Districts
- Naples Zoning
- Bike Lanes
- Bronze Marker Story Map
- City Trees
- Naples Government Services
- Naples Historic District
- Naples Interactive Map
- Naples Walking Map
- Public Information Center
- Naples Bathymetry
- Naples Bay Substrates
- Oyster Reefs
- Seagrass
- Water Sampling Sites

The City currently does not provide information concerning its stormwater infrastructure on its website. Other municipalities provide some stormwater infrastructure information on their websites. Some have their watersheds and basins defined along with discharge points, some have groundwater elevation information along with water quality sampling information that can be downloaded from their website, and some provide major pipe conveyance locations. Each municipality is different but some information that is publicly available can help in providing a consistent message to the public concerning the information that the City prefer the public to use in developing their public or private systems.

As part of the scope of this master plan, GIS information was provided concerning the stormwater infrastructure that the City operates and maintains, basin delineation (major basins), sub basins, easements, right-of-way, and flood zone maps. GIS information was provided on October 27, 2016. The stormwater infrastructure consisted of the following datasets and based on the information found in the dataset the following descriptions apply:

- Minor Water Bodies – Includes surface-retention, swale, sub surface-rock trench, private lake, underground, WWTP retention area, lake, and ditch
- Gravity Mains – Includes size, type, invert and slope of pipes
- Inlets – Includes catchbasin, curb inlet, rear yard drain, open throat, roof, and recessed grate
- Junctions – No clear information is provided on this defined attribute
- Manholes – Includes material types, invert elevation, pipe invert elevation, and rim elevation
- Outfalls – Includes discharge types of standard outlet and outfall along with diameter and type
- Weirs – Includes weir type, weir shape, and orfice
- Raw Stormwater Data - unclear whether this is a temporary location for data until it has been verified
    - Storm Clean Outs – Includes size and type
    - Storm Culverts – Includes diameter, material, and invert elevations
    - Storm Discharge Points – Includes discharge type of standard outlet and outfall along with diameter
    - Storm Network Structures – pump station identification

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- o Storm Open Drains – on the GIS map, this appears to be swales and the dataset includes length of swale with the ability of documenting side slopes, depths, and widths
- o Storm System Valves – includes the type of valve and size
- o Storm Vitural Drainlines – appears to consist of driveway culverts and low areas where drainage could collect and includes length
- o Stormwater Pressure Mains – includes diameter, material, and length
- o Stormwater Network Junctions - No clear information is provided on this defined attribute
- o Stormwater Gravity Main – includes diameter, shape, type, inverts, slopes, and length
- o Stormwater Repairs – includes size and water type
- o Trench Drains – includes invert, size, type, and length

These datasets have been converted into excel spreadsheets to further investigate the data collected and documented in the GIS system. The City has been updating its data and has been documenting infrastructure as it has been installed and referring to as-built information within the dataset. There are several gaps of information and areas where data is incomplete. There is some duplication between the main attributes and the category "Raw Stormwater Data". In addition, the data needed for each attribute needs to be evaluated to determine the best information needed for the attribute.

Although the City has documented the main drainage basins as described in this study, there are also sub basins within the GIS system. These sub basins should correspond with smaller areas that correspond to a network which eventually discharges into a main outfall to a receiving water body. These sub basins do not appear to follow the area in which they collect and then discharge. The importance in defining these sub basins is to give the City information to evaluate whether the discharge piping has the capacity to discharge the amount of area contributing to the outfall and allows the City to determine if there are water quality deficiencies in the area.

City staff has indicated that the City has purchased equipment to document some of the stormwater infrastructure. This equipment will be useful to staff when troubleshooting a stormwater issue, but it would take staff a lot of time to document and fill in the gaps of the GIS system.

It is recommended that the stormwater infrastructure be reconciled into an understandable data set. For example, swales appear to be identified as "open drains" perhaps they can be identified as swales. Also, "minor water bodies" can be identified as the identified water body to better document the assets instead of having to review the entire data set to find the information. In addition, the attribute information should be reviewed to insure that they proper data is being collected for each attribute. After reconciling the items and determining the information that is needed for each attribute, then the City should continue its efforts of including as-built information of both private and public infrastructure projects as well as public repairs and capital improvement plan (CIP) projects.

Another recommendation would be to contract a surveyor with global positioning system (GPS) equipment to obtain information on existing infrastructure that is missing. This would provide staff time to work on the operation and maintenance of the system instead on documenting the system. The use of GPS equipment is cheaper than the conventional surveying equipment and takes less time than surveying.

By updating the GIS system, the City will save money and time from staff to determine where problems occur in the drainage system, document the stormwater infrastructure to determine the cost to maintain the system, and assist the City in determining recover and restoration costs of an aging system to better plan operation and maintenance costs and future capital costs.

TAB 4

Water Quantity

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4. Water Quantity

Water quantity is identified as the amount of stormwater runoff produced by a rainfall event. Water quantity impacts the community significantly when the capacity of the existing stormwater infrastructure is exceeded causing public flooding. Water quantity issues are often studied with the aid of hydraulic and hydrologic modeling, a thorough review of area topography, and complaint information. For this stormwater master plan update, studies that have been performed after 2007, along with a review of the FEMA maps, topographic information, and a mapping of the complaints will be utilized for the assessments of the basins. This section will, also, include a presentation of existing FEMA flood zones, types of flooding applicable to the CITY, and assessments of each basin including recommendations for potential Capital Improvements Projects.

4.1 General Information

To the public, when water quantity is not managed, flooding occurs. Flooding occurs when the stormwater management system does not have enough capacity to convey the stormwater quickly enough nor store the stormwater in stormwater designated areas (ponds, lakes, or swales) for certain storm events. Not all flooding can be prevented. Municipalities have design their stormwater management facilities to handle the more frequent storm events. Not every storm event is designed for. To help the public understand whether an area is impacted by larger storm events, they can examine floodplain maps. Floodplain maps show whether flooding occurs at storm events above the 100 year event. These maps do not show events that occur at a regular basis. Typically, structures such as buildings are designed to with stand a 100 year event. This section provides information on FEMA floodplain mapping along with the types of flooding the City could be experiencing.

4.1.1 FEMA Floodplain Mapping

The latest Federal Insurance Relief Maps (FIRM) by the Federal Emergency Management Agency (FEMA) that covers the City are shown below:

- 12021C0379H - May 16, 2012
- 12021C0383H - May 16, 2012
- 12021C0384H - May 16, 2012
- 12021C0387H - May 16, 2012
- 12021C0391H - May 16, 2012
- 12021C0392H - May 16, 2012
- 12021C0393H - May 16, 2012
- 12021C0394H - May 16, 2012
- 12021C0581H - May 16, 2012
- 12021C0583H - May 16, 2012

Panels covering the City were revised in the conjunction with the latest Flood Insurance Study for Collier County, published on May 16, 2012. As shown on the above referenced FIRM panels the majority of the City is within flood zones indicating a flooding risk of varying severities. Figure 4-1 shows that the majority of the City lies within Zone AE with some of the north and northeast portions of the City being in Zone VE indicating a risk of shallow flooding. The eastern portion of the City along the Gulf Beaches primarily consists of coastal floodplain VE indicating a significant flooding risk due to the potential storm surge potential. The floodplain zoning is described in the following sections and Appendix G contains FEMA maps of all the basins. These descriptions are described in generalizations for an overall understanding of floodplain management, not for a specific analysis of any given area. It should be noted that the potential depth of “floodplain” flooding relative to an area, and/or the band of base flood elevations provided on the FIRM panel, that there comparisons are based on the following:

- Relative differences in natural ground elevations and flood elevations. Thus, if a building structure of a lot has been raised above historic grade, it is protected by as much fill as was imported to raise the structure above the floodplain.
- The assumptions are based on broad topographic interpretations, not site specific data.
- The floodplain elevations are based on FEMA approved modeling of a theoretical 100-year design storm event, not an actual event that occurred.

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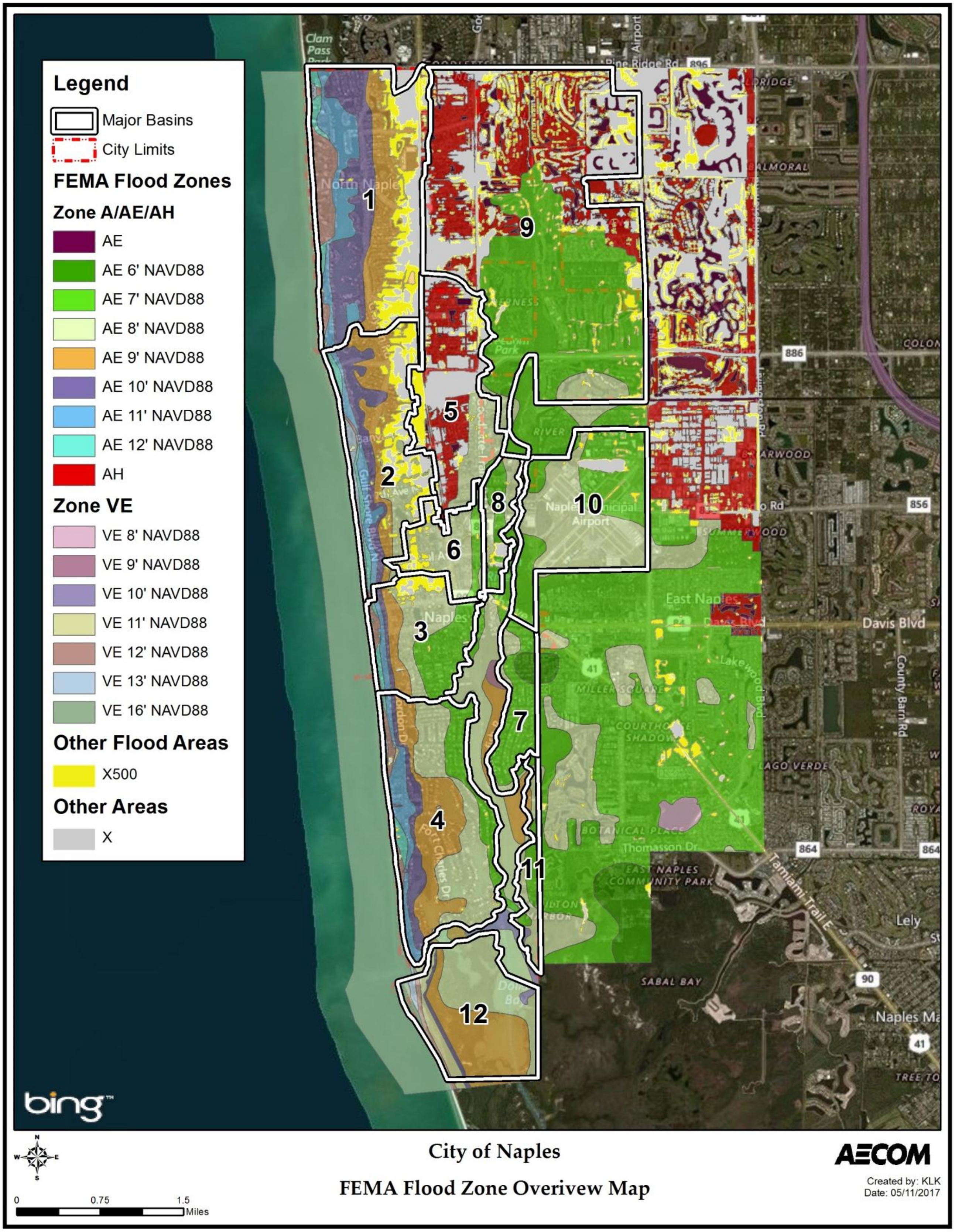
Figure 4-1 Overall FEMA Map



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4.1.1.1 Coastal Floodplains (VE)

A significant floodplain zone covering the western coast 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. Zone VE corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. 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 NAVD just off the coastline and thirteen (13) feet NAVD along the western edge of Naples on the coast. 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 NAVD. 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 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 eight (8) feet deep and as high as 11 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 13 down to 11 (two feet drop) and is completely west of Gulf Shore Blvd with an exception in Basin 4 where it is west of Gordon Drive. Since most of the City in these areas are at elevations 3 to 9 feet NAVD with some elevations from 10 to 11 feet NAVD, one would expect that the depth of flooding (over natural ground) to continue to be as deep as 4 to 10 feet within this band.

To help better understand these relationships between the V Zone and the A Zone, Figure shows a transect schematic.

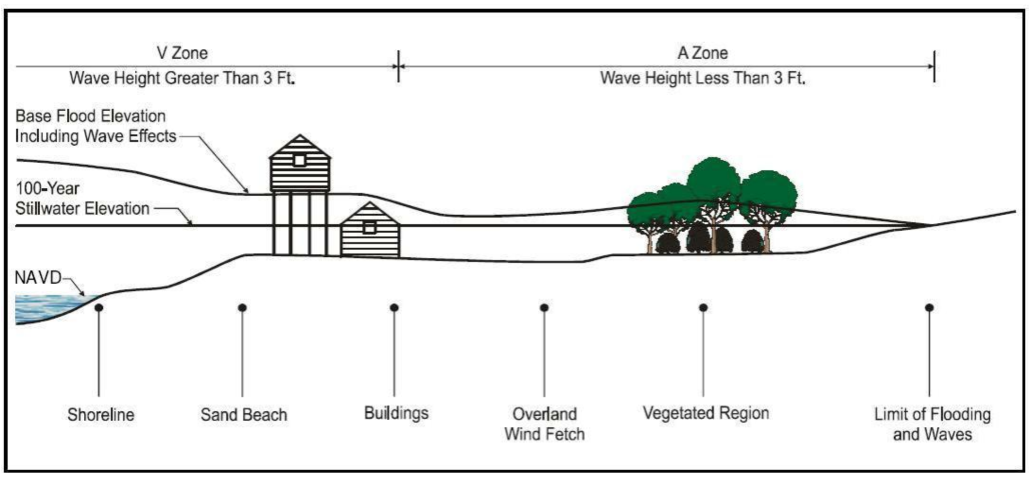

Figure 4-2 Transect Schematic

4.1.1.2 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.

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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 feet NAVD 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-7 which is found just east of, and adjacent to the airport. There is a pocket of AE-6 within Basin 7, which appears to be contained in a low area of the City.

It is interesting to note that the AE bands (AE-12 and AE-11) are found adjacent to the VE-12 and VE-13 bands 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 AE10 and 11 Zones. As a result the band is much wider in this area (Basin 1) than south in Basins 2, 3, and 4. 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 three bands (AE-9, AE-8, and AE-7) are very wide and encompass much of the western City limits east of 2nd and 3rd Street South. This flood zone encumbers much of Basins 1, 2, 3 and 4, and 6. 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 feet NAVD down to 7 feet NAVD. The bulk of Naples Bay contains the AE-9 and AE-8 base flood elevation. Basins 7, 8, and 9 contain primarily the AE-8 and AE-7 base flood elevations. The airport is the majority of Basin 10, and is almost entirely comprised of the AE-7, thus being subjected to the lowest base flood elevations in the City.

There are only two drainage basins in the City that fare better than the airport area in terms of their base flood elevations; Basins 5 and 9. 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.

4.1.1.3 (Zone AH)

Zone AH is the flood insurance rate zone used for areas of 1-percent-annual-chance shallow flooding from rainfall with a constant water-surface elevation (usually areas of ponding) where average depths are less than 3 feet. BFEs derived from detailed hydraulic analyses are shown at selected intervals within this zone. Basins 5 and 9 contain the most of this zone.

4.1.1.4 Other Flood Area 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 an 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 less than one foot of average depth. Thus, the residents in these areas are still subject to potential flooding in these areas. Homes that

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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 Basins 1, 5, and 9, but are also found in Basins 2, 3, 6, 8, and 10.

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 some sections of land that are designated outside of the floodplains in the City of Naples. These sections are in Basin 1, 2, 5, and 9, 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 18. 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).

4.1.2 Types of Flooding

It is important to understand the different types of conditions that cause flooding 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. In this section, a description of the technical categories of flooding is given.

4.1.2.1 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 (drivinghead) 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 approximately 2 feet. On an annual basis, Naples Bay will reach a high tide elevation of approximately 3.2 feet. 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.

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Another extreme variation of this type of flooding is tropical storm surge flooding. 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 capital improvement 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.

4.1.2.2 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 5-year/1-hour return frequency storm event and the system receives a 25-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 a retrofit drainage projects occurs over time that 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 level of service (LOS) performance expectation.

4.1.2.3 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 convey 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.

4.1.2.4 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.

4.1.2.5 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 modeling techniques for inlet design are very site specific and involve site specific data where as comprehensive drainage studies are much broader.

The funding category of this problem type can be either capital, R&R, or operation and maintenance (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.

4.1.2.6 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.

4.1.2.7 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. Modem development regulations and proper geotechnical practices however, should guard today's development activities from additional groundwater flooding problems.

4.2 Basin Assessments

During the 2007 Stormwater Master Plan update, three (3) out of the twelve (12) basins were evaluated, Basins 3, 5, and 6. According to the 2007 Plan, these basins were the only basins that had detailed modeling results of drainage basin studies that were performed up to 2007. Since the 2007 Stormwater Master Plan evaluated prior studies and documents before 2007, the stormwater master plan update concentrates on documents after 2007. The assumption is that the capital improvement projects that were developed for the 2007 master plan were developed to address any LOS deficiencies. A summary of the projects, which have been implemented since 2007, is addressed in the Capital Improvement section of this report.

For this master plan, basin assessments are conducted by reviewing basin studies that occurred after 2007, FEMA maps of each basin, topographic information of each basin, and complaint data compiled by the City from 2015 to 2016. Each basin assessment contains information on the basin, FEMA maps

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(Appendix G) and a complaint map. Appendix H contains the complaint maps of each of the basins with the most recent 2007 LIDAR topographic information for each basin.

4.2.1 Basin 1 Assessment

Basin 1 consists of approximately 1,500 acres of land and is the northern most stormwater basin in the City of Naples. Rectangular in shape, it is approximately 6,000 feet long by 13,500 feet wide. The basin has not been subject of any previous hydraulic or hydrologic modeling studies and was not assessed in previous master planning efforts. The only study that has been conducted in this basin is the “City of Naples Outfall System Coastal Impact Assessment & Management” report by Humiston & Moore Engineers (Appendix A). The purpose of this report was to address stormwater outfalls to the Gulf of Mexico and concentrated on beach nourishment.

The conveyance elements in the basin consist of a system of swales, inlets, pipes, outfalls, detention ponds and bays. The basin, which is bordered on the west by the Gulf of Mexico, features several interconnected bays including Venetian Bay, Inner Doctors Bay and Moorings Bay that lie between Gulf Shore Boulevard North on the west and Crayton Road on the east. The bays open to the Gulf of Mexico at Doctors Pass at the southernmost tip of the basin. The stormwater in the basin is routed directly to the these bays through a number of small diameter pipes or it is routed to one of several wet weather detention ponds then directed to the bays with the use of weirs and larger 42” to 60” diameter pipes. Several outfalls in the northern portion of the basin discharge to Outer Calm Bay directly north of the City limits.

A review of the Basin 1 FEMA Map, Figure 4-3, indicates that the majority of the area along the Gulf of Mexico in the linear stretch surrounding Gulf Shore Boulevard North lies within the VE flood zone indicating a significant flood risk due to storm surge. The majority of this area is associated with flood zone VE 12’ indicating a potential storm surge elevation approximately 12 feet NAVD. This represents a significant flooding hazard in Basin 1 area east of interconnected system of bays due to ground surface elevations in the general range of 3 to 4 feet NAVD. Although, storm surge conditions are not a part of this assessment the relatively low topography in this area is of particular concern and must be evaluated to ensure that the current drainage features are adequate. The basin features bands of flood zone AE that decrease in severity from AE 11 to AE 9 as you travel westerly across the basin. Small portions of flood zone AH along the western portion of the basin represent a chance of shallow flooding with large pockets of flood zone X, indicating a 1 foot depth of flooding during the 100 year storm, in portions of the basin located along the western edge.

The assessment of Basin 1 was primarily based on complaint information provided by the City. This information was evaluated with the aid of topographic information, FEMA flood zone maps relevant drainage features as indicated on the City’s GIS database and visual assessments. Basin 1 complaints from 2015 to 2016 consisted of a total of 19 complaints including 14 drainage complaints, 3 standing water complaints, 3 dropped vertical grade complaints and 1 swale complaint. Some locations had more than one complaint. The complaint locations for Basin 1 are shown below on Figure 4-4 and a list of the complaints along with their location and potential cause is located in Table 4-1.

For the most part, the complaints corresponded with inlet locations, no swales, low roadway elevations, small gutter inlets, and small pipe sizes. After review with the City, capital improvements were developed for this basin and are listed in the Capital Improvement section of this report.

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Figure 4-3 Basin 1 FEMA Map

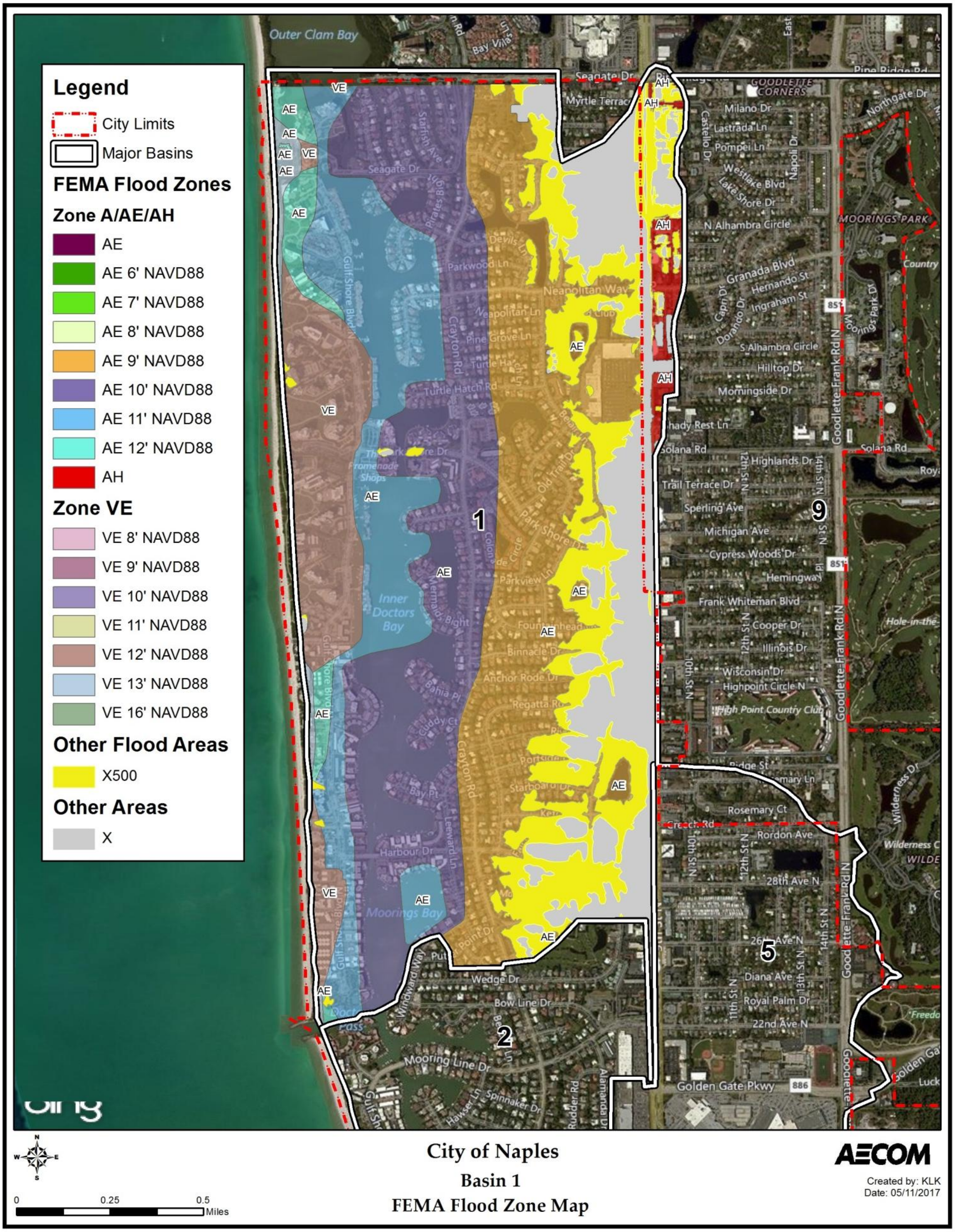

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Table 4-1 Basin 1 Complaint List

ID	Location	Type	Potential Cause
1	Gulf Shore Boulevard North, south of Harbor Drive	Drainage	Low area, small inlets - 2 on east plus low on west side
2	Gulf Shore Boulevard North near Harbor Drive	Drainage	Low Area; no swales, 0.2 miles to nearest inlet; small inlets
3	Gulf Shore Boulevard North, north of Harbor Drive	Drainage	Low area, no swales, small inlet in driveway; nearest inlet approximately 500 feet to the north and 250 feet to the South
4	Bay Point	Drainage, Standing Water	No inlet or piping, no swales and property drains toward street
5	Fountainhead Lane near Fountainhead Way	Drainage, Dropped VG	Low area, no swales, cannot locate inlet on street view
6	707 Fountainhead Lane	Drainage	No swales, only one small inlet. Some pipe sizes missing
7	690 Harbor Drive (near Rivera Drive)	Drainage	No swales, inlet on N side of road or elevated in yard
8	985 Wedge Drive (near Harbor Drive)	Drainage	No swales, valley gutter; missing pipe sizes
9	Park Shore Drive near Old Trail Drive	Drainage	No swales, low area
10	4150 Blair Lane	Standing Water	Road is low, no swales - valley gutters
11	4131 Blair Lane	Dropped VG	Road is low, no swales
12	Southern Pines Drive (on map not long, high pines drive is on the log but not in the city limits)	Drainage	No pipes or inlets in area, no swales
13	W Boulevard Court	Drainage	No Swales , no pipes/inlets in the area
14	Gulf Shore Drive North	Drainage	No inlets in immediate area; inlet to the south is small, inlet to the NE is elevated
15	4751 Gulf Shore Drive North	Drainage	No Swales - curbs with piped drainage
16	Neapolitan Way near Neapolitan Lane	Standing Water	No Swales, valley gutter; large circular driveways; no nearby inlets
17	Riviera Drive near Binnacle Drive	Swale	Very small valley gutter inlets
18	Binnacle Drive near Anchor Road Drive	Dropped VG	Very small valley gutter inlets
19	2571 Leeward Lane	Drainage	Extremely small inlets, pipe size unknown on N and 12" on south.

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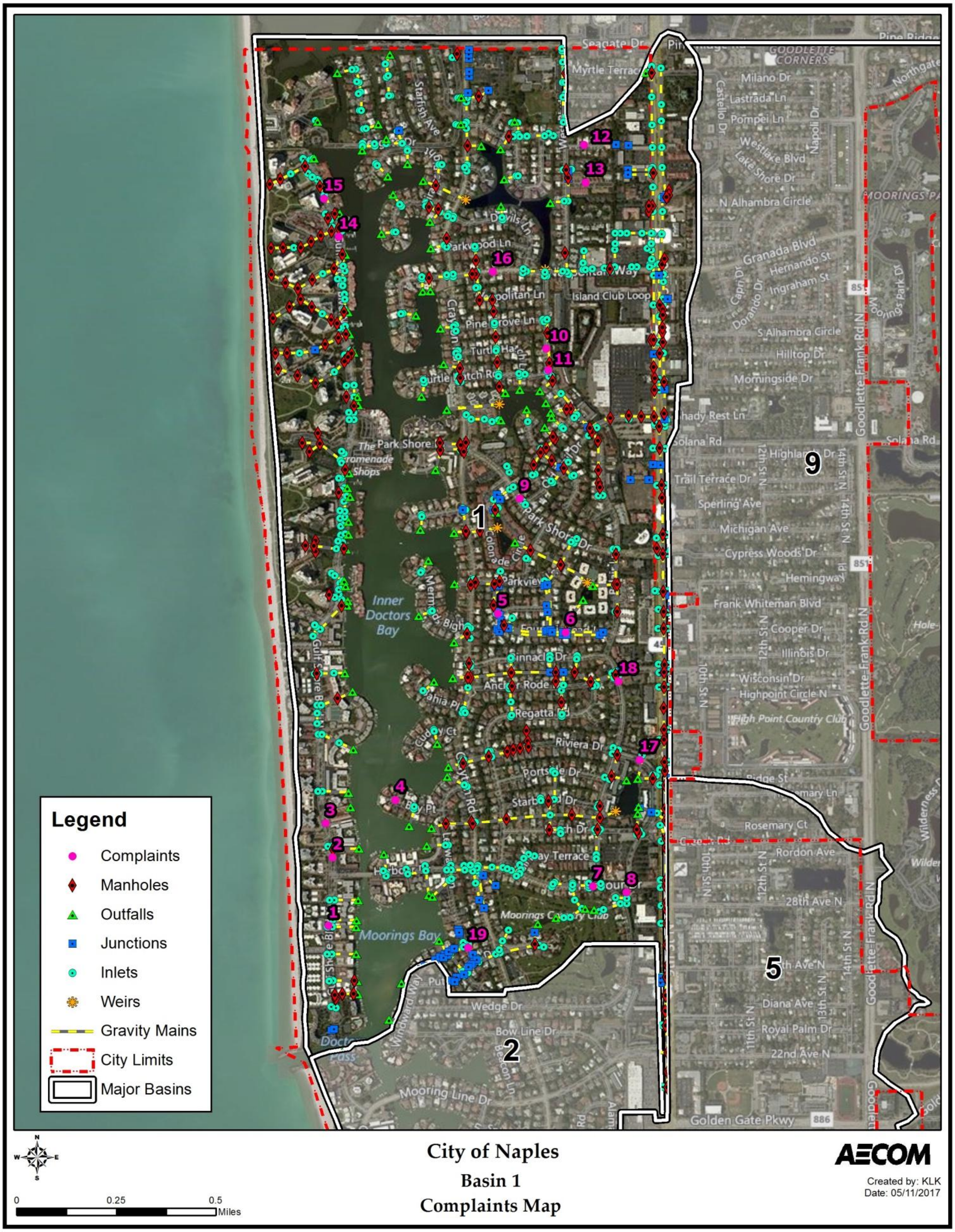
Figure 4-4 Basin 1 Complaint Map



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4.2.2 Basin 2 Assessment

Basin 2 consists of approximately 900 acres of land and is 12,000 feet long and at its widest point is 4,500 feet wide. Stormwater in the basin is primarily conveyed via swales, inlets and pipes to Moorings Bay or Hurricane Harbor in the Northern portion of the basin and to detention ponds then subsequently to the Gulf of Mexico via beach outlets in the southern portion of the basin. Moorings Bay and Hurricane Harbor in the northern portion of the basin opens to the Gulf of Mexico at Doctor's Pass.

The City has completed several studies primarily focusing on the stormwater beach outfalls in the basin. These studies include:

- Final Technical Memorandum on Beach Stormwater Outfalls Hydrologic and Hydraulic Modeling for Existing Conditions by AECOM in November 2012
- Final Technical Memorandum on Beach Stormwater Outfall Alternatives Preliminary Assessment by AECOM in April 2013
- Conceptual Stormwater Management Analysis, Naples Beach Outfalls by Gulfshore Engineering, Inc. in November 2009
- City of Naples Outfall System Coastal Impact Assessment & Management" report by Humiston & Moore Engineers in February 2010

There are 10 beach outfalls discharging to the Gulf of Mexico including one privately owned and operated outfall. In 2005, the Florida Department of Environmental Protection (FDEP), as a part of a Joint Coastal Permit for the Collier County Beach Nourishment project, required a management plan aimed at eliminating the beach stormwater outfalls. FDEP was primarily concerned with beach erosion, turtle nesting habitat, interference with lateral beach access, and water quality degradation.

A study titled "Conceptual Stormwater Management Analysis" (February 2010) (Gulfshore Engineering, Inc., 2009) evaluated the feasibility of eliminating the system of beach outfalls that provided most of the stormwater drainage for the basin. The analysis determined that outright removal would not be practical but the system of outfalls may be reduced in quantity. Further investigation into coastal impacts on beach erosion, water quality and turtle nesting habit and lateral beach access by Huminston & Moore Engineers (February 2010) found that that no significant or documented impacts were found.

In 2012, AECOM performed a hydraulic and hydrologic modeling study on the beach outfalls within the southern portion of Basin 2, modeling the 9 public outfalls in the basin which covered a total surface area of 395 acres. At the time of the basin study, frequent flooding occurred in low lying areas close to the beach. This report is the only report that contain water quantity information that reflected the results of a 5-year, 1-hour storm event. Unfortunately, the storm event was for a 1.7 inch rainfall event and for this area a 5-year, 1-hour storm event is 2.8 inches. Based on the 1.7 inches, there were exceedances on the minimum roadway elevation for Gulf Shore Blvd and Palm Circle W.

In addition, an assessment performed by AECOM the following year was aimed at evaluating the concerns of FDEP and look at potentially eliminating or reducing beach outfalls. At the present time, the beach outfalls are currently in place and no projects to remove or reduce them have taken been initiated.

A review of the Basin 2 FEMA Map, Figure 4-6, shows the majority of the area along the Gulf of Mexico in the linear stretch surrounding Gulf Shore Boulevard North along the western portion of the basin consists of bands of the VE flood zone ranging from VE 13 to VE 12, indicating a significant flood risk due to storm surge. Similar to Basin 1, the area in the VE flood zone along Gulf Shores Boulevard North features very low topography with many portions of the roadway only 3-4 feet above sea level. The western portions of the basin predominately consist of bands of the AE flood zone ranging in severity from AE 11 to AE 8. The basin also consists of smaller area of the AH and X flood zones that pose a lower risk of flooding with X being the best possible flood zone classification.

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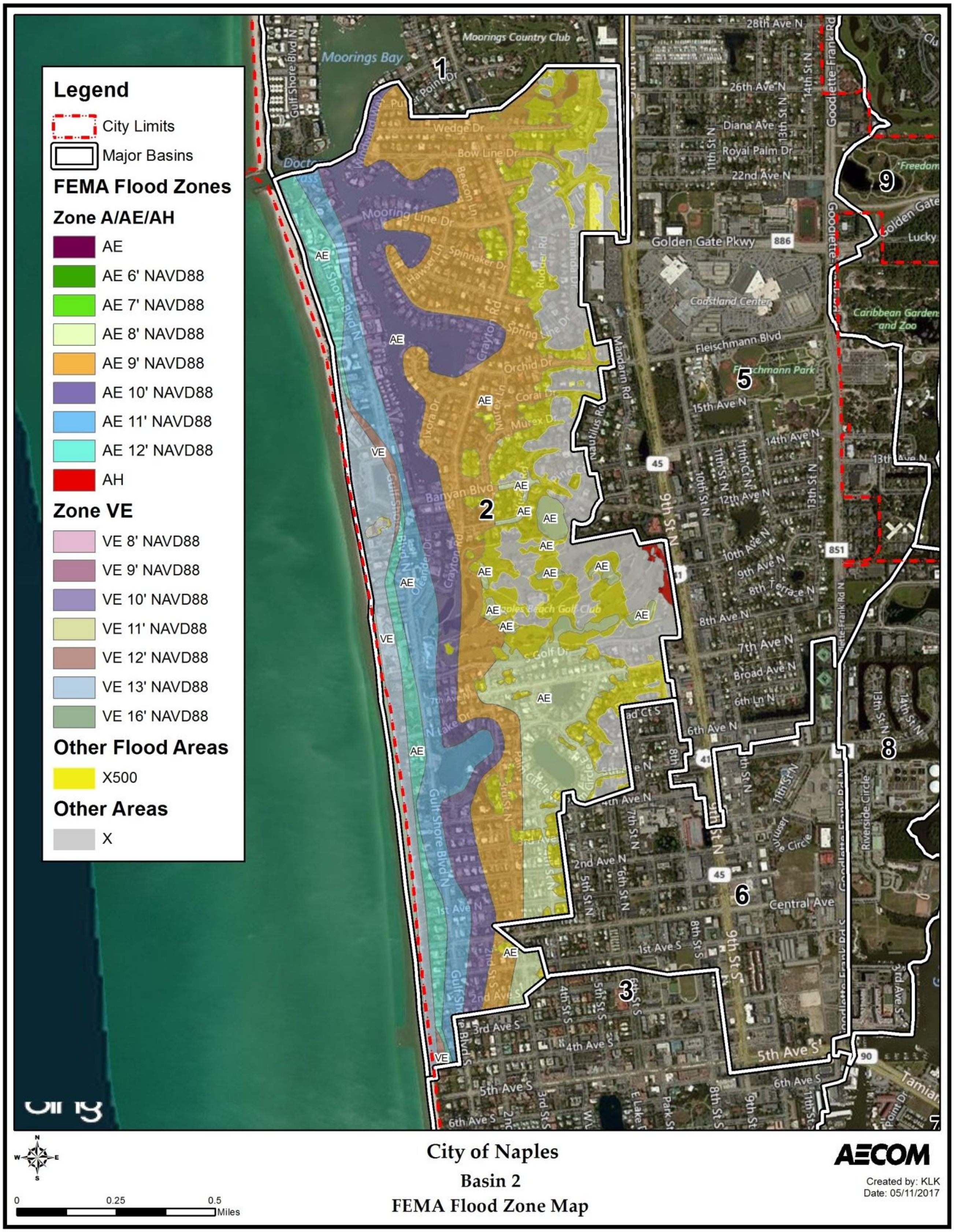
Figure 4-5 Basin 2 FEMA Map



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The assessment of Basin 2 was based on complaint information provided by the City, which was evaluated with the use of topographic information, FEMA flood plain classification, and a review of relevant drainage features as indicated on the City's GIS database. Basin 2 complaints from 2015 to 2016 consisted of a total of 15 complaints including 8 drainage complaints, 3 standing water complaints, 1 dropped vertical grade complaint, and 4 swale complaints. Some of the complaint locations had multiple comments. The complaint locations for Basin 2 are shown in Figure 4-7 and Table 4-2 lists the complaint location, the type and the potential cause.

Table 4-2 Basin 2 Complaint List

ID	Location	Type	Potential Cause
1	292 1st Avenue S near 3rd Street S	Drainage, Standing Water	Swales in some yards, Small pipe sizes, small inlet
2	1st Avenue S near 2nd Street S	Drainage	Pipe size seems small
3	Central Avenue near Gulf Shores Boulevard	Drainage	Pipe size may small, low area, no swales so hard to access, 3 inlets at the intersection.
4	1st Avenue N near Gulf Shore Boulevard	Drainage	Pipe size may be too small, low area
5	2nd Avenue N near Gulf Shores Boulevard N	Standing Water	Pipe size may be too small, Low area
6	2nd Avenue N near 3rd Street N	Drainage	Small Inlets, small pipe size (12"), low area
7	Crayton Boulevard near Ixora Drive	Drainage	Low area, small inlets, small pipe size (12")
8	Banyan Boulevard	Dropped VG	Low area, small pipe size 12"
9	Bow Line Drive	Swale	Low area
10	Wedge Drive	Drainage	Low area
11	Wedge Drive	Swale	Low area, inlets seem adequately sized
12	Wedge Drive	Swale	Low area, inlets seem adequately sized
13	Wedge Drive	Swale	Missing pipe size,small inlets, pipe discharges directly to weir
14	3rd Avenue North near Gulf Shore Boulevard North	Standing Water	12-15 inch pipe size, slightly graded swales, small inlets
15	2225 Beacon Lane	Drainage	Pipe sizes missing or 12", no inlets in direct vicinity.

For the most part, the complaints corresponded with low areas, no swales, small pipe sizes, and missing pipe information. After review with the City, capital improvements were developed for this basin and are listed in the Capital Improvement section of this report.

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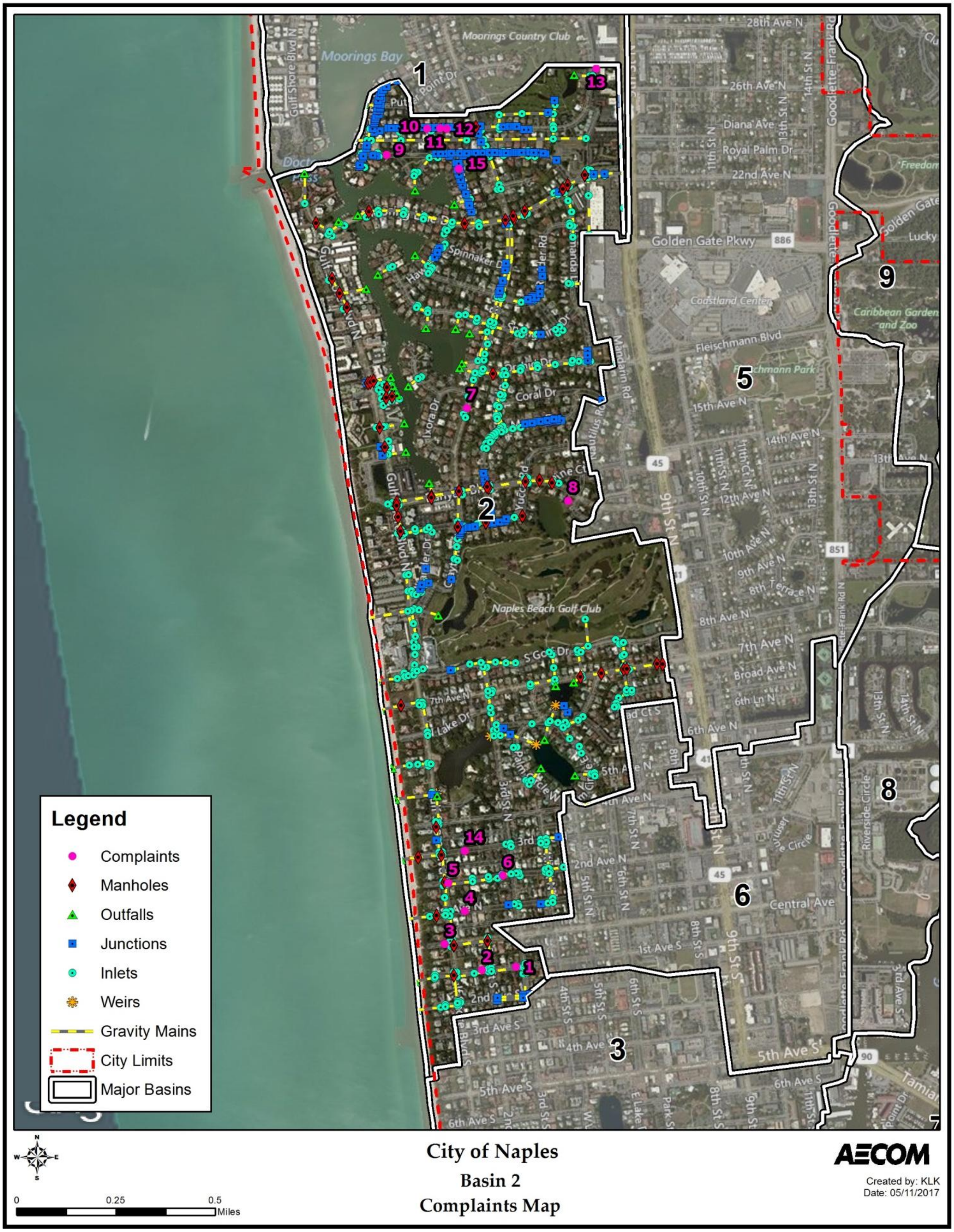
Figure 4-6 Basin 2 Complaint Map



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4.2.3 Basin 3 Assessment

Basin 3 consists of approximately 500 acres of land and is 6,200 feet long and at its widest point is 5,500 feet wide. Stormwater runoff in the basin is routed by swales, inlets, pipes, and detention lakes (East Lake and Spring Lake), and then subsequently routed to the Cove Stormwater Pumping Station on Broad Avenue South and 9th Street South for discharge into Naples Bay.

The City has completed several studies prior to 2007. Camp Dresser and McKee (CDM) was retained in 2001 to perform hydrologic and hydraulic modeling of Basin 3 and evaluated stormwater management system improvements. Several alternatives were developed by CDM concentrating on cost, water quality, and flood control benefits and permitting criteria. The report, “Interim Basin III Design Development Final Report” was finalized February 2001. Alternative 3 consisted of pumping and piping improvements in the basin that would maintain flood waters at a minimum of 2-inches below the road crown under the 2-year/24-hour design storm. This option did not identify any pumping capacity changes thus simplifying the permitting process. The estimated cost for this alternative was identified as 6.73 million in 2001.

The City commenced with basin improvements identified in Alternative 3. A subsequent study by CDM in 2007 titled “Feasibility Study for Basin III Stormwater Management System Improvements and Broad Avenue Linear Park” updated the previously developed hydraulic model for Basin 3 based on updated information and identified water quality treatment facilities in the southern portion of the basin.

Since the initial studies, the Cove Road Pump Station was completed in 2010 and currently, there is a project under design to address erosion concerns at the pump outfall. There have been no additional studies since 2007 for this basin.

A review of the Basin 3 FEMA Map, Figure 4-8, shows the majority of the area along the Gulf of Mexico in the linear stretch surrounding Gulf Shore Boulevard North along the western portion of the basin consists of bands of the VE flood zone ranging from VE 13 to VE 12, indicating a significant flood risk due to storm surge. Similar to Basin 1 and 2, the area in the VE flood zone along Gulf Shores Boulevard North features very low topography with many portions of the roadway only 3 to 4 feet NAVD. The rest of the basin from west to east consists of bands of the AE flood zone ranging in severity from AE 12 to AE 7. There is one small area in Zone X.

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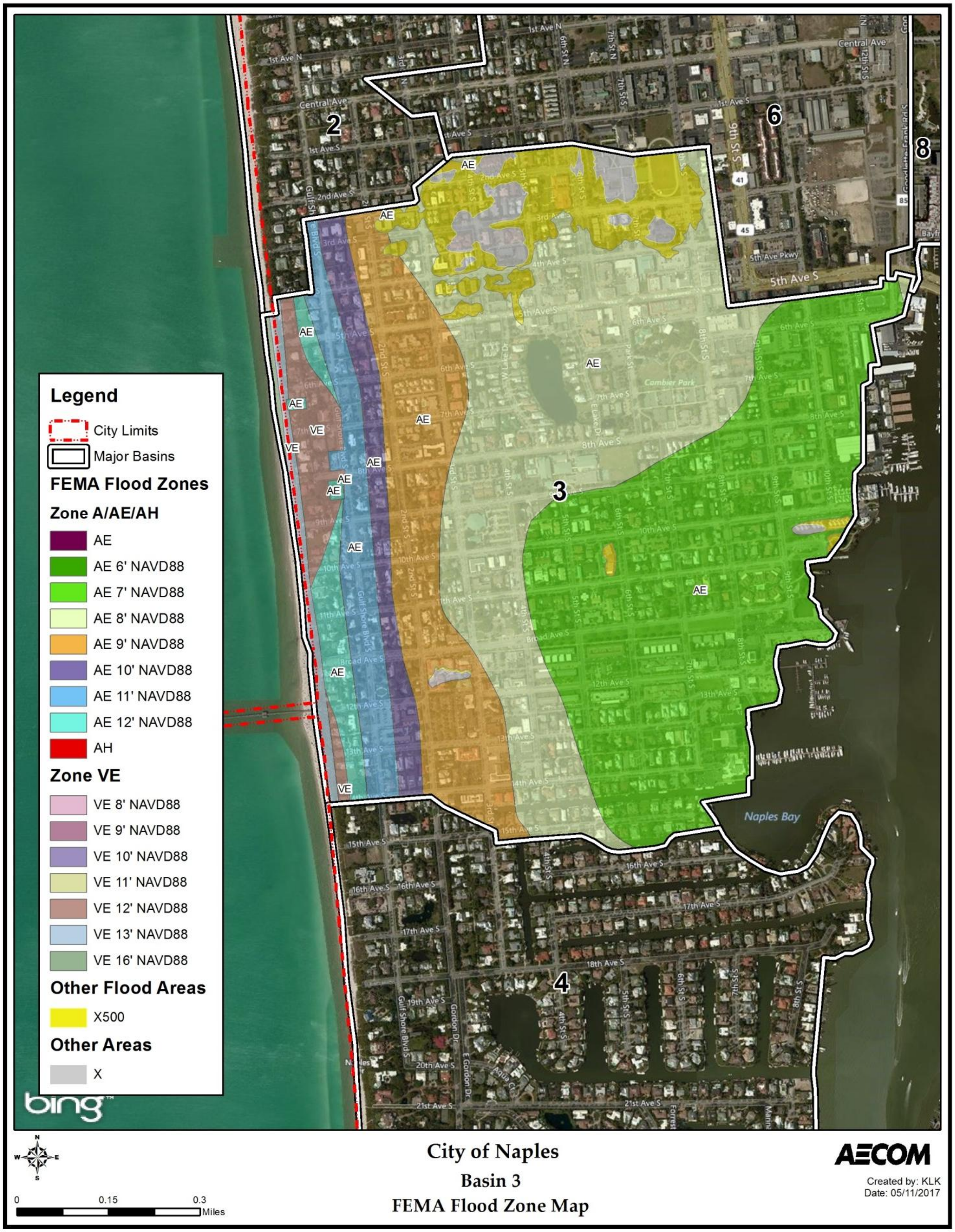
Figure 4-7 Basin 3 FEMA Map



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The assessment of Basin 3 was based on complaint information provided by the City, evaluated with the use of topographic information, FEMA flood plain classification and a review of relevant drainage features as indicated on the City's GIS database. Basin 3 complaints from 2015 to 2016 consisted of a total of 27 complaints including 13 drainage complaints, 8 standing water complaints, 6 dropped vertical grade complaints and 1 swale complaint. The complaint locations for Basin 3 are shown below in Figure 4-9 and Table 4-3.

Table 4-3 Basin 3 Complaint List

ID	Location	Type	Potential Cause
1	12nd Avenue South near Naples Pier	Drainage, Standing Water	No swales, or drainage pipe and inlets (small inlet not shown on GIS), no swales
2	Alleyway near 3rd Street South between 14th Avenue South and 15th Avenue S	Drainage	Low area
3	14th Street South near 4th Street South	Dropped VG	Pipe may be undersized (12"), small inlets
4	4th Street South near 13 Avenue S	Drainage	Pipe may be undersized (10") note: plenty of inlets near complaint area, inlet size small
5	4th Street South near 12 Avenue S	Dropped VG	Pipe may be undersized (8"), small inlet, no swale or conveyance
6	5th Street South near 12 Avenue S	Drainage	Pipe may be undersized (12"), small inlet sizes, no sizes
7	4th Street South near Broad Avenue South	Dropped VG	Pipe may be undersized (12"), no swales, small inlets sizes
8	3rd Street South near 11th Avenue South	Dropped VG	Inlet on road, quantity seems sufficient. Inlets on E side of intersection are elevated and not accessible. Pipe may be undersized
9	3rd Street South near 11th Avenue South	Drainage	Inlet on road, quantity seems sufficient. Inlets on E side of intersection are elevated and not accessible. Pipe may be undersized
10	5th Street South between 9th Avenue South and 10th Avenue South	Standing Water	Pipe size is 18", low area, very small inlets
11	6th Street South near 10th Avenue South	Drainage	Pipe size is 12", Inlets near complaint area, numerous small inlets
12	7th Street South near 10th Avenue South	Standing Water	Small pipe size (12"),very small inlet
13	7th Street South between 10th Avenue South and 11th Avenue South	Swale	12" pipe, may be undersized.
14	Intersection of 7th Avenue S and 3rd Street South	Dropped VG	No swales. Pipe may be undersized.
15	Intersection of 6th Avenue S and 3rd Street South	Dropped VG	No swales. Pipe may be undersized. (10-12"), some inlets on the smaller size
16	Intersection of W Lake Drive and 6th Avenue South	Drainage	Small pipe sizes. Swales seem adequate (12")
17	Intersection of W Lake Drive	Drainage	No pipe sizes. Swales seem adequate (12"),

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	and 7th Avenue South		small inlets
18	Intersection of W Lake Drive and 7th Avenue South	Drainage	Small pipe sizes. Swales seem adequate, small inlets
19	405 5th Street South (4th Street South near 5th Street South)	Drainage	Small pipe sizes (12")
20	4th Avenue South between 5th and 6th Street South	Standing Water	Small pipe sizes (12")
21	348 5th Street South (5th Street South between 3rd Avenue South and 4th Avenue South	Drainage	Small pipe sizes (very small inlet)
22	5th Street South at 3rd Avenue South	Standing Water	Small pipe sizes
23	6th Avenue South	Standing Water	Small inlets
24	5th Avenue South	Standing Water	Small inlets
25	7th Avenue South	Drainage	Pipe size 12"-24", outlets shown in incorrect areas. Missing pipe size. Inlets in alley may be private. Not shown on the GIS.
26	E. Lake Drive	Drainage	Low area, no pipe sizes indicated, small inlets
27	5th Ave S and West Lake Drive	Standing Water	12 inch pipe sizes, (some pipe sizes missing on GIS), extremely small inlets

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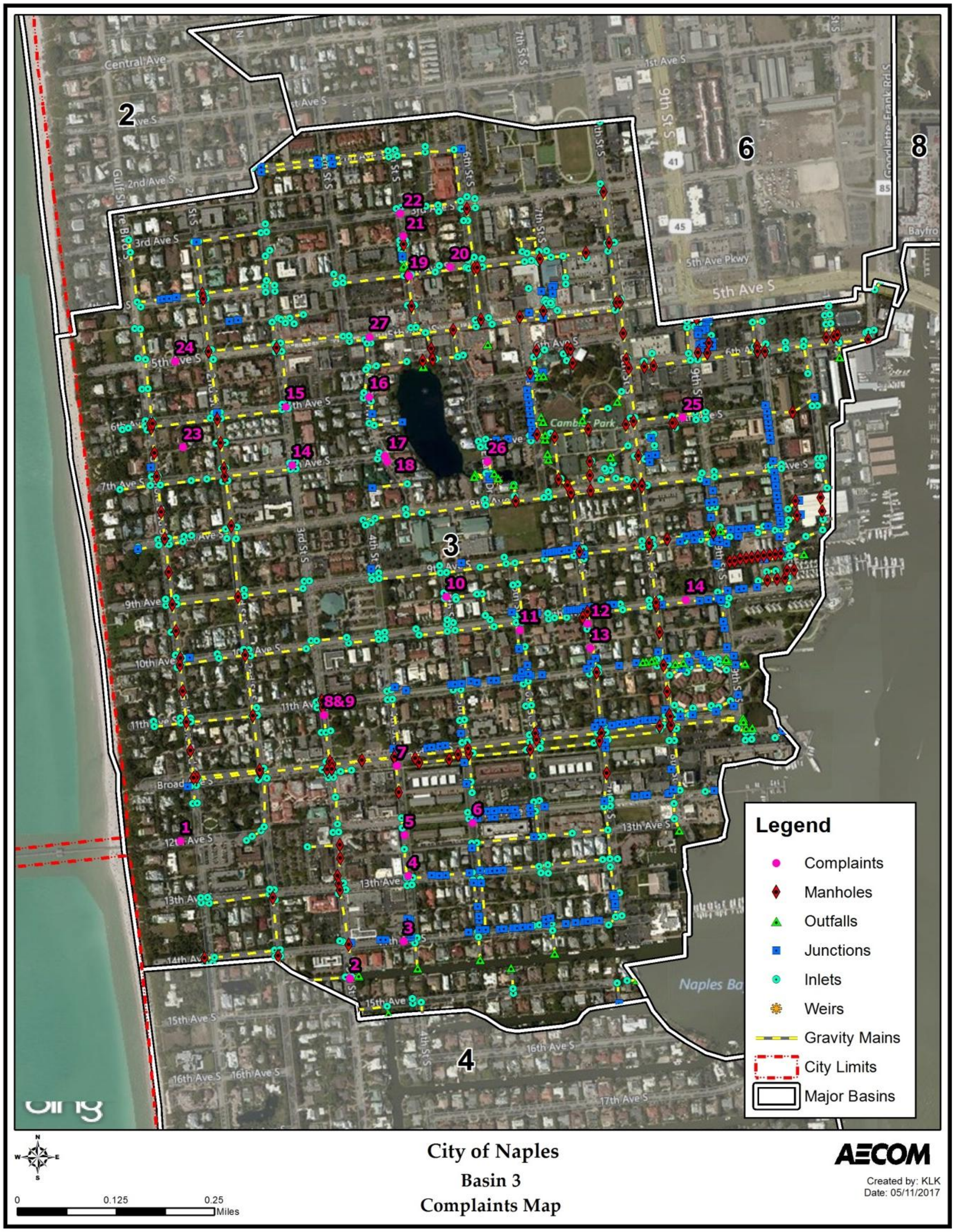
Figure 4-8 Basin 3 Complaint Map



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4.2.4 Basin 4 Assessment

Basin 4 consists of approximately 1,200 acres of land and is the southernmost basin being evaluated in this master planning effort. It is bordered by the Gulf of Mexico on the west and Naples Bay on the east. Rectangular in shape, it is approximately 5,000 feet long by 13,500 feet wide. The basin has not been subject of any previous hydraulic or hydrologic modeling studies and was not assessed in previous master planning efforts. Lantern Lakes Basin Drainage Investigation was prepared for the City of Napes by Hole, Montes and Associates, Inc. in September 2000. The investigation was a follow-up to a prior engineering report submitted to the City identifying possible solutions to flooding in the area, particularly in response to a 100-year flood event several years prior in which the area experienced signification flooding. Recommendations included the construction of a new 24-inch storm sewer between Lantern Lake and Jamaica Channel. In addition, upgrading the capacity of the pumps in the existing pump station (Port Royal) that feeds the 30-inch gravity storm sewer for flow to Treasure Cove was suggested. The conveyance elements in the basin consist of a system of swales, inlets, pipes, outfalls, detention ponds, and one pump station.

A review of the Basin 4 FEMA Map, Figure 4-10, shows the majority of the area along the Gulf of Mexico in the linear stretch surrounding Gulf Shore Boulevard and Gordon Drive along the western portion of the basin consists of bands of the VE flood zone ranging from VE 13 to VE 11, indicating a significant flood risk due to storm surge. Similar to Basin 1, 2, and 3, the area in the VE flood zone along Gulf Shores Boulevard and Gordon Drive features very low topography with many portions of the roadway only 3 to 4 feet NAVD. The rest of the basin from west to east consists of bands of the AE flood zone ranging in severity from AE 12 to AE 7. There are a couple of areas that have been designated Zone X.

The assessment of Basin 4 was based on complaint information provided by the City, evaluated with the use of topographic information, FEMA flood plain classification and a review of relevant drainage features as indicated on the City's GIS database. Basin 4 complaints from 2015 to 2016 consisted of a total of 15 complaints including 11 drainage complaints and 4 standing water complaints. The complaint locations for Basin 4 are shown below in Figure 4-11 and Table 4-4 listed the complaint location, the type, and the potential cause.

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Figure 4-9 Basin 4 FEMA Map

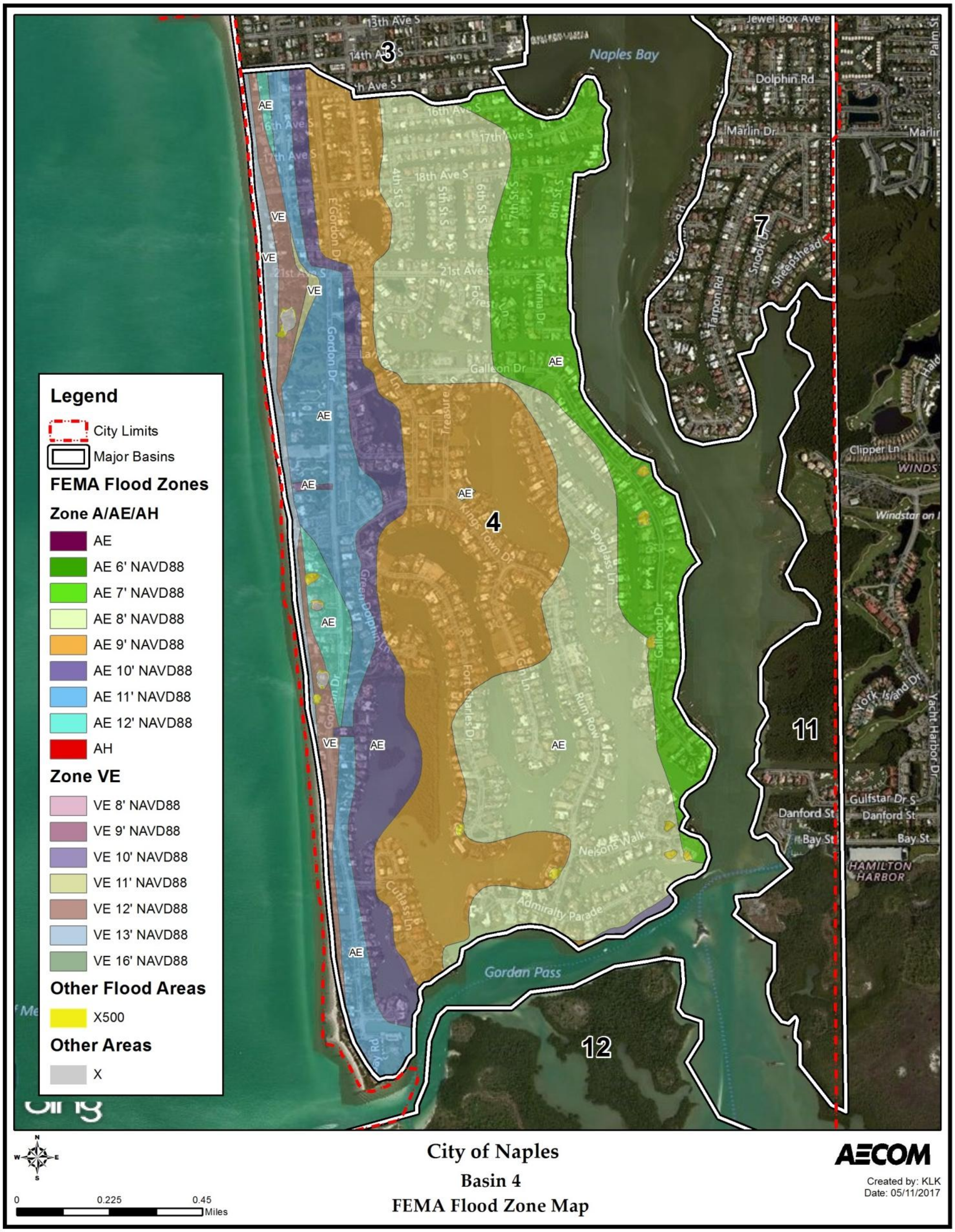

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Table 4-4 Basin 4 Complaint List

ID	Location	Type	Potential Cause
1	Nelson's Walk	Drainage	No swales to convey water to inlets (sufficiently sized)
2	Rum Row	Drainage	No swales, low area
3	Galleon Drive	Drainage	Very small inlets, area leading to inlet obstructed by landscaping.
4	Galleon Drive	Standing Water	Very small inlets, area leading to inlet obstructed by landscaping.
5	Gordon Drive	Drainage	Low Area, 4 inlets nearby with swales. Very small elevated inlets. Pipe size 12"
6	Half Moon Way	Standing Water	No Swales, small inlet that is elevated in yard.
7	Treasure Lane	Drainage	Pipe size no indicted on west side. Other pipe is 12", small inlets, no swales
8	Lantern Lane	Drainage	No swales, extremely small inlets, 12"-18" pipe size, low area
9	21st Avenue South	Standing Water	slightly graded swales, small inlets, 12inch pipes
10	21st Avenue South and Marina Drive	Drainage	Small Inlets to the north, small pipe size (12")
11	6th Street South	Drainage	Small inlets elevated in yard in cul-de-sac area, no swales
12	7th Street South	Drainage	No swales and no inlets on north end of street near this complaint area
13	17th Avenue South	Drainage	Low area, inlet sizing seems sufficient, pipe sizing between 12" and 15"
14	Gulf Shore Boulevard between 17th and 18th Ave. S	Drainage	Low area, inlet sizing seems sufficient, pipe sizing between 12" and 15"
15	Cutlass Lane	Standing Water	Inlets sufficiently sized, pipe size is 12"

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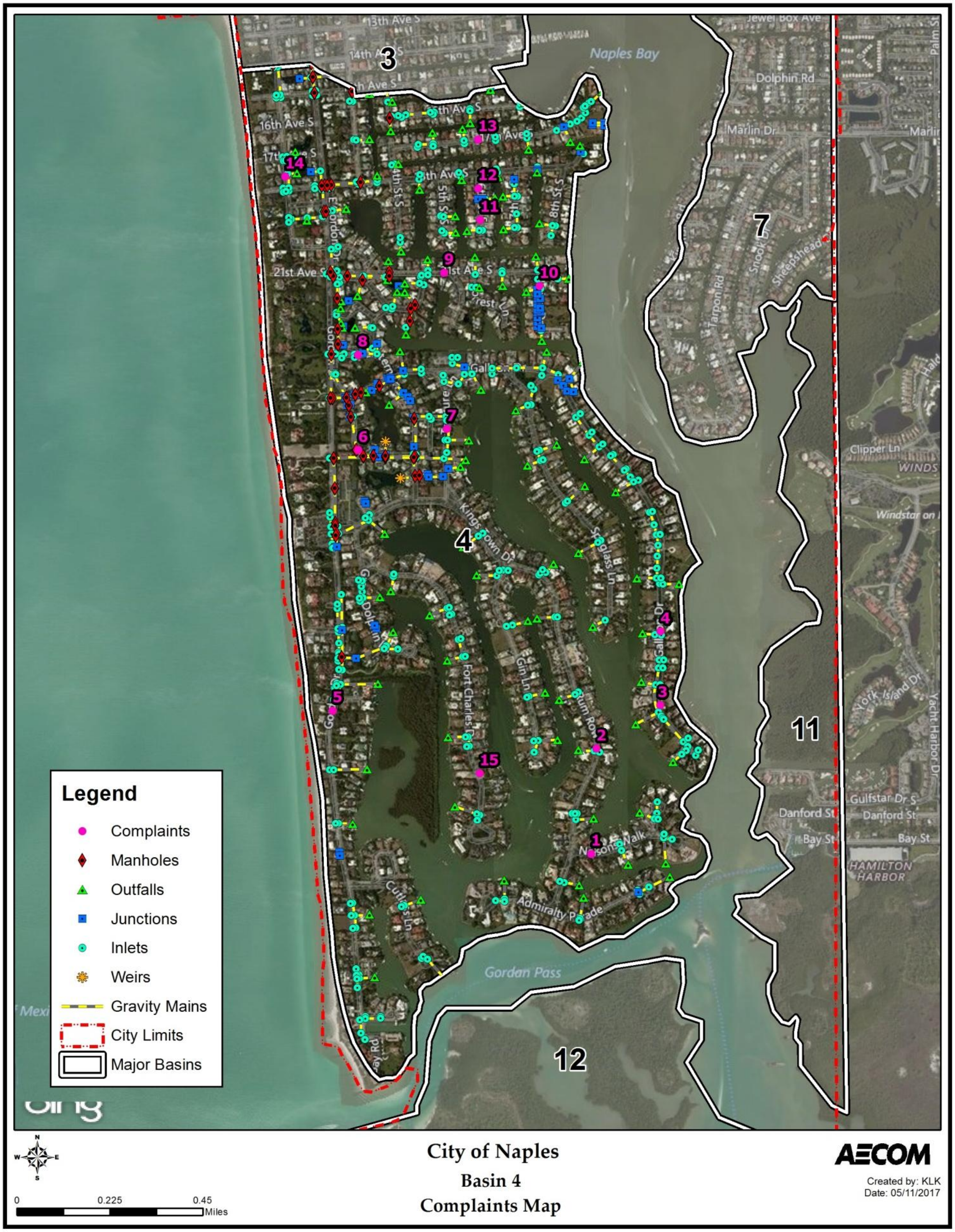
Figure 4-10 Basin 4 Complaint Map



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4.2.5 Basin 5 Assessment

Basin 5 consists of approximately 800 acres of land and is 13,000 feet long and at its widest point is 4,600 feet wide. The basin's stormwater runoff is routed via swales, inlets, pipes, and several detention lakes to a storm sewer pipe system along the west right-of-way of Goodlette Road. This system discharges to the Gordon River. There are also seven (7) City maintained lakes within this basin, Sun Lake, Thurner Lake, Lake 17, Mandarin Lake, Forrest Lake, Willow Lake, and Lake Manor.

The previous master plan took into consideration the Conclusions and Recommendations section of the "Basin V Stormwater System Improvement Plan Phase I: Basin Assessment and Conceptual Improvement Plan", November 2005. Alternative 3 consisted of a refined retrofit LOS criteria that were consistent with what other Florida coastal communities developed to achieve the various LOS criteria for several design storm events, including Class C LOS (i.e., maximum 6-in overtopping the road crown) for the 25-year/72 hour design storm 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 know building elevations. (CDM, 2005) In the previous report CDM recommended a phased approach to the implementation of Alterative 3 summarized below:

- Land and easement acquisition including required to construction and maintain the planned conveyance and detention facilities.
- Modification of the existing detention facilities.
- Water quality evaluation of the existing detention facilities to meet volume requirements.
- Implementation of the conveyance improvements identified in Alternative 3.

No further analysis has been completed after 2007. This report assumes that the improvements have been completed for this basin.

A review of the Basin 5 FEMA Map, Figure 4-12, shows the majority of the area consists of AH zone, which is used for areas of 1-percent-annual-chance shallow flooding from rainfall with a constant water-surface elevation (usually areas of ponding) where average depths are less than 3 feet. There is som AE 7 and AE8 and several areas of Zone X. This area is relatively higher in elevation with topographic elevations ranging from 9 to 12 feet NAVD in Zone X.

The assessment of Basin 5 was based on complaint information provided by the City, evaluated with the use of topographic information, FEMA flood plain classification and a review of relevant drainage features as indicated on the City's GIS database. Basin 5 complaints from 2015 to 2016 consisted of a total of 6 complaints with all the complaints on drainage. The complaint locations for Basin 5 are shown below in Figure 4-13 and Table 4-5 listed the complaint location, the type, and the potential cause.

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Figure 4-11 Basin 5 FEMA Map

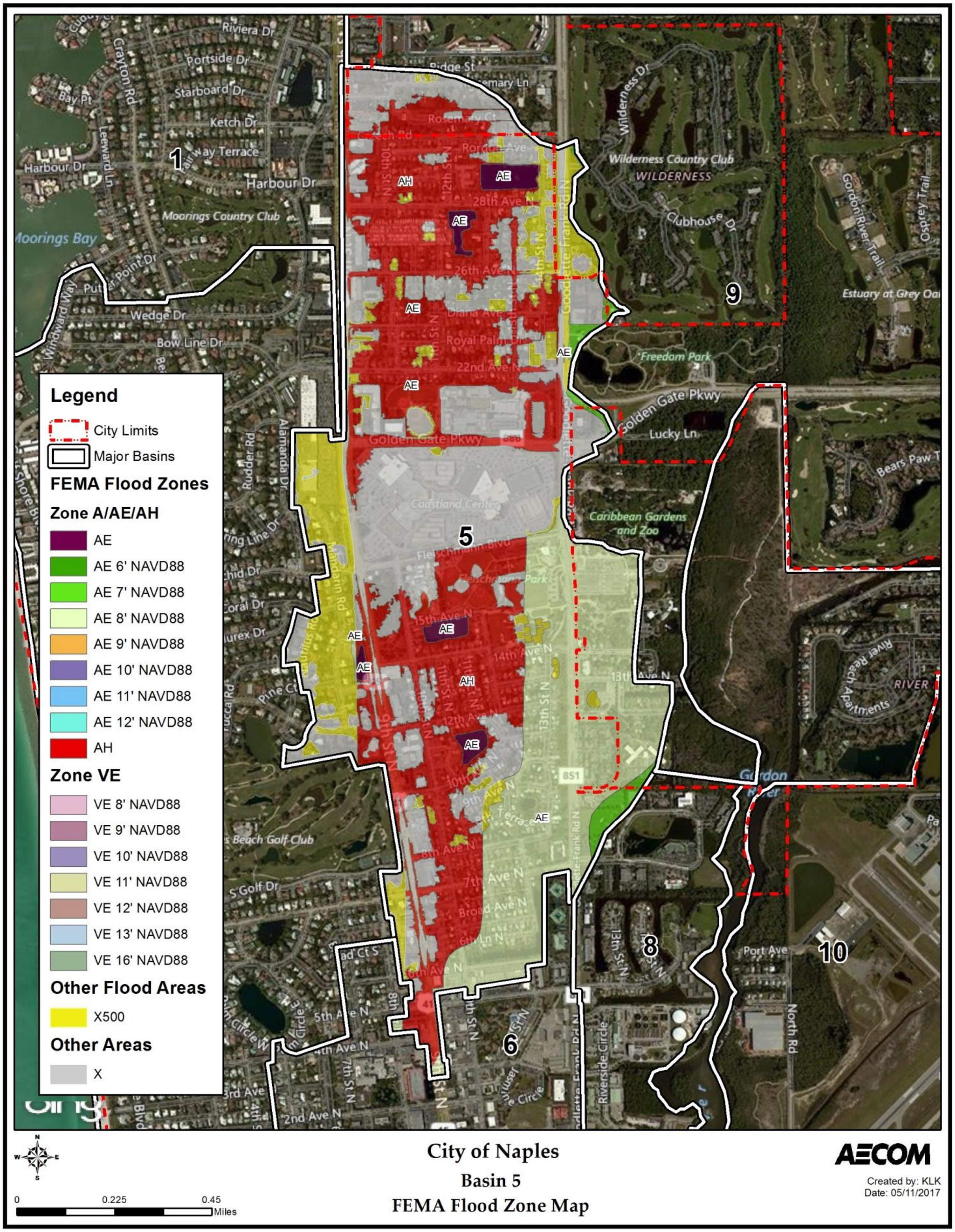

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Table 4-5 Basin 5 Complaint List

ID	Location	Type	Potential Cause
1	6th Lane North	Drainage	Small pipe size (12"), inlets in yard. Slightly graded swales, discharges to weir
2	8th Avenue North near 12th Street N	Drainage	Low elevation, inlet on south side of road is elevated
3	8th Terrace North	Drainage	Pipe sizes missing or 12", no inlets in direct vicinity.
4	14th Avenue North near 10th Street N	Drainage	Pipe size small (12"), no swales
5	15th Avenue North near 10th Street North	Drainage	Pipe size small (12"-18"), no swales
6	11th Street North	Drainage	12" pipe size. GIS information complete, GIS information incomplete. Missing pipe on 11th Street N.

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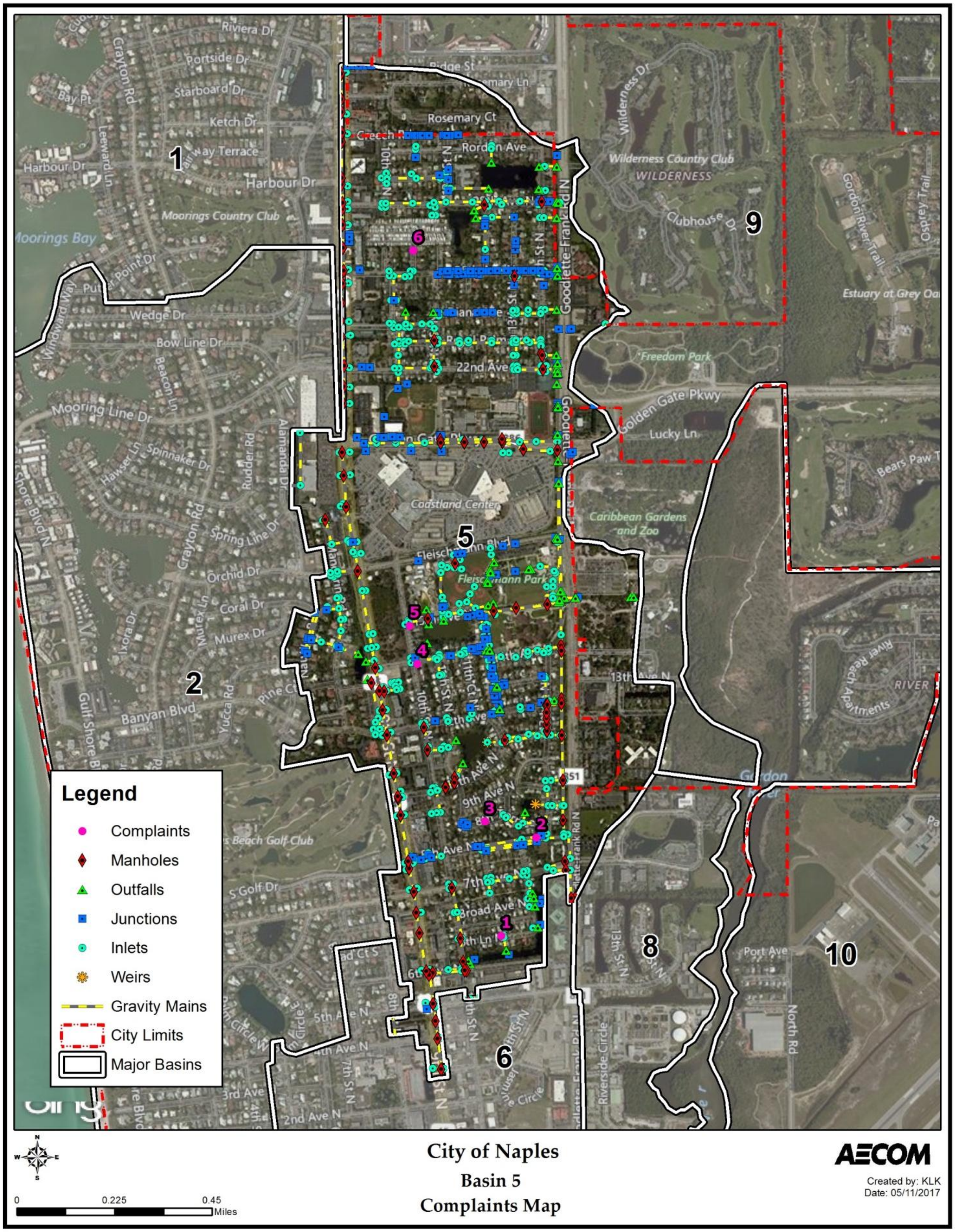
Figure 4-12 Basin 5 Complaint Map



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4.2.6 Basin 6 Assessment

Basin 6 consists of approximately 300 acres of land and is 5,500 feet long and at its widest point is 4,200 feet wide. The majority of stormwater runoff in the basin is conveyed via swales, inlets and pipes to the Goodlette Road (Public Works) 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 ultimately to the Gordon River. There is also one City maintained lake within the basin, NCH Lake.

There have been no new studies completed in this basin. There have been improvements made to Central Avenue and the Public Works pump station since the last study. The previous study contained an evaluation of this basin since there were two basin studies completed in this basin. These studies were the Basin VI Assessment Report – Draft by CDM in 1998 and Drainage Basin VI Stormwater Pump Station and System Improvements Model Methodology Technical Memorandum - Part 2 by CDM in 1998. No further analysis has been completed after 2007. This report assumes that the improvements have been completed for this basin.

A review of the Basin 6 FEMA Map, Figure 4-14, shows the majority of the area consists of AE 7 and 8 on the eastern part of the basin with X500 and Zone X on the western side of the basin. The western area has elevations from 12 feet to 8 feet NAVD. With the AE7 and 8 on the eastern side, the topography ranges from 8 feet NAVD to 3 feet NAVD, which would result in a flooding depth of 1 to 5 feet.

The assessment of Basin 6 was based on complaint information provided by the City, evaluated with the use of topographic information, FEMA flood plain classification and a review of relevant drainage features as indicated on the City's GIS database. Basin 6 complaints from 2015 to 2016 consisted of a total of 3 complaints with all the complaints on drainage. The complaint locations for Basin 6 are shown below in Figure 4-15 and Table 4-6 listed the complaint location, the type, and the potential cause.

Table 4-6 Basin 6 Complaint List

ID	Location	Type	Potential Cause
1	Central Avenue and 10th Street South	Drainage	No swales, some pipe sizes not indicated, no inlets for approximately 350 feet in either direction
2	2nd avenue north and 10th Street North	Drainage	No swales, low area
3	1st Avenue South and 5th Street South	Drainage	Some swales, small inlets that are not placed in the swales

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Figure 4-13 Basin 6 FEMA Map

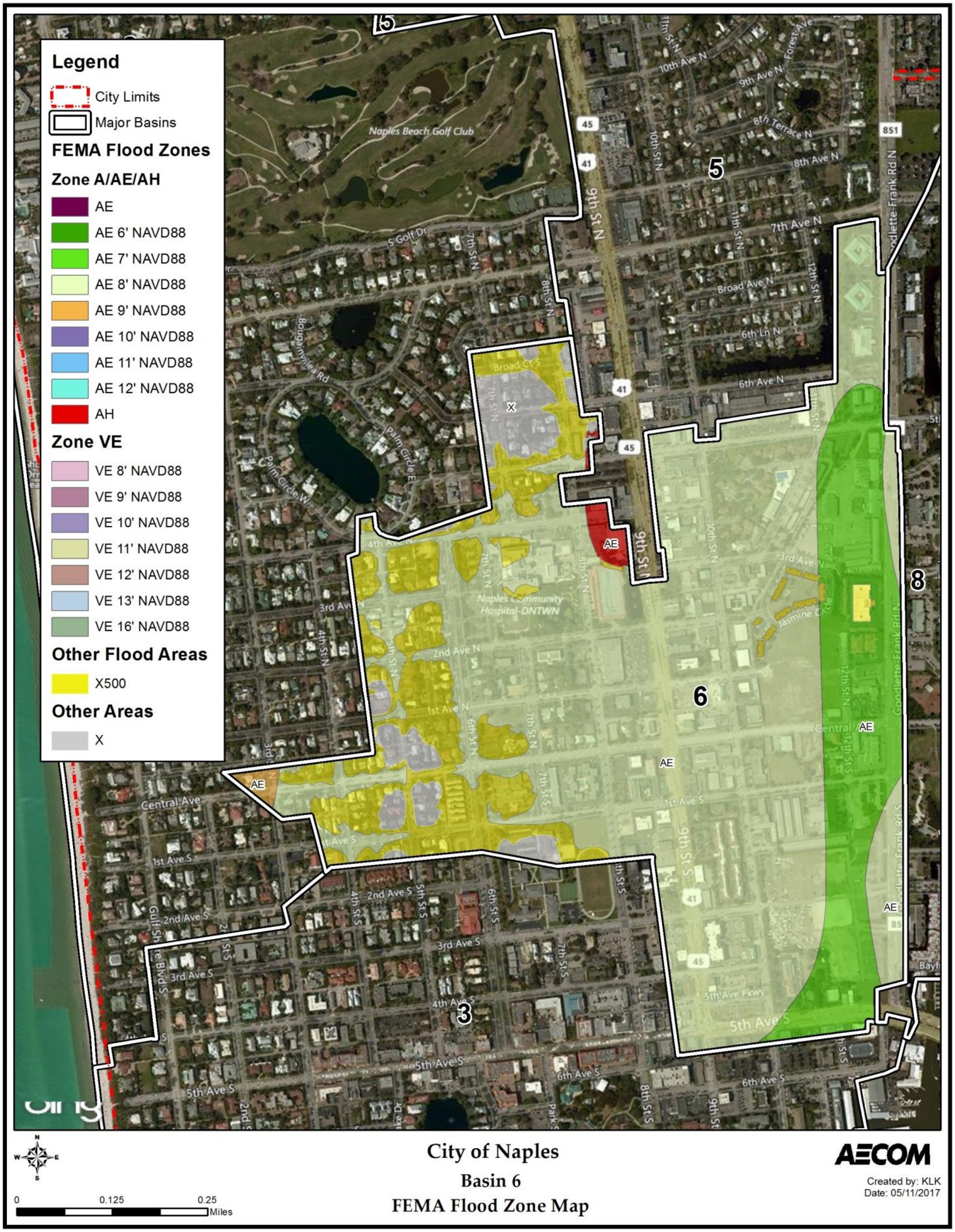

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Figure 4-14 Basin 6 Complaint Map

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4.2.7 Basin 7 Assessment

Basin 7 is approximately 8,500 feet long by 2,500 feet wide and consists of an area of approximately 300 acres. The basin features relatively low topography ranging from 0 feet NAVD to 6 feet NAVD. The conveyance system is characterized by swales, inlets and relatively short lengths of small diameter pipe that discharge into a system of canals, then subsequently to Naples Bay. The basin was not subject to any previous basin studies or master plans and had a relatively low number of drainage complaints. The Basin 7 FEMA Map shown in Figure 4-16 indicates that flood zones in the basin range from large bands of AE 6 and AE 7 to a small pocket of zone AE 10 on the eastern portion of the basin adjacent to Naples Bay.

The assessment of Basin 7 was based on complaint information provided by the City, evaluated with the use of topographic information, FEMA flood plain classification and a review of relevant drainage features as indicated on the City's GIS database. Basin 7 complaints from 2015 to 2016 consisted of a total of 5 complaints with 3 drainage complaints and 2 standing water complaints. The complaint locations for Basin 7 are shown below in Figure 4-17 and Table 4-7 listed the complaint location, the type, and the potential cause.

Complaint locations were not centralized in a specific portion of the basin and the majority of complaint locations were near areas featuring stormwater inlets. Pipe and inlet sizes in the basin are relatively small and a number of locations with drainage inlets are few. The majority of the properties in the basin are built on manmade canals thus drainage may take place via natural grading. The majority of the recommendations for improvements include the addition of swales for conveyance in addition to increasing inlet sizes.

Table 4-7 Basin 7 Complaint List

ID	Location	Type	Potential Cause
1	Cobia Court	Drainage	No swales, pipe size not indicated, low area
2	Snook Drive	Drainage	Small pipe size, small inlets
3	Curlew Avenue	Drainage	Small pipe size that discharges directly to water body, small inlets
4	Wahoo Court	Standing Water	No drainage inlets
5	Blue Point Avenue	Standing Water	No pipe size, small inlet

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Figure 4-15 Basin 7 FEMA Map

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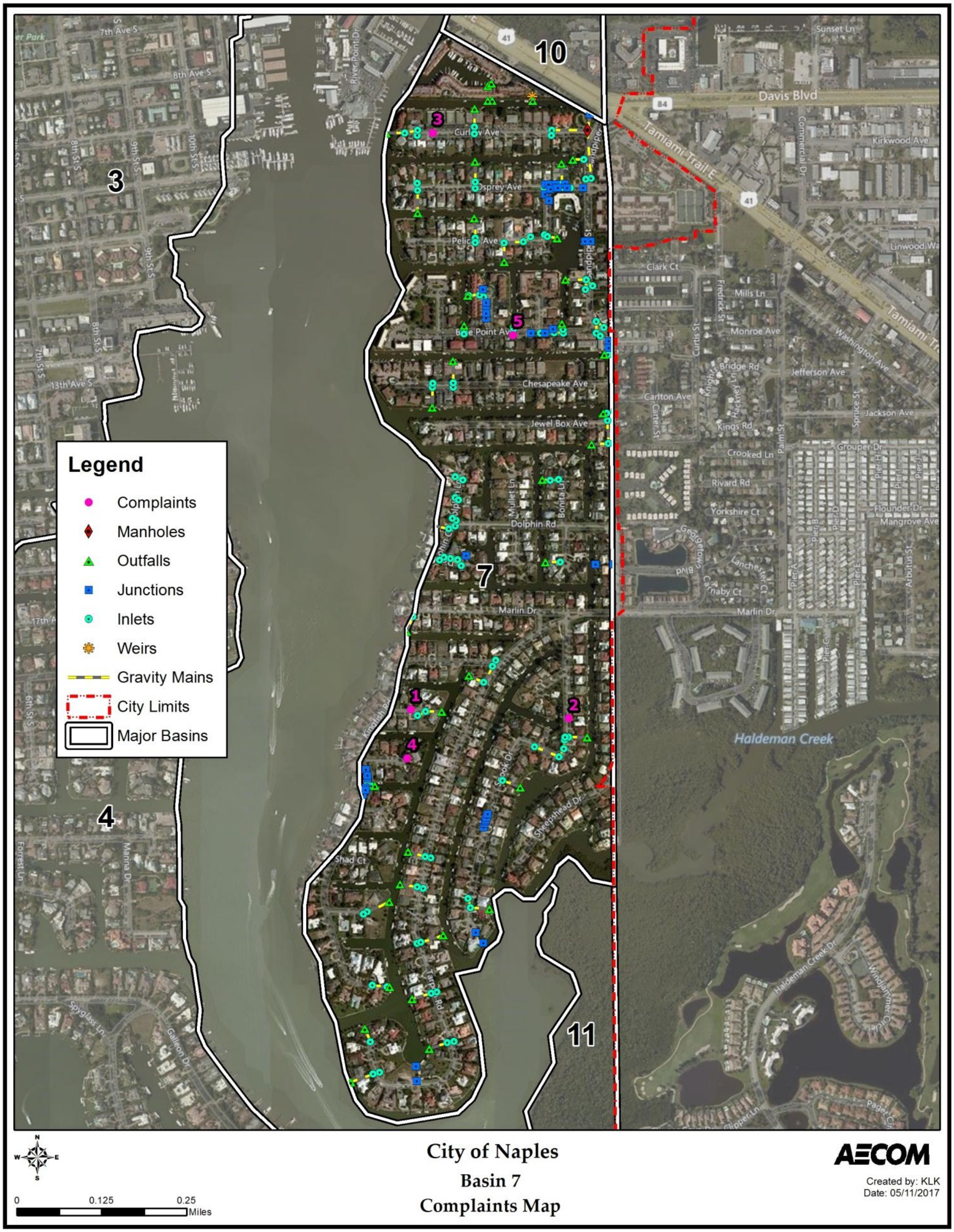
Figure 4-16 Basin 7 Complaint Map



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4.2.8 Basin 8 Assessment

Basin 8 lies in the center of the City and is bounded by the Gordon River on the east side. It consists of a land area of approximately 200 acres. The basin has not been subject of any previous hydraulic or hydrologic modeling studies and was not assessed in previous master planning efforts. The conveyance elements in the basin consist of a system of swales, inlets, small diameter pipes, outfalls and canals that flow in to the Gordon River. The southern portion of the basin consists of larger diameter pipes in a planned united development complex. A large diameter 60-inch storm sewer line on the east side of the basin carries stormwater from Basin 6 to an outfall which discharges to a drainage canal near the Gordon River.

A review of the Basin 8 FEMA Map, Figure 4-18, indicates that the majority of the basin consists of bands of flood zone AE with large bands of AE 8 along the eastern and western portions of the basin. Significant portions of the basins center consists of flood zone AE 7. Several small pockets of flood zone X are located toward the southern portion of the basin. Basin 8 only consisted of one drainage complaint location in the western portion of the basin as shown on Figure 4-19. Detailed information on the complaint and potential solutions is listed in Table 4-8.

Table 4-8 Basin 8 Complaint List

ID	Location	Type	Potential Cause
1	3rd Avenue North near Paradise Circle	Drainage	Low area, no swales, small pipe size (12"), small inlets

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Figure 4-17 Basin 8 FEMA Map

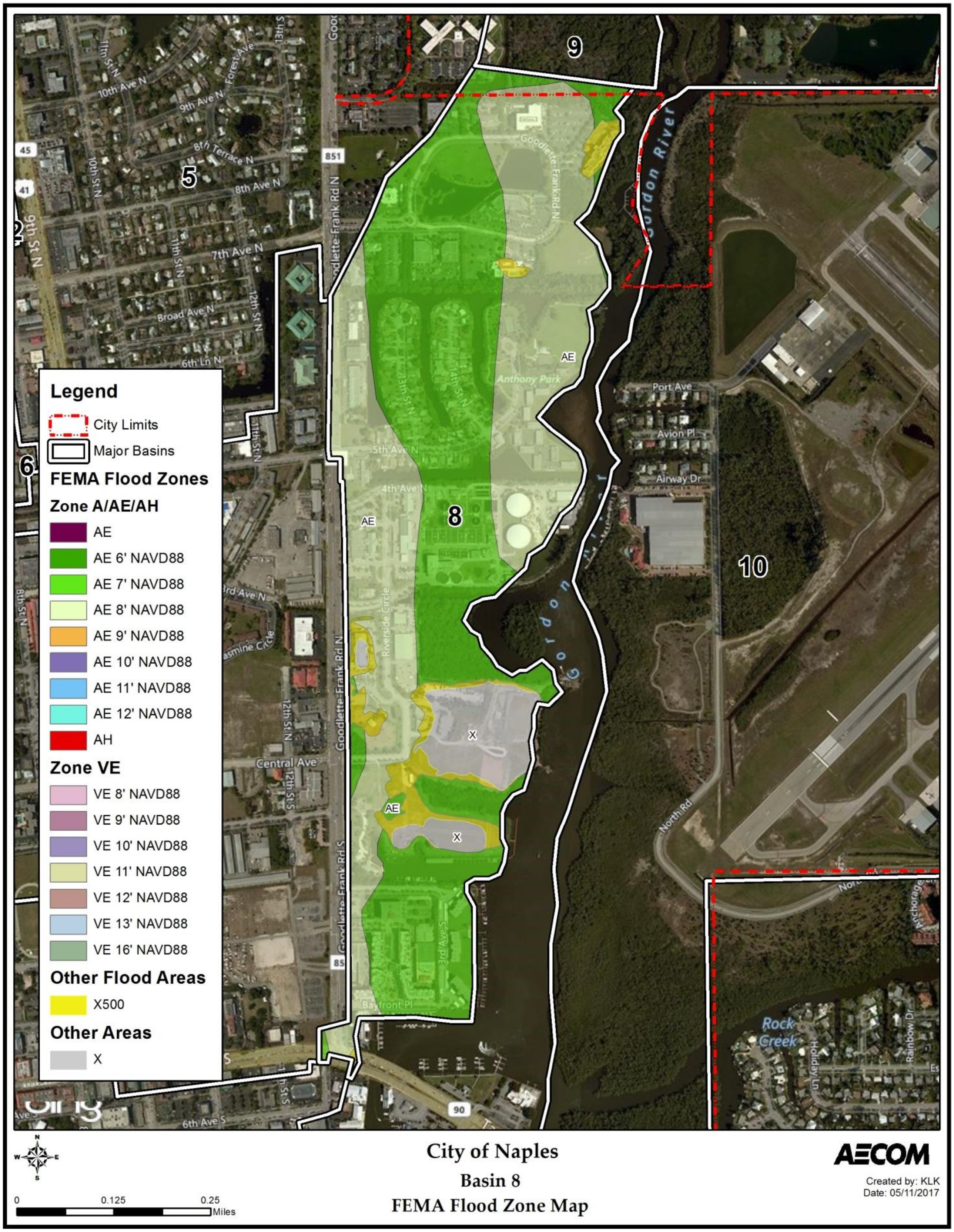

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Figure 4-18 Basin 8 Complaint Map

4.2.9 Basin 10 Assessment

Basin 10 consists almost exclusively of the Naples Municipal Airport with a residential community on the western edge of the basin. The basin consists of approximately 900 acres and is bordered by the Gordon River on the west. The City limited GIS information in the basin and the majority of the basin is covered by a SFWMD permit at the airport.

A review of the Basin 10 FEMA Map, Figure 4-20, indicates that the majority of the basin consists of the AE 7 and AE 8 flood zones. A small portion of flood zone AH lies on the western basin border representing a chance of shallow flooding. In addition the basin consists of small pockets of flood Zone X, indicating a 1 foot depth of flooding during the 100 year storm. Pockets of flood Zone X500, predominately located in the northeast portion of the basin, indicate areas within the 500 year floodplain not located in a special flood hazard area. Basin 10 only consisted of one standing water complaint location near a residential complex in the western portion of the basin as shown on Figure 4-21. Detailed information on the complaint and potential solutions is listed in Table 4-9.

Table 4-9 Basin 10 Complaint List

ID	Location	Type	Potential Cause
1	Port Avenue	Swale	Wooded area inclines away from road. Small structure to allow for natural drainage.

4.3 Repetitive Loss Area Analysis

In the 2007 Master Plan, there was discussion on structural problems from the result of repetitive loss structures. Repetitive loss structures are building structures that have been subjected to insurance claims to flooding at least twice in ten (10) years with claims in excess of $1,000. Due to protecting public information on specific structures, the City has provided a summary of the general areas where they have had repetitive losses.

<u>Area 1 – 16th Avenue South</u> - There is only (1) repetitive loss structure located in this area and it is a Pre-FIRM structure. The mapped area includes all the surrounding Pre-FIRM structures that are well below the required base flood elevation. There is also (1) additional structure that has had a flood claim in this area. This area is completely mapped in a Special Flood Hazard Area. All the structures outside of the mapped area were built to higher elevation requirements and no flood claims have been noted. This area is a natural low spot but most of the flood claims either coincide with heavy storm events or tropical storm and hurricane events. Flooding can be exasperated if it is high tide when one of these events occurs.

<u>Area 2 – 9th & 10th Avenue South</u> - There is only (1) repetitive loss structure located in this area and it is a Pre-FIRM structure. The mapped area includes only a couple of other Pre-FIRM structures located on 10th Avenue South just south of the repetitive loss property. The entire area is completely mapped in a Special Flood Hazard Area. In prior years the area was subject to localized flooding especially at high tide and during heavy storm events but a large stormwater project was completed in the area in 2012 and there has been no recognized flooding in the area since.

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Figure 4-19 Basin 10 FEMA Map

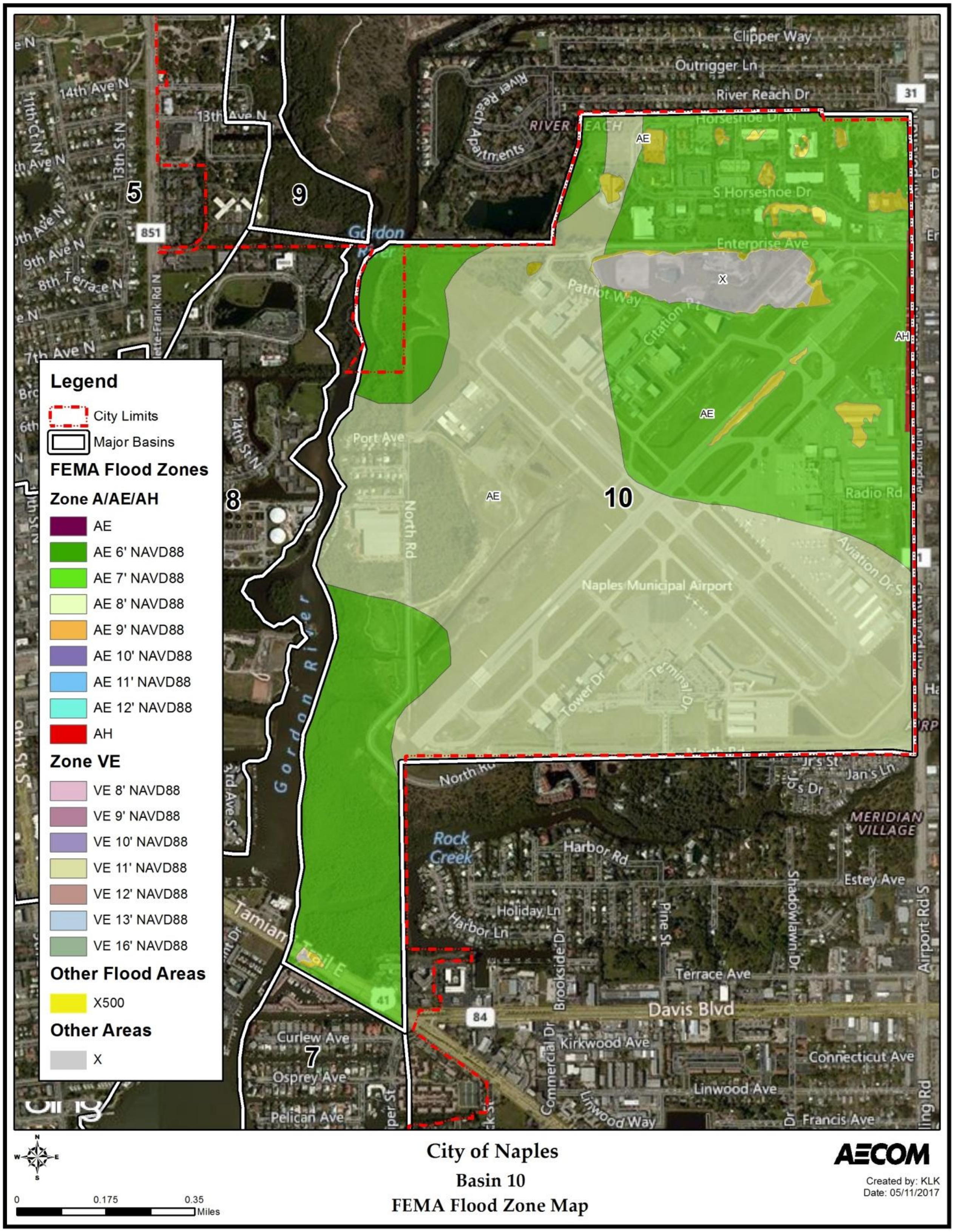

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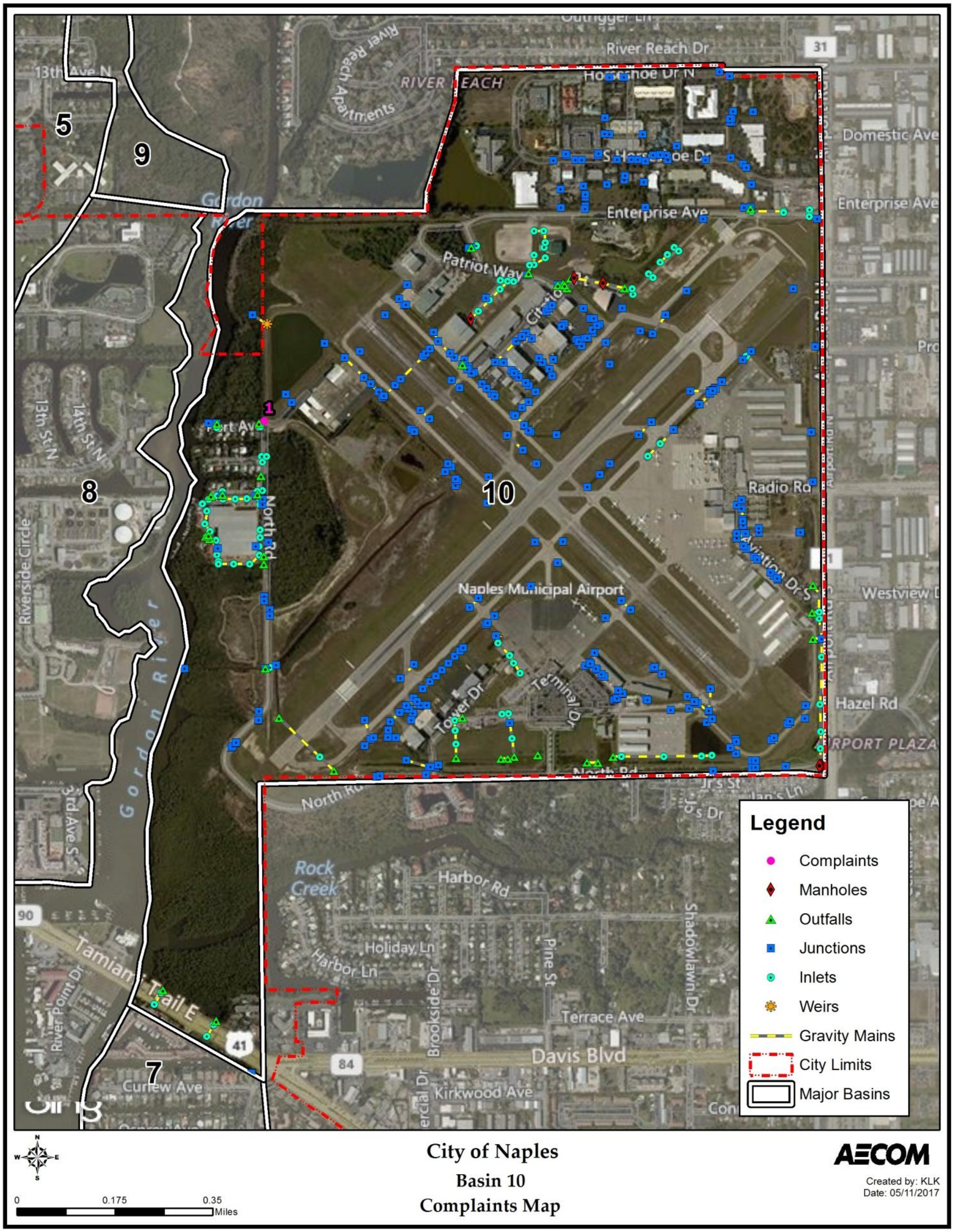
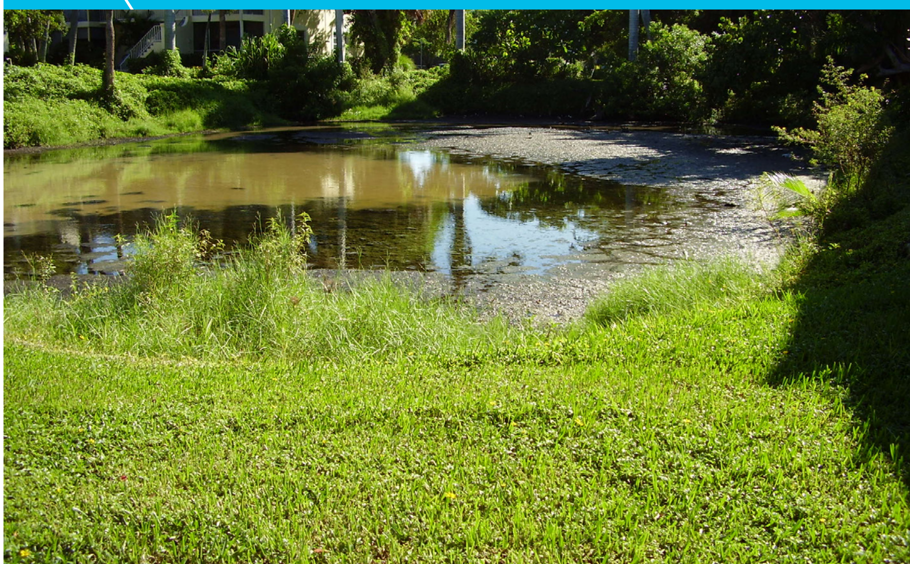
Figure 4-20 Basin 10 Complaint Map





TAB 5

Water Quality and Ecology

5. Water Quality and Ecology

The City of Naples stormwater system has been delineated into 12 basins and includes 28 stormwater ponds and three pump stations (Cardno, 2015a). Note that Basins 9, 11 and 12 have no significant City maintained stormwater infrastructure, thus Basins 1 through 8 and 10 are the primary focus of the water quality and ecologic evaluation for this Stormwater Master Plan Update.

5.1 Review of Existing Data

The City of Naples has enacted a number of water quality monitoring and improvement studies, to address, for the most part, impairments to the water quality and ecology of the Naples Bay. There are also monitoring programs to evaluate water quality throughout City of Naples stormwater systems. Evaluation of direct outfalls from Basin 2 has been the primary focus of the Gulf of Mexico water quality projects, while the Moorings Bay system has received less attention.

5.1.1 Summary of Documents Reviewed

Table 5-1 presents a list of City of Naples water quality and improvement studies since 2007, and following sections provide a brief summary of data reported in these studies. Summary of data is presented in chronological order.

Table 5-1 Summary of Existing Water Quality Monitoring and Improvement Studies

Year	Title of Document	Date Issued	By
2016	Naples Bay Restoration and Water Quality Project at the Cove- Preliminary Design Report	Mar-16	Stantec
2015	Upland Stormwater Lake and Pump Station Water Quality Monitoring – Q4 2014 Quarterly Report	Jan-15	Cardno
2015	Status of the 20 Year Plan to Restore Naples Bay	Apr-15	City of Naples Staff
2015	Naples Bay Monitoring Design Recommendations for a Comprehensive Monitoring Program	Aug-15	Cardno
2015	Naples Bay Water Quality and Biological Analysis Project	Aug-15	Cardno
2015	Natural Resources Division City of Naples FY 2014-15 Annual Report	Oct-15	City of Naples Staff
2014	City of Naples Semi-annual and Quarterly Stormwater Infrastructure Monitoring	Mar-14	AMEC Foster Wheeler
2013	City of Naples Semi-annual and Quarterly Stormwater Infrastructure Monitoring	Jan-13	AMEC Foster Wheeler
2013	A Twenty Year Plan (and visionary guide) for the Restoration on Naples Bay	Feb-13	City of Naples Staff
2013	Bathymetry and sediment characterization of Lake Manor City of Naples, FL	Jul-13	SW Florida Aquatic Ecology Group
2012	City of Naples Stormwater Quality Analysis, Pollutant Loading and Removal Efficiencies	Jan-12	AMEC Foster Wheeler
2012	Stormwater Lakes Management Plan	Mar-12	City of Naples Staff
2008	TMDL Report on Dissolved Oxygen for the Gordon River Extension, WBID 3278K (formerly 3259C)	Aug-08	FDEP

2007	Naples Bay Surface Water Improvement & Management Plan	Jan-07	SFWMD
2007	Stormwater Master Plan	Apr-07	Tetra Tech
2007	Feasibility Study for Basin III Stormwater Management System Improvements and Broad Avenue Linear Park	Aug-07	CDM

5.1.1.1 Naples Bay Surface Water Improvement & Management Plan

The 2007 Naples Bay SWIM Plan by SFWMD focused on water quality as one of its initiatives and the strategies associated with this initiative include water quality and flow monitoring and water quality modeling. SFWMD evaluated the existing water quality-monitoring network to determine its ability to detect change and established hydrologic and hydrodynamic water quality monitoring. SFWMD assisted in pollutant loading model development and testing. Contractors worked on applying the Water Management Model (WMM) as part of the Southwest Florida Feasibility Study, a component of the Comprehensive Everglades Restoration Project (CERP). The SWIM Plan reports a need to spend over $100 million in projects that may improve the Naples Bay Watershed.

5.1.1.2 Feasibility Study for Basin III Stormwater Management System Improvements and Broad Avenue Linear Park

The 2007 Feasibility Study for Basin III Stormwater Management System Improvements and Broad Avenue Linear Park by CDM focused on providing an updated hydrologic and hydraulic modeling evaluation of four alternatives for water quality treatment and a linear park. The evaluation included data collection, facility sizing and alternative evaluations, linear park concept and evaluation, and a design development report. The Watershed Management Model (WMM) was used to estimate nutrient loading rates for the pre and post developed conditions. CDM recommended Alternative 4, which involved a combination of dry and wet treatment facilities and the conversion of 1.5 acres at a marina into a wet detention pond.

5.1.1.3 City of Naples 2007 Stormwater Master Plan

The 2007 Tetra Tech Stormwater Master Plan (SMP) compiled all existing data and historic stormwater master plan information to create an updated SMP. For water quality pollution, the updated SMP focuses on Total Nitrogen, Total Phosphorus, Total Suspended Solids, and Copper. These parameters were chosen because they are well documented and easy to compare. Additionally, the SMP looked at information related to the timing and volume of freshwater flowing into receiving waters in the City. Some of the recommendations related to water quality included: coordinating seagrass efforts carefully, commission a feasibility study to remove beach outfalls, include Moorings Bay System as a water body of concern, focus on improving pollutant removal efficiency during construction of stormwater facilities rather than retrofitting, increase monitoring based on discussed parameters, and establish on-going basin-wide swale restoration program. In 2012, the City amended their stormwater master plan to require the removal of the City’s stormwater beach outfalls (City 2017).

5.1.1.4 TMDL Report on Dissolved Oxygen for the Gordon River Extension

The Final TMDL Report for Everglades West Coast Basin, Gordon River Extension, WBID 3278K, for DO was published by FDEP on 2008. FDEP reported that Total Nitrogen (TN) is the pollutant causing the Gordon River to be impaired for low DO. Low DO was determined to be a parameter of concern based on an analysis of samples collected between 1995-2002 and another set of samples collected between 2000-2007. For the first set of samples, 76 out of 116 samples showed exceedances for the DO parameter (17 being the Impaired Waters Rule (IWR) required number of exceedances). For the second set of samples, 70 out of 72 samples showed exceedances for the DO parameter (12 being the IWR required number of exceedances). TN was determined to be the causative pollutant based on an assessment of potential causative pollutants and their correlation with low DO in the Gordon River.

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5.1.1.5 A Twenty Year Plan for the Restoration on Naples Bay

In 2010, the City published A Twenty Year Plan for the Restoration of Naples Bay. This plan focused on seven major restoration efforts, including water quality. For water quality, the plan proposed installing floating islands and aerators at ten retention ponds/lakes, planting native wetland plants along shorelines, constructing additional rain gardens in the following five years. For the next ten years, in order to improve water quality the plan proposed that two filter marshes be installed, dredge three ponds per year, have a majority of lakes/retention ponds with aerators and floating islands, have all shorelines ringed with wetland vegetation, and residents begin to replace sodded lawns with native flowering vegetation. The City's Plan projected that after 10 years stormwater runoff will have been reduced by 50 percent, irrigation use will be down by 30 percent, and water quality will be improved to the point that the Bay meets all state standards and become "unimpaired".

The report also documented changes in economically and ecologically significant species (City 2010), which are listed as follows:

Mangroves

Mangroves filter pollutants, allow sediment to settle, sequester carbon, reduce erosion, and serve as nursery habitat for a variety of wildlife including commercially and recreationally important fish species. However, prior to understanding ecological services provided by mangroves, and the state protection of mangroves in Florida, mangroves were removed from the City shorelines for residential and commercial development and to eliminate mosquitoes. As a result, the mangrove fringe habitat of Naples Bay was reduced by 70 percent.

Currently, the City is making an effort to encourage the placement of riprap along shorelines rather than seawalls, primarily in front of all new seawalls fronting Naples Bay. Riprap is naturally colonized by mangroves, oysters, crabs, and fish. Similar to mangroves, riprap reduces erosion by absorbing wave energy, reduces turbidity, and improves water clarity.

Riprap has been installed at the shoreline of Collier County's Bayview Park. The riprap at this location frequently recruits mangrove seedlings. These mangroves disappear soon after sprouting, which might be due to local anglers removing them. To allow some of these seedlings to mature, a portion of the park's shoreline was closed off. The closed portion of the shoreline was implemented using educational signs along the roped off area and boardwalk. While the seedlings outside the roped-off area continue to disappear, the mangroves within the closed area are still present and growing.

Oysters

Over the past few decades oyster have declined by 80 percent in Naples Bay. Oysters are important to the health of an estuary since they improve water quality. Additionally, oyster beds/reefs can reduce shoreline erosion and provide important habitat to other organisms. The City has started an oyster restoration project in the Naples Bay and as part of the project has built four oyster reefs in the Bay. Three have been successful while the fourth one has been reduced due primarily to boat wakes.

Seagrass

Seagrass ecosystems are one of the most heavily impacted in Naples Bay, with 90 percent of seagrasses historically present now gone. Seagrass beds serve as a food source, protection, and nursery for many species that are commercially and recreationally important. Seagrasses also improve water clarity by stabilizing bottom sediments. Impacts to seagrasses in the Bay include freshwater discharges, high nutrient levels, low water clarity, dredging, boat wakes, and high sediment loads. Improved water quality, reduced freshwater flows, and reduced suspended sediment would be needed in order to expand the remaining areas of seagrasses in Naples Bay. Currently, City staff annually monitors two areas of the remaining seagrass. Monitoring includes recording species, abundance, sediment type, water depth, epiphyte coverage, and blade lengths.

5.1.1.6 City of Naples Stormwater Quality Analysis, Pollutant Loading and Removal Efficiencies

The 2012 City of Naples Stormwater Quality Analysis, Pollutant Loading and Removal Efficiencies by Amec Foster Wheeler provides the results of stormwater and lakes monitoring conducted by AMEC;

consolidates available data from 2008-2011; and uses related data to develop a model that provides a condition assessment and initial identification of the source of critical water pollutants. As a prioritization strategy, total pollutant loadings discharged from each stormwater lake were calculated.

5.1.1.7 Stormwater Lakes Management Plan

Also in 2012, City staff provided a Proposed Stormwater Lakes Management Plan and an addendum to the plan. This plan proposed that City-owned stormwater lakes be restored to improve each lake's ability to remove pollutants, a comprehensive outreach program should be established, create local ordinances for stormwater lake management, and the creation/use of assessment districts for stormwater lake improvements. This plan identified the five lakes performing the poorest in terms of pollutant removal efficiency. These five lakes are South Lake, Lois Selfon Park (East Lake), Alligator Lake, Swan Lake, and Half Moon Lake. In all five cases, these lakes were adding pollutants to the stormwater discharge. To improve pollutant removal in the lakes, the plan suggests chemical and mineral treatment, aeration, floating vegetation islands, spot dredge, and/or full dredge.

5.1.1.8 Bathymetry and sediment characterization of Lake Manor

In 2013, the SW Florida Aquatic Ecology Group provided the City with a Bathymetry and Sediment Characterization of Lake Manor Report. Water samples were analyzed for chlorides, total Kjeldahl Nitrogen (TKN), total nitrogen (TN), Nitrates + nitrites (NOx), ammonia nitrogen, orthophosphate and total phosphorus (TP). Sediment was analyzed for the same aforementioned nutrients conducted for the water with the addition of total organic carbon and heavy metals (Al, As, Cd, Cu, Pb, Hg and Zn). The results of the report show that nitrogen limitation was occurring in the water and in the sediment. Additionally, the results states that Lake Manor had high concentrations of green micro algae and floating vegetation.

5.1.1.9 City of Naples Semi-annual and Quarterly Stormwater Infrastructure Monitoring

In 2013 and 2014, Amec Foster Wheeler provided the City with Semi-Annual and Quarterly Stormwater Infrastructure Monitoring Reports. The reports present the results of the stormwater and lakes monitoring as well as a prioritization strategy and remediation recommendations. Sampling conducted as part of this project included biannual lakes monitoring and quarterly pump station monitoring. The results of this continued monitoring were used to fill data gaps identified by a previous Amec Foster Wheeler report and to develop recommendations for structural and non-structural Best Management Practices (BMPs) that may be used by the City to improve the water quality of its stormwater lakes and the receiving waters of the state. The results from the 2013 report were able to fill in critical data gaps and identified conveyances with elevated pollutant concentrations and lakes with consistently high discharge pollutant concentrations. In 2014, since this monitoring program has been operated consistently for several years, the entire data set was examined to determine if trends have been detected, and whether there is evidence that trends were the response of City actions or other identifiable causes. In 2014, the report stated that loading estimates developed to support the Collier County Watershed Management Plan shows that more than 75% of TN, TP, and TSS discharging to Gordon River and Naples Bay come from unincorporated portions of Collier County via the GGC.

5.1.1.10 Natural Resources Division City of Naples FY 2014-15 Annual Report

In 2015, the Natural Resources Division of the City published a 2014-2015 Annual Report. The report identified the three major environmental challenges facing the City which included the Golden Gate Canal (GGC) dumping freshwater into Naples Bay, increasing impervious surfaces and stormwater runoff, and sea level rise. Additionally, the report reviewed the status of the Twenty Year Plan to Restore Naples Bay, summarized continuing projects, and described current advisory roles and committee participation.

5.1.1.11 Naples Bay Water Quality and Biological Analysis Project, Naples Bay Monitoring Design Recommendations for a Comprehensive Monitoring Program and Upland Stormwater Lake and Pump Station Water Quality Monitoring

In 2015, Cardno provided the City with three reports: Naples Bay Water Quality and Biological Analysis Project, Naples Bay Monitoring Design Recommendations for a Comprehensive Monitoring Program, and Upland Stormwater Lake and Pump Station Water Quality Monitoring – Q4 2014 Quarterly Report. The Water Quality and Biological Analysis Project provides a comprehensive update on the status of water quality and biology in Naples Bay. This project found that statistics for Naples Bay show a decreasing trend in nutrients but increasing trends in copper, chlorophyll a, turbidity, and bacteria (fecal coliform and enterococci). Additionally, nutrient and solids loading to Naples Bay likely contribute to the decreasing trend in seagrass. The Recommendations for a Comprehensive Monitoring Program compiled and analyzed available data to identify trends in water quality, biology, and the effects of water quality on the biological communities in the Bay. This Program recommended focusing resource management money on sampling biological communities that are more responsive to water quality changes as opposed to fish. The Program also recommended establishing restoration goals that have a specific biological endpoint. The Water Quality Monitoring Report recommended maintaining a semi-annual stormwater lake monitoring program, continue to collect samples, and continue to analyze copper based on conductivity of the lake or pump station at the time of monitoring.

5.1.1.12 Naples Bay Restoration and Water Quality Project at the Cove-Preliminary Design Report

In 2016, Stantec provided the City with a Preliminary Design Report for a Naples Bay Restoration and Water Quality Project at the Cove. This design report focuses the existing conditions at the Cove Outfall and identifies improvements that will reduce freshwater impacts to Cove outfall and assist in the restoration of Naples Bay. Four improvements were developed based on the evaluation: dredging and armoring at the Outfall, constructing a living shoreline, improve water quality upstream, and creating a public amenity at the cove.

5.1.1.13 Status of the 20 Year Plan to Restore Naples Bay

In 2015, the Naples City Manager put out a memo regarding the status of the 20 Year Plan to Restore Naples Bay. The 20 Year Plan had stated that within 5 years freshwater flowing into the Naples Bay would be reduced by a third. However, according the status memo this did not occur in the first five years due to modeling challenges. Another goal of the Plan was that during the first five years floating islands would be installed in 10 lakes and that additional rain gardens would be installed throughout the City. According to the memo, there are now floating islands in seven lakes and several rain gardens have been installed since the creation of the Plan. Five-year goals in the 20 Year Plan related to oysters and seagrasses were not fully met due to the continuation of freshwater discharges into the Bay. Additionally, the Plan had put forth a goal to have an outreach program for mangroves put into place within the first five years and this goal also had not been met at the time of the memo.

5.1.2 Summary of Identified Project Needs

5.1.2.1 Description of City of Naples's Stormwater System

The City's stormwater system connects to Naples Bay, Moorings Bay, and the Gulf of Mexico. According to the 2014-2015 Annual Report by the Natural Resources Division of the City of Naples, the stormwater system includes storm sewers, water control structures, rain gardens, vegetated swales, filter marshes, and 28 stormwater retention ponds within the City. Of those 28 lakes, 17 are private and 11 are on City property (City of Naples, 2010). The following information is a summary of the City's stormwater treatment and relevant water quality information provided in the Naples Bay-20 Year Restoration plan (2010), and the City of Naples FY 2014-2015 Annual Report.

- The City's Natural Resources Division has created various demonstration Rain Gardens. Rain gardens improve water quality by collecting stormwater and allowing plants to filter pollutants (fertilizer, yard waste, sediment, animal waste) naturally before the water drains into storm sewers

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and waterbodies. The City is now encouraging the community to build at least 1,000 rain gardens within the City boundaries, and has provided guidance on their construction.

- A filter marsh created by the City and located in the Riverside circle receives diverted water from a ditch connecting the northernmost City stormwater pump to the Gordon River by point discharge. Stormwater is now filtered by vegetation in the wetland before sheet-flowing over a weir into a mangrove forest before reaching the river.

- Retention ponds reduce flooding by collecting/receiving rainfall and redirecting the stormwater to natural waterbodies. The stormwater ponds in the City are 40 to 50 years old and after decades of use the water quality in these ponds has decreased due to excess of sediment, nutrients (nitrogen and phosphorus), bacteria, and other pollutants. Over the years, a few of the ponds were treated for algae using copper sulfate. This copper moved through the stormwater system and ended up in the Naples Bay, which is now impaired for copper.

    - Alternative methods for managing algae are now in use, including floating islands (artificial platforms of planted vegetation) in seven ponds and aerators within ten ponds. The floating islands out compete the algae by taking in excess nutrients and in some cases excreting a poison that kills algae. The aerators reduce favorable conditions for algae by increasing oxygen and reducing temperature. In general, these methods have been successful at reducing algae within the ponds. However, in some areas the floating islands are not able to handle the excessive amount of nutrients in the ponds caused by fertilizer and grass clippings from residential areas.

5.1.2.2 Stormwater System Project Needs

The Twenty Year Plan to Restore Naples Bay stated that the water quality of the bay would improve and habitat would increase as a result of filter marsh construction, pond shore plantings, and floating islands. However, a recent statistical analysis of the City's water quality data indicates that nutrients are declining in the bay, but copper and bacteria have increased (Cardno, 2015a). Additionally, the City has made efforts to install floating islands and rain gardens. City staff work with residents to educate and assist citizen efforts; however, there is currently no overarching environmental outreach program.

5.2 Receiving Waters Considerations

Stormwater runoff is discharged into three primary receiving water bodies: Naples Bay, the Gulf of Mexico, and Moorings Bay-aka Naples Estuary (Cardno, 2015a). These three water bodies are tidally influenced and support a variety of plant and wildlife species. Additionally, the increased development of the surrounding land areas has negatively affected water quality in Naples and Moorings Bay and in nearshore areas of the Gulf of Mexico. The Gordon River and upland surface waters also receive discharge from the City of Naples stormwater, and is further discussed in this section.

5.2.1 Naples Bay

Naples Bay is a relatively narrow (100-1,500ft) and shallow (1-23ft) estuary with a watershed of approximately 120 square miles (mi^2) (Cardno, 2015a). The Bay is formed by the confluence of the Gordon River and other small tributaries that empty into the Gulf of Mexico through Gordon Pass (Tetra Tech 2007). Although the Naples Bay Watershed (NBW) is wholly contained within Collier County, the City of Naples comprises approximately 14.5 mi^2 (Tera Tech, 2007), out of a total area of 15.93 mi^2, within this watershed. In addition, the NWB is wholly contained within the Big Cypress Basin (Tetra Tech, 2007). Currently, the Big Cypress Basin board collected continuous data on rainfall, evaporation, surface and groundwater levels, stormflow, and water quality from 106 hydrologic monitoring stations, from which seven are of immediate interest to the City of Naples (Gold Gate Weir 1, Gold Gate Weir 2, Gordon River, Haldeman Creek, I-75 Weir 1, CR31 South and The Conservancy).

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On average, the Golden Gate Canal (GGC) discharges 150 million gallons of freshwater a day into Naples Bay. The Bay receives the majority of its runoff from Collier County via the GGC (TetraTech, 2007). Prior to construction of the GGC, the Naples Bay watershed drained a total 10 mi^2 (Cardno, 2015a). Additional sources of freshwater include stormwater runoff, the Gordon River, Rock Creek, and Haldeman Creek, while saltwater exchange between Naples Bay and the Gulf of Mexico occurs via Gordon Pass (Cardno, 2015a). This has affected the salinity of the bay and the animals and plants in that live in the area.

Furthermore, development has increased the amount of impervious surface, increasing in turn the flow of stormwater. As a result, the canal carries large loads of nutrients, copper, bacteria, and sediment, making it a major source of the bay's pollution. All three City of Naples pump stations discharge into Naples Bay or into the Gordon River. Basins 3, 4, 7, 11, and 12 discharge into Naples Bay and Basins 5, 6, 8, 9, and 10 discharge into the Gordon River (TetraTech, 2007). Residential and commercial land uses are dominant within these basins. The Cove Pump Station outfall is the discharge point for Basin 3 and the contributing drainage area covers a largely impervious area of approximately 0.7 mi^2 (Stantec, 2016). The total contribution of surface water from City of Naples to Gordon River and Naples Bay is approximately 10 mi^2 (Amec, 2014).

Currently, Naples Bay supports a fish community similar to other regional estuaries in less developed areas. However, Naples Bay no longer exhibits the natural salinity fluctuations of a protected estuarine bay (Tera Tech, 2007). Since the 1950s, increased pollutant loading due to urbanization, dredge and fill activities, and changes to the salinity regime following construction of the GGC in 1960, have contributed to a loss of 90% of the seagrass beds, 80% of the oyster reefs, and 70% of the mangrove fringe (Schmid et al., 2005, Cardno, 2015a). Furthermore, canals, seawalls and bulkheads have replaced extensive areas of mangrove (Tetra Tech, 2007). The flows and biology of natural tributaries have also been altered by changes in urban infrastructure (Tetra Tech, 2007). Based on a comparison of recent water quality data to a study conducted in the late 1970s (Simpson et al., 1979), freshwater contributions and concentrations of nutrients and chlorophyll a in Naples Bay have improved significantly since the 1970s. These water quality improvements are potentially a result of advances in stormwater practices and adoption of water quality criteria as well as a decrease in flow from the GGC (Cardno, 2015a). However, discharges continue to contribute pollutants, nutrients, and solids to the waterbody. As a result, chlorophyll a concentrations in Naples Bay exceed the FDEP's chlorophyll criteria and the Bay is listed as impaired for copper and iron. Concentrations of fecal coliform and enterococci bacteria are also increasing (Cardno, 2015a). Salinity stratification is not pronounced in Naples Bay, but is greater in the wet season than in the winter months (Cardno, 2015a).

5.2.2 Gulf of Mexico

Ultimately, all of the City of Naples surface water runoff flows to the Gulf of Mexico (TetraTech, 2007). The Gulf of Mexico receives City of Naples surface water runoff directly via 9 stormwater outfalls, within Basin 2, and indirectly via Naples Bay and Moorings Bay (AECOM, 2012; TetraTech, 2007). Basin 2, which also discharges into Moorings Bay, contains primarily residential areas with commercial developments (TetraTech, 2007). Direct stormwater outfalls are no longer permitted in the State of Florida (Tetra Tech, 2007). Furthermore, there have been long-standing concerns from the State's regulatory agencies, City officials and staff, environmental groups, property owners, residents and visitors that the beach outfalls adversely impact beach erosion, lateral beach access, sea turtle nesting habitat, water quality, flooding and beach aesthetics (ECE, 2016). The City of Naples 2007 Stormwater Master Plan report included recommendations to evaluate alternatives to remove the beach outfalls and to treat pollutants.

City of Naples' Basin 2 outfalls were evaluated for their potential to degrade the beach and nearshore ecosystems during a Collier County beach nourishment permitting study (Humiston & Moore Engineers 2010). Specifically, the outfalls were evaluated relative to contribution to beach erosion, impact on sea turtle nesting habitat, degradation of water quality and lateral beach access. The 2010 study found minor, localized beach erosion and no apparent impacts on sea turtle nesting or lateral beach access. Still, in 2012, the City adopted Resolution No 12-13028 and amended their stormwater master plan to require the removal of the City's stormwater beach outfalls. These actions were taken to satisfy the FDEP JCP Condition (Permit No. 0222355-001-JC) for beach nourishment projects (City 2017).

A more recent (2016) report conducted in support of the City of Naples intention to remove the beach outfalls (ECE, 2016) indicated that the outfalls contribute to impaired water quality and the pollutants of interest for stormwater runoff into the Gulf of Mexico were bacteria, nutrients, suspended sediments, and mercury. The ECE 30% Design Technical Report (2016) also provides design requirements and an alternative analysis for the removal of beach outfalls. Overall, the preferred alternative in the 30% report is comprised of a "North System" and a "South System" as follows:

- North Drainage and Treatment System – consolidates the existing stormwater flows associated with Outfalls 2, 3 and 4 (25-Yr) and conveys the flows to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club.
- South Drainage and Treatment System - consolidates the existing stormwater flows associated with existing Outfalls 5, 6, 7, 8, 9 and 10 (25-Yr) and conveys these flows to a pump station located at 3rd Avenue North. An overflow line will be located at Outfall 6 to convey stormwater during extreme storm events.

Both systems will include treatment and discharge lines with diffuser systems placed offshore in the Gulf. The north system will treat 100% of the 25-yr peak flow through the pump station, while the south system will treat 77% of the 25-yr peak flow through the pump station.

5.2.3 Moorings Bay

The Moorings Bay system is comprised of Moorings Bay, Outer and Inner Doctor's Bays, and Venetian Bay and includes a number of man-made finger canals (TetraTech, 2007). This system has been extremely altered/engineered and discharges into the Gulf of Mexico via Doctor's Pass (TetraTech, 2007). The Moorings Bay system receives runoff from City of Naples Basins 1 and 2, and the primary land use in these basins is residential (TetraTech, 2007). Unlike the other waterbodies that receive City of Naples stormwater runoff (Naples Bay and the Gulf of Mexico), Moorings Bay is completely within the City of Naples.

The Moorings Bay system appears to be under-represented in regional water quality initiatives and water quality studies (TetraTech, 2007). However, the City of Naples monitors water quality in several stormwater lakes that contribute to Moorings Bay and these data indicate that Moorings Bay is potentially high in nutrients, bacteria, and copper (Cardno 2015b, AMEC 2014).

5.2.4 Gordon River

The Gordon River, which is located in Collier County, is one of the tributaries to Naples Bay and part of the Southwest Coast Planning Unit within the Everglades West Coast Basin. The river is approximately 3 miles long, originating near the center of the watershed as a drainage canal for several large golf courses. It then flows southward into a wetland region, eventually reaching the confluence with the Golden Gate Canal (FDEP 2008).

In the Gordon River watershed, which covers 5,154 acres, a number of land uses affect water quality through nonpoint source runoff. The most significant nonpoint sources include runoff and erosion from developed areas, small-scale construction, residential and commercial fertilizer use, pets, residential septic tank failure, or poorly designed septic tanks. The watershed has a limited amount of agriculture, with only 58 acres devoted to cropland and pasture (FDEP, 2008). The Gordon River Extension is impaired for dissolved oxygen (DO is < 5.0 mg/L). A final Total Maximum Daily Load (TMDL) for DO in the Gordon River Extension was proposed and adopted in 2008; however this TMDL does not have an associated Basin Management Action Plan (BMAP) yet (FDEP 2008, 2017a). The TMDL identified total nitrogen (TN) as the causative pollutant for the low DO.

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Several filter marsh projects have been completed to improve some of the pollution issues. One is at Collier County's Freedom Park, and the other is on the Conservancy's campus. Both marshes help filter out pollutants from stormwater runoff before it reaches the Gordon River. In addition, the Gordon River control structure at Golden Gate Parkway is intended to limit the flow from tidal exchange to prevent saltwater intrusion to the City of Naples Coastal Ridge wells. Above the control structure, channels are maintained as a dredged stormwater conveyance system to maintain an adequate flow regime. The main network of drainage canals extends approximately 3 miles north of the structure and connects with an additional 13 miles of drainage canals and ditches (FDEP, 2008).

5.2.5 Upland Surface Water

- Discuss the variety of landuse features that affect the upland surface water system
- Discuss the variety of BMPs included within the upland surface water system

5.3 Regulatory Standards Affecting the Stormwater Management Plan

The Federal Water Pollution Control Act of 1948 was the first major federal law to address water pollution (EPA, 2016). Further amendments to the Water Pollution Control Act, triggered by an increase in public awareness and their interest for controlling water pollution, led to the development of the Clean Water Act (CWA) of 1972. The CWA provides the statutory basis for Florida's water quality standards and for best management programs to restore the quality of impaired waters.

City of Naples use state and site-specific regulatory standards as a guidance to evaluate the quality of surface waters in the different WBIDs within the City of Naples boundaries. Waterbodies that receive stormwater from within City of Naples include Gordon River Extension (WBID 3278K), Gordon River Marine Segment (WBID 3278R5), Naples Bay Coastal (WBID 3278R4), Naples Estuary (WBID 3278Q2) and the Gulf of Mexico. In previous reports, some of these waterbodies had different WBIDs. For instance, the Naples Bay Coastal WBID 3278R has been retired, and subdivided by FDEP into five smaller WBIDs: 3278R1, 3278R2, 3278R3, 3278R4, and 3278R5. Only 3278R4 and 3278R5 are now within the City's boundaries. In addition, Amec Foster Wheeler reported a subset of ponds and lakes that do not discharge into their WBID boundaries as reported by FDEP (Amec FW, 2014). These include sample locations (BC, BC-Pond, BCG, Lakes 7, 8, 9, and 10) that discharge into the Gulf of Mexico not into Moorings Bay. In addition, Lake Manor that is shown to contribute to Gordon River Extension actually discharges into Naples Bay Coastal.

Regulatory standards, and guidance relevant to the City of Naples include, Numeric Nutrient Criteria (as applies to Naples Estuary and Naples Bay), Total Maximum Daily Load rules (as applies to Gordon River Extension for DO), the Impaired Waters Rule (IWR) Chapter 62-303 of the Florida Administrative Code (F.A.C), Surface Water Quality Standards (Chapter 62-302, F.A.C.) and/or local criteria set by the City or other local agency. The order in which these regulations are implemented are presented in the following diagram (Figure 5-1), and discussed in detail in the following sections.

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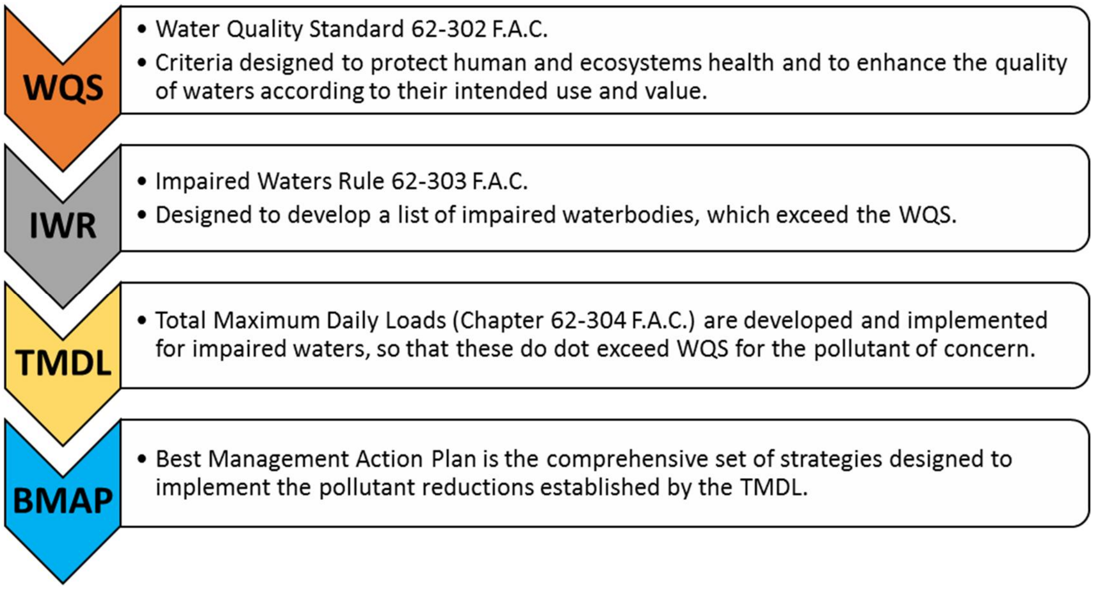
Figure 5-1 Regulation Implementation Chart



5.3.1 Water Quality Standard 62-302 F.A.C.

Florida's surface water quality standards system, adopted in March 1979, and published in 62-302 F.A.C (and 62-302.530 F.A.C.), were designed to protect human and ecosystem health and to enhance the quality of waters according to their intended use and value. The components of this system include classifications of waterbodies based on their use, criteria evaluated and minimum levels for protection of waters, an anti-degradation policy, and special protection of Outstanding Florida Waters.

The FDEP classifies Florida waters in six classes depending on their designated uses, and are arranged in descending degree of protection required as follows: Class I - Potable Water Supplies; Class II - Shellfish Propagation or Harvesting; Class III - Fish Consumption, Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife; Class III-Limited – Fish Consumption; Recreation or Limited Recreation; and/or Propagation and Maintenance of a Limited Population of Fish and Wildlife; Class IV - Agricultural Water Supplies; Class V - Navigation, Utility and Industrial Use.

The water quality standards 62-302 F.A.C. rule establishes that,

- Existing uses and the level of water quality necessary to protect the existing uses should be fully maintained and protected.
- Any discharge of pollution, which causes or contributes to violations of water quality standards, should not be allowed.
- Waters must be protected and enhanced in order to meet the water quality standards, unless exceeding criteria represents the natural conditions of the system.
- If a requested discharge to a waterbody, which is clearly in the public interest, is not expected to reduce the quality of the receiving waters below the classification established for them, it could be permitted.

In addition to standards provided on 62-302 F.A.C. rule, the Numeric Nutrient Criteria (NNC), defined under 62-302.530 F.A.C provides guidance for development and implementation of site-specific nutrient criteria. The first set of statewide numeric nutrient standards for Florida's waters was adopted in 2011, and by 2015, most water bodies in Florida had numeric nutrient standards.

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Most of Florida's freshwater streams, lakes, and springs are covered by numeric interpretations of the nutrient criterion, and only wetlands (except for the Everglades Protection Area) and South Florida canals are not covered by numeric nutrient criteria. Non-perennial streams, man-made or physically altered canals/ditches with poor habitat used primarily as water conveyances for flood control, irrigation, etc., and tidal creeks may also be solely covered by the narrative criterion once properly documented as meeting one of the exclusions for the definition of a stream. In addition, numeric nutrient criteria are established for all estuary segments, including criteria for total nitrogen, total phosphorus, and chlorophyll *a*. For open ocean coastal waters, numeric criteria are established for chlorophyll *a* that are derived from satellite remote sensing techniques (http://www.dep.state.fl.us/water/wqssp/nutrients/).

The NNC established that:

- *When anthropogenic nutrient loading or concentrations exceed a system's assimilative capacity, the primary response consists of changes to the primary producer communities, and excess production of plant biomass. In turn, this enhanced floral biomass can lead to habitat loss, food web alterations, and/or low DO from decomposition of plant biomass or respiration. This chain of events is ultimately reflected in meaningful biological endpoints, such as excessive algal mats, excess water column chlorophyll-a, excess nuisance vascular plant growth, and/or failing Stream Condition Index (SCI) scores. Conversely, if data show that biological health is fully supported in an aquatic system (no adverse responses consistent with the ecological model), one may conclude that the associated nutrient regime is inherently protective of the waterbody, and the NNC is achieved.*

FDEP has developed a NNC for Naples Bay Coastal area and Naples Estuary (Table 5-2).

Table 5-2 NNC Developed for City of Naples Waterbodies

Water Body	TN (mg/L)	TP (mg/L)	Chlorophyll-a (µg/L)
Naples Estuary	0.040, in ≤10% samples	0.85, in ≤10% samples	8.1
Naples Bay Coastal	0.045	0.57	4.3

Proposed Revisions to Chapter 62-302, F.A.C.:
The Department of Environmental Protection (department) is initiating rulemaking to consider proposed revisions to the human health-based surface water quality criteria in Chapter 62-302, F.A.C. The revisions are based on updated scientific information on fish and drinking water consumption rates, toxicological data, and revised methods to estimate bioaccumulation of pollutants in fish. Additionally, the department is proposing to establish a new classification of surface waters (Class I-Treated, Treated Potable Water Supplies) and to reclassify seven Class III surface waters into the new classification (http://www.dep.state.fl.us/water/wqssp/).

5.3.2 Impaired Waters Rule 62-303 F.A.C.

On April 16, 2001 Florida's Environmental Regulation Commission approved chapter 62-303, F.A.C., for identification of impaired surface waters, also known as Impaired Waters Rule (IWR). This rule was most recently revised on October 17, 2016. The IWR provides guidance for the development of a planning list (potentially impaired waters), which include waterbodies that may not be meeting water quality standards but for which sufficient scientific data are not available to judge; and a verified list, that include waters determined based on sufficient, reliable data, to be failing water quality standards. FDEP must submit the verified list to EPA for approval. Each water body on the planning list is further monitored to establish whether it truly is impaired.

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Figure 5-2 Water Body Identification Number (WBID) Map

- To be inserted in the 90% submittal.

How are waterbodies selected to be in the planning list and the verified list?

Pursuant to Chapter 62-303, F.A.C., the FDEP assesses whether there is an adverse trend in nutrients (nitrate-nitrite, TN or TP) or a nutrient response variable (chlorophyll a) and if the waterbody is expected to become impaired. If statistically significant adverse trends are present in causal variables, then the waterbody will initially be placed on the Planning List of potentially impaired waters so that a more rigorous statistical analysis can be conducted.

- *If statistically significant adverse trends are present in causal variables after controlling for confounding variables and the waterbody is expected to become impaired within 10 years, then the waterbody will be placed on the Study List and the Department will develop a site specific interpretation of the NNC for the waterbody.*
- *If statistically significant adverse trends are present in response variables (after controlling for confounding variables) and the waterbody is expected to become impaired within 5 years, then the waterbody will be placed on the Verified List for nutrient impairment, pursuant to subsection 62- 303.450(4), F.A.C., and a TMDL will be developed, which will be a site-specific interpretation of the NNC and set levels/allocations to upstream waterbodies.*

How is the IWR Implemented?

Overall, waterbodies are impaired under the Clean Water Act if they fail to meet their water quality standards according to the IWR. Once a water body is classified as impaired the state is obligated to develop a plan to restore their water quality. According to the Everglades West Coast Group 1 Basin/ South District verified list published by FDEP in October of 2016, the Gordon River Marine Segment (WBID 3278R5), Naples Estuary (WBID 3278Q2) and Naples Bay Coastal (WBIDs 3278R4) are impaired. Table 5-3 summarizes the impairments.

Table 5-3 Status of City of Naples Waters under Existing and Potential Requirements

Water Body	Description of Water Quality Status
Naples Estuary	Impaired for mercury
Naples Bay Coastal	Impaired for copper, iron, mercury, and dissolved oxygen
Gordon River Marine	Impaired for copper, iron, and dissolved oxygen
Gordon River Extension	Impaired for total nitrogen and dissolved oxygen

The current status for impairment of waterbodies within the City of Naples is as follows. Naples Estuary (WBID 3278Q2) is impaired for mercury. The concentration causing the impairment for mercury is methylmercury > 0.3 milligrams per kilograms (mg/Kg) in edible fish tissue. A statewide mercury TMDL has been developed (FDEP 2013), but not yet adopted, and will be used as guidance to reduce mercury loads throughout the state. It should be noted that Naples Estuary was delisted from the Verified List because previous WBID number was retired (3278Q), and all associated data was re-assigned to WBIDs 3278Q1 and 3278Q2. However, the current verified list of impaired waters, has no mention of Naples Estuary or WBID 3278Q2. Furthermore, WBID 3278Q1 was assigned to Clam Bay.

Naples Bay, WBID 3278R4, is impaired for copper, iron, and mercury. The concentration causing impairment for copper is > 3.7 micrograms per liter (µg/L), iron is > 0.3 milligrams per liter (mg/L), and methylmercury is Hg > 0.3 mg/Kg, in edible fish tissue.

Gordon River Marine Segment, WBID 3278R5, is impaired for copper, iron, DO, and mercury. The concentration causing impairment for copper is > 3.7 µg/L, iron is > 0.3 mg/L, and methylmercury > 0.3 mg/Kg in fish tissue. Although this portion of Gordon River is identified as impaired for DO (DO is < 4.0 mg/L), the causative agent for the impairment cannot be identified; it is thus placed in Category 4d. In a FDEP Responsiveness Summary Concerning Public Comments on Chapters 62-302 and 62-303, F.A.C., the District stated: "the Department concluded that the anthropogenic issues in Naples Bay (now known as Gordon River Marine Segment) involve physical alteration (dredge and fill) and inappropriate freshwater delivery, not nutrients. In fact, the nutrients and chlorophyll in Naples Bay are lower than many other minimally disturbed estuary segments to the south." Thus, waterbodies placed into Category 4d, such as WBID 3278R5, will be monitored for their particular impairment before the next cycle of assessments.

The Gordon River Extension (WBID 3278K) is not listed on the verified list; however, this waterbody is impaired for DO (DO is < 5.0 mg/L). A final TMDL for DO in the Gordon River Extension was proposed and adopted in 2008. The TMDL identified total nitrogen (TN) as the causative pollutant for the low DO; a median TN concentration of 0.755 mg/L was calculated during the verified period. The target concentration for TN for the Gordon River is 0.74 mg/L and is believed to be the concentration at which DO for the river will meet Class III freshwater guidelines.

Finally, none of these WBIDs were found to be impaired for nutrients. However, as required by Chapter 2013-71, Law of Florida, as Part of the "Path Forward" Agreement with EPA, the state is required to establish Numeric Nutrient Criteria (NNC) for all estuaries by December 1, 2014. Further, it states "the current conditions of unimpaired waters will be the nutrient standards until NNC are adopted." In other words, until a NNC for estuaries is established, the current TN, total phosphorus (TP), and chlorophyll-a concentrations in unimpaired City of Naples estuaries will be considered acceptable concentrations.

5.3.3 TMDLs, Reasonable Assurance Plans, and Basin Management Action Plans

5.3.3.1 TMDLs

The Total Maximum Daily Load (TMDL) program was established in 1972 through Section 303 (d) of the federal Clean Water Act (CWA). The TMDLs establishes the maximum amount of a pollutant a waterbody can assimilate without exceeding established water quality standards for protection of humans and aquatic life (62-302 F.A.C.). TMDLs are established to determine the loading capacity of impaired waterbodies and to allocate that load among different pollutant sources so that the appropriate control actions can be taken and water quality standards can be achieved. TMDLs must be developed and adopted for each impairment identified on the verified lists developed through the IWR.

Florida is currently working on the development of a more comprehensive approach to protecting water quality. This new approach involves basin-wide assessments and the application of a full range of regulatory and non-regulatory strategies to reduce pollution, and the TMDL is the heart of this comprehensive approach.

<u>Basic steps of the TMDL program include:</u>

1. Assess the quality of surface waters--are they meeting surface water quality standards established on Chapter 62-302.
2. Determine which waters are impaired--which waterbodies are not meeting water quality standards for one of multiple pollutants (Impaired Waters Rule (IWR) - Chapter 62-303).
3. Establish and adopt, by rule, a TMDL for each impaired water body for the pollutants of concern--the ones causing the water quality problems (TMDLs - Chapter 62-304).
4. Develop, with extensive local stakeholder input, Basin Management Action Plans (BMAPs).
5. Implement the strategies and actions in the BMAP

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6. Measure the effectiveness of the BMAP, both continuously at the local level and through a formal re-evaluation every five years.
7. Adapt--change the plan and change the actions if things aren't working
8. Reassess the quality of surface waters continuously

The TMDL point source allocations are generally implemented through EPA's NPDES permits under CWA Section 402. This section of the Act requires that point source discharges be controlled by including water quality-based effluent limits in permits issued to point source entities. Under EPA's permitting regulations, water quality-based discharge limits in NPDES permits must be "consistent with the assumptions and requirements" of load allocations in EPA-approved TMDLs (FDEP, 2013).

To streamline the TMDL program, the FDEP adopted a five-year cycle. In 2000, the FDEP initiated development of TMDLs for the first group of basins (Group 1 - Everglades West Coast). The cycle will be repeated methodically and continuously over time, to determine the successes of clean-up efforts and problems associated with ongoing activities, make necessary changes, and consider and address new circumstances associated with growth and development. In addition, the Watershed Restoration Act directs the FDEP to report to the Governor and legislature after five years on the implementation of the TMDL program and recommend statutory changes necessary to improve it.

The City of Naples is part of the Group 1 Basin, Everglades West Coast Planning Unit in the South District. Not all listed impaired waters in City of Naples have TMDLs. Development of Naples Bay 2-year plan TMDL is still in progress. However, a Phase II municipal separate storm sewer system (MS4) permit (Permit Number FLR04E080) has been established for WBID 3278K, WBID 3278R5, and 3278R4 of the Gordon River Extension, Gordon River Marine Segment and Naples Bay coastal area. This TMDL was developed for DO, but the Gordon River Extension is also impaired for TN, Gordon River Marine Segment is also impaired for iron and copper and the Naples Bay Coastal area is also impaired for iron, copper, and mercury. TMDLs and NNCs should be developed.

Waterbodies have been delisted due to retired WBID number and subdivision of old WBIDs into smaller ones. Changes in the WBID numbers have resulted in elimination of areas previously identified as impaired for fecal coliforms.

Implementation of TMDLs:

The Watershed Restoration Act of 1999 (s. 403.067, F. S.) directs the Department of Environmental Protection to scientifically evaluate the quality of Florida's surface waters and promote the mechanisms necessary to clean up pollution. The threshold limits on pollutants in Florida surface waters, on which TMDLs are based, are set forth primarily in rule 62-302, F.A.C., and the associated table of water quality criteria. The law further directs FDEP to promote, in conjunction with Florida's water management districts, the Department of Agriculture and Consumer Services, local governments, and other affected parties, the specific mechanisms to accomplish the pollutant reductions necessary to meet the TMDL.

5.3.3.2 Basin Management Action Plans (BMAPs)

Adopted TMDLs are implemented through Basin Management Action Plans (BMAPs). BMAPs provide strategies and guidance to reduce and prevent discharges of the causative pollutant(s) identified in the TMDL. FDEP and the affected stakeholders collaborate to develop BMAPs or other implementation approaches. A basin may have more than one BMAP, based on practical considerations. The Florida Watershed Restoration Act (FWRA) contains provisions that guide the development of BMAPs and other TMDL implementation approaches (FDEP 2012b).

BMAPs typically include (FDEP 2008):

- Appropriate load reduction allocations among the affected parties
- A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach

- A description of further research, data collection, or source identification needed to achieve the TMDL
- Timetables for implementation
- Confirmed and potential funding mechanisms
- Any applicable signed agreement(s)
- Local ordinances defining actions to be taken or prohibited
- Any applicable local water quality standards, permits, or load limitation agreements
- Milestones for implementation and water quality improvement
- Implementation tracking, water quality monitoring, and follow-up measures

Progress assessments of adopted BMAPs are conducted every five years and revisions are made as needed, in cooperation with stakeholders.

5.3.3.3 Reasonable Assurance Plans

In some cases, Reasonable Assurance Plans (RAPs) are implemented for impaired waterbodies rather than TMDLs. Most waters that are verified as being impaired by a pollutant will be listed on the state's Verified List pursuant to the FWRA and Section 303(d) of the Clean Water Act. Once a waterbody is listed, TMDLs are developed for the causative pollutant(s). However, as required by the FWRA, the FDEP will evaluate whether existing or proposed pollution control mechanisms will effectively address the impairment before placing a waterbody on the state's Verified List. If it is found and documented that there is reasonable assurance that the impairment will be effectively addressed by the existing or proposed control measure(s), then the waterbody will not be listed on the final Verified List and therefore will not require a TMDL. From there it is determined if the waterbody will be placed in the 4b (Evaluation of Pollution Control Mechanisms) or 4e (Study List) category.

The rules for the 4b and 4e categories are as follows:

- 62-303.600 Evaluation of Pollution Control Mechanisms.

  (1) Upon determining that a water body is impaired, the Department shall evaluate whether existing or proposed technology-based effluent limitations and other pollution control programs under local, state, or federal authority are sufficient to result in the attainment of applicable water quality standards.
  (2) If, as a result of the factors set forth in (1), the water segment is expected to attain water quality standards in the future and is expected to make reasonable progress towards attainment of water quality standards by the time the next 303(d) list is scheduled to be submitted to EPA, the segment shall not be listed on the verified list. The Department shall document the basis for its decision, noting any proposed pollution control mechanisms and expected improvements in water quality that provide reasonable assurance that the water segment will attain applicable water quality standards.

- 62-303.390 The Study List.

  (2) A Class I, II, or III water shall be placed on the study list if: . . . .
  (d) A waterbody segment where pollution control mechanisms are in place or planned that meet the requirements of Rule 62-303.600, F.A.C., except that there is uncertainty when water quality standards will be attained and the waterbody segment requires additional study.

Waterbodies with restoration plans meeting the requirements of Rule 62- 303.600, F.A.C. ["4b plans" or "Reasonable Assurance Plans ("RAPs")] are not placed on the Verified List. For RAPs, there is reasonable assurance that pollution control mechanisms will result in water quality standards being met in the future and reasonable progress towards meeting the water quality standards will be made by the time

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the next Verified List that includes the basin of the affected waterbodies is scheduled to be submitted to EPA.

It is FDEP's responsibility to assure adequate documentation in the administrative record whenever it decides not to list an impaired waterbody. However, the Department expects local stakeholders (including state and local government) to prepare the necessary documentation to demonstrate reasonable assurance that their proposed control mechanisms will restore the waterbody to the current water standards. FDEP provides guidance to stakeholders on what information is needed and how it should be submitted. Standard documentation for RAPs include the descriptions of the impaired waterbody, water quality or aquatic ecological goals, procedures for monitoring and reporting results, and proposed corrective actions (FDEP 2015b).

5.3.4 NPDES Program

The National Pollutant Discharge Elimination System (NPDES) was developed by the U.S. Environmental Protection Agency (EPA), as part of the Clean Water Act of 1972. The NPDES stormwater permitting program was developed in two phases. Phase I was implemented in 1990, and addresses requirements for municipal storm sewer systems (MS4s) for large municipalities (population ≥100,000) and other industrial activities that disturbs >5 acres of land. Phase II was promulgated in 1999, and addresses additional sources, including MS4s not regulated under Phase I, and small construction activities disturbing between 1 and 5 acres of land.

In October 2000, the EPA authorized the Florida Department of Environmental Protection (FDEP) to implement the NPDES stormwater permitting program in the State of Florida. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (F.S.). The NPDES stormwater program regulates point source discharges of stormwater into surface waters of the State of Florida from different municipal, industrial and construction activities. As the NPDES stormwater permitting authority, FDEP is responsible for promulgating rules and issuing permits, managing and reviewing permit applications, and performing compliance and enforcement of these activities. This stormwater permitting program is separate from the State's stormwater/environmental resource permitting programs authorized by Part IV, Chapter 373, F.S. (593 KB) and implemented by FDEP, as well as the water management districts using these rules, and from local stormwater/water quality programs, which have their own regulations and permitting requirements.

The City of Naples was permitted under Phase II of the NPDES program, through FDEP permit number FLR04E080, on November of 2003. The permit is an ongoing process that requires the City to report all efforts implemented for pollution prevention management.

5.3.5 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.

In preparation for development of the Naples Bay SWIM Plan, a Naples Bay SWIM Reconnaissance Report was authorized in 2005. 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.

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

1. Initiative 1 – Water Quality: consists of two distinct but interrelated strategies: Water quality and flow monitoring; and water quality modeling.
2. Initiative 2 – Stormwater Quantity: focuses on identifying inflows from canals and stormwater conduits, including non-point discharges, and on mechanisms to reduce these excess flows and restore more natural timing and quantity of freshwater inflows to the Bay.
3. Initiative 3 – Watershed Master Planning and Implementation: assist local governments in coordinating their plan implementation and construction of projects through a prioritized stormwater retrofit program. A key tool for implementation is solicitation of available federal and state funding and identification of other partnering opportunities.
4. Initiative 4 – Habitat Assessment, Protection and Restoration: 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 will be evaluated and implemented as necessary.

5.3.6 City's Stormwater Management Regulation Program

It is the responsibility of the City, through its Stormwater Management Division (in partnership with other departments such as Building, Planning and Community Services), to effectively and efficiently regulate, manage and maintain stormwater drainage infrastructure and surface water bodies to meet growth management goals of flood prevention, groundwater recharge, wetland preservation and water quality protection (http://www.naplesgov.com/index.aspx?NID=382)

The stormwater management function is critical to achieving the City's current vision statement:

"Naples shall remain a premier City by continuing to protect its natural resources, enhance City aesthetics, ensure public safety, and continue to improve the quality of life for all who live in the City and visit through the year."

5.4 Evaluation of the City's Water Quality Monitoring Program

The City of Naples, Natural Resources Division, currently monitors surface estuarine waters in Naples Bay, the Gordon River, and Moorings Bay. Prior to January 2006, limited water quality monitoring in Naples Bay had been carried out by the Florida Department of Environmental Protection (DEP), and Collier County. However, in January of 2006, the City's Natural Resources Division established a scientific and technically valid water quality sampling program. Since that time, the water quality of Naples Bay and the Gordon River has been sampled on a monthly basis at 16 different locations; 8 one month and 8 different sites the next month. In October 2008, 4 sites were added in Moorings Bay. Sites were revamped in January 2011 for Naples Bay and the Gordon River so that a total of 8 sites are sampled every month and some relocated sites are sampling water coming into the City from creeks and outfalls that drain County lands. This will allow staff to determine what pollutants are entering the City limits and where they are coming from.

Parameters that are measured include turbidity, salinity, temperature, DO, and other physical parameters, and water samples are laboratory-tested for various nutrient, bacteria, and heavy metals. Having met the vigorous quality assurance and quality control requirements of the Florida Department of Environmental Protection (DEP), the data is entered into the official State of Florida data storage system (STORET). The City analyzes this data to assess trends and make management decisions concerning the restoration of Naples Bay.

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The City of Naples Stormwater Master Plan Update will focus on well-documented parameters and pollutants affecting water quality and ecology of main waterbodies and treatment ponds. Key parameters to be addressed and monitored include nutrients (nitrogen and phosphorus), a metal (copper), bacteria (*Enterococci sp*.), total suspended solids (TSS), and DO.

<u>Water Quality Sampling</u>

According to the Florida Department of Environmental Protection (DEP), the number one pollutant in Florida is stormwater runoff, and the City's stormwater system conveys runoff laden with pollution to natural water bodies. This is in addition to the freshwater inflow from the GGC that also conveys large annual loads of pollutants into Naples Bay. The bay has been designated as an impaired water body for nutrients, bacteria, and copper by both DEP and the U.S. Environmental Protection Agency. In January of 2006, the Natural Resources Division established a water quality sampling program that DEP considers to be scientifically valid. Since that time, the water quality of Naples Bay has been continuously tested on a monthly basis. Staff also sample Moorings Bay monthly on behalf of the Moorings Bay Special Taxing District. This mostly artificial lagoon receives stormwater runoff from approximately 75 inflow pipes and also takes in water from Clam Bay to the north through culverts under Seagate Drive. However, its water quality is better than Naples Bay due to the flushing effect of daily tides entering this confined and sea walled bay through Doctors Pass.

In 2014, the City hired a consulting firm with expertise in statistical analysis of environmental data to determine if significant trends existed in the water quality data over time and by location. They found that nutrients are declining, but copper and bacteria are increasing. There are two likely reasons for these results: one is that the fertilizer laws in the City and County are making a difference with respect to fertilizer runoff while, at the same time, the County is undergoing tremendous growth with more bacteria and copper inputs without source control programs. There are three major actions the City can take to further address these pollution issues: one, build more natural structural treatment facilities such as filter marshes, swales, and retention areas; two, change people's behavior through education and outreach; and three, lobby the state and county to divert water out of the GGC before it reaches Naples Bay.

5.4.1 Past and Current Water Quality and Biological Monitoring Programs

Sources to Naples Bay: Currently, the only major input to Naples Bay being quantified is the Main GGC system. The SFWMD maintains daily flow records for the three weirs in the GGC. Although the GGC may represent the most significant input of freshwater into Naples Bay, other tributaries also provide freshwater inflow and potential pollutants associated with that inflow that are not currently being quantified (*i.e.* Gordon River, Rock Creek, and Haldeman Creek).

Upland Stormwater Monitoring: The City currently conducts semi-annual water quality monitoring in 15 of the City's 28 stormwater lakes and quarterly monitoring of the three pump stations.

Naples Bay Water Quality Monitoring: The City is currently monitoring eight locations in Naples Bay and the marine segment of the Gordon River. Three of these locations have been monitored on a bi-monthly and monthly basis since 2005, while the rest were added to the program in 2011 and are currently sampled monthly. The three long-term locations provide a general characterization of Naples Bay, while the remaining five current stations are located in areas to represent stormwater and tributary inputs to the Bay. Additional sub-sets of stations monitored from 2005 to 2010 have been discontinued.

Naples Bay Biological Monitoring: Currently, the City conducts bi-monthly monitoring of fish in Naples Bay using an otter trawling technique. The program uses a random monitoring design in each of four zones covering the Gordon River (Marine Segment), Naples Bay proper, and the Port Royale canal area. Monitoring was specifically designed to mimic the Rookery Bay National Estuarine Research Reserve fish monitoring program to allow for comparisons between the two systems. In addition to fish, the City conducts annual monitoring of the existing seagrass beds in southern Naples Bay.

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5.4.2 Summary of Water Quality and Biological Data

All water quality data discussed in this section refers to data, up to 2014, reported and analyzed in the Cardno report (2015a), and additional 2015 data provided by the City.

Water quality data evaluated in the Cardno report were obtained from the South Florida Water Management District (SFWMD), Collier County, and the Florida **STO**rage and **RET**rieval (STORET) database. However, the primary source of data was the City of Naples Natural Resources Division. Table 5.4 provides a brief description from each source (Cardno, 2015a).

In preparation of this Stormwater Master Plan update, water quality data prepared for upload to FDEP STORET was acquired from the City of Naples for 2015 and reviewed. The data from 2015 was not available to Cardno at the time of their report.

The 2015 data supports the increasing trends that Cardno observed for copper, chlorphyll-a, turbidity, and fecal coliform bacteria. Additionally, the 2015 data supports the decreasing trend in nutrients that Cardno observed.

Table 5-4 Water Quality and Quantity Data Sources Used in Cardno Report (2015a)

Data Source	Location	Data Type	Number of Stations	Data Range	Number of Records
City of Naples	Naples Bay	Grab	16	2005-2010	480
	Naples Bay	Grab	8	2011-Present	384
	Stormwater lakes	Grab	15	2010-Present	81
	Pump Stations	Grab	3	2010-Present	32
	Pump Stations	Flow	3	2011-2014	Annual Totals
Collier County	Naples Bay and Tributaries	Grab	7	1995-2014	1900
	Collier County Facilities Management	Rainfall	1	2008-2014	Daily Records
USGS	Naples Bay	Continuous recording	4	2011-2014	440,420
SFWMD	Naples Bay	Grab	14	2000-2014	49,260
	GGC	Flow	1	2008-2014	Daily Records
NOAA-NERRS	Henderson Ck	Continuous recording	1	2011-2014	118,000
NOAA	GGC	Rainfall	1	1977-2014	Daily Records
FDEP STORET	Naples Bay	Grab	62	1998-2014	770
FDEP	Estero Bay	Continuous recording	3	2011-2014	143,140

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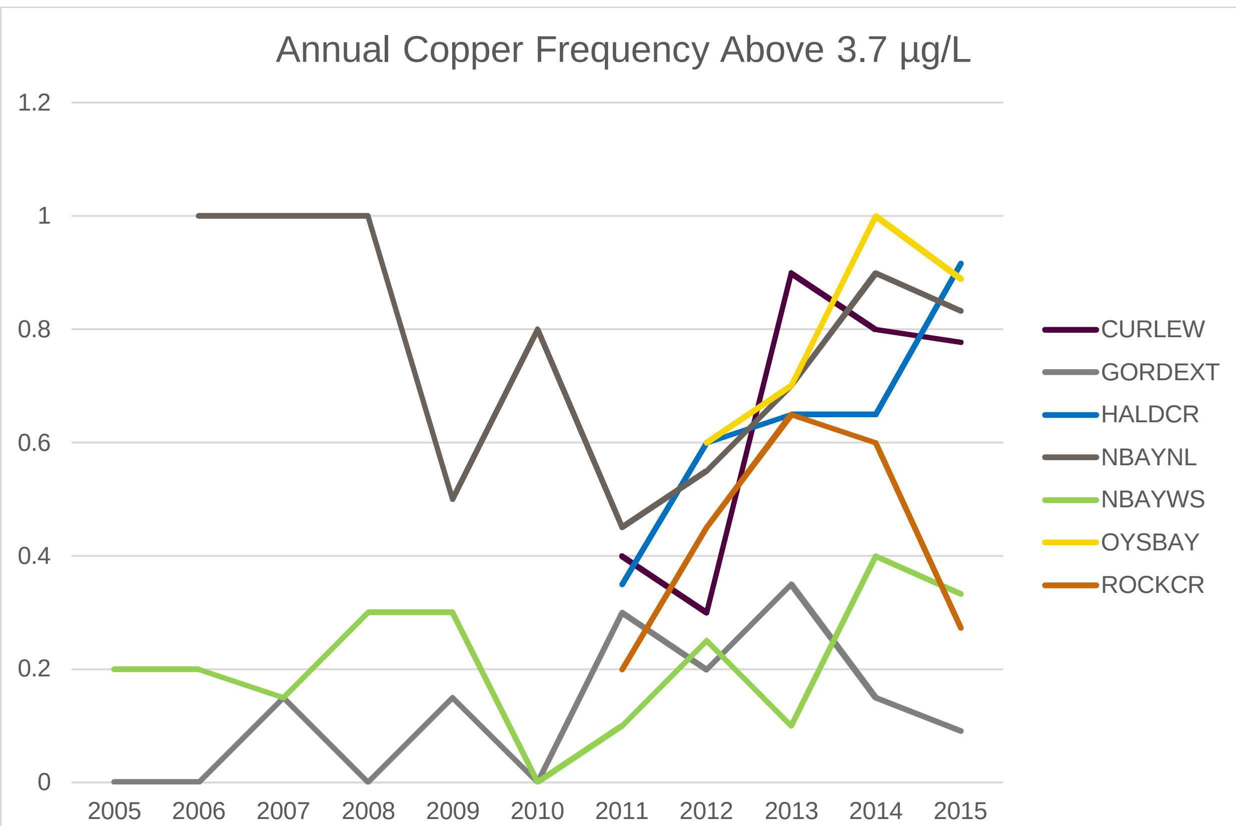
For copper, the 2015 data supports the increasing trends that Cardno observed with the exception of site ROCKCR (see Figure 5-1 below). At ROCKCR, the frequency of samples exceeding 3.7 µg/L of copper was lower than 2012-2014 and only slightly higher than 2011 (the first year samples were collected at this site). However, although 2015 data for copper follows the overall increasing trend that Cardno observed, the 2015 data shows that at all but one site (HALDCR) copper was lower in 2015 than in 2014. Figure 5-3 shows the annual copper frequency above 3.7 µg/L.

The 2015 geometric mean for chlorophyll-a in Naples Bay was 6.15 µg/L, which is consistent with Cardno's findings through 2014 (see Cardno 2015a, Figure 3-27). For nutrients, the 2015 geometric mean for TN (0.11 mg/l) and TP (0.03 mg/l) in Naples Bay were also consistent with the results observed by Cardno through 2014 (see Cardno 2015a, Figure 3-22 and Figure 3-23).

For turbidity, the 2015 range of lognormal values for GORDEXT (0.47-1.46 NTU), GPASS6 (0.47-2.94 NTU), NBAYNL (0.74-1.86 NTU), and NBAYWS (0.59-1.99 NTU) are consistent with the trends observed by Cardno through 2014 (see Cardno 2015a, Figure 3-31).

For fecal coliform bacteria, the 2015 range of lognormal values for GORDEXT (4.13-6.25 cfu/100ml), GPASS6 (0.69-4.36 cfu/100ml), NBAYNL (2.20-6.82 cfu/100ml), and NBAYWS (0.69-5.44 cfu/100ml) are consistent with the trends that Cardno observed from through 2014 (see Cardno 2015a, Figure 3-33). For enterococci bacteria, the 2015 range of lognormal values for GORDEXT (2.30-4.80 cfu/100ml), GPASS6 (2.30-3.95 cfu/100ml), NBAYNL (2.30-5.06 cfu/100ml), and NBAYWS (2.30-3.71 cfu/100ml) are consistent with the trends that Cardno observed (see Cardno 2015a, Figure 3-34).

Figure 5-3 Annual Copper Frequency Above 3.7 µg/L (Cardno 2015a, STORET 2015 Data)



Golden Gate Main Canal

Daily flow data from GGC Weir 1 are available from September 21, 2008 through December 31, 2014. Average daily flow over this time period was approximately 77 million gallons per day (mgd), including times of no flow. When the GGC1 Weir 1 is flowing, the average daily discharge is 123 mgd.

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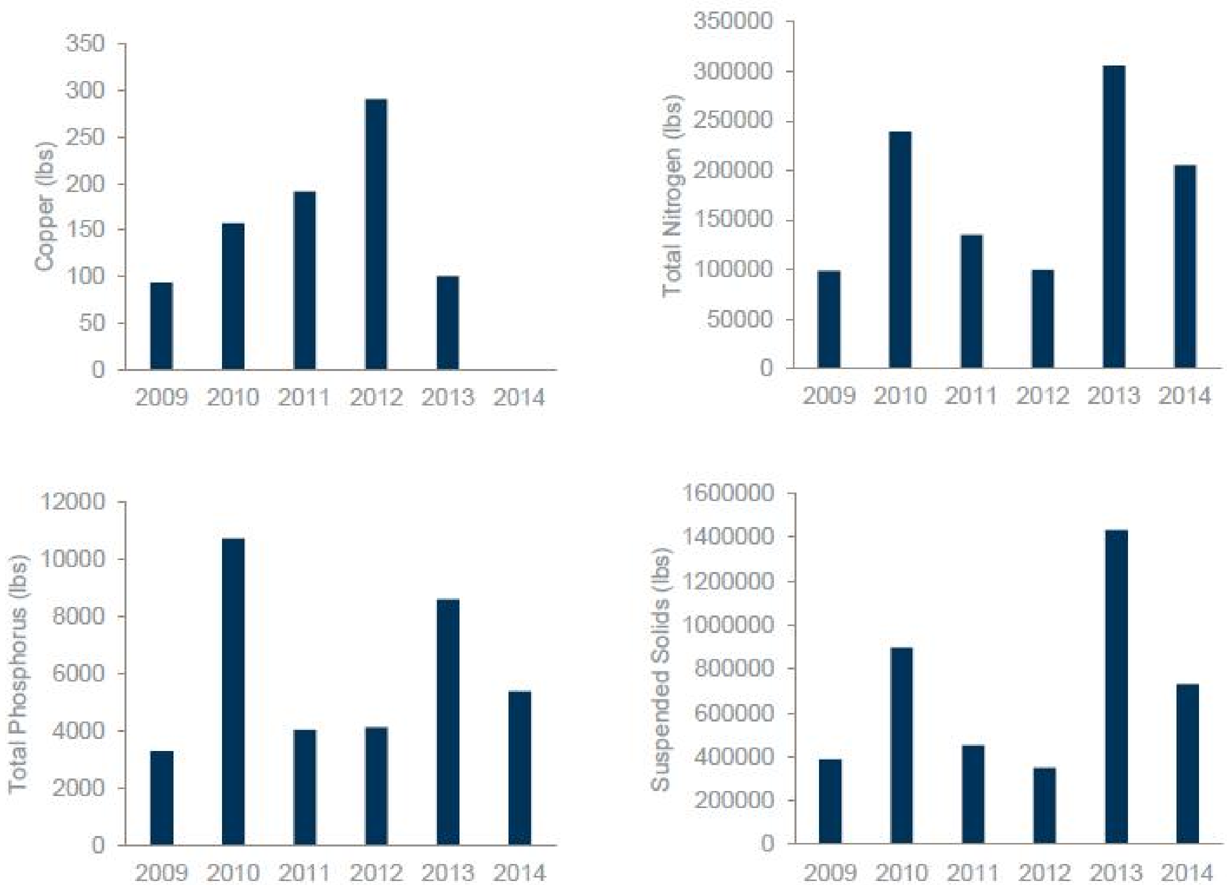
Total freshwater flow during the six months of the wet season (June–November) ranges from approximately 10 to over 40 billion gallons, typically constituting over 90 percent of the annual freshwater flow delivered from the GGC to Naples Bay.

Along with the large volume of freshwater, the GGC also delivers significant loadings of potential pollutants to Naples Bay. Although several water quality constituents are monitored at this location, the analysis reported in the Cardno report (2015a), and summarized herein, will focus on nutrients, copper, and suspended solids as the constituents of concern that represent potential impacts to the Bay. Pollutant loadings were calculated for the 2009 to 2014 period, using water quality measurements from the GGCAT31 sampling location. Over the 2009-2014 time period the average daily loadings from the GGC were approximately 0.45 lbs/day copper; 495 lbs/day nitrogen; 16.5 lbs/day phosphorus; and 1,945 lbs/day suspended solids. With the exception of copper, the time periods with the highest loadings (2010 and 2013) were observed during years with the greatest flow from GGC (Figure 5-4).

Figure 5-4 Total Annual Loads from the Golden Gate Canal System into the Gordon River (Marine Segment) and Naples Bay, 2009-2014 (Figure reprinted from Cardno, 2015a)

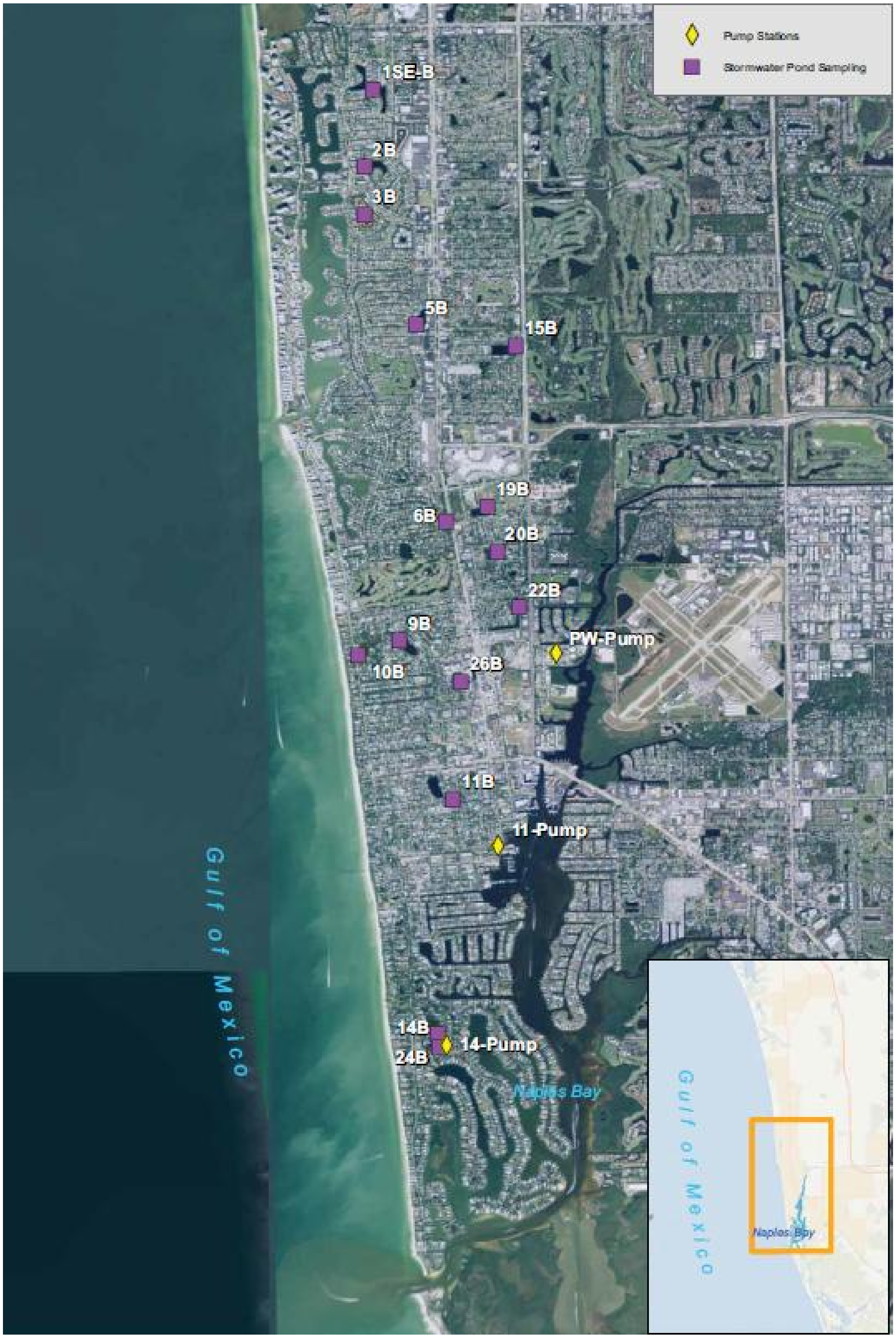


Urban Stormwater Runoff

Currently, 15 of the 28 stormwater lakes within the City and all three pump stations are included in the water quality monitoring program. Of the stormwater lakes in the monitoring program, four discharge to Moorings Bay, six discharge to the Gordon River (Marine Segment) above the SR 41 bridge, one discharges to northern Naples Bay, two discharge to the Port Royal canal area, and two discharge to the

Gulf of Mexico. For the purposes of representing the water quality that enters receiving waterbodies, only data collected at the discharge point of each stormwater lake is included in the analysis. However, due to the small sample size and inconsistent sampling frequency a time series analysis was not developed.

Figure 5-5 Stormwater Lake and Pump Stations Water Quality Monitoring Locations (Figure reprinted from Cardno, 2015a)



Characterization of water quality in stormwater contributions also focused on the major parameters of concern, and included copper, nutrients, suspended solids, and bacteria (fecal coliform and enterococci). In addition, calculations of loads to Naples Bay from the pump stations were performed for three distinct time periods: water year 2012 (October–September 2012); calendar year 2013, and calendar year 2014. The average daily loadings to Naples Bay from the three pump stations over the available time period were approximately 0.032 lbs/day copper; 12.9 lbs/day total nitrogen; 1.9 lbs/day total phosphorus; and 37 lbs/day total suspended solids. Additional loading information per year by pump station is described in Table 5.5.

Table 5-5 Total Annual Loads Delivered to Naples Bay through City of Naples Pump Stations (Cardno, 2015a)

		Total Annual Loads (lbs)		
Pump Station	**Parameter**	**WY2012**	**2013**	**2014**
PW-Pump	Copper	33.1	-	-
	Total Nitrogen	2566.9	-	-
	Total Phosphorus	162.6	-	-
	Suspended Solids	10425.3	-	-
11-Pump	Copper	8.3	11.3	5.4
	Total Nitrogen	5730.3	8755.3	1978.6
	Total Phosphorus	930.5	829.5	346.5
	Suspended Solids	14371.9	11514.7	5376.1
14-Pump	Copper	5.9	8.4	9.9
	Total Nitrogen	356.1	9393.5	4290.4
	Total Phosphorus	130.7	982	1427.8
	Suspended Solids	15219.8	24549.4	13526.9

Naples Bay

The water quality analysis provided in this section focuses on constituents that affect water quality in Naples Bay and have regulatory significance such as, salinity, nutrients, chlorophyll *a*, copper, turbidity, DO, and bacteria (fecal coliform and enterococci). In addition to a graphical and tabular interpretation of conditions of water quality in Naples Bay, the Cardno report (2015a) provides several types of statistical analyses for each constituent of concern at long-term data stations throughout the Bay (**Figure 5.6**). Statistical methods include, autoregressive error time-series models, predictive models between salinity and flow, Inverse Distance Weighting spatial interpolation, regression analysis, and parametric and nonparametric correlation analyses. Specific details of the statistical analysis or date related to predictive models are not discussed herein.

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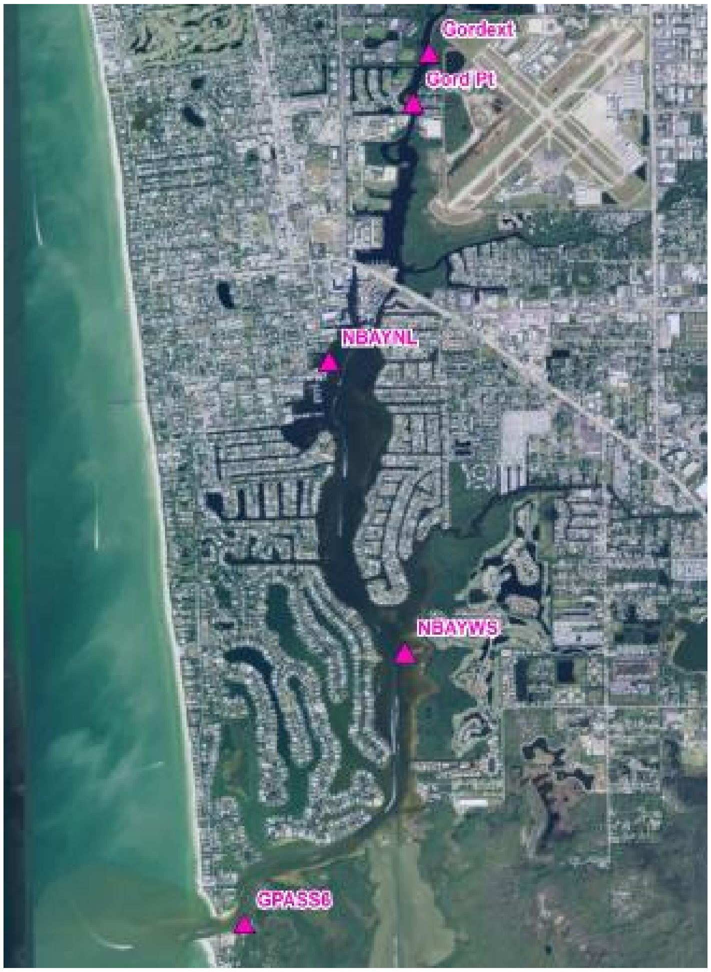
Figure 5-6 Naples Bay Long-Term Water Quality Monitoring Locations (Cardno, 2015a)



Salinity: All four USGS continuous monitoring stations (Figure 5-7) showed a negative relationship between GGC flow and average daily salinity (National Exponential Regression: Rowing Club Point R_2 = 0.86, City Dock R_2 = 0.92, Mid Estuary R_2 = 0.90, Gordon Pass R_2 = 0.79; $p < 0.05$), indicating that the entire Bay is affected by the GGC flow. When GGC flow is greater than approximately 300 cfs, the average salinity in the Gordon River above the SR 41 bridge drops below the regulatory threshold of 2.7 ppt for marine water (62-302.200(30), F.A.C.), turning this section of the Gordon River into a freshwater system. The vast majority of flow from the GGC occurs during the wet season and, as a result, the average salinity during summer months is much lower than during the winter. The seasonal differences in flow result in a more dramatic salt gradient during the wet season that pushes into northern Naples Bay from the Gordon River.

Results of the Autoregressive Error Model (AEM) time-series model analysis indicate salinity in Naples Bay is not changing over time ($p > 0.05$), although the model confirmed that GGC flow and rainfall have a statistically significant negative relationship with salinity in Naples Bay for most stations ($p < 0.05$).

Copper: As discussed in previous sections, the FDEP listed Naples Bay (**W**ater **B**ody **Id**entification Number (WBID) 3278R4) as impaired for copper in 2009 along with Rock Creek (WBID 3278R3), Haldeman Creek (WBID 3278R1), and the Gordon River (Marine Segment) (WBID 3278R5) that contribute to Naples Bay. Cardno (2015a) evaluated the spatial and temporal status of copper in Naples Bay relative to the Class II water quality standard of 3.7 µg/L. The highest copper concentrations were consistently found in Haldeman Creek, where annual average concentrations are four to eight times higher than the water quality standard at the SR 41 (Tamiami Trail Rd.) monitoring location.

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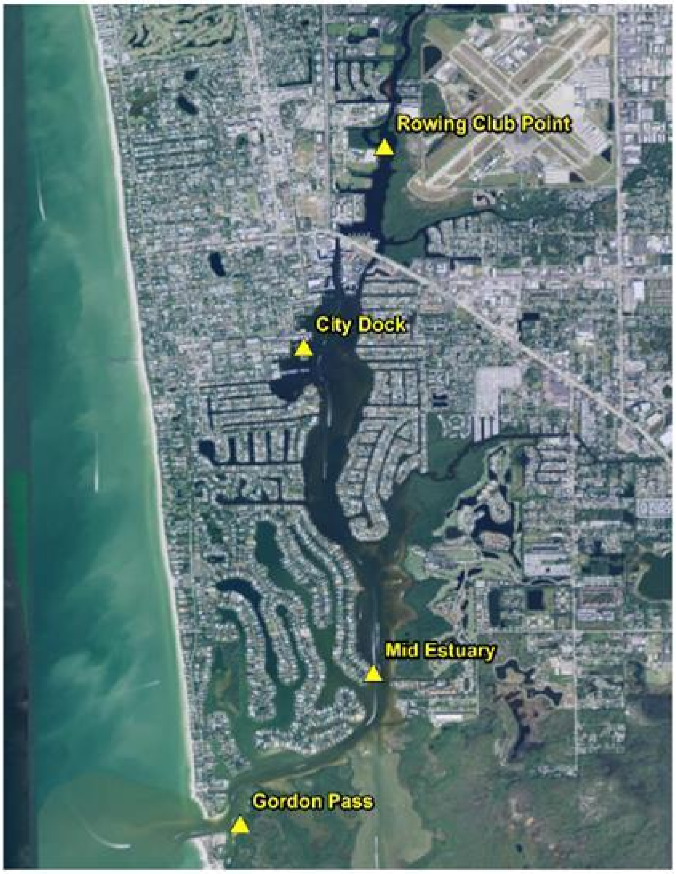
Figure 5-7 USGS Continuous Recorder Stations (Cardno, 2015a)



Copper concentrations at GGCAT31/3945 and GPASS6 were always below the 3.7 µg/L criteria and, therefore, were not included in the analysis. This indicates that copper concentrations delivered to Naples Bay from the GGC and at Gordon Pass do not exceed the water quality standard. Two other stations, HALDCRK and BC5, were above the threshold almost 100 percent of the time. The data from HALDCRK and BC5 were analyzed using the annual average concentrations instead of percentage of samples above the water quality standard. The water quality monitoring station locations are shown in Figure 5-8.

When considering the frequency of results above the threshold of 3.7 µg/L, patterns vary from station to station. GORDEXT/GORDPT has a statistically significant increase in the percent of copper measurements above 3.7 µg/L over time ($r = 0.66$, $p< 0.05$). NBAYNL shows a statistically significant decrease over time in the percent of copper measurements above 3.7 µg/L from 2006 to 2012 ($r = -0.80$, $p < 0.05$) and then a statistically significant increase over time from 2012 to 2014 ($r = 0.99$, $p < 0.05$). At NBAYWS, the percent of copper measurements above 3.7 µg/L was relatively consistent from 2005–2009, dropped to 0 percent in 2010, and then showed a strong but not significant increase from 2010 to 2014. BC2 showed a strong, but not statistically significant, increase in percent of copper measurements above 3.7 µg/L. Of the four stations with only four years of data (ROCKCR, CURLEW, OYSBAY, HALDCR), one showed a statistically significant increase (OYSBAY, $r = 0.98$, $p < 0.05$) in percent of copper above 3.7 µg/L over time. The other three showed high correlation coefficients (> 0.77) and visually clear increases in the percent of samples with copper concentrations above 3.7 µg/L over time from 2011 to 2014, but the increases were not statistically significant because of the small sample size ($0.1 < p < 0.25$). These four stations are located where tributaries enter Naples Bay (HALDCR and ROCKCR) or in dead end canals (OYSBAY and CURLEW) where stormwater enters the Bay.

The annual average copper concentrations at BC5 and HALDCRK (the stations where copper concentrations are almost always above 3.7 µg/L) do not show a significant correlation with time for either the arithmetic or geometric mean over the period of record (2001–2013). Although the data analysis

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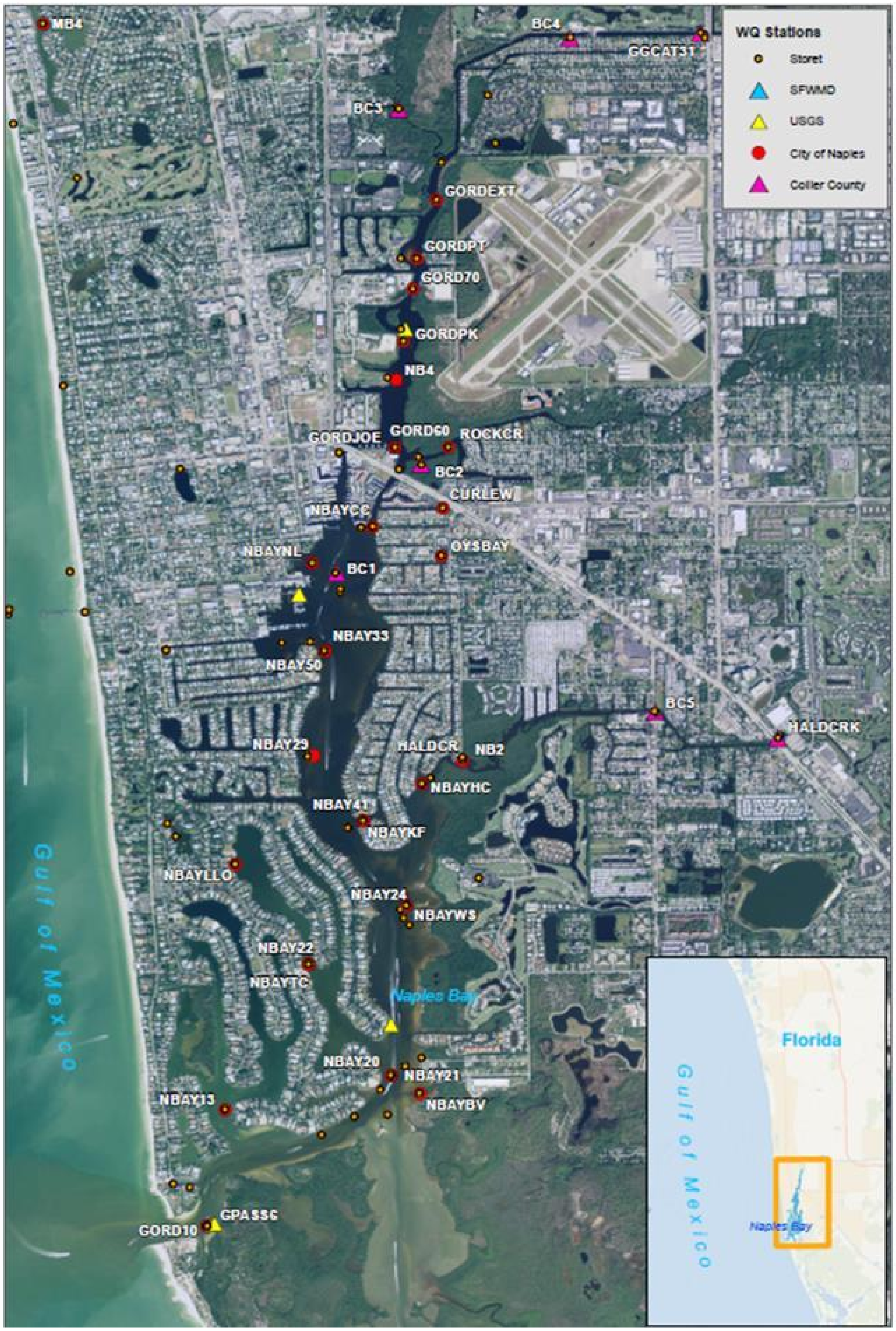
shows that while copper is spatially variable among the stations in Naples Bay and the tributaries, several stations appear to exhibit copper that is more frequently above the water quality standard in more recent years compared to earlier years in the dataset.

Figure 5-8 Water Quality Data Locations, Naples Bay (Cardno, 2015a)



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Nutrients (TN and TP): NNC for Naples Bay were adopted by the FDEP's Environmental Regulatory Commission (ERC) in 2011 and approved by EPA in 2012. The Naples Bay NNC is expressed as annual geometric mean concentrations that are not to be exceeded more than once in a three year period. The allowable concentrations are as follows:

- Total Nitrogen (TN) = 0.57 mg/L;
- Total Phosphorus (TP) = 0.045 mg/L, and
- Chlorophyll *a* = 4.3 µg/L.

Over the period of record (2002–2014) the TN and TP annual geometric mean concentrations in WBID 3278R4 (Naples Bay) appear to have decreased while TN and TP appear to remain relatively stable in WBID 3278R5 (Gordon River Marine Segment) (Figures 3-22 and 3-23). WBID 3278R4 (Naples Bay) has achieved the newly adopted NNC every year since 2006, with TP achieving the criteria every year since 2003, indicating the Bay is in compliance with the NNC. TN in WBID 3278R5 (Gordon River Marine Segment) typically fluctuates above and below the criteria with more than one year in a three year period above the limit, indicating non-compliance with the NNC. Prior to 2011, TP in WBID 3278R5 (Gordon River Marine Segment) exceeded the annual geometric mean NNC limit of 0.045 mg/L at least once in three years, but shows compliance with the NNC since after 2011.

AEM time series models, developed for stations with consistent long-term data, indicate a statistically significant decreasing trend in TN over time for the 2008–2014 period at all of the long-term stations (GORDEXT/GORDPT, NBAYNL, NBAYWS ($p < 0.05$); GPASS6 ($p < 0.1$)). Flow was not a significant covariate at any of the stations (and was not included in the best-fitting model), however rainfall showed a statistically significant positive relationship with TN at the Gordon River (GORDEXT/GORDPT) and mid estuary (NBAYWS) long-term stations. No statistically significant trends over time in TP were observed at any of the long-term stations when assessed over the 2008–2014 time period, and the models had very poor fit and few significant relationships with flow and rainfall.

The time-series model was extended back to 2005 by omitting the GGC flow covariate, which was not available before 2008. In the time-series analysis for 2005–2014, TP did show a statistically significant decreasing trend at the northern bay (NBAYNL) and mid-estuary stations (NBAYWS) in a model that included rainfall as a covariate.

Spatial interpolation of annual average TN were created (for illustration purposes) showing slightly higher nitrogen concentrations are typical in the upper portions of Naples Bay and the Gordon River (Marine Segment) compared to the lower portions of the Bay. This is not unexpected as the upper portion of the Bay is influenced by urban runoff and costal tributaries with less expected tidal exchange with the relatively low nutrient Gulf water. The decreasing overall nitrogen concentrations are apparent when data from 2008 are compared to 2013 data.

Chlorophyll a: The chloroplyll a (Chla) criterion is expressed as an annual geometric mean concentration of 4.3 µg/L not to be exceeded more than once in a three year period. Over the period of record (2000–2014), chlorophyll *a* concentrations in the WBID 3278R5 (Gordon River Marine Segment) and WBID 3278R4 (Naples Bay) have fluctuated around the newly adopted NNC criteria. Since 2005, more than one year in each three year period has exceeded the threshold, indicating chlorophyll *a* is not in compliance with the NNC. A total of 18 individual monitoring locations are included in this assessment for Naples Bay (WBID 3278R4), but only three have sufficient chlorophyll *a* data since 2011. Similarly, six individual locations were used in the assessment of the Gordon River (WBID 3278R5), with only two having data since 2011.

AEM time series models of chlorophyll *a* over time (2008–2014) show a statistically significant increasing trend at all of the long-term sampling locations (GODREXT/GORDPT, NBAYNL, NBAYWS) with the exception of the Gordon Pass location (GPASS6). However, it is possible that a higher laboratory Minimum Detection Limits (MDL) in the older data from the Gordon Pass location may be impacting this analysis. Flow was a significant covariate at the GORDEXT/GORDPT location with a negative relationship (chlorophyll *a* decreases as flow increases). Flow was not a statistically significant covariate at any other station. Rainfall was a statistically significant covariate at the NBAYWS and GPASS6 locations with a positive relationship indicating that chlorophyll *a* increases when rainfall increases. This may represent the localized effect of tributaries and rainfall on chlorophyll *a* concentrations instead of the GGC freshwater flow.

The Spearman's Rank Order Correlation showed that chlorophyll *a,* Naples Bay (WBID 3278R4), is weakly positively correlated with both TN and TP ($0.1 > [r_s] > 0.12$, $p < 0.05$). For the Gordon River Marine Segment (WBID 3278R5), chlorophyll *a* is weakly negatively correlated with TN ($-0.12 > [r_s]$, $p < 0.05$) and weakly negatively correlated with TP (Spearman's rank correlation, $0.21 > [r_s]$, $p < 0.05$). The weak results indicate that nutrient concentrations are not an accurate predictor of chlorophyll *a* in either waterbody.

Inverse Distance Weighting (IDW) interpolation showed higher chlorophyll *a* concentrations are typically found in the northern bay and
Gordon River (Marine Segment), with the highest values observed in Haldeman Creek.

Dissolved Oxygen (DO): In 2013, FDEP adopted revised DO criteria for fresh and marine waters. The new marine DO criterion is based on percent saturation instead of concentration and requires DO to maintain a daily average of 42 percent saturation (62-302.533, F.A.C.). In addition to the daily average, a seven day average percent saturation of 51 and a 30 day average percent saturation of 56 shall also be maintained.

WBIDs 3278R5 (Gordon River Marine Segment) and 3278R4 (Naples Bay) both achieve the DO criteria with far less than 10 percent of measurements below the 42 percent saturation benchmark. The grab sample data available (typically collected on a monthly or bi-monthly schedule) are insufficient to assess the seven day and 30 day average components of the criteria; however, with the vast majority of measurements above the 51 and 56 percent thresholds, there is no reason to suspect any exceedance of the DO weekly and monthly thresholds in Naples Bay.

Four stations in WBID 3278R4 (Naples Bay) and WBID 3278R5 (Gordon River Marine Segment) had enough long-term monitoring data to examine trends in DO concentrations over time at individual stations, accounting for the effects of flow from the GGC and regional rainfall. AEM time series models show no statistically significant trends in DO over time from 2008 to 2014 at the four long-term monitoring locations ($p > 0.05$). The models for the northern Naples Bay and mid-estuary stations (NBAYNL and NBAYWS) had rainfall as a significant negative covariate, with flow also a significant negative covariate at NBAYWS.

Turbidity: Although there is a marine water quality standard for turbidity, the standard is based on comparisons relative to natural background conditions, which are not defined for Naples Bay. In addition, turbidity values in Naples Bay are low relative to the exceedance values defined in the standard. Accordingly, turbidity trends were examined by station rather than by WBID.

Four stations in Naples Bay and Gordon River (Marine Segment) had enough long-term monitoring data to examine trends in turbidity over time at individual stations, accounting for the effects of flow from the GGC and regional rainfall with AEM time series models. Three of the four locations show a statistically significant increasing trend in turbidity in the 2008–2014 time period (GODREXT/GORDPT, NBAYNL, and GPASS6). NBAYWS was the only station that did not show a significant increasing trend. Flow was a statistically significant covariate at the northern Naples Bay (NBAYNL) and mid estuary (NBAYWS) locations with a negative relationship (as flow increases, turbidity decreases). Rainfall was a significant covariate at the Gordon River location (GORDEXT/GORDPT) and the mid estuary location (NBAYWS) with a positive relationship.

Based on IDW interpolation analysis, turbidity appears to increase from 2008 to 2013, with slightly higher values observed in the northern portion of the Bay.

Bacteria (Fecal coliform and Enterococci): The recommended limit of enterococci in marine waters to protect human health is a geometric mean of 35 cfu/100 mL with no more than 10 percent of values to exceed 130 cfu/100 mL (EPA 2012).

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Four stations in Naples Bay and Gordon River (Marine Segment) had enough long-term monitoring data to examine trends in bacteria concentrations over time at individual stations, accounting for the effects of flow from the GGC and regional rainfall with AEM time series models. Models for fecal coliform bacteria show a statistically significant increasing trend over time (2008–2014) at the northern most stations (GORDEXT/GORDPT ($p < 0.05$) and NBAYNL ($p < 0.1$)). Flow and rainfall covariates were seldom statistically significant for the best-fitting fecal coliform auto-regressive time series models.

Enterococci bacteria show a statistically significant increasing trend over time at all long-term stations with the exception of the Gordon River location. GGC flow was not a significant covariate at any station, however rainfall was a significant covariate with a positive relationship at all three Naples Bay long-term locations (NBAYNL, NBAYWS, and GPASS6). Enterococci bacteria persist in marine water much longer than fecal coliform bacteria and therefore may explain the identification of enterococci trends in the more consistently marine locations.

Based on IDW interpolation graphics enterococci levels appear to be higher in 2013 than 2008.

The primary source of biological data was the City of Naples Natural Resources Division ongoing monitoring efforts. Additional data, provided by the City to Cardno, were compiled from other southwest Florida estuary monitoring programs to serve as comparison to Naples Bay data. **Table 5.4** below summarizes data evaluated by Cardno (2015a).

Seagrass:

The City has been monitoring seagrass since 2006. Seagrass transects were monitored 1-2 times per year during the growing season from 2006 to 2014. Monitoring efforts occur along five fixed transects located in three separate seagrass areas (designated BV, NChannel, and SPortRoyal) located in the southernmost portion of Naples Bay. These three areas represent the majority of seagrass known in the Bay. The following indicators were used to evaluate and identify general patterns in the seagrass systems of Naples Bay over time: composition, cover, density, and water depth distribution.

Species observed in the survey area include: shoalweed (*Halodule wrightii*), paddle grass (*Halophila decipiens*), and Engelmann's seagrass (*Halophila engelmannii*). Shoalweed was the most common seagrass, occurring in 88 percent of the quadrats surveyed. Paddle grass and Engelmann's seagrass were less common, occurring in less than 5 percent of quadrats surveyed for the whole survey period from 2006 to 2014.

Cover was assessed using a modified Braun-Blanquet scale, which involves assigning a categorical score to a range of percent bottom cover. Total seagrass cover was generally low across all transects over the entire survey period. Coverage was generally low across all transects over the entire survey period, ranging from less than 5% in most areas up to 25% cover (Bran-Blanquet score of 1 and 2, respectively).

Density was measured as the number of short shoots per square meter. Measurements were taken within each fixed quadrat sampling location during each survey event. When data were considered together by year, shoalweed appeared to be increasing in density until about 2011 and then decreasing through 2014. However, when the data were considered by month, a trend of decreasing density as the growing season progresses becomes apparent. In southwest Florida bays, it is common for seagrass densities to decrease as the growing season progresses from summer to winter. From 2012 to 2014, seagrass surveys in the Naples Bay were conducted later in the survey season, which makes it difficult to determine if the trend is due to seasonal sampling bias or actual overall declines.

Water depths were standardized relative to mean high water (MHW) to eliminate tidal influence on the measurements. During the 2006–2014 monitoring, it was determined that shoalweed grows at the widest range of water depths out of the three species observed. The other two seagrass species were present only in slightly deeper water depths. Depth distributions observed are within the expected range for each species.

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Table 5-6 Biological Data Sources from 2006-2014 (Cardno 2015a)

Data Source	Location	Sample type	Approximate Data Range	Description
City of Naples	Southern Naples Bay	Seagrass	2006-2014	Five transects sampled once or twice per year between April and October. Quadrats placed at fixed points along transect: species composition, cover (Braun-Blanquet scale), shoot count, blade length, qualitative sediment type, water depth, and relative epiphyte coverage recorded.
	Naples and Moorings Bays	Fish-Trawling	2009-2011	Otter trawls pulled for specific lengths and times at four fixed locations in each Bay. Naples Bay was trawled approximately six times per year; Moorings Bay was trawled four times per year. Species identity and abundance recorded. Length of first 20 individuals of each species recorded. Bycatch and environmental conditions recorded.
			2011-2014	Otter trawls pulled for specific length and time. Four grid zones established in each Bay. A random grid box is selected within each zone for sampling in each Bay during each event. Naples Bay is trawled six times per year; Moorings Bay is trawled four times per year. Species were identified and abundance recorded. Length of first 20 individuals of each species recorded. Bycatch and environmental conditions recorded.
Rookery Bay National Estuarine Research Reserve	Rookery Bay	Fish-Trawling	2009-2011	Otter trawls pulled for specific length and time. A random grid box was selected for sampling at each event. Sampling approximately every other month from Apr 2009 to Apr 2011. Species identity and abundance recorded. Length of first 20 individuals of each species recorded. Bycatch and environmental conditions recorded.
	Fakahatchee		2009-2013	Otter trawls pulled for specific length and time. A random grid box was selected for sampling within each bay during each event. All bays trawled six times per year. Species identity and abundance recorded. Length of first 20 individuals of each species recorded. Bycatch and environmental conditions recorded.
	Faka Union Bay			
	Pumpkin Bay			

Fish community:

The City monitored the fish community in Naples Bay using bottom trawls from 2009 to 2014. During each sampling event in Naples Bay, samples were collected from four zones in the Bay. From 2009 to August 2011, sampling was conducted at fixed transect sites, but from October 2011 to 2014 sampling was conducted in one randomly selected grid in each zone during each sampling event. Statistical analyses of the fish community were conducted for structure, diversity, richness, and abundance. Cardno (2014) investigated whether the change in sampling methodology may have affected apparent trends, but this investigation was not conclusive.

No statistically significant relationships between water quality parameters and the fish community were observed in the Naples Bay trawling data. Between 2009 and 2014, Mojarras (*Eucinostomus* spp.) and anchovies (*Anchoa* spp.) were the most numerous taxa collected, accounting for almost 90 percent of the total catch. These two species were also the most frequently caught: occurring in 92 percent and 50 percent (respectively) of the samples.

Cardno (2014) compared fish community data from five (5) other southwest Florida bays with the data from Naples Bay. The similarity of the fish community in Naples Bay to other southwest Florida estuaries indicates the Naples Bay fish community does not appear to be sensitive to changes in water quality occurring in Naples Bay only (i.e. salinity). A reduction in diversity of the fish community occurred more or less simultaneously in 2011 in the six bays investigated by Cardno (2014); however diversity is lower in Naples Bay than the other bays after 2011. Cardno's investigation indicated the pattern of freshwater inputs to Naples Bay may have contributed to the reduced diversity observed after 2011.

5.4.3 Recommendations for Improvement of the Water Quality and Biological Monitoring Programs

The recommendations provided below are verbatim from the Naples Bay Monitoring Design report by Cardno (2015b). These recommendations are intended to complement the ongoing monitoring program and to further the long-term data, while providing additional water quality and biological data to address complex questions related to resource management and restoration. Recommendations were developed taking into account statistical analysis of water quality and biological data, including predictive models, reported in Naples Bay Water Quality and Biological Analysis Report (Cardno, 2015a).

<u>Recommendations for tributary sources:</u>

- Work with the SFWMD to install flow monitoring equipment at the Gordon River and Haldeman Creek weirs, as well as in Rock Creek to generate daily flow volume data comparable to flow volume generated at the GGC weir.
- Work with Collier County to establish a long-term water quality monitoring station at the Gordon River weir to quantify pollutant loads to the Bay from this source. The City already has a water quality monitoring location in Rock Creek (ROCKCR) and Collier County already monitors on the upstream side of the Haldeman Creek weir (HALDCRK).

<u>Recommendations for stormwater monitoring:</u>

- Stormwater lake and pump station monitoring frequency should be increased to monthly for 1-2 years to allow for identification of seasonal patterns and trends over time. After such time, sensitivity testing can be completed to determine if a less frequent (more cost effective) sampling frequency (perhaps bi-monthly) maintains the robust integrity of the dataset.
- Generate estimates of flow from each stormwater lake being monitored either through direct flow monitoring or estimations based on lake design and rainfall amounts to calculate loadings to receiving waters from the lakes.

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- Conduct paired monitoring of stormwater lake inflow and discharge points for all lakes with floating islands and at least three control lakes (no floating islands) for at least one year to quantify water quality changes as a result of inlake treatment.
- Verify with Home Owners Associations (HOA) and lake management contractors that copper is no longer being applied in lakes with floating islands and document the date of last application.
- Confirm all copper analyses are conducted using EPA method 200.8 or SM3113B MIBK.
- Record monthly totals of pump station discharge into Naples Bay to better characterize seasonal flow and loadings.
- Coordinate stormwater lake, pump station, and Naples Bay monitoring events to occur on the same day or within the same week to facilitate comparisons and to provide a basis for statistical correlation of bay measurements with inputs.
- Increase monitoring locations to include all 28 stormwater lakes.
- Generate stormwater volume estimations from the City's MS4 as well as the County's contribution into Naples Bay to generate overall stormwater volume and load estimates for comparison to other sources of flow to the Bay.

<u>Recommendations for Naples Bay water quality monitoring:</u>

- Supplement the Naples Bay monitoring with the addition of two stations to the current program, both of which were previous monitoring locations that were discontinued in 2011 (NBAY29 and NBAYBV) (Figure 2-1). These will improve the ability to characterize the Bay as well as provide site specific data for the area of the Bay nearest the current seagrass monitoring transects.
- The County should consider relocating station BC-3 upstream to the Gordon River weir near Golden Gate Parkway. The current location is subject to influence from the GGC flow, which is reflected in the dataset. Also, relocating the station allows for quantification of loads to Naples Bay from the Gordon River. This recommendation should be considered in conjunction with the previous recommendation to install flow meters in the tributaries to Naples Bay.
- The City's current station ROCKCR can be moved upstream to Airport Pulling Rd to quantify inputs from Rock Creek to Naples Bay (Figure 2-1). The County currently monitors BC-2 in the same location as ROCKCR, so these resources may be better used in quantifying the Rock Creek inputs in the new location. This recommendation should be considered in conjunction with the previous recommendation to install flow meters in the tributaries to Naples Bay.
- The City and County should collaborate on moving stations CURLEW and OYSBAY from their current locations to upstream locations that will allow for better characterization of stormwater inputs to the Bay from these sources (Figure 2-1). The new locations should be in the stormwater pipes that discharge to the Bay, and not in the dead end canals within the Bay where they are currently monitored.
- The City's HALDCR station should be moved "downstream" to a central location in the Haldeman Creek embayment where historic seagrass was observed (Figure 2-1). This would allow for a more robust characterization of this area that will be valuable in future seagrass restoration efforts. Also, the SFWMD currently monitors station NB2 in the same location as HALDCR so the sampling resources can be better used in the new location.
- The City, County, and SFWMD should collaborate monitoring efforts to ensure consistent monitoring frequencies, parameters, timing, and methods are used by all monitoring entities.
- Maintain the frequency of monitoring at all Bay stations as monthly data collection events.
- Confirm all copper laboratory analyses are completed using EPA method 200.8 or SM3113B MIBK.
- Review all laboratory Minimum Detection Limits (MDLs) with the contracted laboratory regularly and attempt to maintain them at reasonably low concentrations that are relatively consistent over time. Large increases in MDLs over the course of long-term monitoring can make it difficult to identify changes over time in the affected parameter.

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- Field measurements of water clarity (*i.e.* Secchi disk depth) and light limitation using LI-COR PAR sensors throughout the water column should be conducted during each monthly water quality event at all stations. This will be useful data when planning for future seagrass and oyster restoration activities. The City should also consider conducting a single water clarity transect on a monthly basis from the GGC down the center of the Bay to Gordon Pass (with sampling intervals to be determined). This could be done during the monthly water quality monitoring events and would be extremely valuable in understanding how, when, and where the GGC loadings are affecting Naples Bay.
- Consider installation of continuous recorders at the same four locations of the USGS recorders that were discontinued in 2014. These provide extremely useful data on daily and seasonal patterns that provide a robust characterization of Bay conditions and identify patterns and changes over time.

<u>Recommendations for Naples Bay biological monitoring:</u>

- Collect water quality grab samples during each biological (fish and seagrass) monitoring event at the location of monitoring for the same parameters as the monthly water quality monitoring.
- The current seagrass monitoring frequency is insufficient for linking the effects of management decisions to changes in seagrass condition. It also does not provide the information needed to evaluate and generate a rigorous cost-efficient survey design for the purpose of seagrass assessment. We recommend that at least three existing transects (locations to be determined later) be monitored on a monthly basis during the growing season (April – October) for approximately two years (pilot study). These data can be evaluated at the end of this period for the purpose of establishing a rigorous design for all seagrass locations. At a minimum, the remaining existing transects should be monitored twice a year once near the beginning and end of the growing season, and at the same time (i.e. during the same months) each year. This information can be used, along with the intense seagrass monitoring, to evaluate the ability to link water quality, biology, and management decisions over both space and time.
- Collect LI-COR PAR light availability measurements with each seagrass quadrat on all transects during each seagrass monitoring event.
- Measure Secchi disk depth along each transect during each seagrass monitoring event. Record when measurement represents “visible on bottom.”
- Map the spatial extent of each seagrass bed during each monitoring event to characterize changes in the size of the beds over time. This would allow for better comparisons of changes in Naples Bay over time as well as compare changes in other bays in the region and statewide.
- Record actual percent cover in addition to Braun-Blanquet score for each transect. Seagrass in Naples Bay is generally sparse and what could be considered a small increase in percent cover, for example from six or seven percent to 20 percent, could represent large relative increases in biomass and habitat function. The Braun-Blanquet scoring system masks these changes and limits the ability to detect changes over time.
- Add an additional fish sampling event during the wet season during the period of greatest GGC flow. The current sampling pattern is designed to capture samples throughout the year but is not capturing high and low flow periods equally.
- Add one or two fixed sampling locations for fish sampling. While the current random sampling method allows for an overall estimate of the fish community structure in Naples Bay, the variation among random sampling locations (in terms of habitat quality and environmental factors) makes it difficult to determine if there are site-specific factors during some sampling events that may mask or distort seasonal and inter-annual patterns. The fixed sampling locations can control for the potential effect of randomized sampling locations and help identify temporal trends.
- Include additional transects (three, if available) during each event in more sheltered areas as well as the current locations. The current monitored areas all have relatively high exposure to physical disturbance and, thus, it is difficult to determine the relative roles of disturbance and water quality on the structure of the seagrass system in Naples Bay. The exact locations of these additional

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transects would be determined in conjunction with the City experts who have greater knowledge of the sheltered areas and potential locations of seagrass.

- The random sampling design for the bi-monthly fish sampling is presumably designed to collect a more representative sample of the fish community within each zone than a fixed sampling design, in order to draw conclusions about differences between zones. However, the environmental differences among random sampling locations means one sample per zone may not always be representative of the breadth of fish habitats contained within the zone. Conducting at least three replicate random trawls within each zone during each fish monitoring event will provide an estimate of the within zone variance that can be used to test whether zones are different. The replicate data may also aid in getting a better estimate of fish community structure to pair with water quality data.
- Measure biomass for the species most commonly caught in the bottom trawls within each zone during each monitoring event (currently those species are *Eucinostomus* and *Anchoa*). There are few differences in the species assemblage or community structure across the sampling zones in Naples Bay, but length data suggest that there may be differences for some species among the zones. Thus, a link between water quality and fish community in Naples Bay may be found in differences in growth and biomass rather than abundance or species richness.
- Copper is a specific water quality constituent of concern in Naples Bay. A copper specific monitoring program to determine the effects of elevated copper concentrations on the biological community of the Bay should be considered. The program may include water quality, sediment, and biology (e.g. fish tissue samples, epiphyte copper accumulation) data to compare with known toxicological (mortality, growth, and reproduction) thresholds can be valuable for identifying any links between copper and the observed biological community in Naples Bay. For example, given the current sampling framework, semi-annual or annual sediment samples could be collected at the water quality monitoring locations, and fish tissue samples could be obtained during bi-monthly sampling events within each zone, along with seagrass epiphyte samples collected during each seagrass monitoring event. The details of such a program are outside the scope of these recommendations, but can be discussed and developed at the City’s discretion.

TAB 6

Level of Service (LOS) Analysis

6. Level of Service (LOS) Analysis

This Level of Service (LOS) Analysis includes a review of the existing LOS standards in the City's Comprehensive Plan and Land Development Regulations and a comparison of the standards to the water quantity assessment in Task 0003. Also included in the scope for this task, is a summary to illustrate where LOS standards are being met in each basin based on previous post-2007 basin studies, LIDAR, or other sources of information. This task includes recommendations on whether the current LOS standards should remain the same or change for future conditions.

A LOS is defined in Chapter 9J-5 FAC as an indicator of the extent or degree of service provided by, or proposed to be provided by a facility based on and related to the operational characteristics of the facility. A LOS standard is capacity relative to demand. For stormwater management, LOS standards represent degrees of protection provided for various development and natural features expressed in terms of storm events to be accommodated by the applicable drainage facilities.

LOS Standards apply to both water quantity, in terms of providing an efficient and effective stormwater management or drainage system which protects the public and property from flooding, and water quality, in terms of protecting surface waters from erosion and degradation of water quality. For water quantity, LOS Standards are used for the design of facilities such as roads, drainage systems such as conveyance and outfalls, and buildings.

Specifying the return period and duration of rainfall to be handled by a drainage facility establishes the degree of protection that the facility can be expected to provide. That is, the chance of overloading a facility designed to accommodate runoff from a 5 year 1-hour "design storm" is one in five, while the chance of satisfactory performance is four in five, in any given year for a storm lasting one hour. Generally, the greater the potential threat to life and property if a drainage system should fail, the more severe or less probable the design storm used in determining the drainage capacity required for that system.

For water quality, LOS is about public health and environmental quality. Water quality standards establish the water quality goals for specific waterbodies as well as for stormwater runoff and treatment quality. Water quality standards consist of the following elements:

- Designated uses such as "supporting aquatic life" or "recreation"
- Water quality criteria necessary to protect the designated uses
- Anti-degradation requirements
- General policies affecting the application and implementation of standards

It is necessary to establish water quality criteria and standards, in order to protect public health and environmental quality, as well as to determine how these items get regulated. For public health, achievement of water quality standards can improve quality of life for residents and visitors, including health and overall well-being, availability of seafood, and recreational fishing to name a few examples. For environment and ecology, water quality standards help maintain the overall health of ecosystems, including seagrass systems and their associated habitat for dependent species in Naples Bay. An assessment of the effectiveness of water quality standards relating to these components will be performed by reviewing existing LOS standards and comparing and contrasting the regulations to the requirements of implemented TMDLs and BMAPs for impaired waters.

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6.1 Water Quantity LOS

6.1.1 Evaluation of Past Studies LOS

A review of studies completed since the 2007 Master Plan included the following: Naples Beach Stormwater Outfalls (AECOM, 2012) in Basin 2, Basin 3 Modeling (Johnson Engineering, 2011), and Central Avenue (Kimley-Horn, 2013).

From Table 6 of the Naples Beach Stormwater Outfalls Report, there were seven nodes where a 5-year 1-hour LOS were not being met for at least a portion of the main roadway in the subbasin. The locations are all within Basin 2.

Table 6-1 Naples Beach Stormwater Outfalls Report LOS Table 6

Location	Main Road Elev, (ft NGVD)	5-yr 1-hr peak stage (ft NGVD)
Gulf Shore Blvd S. near 2nd Ave. So.	4.5-5.0	4.93
Gulf Shore Blvd S. near 1St Ave. So.	4.5 – 5.0	4.96
Gulf Shore Blvd S. So. of 1St Ave N. to No. of 1st Ave. So.	4.5 – 5.0	4.87
Gulf Shore Blvd N. near 1st Ave. N.	4.5 – 5.0	4.76
Gulf Shore Blvd N. near 2nd Ave. N.	4.5 – 5.0	4.87
Gulf Shore Blvd N. near 3rd Ave. N.	4.0 – 4.5	4.36
Palm Circle W. between S. Lake Dr. and 3rd Ave N.	7.0 – 8.5	7.87

In 2011, Johnson Engineering completed modeling for Basin 3 stormwater improvements. The modeling efforts included 2-year 24-hour, 5-year 24-hour and 10-year 24-hour storm events. The proposed condition model indicated only two locations where road flooding was experienced during a 2-year 24-hour storm: at the intersections of Gulf Shore Blvd and 3rd Ave S.(0.41 ft. depth) and Gulf Shore Blvd and 8th Ave. S.(0.58 ft. depth).

In Basin 6, Kimley-Horn prepared calculations for the Central Avenue Streetscape project in 2013. The project included drainage improvements to mitigate flooding frequency concentrated between 8th Street and 12th Street. The calculations were based on a 25-year 3-day storm for computing offsite discharge rates. In addition, the project was designed to comply with the City's Stormwater Ordinance 07-11807, which stipulates that the stormwater conveyance system be designed sufficiently so that the conveyance shall pass the design flow while ensuring that the backwater head does not exceed the proposed berms, walls or other containment systems in a 5-year 24-hour event (5.8 inches of rainfall).

6.1.2 City's Currently Approved LOS

The current water quantity LOS Standards in the City's Comprehensive Plan – Public Facilities and Water Resources Element, which was last updated in 2013, are included in Policies 1-10 and 1-11.

Policy 1-10 states that the LOS standard for surface water management for all development, redevelopment and the primary drainage systems requires no flooding during a 5-year 1-hour storm event for roads, yard drainage, pump stations and trunk lines and requires no flooding during a 100-year storm event for building finished floor elevations.

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Policy 1-11 states that all new development, redevelopment or substantial improvement of platted properties within the City shall be reviewed to assure compliance with local ordinances, design criteria and building code requirements, which include stormwater management systems to be constructed to minimum standards. This policy includes single-family, multi-family and non-residential mixed use properties.

For conveyance and water quantity, the criteria is: Unless otherwise specified by previous South Florida Water Management District (SFWMD) permits or SFWMD criteria, a storm event of 1-hr duration and 5-year return frequency shall be used in computing the minimum off-site discharge rates from private properties to the City's stormwater system. The conveyance system should be designed sufficiently so that the conveyance shall pass the design flow while ensuring that the backwater head does not exceed the proposed berms, walls or other containment systems in a 25-year 24-hour storm event. The side lot swales and other emergency conveyance facilities may be designed to pass the water forward to the public right-of-way.

The water quantity LOS Standards can be found in the Land Development Regulations in Stormwater Ordinance 07-11807, which includes amending Section 16-51 and adding Section 16-115 Stormwater Construction Standards on October 17, 2007.

The Stormwater Ordinance LOS criteria are essentially the same as that included in the 2013 Comprehensive Plan. Any new development, redevelopment or substantial improvement of platted properties shall be reviewed to assure compliance with the following minimum stormwater design criteria:

For Single-family, Multi-family and Non-Residential/Mixed Use, Conveyance/Quantity Goal "A" applies:

(A) Unless otherwise specified by previous SFWMD Permits or SFWMD criteria, a 5-year 1-hour storm per Policy 1-11 above.

In addition, implementation of stormwater improvements must be in compliance with the following Special Criteria:

- Signed and sealed plans and specifications prior to issuance of City permits
- Prior to Certificate of Occupancy or certification by design professional
- Establishment, re-establishment or maintenance of swales within the abutting street R/W in accordance with the City's Right-of-Way Standards handbook
- Prohibition of stormwater discharge into a platted alley unless a drainage conveyance system exists within the alley with sufficient surplus capacity to handle the proposed discharge.
- Roof gutters required on all buildings, although special cases where side yard widths are greater than 10 feet, the Building Official may allow an exemption if less than 25% of roof runoff is directed to die yard and erosion control is addressed.
- Streets, driveways and sidewalks shall be designed to minimize potential for increasing the runoff from private property into the City's stormwater system.
- Maintenance plan required for BMPs or innovative techniques. BMPs must be maintained in perpetuity.
- Environmental protection of downstream water bodies as part of Goal A: in rare instances where an existing property has elevations that will not grade back into the required stormwater master system, then as a minimum, the City requires some form of pre-treatment before discharging to the canal, lake, bay or other water body. Innovative BMPs shall be employed to accomplish this including (but not limited to): interceptor swales, containment berms, rain gardens and interconnection into the seawall rock drain system.

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6.1.3 Assessment of LOS

- Research other municipalities in the region to see how their LOS compares to Naples
- Provide suggestions based on the Regulation Review and the CRS Review

6.1.4 Recommendations on LOS

6.2 Water Quality LOS

Water quality standards are set and achieved in a variety of ways including stormwater design standards and implementations, TMDLs, BMAPs, and water quality mitigation. BMAPs are created to include a list of action items to reduce pollutant loadings to waters designated impaired by the establishment of TMDLs. Stormwater treatment standards are largely implemented through Best Management Practices (BMPs) such as wet retention, dry detention, and vegetated filter swales to name a few. BMPs are typically utilized when constructing new developments or redevelopments in order to meet the current water quality standards and avoid violations (City 2013). For existing developments that were built prior to the creation of current standards and regulations, stormwater retrofitting can be implemented to help those areas to increase their treatment efficiencies by implementing BMPs and subsequently reduce their impact on water quality degradation in the surrounding watershed. Furthermore, if activities or developments are determined to be increasing pollutant loading to an impaired waterbody, then water quality mitigation is required and implemented (SFWMD 2016).

Other programs and policies in place related to water quality and stormwater management include: stormwater utility fee, SFWMD regulations/permits, NPDES regulations/permits, street sweeping, City of Naples Ordinances (Stormwater Ordinance No. 07-11807, Construction Site Management Ordinance No. 14-13561, and Fertilizer Ordinance No. 08-11972), Collier County ordinances (Water Management Ordinance No. 1990-10, and Litter Ordinance No. 2005-44), Stormwater Pollution Prevention public outreach, Swale Restoration and Underdrain Program, filter marsh initiatives, lake assessment and maintenance contracts, and water quality monitoring programs.

An evaluation of the City's LOS criteria as it relates to water quality is useful in determining if current projects, future developments, initiatives and City regulations are meeting the standards put forth by the water management district, county, and state. It is important that the City's regulations and efforts are meeting the aforementioned standards and improving water quality impairments set forth through the establishment of TMDLs.

6.2.1 Existing Requirements for Pollution Abatement

Water quality design and performance criteria for stormwater management systems are regulated by the South Florida Water Management District through the Environmental Resource Permit (ERP) program authorized under Part IV of Chapter 373, F.S. (SFWMD 2016). In addition, the City's Comprehensive Plan (2013) also provides standards and regulations for water quality and stormwater treatment design. The current water quality requirements are listed in Table 6.1 in Section 6.4 of this document. The EPA provides water quality guidelines in their Water Quality Standards Handbook as well, but does not regulate or issue permits within the City. The State of Florida regulates water quality through implementation and adoption of TMDLs and BMAPs, as further discussed below. In addition, the current City Stormwater Ordinance mandates a minimum level of water quality retention/detention on all properties discharging into City owned roadway right-of-ways to be consistent with the SFWMD water quality standards (City 2007).

6.2.1.1 BMAPs and TMDLs

According to FDEP, "*Total Maximum Daily Loads (TMDL) are quantitative analyses of water bodies where one or more water quality standards are not being met, and are aimed at identifying the management strategies necessary to attain those water quality standards*" (FDEP 2016a). TMDLs determine the pollutant causing the impairment to a body of water and provide the maximum loading that the waterbody can receive and still meet water quality standards. Basin Management Action Plans (BMAPs) are developed to identify means to reduce the current and future loading to the TMDL and are implemented based on the adopted TMDL. BMAPs provide information and guidance on how to reduce pollutant loading for each specific waterbody (FDEP 2008).

Within the City of Naples, the Gordon River Extension is impaired for dissolved oxygen (DO is < 5.0 mg/L). The Gordon River Extension is located within Basins 1, 5, and 9, and includes areas that drain into the Gordon River. A final TMDL report for DO in the Gordon River Extension was published and adopted in 2008. The TMDL identified total nitrogen (TN) as the causative pollutant for the low DO. The TMDL requires a 29 percent reduction of TN for all known point sources. This reduction is allocated to the categories of load allocation (nonpoint source component of the load including stormwater runoff) and waste-load allocation (NPDES Stormwater Discharge points and wastewater treatment facility discharges). These allocations are responsible for determining the current load as well as the percentage load reduction in place due to improvements in the area (FDEP 2008). It should be noted that as of April 2017, there is no associated BMAP in place for this TMDL (FDEP 2012b, 2017a, 2017b).

The development of the Naples Bay 2-year plan TMDL is still in progress (FDEP 2015). This TMDL would be for water discharging into Naples Bay. Naples Bay is impaired for iron, copper, and mercury (FDEP 2012a, 2016b). Please see Table 6.2 for a summary of current TMDL and BMAP information.

6.2.1.2 New Construction Standards

Water quality standards for new construction is regulated by the City of Naples in the Comprehensive Plan (2013), the City Stormwater Ordinance as well as the South Florida Water Management District (SFWMD ERP Permitting). According to the Comprehensive Plan and the Stormwater Ordinance, the City provides design guidance for water quality standards, in addition to those regulated by the SFWMD. In accordance with the Stormwater Ordinance 07-11807, any new development, redevelopment or substantial improvement of platted properties within the City of Naples shall be reviewed to assure compliance with the following minimum stormwater design criteria for water quality:

- *Unless otherwise specified by previous SFWMD permits or district criteria, water quality standards shall be determined based upon selecting the most appropriate pollutant removal presumption to the corresponding BMP technique. The BMP guidelines used must meet a presumed pollutant removal of 85 percent Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorus (TP). BMPs that do not effectively remove TN and TP such as "dry detention" will be discouraged. Innovative approaches and LID techniques that reduce percent impervious are encouraged. Although reductions in storage volume may be given to BMPs that use "retention" and exfiltration, under no circumstances will the design storage volume be allowed to be less than one- half inch of retention storage volume nor less than 1.25 inch of dry detention storage volume (based on total site area). The following special conditions shall apply in meeting the above standards:*
    - *on single family lots, no more than one-half inch of detention or retention shall be stored underground in vaults, exfiltration pipes, or French drains;*
    - *rainfall runoff from roof drains can be disregarded from the water quality calculations;*
    - *retention systems shall be designed and located no less than 18 inches above the wet season water table; exfiltration and pervious pavement shall be designed to be a minimum of 24 inches above the wet season water table;*
    - *where special filtering materials are utilized, where swimming pools and patio areas are designed for storage or where special retention provisions are provided consistent with SFWMD criteria or consistent with Chapter 62 of the Florida Administrative Code, the building official may credit such areas in the computation of total on-site storage.*

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The SFWMD water quality design regulations require that new construction projects be designed and operated so that off-site discharges will meet State water quality standards. The SFWMD uses a presumptive criteria, that if the system is permitted, constructed, operated and maintained in accordance with Chapter 62-330, F.A.C., and Part III, Part IV, and Part V of the SFWMD Handbook Volume II, it is presumed to meet State water quality standards. The volume of runoff to be treated from a site shall be determined by the type of treatment system utilized. Systems which have a direct discharge to an Outstanding Florida Water, must provide an additional fifty percent of the required water quality treatment. The SFWMD water quality design criteria are listed below for reference:

- 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 flood protection calculations requires a guarantee of long term operation and maintenance of system bleed-down ability.
    - Systems with inlets in grassed areas will be credited with up to 0.2 inches of the required wet detention amount for the contributing areas. Full credit will be based on a ratio of 10:1 impervious area (paved or building area) to pervious area (i.e. the grassed area) with proportionately less credit grant

Please see Table 6.1 in Section 6.4 for a summary of the above referenced City of Naples and SFWMD water quality design criteria. SFWMD also has specific water quality design regulations in place for the following specific circumstances:

- Commercial and industrial zoned projects shall provide at least one-half inch of dry detention or retention pretreatment as part of the required retention / detention, unless reasonable assurances can be offered that hazardous materials will not enter the project's surface water management system, such as deed restrictions on property planned for re-sale, type of occupancy, recorded lease agreements, local government restrictive codes, ordinances, licenses, and separate containment systems designed to prevent discharge.
- Projects including more than 40% impervious area of the total project area, and which discharge directly to the District stated receiving waters, shall comply with the SFWMD regulations regarding providing at least one half inch of dry detention or retention pretreatment as part of the required water quality treatment.
- Public highway widening projects in urban areas having provided documentation demonstrating that all reasonable design alternatives have been considered, and providing evidence that the presented alternatives are all cost-prohibitive, have the option for the District to reduce the water quality requirements associated with the project.
- Stormwater treatment facilities shall not be constructed within 100 feet of a public drinking water well and shall not be constructed within 75 feet of a private drinking water well.

6.2.1.3 Retrofit Standards

In the City of Naples, there are some developments and structures that were built prior to the current regulations and standards; therefore, these developments might not meet the current design treatment standards. Retrofitting provides for stormwater treatment implementation at older developments and structures that were installed prior to the current standards and regulations. This allows for a reduction in negative impacts to stormwater quality and management. Although retrofitting does not guarantee that these developments and structures fully meet the current standards, it does ensure some degree of water quality improvement. The pollutants of concern for water quality improvement are determined on a case-by-case basis and are based upon factors such as the type and intensity of land use, existing water

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quality data within the area subject to the retrofit, and the degree of impairment or water quality violations in the receiving waters.

The primary requirement of a stormwater quality retrofit project in the City of Naples is that applicants provide proof that the project will provide additional water quality treatment such that there is a net reduction of the stormwater pollutant loading into receiving waters. Applicants can meet this requirement in a variety of ways, including the addition of treatment capacity to an existing stormwater management system such that it reduces loadings of stormwater pollutants of concern to receiving waters; adding treatment or attenuation capability to an existing developed area when either the existing stormwater management system or the developed area has substandard stormwater treatment and attenuation capabilities, compared to what would be required for a new system requiring a permit under Part IV of Chapter 373, F.S.; removing pollutants generated by, or resulting from, previous stormwater discharges (SFWMD 2016).

The applicants should provide reasonable assurances that their proposed stormwater quality retrofit will provide the intended pollutant load reduction from the existing system or systems. Reasonable assurances can include providing design, construction, operation, and maintenance plans for the project showing that it does not cause or contribute to any water quality violation; does not cause any adverse water quality impacts in receiving waters; does not reduce stormwater treatment capacity; does not increase discharges of untreated stormwater; does not cause new adverse water quantity impacts to receiving waters, and/or does not cause or contribute to increased flooding of adjacent lands.

6.2.2 Summary of past recommendations

Please see Table 6.1 below for a summary of previous LOS standards relating to Water Quality. It should be noted that the City's Stormwater Ordinance and the City's 2013 Comprehensive Plan update are consistent with the below recommendations.

Table 6-2 Summary of LOS Criteria Requirements

Agency	Water Quality Requirements
City of Naples (Existing Comprehensive Plan 1996)[a]	<u>Wet Detention:</u> 1st. 1" or 2.5" X % Imp. <u>Dry Detention:</u> Wet Det. X 75%, 1" Min. <u>Retention:</u> Wet Det. X 50%, 1" Min.
City of Naples (Existing Comprehensive Plan Updated December 3, 2013)[b]	<u>Wet Detention:</u> Best Management Practices (refer to Comprehensive Plan section Public Facilities and Water Resources Element Policy 1-11) <u>Dry Detention:</u> 1.25" Minimum <u>Retention:</u> 0.5" Minimum
SFWMD (Environmental Resource Permit Applicant's Handbook Volume II)[c]	<u>Wet Detention:</u> 1st 1" or 2.5" X % Impervious, whichever is greater <u>Dry Detention:</u> Wet Detention X 75%, 1" Minimum <u>Retention:</u> Wet Detention X 50%, 1" Minimum

Sources:
a. Tetra Tech. (2007). City of Naples Stormwater Master Plan Update 90% Draft Report.
b. City of Naples. 2013. Comprehensive Plan. Website: http://www.napleshistoricalsociety.org/pdfs/2016files/City%20of%20Naples%20Comprehensive%20Plan.pdf
c. SFWMD. 2016. Environmental Resource Permit Applicant's Handbook Volume II. Website: https://www.sfwmd.gov/sites/default/files/documents/swerp_applicants_handbook_vol_ii.pdf

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6.3 Recommended Approach to Address LOS for Water Quantity and Water Quality

- Provide a list of recommended LOS criteria for City of Naples Stormwater Management (Table Format) by,
  - Public Street Criteria
  - Building Street Criteria
  - Water Quality Criteria
  - Stormwater Management Facility

The City of Naples Comprehensive Plan identifies the SFWMD Criteria as the recommended level of service goal for meeting water quality standards in the City of Naples (City 2007). However, the City recognizes there is a need for specific standards and details to guide the development community to ensure the proper design and installation of stormwater facilities, grading techniques, and development practices within the City in order to ensure that the applicable provisions of the current Naples Code of Ordinances and goals of this ordinance are met, as well as goals associated with adopted TMDLs are achieved.

The water quality design criteria Level of Service require a project-specific BMP implementation to meet a presumed pollutant removal of 85 percent Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorus (TP). BMPs that do not effectively remove TN and TP such as "dry detention" will be discouraged. Appropriate BMPs for selection are summarized in the Comprehensive Plan Section Public Facilities and Water Resources Element Policy 1-11.

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Table 6-3 TMDL Summary Table

TMDL Name/ID	Water-body Class	Acres	Basin	City of Naples Stormwater Major Basin	Nutrients included in TMDL (or impairment)	Causative Pollutant (parameter)	Requirements of TMDL	BMAP
Gordon River Extension, WBID 3278K (formerly 3259C)	III	5,153	Everglades West Coast Basin Group	All of Basin IX and Basin V Small portion of Basin I (east-southeast section of basin) Approximately 1/3 of Basin VIII (north portion)	low dissolved oxygen (DO)	total nitrogen (TN)	TMDL of TN = 0.74 mg/L Requirement: 29 percent reduction of TN	This TMDL does not have an associated BMAP
Naples Bay Coastal, WBID 3278R4	II	9,581	Everglades West Coast Basin Group	N/A	Iron, Copper	N/A	Development of Naples Bay 2-year TMDL is still in progress.	N/A

Sources:

d. FDEP. (2008). TMDL Report, Dissolved Oxygen TMDL for the Gordon River Extension, WBID 3278K (formerly 3259C). FDEP South District, Everglades West Coast Basin. Website: http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp1/gordondofinal091208.pdf

e. FDEP. (2016b). Statewide Comprehensive List of Impaired Waters. Website: http://www.dep.state.fl.us/water/watersheds/assessment/a-lists.htm

f. FDEP. (2012b). Final Basin Management Action Plan For the Implementation of Total Daily maximum Loads for Dissolved Oxygen Adopted by the Florida Department of Environmental Protection for the Everglades West Coast Basin. Website: http://www.dep.state.fl.us/water/watersheds/docs/bmap/ewc-bmap-final-nov12.pdf

g. FDEP. (2015). TMDLs in the State of Florida. Website: http://www.dep.state.fl.us/water/tmdl/docs/TMDL-MapStatus.pdf

Notes:

- Not all listed impaired waters in City of Naples have TMDLs
- N/A = information not available or applicable at the time of table creation

For Naples Bay Coastal, the focus of the TMDL is unknown at this time.

6.3.1 Implementation

Discuss recommendations for how Public Works can actually implement LOS recommendations

TAB 7

Regulatory and Development Code Review

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7. Regulatory and Development Code Review

As the stormwater master plan develops, a review of the City's regulatory and development code is completed to compare the current regulations that are in place to the recommendations needed to provide the City guidance on the implementation of the plan. The key purpose of the review is to review the City land development codes, ordinances, stormwater utility codes and policies related to stormwater management; identify inconsistencies and gaps; and provide recommendations to enhance long term water quality and stormwater management. This review consists of reviewing the City codes and ordinances, the National Flood Insurance Program (NFIP) Community Rating System (CRS) for the City, and the Municipal Separate Storm Sewer (MS4) Program or the City's National Pollutant Discharge Elimination System Phase II Permit (NPDES).

7.1 Codes and Ordinances

The following materials were reviewed:

- Comprehensive Plan: reviewed to identify gaps and inconsistencies between Plan and Ordinance and opportunities to address Comprehensive Plan objectives in the revised ordinance
    - Future Land Use Element
    - Conservation and Coastal Management Element
    - Transportation Element
    - Public Facilities and Water Resources Element
    - Capital Improvements Element
    - Comprehensive Plan Maps
- City Ordinance including Land Development Codes
    - Chapter 16 - Construction, Rehabilitation and Property Maintenance Regulations
    - Chapter 30 – Utilities
    - Chapter 44 - General Provisions
    - Chapter 50 - Development and Design Standards
    - Chapter 52 - Resource Protection Standards
    - Chapter 54 - Subdivision Standards
    - Chapter 56 - Supplemental Standards
    - Chapter 58 - Zoning
- Collier County Multi-Jurisdictional Local Mitigation Strategy (March 31, 2015)
- 2012 Flood Insurance Rate Maps (FIRM) for Collier County (for context only), including: Panel 379, 383, 384, 387, 391, 392, 393, 394, 581, 583

Please note that all recommendations presented in Table 7.1 were developed for the purpose of enhancing long-term water quality and stormwater management. Recommendations #3, #6, #7, #10, #11, #13, #16 and #17 specifically address opportunities to bridge gaps between the land development ordinance and the Comprehensive Plan. Individual recommendations are identified when determined to better position the City for future flood mapping (Goal 1), NFIP Reform (Goal 2), and protection from future flood events (Goal 3).

The only inconsistency noted in Table 7.1 relates to the definition of Coastal High-Hazard Area which differs between the Naples (FL) Code of Ordinance, the Comprehensive Plan, and the Florida Building Code. See details under Recommendation #8.

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Table 7-1 Recommendations to Codes, Ordinances and Comprehensive Plan

City Ordinance / Comprehensive Plan	Current Provision	Recommendation
Chapter 16 CONSTRUCTION, REHABILITATION AND PROPERTY MAINTENANCE REGULATIONS	Sec. 16-112. - Florida Building Code adopted; amendments For City of Naples amendments to Florida Building Code (FBC), Fifth Edition (2014) and Florida Residential Code (FRC), Fifth Edition (2014) reference City of Naples Building Code Adoption Ordinance 15-13696. **Amendment 1:** Section 202 FBC (2014) definition of Substantial Improvement (SI) is modified to limit SI value to cumulative changes during a 1-year period. The relatively short period for incurred improvement costs serves to keep non-compliant NFIP structures from being brought into compliance, resulting in a more vulnerable building stock for City of Naples and potentially higher NFIP premiums for all policy holders.	**Recommendation #1:** Increase period for cumulative improvements from 1-year to minimum of 5-year period to bring more improved buildings into NFIP compliance which will better position the City for future flood events and NFIP reforms. Additionally, CRS points for both cumulative SI and cumulative substantial damage (not currently addressed in Naples FBC amendments) standards are available for 5-year and 10-year periods. CRS points for this higher regulatory standard require at least a 5-year period for all building types. **Recommendation #1 serves Goals 1, 2, and 3**
	Amendment 2: Section R322 FRC (2014) adds the following statement to the provision that restricts use of below flood elevation enclosures to parking, access or storage: "The interior portion of such enclosed area shall not be partitioned or finished into separate rooms except for building access and small mechanical rooms."	**Recommendation #2:** Replace 'small mechanical rooms' with 'storage' to comply with NFIP regulations. Mechanical equipment is vulnerable to inundation and should be maintained above the design flood elevation. **Recommendation #2 serves Goals 1, 2, and 3**
	Sec. 16-114. - Submission of sidewalk, street and project site drainage and driveway plans. **Summary:** Section requires submittal of site plan that includes perimeter retaining structures or surface water management plan which provides for containment of runoff on-site with surplus routed to rights-of-way or right-of-way swales for drainage as applicable	<u>No recommended changes</u>**.**
	Sec. 16-115. - Stormwater construction standards. **Summary:** Section includes stormwater construction standards and design criteria for new development, redevelopment, and substantial improvement of platted properties. For quantity criteria, "a storm	**Recommendation #3:** Add three Best Management Selection Criteria Tables from Policy 1-11 of the Comprehensive Plan's Public Facilities and Water Resources Element to end of existing section. **Recommendation #3 serves Goal 3**

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	event of a one-hour duration and five-year return frequency shall be used in computing the minimum off-site discharge rates from private properties to the City's stormwater system". Further, "conveyance shall pass design flow while ensuring that the backwater head does not exceed the proposed berms, walls or other containment systems in a 25-year - 24-hour storm event"	**Recommendation #4:** Utilize Low-Impact Development (LID) approach to stormwater management by capturing and retaining the Design Storm (as defined under Technical Criteria (A)) on-site. Alternatives (e.g., capture/retain 95th percentile average annual rainfall event) and fees-in-lieu option should be addressed where required volume creates a hardship or is technically infeasible. **Recommendation #4 serves Goal 3**
	Sec. 16-291. - Construction site management **Summary:** Submittal requirements include grading and drainage surface water management plan for street and project site with reference to Section 16-114 (see above) and subsections (d)(4) and (5). Section (d)(4) – Final grading – requires no surface water in excess of pre-construction amounts flows onto adjacent properties and that discharge flows to system. Section (d)(5) – Surface water - requires filtration of surface water prior to discharge in accordance with State law.	**Recommendation #5:** Consider requiring or incentivizing final grading/drainage plan that retains design storm surface water in excess of pre-construction discharge amount. **Recommendation #5 serves Goal 3**
Chapter 30 **Utilities**	**ARTICLE VI. – STORMWATER MANAGEMENT** **Summary:** Section generally addresses establishment, administration and fiscal aspects of City's stormwater system.	**Recommendation #6:** Add definition for new term - Best Management (BMP) Practice Selection Criteria and Credits. BMP incentive plan described in Policy 1-11 of the Comprehensive Plan's Public Facilities and Water Resources Element has many stormwater management-related credits available. **Recommendation #6 serves Goal 3**

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	Sec. 30-340. - Credit policy for approved stormwater management systems credits. **Summary:** Section describes existing credits system for properties that operate and maintain approved stormwater management systems.	**Recommendation #7:** Expand existing credit system by adding reference to new Best Management Selection Criteria Tables recommended for Section 16-115. Describe City council authorization to administer the credit system in Section 30-340 or elsewhere in Chapter 30. **Recommendation #7 serves Goal 3**
Chapter 44 - GENERAL PROVISIONS (definitions)	**Section 44-8:** <u>Coastal high-hazard areas</u> means areas designated by local governments, and includes areas which have historically experienced destruction or severe damage, or which may experience destruction or severe damage, from storm surge, waves, erosion or other outcomes of rapidly moving or storm-driven water. Please note the following definitions for same terminology: **Comprehensive Plan (Conservation and Coastal Management Element: Policy 5-1):** The <u>Coastal high-hazard area</u> is the area below the elevation of the Category 1 Storm Surge line as established by a Sea, Lake and Overland Surges from Hurricanes (SLOSH) computerized storm surge model. This area includes much of the City of Naples, including most of its public infrastructure. **2014 Florida Building Code** (FBC) defines <u>Coastal high-hazard area</u> as follows: Area within the special flood hazard area extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area that is subject to high-veloCity wave action from storms or seismic sources, and shown on a Flood Insurance Rate Map (FIRM) or other flood hazard map as veloCity Zone V, VO, VE or V1-30.	**Recommendation #8:** Revise 'coastal high hazard area' definition in land development code and Comprehensive Plan to match definition in FBC which is tied to NFIP designated (*not local government*) Zones V that trigger code provisions and design requirements related to scour and hydrodynamic loading. If storm surge criteria described in Comprehensive needs to be maintained, then use different terminology. Existing *inconsistencies* will lead to confusion. **Recommendation #8 potentially serves Goal 3**
Chapter 50 - DEVELOPMENT AND DESIGN STANDARDS	**ARTICLE IV: Parking and Loading - Sec. 50-103. Design and construction standards, (c) Surfacing** **Summary:** Section describes pervious surface options and lists situations where and conditions under which pervious parking surfaces are permitted.	**Recommendation #9:** Consider expanding current conditions where pervious surfaces are allowed **Recommendation #9 serves Goal 3**

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	ARTICLE V: DRIVEWAYS - Sec. 50-131. Location; paving, (e) Driveways shall be paved or otherwise stabilized	**Recommendation #10:** Add language to describe pervious surface options that provide stabilization similar to language in Section 50-103(c). Also, if implementing recommendation for stormwater credits in the Section 16-115 (per Recommendation #3), then note available incentives and add reference. **Recommendation #10 serves Goal 3**
Chapter 52 - RESOURCE PROTECTION STANDARDS	**ARTICLE II – Coastal Construction** **Summary**: The purpose of this article is to provide minimum standards for the design and construction of buildings and structures to reduce the potential harmful effects of natural phenomena occurring along the *coastal* areas of the City **Sec. 52-32. - Coastal construction code** **Summary:** Provides minimum standards for the design and construction of buildings and structures to reduce the harmful effects of hurricanes and other natural disasters occurring along the *coastal* areas of the City, which fronts on the Gulf of Mexico. The standards are intended to specifically address design features which affect the structural stability of the beaches, dunes and topography of adjacent properties. *Coastal building zone (CBZ)* is defined as the land area from the seasonal high-water line to a line 1,500 feet landward from the *coastal* construction control line as established pursuant to F.S. § 161.053 **Sec. 52-33. - Coastal construction setback line (CCSL)** **Summary:** Section establishes creation of CCSL and lists prohibited activities seaward of CCSL which include: constructing any structure, making any excavation, depositing any fill, removing any beach material or otherwise altering existing ground elevations, soil structure and natural formation or driving any vehicle on, over or across any sand dune or beach, or damaging sand dunes or beach or the vegetation growing thereon, seaward of the CCSL, other than normal beach maintenance and cleanup or emergency repairs, without obtaining either a variance or a permit from the City. Further,	**Recommendation #11:** Protection of dune system as provided in Chapter 52 is governed by State statute. However, per Conservation and Coastal Management Element of the Comprehensive Plan Policy 4-10, City should enforce (or step up enforcement of) regulations pertaining to CBZ and CCSL. **Recommendation #11 serves Goal 3**

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	landscaping and beach/dune revegetation projects must utilize native beach-stabilizing vegetation and native species of salt-tolerant trees and shrubs which are partially listed.	
	Sec. 52-34. - Seawalls and revetments Section refers to Chapter 16, Article VII which is shown as 'reserved' with footnote (Ord. No. 13-13302, § 1, adopted June 12, 2013, repealed Article VII, §§ 16-251—16-254, pertained to seawalls and revetments. See also the Code Comparative Table). Please note that seawalls are now addressed in Section 52-92 (below). **Sec. 52-92 – Water Resources Generally** **Summary:** Most significantly with respect to stormwater management and protection from flooding, this section addresses obstruction of waterways (b), and construction of seawalls, groins and other beach erosion control structures (d). While Section 54-65 (Canals) requires a minimum height for seawalls adjacent to canals, Section 52-92(d) places a limit on seawall heights (4.8 feet NAVD) and conditions on where and how new seawalls may be installed.	**Recommendation #12: TBD**
	Sec. 52-93. - Dredging, filling and other marine construction in inland waters **Summary:** "…No dredging or filling shall be performed in, upon or contiguous to any inland water area of the City, including but not limited to construction under section 52-92(c) through (e), until approval of such work has been obtained in accordance with the procedures and requirements set forth in this section." Section goes on to list many environmental hurdles to clear at State and Federal level unless for boat slips and areas adjacent to docks (w/ mitigation and control requirements). New docks to include design measure to avoid future dredging. Compliant docks may be dredged.	No recommended changes. Section requirements serve to protect natural coastal features which are vital to mitigating flood damage and limiting stress on stormwater system.
	Sec. 52-155. – Additional Submittal Requirements **Summary:** Section falls under Article VI: Development of Significant Environmental	No recommended changes. Section requirements serve to protect natural coastal features which are vital to mitigating flood damage and limiting

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	Impact' which applies to conservation areas [described as Conservation District and Transitional Conservation District in Chapter 58 – Zoning (see below)]. Development permit applicants for conservation areas must submit a significant environmental impact (DSEI) assessment that addresses specified 'surface water and stormwater review' elements.	stress on stormwater system.
	Sec. 52-184. - Timing of fertilizer application; content and application rate; impervious surfaces; buffer zones; and mode of application **Summary:** As related to stromwater quality, this section prohibits application of fertilizers on impervious surfaces, how to prevent, and redress.	No recommended changes.
Chapter 54 - SUBDIVISION STANDARDS	**Sec. 54-6. - Flood damage prevention standards for subdivision proposals** **Summary:** Section includes four very general guidelines ('standards') for flood damage prevention that must be addressed by all subdivision proposals and other development including manufactured homes.	**Recommendation #13**: Modify items (2) and (3) to provide enforceable detail by referencing the existing minimum requirements in Chapters 16 and 30. More significantly, this would be a good place to reference the Proposed Best Management (BMP) Practice Selection Criteria and Credits as described in Recommendation #3. Many BMP measures are most efficiently incorporated in the planning stages of new subdivisions, and should be presented to the developer for consideration when preparing subdivision plans for permitting. **Recommendation #13 serves Goal 3**
	Sec. 54-31. - Approval procedure **Summary:** Section includes procedures and requirements for plat submittals. **Recommendation #14**: Revisit Section to address possible formatting issues, incorrect charging language, and apparent omissions. As accessed in Municode (3/31/17), part (b) Major Subdivisions does not include parallel list of Standards included in part (a) Minor Subdivisions, and charging language for both address minor subdivisions only.	**Recommendation #14 is primarily editorial in nature and does not necessarily serve Goals 1, 2 or 3**
	Sec. 54-64. – Drainage	No recommended changes.

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	Sec. 54-65. - Canals **Summary:** In addition to canal construction standards, the section includes minimum height (relative to mean low water) for seawalls adjacent to canals.	No recommended changes.
	Sec. 54-68. - Recreation areas and facilities **Summary:** Section requires designation of recreational areas and facilities (or dedication of land to City for public recreational use) for new subdivisions and public beach access for Gulffront properties. Since the amount of recreational land needed varies as a function of future resident's needs, the amount of dedicated recreational land is not specified.	No recommended changes.
	Sec. 54-74. - Land development innovations.	**Recommendation #15:** Specifically reference Low Impact Development (LID) as example of development project type that may qualify under this section. Additionally, preparation of an LID Implementation Manual is proposed to provide property owners and developers a range of options for meeting stormwater quantity, quality, and resiliency standards while maintaining contextual sensitivity. The manual would allow for flexibility to select the appropriate BMPs to that which can be integrated into the overall design of the property offering improved aesthetics and function. **Recommendation #15 serves Goal 3**
Chapter 56 – Supplemental Standards	**Sec. 56-40. - Lot coverage, maximum permitted** Current section limits percentage (19 – 25%) of lot cover by all combined principle structures, accessory structures and roofed structures for Zones R3-6, R3-12, R3T-12, R3-15, R3T-18, R3-18 and HC, and PD for multifamily residences and transient lodging facilities or nursing, group or rest homes. An additional 10% is allowed for parking structures.	**Recommendation #16:** Introduce limits for maximum lot coverage for other impervious surfaces (e.g. driveways, patios) with option for increased area limits when using pervious surfaces. Reference BMP incentive table (described in Section 54-6 review) for possible credits available for pervious surface and consider adding incentive for lots that have significantly less coverage than maximums shown in current Sec. 56-40 table. **Recommendation #16 serves Goal 3**

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
Chapter 58 – Zoning	**Sec. 58-60, 58-90, 58-120, 58-150, 58-180, 58-210, 58-240. - Maximum building area**	**Recommendation #17:** Consider lowering percentages for maximum building areas in the above described Residential districts. Also, introduce limits for maximum lot coverage for other impervious surfaces like driveways with option for increased area limits when using pervious surfaces. Reference BMP incentive table (described in Section 54-6 review) for possible credits available for pervious surface and consider adding incentive for lots that have significantly less coverage than maximums shown in current tables. Consider lowering minimum floor areas listed in each section as well. **Recommendation #17 serves Goal 3**
	Sec. 58-864. - Designation of districts; identification of district boundaries **Summary:** Conservation (C) districts are generally designated on Future Land Use Map. When development is proposed for the Transitional Conservation (TC) district, the prospective developer is required to complete and submit an environmental assessment, general development and site plan including proposed C/TC boundary with supporting characteristics.	No recommended changes. Section requirements serve to protect natural coastal features which are vital to mitigating flood damage and limiting stress on stormwater system.
	Sec. 58-865. - Definitions and general standards **Summary:** The conservation zoning district includes those areas having significant ecological, hydrological, physical or socioeconomic importance to the public. The principal consideration concerning uses within the conservation zoning district is the preservation of the natural functions and benefits of these areas while allowing natural uses and low intensity development which follows the guidelines outlined for each subcategory in this division. Preserving the integrity of these areas… provides a degree of natural protection against storms, helps maintain air and water quality… and promotes soil stabilization. Conservation Zoning District subcategories include: Marine grass beds,	No changes recommended. Section requirements serve to protect natural coastal features which are vital to mitigating flood damage and limiting stress on stormwater system.

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City Ordinance / Comprehensive Plan	Current Provision	Recommendation
	Tidal swamp/marsh areas, freshwater swamp/marsh areas, Class II waters, Gulf beaches/dunes, High-hazard areas. Permitted and conditional uses (when applicable) of each subcategory are listed in **Sections 58-870 through 58-877**.	
	Sec. 58-875. - Transitional conservation district **Summary:** TC district functions as buffer to ensure compatible development adjacent to the conservation zoning district. Special precautions (as described in Section 58-864) are required to protect environmental resources.	No changes recommended. Section requirements serve to protect natural coastal features which are vital to mitigating flood damage and limiting stress on stormwater system.

7.2 NFIP CRS

As of October 1, 2015 the City of Naples is a Class 5 community under the Community Rating System (CRS) of the National Flood Insurance Program (NFIP), which allows property owners in a Special Flood Hazard Area to receive up to a 25% discount on their flood insurance premium.

The next Community Verification Visit (CVV) would be in 2018, and will use the new Coordinator's Manual that is anticipated to be released in early 2017 (but has not been published at the time of preparation of this 60% draft report). Only minor changes are anticipated in the 2017 Manual.

Current efforts by the City to manage stormwater and flooding issues through the Land Development Code, especially Article IV. - Floodplain Management, have earned credit points for the City under various CRS Activities, e.g. Activity 450 - Stormwater Management, Activity 540 - Drainage System Maintenance and Activity 330 - Outreach Projects. Continuing outreach efforts and enforcement of regulations already in place will help the City maintain the previous credits. For additional credits, the City could implement other recommendations from earlier parts of this chapter and the following specific recommendations:

- **Recommendations for changes to floodplain management ordinance**
    - The ordinance addresses maintenance of floodplain management records (under Sec. 16-146. - Duties and powers of the floodplain administrator), but does not specifically mention Elevation Certificates. Maintaining Elevation Certificates is creditable under CRS Activity 312.
    - The City could adopt higher regulatory standards, by adopting freeboard, enforcing V-zone regulations for A-zones, for example, prohibiting fill for structural support, prohibiting human alteration of any sand dunes, and limiting installation of manufactured homes.

- **Recommendations for the watershed master plan** - The City can receive CRS credits under CRS Activity 452.b. Watershed Master Plan (WMP) if the plan meets the following basic requirements:
    - The plan must identify the natural drainage system and constructed channels.
    - The community must have adopted regulatory standards that are based on the plan and that receive credit under Stormwater Management Regulations (SMR under Activity 452.a). In the last cycle, the City received credit for the regulatory standards mentioned in

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the Land development code for Size of Development (SZ) and Design Storm (DS), but those regulations were not connected to the watershed master plan.

- o The plan's regulatory standards must manage future peak flows so that they do not increase over present values.
- o The plan's regulatory standards must require management of runoff from all storms up to and including the 25-year event.

More background on the above recommendations is provided in the following explanation from the CRS Manual, *"CRS credits are awarded to a community regulating development according to a watershed management master plan that analyzes the combined effects of existing and expected development on drainage throughout the watershed. A stormwater management regulation credited under Section 452.a (SMR) helps to manage increased runoff from a developing watershed, but it does not solve the problem entirely. The flood peak at a point downstream in a watershed is a result of both the quantity of upstream runoff and the time it takes for water to travel down the watershed. Development within the watershed usually has an impact on both of these characteristics. The objective of watershed master planning under Section 452.b (WMP) is to provide the community with a tool it can use to make decisions that will reduce the increased flooding from development on a watershed-wide basis. Most communities have some way of dealing with drainage problems, through a capital improvement plan, planned flood control structures, or perhaps just by responding to complaints as they arise. A watershed master plan, like other community plans, allows communities within the watershed to consider future development as they work on current problems."*

- **Repetitive Loss Area Analysis (RLAA)** - The CRS is very interested in supporting local efforts to mitigate repetitive loss properties, defined as properties that have two or more claims of more than $1,000 paid by the NFIP within a 10-year period since 1978.

  An RLAA is a careful examination and mitigation assessment for a community with a high number of repetitive loss properties. Conducting the analysis can secure up to 140 points under CRS Activity 510 - Floodplain Management Planning. The 2017 Manual is expected to make this analysis mandatory for communities that have more than 50 repetitive loss properties (the County Local Mitigation Strategy states that there are 32 repetitive loss properties in the whole county, so the City does not have more than 50 repetitive loss properties at this point).

7.3 Private Development

- Review regulatory standards for private development projects regarding stormwater water quality
- Describe opportunities to enhance water quality
- Include Table with list of opportunities

7.4 MS-4 Permit

- Review MS-4 Permit and program elements

TAB 8

Climate Adaptation

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8. Climate Adaptation

Local governments, which bear the largest responsibility for coastal planning like the City of Naples, long have struggled with balancing strong demand for increasing development with protection of fragile environmental and cultural resources. Now these same governments must consider the threats that substantial sea-level rise pose to current planning, existing development, and beleaguered ecological systems. These threats include inundation, flooding, enhanced storm surges, loss of infrastructure, destruction of wetlands and beaches, and increased risks for public health and safety. Although taking regulatory initiatives to adapt to predict future threats can be difficult, it can also conserve resources, mitigate crises, and protect ecosystems.

8.1 How does sea level rise (SLR) relate to stormwater management?

The storm sewer system in Naples is designed to convey storm water away from low-lying developed areas to stormwater ponds, canals, and ultimately, the Gulf of Mexico.

In recognition of the potential effects of sea level rise on coastal assets, the City has included stages of planning for adaptive actions into the master plan process for stormwater infrastructure and operations. One important analysis for planning adaptation is developing an understanding of the potential inundation due to sea level rise and flooding by high tides and coastal storm events. This section summarizes the work performed to assess the exposure of the Naples stormwater system assets to sea level rise.

The vulnerability of stormwater management systems to sea level rise and storm events depends on the system's current storage and flow capacity, the elevation and location of their outfalls, and whether they are gravity drained or pumped.

In general, stormwater systems have a reliance on uninterrupted power and many of the components are sensitive to water and salt exposure. The capacities to collect, convey, and discharge flows to the bays and Gulf will be reduced by higher sea levels. Outfalls that are below the future high tide or storm event levels may need to be elevated, have check valves installed to prevent backflow, and be pumped rather than gravity drained. Reduced discharge capacity and/or failures or pump stations could cause flooding of adjacent properties and disrupt access to homes, jobs, and recreation areas, leading to potentially significant consequences.

Without action, SLR poses the following threats to the stormwater system and adjacent areas:

- **Urban flooding.** The majority of the Naples stormwater system is gravity driven. Excess stormwater flows from higher elevations until reaching the Gulf and Bay at the lowest level. As low-lying stormwater outfalls become partially or completely inundated by rising water levels, drainage of stormwater can be impeded, resulting in inland urban flooding during storms. Difficulties draining stormwater can cause road closures, impede access to facilities, and damage private and public property.

- **Saltwater intrusion to stormwater system.** During large tide and storm events, saltwater may enter the stormwater system through open outfalls, leaky tide gates, overflow weirs, and through catch basins located in areas where coastal waters have overtopped the shoreline. Backflow of high tides into the stormwater system may cause surface flooding in low-lying areas that sit at elevations below the hydraulic grade line, even if shoreline protection systems are high enough to prevent overland flooding (Figure 8-1). Saltwater may also cause premature corrosion of pipes and equipment in the system.

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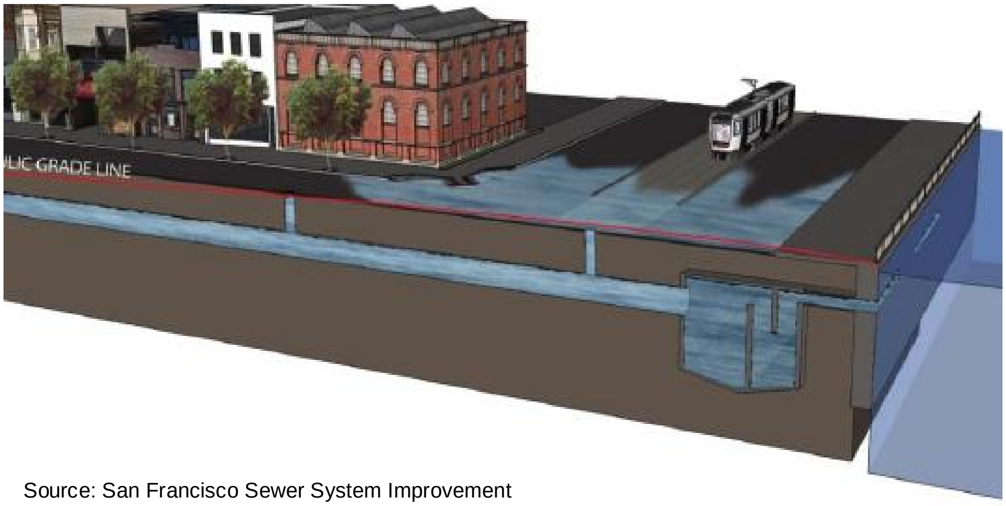
- **Elevated groundwater levels.** As sea levels rise, so will groundwater levels. SLR causes saline water to intrude into underground reservoirs, raising the historical groundwater elevation ranges beyond what the Naples utilities were planned and built to accommodate.

  The incoming saline water also changes the chemistry of the freshwater reservoir, which has the potential to increase corrosion rates of underground utilities.



Source: San Francisco Sewer System Improvement

Figure 8-1 Schematic Showing Backflow of High Tides into the Stormwater System Causing Surface Street Flooding

8.2 Sea Level Rise Projections

Sea level trends are recorded locally by tide stations, and more recently, globally by satellite altimetry. Globally, sea levels rise for two primary reasons: melting of land-based ice masses (glaciers and continental ice sheets) and expansion of seawater as it warms (thermal expansion). During the 20th century, these two processes have caused global ocean levels to increase at an average rate of 0.07 inches/year (1.8 mm/year) (NOAA, 2012). Recent observations show that this rate has accelerated to 0.13 inches/year (3.3 mm/year) in the past 20 years, roughly twice the average rate of the preceding 80 years (NOAA, 2012 and National, 2016).

Historical Sea Level Rise Trends

Tide gage records indicate that mean sea levels have risen approximately ten inches in the Naples area over the last century (Figure 8-2). The local historical sea level rise rate is faster than the global average rate. With global sea levels projected to continue to rise, public and private shoreline assets, including City stormwater infrastructure, will become more vulnerable to an increase in the frequency and magnitude of high tides and coastal flood events.

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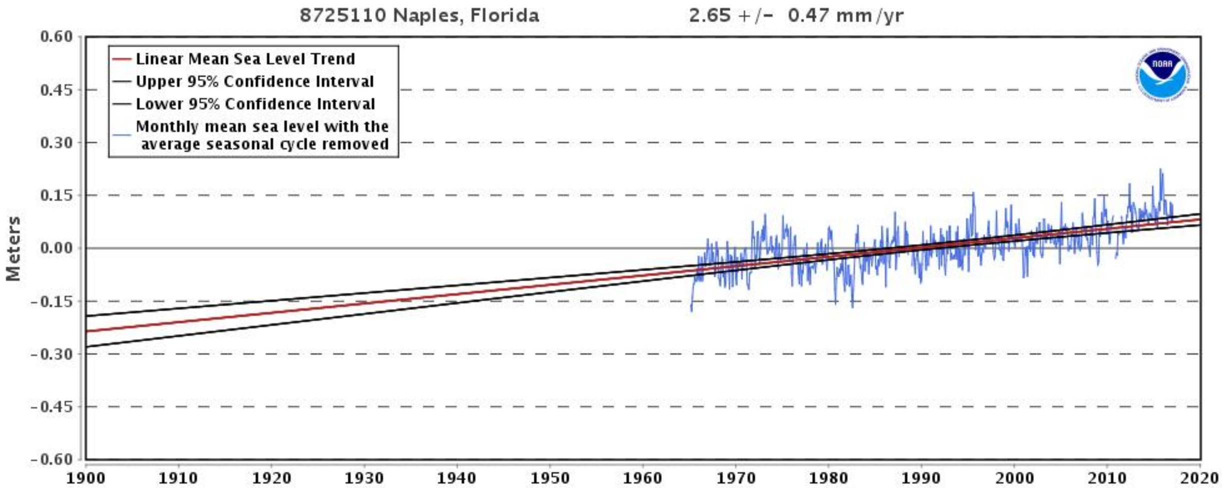
Figure 8-2 Regional Sea Level Rise Trends Observed at the Naples Tide Station



Source: National Oceanic and Atmospheric Administration (NOAA) Sea Levels Online.

Sea Level Rise Projections

Future sea level projections have been developed by scientists using coupled ocean-atmosphere models called global circulation models. The most likely projections are based on a moderate level of global greenhouse gas emissions and continued accelerating land ice melt patterns. The upper range estimates represent less likely, but possible amounts of SLR using very high greenhouse gas emission scenarios with significant land ice melt. Because there is uncertainty associated with SLR projections, it is generally recommended to consider a range of potential SLR scenarios in project planning.

Selection of the most appropriate SLR scenario to prepare for future conditions should consider the following factors:

- **Project lifespan** – how long will the project be in use?
- **Site and asset adaptability** – is there an ability to adapt to higher sea levels that may occur in the future (for example, building additional flood protection or raising site elevations in the future)?
- **Risk tolerance** – is there flexibility to accommodate flooding? Is the consequence of flooding low or high?

Although Florida does not have state-level sea level rise guidance for project planning, there are a variety of federal studies that serve as the basis for design and planning projects throughout the state. Table 8-1 lists several planning efforts in the southwest and southeast Florida region. Due to the range in SLR projections, many local planning efforts rely on a combination of multiple projection sources. For example, the Southeast Florida Regional Climate Compact's Unified Sea Level Rise Projection guidance referenced projections provided by the U.S. Army Corps of Engineers and NOAA, depending on project planning timeline.

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Table 8-1 Sea Level Rise Projections for Year 2100 Used in Florida Studies

Lead Agency *2100 Projections*	Study Description	Florida Agency/Study Using Projections
U.S. Army Corps of Engineers *SLR: 8 – 60 inches relative to 1992 mean sea level*	The U.S. Army Corps of Engineers (USACE) issued guidance in 2009 and 2011 for taking SLR into account for coastal defense projects. The guidance presents three scenarios: a low scenario that projects the historical trend; and an intermediate and high scenario, which includes the latest NRC and IPCC accelerated sea level projections and vertical land movement. SLR projections are relative to 1992 mean sea level.	Collier County/ Collier County Floodplain Management Plan (2015) Southeast Florida Regional Climate Compact / Unified Sea Level Rise Projection (2011)
Intergovernmental Panel on Climate Change *SLR: 10 – 39 inches relative to 1986-2005 mean sea level*	The Intergovernmental Panel on Climate Change (IPCC) is heavily relied on in climate change planning, as the group is responsible for developing a range of possible future emissions scenarios that are used in climate models. Since 1990, the group has released a series of reports, including the most recent in 2013, which includes their most recent future sea level rise projections.	Lee County Climate Change Vulnerability Assessment (2010)
U.S. Environmental Protection Agency *SLR: 10 – 46 inches relative to 1990 mean sea level*	In 2008, the Environmental Protection Agency (EPA) conducted an analysis of the effects that climate stressors, including SLR, may have on the southwest region of Florida. Three "severity" scenarios were initially considered: least case (90% probability of occurrence), moderate case (50% probability of occurrence), and worst case (5% probability of occurrence). The scenarios rely on the historical SLR rate at St. Petersburg, FL and the normalized future projections developed by the EPA relative to 1990 mean sea level[i].	Southwest Florida Regional Planning Council / The Comprehensive Southwest Florida / Charlotte Harbor Climate Change Vulnerability Assessment (2009) Tampa Bay Regional Planning Council / Sea Level Rise in the Tampa Bay Region (2006) Lee County Climate Change Vulnerability Assessment (2010)
National Research Council *SLR: 20-40 inches*	In 2010, the National Research Council (NRC) released a report quantifying the possible outcomes of different emissions scenarios using the latest scientific literature. The future sea levels described in the study relied on projections from the IPCC and were supplemented by additional scientific studies that account for accelerated melting of glacial ice.	Florida Oceans and Coastal Council / Climate Change and Sea-Level Rise in Florida (2010)
National Oceanic and Atmospheric Administration[ii] *SLR: 8 to 79 inches relative to 1992 mean sea level*	The National Climate Assessment (NCA), led by NOAA, synthesizes the latest sea level rise science every four years. The 2012 report described four scenarios, which relied on extrapolation of existing sea level trends, the IPCC AR4 report, and a calculation of the maximum possible glacier and ice sheet loss by the end of the century.	Southeast Florida Regional Climate Compact / Unified Sea Level Rise Projection (2011)

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8.3 Existing and Potential Future Water Levels

Selection of future water level scenarios is a key component of a sea level rise vulnerability assessment. Future water levels are an important input to the development of asset vulnerability/flood inundation maps. It is important to first define baseline conditions for the existing water elevations to provide a basis to evaluate the impacts of flooding from future sea level rise and coastal storms.

Tide elevations are measured relative to a vertical datum—a baseline starting position against which other elevations may be related. There are two types of vertical datums: orthometric and tidal. Tidal datums are elevations defined by a certain phase of the tide: e.g. mean sea level or mean higher high water (MHHW), which is commonly referred to as the "average daily high tide."

An orthometric datum is a referenced plane of zero elevation that historically attempted to approximate the average elevation of the surface of global oceans or "sea level" (such as the National Geodetic Vertical Datum of 1929 – NGVD29). The North American Vertical Datum of 1988 (NAVD88) is the current national standard reference datum and is used in this discussion of tidal elevations.

8.3.1 Daily and Storm Tide Levels – Existing Conditions

Tidal datums are estimated by the National Oceanographic and Atmospheric Administration (NOAA) using observed water level data at tide stations. The mean higher high water (MHHW) tidal datum was selected to represent the average daily high tide for the sea level rise inundation mapping at the City of Naples. The MHHW tide elevation for existing conditions was computed by NOAA using observed water level data from 1983-2001 at the Naples tide station (#8725110).

NOAA also provides estimates of storm tides at the Naples tide station. Storm tides include the effects of the astronomical tide, storm surge (due to atmospheric pressure and meteorological effects), and runoff. The existing storm tide levels were estimated by NOAA using a statistical analysis of 84 years of measured annual maximum water level data.

Daily and storm tide levels at two Naples tide stations (Naples and Naples Bay North) are shown in Table 8-2.

Table 8-2 Tidal Datums at Naples Tide Stations

	Naples (#8725110)		Naples Bay North (#8725114)	
Datum	**NAVD88‡ (feet)**	**MHHW (feet)**	**NAVD88‡ (feet)**	**MHHW (feet)**
100-year Storm Tide Level	4.31	3.73	-	-
10-year Storm Tide Level	2.67	2.09	-	-
Highest Astronomical Tide	1.51	0.93	-	-
Mean Higher High Water (MHHW)	0.58	0	0.69	0
Mean High Water (MHW)	0.33	-0.25	0.44	-0.25
North American Vertical Datum of 1988 (NAVD88)	0.0	-0.58	0.0	-0.69
Mean Tide Level (MTL)	-0.68	-1.26	-0.55	-1.24
Mean Sea Level (MSL)	-0.64	-1.22	-0.50	-1.19
Mean Low Water (MLW)	-1.68	-2.26	-1.54	-2.23
Mean Lower Low Water (MLLW)	-2.29	-2.87	-2.07	-2.76

Notes: ‡ North American Vertical Datum of 1988

The largest annual tides, often referred to king tides, occur approximately four or five days each year when a spring tide coincides with the moon being in its closest position (perigee) to the earth. King tides typically occur during the fall months in south Florida. Although king tides typically only increase sea levels several inches above spring tide levels, they can cause flooding to low-lying coastlines, particularly if coinciding with a storm event or other oceanographic condition that elevates tides above normal levels (such as during the September 2015 king tides). Because king tides often cause minor flooding and drainage issues, estimating typical king tide elevations is important in understanding high tide impacts to the Naples stormwater system.

Table 8-3 shows recent king tides at the Naples tide station relative to the MHHW tidal datum.

Table 8-3 Recent Astronomical King Tides at the Naples Tide Station (2011-2016)

	Naples (#8725110)		
Date	**Predicted (feet above MHHW)**	**Observed (feet above MHHW)**	**Difference (feet)**
October 27, 2011	0.83	0.93	0.10
September 19, 2013	0.59	0.95	0.36
October 19, 2013	0.43	1.15	0.72
October 7, 2014	0.44	1.00	0.56
September 28, 2015	0.73	1.53	0.80
October 28, 2015	0.70	1.83	1.13
November 26, 2015	0.63	0.29	-0.34
October 18, 2016	0.67	1.33	0.66
November 13, 2016	0.72	1.43	0.71
Average	0.64	1.16	0.52

Observed water levels during king tide events may be higher than predicted astronomical tides due to additional factors such as precipitation, storm surge, and recent sea level rise that is not captured in the predicted tides. Based on the recent king tide events listed above, the observed average king tide at the Naples tide station is approximately 1 ft above MHHW. Similarly, the calculated 10-year extreme tide is approximately 2 ft above MHHW. These relationships will be used in Section 8.3.2 to relate the MHHW, king tide, and 10-year tide elevations to help interpret the SLR inundation maps used in the SLR exposure assessment.

8.3.2 Daily and Storm Tide Levels – Future Conditions

Five SLR amounts – 1, 2, 3, 4, and 5 feet - were evaluated as a part of the SLR exposure assessment for City's stormwater system. SLR amounts of 1 to 5 feet cover the range of the USACE projections for the NOAA Naples tide station at 2100, capturing a broad range of scenarios between the most likely and high-end of the uncertainty range at both mid-century and end of the century (Figure 8-3).

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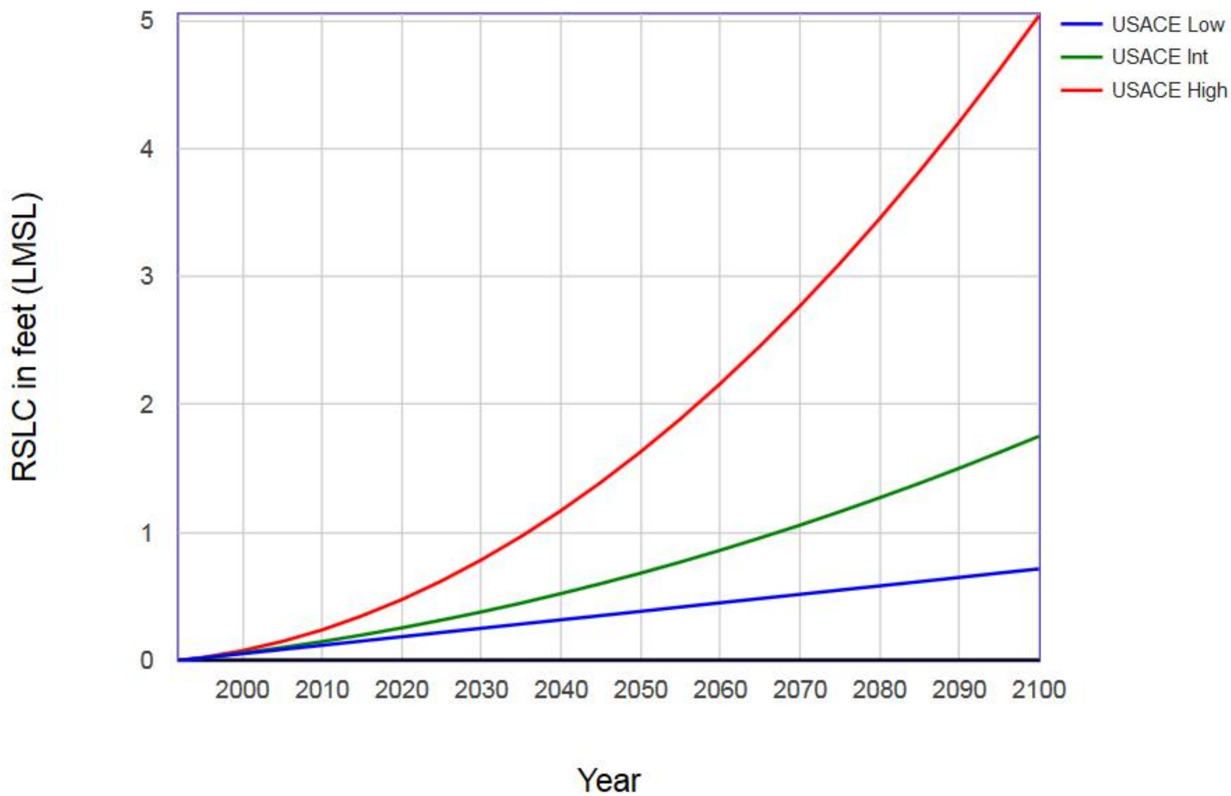
Figure 8-3 Relative Sea Level Rise Projections for Naples, FL



Note: All sea level rise projections are relative to 1992. This is the mid-point of the current National Tidal Datum Epoch, a 19-year period used by NOAA to define the tidal datums.

Each SLR amount was added to the MHHW tidal datum to create five future water level scenarios. Each scenario represents (1) permanent inundation scenarios by daily high tides or (2) temporary flood conditions from combinations of SLR and storm tides (for example, king tide or the 10-year tide). Therefore, a single water level scenario can represent either permanent inundation or temporary flooding, as shown in Table 8-4. The following water level conditions are presented in Table 8-4:

- **MHHW** – typical daily high tide (permanent inundation)
- **King tide** – typical king tide elevation (temporary condition occurring approximately four to five times each year)
- **10-year tide** – storm tide condition with a 10-percent annual chance of occurrence (temporary condition occurring approximately once every ten years)

The water level scenarios shown in Table 8-4 correspond to the SLR inundation maps discussed in Section 8.4.

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Table 8-4 Future Water Level Scenarios Representing Permanent Inundation and Temporary Flooding

Permanent Inundation	Temporary Flooding
MHHW + 1 ft SLR	King Tide
MHHW + 2 ft SLR	King Tide + 1 ft SLR or 10-year tide
MHHW + 3 ft SLR	King Tide + 2 ft SLR or 10-year tide + 1 ft SLR
MHHW + 4 ft SLR	King Tide + 3 ft SLR or 10-year tide + 2 ft SLR
MHHW + 5 ft SLR	King Tide + 4 ft SLR or 10-year tide + 3 ft SLR

8.4 Storm Surge and SLR Flood Maps

Inundation maps are a valuable tool for evaluating potential exposure of stormwater assets to future sea level rise and tide conditions. Inundation maps are typically used to evaluate when (under what amount of sea level rise and/or storm tide) and by how much (what depth of inundation) an asset will be exposed to inundation or flooding.

Future inundation layers for each of the selected sea level rise scenarios were downloaded from the NOAA Sea Level Rise and Coastal Impacts Viewer[1]. NOAA's depth of flooding raster[2] files were created by subtracting the land surface digital elevation model (DEM) from the MHHW + SLR water surface DEM. The resultant DEM (or "inundation depth raster") provides both the inland extent and the depth of inundation. The maps also differentiate between low-lying areas that have a direct flooding pathway to the flood source (such as the Gulf of Mexico or Naples Bay) and low-lying hydraulically disconnected areas. These disconnected low-lying areas are shown on the inundation maps in green instead of blue, where blue indicates low-lying areas that are exposed to direct inundation. Low-lying disconnected areas may experience drainage issues due to stormwater backflow by high tides through the stormwater collection system or due to elevated groundwater levels in the future. Figure 8-4 is a cross section that illustrates an inland disconnected low-lying area.

Example SLR inundation maps for north and south Naples are shown in Figure 8-5 and Figure 8-6 for the MHHW + 3 ft SLR permanent inundation scenario, which also represents projected temporary flooding from a king tide + 2 ft SLR or 10-year tide + 1 ft SLR. Based on the SLR inundation mapping, the Old Naples neighborhood waterfront south of 5th Avenue appears to be one of the first areas exposed to frequent tidal inundation. Additional low-lying disconnected areas such as Gulf Shore Boulevard between 13th and 20th Avenues, Gordon Drive south of 33rd Avenue, and Gulf Shore Boulevard north of Doctors Pass may experience drainage issues due to high tides backing up into the stormwater system and/or elevated groundwater levels during temporary flooding events such as king tides or storm surge events.

[Note: Figure 8-5 and Figure 8-6 contain a labeling error that will be corrected in the final document]

[1] https://coast.noaa.gov/slr/

[2] A raster consists of a matrix of pixels organized into a surface area grid where each grid cell contains a value representing information (e.g., water depth values).

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Figure 8-4 Example Shoreline Cross Section Showing Disconnected Low-Lying Area

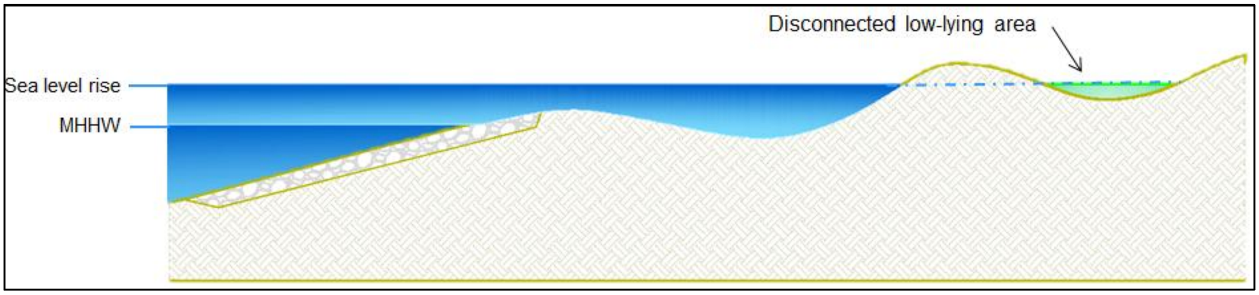

Figure 8-5 Projected Inundation for the MHHW + 3 ft Scenario in North Naples (Draft)

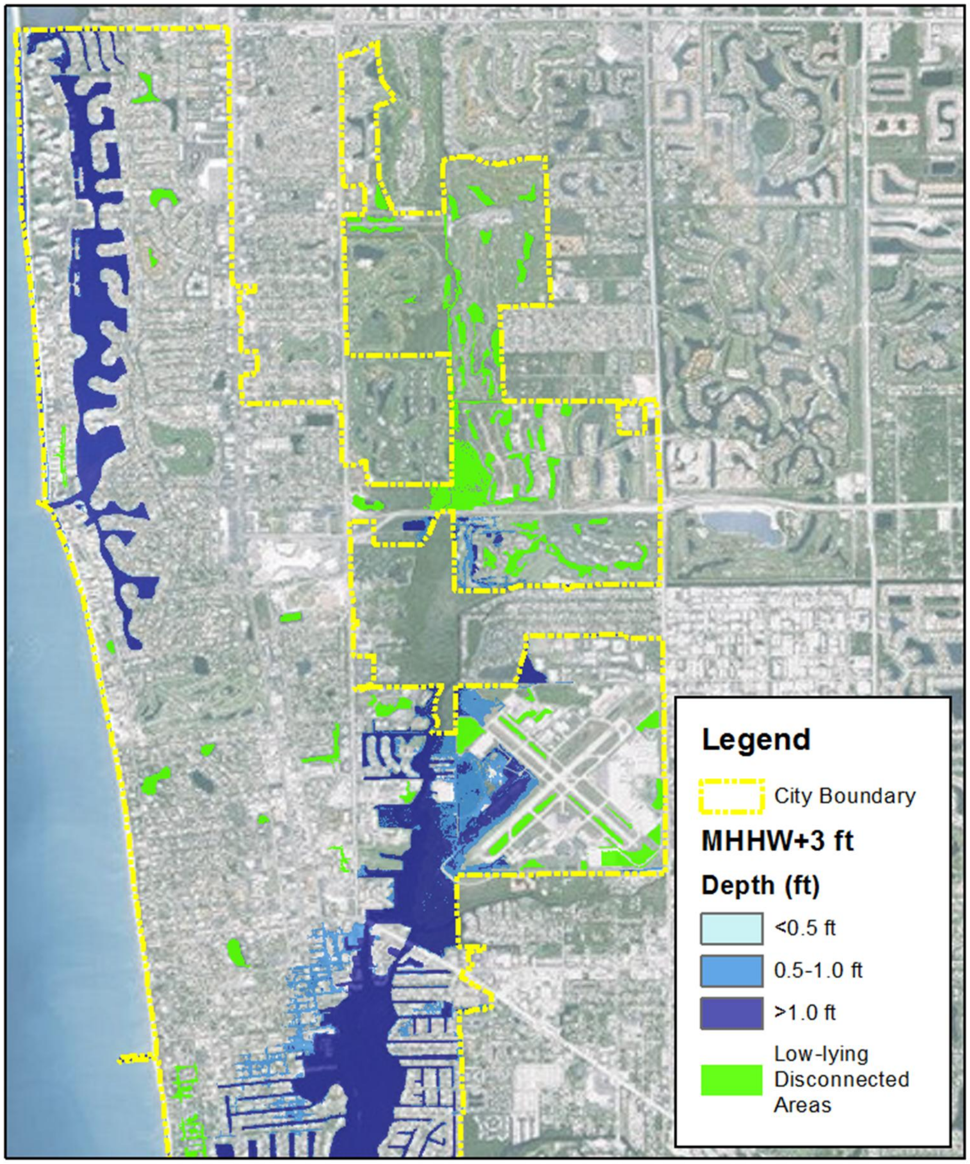

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Figure 8-6 Projected Inundation for the MHHW + 3 ft SLR Scenario in South Naples (Draft)

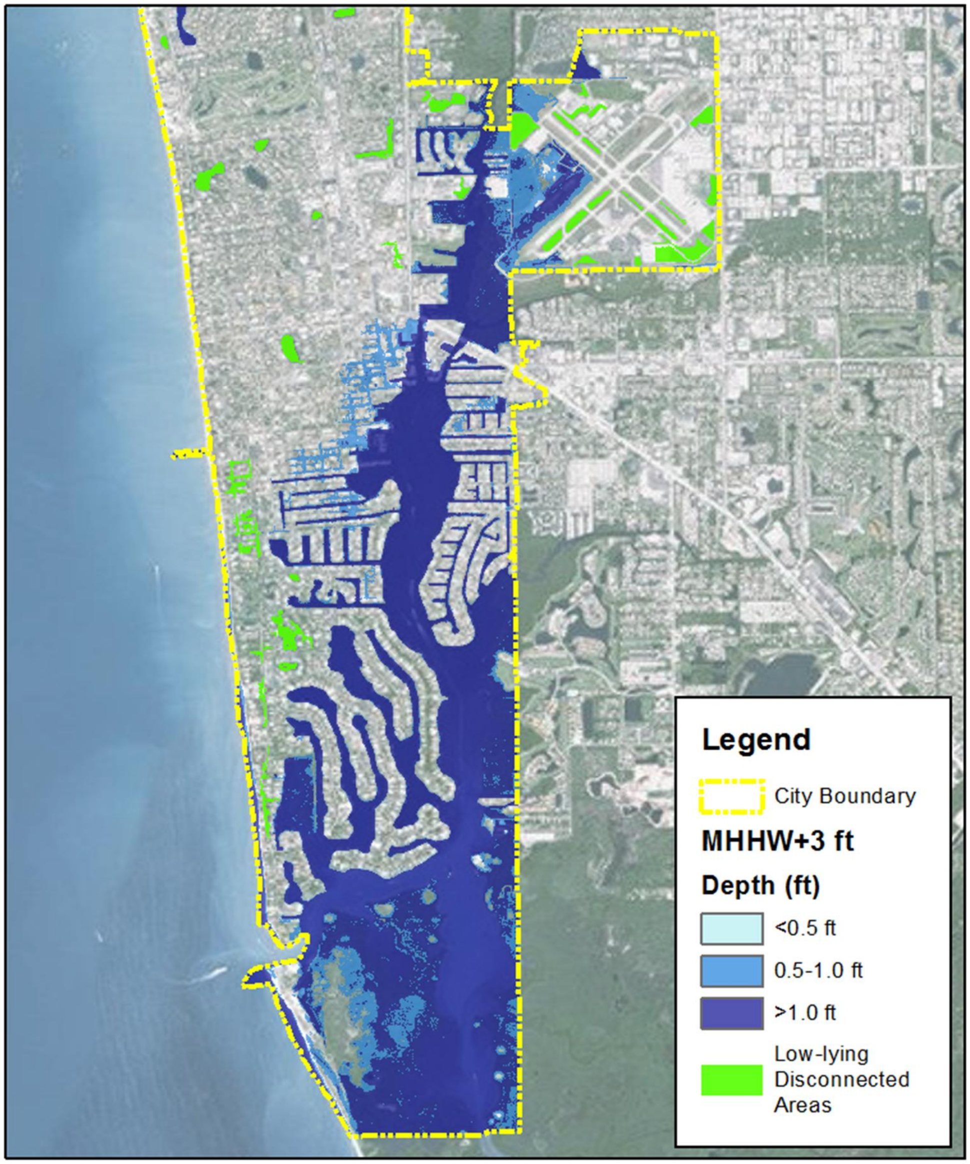
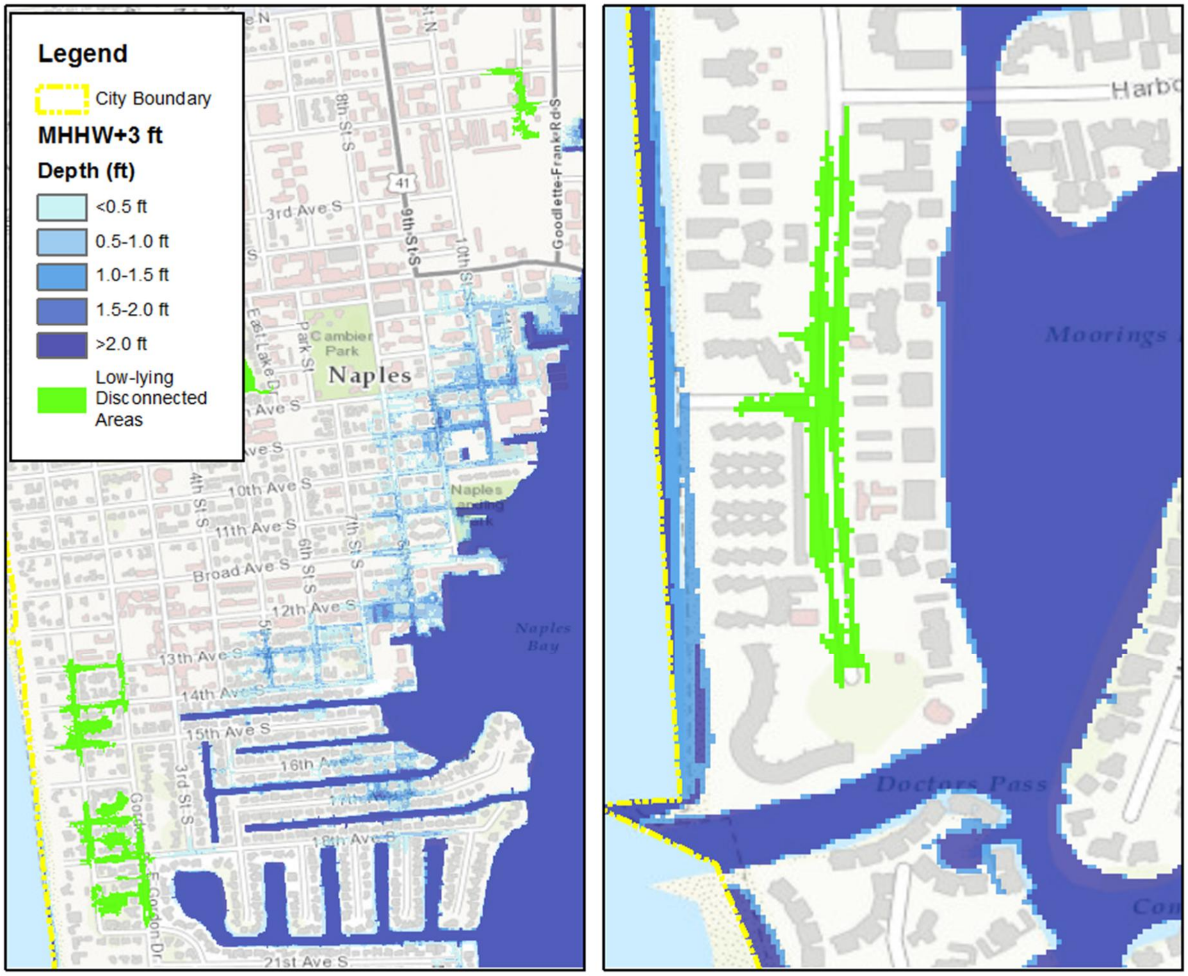


Figure 8-7 shows two zoom maps illustrating projected areas of tidal flooding (Old Naples south of 5th Avenue) and a low-lying disconnected area along Gulf Shore Boulevard north of Doctors Pass that may be exposed in the future to backflow through the stormwater collection system during extreme high tides. The SLR inundation maps for the other scenarios can be used in a similar manner to identify areas of vulnerability for each SLR scenario.

Figure 8-7 Example Areas of Projected Tidal Inundation and Flooding Under the MHHW + 3 ft SLR Scenario



Note: The left panel shows an example area of projected tidal inundation under the MHHW + 3 ft SLR scenario and the right panel shows an example area of potential street flooding due to high tides backing up through the stormwater system under the king tide + 2 ft SLR or 10-year tide + 1 ft SLR scenarios.

8.5 Summary of SLR Impacts to Stormwater System Components

Sea level rise impacts to the stormwater system were evaluated primarily through the use of the SLR inundation maps. As a result, this assessment of vulnerability is primarily an exposure assessment and does not consider other aspects of vulnerability such as sensitivity and adaptive capacity. The sections below evaluate the SLR vulnerability (exposure) of pump stations, outfalls, and inlets in Naples. Exposure to SLR inundation and flooding are evaluated for the five SLR scenarios identified in Section 8.3.2. The SLR exposure assessment focuses on the scenarios equal to and greater than the MHHW + 3 ft SLR scenario because SLR and flooding impacts to the stormwater system are negligible for lower SLR scenarios; however, it should be noted that this assessment does not evaluate the combined effects of precipitation and high tides/SLR, which would require a more rigorous assessment. It is likely that increased vulnerabilities would be identified through such an assessment even for low to moderate amounts of SLR since elevated tide levels reduce the capacity of the stormwater system to discharge precipitation runoff through gravity fed collection and discharge systems.

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8.5.1 Pump Stations

Three pump stations serve the City's stormwater collection network and are used to convey excess stormwater to receiving channels or the Gulf. Flooding at any station has the potential to cause severe consequences to the overall level of service of the City's stormwater system. Many critical facilities, businesses, and residences rely on pump stations to prevent backup and overflows. Pump stations are particularly vulnerable to flooding because they rely on electrical components and have mechanical parts, which are sensitive to floodwaters.

The assessment for each pump stations draws upon the following data sources:

- 2007 LiDAR dataset (ground elevations)
- Design and as-built drawings provided by the City (ground and station component elevations)

8.5.1.1 Exposure

There are numerous potential pathways, including doorways, vents, windows, or improper seals, for floodwaters to impact sensitive pump station components housed inside the building structures. Therefore, elevations of key pump station components (e.g., lowest adjacent grade, pump motor base, and electrical equipment) were identified relative to potential future flood elevations that consider SLR and extreme tides.

Each pump station has a unique physical configuration, but each station's exposure to flooding can be evaluated by identifying the lowest elevation at which water will impact or enter into the pump station (e.g., through doorways, access hatches, or other openings near ground level) and affect water sensitive components. The lowest flood pathway elevation for each pump station was identified through review of as-build drawings. The review showed that the majority of the pump stations have flood access points that are near or at ground level. Therefore, the lowest flood pathway elevation for each pump station is assumed to be the same as its lowest adjacent grade elevation. Elevations of additional pump station components (e.g., electrical equipment, pumps, outfalls) could be compiled to further refine the vulnerability analysis and in the development of adaptation strategies.

A preliminary assessment of each pump station's exposure to SLR inundation and flooding was conducted using the adjacent ground surface elevation at each pump station relative to future water levels. The projected depth of inundation for each SLR scenario was extracted at each pump station and is presented in Table 8-5. Figure 8-8 shows the location of each pump station. The Cove Road pump station is the most vulnerable because it is exposed to inundation at the MHHW + 3 ft SLR scenario, followed by the Public Works and Port Royal pump stations, which are located at higher elevations. Note that this evaluation does not take into account the specific design and configuration of each pump station and is instead based simply on the adjacent ground surface elevation from the bare earth Lidar dataset.

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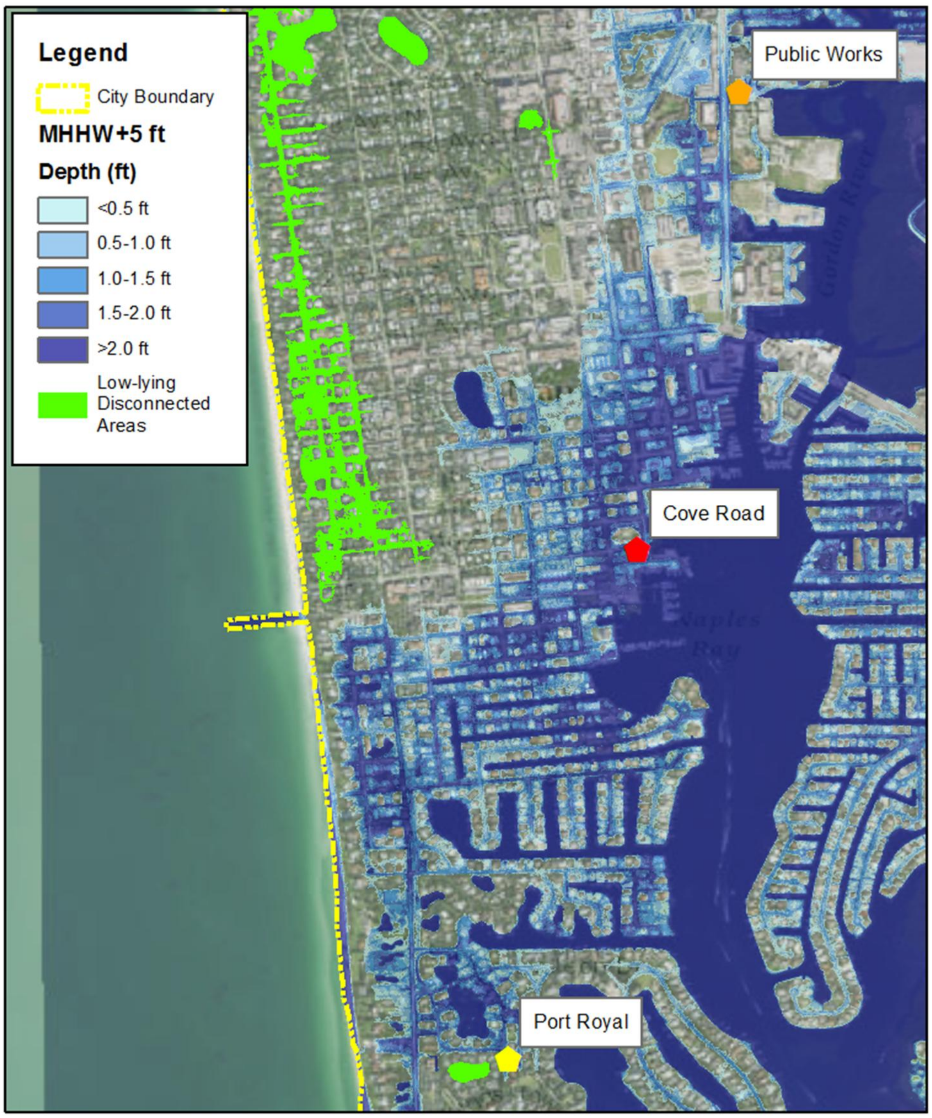
Table 8-5 SLR Exposure and Depth of Inundation at Pump Stations for each SLR Scenario

Pump Station	Scenario of First Impact	MHHW + 3 ft SLR (King Tide+2 ft 10-year tide+1 ft)	MHHW + 4 ft SLR (King Tide+3 ft 10-year tide + 2 ft)	MHHW + 5 ft SLR (King Tide+ 4 ft 10-year tide+3 ft)
Public Works	MHHW + 4 ft SLR	-	þ (0.3 ft)	þ (1.3 ft)
Cove Road	MHHW + 3 ft SLR	þ (0.1 ft)	þ (1.1 ft)	þ (2.1 ft)
Port Royal	MHHW + 5 ft SLR	-	-	þ (0.7 ft)

Note: Projected depth of inundation at each pump station for each SLR scenario is indicated in parentheses.

Figure 8-8 SLR Exposure of Naples Stormwater Pump Stations



Note: Symbol color indicates timing of SLR exposure: MHHW + 3 ft SLR (red), MHHW + 4 ft SLR (orange), and MHHW + 5 ft SLR (yellow)

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8.5.1.2 Data Gaps

- This analysis has not yet incorporated the design and/or as-built drawing information from each pump station, which provides more specific information about asset-specific flood vulnerabilities.
- This analysis has not reviewed impacts to power supply to pump stations, such as buried utilities or power substations, which if flooded could result in loss of power to the pump stations.
- This analysis has not evaluated the presence of back-up generators that could supply power to the pump stations in the event of loss of power.

8.5.2 Outfalls

The Naples stormwater system has approximately 300 coastal outfalls that discharge stormwater into tidal waters:

- Gulf of Mexico (beach) – 10 outfalls
- North Naples (Moorings Bay, Outer Doctors Bay, Inner Doctors Bay, Hurricane Harbor) – 97 outfalls
- Naples Bay – 196 outfalls

Coastal outfalls are vulnerable to sea level rise because they discharge into tidal waters. As mean sea level increases as a result of sea level rise, outfalls will become submerged by high tides a greater percentage of the time. This also increases the likelihood that heavy precipitation events will coincide with moderate to high tide levels and impede gravity drainage from the stormwater system. The exposure of coastal outfalls to sea level rise is evaluated in Section 8.5.2.1.

The City is currently developing plans to remove and consolidate the beach outfalls and install pump stations due to ongoing issues with beach water quality, blocked discharges, frequent maintenance requirements, deteriorating condition, and poor level of service. If left in place, these issues would continue and likely worsen in the future as a result of sea level rise. Since plans are underway to remove the beach outfalls, they were not evaluated in this SLR vulnerability analysis.

8.5.2.1 Exposure

Table 8-6 shows the relative number of coastal outfalls within each stormwater basin. Basins 1, 4, and 7 have the largest number of coastal outfalls that may be subject to sea level rise impacts.

8.5.2.2 Data Gaps

- This analysis did not consider the invert elevations of the coastal outfalls. A more detailed evaluation of outfall vulnerability to SLR could be conducted by incorporating the outfall elevations relative to future tide levels.

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Table 8-6 Number of Coastal Outfalls within each Stormwater Basin

Basin	Approximate Number of Coastal Outfalls	Percentage of Total
Basin 1	76	25%
Basin 2	30	10%
Basin 3	21	7%
Basin 4	91	30%
Basin 5	0	0%
Basin 6	2	1%
Basin 7	43	14%
Basin 8	28	9%
Basin 9	0	0%
Basin 10	4	1%
Basin 11	0	0%
Basin 12	0	0%
Other	9	3%

8.5.3 Inlets

8.5.3.1 Exposure

Stormwater inlets can be a potential source of surface street flooding if they have open connections to tidal water bodies. High tides (such as King Tides) can backflow into the storm drain system and temporarily flood low-lying areas if outfalls are not equipped with backflow prevention devices. Additionally, low-lying areas can be susceptible to elevated groundwater elevations, which can increase rates of infiltration into stormwater pipes. Areas potentially exposed to backflow flooding or groundwater impacts can be identified by overlaying the stormwater inlet locations with the low-lying hydraulically disconnected areas from the SLR inundation mapping. This exposure assessment considers the role of inlets in contributing to the SLR vulnerability of Naples' neighborhoods by acting as conduits for surface street flooding.

Using Basin 1 as an example(Figure 8-9), 11 inlets (shown in red) in the southwest portion of the basin along Gulfshore Boulevard may experience issues with backflow flooding in the street under the MHHW + 3 ft SLR scenario. At MHHW + 4 ft SLR, an additional 16 inlets (shown in orange) may be exposed to backflow flooding farther north along Gulfshore Boulevard. At MHHW + 5 ft SLR, Gulfshore Boulevard becomes exposed to overland flooding from the bay as well and an additional 100 inlets (shown in yellow) may be exposed to backflow flooding along the eastern shoreline of Venetian Bay, Inner and Outer Doctors Bay, and Moorings Bay.

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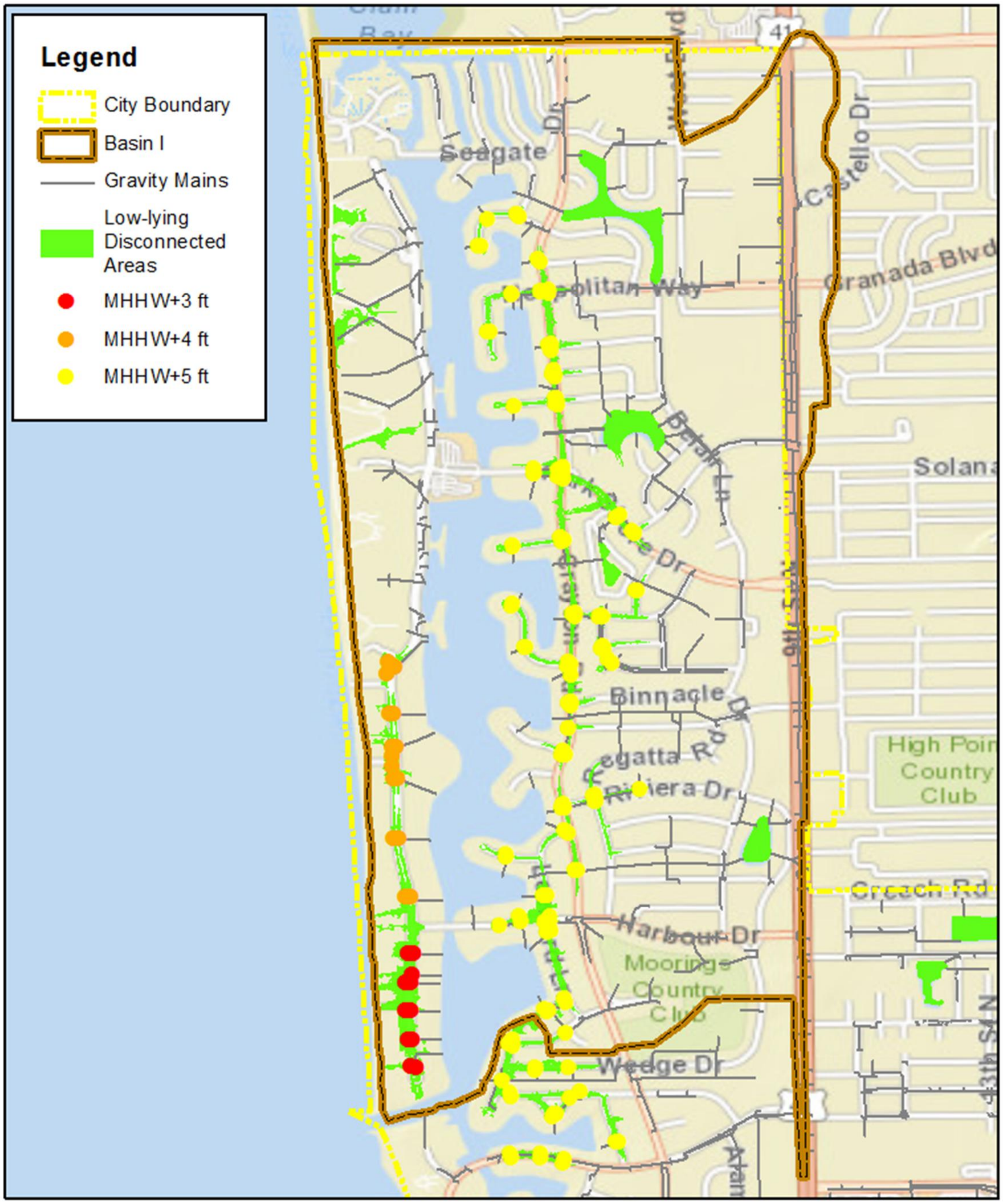

Figure 8-9 Exposure of Inlets to Backflorw Flooding and Groundwater Effects in Basin 1

Note: Green areas indicate low-lying areas that may be exposed to backflow flooding under the MHHW + 3 ft, +4 ft, and +5 ft SLR scenarios.

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Similar vulnerabilities in the other basins can be evaluated based on examination of Table 8-7 and the SLR inundation maps (Figure 8-10). This table and figure indicate the number and location of inlets that may be sources of backflow flooding or experience groundwater impacts under the MHHW + 3 ft, + 4 ft, and + 5 ft SLR scenarios. Basins 1, 3, 4, and 6 appear to be the most vulnerable to issues associated with backflow flooding and elevated groundwater under the MHHW + 3 ft SLR scenario. At the MHHW + 4 ft SLR scenario, Basins 2 and 6 show vulnerability as well. At the MHHW + 5 ft scenario, Basin 9 also shows vulnerability.

Adaptation strategies to address surface street flooding as a result of backflow may include installation of backflow prevention devices on coastal outfalls that drain the areas indicated in Figure 8-10, consolidation of outfalls, or conversion to pumping.

Table 8-7 Number of Inlets Exposed to Backflow Flooding or Groundwater Impacts for Each SLR Scenario

Basin	**MHHW+3 ft** (King Tide+2 ft 10-year tide+1 ft)	**MHHW+4 ft** (King Tide+3 ft 10-year tide + 2 ft)	**MHHW+5 ft** (King Tide+ 4 ft 10-year tide+3 ft)
1	11	27	100
2	-	24	76
3	16	47	87
4	59	7	-
5	-	6	1
6	13	18	9
7	-	-	-
8	-	-	-
9	-	-	9

Note: Number of impacted inlets in each basin is not cumulative because some inlets become exposed to overland flooding at higher scenarios and are therefore not included in the tally shown above.

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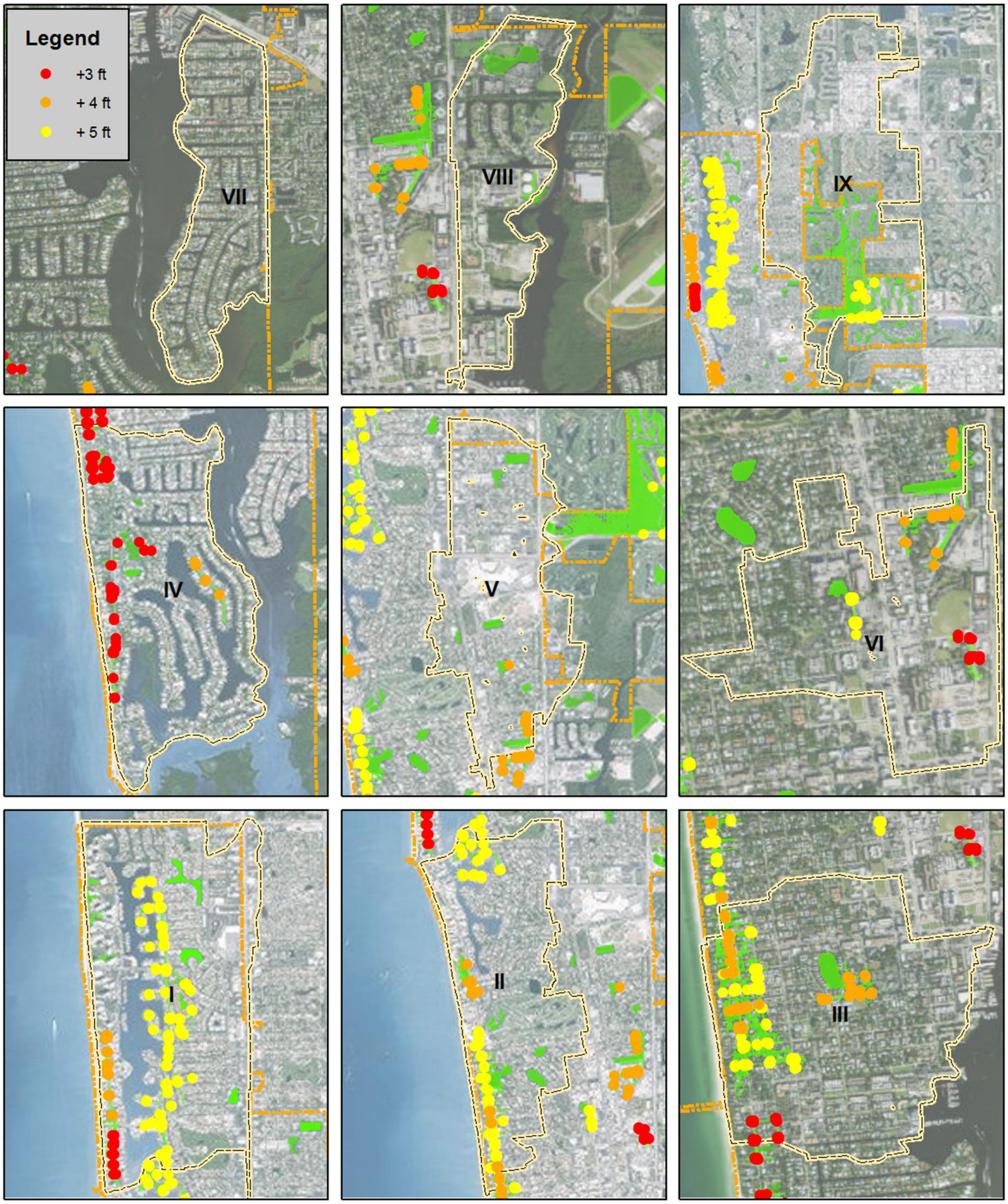

Figure 8-10 Exposure of Inlets to Backflow Flooding and Groundwater Effects in Basins 1 to 9

Note: Exposure to each SLR scenario indicated by symbol color: MHHW + 3 ft SLR (red), MHHW + 4 ft SLR (orange), and MHHW + 5 ft SLR (yellow) SLR. While inland inlets will not be exposed to tidal flooding from backflow, they are shown in the figure above to indicate potential exposure to groundwater effects as well. This assessment did not distinguish between inlets that connect to inland vs. tidal water bodies.

8.5.3.2 Data Gaps

The following data gaps were identified related to the exposure of inlets to SLR and tidal flooding:

- Tide gates and backflow prevention on outfalls may reduce backflow flooding. This assessment did not consider the ability of tide gates to prevent backflow into the stormwater system because this information was not available. It is unknown if this information is unavailable or if there are simply no tide gates on outfalls in Naples.

8.6 Evaluate Resiliency Design Standards [in progress]

- (w.r.t. life expectancy of structure) by other Government agencies e.g. DOT, USACE, Collier County, SFWMD

8.7 Discussion of stormwater management practices [in progress]

- O&M costs (in addition to CIP)
- Opportunities for green infrastructure as climate adaptation strategy (bioretention, pervious pavement, etc)
- Pollution catchment/treatment systems for stormwater

8.8 Key Vulnerabilities and Potential Adaptation Strategies [in progress]

- How stormwater infrastructure plans take sea level rise/climate change into account
- Future planning / policy development e.g. low elevation downtown spots (potential CIP?), street elevations, municipal code (building elevation in relation to flood plain, seawall height etc)
- Information / assessment needs e.g. need to keep abreast of information changes/updates etc; need for City climate adaptation and resiliency plan; need for City climate adaptation and resiliency task force
- CIP projects in planning or design – can they be adapted? e.g. backflow preventers, pump capacity, storage, flood-proofing, etc.
- Future studies and further evaluations

8.8.1 Summary of Key Vulnerabilities [in progress]

- Pump Stations
- Outfalls
- Inlets

8.8.2 Potential Adaptation Strategies

Adaptation consists of actions to reduce the vulnerability of natural and built systems to increase resilience in the face of expected climate change or extreme weather events. Adaptation strategies and actions need to be robust, yet flexible, with short- and long-term approaches to resilience. There are three general categories of adaptation strategies applicable to stormwater systems: information, governance, and physical strategies (Figure 8-11).

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Informational strategies refer to strategies that increase our level of understanding of climate change vulnerabilities, such as case studies, gathering data, and monitoring assets. **Governance strategies** refer to policy related strategies that provide a better regulatory framework or process for addressing climate change vulnerabilities, such as updating zoning or land use, design standards, and maintenance procedures. **Physical strategies** refer to infrastructure modifications or new construction to reduce vulnerabilities, such as green infrastructure, elevating structures, and flood barriers.

The sections below provide examples of adaptation strategies in each of the three general categories – information, governance, and physical – and provides examples of comprehensive strategies which address multiple planning horizon timeframes, new daily conditions and extreme high water events, multiple impacts and vulnerabilities, and multiple assists. Specific recommendations for the Naples stormwater system are not yet identified; however, further evaluation could identify applicable strategies to pursue further.

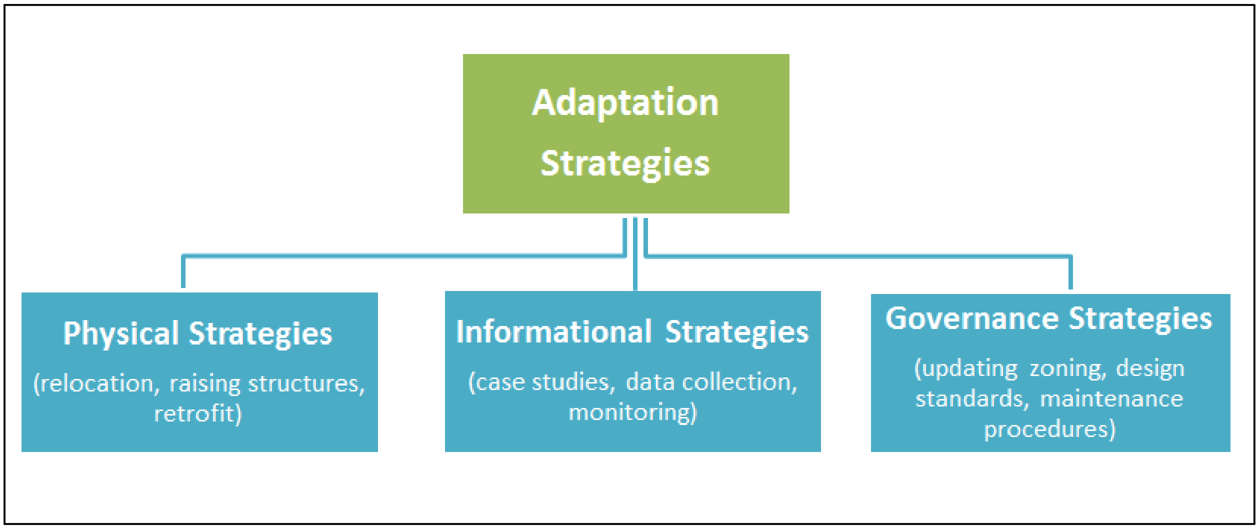

Figure 8-11 Illustration of Physical, Information, and Governance-related Adaptation Strategies

8.8.3 Physical Strategies

Physical adaptation strategies usually fall into one of three options: 1) accommodate (e.g., elevate or waterproof assets in place), 2) protect (e.g., create natural or engineered barriers, such as raised natural shorelines or levees), or 3) retreat (e.g., relocate sensitive assets to low-risk areas). Strategies should consider the scale of impact to support the resilience of the overall stormwater system, including both asset specific and regional strategies.

8.8.3.1 Temporary Measures

Temporary protection is generally erected in advance of predicted floods as part of a City's emergency response protocols. For example, temporary protection measures may be deployed around vulnerable pump stations to prevent overland flooding or around low-lying stormwater inlets with direct tidal connections to prevent flooding from backflow through the stormwater system. Example temporary flood protection strategies include:

- Traditional or self-inflating sandbags
- Reusable water-filled flood protection tubes
- Removable flood walls
- Develop emergency response protocols
- Portable pump stations

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8.8.3.2 Permanent Measures

Permanently installed protection may be designed to either provide recurrent temporary protection (e.g., flood doors and self-rising flood walls), or for continual use (e.g., elevation of electrical components). The following strategies provide medium- to long-term options for adaptation to various types of climate change:

- Elevate vulnerable asset components such as mechanical and electrical equipment
- Elevate vulnerable buildings
- Dry floodproofing with barriers, waterproof membranes, sealants, or watertight doors
- Wet floodproofing such as water-resistant materials, flood vents
- Flood protection walls, levees, and berms
- Self-rising flood barriers
- Install backflow protection on stormwater outfalls
- Install back-up power for electrical systems such as pump stations

8.8.3.3 Regional Measures

In addition to asset-specific adaptation options that are intended to improve the resiliency of an individual facility or structure, regional measures can be utilized to protect assets at a neighborhood or regional scale. Regional solutions offer effective, large-scale flood protection while also providing ancillary services beyond protection of the individual asset. For example, while asset-specific adaptation strategies provide flood protection for an individual structure, regional flood protection strategies may also maintain access to the structure by protecting the surrounding area (such as streets and sidewalks). Regional solutions area can also be more cost effective than local adaptation strategies as they often involve numerous stakeholders, creating a sharing of the overall cost. However, the involvement of multiple stakeholders in regional flood protection strategies may present challenges of coordination and agreement of design.

It may be beneficial to utilize a combination of asset-specific and regional flood protection measures. While large-scale regional flood protection measures are being planned, coordinated, and implemented, asset-specific strategies can be used to protect critical facilities from episodic flood events that may occur over the short-term. Asset-specific flood protection may also be used to provide backup flood protection for critical assets in the event of a regional flood defense failure.

8.8.4 Informational Strategies

Informational strategies create a baseline by which to assess and monitor impacts and to evaluate the success of adaptation strategies. These studies help understand the interactions between rainfall, SLR, extreme tides, and urban/stormwater flooding, and to assess the vulnerability and risk of the system to climate change impacts. Monitoring adaptation projects and collecting system and background data is important to advance adaptation knowledge. Setting up systems for long-term monitoring can identify trigger points for action and can help inform whether adjustments are needed to adaptation projects and provide lessons learned that improve the design and performance of the next generation of adaptation projects. Additional information is needed to better integrate climate change adaptation into the current Naples Stormwater Master Plan.

8.8.4.1 Perform Additional Studies

This sea level rise assessment used the best available information to conduct a high-level vulnerability assessment of the Naples stormwater system. Several informational and data gaps were identified for each asset category. Future climate change adaptation planning efforts may benefit from additional studies to:

- Resolve asset data gaps identified in Section 8.5
- Conduct a more detailed vulnerability assessment at a site-specific level (for example, considering more detailed information about pump stations or modeling the stormwater system performance in response to high sea levels)
- Assess interdependences between assets
- Further analyze precipitation and tidal flooding depths at assets
- Regularly review emerging climate science and updates
- Conduct comprehensive economic risk analysis of flooding SLR impact

8.8.4.2 Data Management

The following data management actions may provide additional information related to sea level rise vulnerabilities and help plan future adaptation efforts:

- Monitor implemented adaptation projects
- Collect data on groundwater elevations and salinity
- Document location and extent of temporary flooding
- Coordinate monitoring and tracking of storm events to prepare for flooding and emergency response

8.8.5 Governance Strategies

The overall governance adaptation strategies described in this section focus on increasing public awareness of risks and employing the collaboration of many parties. These strategies include regulatory controls, land use management policies, surface and groundwater management measures, protections for buildings and infrastructure, and environmental controls.

- Assess feasibility of low-impact development stormwater practices
- Coordinate with City-wide efforts to address flood resilience in the community and identify opportunities to partner on projects
- Develop sea level rise guidance to inform planning and design of future capital projects

TAB 9

Best Management Practice (BMP) Review

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9. Best Management Practice (BMP) Review

9.1 BMP Evaluation

Low Impact Development (LID) devices are specific Best Management Practices (BMPs) intended to address stormwater management using natural processes. The integration of LID into a site plan or master plan is referred to as Integrated Management Practices (IMPs). LID is also referred to as Water Sensitive Urban Design (WSUD) or Green Infrastructure (GI).

The LID approach is intended to mimic natural processes and pre-development hydrologic patterns by minimizing impervious surfaces and capturing and retaining rainwater where it lands with the intent to infiltrate and evapotranspirate via small scale integrated devices, and also by the reuse of rainwater.

The goals and benefits of LID BMPs include improving water quality, attenuating flows, recharging groundwater, reducing potable water consumption, habitat restoration, improving aesthetics, and protentially a cost reduction in community infrastructure

There are a variety of BMP programs that have been initiated in the past 10 years. The FDEP Green Industry (GI) BMPs were developed to assist the turf and landscape industry to protect the environment. Their goals are to reduce nonpoint source pollution and promote the efficient use of water by:

- Reducing the offsite transport of sediment, nutrients and pesticides through surface and ground water.
- Using the appropriate site design and plant selection.
- Using appropriate rates and methods of applying fertilizer and irrigation.
- Using integrated pest management (IPM) to minimize pests and apply chemicals only when appropriate.

GI BMPs include: Treatment swales, Vegetated Natural Buffers, Pervious Pavements, Green Roofs with Cisterns, Stormwater Harvesting, Rain Gardens, Rainwater Harvesting systems, and Rainfall Interceptor Trees

In addition, Site Planning BMPs and Source Control BMPs include natural area conservation, minimization of total impervious area, minimization of Directly Connected Impervious Areas, and the use of Florida Friendly Landscaping and Fertilizers.

The City of Naples Stormwater Ordinance 07-11807 encourages the use of the latest BMPs and LID approaches as defined by the State. The goal is to improve control of runoff to the City's swale system, increased retention systems on private property with more runoff percolating into the groundwater, improved pre-treatment of runoff and potentially reduced flood elevations experienced from specific storm events. The Stormwater Ordinance includes a table of BMP Selection Criteria, which includes a proposed credit for use of a BMP. The current BMP Selection Criteria table is shown in Table XX.

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Table 9-1 Best Management Selection Criteria

Proposed BMP Selection Guide			
	Additional BMP Measure Utilized	Proposed Credit	Justification Explanation
1	Common Swale on Joint Lot Line	1.0 SC	Grading disparities between properties and minimal distance between side setbacks result in difficult to construct an efficient stormwater treatment system that is difficult to maintain. Any property owner that can negotiate and develop a common swale between two lot lines provides a typically superior to maintain, problem free solution that can remove pollutants with a high efficiency as well as carry on-site stormwater in an easier to maintain technique that underground vaults and pipes.
2	Home Roof Drains Connected Directly to Swales or Exfiltration (making roof NDCIA)	1.0 SC	Because of FFE Requirements most new homes are well above the crown of the roadway and driveways have steep slopes where all impervious pollutants drain into Public Right-of-Way with little treatment. Valid techniques, such as pervious concrete, geoblocks, and other innovative landscape architectural techniques that decrease the impervious runoff and allow for some protection will provide credits.
3	Pervious Driveway · Flat (≤ 2% slope) · Med (2% > 5% slope) · Steep (≥ 5% slope)	· 1.0 SC · 0.5 SC · 0.0 SC	Driveways that are made of pervious materials that allow percolation will be given BMP credits. Their effectiveness is directly related to driveway slope.
4	Driveway Trench Drain	0.5 SC	The slope of driveways usually do not allow for reverse grading to treat on-site, thus substantial portions of impervious area go to the street untreated. Credit will be given to effective use of intercepting trench drains.
5	Driveway Runoff Collection – "Rain Gardens"	1.0 SC	Most driveways slope toward the roadway and convey runoff directly into the street without providing any treatment. A depressed landscape area located adjacent to the driveway will be encouraged through BMP credits.
6	Loop Driveway Inverted "Rain Gardens" (instead of raised islands)	1.0 SC	Most looped driveways utilize a raised landscape area that reduces potential treatment area from the very important low portion of the lot where driveways need treatment. A depressed landscape area in these locations will be encouraged through BMP credits.
7	Pool and Deck "Self-Containment" Design	0.5 SC	Designing a pool deck area to shed the runoff back to the pool instead of penetrating additional stormwater runoff will be rewarded with BMP credits.
8	Native Landscaping That Does Not Require Fertilizers/Pesticides	1.0 SC	Landscaping to be documented to be Florida native species compatible with local native soils will be presumed to not require special watering, fertilizing, and pesticide needs that waste water and penetrate pollutant runoff thus BMP credits may be assessed.
9	Home Roof Drain Fitted with Rain Barrels	0.5 SC	Most roof drains are connected to the general conveyance of the property to direct the runoff immediately offsite following a storm event. A rain barrel intercepts this runoff to be used for irrigation purposes during times with lower rainfall therein preserving potable water and its use will credit BMP's.

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These BMPs are focused more towards single-family residential properties. A review of current guiding documents including USGBC LEED, US EPA and regional documents such as Sarasota County will be referenced and utilized to provide a more comprehensive list of BMPs and their benefits as well as limitations.

The United States EPA's National Menu of BMPs for Stormwater is based on the Phase II National Pollutant Discharge Elimination System rule's six minimum control measures:

- Public Education and Outreach on Stormwater Impacts
- Public Involvement
- Illicit Discharge Detection and Elimination
- Construction
- Post Construction
- Pollution Prevention/Good Housekeeping

The general minimum requirements allow the use of appropriate situation-specific sets of practices to achieve the minimum measures.

A description and evaluation of up to five agreed upon Green Infrastructure (GI) and Low Impact Development (LID) BMPs for their applicability in the City of Naples will be prepared after the five BMPs are discussed and selected with City staff.

- Describe each BMP's contribution towards meeting stormwater quality and quantity goals
- Describe benefits for local ecology and bio-diversity

9.1.1 BMP Matrix

- Include matrix to be used as an implementation guide including metrics such as retrofit opportunities, benefits, potential constraints, siting applications, and general performance criteria.

9.1.2 Land Development Code

- Describe the applicability of including the BMP matrix in the Land Development Code.
- Pinellas County has included incentives within its Land Development Code that allow open space requirements to be satisfied through GI stormwater management techniques.

TAB 10

Operational Strategies

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10. Operational Strategies

After planning, design, and construction of the stormwater facilities that are needed to effectively convey and treat stormwater runoff, operational strategies become very important in managing stormwater infrastructure. These strategies help keep each stormwater management element functional to perform at its optimal level. In addition, good strategies help prolong the infrastructure's life span and keeping capital costs to the public down. They also help a City be proactive in its recovery and replacement program by identifying issues before they become an emergent expense.

10.1 Stormwater Infrastructure

There are several elements that combine a functional stormwater management system. The following describes the elements that the City currently maintains:

- Outfalls – Outfalls are defined as structures that ultimately discharge runoff to a receiving water body. These structures are pipe outlets, gates, control structures, or weirs. The City has identified approximately 651 outfalls that they currently monitor and maintain.
- Manholes – Manholes are identified as structures that connect pipes to convey the runoff ultimately to the outfalls. These manholes consist of catch basins with inlets, concrete manholes, junction boxes, and conflict boxes. They can also be associated with water control structures. The City has identified approximately 771 manholes that they currently monitor and maintain.
- Pipes – Pipes are the main infrastructure used to convey stormwater runoff. Pipes within the City range from 8 inches in diameter to 60 inches in diameter. They are circular, elliptical, or boxed shape and are made of material such as reinforced concrete (RCP), corrugated aluminum (CAP), or High Density Polyethylene (HDPE). These pipes can be gravity mains or force mains (when discharging from a pump station). The City has identified approximately 100 miles of pipe that they currently monitor and maintain.
- Lakes – Lakes are used to collect and treat stormwater runoff. There are approximately 350 acres of lakes within the City limits owned by over 70 different landowners. There are 28 lakes identified on the City's inventory. Of the 28 inventoried lakes, 21 receive drainage from public right-of-way (street) within the City. Although the remaining seven (7) lakes do not receive public drainage, they do discharge into the City's stormwater collection system. Five of the 28 lakes are owned by the City, 19 are privately owned, and four have "undetermined ownership". All of the privately-owned lakes that receive stormwater from City streets have a drainage easement over them.
- Pumps – There are three pump stations that the City operates and maintains. They are the Public Works Pump Station, the Cove Pump Station, and the Port Royal Pump Station.
    - <u>Public Works Pump Station</u> – The Public Works Pump Station is located east of the intersection of Goodlette-Frank Road and 3rd Avenue North. This pump station consists of a two main pumps (21,000 gpm each), a jockey pump (5,625 gpm), and an Aquifer Storage Recovery (ASR) pump (1,390 gpm). The Public Works Pump Station discharges to a sedimentation basin on the east side of Riverside Circle, which then flows to the Gordon River/Naples Bay. This station serves Basins 4 and 8, with a combined drainage area of over 200 acres. It also discharges excess stormwater into the City's ASR-2 Well to supplement the reclaimed water supply.

      This pump station also includes a wet well and bar screening systems and control along with the pump, motor, control equipment, and outfall structure. There is also generator and fuel tank for emergency operations.
    - <u>Cove Pump Station</u> – The Cove Pump Station is located at the southwest corner of Broad Avenue South and 9th Street South. This pump station consist three pumps (25,000 gpm

each). The pump station outfall is the discharge point for the City's Stormwater Basin 3, which covers approximately 477 acres, into Naples Bay.

- o Port Royal Pump Station – The Port Royal Pump Station is located at 2665 Lantern Lane. This pump station consists of three pumps (2,500 gpm each). This pump station serves approximately 40 acres of residential land within Basin 4, which is characterized by the Port Royal and Aqualane Shores residential developments. The pump station discharges stormwater to Treasure Cove, which flows to Naples Bay.

- Streets – As part of its stormwater maintenance, the City sweeps 311 curb miles of roadways to remove any pollutants that would travel into the stormwater management system.

- Filter Marsh –

10.2 Stormwater Maintenance

- Regular Maintenance Activities
- Work Orders – 6,000 last year FY 2015-2016 Describe the maintenance schedule – reactive versus planned schedule.
- Describe current maintenance zones, if any.
- Summarize the current levels of service for maintenance activities

10.2.1 Maintenance Activities

- Street Sweeping – 10 Districts, conduct them in order, six week turn around. Sweep 3rd Street South and 5th Ave South every week. 311 curb miles. Streets are swept approximately 10 times a year. Occasional pre-storm prep.
- Repair Catch basins
- Run vacuum truck – pipes and catch basins
- Occasional swale cleaning
- No driveway culverts – swale should be property owner responsibility. Sub may work out, depends on need.
- Clean outfalls – haven't cleaned all 651 outfalls (no regular schedule)
- Run cameras – video storm pipes
- Inspect Pump stations – clean pump station outfalls
- Bar screens – cleaning, fill with oil (monthly), conveyors, operators, and dumpsters (Pump Station check list)
- Control structures – inspection is quarterly, 28 control structures. Clear outfall, check structure (takes 1 week to conduct quarterly inspections)
- Maintain aerators, if issues with aerators
- Filter Marsh – manual structures
- Fix catch basins (cracks on top)
- No routine, cleaning of catch basins, manholes, pipes. As needed.
- Haven't inspected 651 outfalls or cleaned
- 3 Pump Stations – telemetry, alarm doesn't always go off, fire pump engines, starter engine is battery, diesel pump stations.
- Port Royal PS – telemetry, backup-electric motors, generators
- Public Works PS – electrics, 500 gallon generator
- Cove PS – diesel tank, 500 gallon, 100 gallon for standby generator
- Subcontractor maintains floating island and aerators
- Shoreline de-weeding. Staff inspects bi-monthly
- Beach Outfalls – inspected quarterly (9 total, 1 is private), repair outfalls or secure
- No wet swales or ditches
- No exfiltration

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10.2.2 Operations

- Pre-storm on control structures
- Pre-storm – open all lakes
- Describe that there are two employees that maintain the system and video inspect the pipe and that there is one employee for street sweeping

10.2.3 Equipment

- 1 Street sweeper
- 1 Vacuum Truck
- Utility truck – mini crane
- Pickup truck
- 1 – Pool Truck, as needed
- Cement mixer for basin repairs
- Pressure washer (3000 psi)
- GPS unit

10.2.4 Employees

- Operations Manager plus 3 employees
- Subcontractors

10.3 Operational Recommendations

- Provide recommendations for staffing, maintenance schedules, level of service, and operational protocols after evaluating the existing system.

TAB 11

Capital Improvement Program

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11. Capital Improvement Program

11.1 Evaluation of Past 10-Years

The 2007 Master Plan developed a 10 Year Integrated Storm Water Management CIP List. Tables 11-11-1 and 11-11-2 below, summarize the last 10 years of project and program accomplishments, for both water quality and water quantity.

Table 11-1 Summary of 2007 Master Plan Water Quality Project Initiatives for Naples Bay

City CIP ID #	Brief Title	Status
6.1.1	Broad Avenue South Linear and Water Quality Park	Completed
N/A	Lakes to Bay Goodlette-Frank Conservancy Filter Marsh System	Completed
N/A	Gordon River Water Quality Park	Completed
N/A	East Naples Bay Swale Restoration Improvements	Completed
N/A	Gateway Triangle Stormwater Management	Completed
N/A	Modification of Golden Gate Canal Weir #2	Completed
N/A	Modification of I-75 Canal Weir #1	Completed
6.1.2	Cove Pump Station/Naples Bay Outfall Detention Water Quality Basin	Ongoing
N/A	Golden Gate Canal Outfall Improvements	??

Table 11-2 Summary of 2007 Master Capital Improvement Projects

City CIP ID #	Brief Title	Status
1.1	Primary Conveyance System Analysis & Modeling (Specific Basin Studies)	
1.1.1	Primary Conveyance System Analysis & Modeling Basin I	
1.1.2	Primary Conveyance System Analysis & Modeling Basin 2	
1.1.3	Primary Conveyance System Analysis & Modeling Basin 3	Completed
1.1.4	Primary Conveyance System Analysis & Modeling Basin 4	
1.1.5	Primary Conveyance System Analysis & Modeling Basin 5	Completed
1.1.6	Primary Conveyance System Analysis & Modeling Basin 6	Completed
1.1.7	Primary Conveyance System Analysis & Modeling Basin 7	
1.1.8	Primary Conveyance System Analysis & Modeling Basin 8	
1.1.9	Primary Conveyance System Analysis & Modeling Basin 9	
1.1.10	Primary Conveyance System Analysis & Modeling Basin 10	
1.1.11	Primary Conveyance System Analysis & Modeling Basin 11	
1.1.12	Primary Conveyance System Analysis & Modeling Basin 12	
1.2	5 and 10 year CIP Refinement	
1.3	Secondary Conveyance System Analysis/Modeling	
1.4	Naples Bay Basin Management Plan	Completed
1.5	Beach Management Plan for Removal of Ten Stormwater Outfalls	Completed
1.6	Lake Water Quality Management Plan	Completed

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1.7.2	Citywide Stormwater Master Plan Ph-2 GIS Completion & Comp Plan Adjustment	
1.7.3	Rate Study	Completed
1.8	Stormwater Drainage GIS Inventory, Inspection & Evaluation (asset management)	
3.1	Unidentified Stormwater Projects in Basin 1	
3.2	Unidentified Stormwater Projects in Basin 1	
3.3	Stormwater Projects in Basin 3	
3.3.1	Construction of Stormwater Projects in Basin 3 - Phase 1 Improvements	Completed
3.3.2	Design & Permitting of Stormwater Projects in Basin 3 - Phase 2	Completed
3.3.3	Construction of Stormwater Projects in Basin 3 - Phase 2 Improvements	Completed
3.3.4	Construction of Stormwater Projects in Basin 3 - Phase 3 PS and Treatment	Completed
3.4	Unidentified Stormwater Projects in Basin 4	
3.5	Stormwater Projects in Basin 5	
3.5.1	Add new pipe along 10th Ave. No. & 15th Ave. No.	
3.5.2	Add Parallel Storm Sewer Along 10th Street North	
3.5.3	Add Parallel Pipe, Outfall from 6th Avenue North Pond	
3.5.4	Add Parallel Pipe along 8th Avenue North	Completed
3.5.5	Detention Improvements at 13th Street North Pond	Completed
3.5.6	Pipe & detention improvements along 10th Avenue North	Completed
3.5.7	Add parallel pipe along 11th Street North	Completed
3.5.8	Add new pipe along 11th Street North	Completed
3.5.9	Add parallel pipe along 14th Avenue North	Completed
3.5.10	Pipe improvements along 12th Street North	Completed
3.5.11	Detention improvements at 15th Avenue North Pond	Completed
3.5.12	Conveyance improvements adjacent to the mall	Completed
3.5.13	Pipe improvements along Golden Gate Parkway	
3.5.14	Add parallel pipe along Golden Gate Parkway	
3.5.15	Pipe & detention improvements along Diana Ave / 10th Street N	Completed
3.5.16	Replace existing pipe under Golden Gate Parkway	
3.5.17	Pipe improvements along Royal Palm Drive	Completed
3.5.18	Add parallel pipe along Diana Avenue	Completed
3.5.19	Replace existing pipe along 26th Avenue North	Completed
3.5.20	Pipe improvements along 28th Avenue North	Completed
3.5.21	Add parallel pipe, outfall from 28th Avenue North Pond	Completed
3.5.22	Add parallel pipe, outfall from 14th Street North Pond	Completed
3.5.23	Weir modifications adjacent to Reach 03	Completed
3.5.24	Replace existing pipe under Goodlette-Frank Road	Completed
3.5.25	Widen existing channel sections along Reach 03	Completed
3.5.26	Construct 27-acre SWMF along Reach 03	
3.6	Stormwater Projects in Basin 6	
3.7	Stormwater design and permitting projects in Basin 7	

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3.8	Stormwater design and permitting projects in Basin 8	
3.9	Stormwater design and permitting projects in Basin 9	
3.10	Stormwater design and permitting projects in Basin 10	
3.11	Stormwater design and permitting projects in Basin 11	
3.12	Stormwater design and permitting projects in Basin 12	
3.13	CIP Implementation	
3.13.1	Gordon River Improvements (Alternative 1 with all 22 improvements)	Completed
4.1	Water quality swale & stormwater drainage facility reconstruction	Completed
4.2	Reconstruct drainage inlets (safety, lost capacity, & filter)	Completed
4.3	Citywide storm sewer system repair & replacement projects	Completed
4.4	Outfall storm drain pipe slip lining & replacement	Completed
4.5	Royal Harbor Water Quality Swales (Elimination of paved point discharge outfall swales)	Completed
5.1	Survey/log actual flood complaints	Completed
5.2	Inspection and cleaning structures and culverts	Completed
5.3	maintenance of canals and ditches	Completed
5.4	retention ponds and water bodies	Completed
5.5	Maintenance of Pump Stations and force mains	Completed
6.2	TMDL Programs	Completed
6.3	NPDES Programs	Completed
5.6	Pollution prevention and good housekeeping. NPDES Phase II Stormwater Public Education & Public Outreach Control Measure	Completed
6.1	SWIM Programs	
6.1.1	Stormwater Management - Broad Ave. Linear Park & Filter Marsh	
6.1.2	Cove Pump Station / Naples bay Outfall Detention Water Quality Basin	Ongoing
6.1.3	Stormwater Management - Goodlette Frank Road Water Quality Greenway	

- Need to summarize the accomplishments and identify any set-backs on completing these projects.

11.2 Proposed Projects

As part of the 2017 Master Plan Update, a review of the City's Complaint Log issue locations, LIDAR topography, pipe sizes and inlet locations and FEMA Flood Zone Maps by basin resulted in targeted areas for potential capital improvement projects. These locations were discussed at a meeting with City staff held on April 13, 2017. Based on those discussions, the following capital improvement projects list by basin was developed:

11.2.1 Basin 1

1. Gulfshore Blvd North south of Vedado Way to inlet (Complaint Areas 1,2 and 3)

   Project Description - A subbasin hydrologic and hydraulic analysis to determine if the existing roadway meets current LOS standards. The study would review pipe sizing, including the outfall just north of Harbor Drive.

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2. East side of Gulfshore Blvd North – South of Seagate to North of Parkshore Drive (Complaint Areas 14-15)

   Project Description – In initial review of options for reclaiming swales and retention ponds to original volumes or expanding and improving ponds along with examining the potential for rain gardens. After the review, design, permit, and construct improvements.

3. Devil's Lake (Lake #1)

   Project Description - Public Education Program to educate on high level of copper due to excessive use of algacides/herbicides.

4. Seagate Drive Area

   Project Description - A subbasin hydrologic and hydraulic analysis to determine if the existing roadway meets current LOS Standards. In addition, a swale reclamation program for swales is suggested to reclaim swales that have been filled in and/or landscaped.

11.2.2 Basin 2

1. Wedge Drive (Complaint Areas 9-12)

   Project Description - Recommend a LOS Analysis due to complaints of water in swales, and road elevation is low. There is a water table issue.

2. Gulfshore Blvd South – from 3rd St. and 4th Ave. North to 1st Ave. South

   Project Description - This area is to be reviewed as part of the Ocean Outfall Study scheduled to be completed in December 2017.

11.2.3 Basin 3

1. 12th – 14th Ave. South between 3rd – 5th St. South

   Project Description - LOS Analysis for pipe size issues

2. 8th Street from 3rd Ave. south to 4th Ave. North

   Project Description - CRA Streetscape project that includes stormwater is currently under design.

11.2.4 Basin 4

1. Project Description - Study the area and provide recommendations for artesian wells in the western area.

2. Project Description - Study how large private drainage systems on the beach side impact the City's system from both a quality and quantity standpoint.

11.2.5 Basin 5

1. Mandarin Road from Orchid Drive to Allamanda Drive

   Project Description - LOS Analysis (12 inch diameter pipe)

2. Lake #19 –Fleischman Lake (15th Avenue North Lake)

   Project Description – Dredge Lake

3. The City received complaints on three (3) northern lakes in this Basin. Two are City owned, Sun Lake and Thurner Lake. The two northern lakes have water quality issues which can be

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addressed in a Lake Management Plan update. The southernmost of the lakes is owned by Collier County. Public Education is recommended.

11.2.6 Basin 6

1. 8th Street experiences flooding due to the intensity of development

   Project Description - CRA Project includes 8th St. south up to 4th Avenue North.

2. The Naples Community Hospital Lake has the highest concentration of copper of any lake.

   Project Description - This is a Public Education issue.

11.2.7 Basin 7

1. Project Description - Concrete flumes were replaced with side yard swales, which are now mostly filled in and/or landscaped.

2. Project Description - Need to update GIS in this basin.

11.2.8 Basin 8

1. No potential CIP projects identified. Localized flooding only.

11.2.9 Basin X

1. Avion Park

   Project Description - swale reclamation and water quality issues with discharges to mangroves and vegetation accumulation

11.2.10 Lake Management Plan Projects

The Lakes Management Plan was identified as a Capital Improvement Project in the 2007 Master Plan. The Lakes Management Plan was completed in February of 2012 and included the following Capital Projects listed in Table 11-3.

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Table 11-3 Lake Management Plan Projects

Lake Tier	Lake No. and Name	Basin No.	Project(s)	Status (need from City)
Tier I Lakes – City Owned	#19 – Fleischman Lake 15th Ave North Lake	5	Spot Dredge Muck and Sediment	
	#22 – Lake Manor	5	1.Vegetative Maintenance 2.Spot Dredge Muck and Sediment	
	#23 - Lowdermilk Lake	2	Structural repairs to Erosion, Pipe	
Tier II Lakes – High Priority Pollutant Loading	#2 – Swan Lake	1	1. Aeration 2.Spot Dredge Muck and Sediment	
	#11 – Spring Lake	3	Full Dredge Muck and Sediment	
	#8 – North Lake	2	1.Structural Repairs to Erosion, Pipe 2.Full Dredge Muck and Sediment	
	#9 – South Lake	2	1.Aeration 2.Structural Repairs to Erosion, Pipe	
	#10 – Alligator Lake	2	Structural Repairs to Erosion, Pipe	
	#14 – Lantern Lake	4	1.Aeration 2.Structural Repairs to Erosion, Pipe	
Tier III Lakes – Remaining Inventoried Lakes	#1 – Devil's Lake	1	Aeration	
	#21 – Willow Lake	5	Structural Repairs to Erosion, Pipe	
	#25 – Unnamed Lake	Need to confirm	Structural Repairs to Erosion, Pipe	

11.2.11 Water Quality Projects

- Evaluate and rank the existing water quality conditions (pre 2007) for the subbasins in the City using the EMC method
- Evaluate and rank the current water quality conditions for the subbasins in the City using completed projects from the 2007 Stormwater Master Plan Update using the EMC method
- Select water quality projects using the aforementioned criteria for current water quality conditions
- Evaluate the effectiveness of the selected projects using the EMC method

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This table will be refined as we complete the analysis but thought you could place it as a holder for additional information.

Subbasin ID	Existing Water Quality Ranking (pre 2007) Worst to Best (1 to 12)	Current Water Quality Ranking Worst to Best (1 to 12)
1	2	
2	4	
3	5	
4	7	
5	3	
6	8	
7	9	
8	10	
9	1	
10	6	
11	12	
12	11	

- Pollutant load reduction per Net Present Worth cost;
- Land required and availability;
  - Projects on public lands are strongly preferred;
  - The cost of land acquisition would be included in project cost, while the opportunity cost of devoting land to this purpose rather than other desirable uses will be considered, even on public lands;
- Feasibility, primarily permeability but also preference for proven technologies;
- Priorities of the City of Naples and community acceptance; and
- Available funding sources and grant programs.

11.2.12 City Identified Projects

In addition to the Basin-specific projects identified above, several general projects/programs were discussed in the meeting with City staff on April 13, 2017.

- Review and update the City's GIS database for stormwater infrastructure
- Update of the 2012 Lake Management Plan
- Lining of aged stormwater trunk lines
- Review City-owned parcels for storage or water quality treatment opportunities

Major programs that have been identified by City staff include the following:

- Naples Beach Restoration and Water Quality Project (Beach Outfall Removal) - $20,000,000
- Naples Bay Water Quality Project, a.k.a. the Cove Pump Station Outfall Improvement Project - $1,000,000
- Roadway Improvements/Reconstruction) to raise the elevation of curb and road crown (resiliency) - $25,000,000

- Expand Stormwater Delivery to ASR for irrigation - $4,250,000

11.2.13 Conceptual Projects

- Need to determine up to 9 conceptual projects that address water quantity or quality concerns.

11.3 Probable Cost Estimates

11.4 Ranking Projects

- Determine the ranking system for the projects by priorities. Quantity, Quality, Environmental, Recreation, Costs, etc.
- Summarize and rank projects by drainage basin and benefit to cost ratio- Table Format

11.5 Proposed Capital Improvement Plan

- Consolidate the existing project list with the proposed project list
- Prepare an integrated CIP list

11.6 Findings and Recommendations

TAB 12

Funding

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12. Funding

12.1 Rate Evaluation

12.1.1 Overview

{Insert narrative to discuss the process related to the rate evaluation, selection of the comparable communities and observations provided}

12.1.2 Comparable Systems

Community	Population*	Location Type	Median Household Income*	Stormwater Utility
City of Naples, FL	***21,512***	***Coastal***	***$79,515***	***Yes***
City of Venice, FL	22,211	Coastal	$49,926	Yes
City of Jacksonville Beach, FL	23,064	Coastal	$62,229	Yes
City of Fort Walton Beach, FL	21,817	Coastal	$47,149	Yes

* 2015 Census Estimates

{Insert narrative regarding why these three communities were chosen}

12.1.3 Commonalities and Methodologies

Community	Number of People Served
City of Naples, FL	*Research ongoing*
City of Venice, FL	*Research ongoing*
City of Jacksonville Beach, FL	*Research ongoing*
City of Fort Walton Beach, FL	*Research ongoing*

Community	Equivalent Residential Unit (ERU) Definition	
City of Naples, FL	*Research ongoing*	x,xxx sq ft
City of Venice, FL	*Research ongoing*	x,xxx sq ft
City of Jacksonville Beach, FL	*Research ongoing*	x,xxx sq ft

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City of Fort Walton Beach, FL	*Research ongoing*	x,xxx sq ft

Community	Methods for Determining Impervious Area
City of Naples, FL	*Research ongoing*
City of Venice, FL	*Research ongoing*
City of Jacksonville Beach, FL	*Research ongoing*
City of Fort Walton Beach, FL	*Research ongoing*

Community	Impact/Development Fee (Y/N)	Impact/Development Fee Amount	Monthly Stormwater Fee (Y/N)	Monthly Stormwater Fee Amount
City of Naples, FL	*Research ongoing*	*Research ongoing*	*Research ongoing*	*Research ongoing*
City of Venice, FL	*Research ongoing*	*Research ongoing*	*Research ongoing*	*Research ongoing*
City of Jacksonville Beach, FL	*Research ongoing*	*Research ongoing*	*Research ongoing*	*Research ongoing*
City of Fort Walton Beach, FL	*Research ongoing*	*Research ongoing*	*Research ongoing*	*Research ongoing*

Community	Fee Collection Methods	
	Impact/Development Fee	Monthly Fee
City of Naples, FL	*Research ongoing*	*Research ongoing*
City of Venice, FL	*Research ongoing*	*Research ongoing*
City of Jacksonville Beach, FL	*Research ongoing*	*Research ongoing*
City of Fort Walton Beach, FL	*Research ongoing*	*Research ongoing*

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Residential versus Non-Residential Fee Structures and Methodologies

(Insert narrative and tables as appropriate}

12.2 Funding Strategy

12.2.1 Overview

Angie Brewer and Associates, LC (ABA) has been engaged by the City of Naples to provide an analysis of potential funding opportunities related to the Stormwater Master Plan. ABA reviewed information for xxxxxxxx (xx) projects and identified xxxxxxxx (xx) funding sources that are good candidates to provide additional outside funding to these projects. The funding sources identified are not general in nature. They were selected for their specific relation to the projects(s) which they could fund. The result of the analysis is the development of the Funding Strategy.

Overall Strategy - Based on the information that was available at the time this document was developed, ABA recommends that the City pursue all xxxxxxxx (xx) funding sources identified as each one is directly applicable to a specific project or projects. None of the included funding sources is considered a “long shot” or “a stretch”. Each one was carefully reviewed to ensure that it was applicable and relative to the project(s) it has been matched to.

The Funding Strategy includes a detailed breakdown of the potential funding sources for the elements which were reviewed for fundability. This strategy includes information such as funding cycles, match requirements, administrative burden and special considerations.

It is important to note that this document is a snapshot in time at its completion. The current economic climate is under constant change. Pressure from the top levels of the federal and state governments to reduce budgets and eliminate programs is a constant concern. It is possible that some of these sources will not exist in the future or that currently unknown new sources will become available.

12.2.2 Leveraging, Project Consolidation and Viability versus Cost

12.2.2.1 Leveraging

Leveraging is simply using funds from one source, internal or external, as match for another funding source thereby increasing the available funding for a project. Our view on leveraging is based on the belief that evaluation of all aspects of a program, without restriction to a project level approach, greatly improves chances of success. If everything is viewed from only a project level approach, this will create gaps and the City may miss out on an opportunity to leverage funds from one source by matching another. ABA maintains a focus at a program level first to define the overall needs. Then it is possible to assist the City in identifying the specific project elements that align with specific funding sources. With that perspective in mind, ABA seeks funding sources that will accept another source as its match rather than using the City funds as the only source of match.

12.2.2.2 Project Consolidation/Bundling

There are times when smaller project elements can be merged with other projects, or project elements, to create an application that will score higher and is more appealing to the funding source. This will be an ongoing consideration as the City moves forward with funding acquisition.

12.2.2.3 Viability versus Costs

There are many programs available to fund a multitude of projects and project elements and while it would seem appropriate to apply for all opportunities that are identified, this is not always the case. There are times when the cost of an application and the required funding administration, either by a consultant

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or City staff, is too onerous for the amount of money that is being awarded. This does not mean that smaller funding opportunities should be ignored, but that an evaluation of the application process and the administration requirements should be performed before moving forward. The Funding Strategy has an evaluation of these factors included in the recommendations. This will help to ensure that the associated costs of applying and administering the funding do not outweigh the financial benefit.

12.2.3 Funding Sources

12.2.3.1 Legend

Below is an example of the Key Facts section included for each funding source identified in the Funding Strategy. The second column contains an explanation of the potential information in each cell.

Key Facts	
Grant and/or Loan:	Identifies the funding source as a grant and/or a loan.
Terms:	N/A for a grant. If a loan, this will include an estimate of the interest rate and the maximum length of the loan repayment.
Maximum Funding per Cycle:	Identifies the maximum funding available per funding cycle.
Match Requirement:	Identifies the required match percentage and any special match conditions or exclusions.
Application Burden:	Low – Can be completed in-house or with minimal outside support Moderate – Typically completed by an in-house trained grant writer or outside consultant. High – Typically completed by a consultant and may include special technical reports or studies and planning documents.
Special Application Considerations:	Identifies important factors related to schedule and effort such as partnerships, public involvement, and special timetables.
Administrative Burden:	Low – Can be completed in-house or with minimal outside support Moderate – Typically completed by an in-house trained grant administrator or outside consultant. High – Typically completed by a consultant and may include special reports or compliance requirements such as Davis Bacon and EEO.
Special Administrative Considerations:	Identifies important factors related to schedule and effort such as Davis Bacon, EEO monitoring, and others.

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	Funding Source No. 1	Funding Source No. 2	Funding Source No. 3	Funding Source No. 4	Funding Source No. 5	Funding Source No. 6	Funding Source No. 7	Funding Source No. 8	Funding Source No. 9	Funding Source No. 10	Funding Source No. 11	Funding Source No. 12	Funding Source No. 13	Funding Source No. 14	Funding Source No. 15	Funding Source No. 16	Funding Source No. 17	Funding Source No. 18	Funding Source No. 19
Project A																			
Project B																			
Project C																			
Project D																			
Project E																			
Project F-Z (as needed)																			

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12.2.3.2 Community Development Program

Bank of America Foundation

Community revitalization: Supporting local and regional revitalization efforts taking a comprehensive approach to create economic opportunity and communities of choice. This may include large infrastructure and cultural institutions that are economic drivers for employment and contribute to overall community vitality.

- Comprehensive placed-based revitalization: Activities leveraging Public/Private Investment and community partnerships (Choice Neighborhoods, Promise Zones, etc.)
- Fostering green communities: Activities that seek the creation, preservation or restoration of open/green/parks space
- Transit oriented development: Activities that support transit oriented development as a means to connect individuals to jobs, services and overall economic opportunity
- Economic development: Efforts that spur small business growth and healthy commercial corridors

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
ü	**Design**	ü	**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annually
Begin Planning	Early March
Letter of Interest Due	N/A
Application Due	Early May

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$100,000
Match Requirement	Match Requirements Not Stated
Application Burden	Low
Special Application Considerations	None
Administrative Burden	Moderate
Special Administrative Considerations	None

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12.2.3.3 Cooperative Funding Program

Southwest Florida Water Management District

The South Florida Water Management District provides guidelines for funding specific categories of stormwater projects. The stormwater component of the Cooperative Funding Program will share the cost of local projects that address water quality and flooding issues caused by stormwater runoff.

Examples of eligible stormwater projects in previous years include stormwater treatment areas, innovative restoration projects that improve water quality, water storage and infrastructure modifications, sediment reduction facilities and stormwater retrofits.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
	Design		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early August
Letter of Interest Due	N/A
Application Due	Late October

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$250,000 - 2,000,000
Match Requirement	Up to 60% Match Required
Application Burden	Moderate
Special Application Considerations	Attend Board Meeting
Administrative Burden	Moderate
Special Administrative Considerations	None

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12.2.3.4 Environmental Education Regional Model Grant

US Environmental Protection Agency

The goal of this competitive grant program is to enhance public awareness and knowledge about environmental issues in order to encourage the public to make informed environmental decisions and to be responsible in light of environmental issues.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
	Design		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early October
Letter of Interest Due	N/A
Application Due	Mid-November

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$91,000
Match Requirement	25% Non-Federal Match Required
Application Burden	Moderate
Special Application Considerations	None
Administrative Burden	Moderate
Special Administrative Considerations	None

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12.2.3.5 Environmental Solutions for Communities

National Fish and Wildlife Foundation/Wells Fargo

The Environmental Solutions for Communities initiative is designed to support projects that link economic development and community well-being to the stewardship and health of the environment. This initiative is supported through a $15 million contribution from Wells Fargo that will be used to leverage other investments with a total impact of over $37.5 million.

Funding priorities for this program include:

- Conserving critical land and water resources and improving local water quality
- Restoring and managing natural habitat, species and ecosystems that are important to community livelihoods
- Facilitating investments in green infrastructure, renewable energy and energy efficiency
- Encouraging broad-based citizen participation in project implementation.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
	Design		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early October
Letter of Interest Due	N/A
Application Due	Early December

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$100,000
Match Requirement	50% Match Required
Application Burden	Moderate
Special Application Considerations	None
Administrative Burden	Low
Special Administrative Considerations	None

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12.2.3.6 Five Star & Urban Water Restoration Program

National Fish and Wildlife Foundation

The Five Star and Urban Waters Restoration Grant Program seeks to develop community capacity to sustain local natural resources for future generations by providing modest financial assistance to diverse local partnerships focused on improving water quality, watersheds and the species and habitats they support. Projects include a variety of ecological improvements including: wetland, riparian, forest and coastal habitat restoration; wildlife conservation; community tree canopy enhancement; and/or water quality monitoring and stormwater management; along with targeted community outreach, education and stewardship.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
ü	**Design**		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early November
Letter of Interest Due	N/A
Application Due	Early February

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$50,000
Match Requirement	50% Non-Federal Match Required
Application Burden	Moderate
Special Application Considerations	None
Administrative Burden	Moderate
Special Administrative Considerations	None

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12.2.3.7 Max and Victoria Dreyfus Foundation Grant

Max and Victoria Dreyfus Foundation

This program provides grants for museums, cultural, and performing arts programs; schools, hospitals, educational and skills training programs, and programs for youth, seniors, and the handicapped; environmental and wildlife protection activities; and other community-based organizations.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
	Design	ü	**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early March
Letter of Interest Due	N/A
Application Due	Early May

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$20,000
Match Requirement	Match Requirements Not Stated
Application Burden	Moderate
Special Application Considerations	None
Administrative Burden	Moderate
Special Administrative Considerations	None

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12.2.3.8 NOAA Gulf of Mexico Bay-Watershed Education and Training (B-WET) Program

National Oceanic and Atmospheric Administration

The primary delivery of BWET is through competitive funding that promotes Meaningful Watershed Educational Experiences (MWEEs). MWEEs are multi-stage activities that include learning both outdoors and in the classroom, and aim to increase the environmental literacy of all participants.

Additionally, Gulf of Mexico B-WET projects support the priority issues of the Gulf of Mexico Alliance, with the goal of significantly increasing regional collaboration to enhance the ecological and economic health of the Gulf of Mexico.

The Alliance has identified the following regionally significant priority issues:

-Coastal Resilience	-Data & Monitoring
-Education & Engagement	-Habitat Resources
-Water Resources	-Wildlife & Fisheries

Eligible Project Types			
ü	**Planning**		**Infrastructure/Capital**
	Design	ü	**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Late July
Letter of Interest Due	N/A
Application Due	Late October

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$100,000
Match Requirement	None
Application Burden	Moderate
Special Application Considerations	Show partnerships
Administrative Burden	Moderate
Special Administrative Considerations	None

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12.2.3.9 Partners for Places

Funder's Network for Smart Growth

National funders invest in local projects to promote a healthy environment, a strong economy, and well-being of all residents. Through these projects, Partners for Places fosters long-term relationships that make our urban areas more prosperous, livable, and vibrant.

Eligible Project Types			
ü	**Planning**		**Infrastructure/Capital**
ü	**Design**		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early November
Letter of Interest Due	N/A
Application Due	Late January

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$75,000
Match Requirement	50% Match Required
Application Burden	Low
Special Application Considerations	Must have Sustainability Office
Administrative Burden	Low
Special Administrative Considerations	None

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12.2.3.10 PIG Difference Grant

New Pig Corporation

This program provides funds to improve sustainability of waterways, watersheds, estuaries, tidal pools or wetlands, or the wildlife that are directly affected by them. Most anything that improves sustainability of a body of water will be considered. Projects must be hands-on in nature. This program looks for innovative groups in local communities working to make their corner of the world more sustainable.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
	Design		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Ongoing
Begin Planning	60 Days Prior to Submission
Letter of Interest Due	N/A
Application Due	Ongoing

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	$5,000 plus materials
Match Requirement	None
Application Burden	Low
Special Application Considerations	None
Administrative Burden	Low
Special Administrative Considerations	None

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12.2.3.11 Section 319 Grant Program

Florida Department of Environmental Protection

These grant funds can be used to implement projects or programs that will help to reduce nonpoint sources of pollution. Projects or programs must be conducted within the state's NPS priority watersheds, which are the state's SWIM watersheds and National Estuary Program waters.

Examples of fundable projects include: demonstration and evaluation of Best Management Practices (BMPs), nonpoint pollution reduction in priority watersheds, ground water protection from nonpoint sources, and public education programs on nonpoint source management.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
	Design	ü	**Programmatic**

Funding Cycle Details	
Cycle Frequency	Annual
Begin Planning	Early January
Letter of Interest Due	N/A
Application Due	Late May

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	Varies - Up to $1,000,000
Match Requirement	40% Non-Federal Match Required
Application Burden	High
Special Application Considerations	Technical Data
Administrative Burden	High
Special Administrative Considerations	Technical Data/Monitoring

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12.2.3.12 State Revolving Fund Loan Program (SRF) – Clean Water

Florida Department of Environmental Protection

The aim of the Clean Water State Revolving Fund (SRF) Program is to provide low-interest loans to eligible entities for planning, designing, and constructing public wastewater, reclaimed water and storm water facilities.

Eligible Project Types			
ü	**Planning**	ü	**Infrastructure/Capital**
ü	**Design**		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Ongoing
Begin Planning	90 Days Prior to Submission
Letter of Interest Due	N/A
Application Due	Ongoing

Key Facts	
Grant or Loan	Loan
Terms	20 Years / Current Rate btw 0.00-2.00%
Maximum Funding/Cycle	Subject to Annual Segment Cap
Match Requirement	None
Application Burden	High
Special Application Considerations	Planning/Environmental Documents
Administrative Burden	High
Special Administrative Considerations	Davis Bacon / American Iron and Steel

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12.2.3.13 Total Maximum Daily Load (TMDL) Water Quality Restoration Program

Florida Department of Environmental Protection

Applicants are eligible for the TMDL Water Quality Restoration Grant for the following types of projects: projects that reduce stormwater pollutant loadings from urban areas that discharge to waterbodies on the state's verified list of impaired waters; projects at least at the 60% design phase; and the construction will be completed within three years.

Eligible Project Types			
	Planning	ü	**Infrastructure/Capital**
ü	**Design**		**Programmatic**

Funding Cycle Details	
Cycle Frequency	Every 4 Months
Begin Planning	90 Days Prior to Submission
Letter of Interest Due	N/A
Application Due	March / July / November

Key Facts	
Grant or Loan	Grant
Terms	N/A
Maximum Funding/Cycle	Based on Funding Availability
Match Requirement	50% Non-Federal Match Required
Application Burden	High
Special Application Considerations	Technical Data/Permitting Status
Administrative Burden	High
Special Administrative Considerations	Storm Event Monitoring

12.2.4 Conclusion and Strategy

{DRAFT} The City of Naples has an opportunity to bring grant and low-cost funding dollars back into the community. The funding sources presented offer the City potential savings in the $10,000's to $1,000,000's range versus traditional project funding sources. By engaging in the development of the Funding Strategy, the City has chosen a path that should lead to an increased ability to provide valuable resources to the community at the lowest possible capital costs.

Overall Strategy and Direction - ABA recommends that the City apply for all of the grants included in this strategy as each funding cycle opens up and assuming the City meets the required planning minimums of each funding source at that time. Each grant included creates a direct opportunity for the City to reduce the overall cost and financial impact of the project and was selected because of its applicability. None of the grants included are deemed to be "out of reach" or "a long shot". All have been evaluated and represent a strong opportunity for success.

It is important to remember that funding opportunities become available and disappear frequently and without warning. Changes in politics, foundation focuses, and perceived needs all contribute to these frequent changes. Due to these facts, this Funding Strategy is not intended to capture all of the available funding for a particular project. It is intended to serve as a general evaluation for successfully funding the projects contained within.

While the research conducted for this Funding Strategy has identified significant amounts of potential funding, it is important to remember that not every funding source is an exact fit for a given project and

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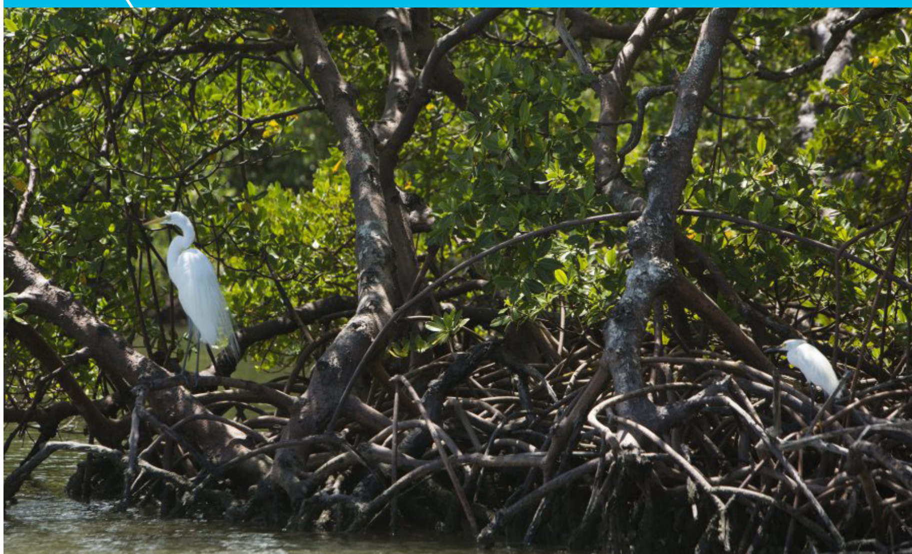
ABA cannot guarantee that any one application will result in a successful outcome, including but not limited to a funding award. We strive to only pursue the opportunities that have the highest chance of success for the client and to submit an application which is fully compliant with program requirements.

If elements are added to the project beyond the basic understandings at the time of this report, analysis of the elements and their impact on potential funding will be required to fully understand how the grant opportunities provided in this document are affected.



TAB 13

Stormwater and Natural Resource Division

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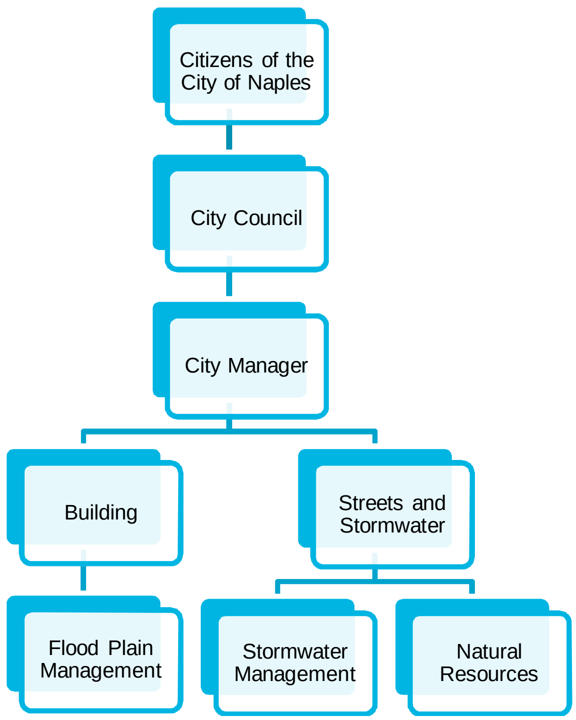
13. Stormwater & Natural Resources Divisions Review

As part of the investigation and evaluation of the stormwater management program, each division that is responsible for stormwater management was reviewed to consider strategies to more effectively deliver services, projects, and programs as well as other Division improvements in an effort to align resources with the mission and goals of each Division and the City and project and program goals proposed in the Stormwater Master Plan. In order to evaluate each division, meetings were held to interview current key staff to document the duties to each staff within each Division. These meetings not only determine staff duties but gave insight on the actions of each department.

The Stormwater Management and Natural Resources Divisions fall under the Streets and Stormwater Department of the City. This department sub sequentially falls under the City Manager who answers to the City Council and ultimately to the citizens of the City of Naples as shown in the organization chart in Figure 13-1. This chart does not represent the entire organization of the City, but only applies to those divisions that are involved in the City's stormwater management activities.

Figure 13-1 City of Naples Organizational Chart



The Streets and Stormwater Department operates in two funds under the City budget: Streets & Traffic Fund and Stormwater Fund. These functions are combined under one Director, yet operate out of two separate and independent funds. The Stormwater Fund operates as an Enterprise Fund, which is used to account for operations that are financed and operated in a manner similar to private business. The Stormwater Fund is responsible for maintaining and improving the stormwater management system which includes storm drainage, flood protection, ecological systems, and water quality infrastructure and programs.

According to the "City of Naples, Florida Fiscal Year 2016-2017 Proposed Budget", staffing is shared between the Divisions as illustrated in Table 13-1.

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Table 13-1 Division Staffing

Job Title	Streets Division	Stormwater Division	Natural Resources Division	Total Staff
Streets & Stormwater Director	0.25	0.75	0	1
Engineering Manager	0.25	0.75	0	1
Construction Project Manager	0.25	0.75	0	1
Operations Supervisor	0	1	0	1
Engineering Aide	0	1	0	1
Equipment Operator III	0	1	0	1
Utility Coordinator	0	1	0	1
Utility Technician I	0	1	0	1
Administrative Coordinator	0.25	0.75	0	1
Natural Resources Manager	0	0	1	1
Environmental Specialist	0	0	1	1
Project Coordinator/Public Outreach	0	0.5	0.5	1

13.1 Stormwater Division

It is the responsibility of the City, through its Stormwater Management Division (in partnership with other departments such as Building, Planning and Community Services), to effectively and efficiently regulate, manage and maintain stormwater drainage infrastructure and surface water bodies to meet growth management goals of flood prevention, groundwater recharge, wetland preservation and water quality protection.

The stormwater management function is critical to achieving the City's current vision statement: "Naples shall remain a premier City by continuing to protect its natural resources, enhance City aesthetics, ensure public safety, and continue to improve the quality of life for all who live in the City and visit through the year."

13.1.1 Stormwater Division Mission

According to the "City of Naples, Florida Fiscal Year 2016-2017 Proposed Budget",

The mission of the Stormwater Division is to protect people and property against flood by maintaining and improving the public stormwater management system, while protecting and restoring ecological systems that work naturally to improve water quality, the environment and quality of life for residents and visitors.

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According to the City's website, the Stormwater Division Mission is "to improve flood protection and water quality through the construction, maintenance and operation of the public stormwater system and the preservation and restoration of area waterways."

13.1.2 Stormwater Division Goals

- Growth Management goals of flood prevention, groundwater recharge, wetland preservation and water quality protection.

13.1.3 Stormwater Division Objectives

According to the "City of Naples, Florida Fiscal Year 2016-2017 Proposed Budget", the overall objective is to manage stormwater in ways that reuse, store, recharge the aquifer, improve water quality, and achieve the drainage level of service as provided for within the City's Comprehensive Plan, thereby protecting public health, property and the environment.

13.1.4 Stormwater Division Budget

- Review the current budget for this department including how operation and maintenance, capital improvements, and programs are funded

13.2 Natural Resource Division

13.2.1 Natural Resource Division Mission

According to the City's website, the Natural Resource Division mission is to protect people and property against flood by maintaining and improving the public stormwater management system, while protecting and restoring ecological systems that work naturally to improve water quality, the environment, and the quality of life for residents and visitors.

13.2.2 Natural Resource Division Goals

13.2.3 Natural Resource Division Objectives

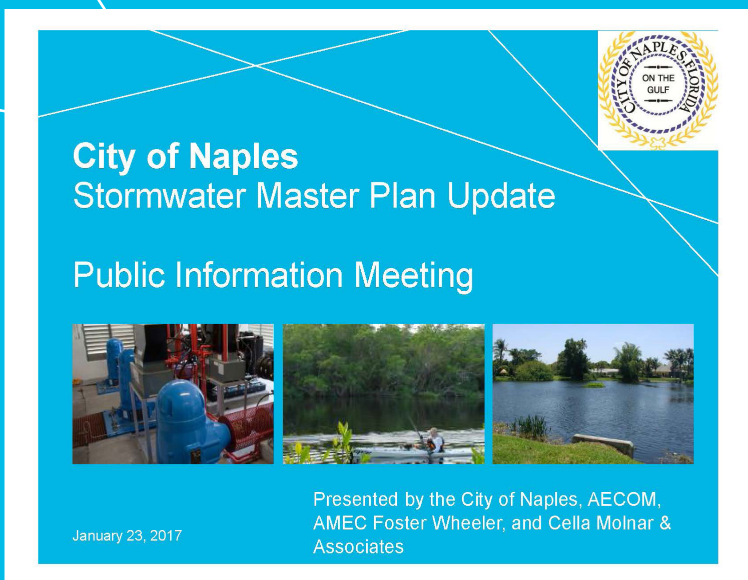
13.2.4 Natural Resource Division Budget

- Review the current budget for this department including how operation and maintenance, capital improvements, and programs are funded

13.3 Evaluation and Findings

- Comparison with Cities of Similar Size and/or Budgets
- Strategies to align resources with Division mission and goals, and program goals proposed in the SWMP:
    - Management Strategies
    - Staffing Levels
    - Budget Allocations

13.4 Recommendations



TAB 14

Public Involvement

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14. Public Involvement

Public involvement, participation and education in stormwater management are prerequisites to the City successfully executing its duties and responsibilities under the Phase II NPDES Permit. Since stormwater management's main purpose is to provide flood protection and to treat runoff in order to protect the public and the environment, the public involvement process consisted of providing:

- information to the public on the stormwater master planning process and elements of a stormwater management plan
- gathering information from the public on their concerns to stormwater management (etc. flooding and water quality)
- gather information on the public's priorities concerning stormwater management
- provide recommendations and planning elements as a result of the analysis and priorities

The public involvement plan for the stormwater master plan consisted of two (2) public meetings where the public participated in the process of information gathering and two (2) City council workshops that consist of a 60% meeting of the document and 100% meeting of the document. The purpose of the 60% meeting is to provide the findings on the current stormwater management plan and along with suggested recommendations and gather feedback from the council and the 100% meeting is to provide the entire final document.

14.1 Public Meeting Summary

There were two public information workshops on Monday, January 23, 2017 and on Wednesday, February 22, 2017 at the River Park Community Center, 301 11th Street North, Naples Florida. Appendix I contains a summary of the Public Meeting. The public meeting was conducted in an "open house" format. There were 10 stations were the public visited to receive information and provide feedback. The first station was a presentation describing what a stormwater masterplan is and what the elements of a stormwater master plan are. The other nine (9) stations were display boards that explained each element of the master plan and required the public to provide feedback on questions. These display boards along with the presentation are located in Appendix I. The following are the results from the responses to the display boards:

14.1.1 Station 1 – Presentation

Station 1 consisted of the presentation. The purpose of this station was to inform the public that the meeting was intended to be informative and interactive. The presentation gave a brief history of the City's stormwater master planning process, why it was important to develop a stormwater master plan, what are the elements of a stormwater master plan, and what information the public could provide for the master planning process.

14.1.2 Station 2 – Overview Map

This station provided an overview map of the City where the public could place a dot in locations were they indicated there was a concern in water quantity – flooding, water quality and ecology, operation and maintenance, or other issues that they had witnessed throughout the City. The following issues were identified:

- Water Quantity
    - Alley between 10th Avenue and 11th Avenue
    - South of the intersection of 9th Avenue and 10th Street
    - Intersection of 8th Avenue and 2nd Street
    - Intersection of 3rd Avenue and 10th Street

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- o Southwest corner of the intersection of 5th Avenue and Goodlette-Frank Road
- o Mid-block of Hurricane Harbor Lane

· Water Quality

- o On the beach, approximately 800 feet south of the intersection of Galleon Drive and Gordon Drive. Claim that there is an artesian well on the beach
- o Strong odor near the Coast Guard Station at the park

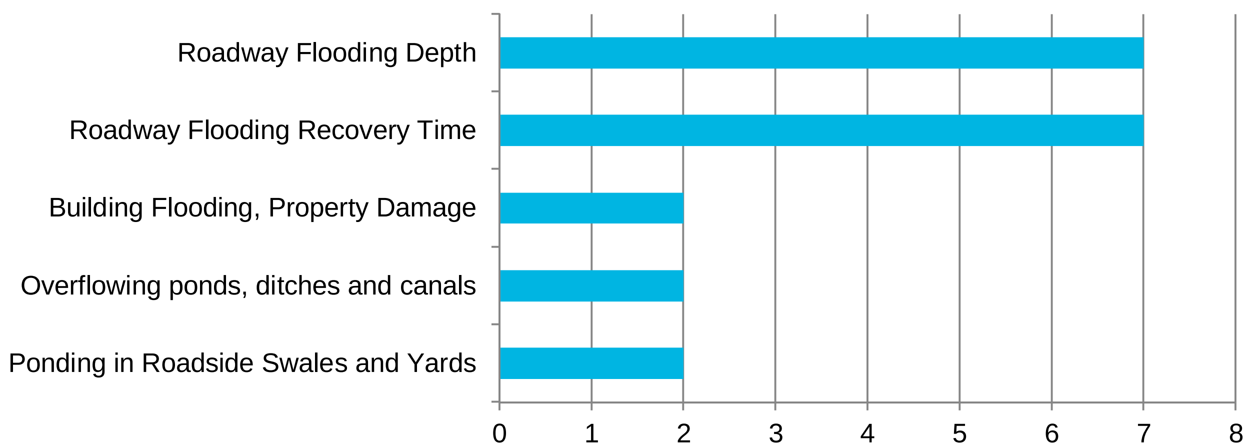
14.1.3 Station 3 - Water Quantity (Flooding and Recovery)

This station provided information concerning water quantity. The display board described what water quantity was and stated:

Water Quantity refers to the amount of stormwater runoff that is produced from a rainfall event. Water quantity impacts the public through flooding conditions and recovery time. It is often managed by creating storage and conveyance systems such as local lakes and ponds, ditches, canals, and pipes/inlets, prior to discharge into receiving water bodies such as the Gulf of Mexico and Naples Bay. Stormwater runoff also infiltrates into the groundwater system.

The display board asked for the public to provide information for one question. The following is the one request along with the results:

When it comes to Water Quantity, which items concern you most?



Based on the results of this station, the public is more concerned with roadway flooding and recovery time of the flood events.

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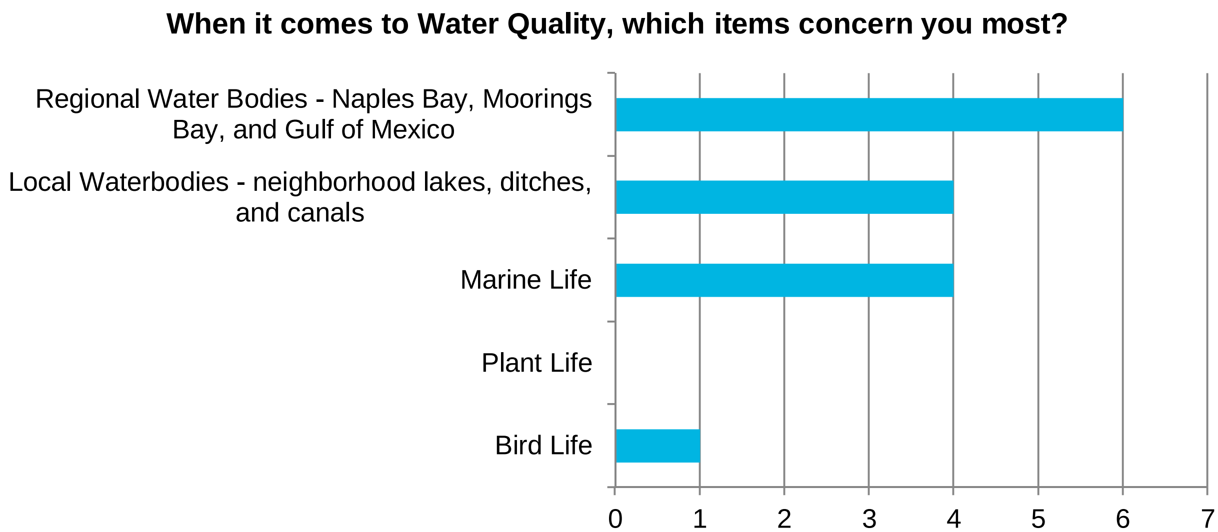
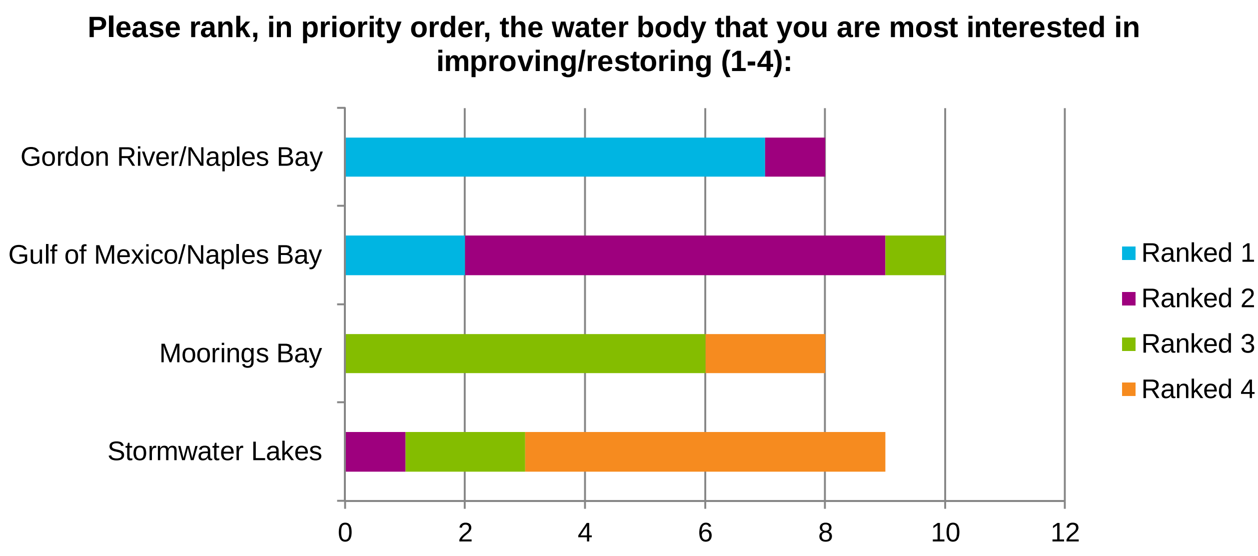
14.1.4 Station 4 - Water Quality and Ecology

This station provided information concerning water quality and ecology. The display board described what water quality and ecology was and stated:

Water Quality refers to the nutrients or pollutants that are found in the stormwater runoff. As stormwater flows across the land it picks up pollutants such as bacteria, fertilizers, oil and soil; this can affect the ecology of receiving water bodies (canals, lakes, rivers, and the gulf).

The display board asked for the public to provide information for two questions. The following are two requests along with the results.





Based on the results of this section, the public was more concerned with water quality issues in both regional and local waterbodies and were more concerned with marine life. Also, the public is more interested in improving/restoring the Gordon River and Naples Bay over other water bodies.

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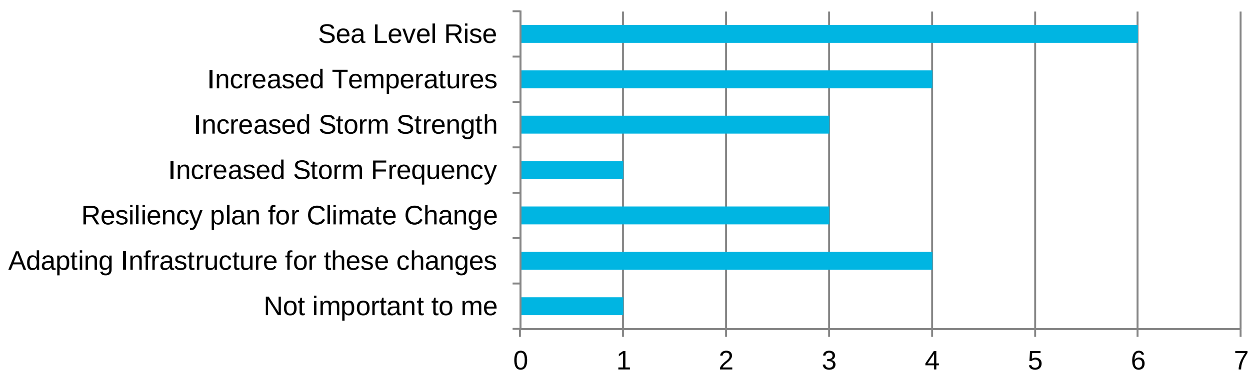
14.1.5 Station 5 - Climate Adaptation (Sea Level Rise and Resiliency)

This station provided information concerning climate adaptation – sea level rise and resiliency. The display board described what climate adaptation was and stated:

Climate Change is a debated issue, yet many municipalities are planning infrastructure projects and studies to account for sea level rise, increase storm strength and frequencies, and increased temperatures. Climate Adaptation includes preparing or planning for infrastructure that can withstand these changes.

The display board requested input from the public on one item. The following is the one request along with the results.

When it comes to Climate Adaptation, which items concern you most?



Based on the results, the public has concern with sea level rise and would like to see the City adapting infrastructure for these changes.

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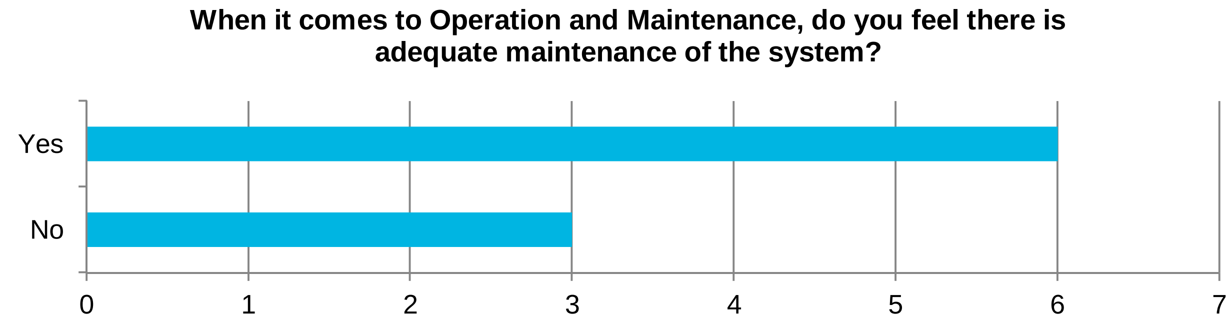
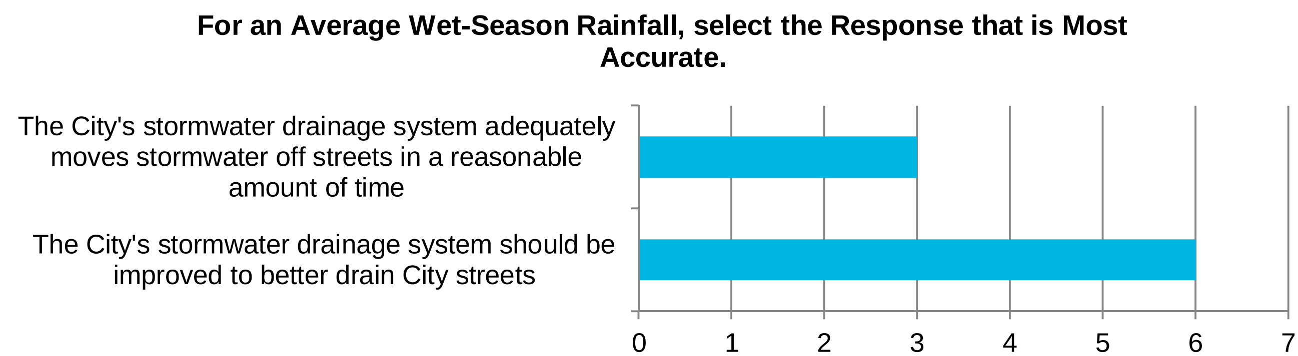
14.1.6 Station 6 - Operation and Maintenance

This station provided information concerning operation and maintenance. This display board described what operation and maintenance was and stated:

The City currently operates and maintains 651 Outfalls, 3,648 Catch Basins, 771 Manholes, 100 miles of pipe, 28 lakes, and 3 pump stations. It also sweeps 311 curb miles of streets in order to remove potential pollutants before they enter the stormwater system. It is important for the City to maintain stormwater facilities frequently enough to prevent flooding and pollutants from entering water bodies.

The board requested information from the public on two items. The following are the results of those requests.





Based on the response of the public, the public believes there is adequate operation and maintenance of the stormwater management system. In addition, the public feels that the drainage system should be improved to better drain the City's streets.

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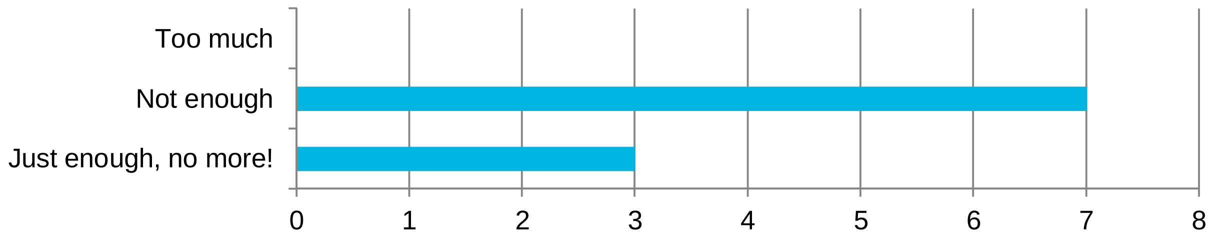
14.1.7 Station 7 - Regulation

This station provided information concerning regulation. The display board described what regulation was and stated:

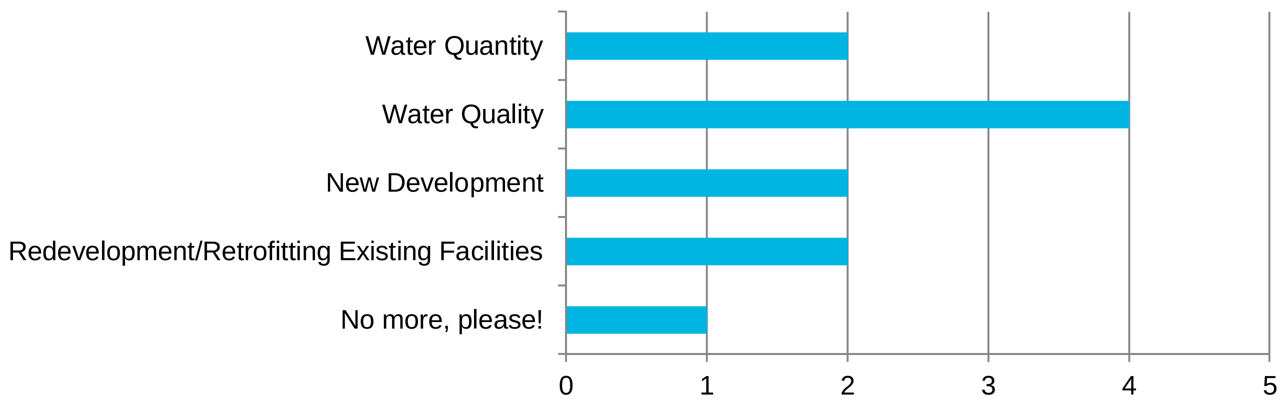
Stormwater management is regulated at the Federal, State, County, and City levels. These regulations help protect our water resources from both a water quantity and quality standpoint.

The display board requested information from the public on two items. The following are the two items along with the results.

When it comes to Regulations, do you believe there is too much or not enough regulation?



Where would you like to see more regulations?



Based on the results, the public believes that there is not enough regulation and that they would like to see more regulation in water quality.

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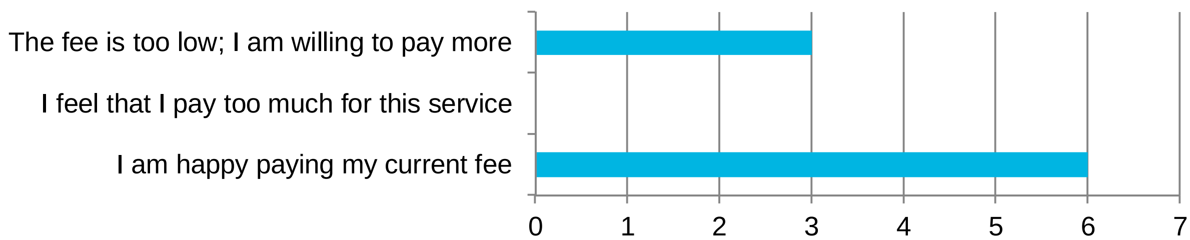
14.1.8 Station 8 – Funding (Stormwater Utility Fees and Grants)

This station provided information concerning funding. The display boards described what funding was and stated:

Effective Stormwater Management programs require adequate funding. Funding is needed for new infrastructure, repairing old infrastructure, and for the operation and maintenance of the structures. Where does this funding come from? The City currently has a stormwater utility fee, which equates to $13.06 per month per average residential unit (ARU). This fee, along with grants, allows the City to manage stormwater. The City is always investigating other financial resources to ease the burden on tax payers.

The display board requested the public to provide information for one item. The following is the one item along with the result.

When it comes to the existing Stormwater Utility Fee, what do you think about the fee?



Based on the results, the public is content with its current stormwater utility fee.

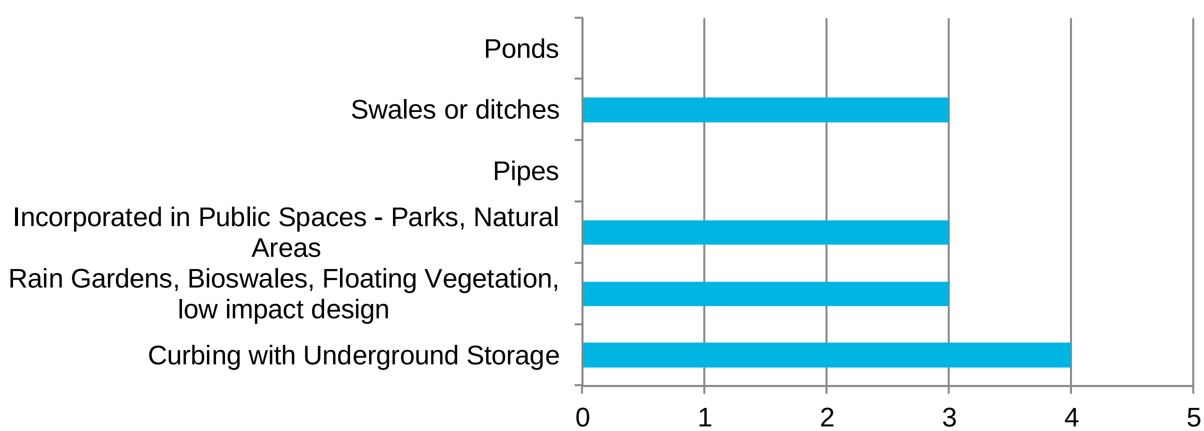
14.1.9 Station 9 - Capital Improvements

This station provided information concerning capital improvements. The display board described what capital improvements were and stated:

Capital Improvements are vital to managing a stormwater system. These improvements can be new projects, capital purchases, or recovery and replacement projects.

The display board requested the public to provide input in three areas. The following are the results of the requests along with the results.

When it comes to Capital Improvements, I prefer projects that are…?



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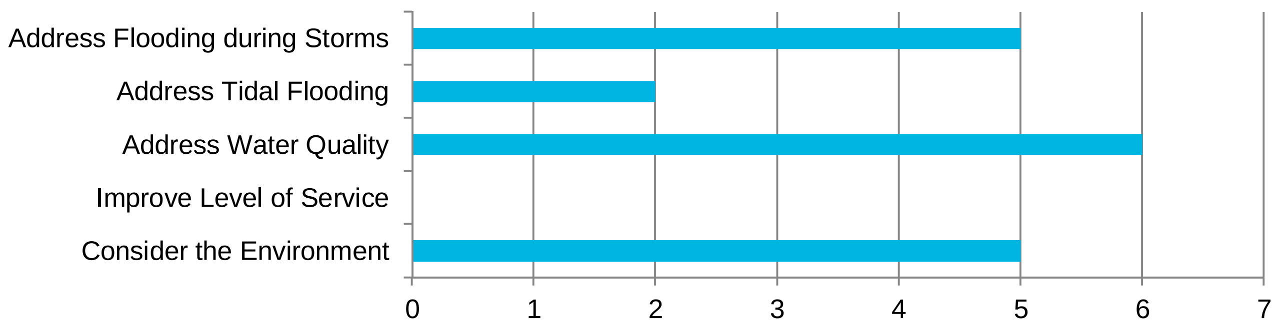
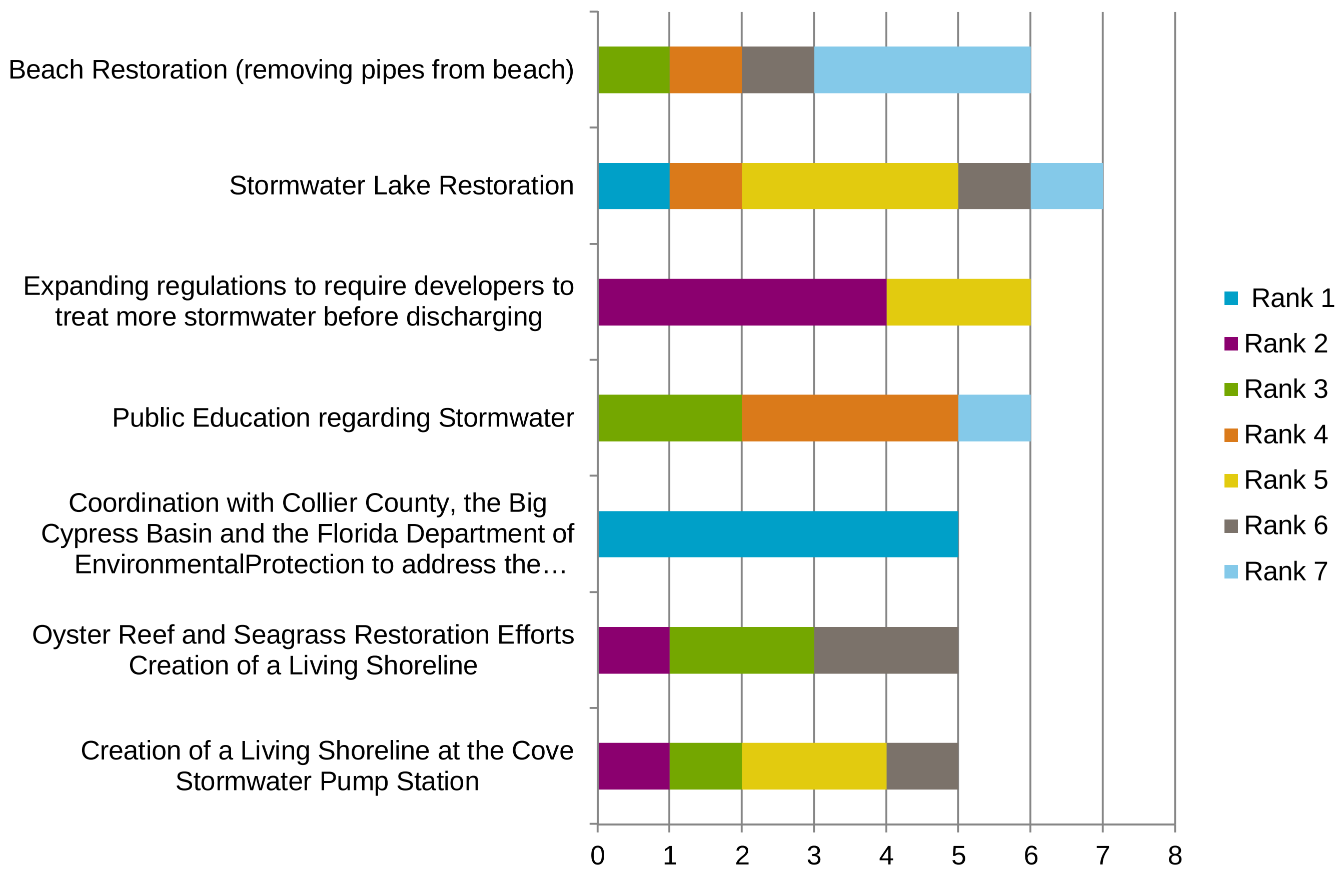
I prefer projects that?



Please rank, in priority order, the Stormwater projects/programs that are most important to you. 1-7 priorities.



Based on the results of the information provided by the public, the public was not entirely clear on the types of projects it prefers. Curbing with underground storage only received one vote more than projects that were incorporated in public spaces, rain gardens, bioswales, floating vegetation and low impact design, swales and ditches. As to preference on the function of a project, the public preferred water quality by one vote over projects that address flooding and the environment. Lastly, when ranking in priority order the stormwater projects/programs, the public felt it was more important to coordinate with Collier County, the Big Cypress Basin, and the Florida Department of Environmental Protection first, and then, expanding regulations to require developers to treat more stormwater before discharging.

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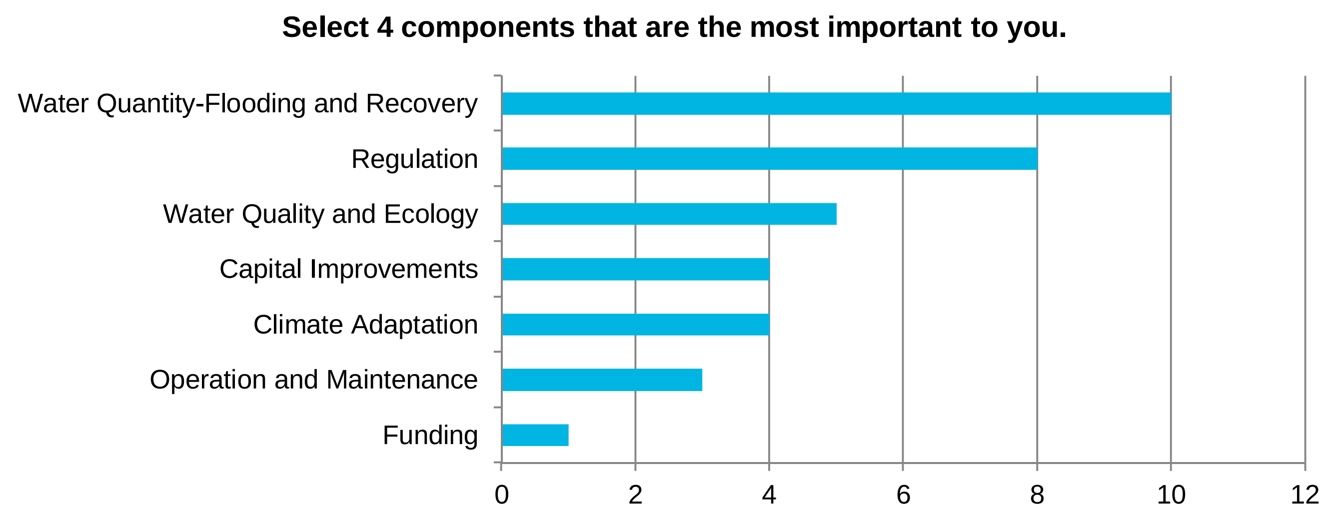
14.1.10 Station 10 - Summary of Priorities

After the public had visited all of the stations to understand each component of the stormwater master plan, the purpose of the last station was for the public to give their opinion of the top 4 priorities the City should take into consideration during its master planning process.



14.2 City Council Workshops

14.2.1 60% Review

14.2.2 100% Review

14.3 Results

- Explain how the public involvement was utilized in the stormwater master planning process.

TAB 15

Recommendations

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15. Recommendations

TAB 16

Conclusions

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16. Conclusions

TAB 17

Works Sited

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17. Works Cited

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Appendices

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Appendix A Documents Reviewed

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Appendix B Naples Municipal Airport Station USW00012897

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Appendix C Groundwater Information

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Appendix D Basin Maps

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Appendix E Soil Survey

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Appendix F GIS Database Information

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Appendix G FEMA Maps per Basin

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Appendix H Complaint Maps per Basin

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Appendix I Public Meeting Information

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