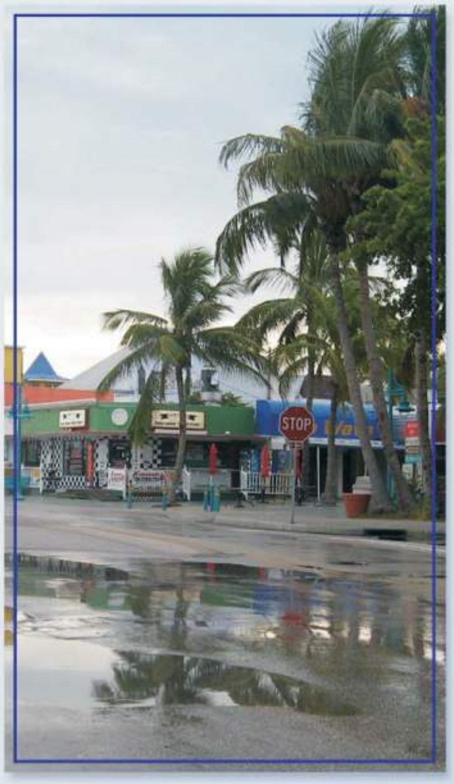
Town of

Fort Myers Beach, Florida

Stormwater Master Plan



SEPTEMBER 2010
Executive Summary Updated May 2013

CDM

Contents

Appendices

Figures

Tables

List of Acronyms

B

Best Management Practice	BMP
best management action plan	BMAP
biochemical oxygen demand	BOD

C

cadmium	Cd
Capital Improvement Program	CIP
chemical oxygen demand	COD
Clean Water Act	CWA
Continuous Deflective Separation	CDS
copper	Cu

D

Digital elevation map	DEM
directly connected impervious area	DCIA
dissolved phosphorus	DP

E

Environmental Protection Agency	EPA
Environmental Resource Permit	ERP
Estero Bay-Caloosahatchee River Nutrient Loading Assessment Study	EBCRNLAS
Event Mean Concentration	EMC
Extraction Procedure	EP

F

Federal Emergency Management Association	FEMA
Flood Insurance Rate Map	FIRM
Flood Insurance Studies	FIS
Florida Administrative Code	F.A.C.
Florida Department of Community Affairs	FDCA
Florida Department of Environmental Protection	FDEP
Florida Department of Health	FDOH
Florida Department of Transportation	FDOT
Florida Statutes	FS

G

Geographic information system	GIS

H

high density polyethylene	HDPE
Hydrologic Soil Group	HSG
hydrologic units	Hus
hydrological database	DBHYDRO

L

level of service	LOS
Light Detection and Ranging	LiDAR
Local Planning Agency	LPA

M

Management and Storage of Surface Water	MSSW
Municipal Separate Storm Sewer System	MS4s

N

National Oceanic and Atmospheric Administration	NOAA
National Pollutant Discharge Elimination System	NPDES
Natural Resources Conservation Service	NRCS
non directly connected impervious area	NDCIA
non-point sources	NPS
North American Vertical Datum	NAVD

P

Personal Responsibility for Island Stormwater Management	PRISM
Pollutant Load Reduction Goals	PLRG
point sources	PS

R

residential high density	RHD
residential medium density	RMD
Resource Conservation and Recovery Act	RCRA

S

seasonal high water table	SHW
South Florida Water Management District	SFWMD
Stormwater Management Model	SWMM
Stormwater Management Program	SWMP

T

total dissolved solids	TDS
total Kjeldahl nitrogen	TKN
total maximum daily load	TMDL
total nitrogen	TN
total phosphorus	TP
total suspended solids	TSS

U

unit area loads	UALs

W

wastewater treatment plant	WWTP
Watershed Management Model	WMM

Executive Summary (Updated May 2013)
Stormwater Master Plan

Background and Purpose

During large rainfall events many areas of the Town of Fort Myers Beach, including the only evacuation route along Estero Boulevard, suffer from severe stormwater flooding. Many residential properties on the island are subject to repeated flooding, including over 50 repetitive loss properties identified by the Federal Emergency Management Association (FEMA) as part of the flood insurance they provide. In addition, water quality is an important stormwater issue for the Town as stormwater runoff can be related to beach closings due to high bacteria levels and can also impact wildlife and aquatic species. Therefore, the State Total Maximum Daily Load (TMDL) requirements and the Lee County stormwater permit (of which the Town is a co-permittee with Lee County) require minimum levels of action that the Town must take to reduce stormwater pollutant loadings.

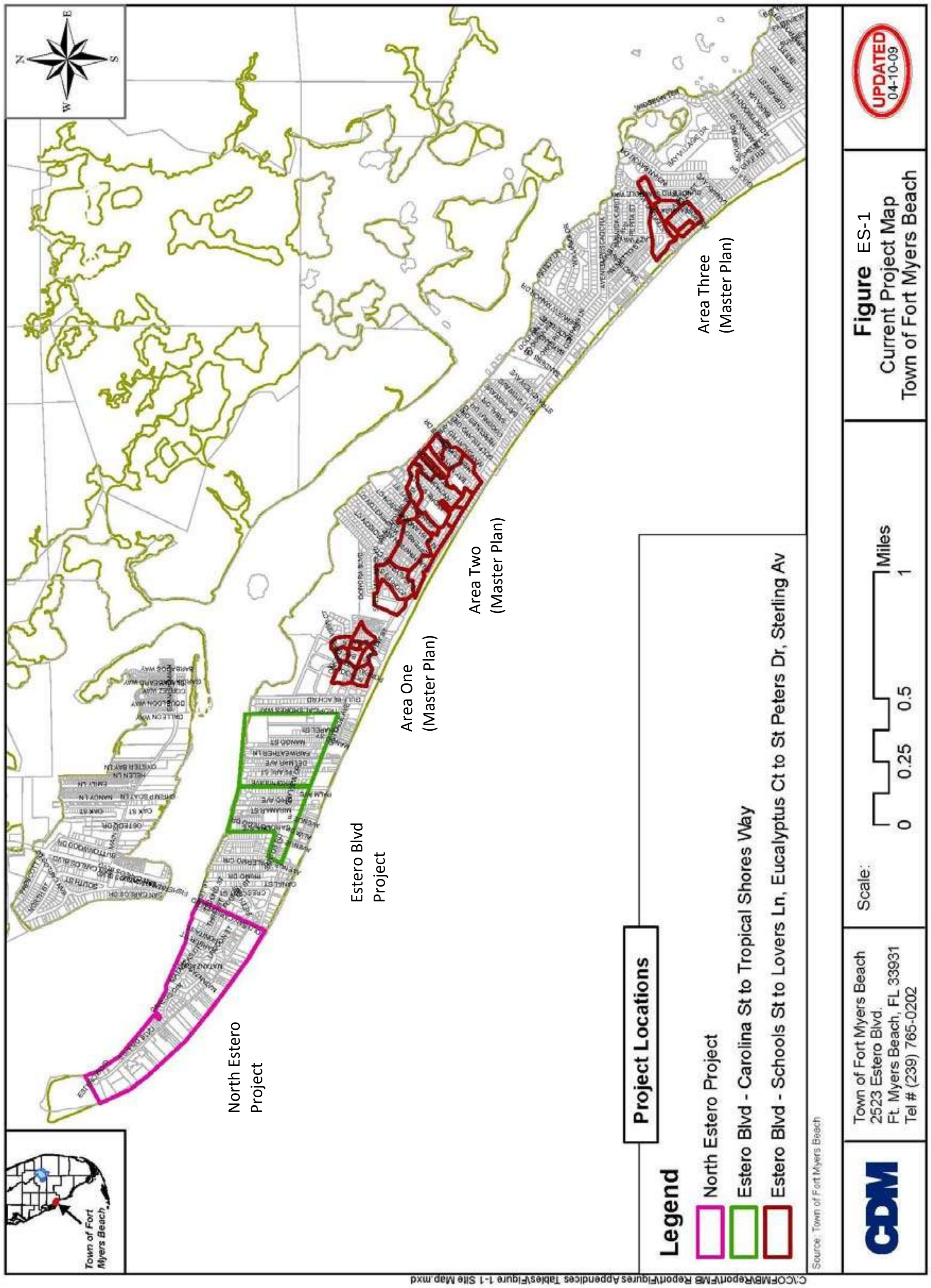
In response to these flooding and water quality issues, **Figure ES-1** shows existing and planned stormwater project areas for the Town. As part of ongoing efforts to address stormwater related flooding and water quality issues, the Town has developed a Stormwater Master Plan. The basis of the master plan comes from the Town of Fort Myers Beach Comprehensive Plan developed in 1999 which includes Goal Number 9 as:

> ***"To provide optimal flood protection and improved stormwater quality within the constraints imposed by location and existing land-use patterns."***

To reach this goal, the comprehensive plan developed six objectives that the Town has started to implement. Development of a Stormwater Master Plan and a review of options to fund it (including the potential to create a stormwater utility) fulfill this sixth objective.

This Executive Summary provides a summary of the detailed analysis and findings provided in the main report. References to the main report sections are provided for additional details as needed.

In addition, the final section of the Executive Summary provides the Town-wide Implementation Plan which was developed after the main report was finalized in 2010. As the Executive Summary was updated in May 2013, the project costs provided in the Executive Summary are about 10% higher than those given in the main report. The cost adjustment is based on the increase of the ENR construction cost index from 2009 to 2013.


Town of Fort Myers Beach
North Estero Project
Estero Blvd Project
Area One (Master Plan)
Area Two (Master Plan)
Area Three (Master Plan)
Legend
Project Locations
North Estero Project
Estero Blvd - Carolina St to Tropical Shores Way
Estero Blvd - Schools St to Lovers Ln, Eucalyptus Ct to St Peters Dr, Sterling Av
Source: Town of Fort Myers Beach
CDM
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Scale:
0 0.25 0.5 1 Miles
Figure ES-1
Current Project Map
Town of Fort Myers Beach
UPDATED 04-10-09

Flooding Evaluations

The master plan development included detailed evaluations of three problem areas identified by Town staff as being representative of other flooding and water quality issues island-wide. These areas are shown on Figure ES-1. Based on the development characteristics and reasons for flooding, findings for the three areas are used to provide general master planning recommendations island-wide. The majority of flooding in these areas occurs in roads at intersections with Estero Boulevard. In some of the problem areas, road flooding ponds until it overflows into adjacent private properties. Some residents have reported that at times, they need to wade through water to get to/from their house and in some cases there has been reported flooding into homes.

Using existing and newly collected field data, a stormwater hydraulic model of the three areas was developed to evaluate flooding and level of service as described in Section 2 of this Master Plan. Photographs of flooding, like the examples shown in **Photographs ES-1** through **ES-4,** were used to delineate the flooding. Additional photos are provided in Section 2 and Appendix C.

Photograph ES-1: Area 1 - Bay Road near Estero Blvd

Photograph ES-2: Area 2 - Andre Mar Dr. and Estero Blvd.

Photograph ES-4: Area 2 **-** Estero Blvd. and St Peters Dr.

Photograph ES-4: Area 3 - Estero Blvd. and Sterling Ave.

Figure ES-2 shows the existing stormwater infrastructure modeled and delineation of flooding for problem area one. Similar figures are provided in Section 2 for areas two and three.

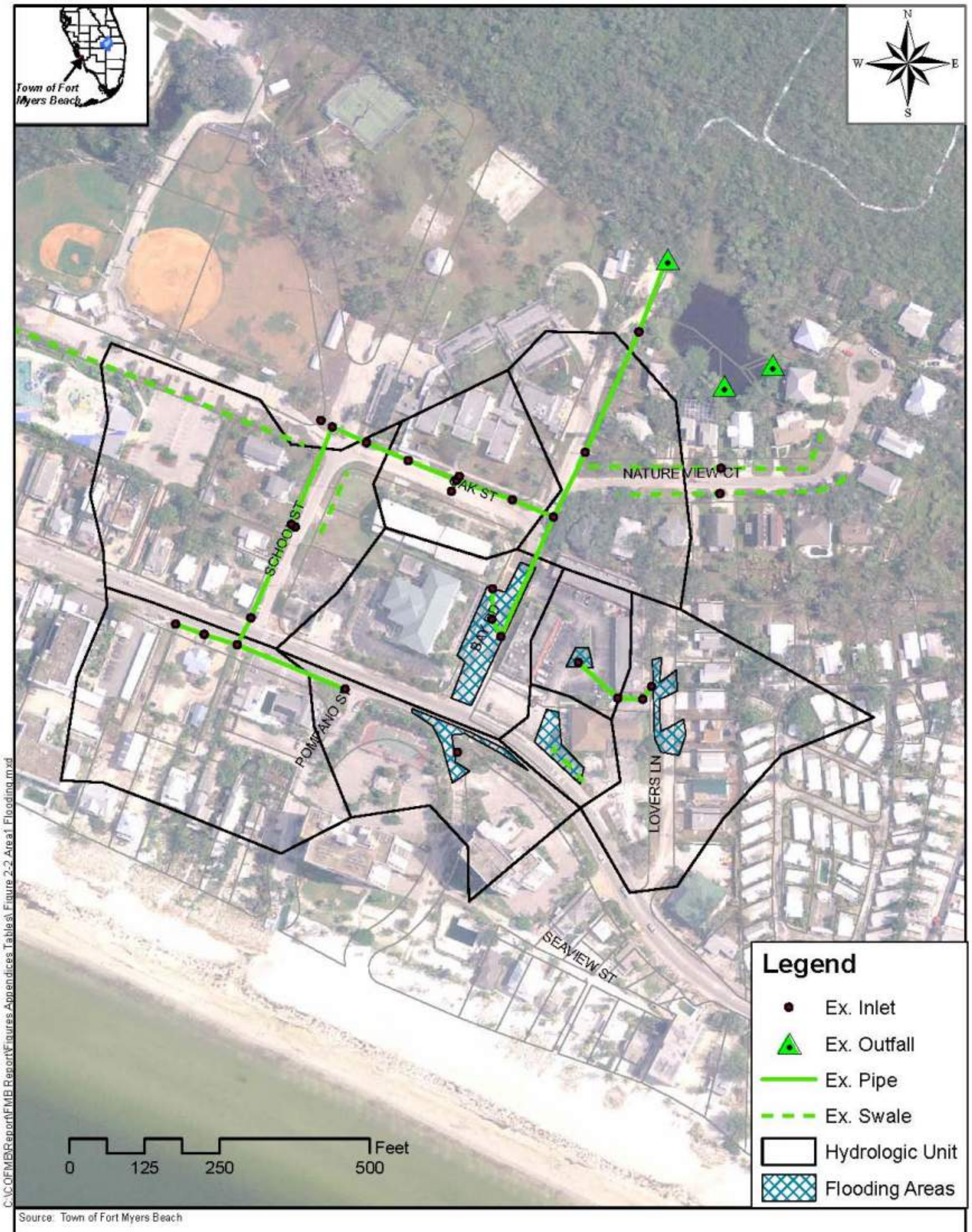


Figure ES-2
Area 1 - Flooding 2.5-inch Storm
Estero Boulevard & Bay Road

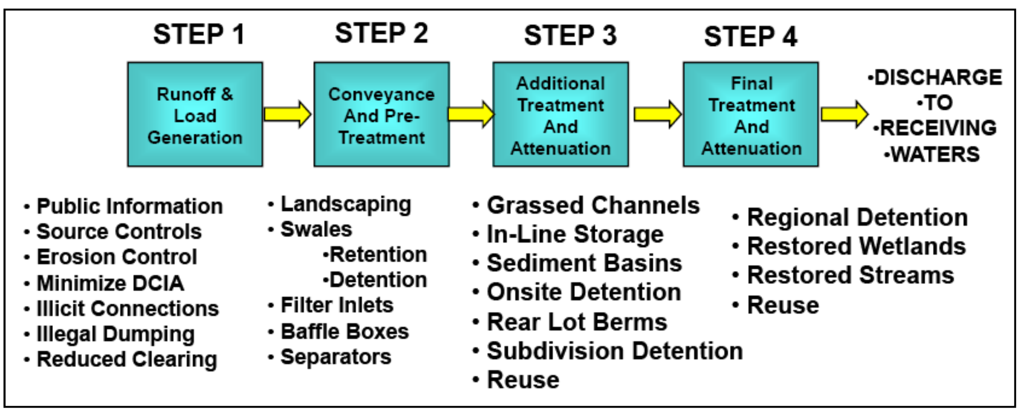
Water Quality Evaluations

A water quality model of the three problem areas was developed to estimate the annual and seasonal pollution loads from non-point sources due to stormwater runoff. The model was used to evaluate current and future conditions in order to assist in identifying best management practices (BMP) that can be included as part of the alternatives being evaluated. In addition, as the three problem areas are representative of water quality issues island-wide, the results were used to make island-wide master planning recommendations.

Best Management Practices

BMPs are measures used to reduce the amount of stormwater runoff and/or reduce the pollutant loading for the protection of natural resources and to comply with established water quality regulations. BMPs can be "mixed and matched" to develop a "treatment train." In order to maximize flood control, pollutant load reduction, aquifer recharge, and wetlands benefits, the treatment train concept maximizes the use of available site conditions from the point of where stormwater runoff begins to the point of where the runoff discharges to a receiving water (canals and Estero Bay in the case of the Town). **Figure ES-3** shows a schematic flowchart of the treatment train concept.

Figure ES-3. Best Management Practices Treatment Train Approach



Non-Structural BMPs. Non-structural BMPs are control measures that can be implemented to improve water quality without the need to construct new physical stormwater facilities. The Town has been implementing many of these types of controls as described in Section 3 of the report and the recommendations are provided later in this section. The non-structural BMPs are listed as Step 1 in Figure ES-3 and include the following.

- Public information programs like the Town's PRISM program to educate residents on what they can do to help.
- Source controls of pollutants and erosion control through ordinances and street sweeping.

- Minimizing directly connected impervious areas (DCIA) and reduced clearing through ordinances and land use planning.
- Identifying and eliminating illicit connections and illegal dumping.

Structural Stormwater BMPs. Structural BMPs require construction of new stormwater facilities. Structural BMPs are listed in steps 2-4 of Figure ES-3 and include the following that are most applicable to the Town.

- Shallow grassed swales and exfiltration trenches that induce infiltration and provide conveyance.
- Water quality inlets and baffle boxes to remove pollutants.
- Basins or ponds to detain (temporarily hold) or retain stormwater.
- Porous pavement that reduces runoff.

Water Quality Model

Pollutant loads to the canals and bay due to stormwater runoff were modeled for the problem areas based on rainfall, pervious and impervious runoff coefficients, event mean concentrations for each pollutant type, and loading rates typical for each land use type. The analysis is consistent with recent similar work by the Florida Department of Environmental Protection (FDEP) for Total Maximum Daily Loads (TMDL) for Estero Bay.

Similar to the FDEP TMDL studies in southwest Florida, the most critical pollutants of concern for the Town are Total Nitrogen (TN) and Total Phosphorous (TP) from the use of fertilizers, plant matter, and road runoff in both residential and commercial areas. BMPs such as swales, dry retention, dry detention, and wet detention have removal efficiencies of these constituents as high as 40 percent, 90 percent, 30 percent and 50 percent, respectively.

Alternatives and Level of Service

Three sets of alternatives were evaluated for the three problem areas as follows.

1. Clean and maintain existing stormwater system. This alternative is an operation and maintenance option that involves no capital improvements within the study area. This alternative is described in Section 4.2.

2. Fully connect existing stormwater system. This alternative is based on extending the existing system to achieve a higher level of service. This alternative is described in Section 4.3.

3. Fully connect and upgrade existing stormwater system. This alternative is based on achieving a higher level of service than alternative two by upsizing / replacing existing infrastructure. It can be implemented in a phased approach with alternative 2. This alternative is described in Section 4.4.

Figure ES-4 (on page 8) provides an example of how Alternative 3 for area one is laid-out. Maps for the additional areas are provided in Figures 4-1 through 4-10 in Section 4. As these alternatives will increase stormwater discharges to existing outfalls, the South Florida Water Management District (SFWMD) will require BMPs as a retrofit to the existing system. As the Town is retro-fitting in areas previously developed, the number and types of BMPs the SFWMD ultimately require will likely not be as stringent as those required for new development, but will need to be negotiated based on a site specific cost-effective analysis. Potential BMPs were identified for each area based on physical space constraints, permitting constraints, level of benefit achieved and financial costs. **Figure ES-5** (on page 9) provides an example of potential BMPs for problem area one. Potential BMPS for all three areas are provided in Figures 4-11 through 4-14 in Section 4.6.

Level of Service

As part of the master planning process, a level of service (LOS) criteria was established to protect public safety and property, and provide direction for the Town Capital Improvement Program (CIP). The LOS goals for the Town were based on experience in the Town of Fort Myers Beach and similar programs such as Collier County (Gordon River) and the cities of Jacksonville, Atlantic Beach, Daytona Beach, Miami, and Ormond Beach. In addition, an evaluation for a range of alternatives was used to evaluate what LOS goals are reasonable for the Town to achieve.

The LOS criteria are based on an acceptable level of flooding (inches) over a range of rainfall events. The SFWMD design storms used for an Environmental Resource Permit (ERP) basis of review were used as the rainfall events and are provided in **Table ES- 1** (on page 10). Additionally, the Florida Department of Transportation (FDOT) 4-hour storm was used to analyze the effects of a shorter duration rain event.

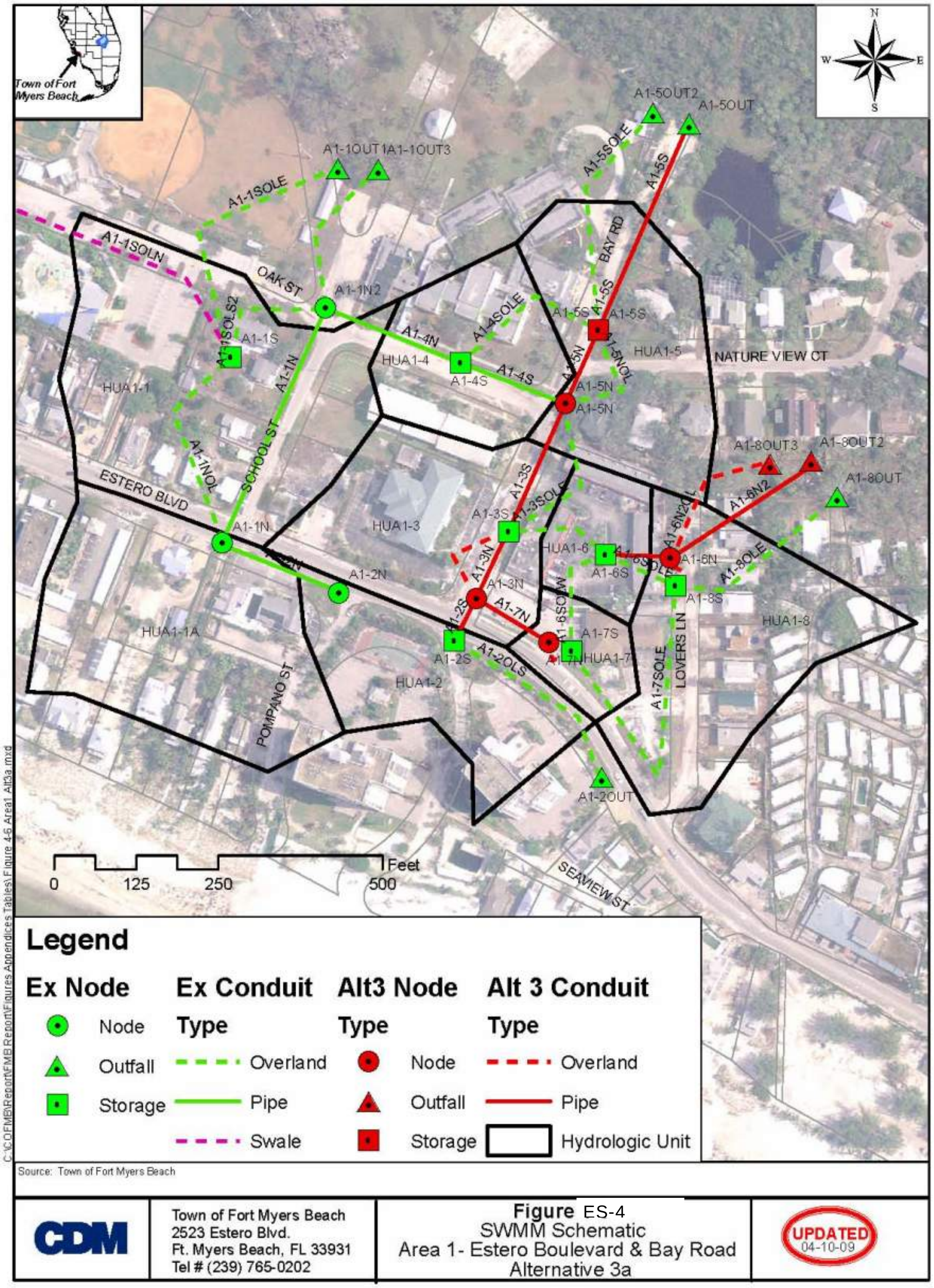


Figure ES-4
SWMM Schematic
Area 1- Estero Boulevard & Bay Road
Alternative 3a

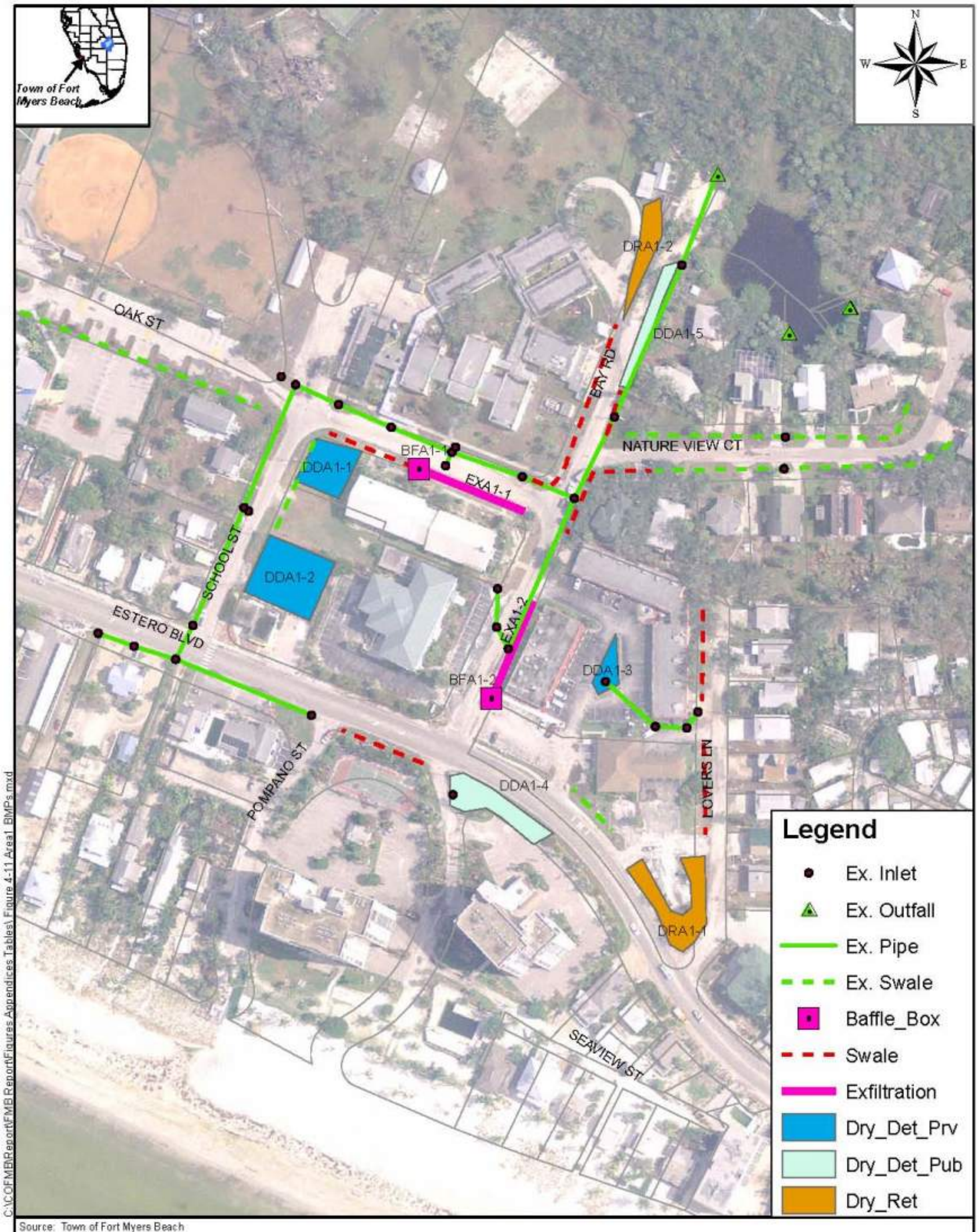


Figure ES-5
Proposed BMPs Area 1
Estero Boulevard & Bay Road

Table ES-1. SFWMD Rainfall Events

Storms	Volume (inches)
1-year, 4-hour*	2.5
2-year, 24-hour	5.0
5-year, 24-hour	5.7
10-year, 72-hour	9.5
25-year, 72-hour	11.5
100-year, 72-hour	15.0

* Used the FDOT 4-hour rainfall distribution

The LOS criteria include four classes of acceptable levels of flooding as defined in **Table ES-2**. In general Class A has no flooding on any streets, while Class B, C, and D allow up to three, six, and nine inches of flooding on streets, respectively. For all classes, no flooding of first floor building elevations is acceptable. As shown in Table ES-2, the 1-year and 2-year LOS for all roads is Class B (no flooding greater than 3 inches). Similarly the 5-year LOS for evacuation routes is Class B, but Class C for other roads (up to 6 inches of flooding).

Table ES-2. Level of Service Goals for Town of Fort Myers Beach

Rain Event	1-Year (2.5-inches)[#]		2-Year (5-inches)[*]		5-Year (5.7-inches)[*]		10-Year (9.5-inches)[*]		25-Year (11.5-inches)[*]		100-Year (15-inches)[*]	
Structure/Facility	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**
Houses/Buildings	<FFE [1]	D	<FFE	D	<FFE	D	<FFE	D	<FFE	D	<FFE	D
Evacuation Route [2]	1/2 W [3]	B	1/2 W	B	1/2 W	B	1/2 W	C	1/2 W	D	1/2 W	D
Other Roads [4]	< 3 in.	B	< 3 in.	B	< 6 in.	C	< 9 in.	D	> 9 in.	NA	> 9 in.	NA
Critical Elevation [5]	< 3 in.	B	< 3 in.	B	< 6 in.	C	< 9 in.	D	> 9 in.	NA	> 9 in.	NA

Class A: Full conveyance of storm runoff and maintains full width of evacuation route clear of flooding.
Class B: Manages erosion and maintains half of width of evacuation route clear of flooding and other roads to less than 3 inches.
Class C: Provides control of flood waters to less than 6 inches over evacuation routes and other roads.
Class D: Provides flood protection of first-floor elevations (FFE) and control of flood waters to less than 9 inches over evacuation routes.
Class NA: There is no level of service class that applies to this flood depth.

(1) Peak flood stages less than the FFE based on available data.
(2) Emergency and Evacuation routes as defined by town. (E.g. Estero Boulevard)
(3) Flood inundation limited to each side of the road such that half of the roadway width (W) or one travel lane width is not flooded.
(4) Other roads which are not critical for evacuation, but that will be used to estimate encroachment of FFEs.
(5) Critical elevations such as parking lots, yards and other areas defined as critical by the town.
Refers to FDOT Florida Department of Transportation's 1-Year, 2.5-inch rainfall event.
* Refers to SFWMD South Florida Water Management District's rainfall events as provided in Table 2-1 on page 2-21.

As part of establishing the LOS criteria, their direct affect on the size and cost of the alternatives needed to reach them was considered. For Alternative 2, locations that lacked connectivity to the existing stormwater system were provided with new piping or swales. This resulted in some reduction of flooding but overall improvement to the LOS was limited. For Alternative 3, the existing collection system and outfalls were upsized to at least 24-inch pipes where feasible. These results were considered the best-case scenario without significant costs for options requiring pumping facilities and therefore used as the criteria for setting the LOS goals in Table ES- 2.

Cost Comparisons

A cost/benefit analysis is summarized in **Table ES-3** by alternative and problem area. Appendices F and G provide a breakdown of the cost estimates for Alternatives 2 and 3 by problem area.

Table ES- 3. Project Cost/Benefit Analysis by Alternative and Area (Updated to $2013)

Alternative	Area	Cost	LOS	Benefit
Alt 2a	1	$473,000	<2-Year	- 3 to 12-inch reduction in flooding for 2-yr storm - improved LOS to Lovers Lane
Alt 2b	1	$495,000	<2-Year	- 3 to 12-inch reduction in flooding for 2-yr storm - no easements required for Lovers Lane
Alt 2	2	$1,760,000	<2-Year	- 1 to 2-inch reduction in flooding for 2-yr storm
Alt 2	3	$616,000	<2-Year	- 0 to 6-inch reduction in flooding for 2-yr storm
Alt 3a	1	$605,000	5-Year	- 2 to 13-inch reduction in flooding for 5-yr storm - improved LOS to Lovers Lane
Alt 3b	1	$572,000	5-Year	- 2 to 13-inch reduction in flooding for 5-yr storm - no easements required for Lovers Lane
Alt 3	2	$2,200,000	5-Year	- 2 to 10-inch reduction in flooding for 5-yr storm
Alt 3	3	$803,000	5-Year	- 2 to 7-inch reduction in flooding for 5-yr storm

Notes:
1. Estimate of cost is $2013 (adjusted in this updated executive summary up from $2009 in the main report).
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easements.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table ES-4 summarizes the total project cost estimates by alternative.

Table ES- 4. Project Cost by Alternative (Updated to $2013)

Alternative	Cost	LOS
Alt 2	$2.9 M	<2-Year
Alt 3	$3.6 M	5-Year

Notes:
1. Estimate of cost is $2013 (adjusted in this updated executive summary up from $2009 in the main report).
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easements.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Alternative 1 should be considered a necessary step before implementing Alternatives 2 and 3. Alternative 2 will provide some improvement to LOS, but nuisance flooding will continue to be an issue in some of the problem areas. Alternative 3 provides an improvement in LOS and flood duration that Alternative 2 cannot achieve. Some combination of Alternatives 2 and 3 might be the most cost-effective solution for the long term.

Recommendations for the Three Problem Areas

The three problems areas were selected as they are representative of stormwater management issues and needs Town-wide. Specifically, stormwater management improvements for the three problem areas, as well as Town-wide, are constrained by limited topographic relief, limited available land for stormwater storage and infiltration, and influence of tides due to proximity to Estero Bay and the Gulf of Mexico. Directing gravity flow of stormwater runoff to the Gulf of Mexico side of the problem areas is prohibitive based on water quality concerns for beaches. Gravity flow of runoff to the Estero Bay side also has water quality concerns but contains a much greater area of terrain in which to detain/infiltrate runoff via swales or other BMPs. However, terrain from the three problems areas to the existing outfalls on the Estero Bay side of the island has a slight uphill grade that prevents natural overland flow in this direction.

These constraints present greater challenges to convey runoff and provide surface water quality treatment before the flow is received by existing pipes. The existing stormwater system of pipes and swales is fragmented, has significant build-up of sand, and lacks connectivity. Many of the problem areas are disconnected from the existing stormwater systems and have no primary outfall. In these low areas, stormwater runoff collects and ponds until reaching an elevation where it slowly meanders to private residential yards and infiltrates or perhaps finds its way to the existing stormwater system.

Review Criteria

Five major factors are typically considered in the selection of capital improvements program (CIP) alternatives and recommendations to meet level of service goals. These factors include:

- Technical Feasibility and Reliability
- Environmental Consistency
- Socio-Political Acceptability
- Economic Reasonability
- Financial Ability

Technical Feasibility and Reliability

The hydraulic model was developed to evaluate solutions for chronic flooding. While increased pipe sizes are sufficient to reduce flooding for the 2-year, 24-hour storm, the results indicate solutions are expensive for storms larger than the 5-year, 24-hour event.

Three alternatives were developed with input from the Town staff. Alternative 1 consists of returning the existing system to design capacity through maintenance and replacement of damaged pipes/inlets and grading and grooming of swales. While this alternative reduces the amount of flooding, it does not achieve the 5-year level of service (LOS) goals.

In Alternative 2 new pipes and/or swales would be connected from the flooding areas to the existing stormwater systems. The model was used to evaluate the ability of the existing system to receive and convey these flows. This alternative would improve road flooding in some of the problem areas for the 2-year, 24-hour storm event. However, the 5-year, 24-hour storm would still produce extensive flooding over the study areas. Therefore, these improvements will be insufficient to eliminate the overall general nuisance flooding currently being experienced, although durations of flooding would be reduced.

In Alternative 3, existing piping of the stormwater system is upsized to a maximum equivalent circular diameter of 24-inches (based on cover allowance and high groundwater table) to achieve a higher LOS. This scenario evaluated the ability of a higher level system to receive and convey flows. It was also used to establish LOS goals for the Town. The model results show that the 5-year, 24-hour storm was the highest attainable LOS based on capital cost limitations and topography.

To achieve a higher LOS than the 5-year, 24-hour storm event, pumping facilities would need to be proposed at various locations. Pumping of stormwater would be a very cost intensive financial option for the Town compared to the benefit received.

Environmental Consistency

The alternatives have been formulated to be consistent with water quality protection for Estero Bay and associated canals around the Town, to minimize wetland and water quality impacts. The alternatives will result in the retrofit of the three problem areas using BMPs. The BMPs will provide treatment and infiltration of stormwater where practicable in order to reduce existing pollutant loads and associated water quality impacts within the requirements of SFWMD permitting guidelines, while proactively addressing treatment for the upcoming TMDL program, which will be eventually enforced through the NPDES permit process.

Socio-Political Acceptability

The alternatives address flooding and water quality concerns; however, public information will be an important aspect of the alternatives since some of the stormwater management issues in the Town require use of easements or obtaining agreements to use private property. Individual actions by citizens on their own lots can also assist or adversely affect this program by storing and infiltrating stormwater onsite where possible. The alternatives are likely to be permittable because they control or reduce nonpoint source pollutant loads to Estero Bay, lower flood stages, increase aquifer recharge where possible, and do not adversely impact wetlands.

Economic Reasonability

The alternatives reviewed include a wide range of economic costs that ultimately provide the Town with choices that relate LOS goals to economic costs. In general, each of the alternatives are economically reasonable for the LOS they provide, and compares favorably when compared to projects and costs that similar coastal communities have implemented.

Financial Ability

An important consideration in this project is the ability to fund the best technical, environmental, social, political, and economic option. Due to the cost associated with solving the flooding problems and retrofitting existing development with water quality controls, the projects can be implemented in phases to commensurate with the funding available. Therefore, solutions were geared toward a phased approach. In addition, a variety of funding options were identified for further evaluation by the Town as they consider what level of service to provide when compared with the costs to implement them.

Recommended Alternative, Prioritizing, and Phasing

Based on a review of the alternatives using the five criteria, Alternative 3 is recommended for implementation since it provides the best improvement to meet the Town's LOS goals. Furthermore, the system improvements can be phased to accommodate capital funding constraints while still improving LOS.

To phase this work, it is recommended to make the improvements in Alternative 3 to add the new stormwater system components that connect areas with flooding to the existing system without making the upgrades to the existing system. The Town can then implement the existing system upsizing recommended in Alternative 3 as funds are available.

In addition, depending on the availability of funding, the Town may want to prioritize which problem areas are completed first as follows:

1. Problem area 2 is the most expensive area to implement improvements, however, it is also the one causing the most adverse impacts to the most people as it floods homes and causes traffic delays along Estero Boulevard.

2. Problem area 3 is the second highest priority as it causes residential flooding.

3. Problem area 1 is the third priority as while it causes significant flooding along Bay Street, it has the least potential for property damage due to flooding, has existing infrastructure that will help alleviate flooding when kept free of sediment, and is in one of a few areas in the town where an alternate route around the flooding is available.

Ultimately, permitting of the proposed improvements for water quality requirements will need to be negotiated with the SFWMD as a retrofit system.

Town-wide Recommendations for Stormwater Capital Improvements

As described in Section 4, the three problem areas were selected for detailed analysis as they provide a reasonable representation of flooding and water quality issues Town-wide, as much of the Town has similar hydrologic/hydraulic characteristics and constraints. Therefore, the following general recommendations based on findings in the three problem areas are provided to give guidance for Town-wide stormwater capital improvements.

1. **Stormwater operation and maintenance program.** The Town should continue to expand its routine operation and maintenance of the existing and any new systems developed. This is critical as in some cases flooding is the result of plugged pipes and inlets filled with sediment and sand. This is especially critical for the Town as sand is so prevalent and easily migrates into the stormwater system. At a minimum, the Town should continue to inspect all stormwater system components annually and clean/remove sediment and sand as required in the NPDES permit. Based on experience, the Town should continue to identify portions of the stormwater system where more frequent maintenance is needed (in addition to the areas the Town is already doing this). Ultimately, this may require additional staff and equipment to provide the level of attention this work requires.

2. **Stormwater infrastructure inventory and GIS development**. While the Town has a GIS coverage and list of known stormwater infrastructure, it does not have all structures included. In addition, it does not include critical information on how the inlets, pipes, swales, outfalls, and other pieces all connect. Finally it does not include attribute information, such as the pipe sizes and invert elevations. Therefore it is recommended that the Town complete similar field surveys in the remaining areas of the Town as CDM completed in the three problem areas for this Master Plan.

3. **Use of swales for conveyance.** Where additional conveyance is needed in areas outside of the three problems areas, it is generally best for the Town to use swales where possible instead of underground pipes. Swales offer greater storage and water quality benefits through recharge/infiltration that pipes do not provide. In addition, swales generally cost much less to construct and are easier to inspect for potential clogging and cleaning. Overall, it is recommended the Town consider implementing a Town-wide swale program to rehabilitate filled in swales and require the development of swales along all streets.

4. **Use of the BMP train.** The BMP train provided in Figure 3-5 of Section 3 provides general guidance on the priority/order of selection of the most cost-effective BMP measures. When identifying BMPs for areas outside of the three problem areas, the Town should start with items identified in step 1 and progress to step 4 as site characteristics and costs allow. Further guidance on

the most appropriate BMPs for other areas can be obtained from the BMP selection considerations provided in Section 4.6 of this Master Plan.

5. **Water quality retro-fits for remaining outfalls.** This Master Plan deals with 11 of the approximately 90 stormwater outfalls the Town has. The Town has general concerns for water quality impacts. As such, the Town may consider starting to implement a program to retro-fit outfalls with baffle boxes and inlet and vortex separators for the outfalls. These have been successfully implemented in many similar coastal communities.

   In addition, while there are no current TMDL requirements established for Estero Bay, one important consideration is the current momentum within the FDEP to set new TMDL limits that may eventually require retro-fits for already developed areas. The TMDL limits being set for freshwater draining to Estero Bay from the Caloosahatchee River, Hendry Creek, and Imperial River are requiring communities to reduce nutrient loads by 40 percent or more. The FDEP is working to set TMDL limits for estuaries and bays. Furthermore, the US EPA is working to publish its own recommendation for nutrient limits to estuaries and bays. Based on the extremely stringent limits they published in January 2010 that exceed the State recommended TMDL limits for freshwaters, the limits set for the estuaries and bays may be even more stringent than what the State ultimately sets for estuaries. Once both the State and Federal limits are established, the Town may be required to make significant nutrient load reductions.

6. **Establish infrastructure standards and obtain as-built drawings.** Historically the Town has not required and obtained as-built drawings for stormwater systems installed as needed around the Town. It is recommended that the Town adopt or develop a set of standard specifications for all future stormwater projects to follow. In addition, the Town should require that at completion of construction, as-built drawings be submitted to the Town. In addition, the Town should provide a Town inspection of new construction during the construction process to verify connectivity and that the Town standards are being followed.

7. **Consider the creation of a Stormwater utility.** One potentially beneficial funding mechanism would be to create a stormwater utility to fund the development, operation, and maintenance of the Town's stormwater system. This will link costs directly with the service that is provided.

8. **Coordinate work with Estero Boulevard and Lee County.** As the County and Town work together on plans for repaving of Estero Boulevard, this creates opportunities to identify cost-saving opportunities to improve stormwater infrastructure at the same time.

9. **Look for cooperative and creative solutions with other public and private projects.** Overall, the Town should always be open to identify and coordinate

creative stormwater alternatives with both public and private non-stormwater projects. One potential opportunity is to discuss possible options for BMPs as part of the planned Town Library addition on the open lot at the corner of Estero Boulevard and School Street.

Town-wide Recommendations for Non-Structural Stormwater Controls

Non-structural controls aid in the control of both water quantity and water quality aspects of stormwater. Nonstructural controls are not capital projects that are constructed by the Town but rather are source controls, ordinances, and regulations that depend on participation by residents and implementation by development or re-development to minimize the water quantity and quality impacts associated with development.

The Town has already implemented a public outreach and education program that includes informational documents entitled Personal Responsibility for Island Stormwater Management (PRISM) and a Guide for Harvesting Rain Water. These documents are available at the Town Hall or through the Towns' website.

CDM recommends that nonstructural controls continue to be incorporated in the Stormwater Master Plan. The effectiveness of nonstructural controls depends largely on several factors that are not fiscal in nature. These factors include practices set forth through ordinances and public participation and awareness. A summary of recommended nonstructural controls follows:

- Fertilizer Application Control – Continue public education and enforcement of existing Town ordinance
- Pesticide and Herbicide Control – Continue public education and enforcement of existing Town ordinance
- Solid Waste Management and Control of Illegal Dumping
- Directly Connected Impervious Area (DCIA) Minimization
- Water Conservation Landscaping
- Illicit Connections - Identification and Removal
- Erosion and Sediment Control on Construction Sites
- Stormwater Management Ordinance Requirements

One example is creating an ordinance that limits the amount of impervious area that can be developed on a single lot. An ordinance would be required to control imperviousness as the current SFWMD rules require a permit only for projects that affect an area of one-acre or more, excluding most lots in the Town. To assist the Town in forming a basis for a new ordinance, CDM provided the Town's Local Planning Agency (LPA) with example ordinances from similar coastal communities and discussed them at their October 21, 2008 meeting. These examples support limits as low as 40 percent for residential areas as shown in **Table ES- 5**. The complete ordinances are provided in Appendix H of this Master Plan.

If an ordinance is not developed, the Town can expect percent imperviousness to continue to increase over time, following the ongoing trends to modify homes and buildings to be larger. If this occurs, when the current 35 percent and 40 percent impervious for medium and high density residential grows to much greater than 40 percent, it will likely lead to a need for significant stormwater infrastructure improvements, including underground piping, using large open areas to construct treatment areas, and likely require the need for stormwater pumping systems in order to meet the level of service goals. Furthermore, with the potential regulatory limitations being developed, allowing impervious development beyond 60 percent could require alternatives that would not be cost feasible in order to meet the level of service goals. On the other hand, limiting imperviousness to anything much less, such as 35 percent or less, would not be realistic, as much of the Town was originally developed at 35 to 40 percent imperviousness.

Table ES- 5. Examples of Coastal Ordinances Limiting Residential Imperviousness

Municipality	**Residential Impervious Limits**	**Other Notes**
St. Augustine Beach, FL	40% and 50% for low and medium density residential respectively	Porous paving material does not count as impervious
Siesta Key, Sarasota County, FL	50% for any residential type	None
Key West, FL	40% and 50% for low and medium density residential respectively	Porous material may be used subject to approval by city.
Neptune Beach, FL	50%; 35% for apartments complexes	Semi-pervious surfaces and water detention systems encouraged and not counted as impervious; Higher percentages allowed if runoff calculations sealed by P.E. indicate no net increase in runoff.
Atlantic Beach, FL	50% for any residential type	Does not include roof and balcony overhangs; does not include swimming pools; Pervious paving areas only count as 50% towards impervious area
Satellite Beach, FL	50% plus additional 10% for pavers	Swimming pools exempt
Kure Beach, NC	36% for all areas within 575 feet designated as shell fishing waters or critical water supply watershed	None
Surfside Beach, SC	40, 45, and 50% for low, medium and high density residential, respectively	None

Town-wide Implementation Plan

Based on the Town-wide recommendations, the detailed evaluations completed for Areas 1, 2 and 3 were used to develop the following conceptual level implementation plan. It provides a generalized budget, schedule and funding plan to implement the recommendations Town-wide.

Town-wide Implementation Budget

Figure ES-6 provides a map of the Town showing separate stormwater management areas to indicate where master planning efforts are needed outside of the three detailed study areas. The different areas use streets as the basis to differentiate between the following stormwater management areas:

- Streets with completed and planned comprehensive stormwater projects are highlighted as solid green. This includes the recently completed North Estero Project, the ongoing Basins Based FEMA funded project and the three detailed study areas evaluated as part of this stormwater master plan.

- Streets on the north end of the island that are not part of the other northern projects are highlighted in yellow.

- Streets with existing, well-connected and maintained swales and/or other best management practices (BMPs) are highlighted with a green dashed line. This includes locations with SFWMD Environmental Resource Permits (ERP) that regulate site-specific stormwater. This also includes the approximate two-mile stretch of Estero Blvd on the south end of the Island that has a continuous swale system. These locations are expected to have significantly lower stormwater improvement needs than identified for the three detailed study areas.

- Streets that are owned and maintained by someone other than the Town or County are highlighted with a light-blue dashed line. In general, efforts to manage the onsite stormwater in these locations are not the responsibility of the Town. However, as with the County owned Estero Blvd, the Town may need to manage stormwater coming from those areas into adjacent Town-owned areas and properties. In general, these locations are expected to have significantly lower stormwater needs than identified for three detailed study areas.

- Streets with stormwater needs similar to the three detailed study areas are highlighted in red. Small-scale stormwater improvements have sporadically been made as-needed in these locations and have not been part of an overall coordinated effort. These areas receive runoff from the County's Estero Blvd. Most residential properties on these streets do not have an adjacent canal or wetlands where stormwater might be directed by property owners. These locations are expected to have similar stormwater improvement costs as the detailed study areas.

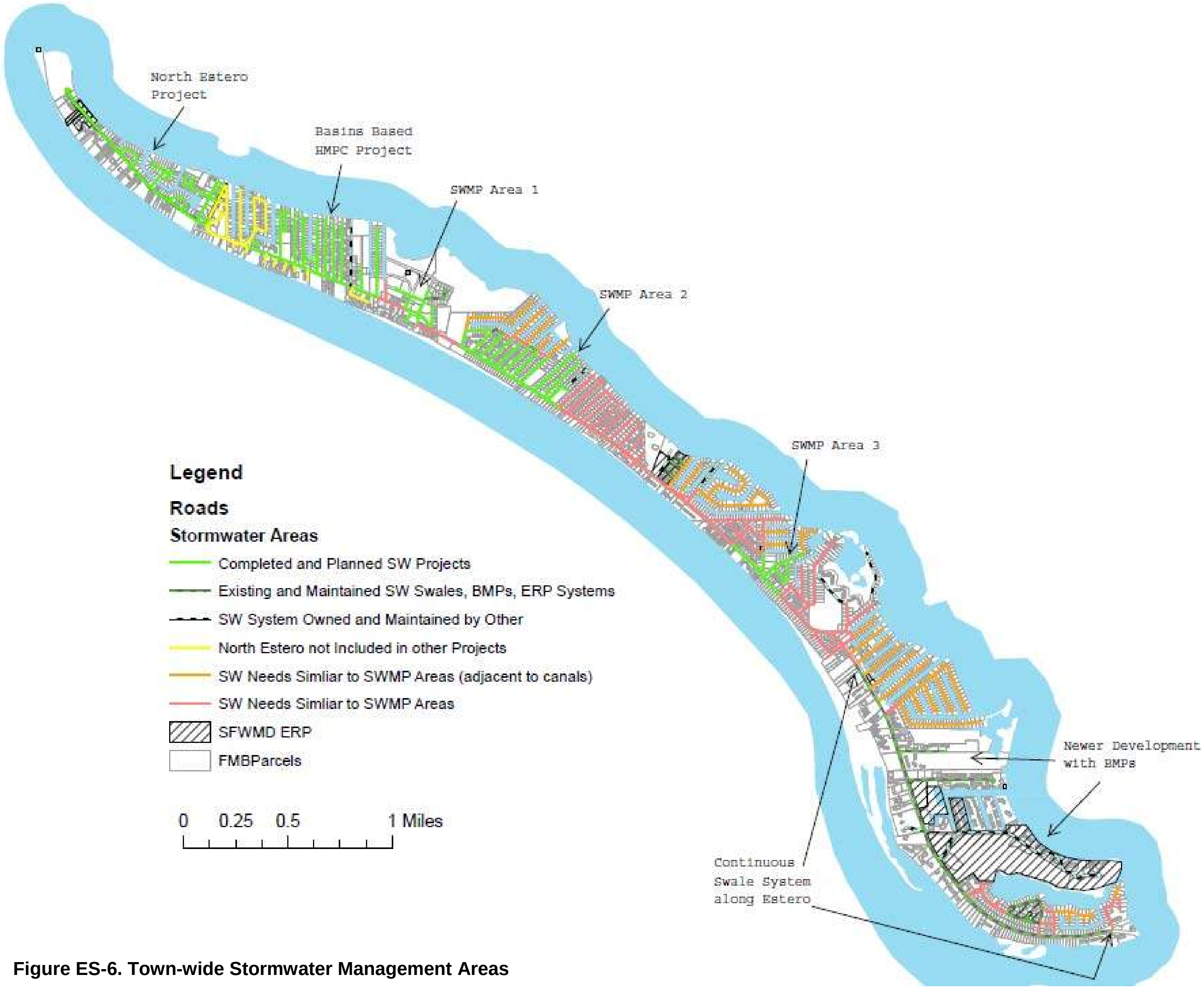


Figure ES-6. Town-wide Stormwater Management Areas

- Streets with stormwater needs similar to the three detailed study areas but also where the majority of properties have an adjacent canal or wetlands are highlighted in orange. These properties likely have reduced stormwater flooding issues as property owners may grade their property to direct runoff to adjacent canals and wetlands. However, these properties may be critical to help address water quality issues under future regulations to reduce pollutant loading to Estero Bay. These locations still have needs to manage runoff from properties graded towards streets, as well as runoff from local roads and in some cases Estero Blvd. Overall the stormwater improvement costs for these areas are expected to be less than the average for the detailed study areas, but in some cases could be similar or higher if less area is available for BMPs.

Based on the areas described for Figure ES-6, **Table ES-6** provides an estimate of the Town-wide costs to implement the stormwater master plan. The top half of the table summarizes the costs for the three detailed study areas as described in Section 4. For each of the areas, the unit cost in million dollars per mile of road (M$/mile) is calculated in column three based on the total project costs and miles of roads provided in columns four and two respectively. The unit costs for each area are fairly consistent, ranging from 0.81 to 0.91 M$/mile, with an average of 0.86 M$/mile.

Table ES-6. Estimate of Town-wide Costs to Implement the Master Plan (Updated to $2013)

Stormwater Master Plan (SWMP) Evaluation Areas	Roads (miles)	Unit Cost (M$/mile)	Area Cost (M$)	Comment
SWMP Area 1	0.7	0.81	0.60	per SWMP Section 4
SWMP Area 2	2.6	0.86	2.20	per SWMP Section 4
SWMP Area 3	0.9	0.91	0.81	per SWMP Section 4
	4.2		***3.6***	***Total for SWMP Evaluation Areas***
Other Stormwater Management Areas Without Existing Plans	**Roads (miles)**	**Unit Cost (M$/mile)**	**Area Cost (M$)**	**Comment**
North Estero Area	2.3	1.00	2.27	N. Estero / 12-Streets project unit cost
Areas Similar to SWMP Areas 1-3	8.0	0.86	6.83	SWMP average unit cost
Areas Adjacent Canals Similar to SWMP	5.9	0.81	4.79	SWMP minimum unit cost
Areas with Existing Stormwater ERPs	0.7	0.22	0.15	Minimal unit cost needs
Areas with Existing Swales and BMPs	2.9	0.22	0.64	Minimal unit cost needs
	19.7		***14.7***	***Total Projected for Other Areas***
	23.9		**18.3**	**Total Town-wide Imrpovements**
Notes:				
M$ is cost in million dollars				
Costs are in 2013 dollars (adjusted from 2009 dollars in main report)				

The bottom half of Table ES-6 provides estimates for the other areas in the Town not already under a separate stormwater project or plan. For each of these areas, the total length of roads highlighted in Figure ES-6 is listed in column two. Unit costs for the areas similar to the detailed study areas (highlighted in red on Figure ES-6) are assumed to require the study area average of 0.86 M$/mile, giving an estimated cost of $6.8M for properties along those 8-miles of roads. Unit costs for the areas similar to the detailed study areas but adjacent to canals/wetlands may be lower, therefore the low end cost of 0.81 M$/mile is used. While the costs in these areas may be even lower it is appropriate for planning purposes. For the locations with existing SFWMD ERPs and continuous well-maintained swales/BMPs, an estimate of 0.22 M$/mile is used to provide a planning budget for the limited as-needed improvements anticipated in these areas.

Overall, the total projected capital cost for stormwater improvements to address flooding and provide retrofit BMPs where possible is estimated to be $18.3M Town-wide. This includes the $3.6M for the three detailed study areas and an additional $14.7M for other areas not already under a separate plan. These costs are based on the assumptions described for conceptual level purposes, and may ultimately be different depending on site-specific constraints, amount of flooding and water quality issues at each location.

Table ES-7 provides a summary of the improvement costs with estimates for other Town-wide recommendations. This includes an additional $2.2M to retro-fit up to 80 stormwater outfalls with water quality baffle boxes. The need for these may depend on SFWMD permitting requirements on a case-by case basis as well as potential future regulations to reduce pollutant loading to Estero Bay. Also included are one-time budget estimates to establish standard stormwater design standards for future projects and complete a Town-wide inventory/survey of all stormwater structures to understand their connectivity and provide a comprehensive GIS for planning, design and O&M purposes. The total capital and other one-time costs subtotal is $20.1M.

The second half of Table ES-7 provides annual estimates for Town staff to operate and maintain the systems, coordinate public policies/outreach, complete inspections for stormwater related ordinances, and manage construction projects. The annual costs are $426,700, or $8.53M over a 20-year planning period.

Table ES-7. Estimated Town-wide 20-Year Implementation Costs (Updated to $2013)

Capital Improvements and Other One-Time Costs	**Budget ($)**
Total Town-wide Improvements (Design/Permit/Construction)	18,290,000
Additional Outfall Water Quality Retro-Fits (80)	2,200,000
Establish Design Standards	55,000
Infrastructure Inventory and GIS Development	220,000
Establish a Stormwater Utility	110,000
Subtotal: Capital and Other One-Time Costs	***20,875,000***
Annual Operations and Maintenance Needs	
Operation and Maintenance (1.5% of capital improvements)	307,350
Policy Coordination and Inspections (Town Staff - 0.5)	42,350
Project Management (Town Staff 1.0)	77,000
Subtotal: Annual Costs	*426,700*
Subtotal: 20-Years of Annual Costs	***8,534,000***
Master Plan 20-Year Implementation Costs	**29,409,000**

Town-wide Implementation Schedule

The master plan provides an overall framework to guide improvements that will be implemented over time on an as-needed basis to address flooding and water quality issues that currently exist as well as ones that may arise in the future as the result of development changes, aging infrastructure and future regulatory requirements. In addition, the implementation of the plan should be coordinated with other long-term infrastructure projects. For example, this would include the water utility rehabilitation and improvement projects. Also, implementation should be coordinated with the availability of other funding sources described n Section 4, such as annual grants and the creation of a stormwater utility.

Based on these considerations, it is recommended the planning schedule be based on a 20-year implementation period. The total costs associated with the master plan using the Year-2013 costs in Table ES-7 amounts to $29.4M (or 1.47 M$/yr) and would complete on average approximately 1.2 miles of improvements per year.

Town-wide Implementation Funding

The Town currently funds its stormwater program from ad valorem taxes through the General Fund. This reflects the traditional source of funding for stormwater systems. The demands on the Town's General Fund have increased annually while the economy has continued to be under considerable stress. In addition, the Town Charter has provisions that restrict its ability to issue debt for a term longer than three years.

The total implementation cost of $29.4M suggests the need to identify other forms of funding available for consideration. Initially and simultaneously it is important to consider and aggressively access all forms of program assistance. Funding for and understanding the critical functions performed under the O&M budget is vital to the budgeting process. Many times municipalities highlight the capital cost needs without an equal understanding of O&M funding required. It is important to note there are no outside forms of assistance for O&M cost needs. There are a few Federal and State assistance programs for capital needs. All of these programs are driven by a grant application process.

All possible sources of grant funding and coordination with other projects should be evaluated as described in Section 4. The Town has been very successful at obtaining inter-governmental grants (such as FEMA and SFWMD) for the North Estero and Basins Based projects to pay for significant portions of those stormwater related project costs. It is anticipated that these and other similar sources will continue to fund a portion of the implementation costs. This may include new grant sources related to new regulations such as a potential TMDL requirement for Estero Bay. While it is very difficult to estimate how much grant funding and cost sharing from related projects (such as water utility improvements) will be obtained, for planning purposes, the Town may use a planning level goal of 25% of the costs coming from these types of sources.

Stormwater Utility

For the remaining 75% of the costs, experience has shown that a permanent, reliable, sustainable, and fair funding source is needed in order to systematically implement this type of program. A common and successful stormwater funding option utilized by many cities and counties throughout Florida as well as throughout the country is a Stormwater Utility.

Typically, a stormwater utility program is funded by a user fee. A stormwater utility is similar to water and wastewater utilities that are based on a service provided. In a stormwater utility a fee is charged based on the services provided on a communitywide bases. While in water and wastewater utilities the fee is based on the volume, the typical stormwater utility bases its fee on the amount of impervious areas on each parcel of developed property. The billing unit is typically the equivalent residential unit (ERU).

As previously noted stormwater utilities have been in full operation throughout Florida for many years. The City of Tallahassee established a stormwater utility in 1985. Florida Statues Chapter 403 authorizes the establishment of a stormwater utility through local government ordinance adoption.

Central to the establishment of a stormwater utility is identifying the number and types of development units. Therefore, in order to develop a stormwater utility, the Town of Fort Myers Beach would need to identify the number of single family units, multi-family units, condo units, commercial units, and institutional units. These numbers could then be used to develop Equivalent Residential Units (ERU). Based on experience with the establishment and implementation of Stormwater Utilities, a user fee that is based on Equivalent Residential Units can produce roughly $100,000 /$1/ERU.

Addressing the needs of the total $29.4M implementation costs over a 20-year period and assuming that 25% of the costs come from multiple other sources (grants, Gas Tax, inter-local opportunities), the 20-year funding required is $22.1M. In keeping with the Town Charter of limiting the term of indebtedness, implementation can be achieved through a stormwater utility with a monthly user charge of $11/ERU using seven three-year cycles (based on preliminary information for number of units from the appraiser office).

Many communities that have established Stormwater Utilities have dedicated the revenue generated by the utility to capital improvements while continuing the funding of Administration and Maintenance through the General Fund. If this is done, the monthly user charge can be reduced to $8/ERU.

In addition, municipalities can bond projects or programs against the stormwater utility. Three examples of funding projects through a stormwater utility are:

- Perform work as money becomes available.
- Short or long term bonds.
- Special Assessments – bonds sold against stormwater utility revenues.

In addressing the best fit for the Town at this time it is critical that a grass roots program be initiated that involves all levels of the community, including elected officials, property owners, and interest groups. Utilizing the results of this report it is essential to conduct site specific workshops addressing issues and their solutions in order to establish a proper level of understanding of the budget needs. This level of public involvement has been shown to be vital to the success of any public works program. Once the public has understood the issues and their potential solutions (and costs), an effective discussion on funding options can occur. Establishing the public's proper understanding of specific needs before presenting funding options is critical for successful implementation.

Conclusions

As described in this report, areas within the Town of Fort Myers Beach suffer from severe stormwater flooding during large rainfall events. This includes the only evacuation route along Estero Boulevard and for many residents properties are subject to repeated flooding. Another impact of the flooding is additional wear on the roads and washing out of sand from properties and out from under sidewalks and roads.

In addition, untreated stormwater runs off to the canals and bay that surround the island. Water quality is an important stormwater issue for the Town as stormwater runoff can be related to beach closings due to high bacteria levels and can also impact wildlife and aquatic species. Existing regulatory requirements require minimum levels of action that the Town must take to reduce stormwater pollutant loadings, and potential new regulations in the future may add to those requirements.

It will take a coordinated effort by the Town to address these flooding and water quality issues. Direction for this effort is provided in the Stormwater Master Plan outlined in this report. The plan includes combining ongoing and new efforts to meet the Town's Comprehensive Plan Goal Number 9;

> ***"To provide optimal flood protection and improved stormwater quality within the constraints imposed by location and existing land-use patterns."***

By implementing this plan, the Town will reach this goal using a well organized and efficient approach.

Section 1
Background and Purpose

1.1 Technical Report Purpose and Organization

This report provides the technical assumptions, analysis, and results to support the Stormwater Master Plan Report for the Town of Fort Myers Beach (Town). The master plan was developed as part of the Town's ongoing efforts to address stormwater related flooding and water quality issues. To develop this plan, the Town contracted with Camp Dresser and McKee Inc. (CDM) to address three overall plan objectives:

- Provide an evaluation of innovative and cost-effective stormwater Best Management Practice (BMP) technologies applicable to the Town's barrier island, flat terrain, and tidally influenced stormwater system.

- Develop conceptual stormwater improvement options and recommendations for the Town's three major flooding areas as shown in **Figure 1-1**, and for the Town's 90 stormwater outfalls (grouped by type).

- Develop a Stormwater Master Plan incorporating the BMP technologies and conceptual problem area improvement projects in a prioritized list for implementation to proactively address pending environmental regulations (e.g., total maximum daily loads - TMDLs) while providing flood control to meet the level of service (LOS) to the maximum extent practicable.

The basis of the master plan comes from the Town of Fort Myers Beach Comprehensive Plan developed in 1999. As part of the Stormwater Management element of the Comprehensive Plan, CDM studied the Town's stormwater issues and made recommendations, many of which the Town has started to implement. As a result of that work, the Town's comprehensive plan stormwater Goal Number 9 is:

> ***"To provide optimal flood protection and improved stormwater quality within the constraints imposed by location and existing land-use patterns."***

To reach this goal, 6 objectives and 24 recommended policies were developed that the Town has started to implement. This includes completing and planning many small-scale drainage improvement projects to address the most immediate needs. It also includes recommendations for BMPs. The sixth objective to meet Goal Number 9 is to complete a Stormwater Master Plan and review funding options, including the potential to create a stormwater utility. The Stormwater Master Plan in this report fulfills that sixth objective.

The stormwater master plan and supporting work documented in this report consists of five main sections as follows.

C:\COFMB\Report\FMB Report\Figures Appendices Tables\Figure 1-1 Site Map.mxd

Source: Town of Fort Myers Beach

CDM	Town of Fort Myers Beach 2523 Estero Blvd. Ft. Myers Beach, FL 33931 Tel # (239) 765-0202	Scale: 0 600 1,200 2,400 Feet	**Figure 1-1** Site Map Problem Areas 1, 2 and 3	UPDATED 04-10-09

Executive Summary – Based on the findings for the three problem areas described in Sections 1 - 4, the Executive Summary describes the master planning process and provides the overall master planning recommendations for the Town to follow as it continues to address stormwater related issues.

Section 1 – Purpose and Organization: Section 1 provides the purpose, background and overall approach used to develop the master plan. It also includes a description of existing information and reports related to the Town's stormwater issues. Finally, it includes a description of the stormwater related regulatory agencies and issues.

Section 2 – Water Quantity Evaluations: Section 2 describes the field investigations completed as part of this project to identify specific flooding issues and sources for three problem areas. This includes the development of a computer model (using US EPA SWMM) to quantify stormwater and related flooding volumes in the three problem areas. The model results are used to further refine the Town's existing level of service goals that were set as temporary goals until a master plan was completed.

Section 3 – Water Quality Evaluations: Section 3 provides an evaluation of the key stormwater pollutant loads for the three problem areas. This includes the development of a pollutant loading model (using WMM) that was used to evaluate existing loads and how they can be better controlled and treated using BMPs.

Section 4 – Evaluation of Alternatives: Based on the findings and analysis provided in sections 2 and 3, Section 4 provides three sets of conceptual alternatives to improve stormwater flooding issues in the three problem areas. This includes both improved conveyance of stormwater to outfalls along Estero Bay as well as the use of BMPs to reduce pollutant loading. The costs provided in Section 4 are for the three problem areas only.

The final conclusions and recommendations are provided as part of the Executive Summary.

1.2 Background of Flooding and Water Quality Issues

The Town of Fort Myers Beach is a relatively long and narrow coastal barrier island located southwest of Lee County. It is comprised of the 7,713-acres of Estero Island that was incorporated as the Town of Fort Myers Beach in 1995. Prior to being incorporated, Estero Island development and local government was through Lee County.

The Town is nearly built out to its maximum capacity. The majority of the development occurred over 20 years ago, during a period when there were very few stormwater regulations and ordinances. As a result, many residential lots, typically parcels which developed on highly pervious soil along the coast of Gulf of Mexico, are paved heavily with impervious structures (such as houses and driveways). This has also led to a limited number of existing BMPs to treat stormwater and minimize pollutant loading. Consequently, the Town has both flooding and water quality issues related to stormwater.

1.2.1 Flooding Issues

Being a coastal barrier island with an average topographic elevation of about four feet above mean sea level makes the Town highly susceptible to both coastal and stormwater flooding. During major storm events, most areas of the island, including the only evacuation route along Estero Boulevard, suffer from severe flooding problems. In addition, many residential properties on the island are subject to repeated flooding, including over 50 repetitive loss properties identified by the Federal Emergency Management Association (FEMA) as part of the flood insurance they provide.

In general, there are adequate stormwater drainage facilities on the most southern part of the island where the development is relatively new and swales are present along Estero Boulevard. However, existing stormwater drainage facilities are inadequate in many other areas of the Town. In most areas, the existing drainage system is discontinuous and primarily consists of inlets, pipes, and swales constructed as-needed to alleviate localized flooding issues. In most cases, the construction of the system did not include the submission of As-Built drawings, and therefore the connectivity of inlets to each other and outfalls is not well known. As a result of the limited historical system information, along with the ubiquitous presence of sand in yards and driveways that routinely flushes into the storm system, the system is difficult to maintain.

Two chronic flooding areas have been awarded FEMA grants through the Hazard Mitigation Program to design stormwater improvements that will reduce repetitive losses being covered under the FEMA flood insurance program. The first of these is the North Estero Stormwater Improvements project that was designed in 2007 and started construction in 2009. The second area awarded FEMA grant funding is the Twelve Streets area between Carolina and Tropical Streets. The design process for this area was started at the beginning of 2009 and is ongoing at this time.

The scope of this master planning effort focuses on developing conceptual stormwater improvement plans for the next three chronic flooding areas. **Figure 1-2** shows the areas of the two ongoing FEMA projects as well as the three master plan problem areas. A description of the three problem areas being addressed by this master plan follows.

Area 1 Estero Boulevard from School Street to Lovers Lane. Area 1 includes Estero Boulevard extending from School Street to Lovers Lane. It also includes the area of Bay Street extending from Estero Boulevard to Oak Street. It is surrounded by commercial development on the west and residential development on all other sides. The average topographic elevation for this area is 4.0 ft North American Vertical Datum (NAVD) and an average impervious area of 45 percent. This area has a stormwater drainage network that leads to an outfall at the end of Bay Street.

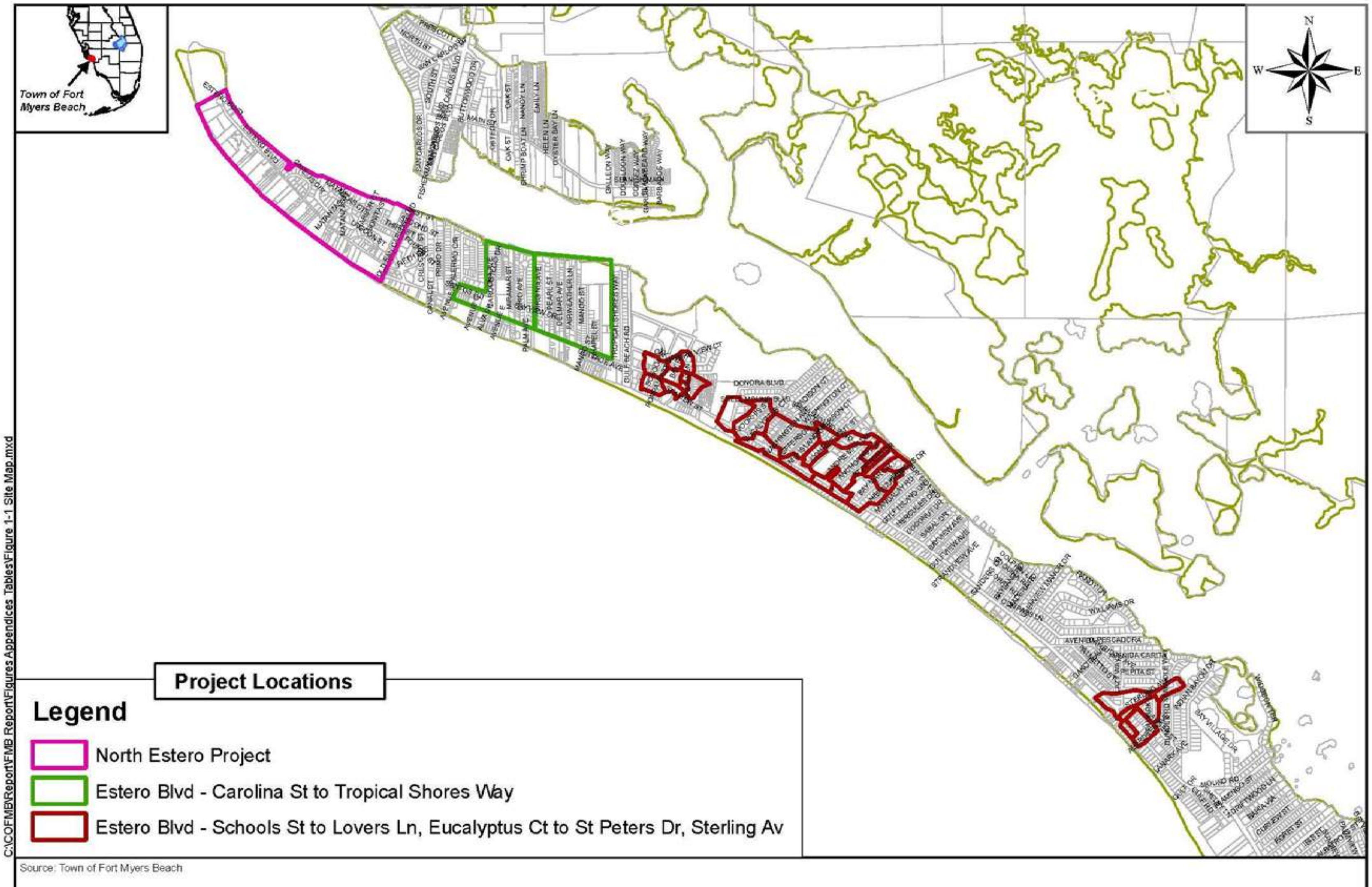
Area 2 Estero Boulevard from Eucalyptus Court to Saint Peter's Drive. Area 2 includes a portion of Estero Boulevard extending from Voorhis Drive to St. Peter's Drive. This problem area is composed mainly of high density residential development with the average impervious area of 35 percent and an average topographic elevation of 4.0 ft-NAVD. It has a very scarce stormwater drainage network which is significantly insufficient and inefficient for proper stormwater drainage. Also, the drainage network of swales, culverts and dry detention basins is lacking on most of the coverage of this problem area.

Area 3 Falkirk Street, Lauder and Sterling Avenue. Area 3 includes the residential "triangle" between Falkirk, Lauder, and Sterling. It also includes flooding along Estero Boulevard primarily at the intersection with Sterling Avenue, but extends north to Lazy Way. The triangle area consists of medium density residential. There are commercial areas along the north side of Sterling, including a Women's Club that has a fair amount of open land. The average topographic elevation for this area is 3.5 ft-NAVD and an average impervious area of 35 percent.

In each of the three problem areas, the streets have chronic flooding that is present through much of the summer, particularly along Estero Boulevard. This is primarily the result of almost daily late afternoon thunderstorms that occur in the summer along with the lack of drainage for Estero Boulevard. As a result, some property owners along Estero Boulevard have built up the edge of their property to prevent the Estero Boulevard stormwater runoff from flooding their yards.

1.2.2 Water Quality Issues

In addition to flooding issues, water quality is a critical stormwater issue for the Town residences and the local economy. Fort Myers Beach residences and visitors come to the island to enjoy the many beaches and recreational activities that the Gulf of



Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Scale: 0 0.25 0.5 1 Miles

Figure 1-2
Current Project Map
Town of Fort Myers Beach

UPDATED 04-10-09

Mexico and Estero Bay provide. In addition, the Gulf and Bay are important water bodies that support wildlife and aquatic species that can be adversely affected by stormwater runoff pollutant loads.

On occasion, beaches are closed by the Lee County Department of Health due to high bacteria levels in the water that may be in part due to stormwater runoff. In many cases, it is likely that beach closures and other environmental impacts are due to pollutant loads originating from other communities. This is particularly true as Fort Myers Beach is at the mouth of the Caloosahatchee River that picks up pollutant loads from many communities inland, including regulatory release of stored water from Lake Okeechobee.

However, it is still important that the Town is responsible for its own water quality impacts. In addition, the State TMDL requirements and the Lee County stormwater permit (of which the Town is a co-permittee under Lee County) require minimum levels of action that the Town must take to reduce stormwater pollutant loadings. This includes water quality sampling that is being performed by Lee County in Estero Bay. The existing and potentially more stringent future State requirements are described in more detail later in Section 1.

1.3 Stormwater Level of Service

The primary purpose of the LOS criteria is to protect public safety and property. In addition, proper LOS decisions for water quantity (flooding) and water quality protection are essential for the implementing entity as those decisions set the goals for the Capital Improvement Program (CIP).

Stormwater management has become a complex national issue. In the past, ditching and draining to convey stormwater away from development, coupled with filling of floodplains and wetlands, was the accepted practice. Over the years, flood damages along with adverse impacts to water quality, fisheries, scenic areas, recharge areas, and wildlife habitats have served to motivate changes in enlightened, accepted approaches to stormwater management. Stormwater management goals now involve storage, conveyance, recharge, and treatment aspects along with proper timing, duration, levels of flooding, and nutrient releases for natural areas or wetlands to ensure a comprehensive management approach to what has become a local, state, and federal issue.

The Fort Myers Beach comprehensive plan adopted on January 16, 2007, established interim LOS standards for flood protection. The plan states that these standards will be effective until the completion of the evaluation under Stormwater Management Element Policy 9-F-1 to 6. These interim LOS are as follows:

- During a 3-day rainfall accumulation of 13.7 inches or less (3-day, 100-year storm as defined by the South Florida Water Management District [SFWMD]), one lane of evacuation routes should remain passable (defined as less than 6 inches of standing water over the crown). Emergency shelters and essential services should not be flooded.

- During a 3-day rainfall accumulation of 11.7 inches or less (3-day, 25-year storm as defined by SFWMD), all lanes of evacuation routes should remain passable. Emergency shelters and essential services should not be flooded.

- During Coastal flooding up to 4.0 feet above mean sea level, all lanes of evacuation routes should remain passable. Emergency shelters and essential services should not be flooded.

As part of the stormwater master planning work, the interim LOS criteria are re-evaluated using the water quantity (flooding) model and recommendations and modifications presented in Section 2 of this report.

1.4 Previous Studies and Information

In addition to the Town's Comprehensive Master Plan, several other studies were reviewed as part of the development of the overall master plan.

1.4.1 Stormwater Management Study (2008)

The *Town of Fort Myers Beach Stormwater Management Study*, dated March 27, 2008, was prepared for the Town of Fort Myers Beach by Coastal Engineering Consultants, Inc. (CEC). This study was funded by a grant from the SFWMD and presented the following information:

- An overview of the Town's stormwater management issues;
- Stormwater management techniques commonly used by other municipalities;
- Stormwater management techniques that can be used by individual property owners;
- Evaluation of each potential technique as it pertains to the Town's stormwater management issues; and
- Development of a conceptual plan for managing the Town's stormwater.

As described earlier, the 2008 report documents that the 7,713-acre densely populated island is approaching build-out and beginning to undergo redevelopment of residential and commercial properties. The existing stormwater management system, made up of swales, inlets, and pipe systems is functioning at a less than optimal level. A lack of open areas exists to expand and update the existing stormwater system. Land elevations are typically low (less than five feet above sea level). These factors create challenges for improving the quantity and quality of stormwater runoff from the island.

The report also identified that significant data gaps exist in the underground collection and conveyance system. The biggest gap appears to be the lack of detail in the connectivity of the stormwater management system. Outfalls for some of these systems are unknown or may not exist.

The report further mentions that structural and non-structural techniques exist to better manage stormwater runoff. Structural techniques include street sweeping, water quality inlets and devices, swales, ponds, constructed wetlands, and underground storage. Non-structural tools include education awareness, incentives, and zoning. Evaluation is presented of the different techniques and their applicability to the stormwater management issues of the Town.

Recommendations in the 2008 report include that the Town complete a comprehensive inventory of the existing stormwater systems and an assessment of the system capacity. The following techniques were recommended for consideration: street sweeping, swales and vegetated strips, education programs, fiscal incentives, zoning, landscape certification program, green parking standards, and low impact development. Other structural techniques (such as water quality inlets and devices, ponds and wetlands, and underground storage) should be further considered after completion of the assessment of the existing stormwater management system.

In conclusion, the study states that stormwater management improvements are generally needed throughout the Town limits. In consideration of the available financial resources, the Town must rely on its residents and businesses to become actively involved in addressing stormwater management.

1.4.2 FEMA Flood Insurance Studies and Flood Insurance Rate Maps (2008)

A floodplain is an area inundated, or flooded by a particular rain or tidal event. Floodplains are often described by their frequency of occurrence and/or return period (e.g., 25-year or 100-year). Within the Town of Fort Myers Beach, two classifications of floodplains exist: tidal and stormwater. Tidal floodplains are the result of tide- and wind-generated flood stages, while stormwater (sometimes called riverine or fluvial) floodplains are associated with rainfall.

FEMA establishes flood levels and flood insurance standards. It is common practice for FEMA Flood Insurance Studies (FIS) to consider tidal and stormwater flood events to be independent of one another then superimpose the independent results upon each other to produce comprehensive tidal/stormwater floodplain maps. Based upon these standard practices, the FEMA FIS for Lee County, Florida and Incorporated Areas (dated effective August 28, 2008) and associated Flood Insurance Rate Maps (FIRMs) identify portions of the county as flood prone and provide an estimate of the 100-year flood stages in order to provide guidance for home building and road elevations.

For this study, CDM collected available data to estimate the initial tidal and stormwater flood elevations for the boundary conditions throughout Fort Myers Beach. The following FEMA documents, all dated effective August 28, 2008, were reviewed and are provided in Appendix B.

- FIRMs: Map Numbers 12071C0554F, 12071C0558F and 12071C0566F
- FIS: Flood Insurance Study Number 12071CV001A, Volume 1, Lee County

Island-wide, Fort Myers Beach is listed as a special flood hazard area subject to inundation by the 1 percent annual chance (100-year storm event) flood. The western side of Fort Myers Beach immediately adjacent to the Gulf of Mexico is generally listed by FEMA as Zone VE, "Coastal flooding zone with velocity hazard (wave action); Base Flood Elevations determined." The central and the eastern side of Fort Myers Beach immediately adjacent to Estero Bay is generally listed by FEMA as Zone AE, "Base Flood Elevations determined."

Proper floodplain/floodway data are critical to guiding new development in the establishment of first-floor elevations, road crown elevations, lake control structure and tailwater elevations, allowable fill quantities/encroachment and facility sizing. Additional analysis for the hydraulic model boundary conditions is described in Section 2 of this report.

1.4.3 FDEP Nutrient Loading Assessment (2009)

On February 13, 2009, the Florida Department of Environmental Protection (FDEP) published a draft Nutrient TMDL Report for the Caloosahatchee Estuary (Water Body Identification Number, WBID Numbers 3240A, 3240B, 3240C). According to the FDEP, a TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. The TMDL established for the Caloosahatchee Estuary requires a 40 percent reduction in total nitrogen (TN). The considered water boundaries include only the estuarine and tidal portions and discontinue at the downstream end of the Caloosahatchee River at San Carlos Bay.

Based on the most recent available information, Estero Bay (outfall location of project areas) has not been listed on the Verified List of Impaired Waters. However, this does not preclude the possibility of a future TMDL for Estero Bay. If Estero Bay were to be listed as an Impaired Water, a TMDL may be required and could include nutrient and/or pollutant reductions through a Basin Management Action Plan (BMAP). Additional information on potential related regulations by the US EPA and FDEP are described in **Section 1.5**.

1.4.4 North Estero Stormwater Improvements (2007)

In October 2007 Environmental Consulting & Technology, Inc. (ECT) submitted to the Town of Fort Myers Beach a report with calculations and plans for a Drainage Improvement Project along North Estero Boulevard. Based on updates made to the design in 2009, the project consists of approximately 9,000 feet of high density polyethylene (HDPE) pipe with slot drains, 44 Type-10 stormwater curb inlets, and 30,571 cubic feet of stormwater treatment chambers. The drainage system is designed to capture, treat, and convey runoff from a 1-hour 5-year storm event and is currently under construction.

1.5 Regulatory and Other Agency Coordination

Stormwater outfalls to "Water of the State" are regulated by federal, state, and local agencies. Therefore, any modifications or improvements to the Town's stormwater system need to be developed within the following regulatory framework to be implemented.

1.5.1 United States Environmental Protection Agency

The US EPA was mandated by Congress through Section 405 of the Water Quality Act of 1987 to promulgate a National Pollutant Discharge Elimination System (NPDES) permitting program for municipal stormwater discharge. On December 8, 1999, the NPDES permitting program was expanded to Phase II to include small municipalities with storm sewer systems serving less than 100,000 persons. As it has done with many States, the US EPA has delegated the NPDES permitting authority to the State of Florida Department of Environmental Protection (FDEP).

1.5.2 Lee County NPDES Permit from the FDEP

Lee County holds a Municipal Separate Storm Sewer System (MS4s) permit issued by the FDEP agency. The DEP is responsible for implementing the stormwater element of the federal NPDES as part of the Department's Wastewater Facility and Activities Permitting program. The stormwater element of the NPDES program is mandated by the Clean Water Act (CWA) Section 402(p). Authorized by Section 403.0885, Florida Statutes (F.S.), the Department's federally approved NPDES stormwater program is set out in various provisions within Chapters 62-4, 62-620, 62-621 and 62-624 of the Florida Administrative Code (F.A.C.). Chapter 62-624, F.A.C. specifically addresses MS4s permit requirements.

The Town of Fort Myers Beach is one of the 15 entities authorized for stormwater discharge under comprehensive Lee County MS4s permit (Permit Number FLS000035). The Town is authorized to discharge to waters of the state per the approved Stormwater Management Programs (SWMPs), effluent limitations, monitoring requirements, and other provisions as set forth in this permit. The Town has actively been fulfilling the requirements of the permit related to their existing outfalls. These efforts are documented in annual reports submitted by the Town to the FDEP.

1.5.3 South Florida Water Management District

The SFWMD also has responsibilities for stormwater management under F.A.C. Chapters 40D-4, 40D-40 and 40D-400 through issuance of an Environmental Resource Permit (ERP). SFWMD also regulates the surface water drainage under F.A.C. Chapters 40E-40 and 40E-41. In addition, its responsibilities include regulation of dredge and fill activities. Since SFWMD has jurisdiction, their criteria and standards will be used as the guideline for conceptual planning of both water quality and quantity improvements. These guidelines are provided in the South Florida Water Management District ERP Information Manual Volume IV (2007). Specific requirements related to the Town's retrofit needs are provided in the water quality and alternatives sections of this report.

1.5.4 Pending Federal and State Regulations

Over the last two years, three significant related water quality and stormwater regulation issues have emerged that will likely impact the Town of Fort Myers Beach in the near future. They are:

1. The ongoing Total Maximum Daily Load (TMDL) program by the FDEP.

2. The draft Numeric Nutrient Rule as proposed by US EPA.

3. The draft Unified Statewide Stormwater Rule as proposed by FDEP.

FDEP TMDL Program

The TMDL program is required by the Clean Water Act to identify the maximum allowable loads for all sources to impaired waters and also identify the load reductions to achieve the designated use(s). As described previously, it is under this program that the FDEP Nutrient Loading Assessment (2009) developed targeted reduction in TN of 40 percent for the Caloosahatchee Estuary. The FDEP leads this effort working with local stakeholders including water management districts, cities, counties, and private interests. The TMDL program works to develop a scientifically sound database of information and calibrated-validated hydrology, hydraulic, and water quality models to identify the TMDL, build on pollutant load reduction goals (PLRGs), support the load allocation and reduction process, and establish the foundation for evaluations of management practices to improve water quality. Because of this, it is the most watershed-specific information for informed decisions for water quality and water environmental health. Enforcement would be through NPDES permitting for domestic wastewater, industrial wastewater and MS4 stormwater outfalls.

The current Caloosahatchee TMDL does not apply to Fort Myers Beach. However, the state plans to provide a draft TMDL for estuaries that could impact the Town. The draft was originally planned for July 2010, but is currently on hold with no scheduled completion date. This could ultimately lead to a best management action plan (BMAP) that would require the Town to complete retrofits to reduce nutrient loads to Estero Bay.

US EPA Numeric Nutrient Rule

In 2001, the Environmental Protection Agency (EPA) asked all states with narrative nutrient criteria to develop numerical criteria. The state of Florida created a technical advisory committee to help scientifically develop such criteria and they have been meeting for the last 7 years discussing this topic. Draft state criteria were created earlier this year. EPA was sued a few years ago for not requiring Florida to more quickly develop numerical criteria and in early 2009, EPA settled the lawsuit by agreeing that it will issue numerical criteria for lakes and streams by January 2010 and for estuaries by January 2011. The FDEP has been working, with the support of EPA Region IV, to develop a numerical nutrient rule that considers the nature and characteristics of each water body type (e.g., lakes, streams, springs) and variations between Florida regions (e.g., panhandle vs. southwest Florida) and types of systems (e.g., blackwater vs. clear). EPA provided the draft criteria for the freshwater lakes and streams, which are more stringent than those drafted by FDEP under the TMDL program. Also, even though the state of Florida plans to grandfather areas of the state that have already adopted nutrient TMDLs (i.e., these areas will not have to meet the new criteria), EPA does not plan to grandfather such areas and at each permit reissuance, impacts will be reviewed based on the new rule.

The EPA draft rule issued in January 2010 received a significant amount of public comment. A number of professional organizations and state agencies have provided comments that strongly object to the draft rules as being overly restrictive and do not take into account enough watershed specific characteristics. Based on the comments, the US EPA plans to issue a revised draft rule in October 2010 and is scheduled to issue the final regulations in January 2011, along with a draft of the estuary rule for public comment. It is the draft estuary rule in January 2011 that will affect Fort Myers Beach.

SFWMD and FDEP Unified Statewide Stormwater Rule

The SFWMD and FDEP have been working with various groups in southwest Florida over the last 6 to 7 years in the development of supplemental water quality criteria for Environmental Resource Permits (ERPs) in order to better protect water quality. These supplemental criteria would give credit for additional non-traditional best management practices (BMPs) and encourage stormwater reuse while controlling the average annual volume of discharge and nutrients to historic (pre-development) levels. This would encourage stormwater reuse. FDEP has been working to extend these criteria to a unified statewide rule that considers variations in hydrology and physical characteristics across Florida. If adopted as it has been drafted today, this rule would exempt retrofits for stormwater systems that provide some load reduction, such as stormwater master plan projects with water quality BMP features.

1.5.5 Florida Department of Community Affairs

The Florida Department of Community Affairs (FDCA) is the implementation agency for the State Comprehensive Plan (Chapter 187, Florida Statutes). Local comprehensive plan elements are submitted to the FDCA after receiving comments from the local regional planning council (Southwest Florida Regional Planning Council). Typically, adhering to guidelines of the local water management district will ensure compliance with the local and state comprehensive plan requirements.

1.5.6 Lee County Department of Transportation

The Lee County Department of Transportation (DOT) owns and maintains Estero Boulevard, which is the primary and only street that runs the entire length of the

Island. In January 2008, the Lee County DOT began the Estero Boulevard Corridor Analysis and Design project in conjunction with the Town. Ultimately, this project will work towards implementing the Town's Estero Boulevard Master Plan adopted in 2001. As many of the stormwater flooding issues in the Town are directly related to runoff from Estero Boulevard, coordination of stormwater system improvements with this ongoing project is important. This includes identifying how and where county stormwater systems need to be connected to the Towns existing stormwater system, and where improvements to the Town's system are needed. This project may also provide opportunities to save money by coordinating construction activities between Estero Boulevard and stormwater system (and other utility) improvements.

Section 2
Water Quantity Evaluations

2.1 Overview

Surface water hydrologic and hydraulic modeling has been performed using the U.S. Environmental Protection Agency (USEPA) Stormwater Management Model (SWMM) to estimate flooding and Levels of Service (LOS). The SWMM computer model was selected based on its ability to simulate the unique hydrologic and hydraulic characteristics of the three problem areas. In addition, SWMM has been verified for stormwater design and master plan uses throughout Florida and is accepted by the Florida regulatory community. The water quality evaluations (discussed in Section 3) were conducted utilizing a separate model, the Watershed Management Model (WMM) developed by CDM.

As part of the stormwater master plan the surface water model is used to:

- Aid in the development of flood control Levels of Service (LOS) for the town.
- Determine alternatives the Town may implement at flooding locations to meet or approach these LOS goals.

2.2 Data Evaluation

As described in Section 1, some of the unique challenges associated with stormwater for the Town of Fort Myers Beach include that the Town is a nearly completely built-out beach community, with relatively low-lying topography that is intersected by canals and wetlands on Estero Bay. The subtropical climate with high intensity rainfalls, relatively flat topography, limited soil storage (due to the topography and a water table near land surface), high amount of impervious (paved) area, and limited available storage all contribute to severe flooding potential. To develop a model that will adequately address these issues, the following data and information were collected and evaluated:

2.2.1 Field Inventory

The Town of Fort Myers Beach provided CDM with GIS shapefiles of existing stormwater infrastructure. Additionally, CDM performed a field inventory of the existing stormwater system in the vicinity of the three problem areas. This entailed verifying the existing inlets, pipes, swales, and outfalls in the field and mapping features that were not already contained in the Town's GIS. This also included estimating the depths of inlets and sizes of conduits. The Town's GIS was updated with the field investigation information.

During the field inventory clogged inlets were observed at several locations:

- Inlet in Oak Street in front of Methodist Church
- Inlets in Bay Road in front of Methodist Church (node A1-3)
- Inlet at intersection of Estero Boulevard and Seaview Street (node A1-2S)
- Inlet in Sea Grape Plaza (node A1-6S)
- Inlet in Shell Mound Blvd (south side of road) east of Donora Blvd (node A2-2N3)
- Inlet in Apartments west of Voorhis Street (node A2-2N2)

While conducting the field inventory potential locations for BMPs were considered. Some of these locations are on private property and have been separated between public and private accordingly in Section 3 of this report.

On December 12, 2008 a rain event occurred and photos were taken of flooding in some of the problem areas. The results of these field observations are covered in detail in Section 2.3.

CDM also retrieved LiDAR, Topographic, Land Use and Soils information from the National Geodetic Survey and Lee County. The procedures used to implement this data in the construction of the model are described below.

2.2.2 Topographic Data and LiDAR

Light Detection and Ranging (LiDAR) data of Lee County was used to develop a digital elevation map (DEM) of the area (a topographic surface in three dimensions). The accuracy of the LiDAR elevations is less than that of typical survey data; however, the relative change in elevation between LiDAR grid points is useful. The LiDAR provides complete coverage of the three problem areas, whereas survey provides only partial coverage and is not useful by itself for preparing a DEM. As no survey data was initially available for the study areas, the LiDAR was used to estimate surface elevations. The LiDAR data was obtained from the Lee County GIS Department. A graphic of the LiDAR topography is shown in **Figure 2-1**.

The LiDAR topographic data was also used to define hydrologic boundaries, overland flow slopes, critical flood elevations, and stage-area-storage relationships. The SWMM was built using elevations referencing the North American Vertical Datum of 1988 (NAVD).

Subsequent to the alternatives analysis described in Section 4, a number of key locations were identified where accurate elevation data was critical (such as outfall inverts) or the existing LiDAR was either incomplete or potentially outdated due to more recent development. To confirm the elevations, the Town had these locations professionally surveyed. The locations targeted low-lying flooding areas at intersections along Estero Boulevard and existing stormwater infrastructure adjacent to these areas. The results of the survey are included in Appendix B. In general, the survey data confirmed the LiDAR elevations and it was determined that no changes were required for the alternatives that were evaluated using the elevations based on the LiDAR data.

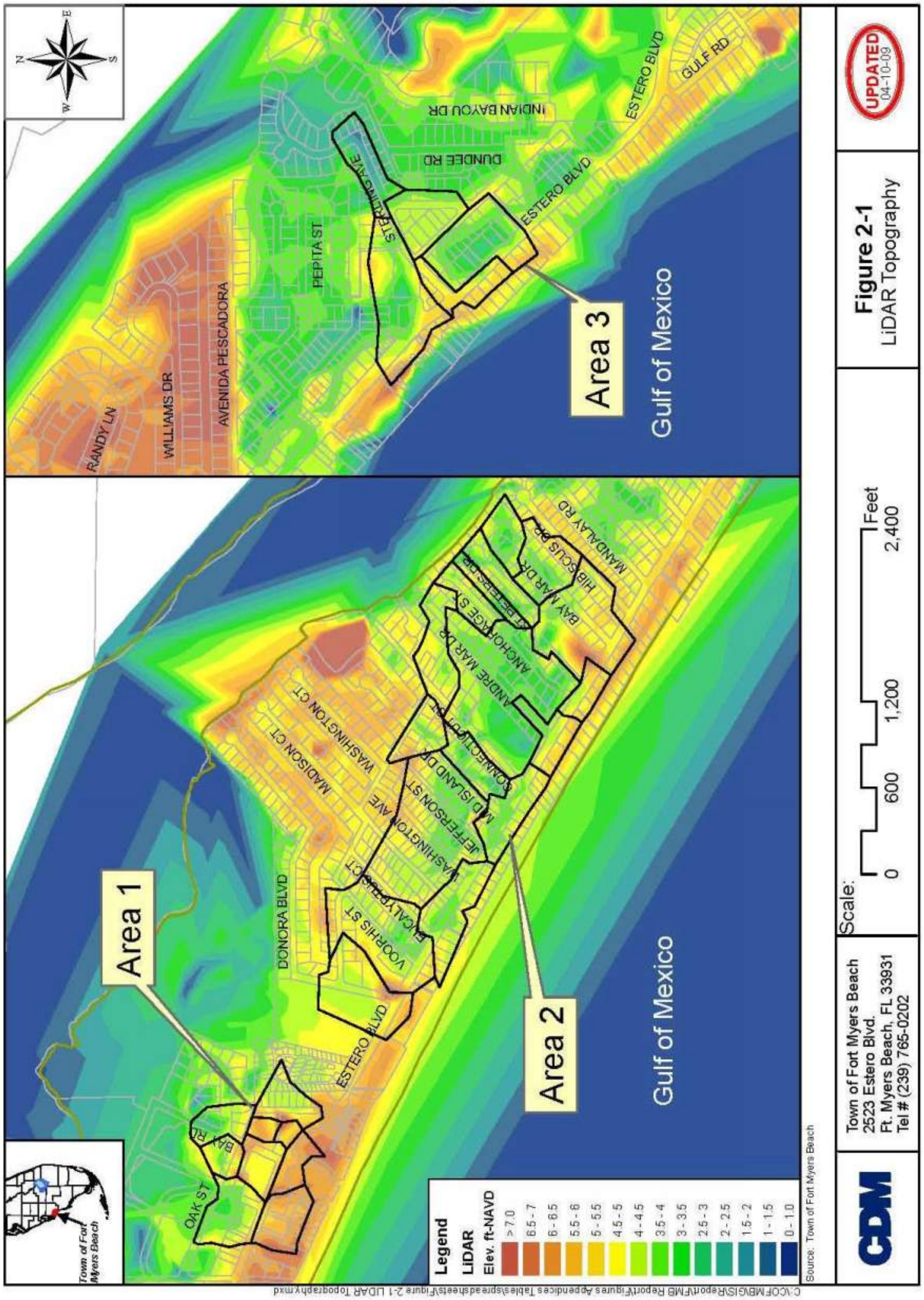
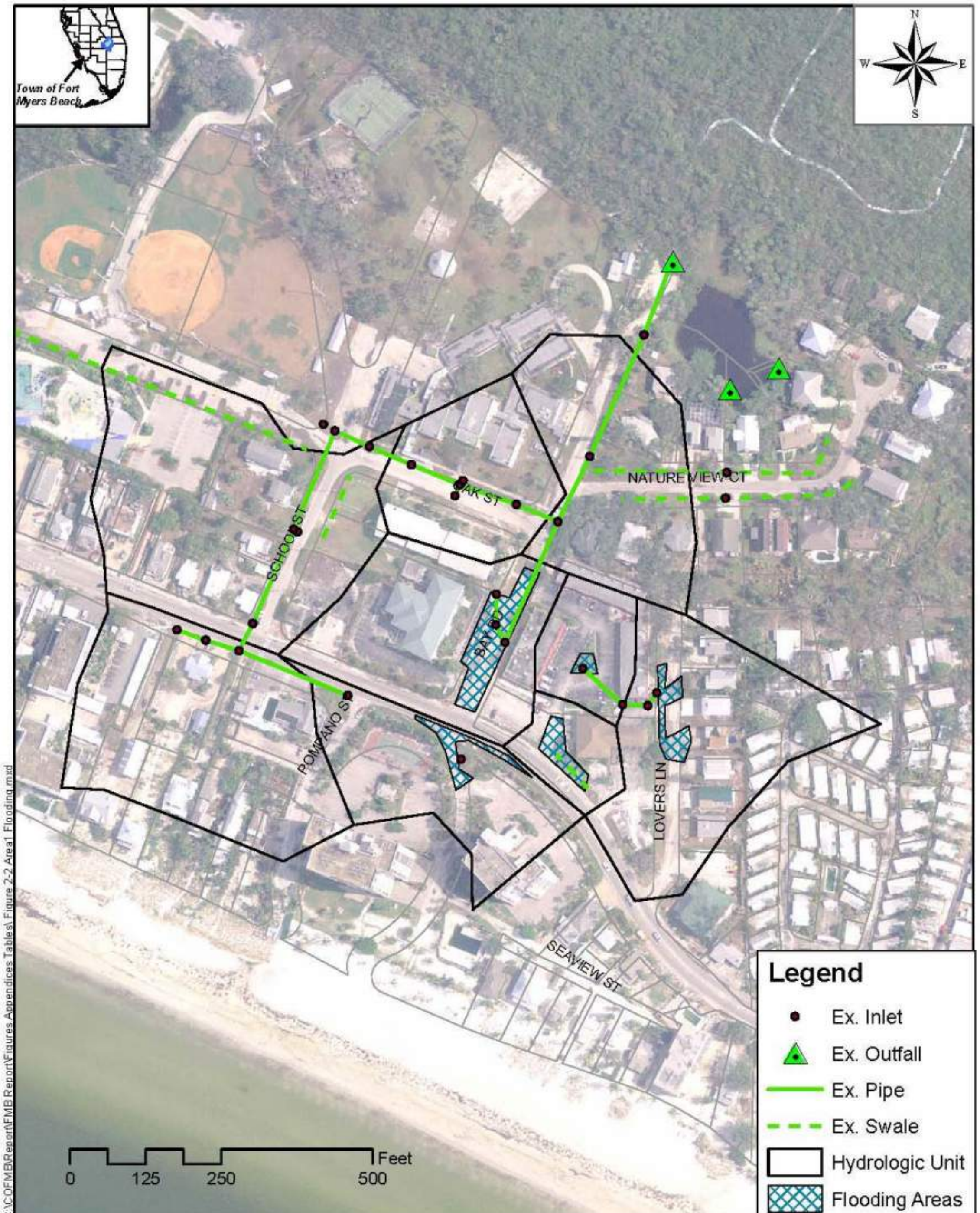


Figure 2-1
LiDAR Topography
UPDATED 04-10-09
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Scale:
0
600
1,200
2,400
Feet
Area 1
Area 2
Area 3
Gulf of Mexico
Gulf of Mexico
Legend
LiDAR
Elev. ft-NAVD
> 7.0
6.5 - 7
6 - 6.5
5.5 - 6
5 - 5.5
4.5 - 5
4 - 4.5
3.5 - 4
3 - 3.5
2.5 - 3
2 - 2.5
1.5 - 2
1 - 1.5
0 - 1.0
Source: Town of Fort Myers Beach
Town of Fort Myers Beach
ESTERO BLVD
DONORA BLVD
VOORHIS ST
MADISON CT
WASHINGTON CT
WASHINGTON AVE
JEFFERSON ST
ANDRE MAR DR
ANCHORAGE ST
BAY MAR DR
HIBISCUS DR
MANDALAY RD
OAK ST
BAY RD
RANDY LN
WILLIAMS DR
AVENIDA PESCADORA
PEPITA ST
DUNDEE RD
INDIAN BAYOU DR
GULF RD

2.3 Problem Areas

As mentioned in Section 1, the study area includes three problem areas that have been identified as having a history of flooding. The majority of flooding occurs in roads at intersections with Estero Boulevard. In some of the problem areas road flooding ponds until it overflows into adjacent private properties. Some residents have reported that at times, they need to wade through water to get to/from their house and in some cases there has been reported flooding into homes. Where available, photographs of the problem areas taken during and after rain storms were used to assist with the delineation of flooding.

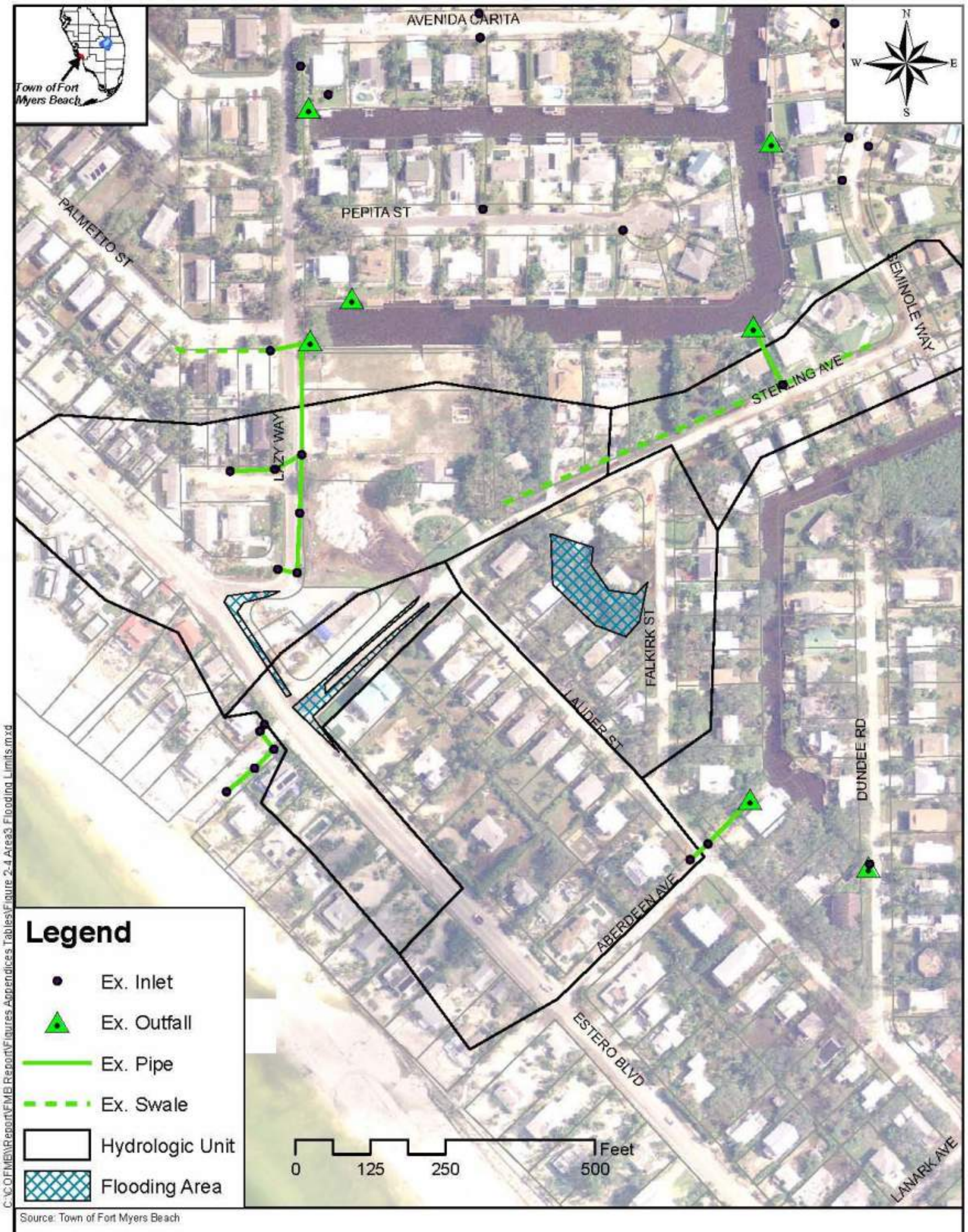
On December 12, 2008 a rain event of 1.6 inches (as measured by Mosquito Control District, 300 Lazy Way, Fort Myers Beach) was observed and CDM took photographs of flooding at the three study area locations. The complete set of photos is provided in Appendix C. Where photos were not available to document the locations and extent of flooding, anecdotal information from resident complaints were used in conjunction with estimates from SWMM for the 2.5-inch design storm. The estimated extent of flooding for each of the problem areas is described as follows and shown in **Figures 2-2** through **2-4**.



Source: Town of Fort Myers Beach

CDM	Town of Fort Myers Beach 2523 Estero Blvd. Ft. Myers Beach, FL 33931 Tel # (239) 765-0202	**Figure 2-2** Area 1 - Flooding 2.5-inch Storm Estero Boulevard & Bay Road	UPDATED 04-10-09


Figure 2-3
Area 2 - Flooding 2.5-inch Storm
Estero Blvd - Voorhis St to St Peters Dr
UPDATED 04-10-09
Scale:
0 200 400 800 Feet
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
CDM
Legend
Ex. Inlet
Ex. Outfall
Ex. Pipe
Ex. Swale
Hydrologic Unit
Flooding Area
Town of Fort Myers Beach
ESTERO BLVD
WASHINGTON AVE
JEFFERSON ST
MID ISLAND DR
CONNECTICUT ST
ANDRE MAR DR
ANCHORAGE ST
ST PETERS DR
BAY MAR DR
HIBISCUS DR
MADISON CT
WASHINGTON CT
JEFFERSON CT
EUCALYPTUS CT
VOORHIS ST
DONORA BLVD
HELL PEARL BLVD
C:\CDM\BR\eport\FMB Report\Figures Appendices Tables\ Figure 2-3 Area2 Flooding Limits.mxd



Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure 2-4
Area 3 - Flooding 2.5-inch Storm
Estero Blvd - Sterling Ave to Lazy Way

UPDATED 04-10-09

Problem Area 1 Estero Boulevard and Bay Road:

Figure 2-2 shows the estimated limits of flooding for problem area 1. Area 1 extends along Estero Boulevard from School Street to Lovers Lane. The land use is primarily medium density residential and institutional. Flooding is caused by a combination of low-lying topography, isolated basins lacking positive outfalls, and clogged storm inlets. The intersection of Estero Boulevard and Bay Road experiences flooding during small rain events. Ponding water collects in a low area of Bay Road from the intersection of Bay Road and Estero Boulevard (**Photograph 1**) extending northward towards Oak Street.

The source of the flooding appears to be sheet flow to the north from Estero Boulevard and overflow from Sea Grape Plaza as shown in **Photograph 2**. Sea Grape Plaza also floods at the center island of the parking area and at the entrance on Estero Boulevard next to Wachovia Bank (**Photographs 3 and 4**).

Behind Sea Grape Plaza runoff collects in low areas in Lovers Lane (**Photograph 5**). In **Photograph 6** on the other side of Estero Boulevard from Bay Road, Seaview Street also floods during small rain events. The flooding appears to collect in a low area at the intersection of Seaview Street and Estero Boulevard and eventually spills over the entryway and sheet drains east along the south side of Estero Boulevard.

Photograph 1: Bay Road near Estero Blvd

Photograph 2: Overflow from Sea Grape Plaza onto Bay Road.

Photograph 3: Sea Grape Plaza, center island in parking area.

Photograph 4: Wachovia Bank near Sea Grape Plaza.

Photograph 5: Lovers Lane, low area behind Sea Grape Plaza.

Photograph 6: Sea View St. at Estero Blvd.

Problem Area 2 Estero Blvd between Madison Court and Eucalyptus Court:

Figure 2-3 shows the estimated limits of flooding for problem area 2 from Voorhis Street to St. Peters Drive. The first section of area 2 covers Estero Boulevard from Madison Court to Eucalyptus Court. The land use is primarily medium and high-density residential. Flooding is caused by a combination of low-lying topography and lack of stormwater collection infrastructure. The intersection of Madison Court and Estero Boulevard is flooded during small rain events (**Photographs 7 and 8)**. Flooding is trapped in a low area on the north side of Madison Court and eventually spills over into the sidewalk of Estero Boulevard draining west towards Eucalyptus Court.

At the intersection of Eucalyptus Court and Estero Boulevard sheet flow from Madison Court and localized runoff collect and pond in front of and around EMBARQ, a commercial communications building. As ponding increases some runoff may spill over to the west and contribute to flooding at the corner of Estero Boulevard and Voorhis Street. Furthermore, the flooding at Eucalyptus Court and Madison Court is in a low-lying depression area and therefore remains for long periods of time before evaporating and/or infiltrating into surrounding soils.

Photograph 7: Madison Ct. and Estero Blvd. looking west.

Photograph 8: Madison Ct. and Estero Blvd. looking south.

Area 2 Estero Blvd between Washington Avenue and Connecticut Street:

Although no photographs were taken at this intersection, flooding has been seen on the coastal side of Estero Boulevard between Washington Avenue and Jefferson Street as shown in **Figure 2-3**. Some of the local residents have installed berms on their properties on the beach side of Estero Boulevard leaving ponding water with nowhere to go.

Area 2 Estero Blvd between Andre Mar Drive and St Peters Drive:

At the intersection of Andre Mar and Estero Boulevard flooding is caused by a combination of low-lying topography and lack of stormwater collection infrastructure. The runoff collects at the intersection of Estero Boulevard and Andre Mar Drive (**Photograph 10**) and drains northward in Andre Mar Drive before spilling into yards (**Photograph 11).** The adjacent yards have visible gravel surfaces allowing for infiltration. LiDAR shows the elevations of these adjacent properties to be more than one foot less in elevation than the road thus providing a natural sink for water to pond.

Photograph 10: Andre Mar Dr. and Estero Blvd. looking south...

Photograph 11: Andre Mar Dr. looking north, runoff into yards.

The intersections of Anchorage Street and St. Peters Drive at Estero Boulevard flood during small rain events. At these intersections the source of flooding can be seen coming from both sides of Estero Boulevard (see **Photographs 12 through 15)**. The water collects on both sides of the road at St. Peters Drive (**Photograph 16**) and is blocked off from entering the existing swale network at St. Peters Lutheran Church on the north side of Estero Boulevard (**Photograph 17**). The flooding reaches a certain level before spilling into adjacent lots on both sides of Estero Boulevard.

Photograph 12: Estero Blvd. looking east towards Anchorage St.

Photograph 13: Estero Blvd. looking east past Anchorage St.

Photograph 14: Estero Blvd. looking west past Anchorage St.

Photograph 15: Estero Blvd. looking east past St Peters Dr.

Photograph 16: Estero Blvd. looking west towards St. Peters Dr.

Photograph 17: Estero Blvd. looking north down St. Peters Dr.

Area 3 Estero Blvd at Sterling Avenue:

Figure 2-4 shows the estimated limits of flooding for area 3. The two problem areas are at the intersection of Estero Boulevard and Sterling Avenue and in a low area near the intersection of Falkirk Street and Lauder Street. The intersection of Estero Boulevard and Sterling Avenue (**Photograph 18**) floods during small rain events. Water can be seen ponding on both sides of Sterling just north of the intersection. From the intersection of Estero and Sterling runoff drains west (**Photograph 19**) towards Lazy Way eventually collecting in a swale that drains to existing stormwater piping. This piping in Lazy Way outfalls to a 24-inch conduit at the intersection of Lazy Way and Palmetto Street.

Photograph 18: Estero Blvd. and Sterling Ave. looking south.

Photograph 19: Estero Blvd. looking west towards Lazy Way.

2.4 Stormwater Management Model (SWMM)

The Storm Water Management Model (SWMM) is a dynamic hydrologic and hydraulic model capable of performing continuous or event simulations of surface runoff and groundwater base flow, and subsequent hydraulic conveyance in open channel and pipe systems. SWMM5 was used to perform the hydrologic and hydraulic calculations.

2.4.1 Hydrologic Model

The hydrologic model operates by applying precipitation across hydrologic units (HUs) that calculate overland flow and infiltration that is conveyed as surface runoff to loading points of the stormwater system. Runoff and base flow hydrographs for these loading points provide input for hydraulic routing in downstream reaches.

2.4.2 Hydraulic Model

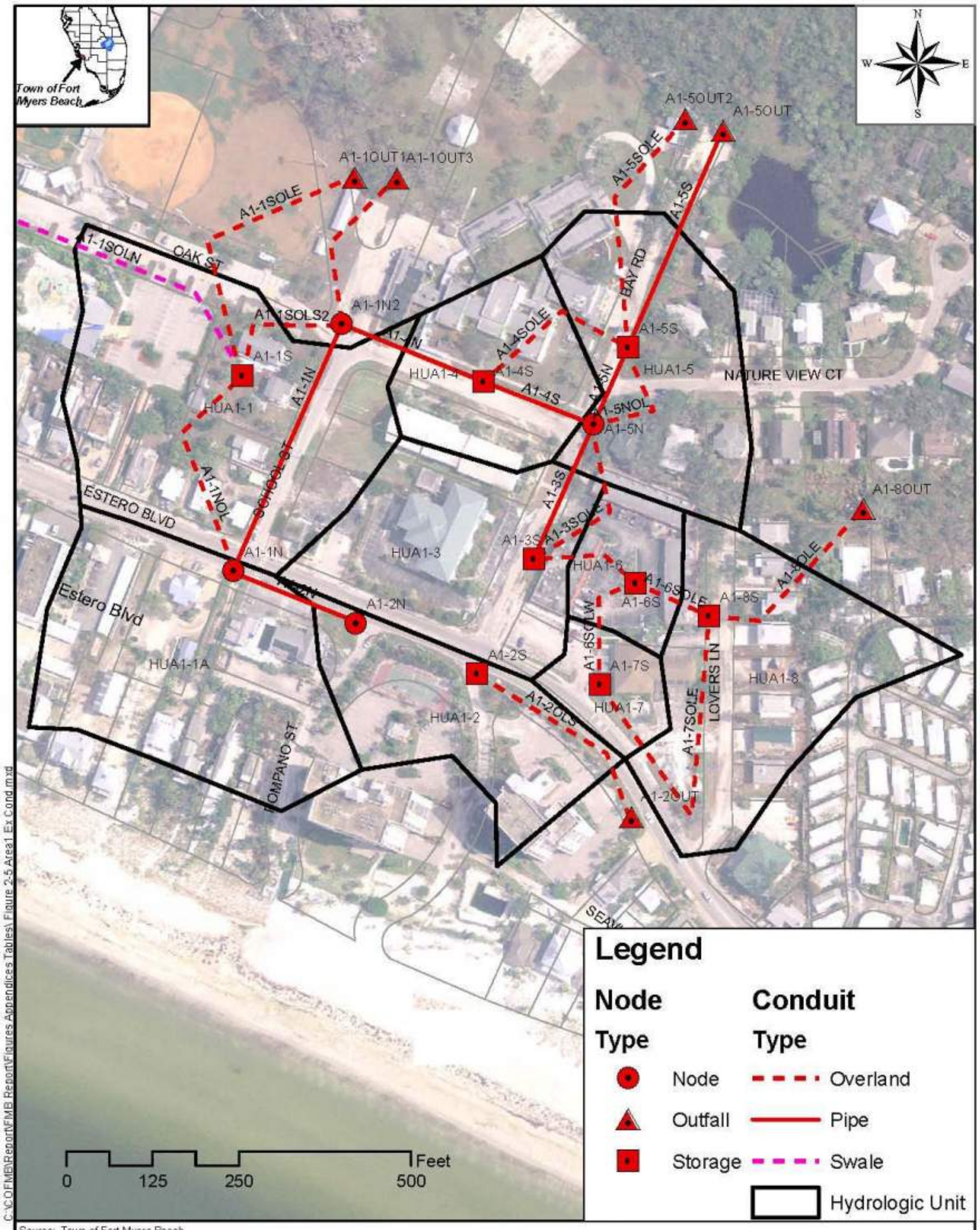
SWMM uses a link-node representation of the stormwater management system to dynamically route flows by continuously solving the complete one-dimensional Saint-Venant flow equations. The dynamic flow routing allows for representation of channel storage, branched or looped networks, backwater effects, free surface flow, pressure flow, entrance and exit losses, weirs, orifices, pumping facilities, rating curves, and other special structures/links. Control rules may be used to operate the structures based on timing and/or stage and flow conditions within the model.

2.4.3 Water Quantity Model Schematic

A necessary task of any stormwater master plan is the creation of a simplified numerical representation of the actual system. The first step in this task is the development of a model schematic, which also aids in checking input data and interpreting results. The model schematics are presented in **Figures 2-5 through 2-8** for the three problem areas. The schematics show the delineation of:

- Hydrologic units (catchment areas that all drain to a single point)
- Hydrologic load points (where runoff goes into a node or storage area)
- Conveyance conduits (how nodes are connected by pipes and swales)
- Storage (areas to account for surface ponding)
- Overland flow paths (pathways for when ponding areas "spill" over to an adjacent hydrologic unit)

The schematics also illustrate where stormwater runoff for each hydrologic unit is loaded into the hydraulic system. Additionally, they provide a visual reference between the actual physical system and the numerical model. The hydrologic components are described in the next section while the hydraulic components are covered in Section 2.7.



CDM

Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure 2-5
SWMM Schematic
Existing Conditions Area 1

UPDATED 04-10-09

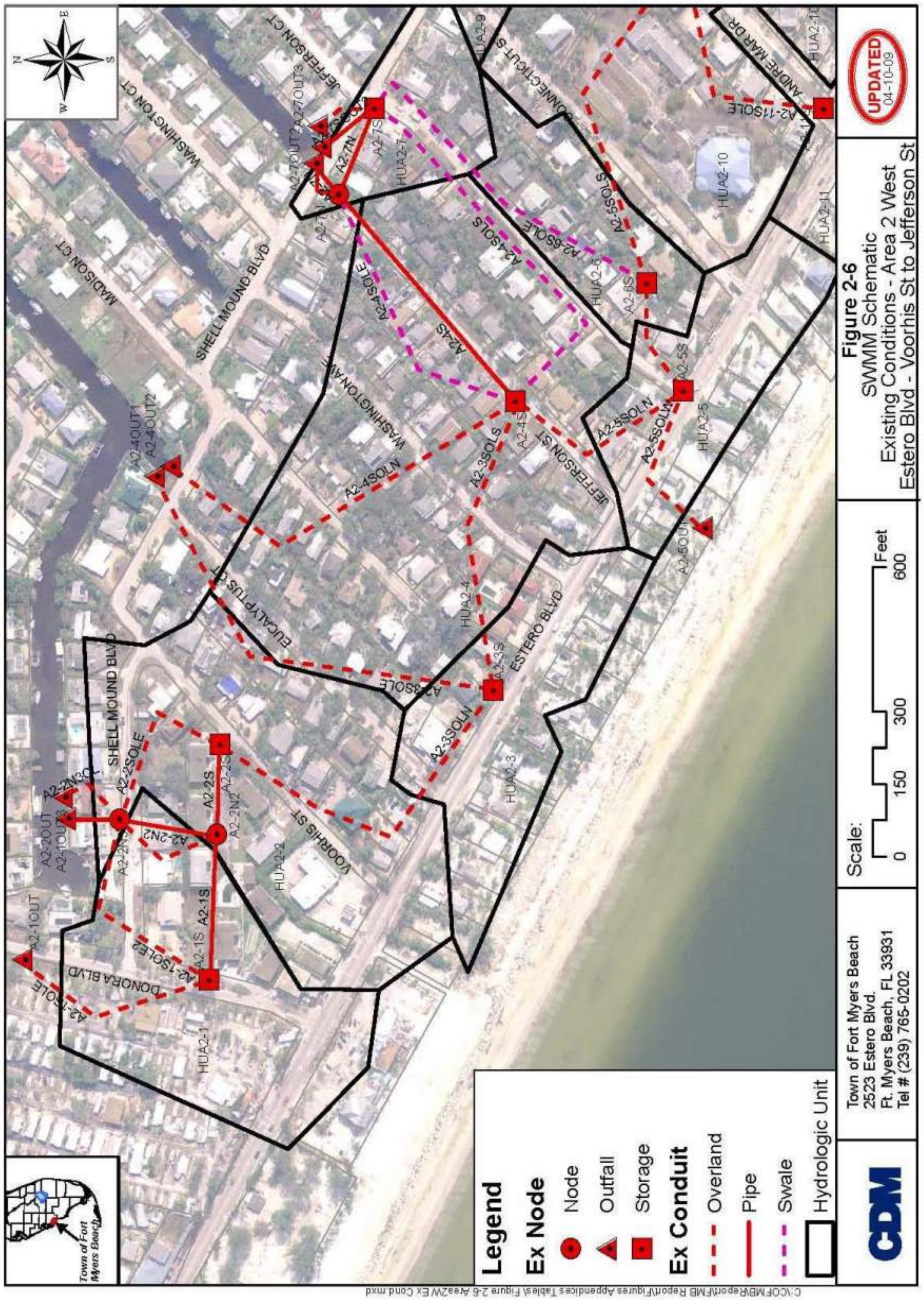
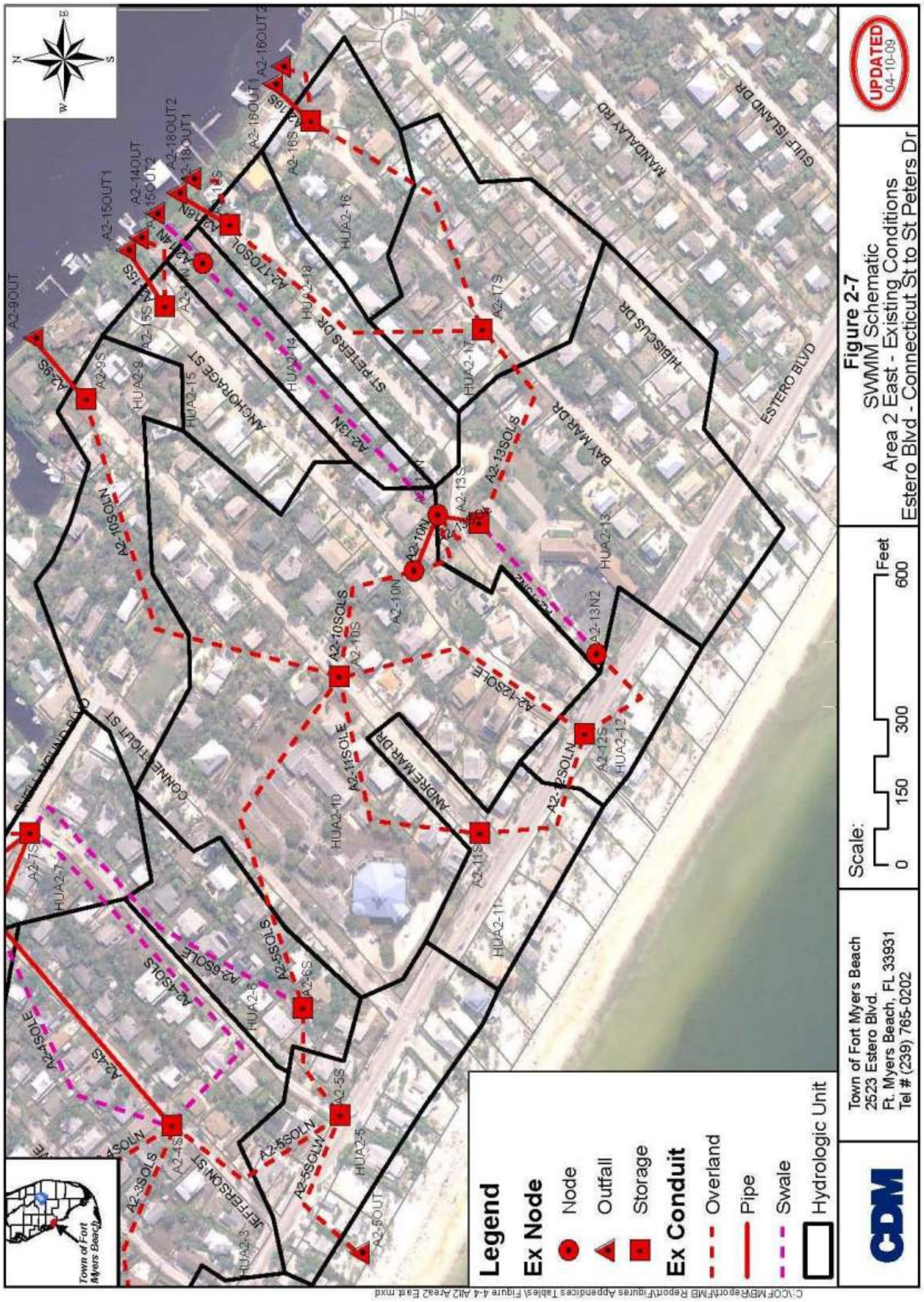


Figure 2-6
SWMM Schematic
Existing Conditions - Area 2 West
Estero Blvd - Voorhis St to Jefferson St
UPDATED 04-10-09
Scale:
0
150
300
600
Feet
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Legend
Ex Node
Node
Outfall
Storage
Ex Conduit
Overland
Pipe
Swale
Hydrologic Unit
Town of Fort Myers Beach
ESTERO BLVD
SHELL MOUND BLVD
JEFFERSON ST
VOORHIS ST
EUCALYPTUS CT
WASHINGTON AVE
DONORA BLVD
MADISON CT
WASHINGTON CT
JEFFERSON CT
CONNECTICUT ST
ANDRE MAR DR
HUA2-1
HUA2-2
HUA2-3
HUA2-4
HUA2-5
HUA2-6
HUA2-7
HUA2-10
HUA2-11


Legend
Ex Node
Node
Outfall
Storage
Ex Conduit
Overland
Pipe
Swale
Hydrologic Unit
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Scale:
0
150
300
600
Feet
Figure 2-7
SWMM Schematic
Area 2 East - Existing Conditions
Estero Blvd - Connecticut St to St Peters Dr
UPDATED
04-10-09
ESTERO BLVD
ST PETERS DR
ANCHORAGE ST
BAY MAR DR
HIBISCUS DR
MANDALAY RD
GULF ISLAND DR
ANDRE MAR DR
CONNECTICUT ST
JEFFERSON ST

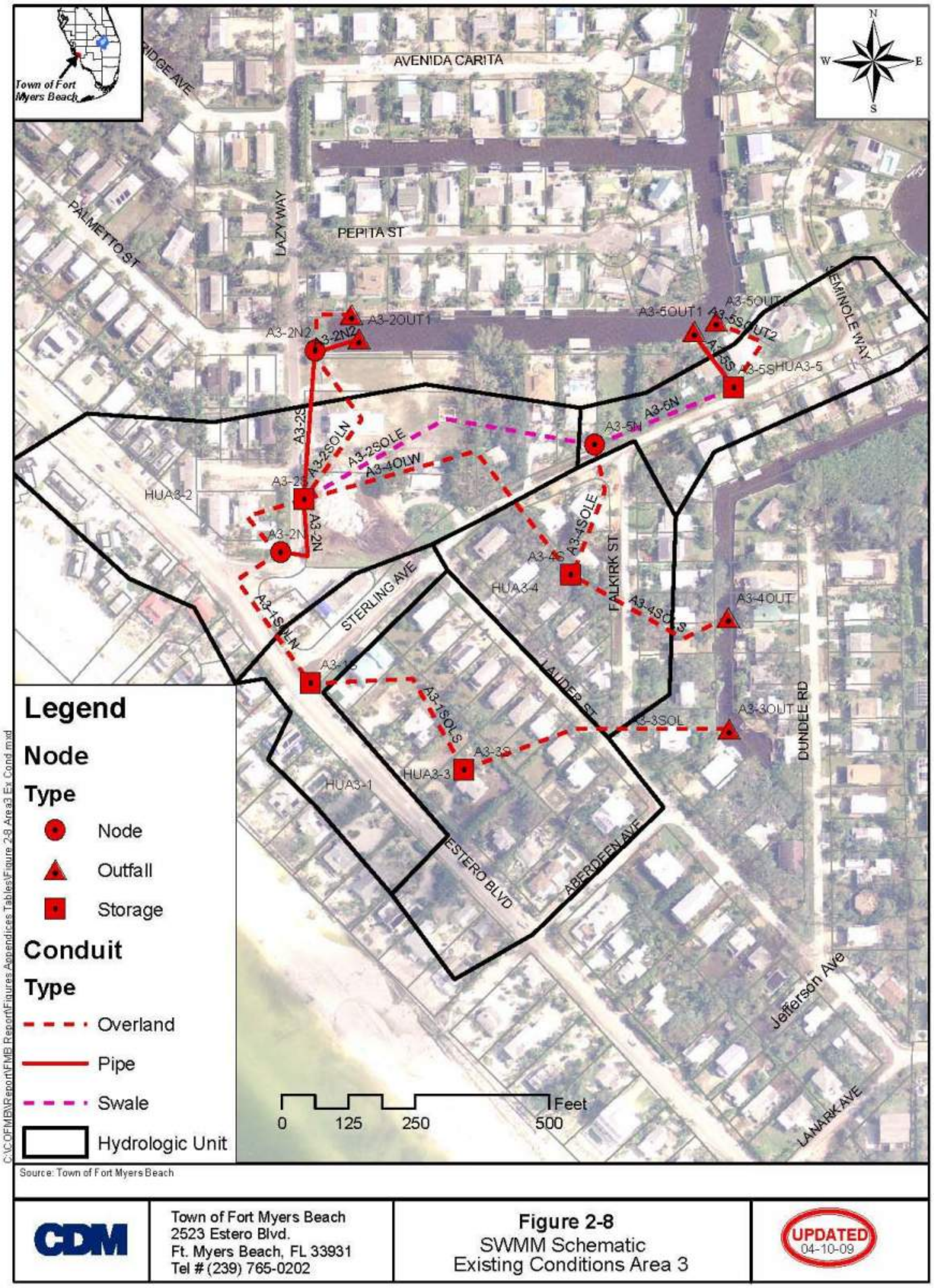


Figure 2-8
SWMM Schematic
Existing Conditions Area 3

2.5 Hydrologic Unit Delineations

Hydrologic units (HUs) were delineated using LiDAR, aerial maps and the storm sewer base plan provided by the Town of Fort Myers Beach. Hydrologic units are defined by natural physical features or constructed stormwater conveyance systems that control and direct stormwater runoff to a common outfall.

Generally, the following criteria were used to determine hydrologic unit delineations:

- Large-scale physical features such as ridges, and major roads were used to establish hydrologic divides.
- A map of the existing stormwater drainage system was also used to help delineate the hydrologic units.

Topographical land survey was not available for the problem areas, so hydrologic boundaries were determined using the LiDAR data by considering the location of storm sewers and their estimated elevations. These boundaries are based on the best available data and should be sufficient for the purposes of this study. When topographical survey data becomes available, hydrologic unit boundaries should be verified.

The three problem areas were sub-divided into 31 distinct HUs. The hydrologic units were given a unique identification number using a four-character numeric code (HUA1-X). The third and fourth characters indicate the problem area (A1, A2, and A3). The characters after the dash distinguish each hydrologic unit within the problem area. The divisions were based on a combination of topographic information, Town stormwater pipes and catchments, and aerial photogrammetry.

The hydrologic parameters assigned to each HU include area, width, slope, percent directly connected impervious area (DCIA), roughness, initial abstraction, infiltration, and groundwater parameters. Infiltration, groundwater, and DCIA are described in the following sub-sections. HU width was computed by dividing the HU area by a representative flow path length. This length was found by averaging three likely flow paths within a given HU, and HU slope was found from averaging the slopes along each of these paths.

Due to the relatively flat nature of the topography, HU divides are often overtopped during high intensity events, requiring interconnecting links (overland flow conduits) representing the topography of the divide, such as a road crown profile. **Tables A-1**, **A-2** and **A-3** of **Appendix A** provide the resultant hydrologic model data for overland flow, land use and soils for each of the modeled subbasins.

2.6 Hydrologic Parameters

The following sections describe the methodology and results used to develop hydrologic parameters for the RUNOFF module, including hydrologic unit width and area, DCIA, average overland flow slope, surface friction factors, initial depression storage abstractions, infiltration rates and soil storage capacities.

2.6.1 Rainfall Data

Rainfall data was used to generate stormwater runoff hydrographs for each hydrologic unit represented in the hydrologic model. Observed rainfall data is generally characterized by an amount (depth, measured in inches), intensity (inches per hour), frequency of occurrence (return period, in years), event duration (hours), spatial distribution (locational variance), and temporal distribution (time variance). Design storm events are usually identified by the return period of the rainfall depth and by the event duration. For example, a 25-year, 72-hour design event describes a rainfall depth over a 3-day period that has a four percent (1/25) chance of occurring at a particular location in any given year.

Table 2-1 summarizes the design storm rainfall volumes for the predictive simulations (events) taken from the SFWMD Basis of Review, March 2009 used for the subject study. The standard SFWMD design storm distributions were used for the 24-hour and 72-hour periods. Additionally, the Florida Department of Transportation (FDOT) 4-hour storm was used to analyze the effects of a shorter duration rain event. The 24-hour design storms used the SCS-Type II Florida Modified rainfall distribution while the 72-hour storms used the SFWMD 72-hour distribution.

Table 2-1. Rainfall Volumes (inches) for Production Simulations

Storms	Volume (inches)
1-year, 4-hour*	2.5
2-year, 24-hour	5.0
5-year, 24-hour	5.7
10-year, 72-hour	9.5
25-year, 72-hour	11.5
100-year, 72-hour	15.0

* Used the FDOT 4-hour rainfall distribution

2.6.2 Overland Flow Parameters

SWMM uses overland flow data in the form of hydrologic unit widths and average surface slopes to create a physically based overland flow runoff plane that generates stormwater runoff. The overland flow path length was calculated as the average area-weighted travel length to the hydraulic load point. Overland flow slope is the average slope over the flow path length and is calculated by dividing the difference in elevation by the hydraulic length. Length and slope data were estimated using LiDAR. The overland flow path width is required as input to SWMM. To obtain a representative, area-weighted hydrologic unit width, the hydrologic unit area was divided by the area-weighted flow path length. Generally, two or three overland flow paths were used to determine representative parameters for each basin. **Table A-1** in **Appendix A** shows the values used in the calculation of the area-weighted overland flow parameters.

2.6.3 Land Use Parameters

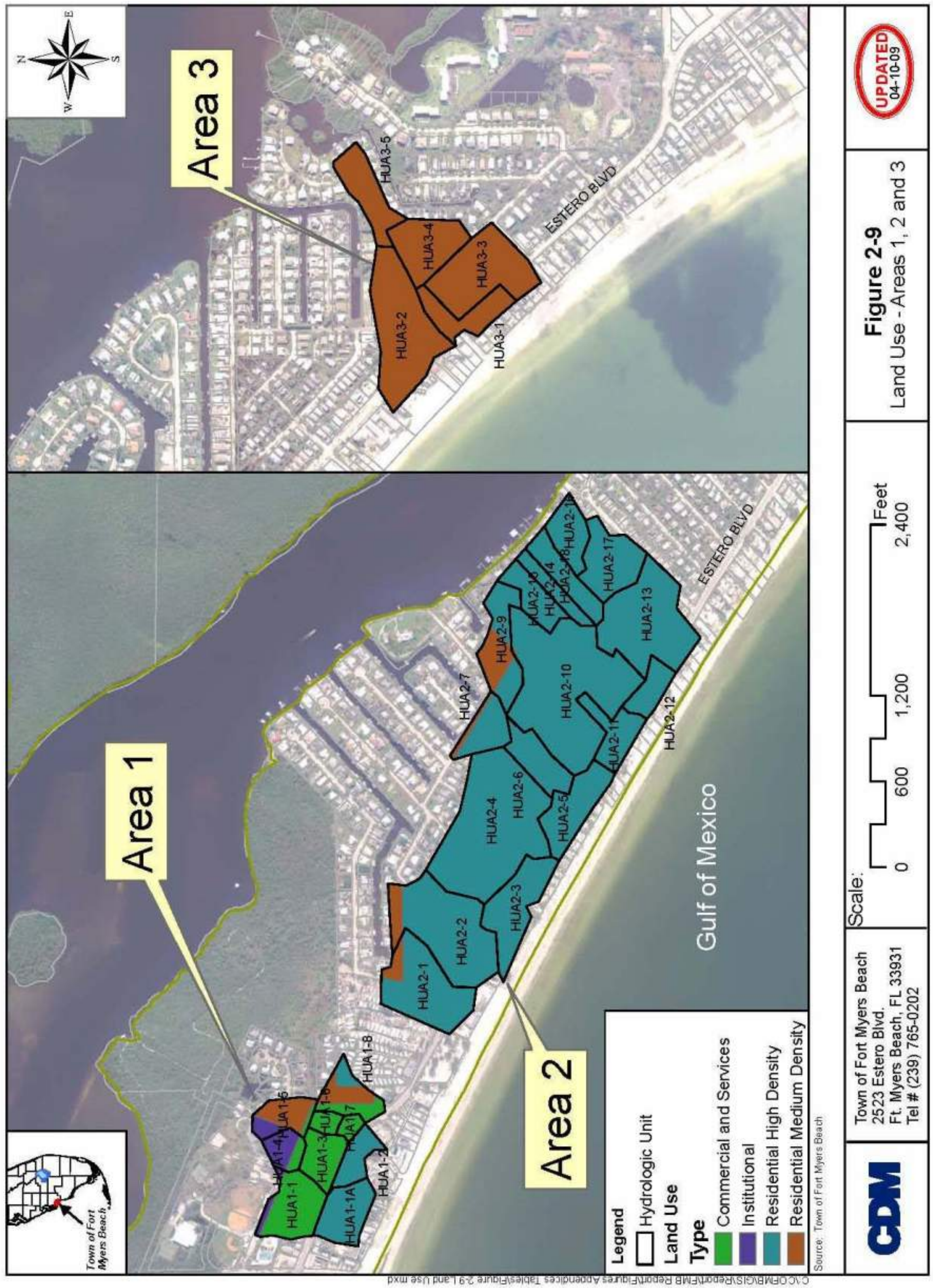
Land use data was used to estimate the imperviousness, surface friction factors, and initial abstractions for each hydrologic unit. Existing land use conditions were obtained using the SFWMD Land Use plans (2004), available aerial photographs and field investigations.

The percent imperviousness of each hydrologic unit is a significant parameter affecting the volume and rate of stormwater runoff. In SWMM, impervious surfaces generate runoff from rainfall without infiltration. As shown in **Figure 2-9** for the study area, four residential land use categories were defined: commercial and services (COM), institutional (INST), medium-density residential (RMD), and high-density residential (RHD).

The 2007 South Florida Water Management (SFWMD) Report titled Nutrient Load Assessment for the Estero Bay and Caloosahatchee River Watershed indicates typical ranges of percent imperviousness assigned to these land uses are RMD at 20-35 percent, RHD at 40-70 percent, COM at 80-90 percent, and INST at 30-50 percent. Using aerial imagery, the area of roofs, sidewalks, roads and other impervious surfaces were reviewed for six of the Fort Myers Beach hydrologic units. Additionally, the elementary school in problem area 1 designated as INST was checked. Based on these checks, the average impervious percentage for each land use type used in this report is:

- RMD: 35 percent
- RHD: 40 percent
- COM: 90 percent
- INST: 15 percent

The directly connected impervious area, or DCIA, represents all the impervious surfaces with a direct hydraulic connection to the stormwater system (such as paved roads or parking lots that drain to stormwater catchbasins). The non-directly connected impervious area, or NDCIA, represents impervious surfaces that are not hydraulically connected to the stormwater system (such as driveways or parking lots that shed water onto pervious areas where infiltration may occur). By weighting the proportion of land uses categories by area within each hydrologic unit, area-weighted DCIA values were calculated for all hydrologic units. For the 84 hydrologic units defined within the study area, the average DCIA value was 34 percent.


Area 1
Area 2
Area 3
Gulf of Mexico
ESTERO BLVD
HUA2-1
HUA2-2
HUA2-3
HUA2-4
HUA2-5
HUA2-6
HUA2-7
HUA2-9
HUA2-10
HUA2-12
HUA2-13
HUA2-17
HUA3-1
HUA3-2
HUA3-3
HUA3-4
HUA3-5
HUA1-1
HUA1-1A
HUA1-8
Town of Fort Myers Beach
Legend
Hydrologic Unit
Land Use
Type
Commercial and Services
Institutional
Residential High Density
Residential Medium Density
Source: Town of Fort Myers Beach
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Scale:
0
600
1,200
2,400
Feet
Figure 2-9
Land Use - Areas 1, 2 and 3
UPDATED
04-10-09

Manning's roughness factors and initial abstraction values for overland flows were set to typical values based on land use and soil types.

Table A-2 in **Appendix A** lists the land use parameters assigned to each hydrologic unit.

2.6.4 Soil Parameters

Each soil type has been assigned a soil series and a Hydrologic Soil Group designated by the Natural Resources Conservation Service (NRCS). Hydrologic Soil Group (HSG) A is comprised of soils having very high infiltration potential and low runoff potential. HSG D is characterized by soils with a very low infiltration potential and a high runoff potential. HSG B and C are designated between these two categories. Soil group percentages for each hydrologic unit are estimated by overlaying a map of the hydrologic unit boundaries of the NRCS soil map. From the overlay map, the percentage of each soil group within a hydrologic unit can be estimated manually or by using GIS software.

According to the Lee County soil survey (NRCS, 1984) and looking at **Figure 2-10** for the study area, five different soil types were encountered. The study area consists mainly of Type C soils with a small percentage of Type B/D and D. This indicates limited infiltration capacity unless subsurface conditions are improved for drainage. Since there was such a small quantity of type B/D soils they were modeled similar to Type C soils in the area. **Table A-3** in **Appendix A** summarizes the Soil Parameters for the study area.

The Horton infiltration equation option in RUNOFF was used to calculate the rate and volume of water that infiltrates into the soil. According to the Horton equation, infiltration is computed as:

$$f_t = f_{min} + (f_{max} - f_{min})\, e^{-kt}$$

f_t = the infiltration capacity of the soil (in/hr) at time t
f_{min} = the minimum (or final) infiltration capacity (in/ hr)
f_{max} = the maximum (or initial) infiltration capacity (in/hr)
k = an exponential decay constant (hr^{-1})
t = time (hr)

The decay constant, k, is an empirical parameter that controls the rate of decrease in infiltration capacity during a rainfall event. The infiltration rate is assumed to decrease exponentially from the maximum capacity down to the minimum capacity. That is, a lower decay constant gives a slower rate of decrease in infiltration capacity, and a higher decay constant forces the infiltration capacity to reach its minimum value more quickly. Area-weighted infiltration parameters were computed based on the percentage of each hydrologic soil group within a hydrologic unit. It should be noted that all infiltration parameters are weighted by the proportion of pervious and

Figure 2-10
Soil Classification
Areas 1, 2 and 3

NDCIA surfaces in each hydrologic unit. Although no infiltration occurs over NDCIA surfaces, the resulting runoff is directed to an infiltrating pervious surface area. The average depth to groundwater table should be estimated for each hydrologic unit based upon a long-term average from groundwater monitoring wells. Data from the August 2000 edition of SFWMD's Basis of Review for Environmental Resource Permit Applications was used to estimate the available soil storage capacity based on depth to the groundwater table.

2.6.5 Additional Initial Abstractions

Depression areas that are not represented as storage elements in the hydraulic model are converted to an initial abstraction. The abstraction is assigned to either impervious or pervious surfaces (or both), depending on the location. The volume of the abstraction is then converted to inches over the pervious/NDCIA or DCIA area of the subcatchment. This is then added to the default abstractions estimated by land uses, thus changing the depressional storage assigned to each HU. There were no significant initial abstractions that needed to be added to the model.

2.7 Hydraulic Parameters

The model schematics previously shown in Figures 2-5 through 2-8 of this section show the delineation of hydrologic units, the existing storm sewer system, and the names and locations of model nodes. SWMM uses a junction/conduit (node/link) representation of the stormwater system. The stormwater system is comprised of primarily small circular and elliptical pipes ranging in size from 12 to 24-inches, roadside swales and natural overland flow pathways.

2.7.1 Nodes

Nodes are located at:

- The ends of conduits;
- Locations where the stormwater pipes change diameter (not all changes in diameter result in model nodes, some are aggregated into equivalent systems);
- Points representing the HU low elevations (storage units).

Table A-4 in **Appendix A** provides the hydraulic model data by node (name, location, type (node/storage unit/outfall), and invert). The invert is the base elevation of the node and the initial stage is the elevation of water in the node under normal conditions.

Some nodes in SWMM are represented as storage units. Storage units include closed basins, natural depression areas and ponds that store and attenuate runoff within the system. In relatively flat areas where flood waters may overflow channel banks or swales and fill low-lying areas it is necessary to develop stage-storage relationships. An accounting of the volume of these areas is needed for both accurate flood elevation predictions as well as peak flow estimates.

Stage-area storage relationships were estimated for each HU from topography, LiDAR and photos using ArcGIS 3D-Analyst tools. The plan areas for stages at 0.5 foot intervals (of depth above node invert) were calculated from the surface as appropriate. Not all HUs have related storage nodes as some HUs have no storage beyond that which is represented in the model links.

2.7.2 Conduits (Links)

Conduits in the model are used to represent both pipes/culverts as well as hydraulic overland flows.

2.7.2.1 Culverts and Pipes

SWMM links can be classified as conveyance elements. Conveyance elements include closed conduits, pumps, open channels, swales and street surfaces that collect and route runoff through the system. **Table A-5 Appendix A** provides the hydraulic model data by conduit (conduit name, type, depth, width, length, Manning's roughness, upstream invert, and downstream invert).

The Town provided CDM with a GIS layer of storm inlets and pipes as discussed in Section 2. There were a number of pipe sections with missing diameters that had to be field verified. It is likely that these pipes will be partially to fully submerged during the storm events being analyzed. Many of the pipe inverts were estimated to be at elevation 1.0 ft-NAVD in the model based on field observations and LiDAR. There was also an effort made to provide positive slope of the inverts toward the outfalls.

Except where there was visible evidence of pipe/inlet blockage (such as Bay Road, conduit A1-3S) the pipes were evaluated in a clean condition; therefore, all reinforced concrete pipes were set to a Manning's roughness value of 0.014 unless the pipe was known to be a corrugated metal pipe (CMP), then the roughness was set to 0.024. The pipe lengths were determined using GIS data. Entrance losses were set to 0.25 unless there were special circumstances. Exit losses ranged from 0.25 for straight sections of pipe to 1.0 for outfalls to lakes, ponds, or Estero Bay.

In SWMM, culverts may be lengthened to ensure computational stability where necessary. The Manning's roughness coefficient (n) would then be altered for these lengthened culverts to account for the extra length. SWMM will automatically do this computation if certain controls are set, or SWMM will lower the time step accordingly to ensure stability in all conduit links. For the culverts that were artificially lengthened storage was removed from an adjacent node to compensate for the added volume. For smaller culverts, this step is not necessary because the added volume is minimal compared to the system, and SWMM makes this calculation internally.

2.7.2.2 Hydraulic Overland Flow

Somewhat different from hydrologic overland flow (where infiltration and soils affect the movement of surface runoff) is hydraulic overland flow. This link (rather than a surface flow line) is a natural cross-section which is a profile representative of the topographic ridge along the boundary between two subbasins. The length of these channels is relatively short, typically 50 feet, while the widths can vary (between 10 and 400 feet). The links act similar to a weir, which begins to flow only when the ponding on either side of the link reaches the height of the topographic ridge boundary. During high intensity events, surface ponding is prevalent and transfer will occur from one HU to another. It is desirable to keep these lengths relatively short (to approximate a weir), but some length is needed for computational stability.

2.8 Outfall Boundary Conditions

The stormwater system in the three problem areas is influenced by initial water levels throughout the system primarily from Estero Bay. Therefore, hydraulic boundary conditions are needed to simulate tidal tailwater effects of Estero Bay. Typically for master planning purposes, a 1-year tidal flood stage is used as a boundary condition in the tidal zone.

2.8.1 Analysis of FEMA Information

To obtain the 1-year tidal stage boundary condition, a regression analysis was completed from the stillwater elevations shown in the current Lee County FEMA FIS. The stillwater elevations were shown in the FIS at various transects along the shoreline of Lee County. **Figure B.1** in the appendix provides an excerpt from the FEMA FIS showing transect location map. Transects 21, 21.5, 22 and 23 provided stillwater elevation information for the Town of Fort Myers Beach both on the Gulf of Mexico side and the Estero Bay side of the barrier island.

A power curve regression and a log-linear regression were determined using the FEMA stillwater elevations for both the Gulf of Mexico side (10-, 50-, 100- and 500-year) and the Estero Bay side (10-, 100- and 500-year) of Fort Myers Beach. Based on the available data for each transect, a regression equation was derived (power and log-linear) to describe the curve and understand how the regression line fit the existing data points. The regression equation was then used to extrapolate events (e.g., 1-year stillwater) outside of the given data range. In reviewing the fit for each regression, the log-linear regression reported a slightly better fit to the existing data than the power curve regression. However, in extrapolating the 1-year stillwater elevation, it was noted that the log-linear regression reported an uncharacteristically low elevation. The power curve was used to determine extrapolated values. The power curve regression reported the extrapolated 1-year tidal stage for Estero Bay Transects 21-23 as approximately +1.0 feet NAVD88 (+2.18 feet NGVD29) on the Estero Bay side of Fort Myers Beach.

In reviewing the stillwater elevations described for both the Gulf of Mexico side and Estero Bay side portions of the transects, it was observed that the stillwater elevations published for the Gulf of Mexico side were substantially higher than the Estero Bay side. In telephone discussions with the consultant responsible for determining stillwater elevations in the Gulf of Mexico and Estero Bay for the August 28, 2008 Lee County FEMA FIS, it was revealed that the stillwater values were derived from a 1990s FEMA surge model that utilized a very course grid, providing less accuracy in the Estero Bay estimate.

Appendix B includes supporting information for this evaluation. **Table B.2** provides Coastal Flood Insurance Zone data given in the FEMA FIS for the Estero Bay side and Gulf of Mexico side of Fort Myers Beach. **Table B.3** shows the stillwater equations used to extrapolate data. Table B.3 shows the regression yielded good approximations (R^2 value of approximately 0.95).

2.8.2 Sensitivity Analysis

Due to the uncertainty of the Estero Bay Stillwater elevation based on the large difference observed from the Gulf of Mexico elevation, a sensitivity analysis was made using the model to compare the amount of flooding between using the 1.0-feet NAVD elevation and using 2.0-feet NAVD. The 2.0-feet NAVD elevation is based on an average of the Gulf of Mexico 1-year stillwater elevation (+2.9 feet NAVD88) and the Estero Bay 1-year stillwater elevation (+1.0 feet NAVD88), rounded to the nearest tenth of a foot.

As an additional check, historical stage data for Estero Bay and the Gulf of Mexico at Fort Myers Beach was analyzed. Partial time series analysis indicated the one-year tidal stillwater is approximately 1.0 ft-NAVD and the 5-year stillwater elevation is approximately 2.0 ft-NAVD.

The sensitivity analysis was performed on problem area 1 for the outfall at the end of Bay Street. Based on the simulations, changing the boundary condition for the stillwater elevation from 2.0 to elevation 1.0 ft-NAVD has negligible effects on existing condition peak stages for all design storms. Based on the analysis, to be conservative the model was set to use 2.0-feet as the stillwater elevation.

2.9 Model Validation

Model validation refers to reviewing model results and comparing them to expected, reasonable values or those measured in the field during an actual rainfall event. This exercise serves as a reality check on model results, and helps to establish model reliability. The model was developed using measured and standard literature values for the modeling parameters. During validation, parameter values were refined until the model output compared reasonably with in-situ data.

2.9.1 Flow and Rainfall Measurements

No stage or flow measurements are available in the study area. Therefore, calibration to measured stages was not possible.

2.9.2 Model Validation

The model has been validated to limited reasonable data. Therefore, it is still important to verify that the model represents the system for other observed storm conditions, if possible. Model assumptions that were made about flow conditions during the validation should be checked for validity during the larger design storm events. Validating the model for design storm applications is an important task when establishing model reliability.

Photographs taken on December 12, 2008 and presented earlier in this section (Section 2.3 Problem Areas) were used to validate the model at some locations in the study area.

Photograph 20: Bay Road just north of Estero Boulevard, December 12, 2008 rain event.

In Area 1 at Bay Road and Estero Boulevard flooding is shown in **Photo 20**. The existing storm inlet (SWMM node A1-3S) is submerged. Field observations conducted in October 2008 verified that this existing inlet was filled with sediment. This photograph and other observations made at inlets downstream during this rain event confirmed the blockage. The photograph was used to estimate depth of flooding applied to the model's stage-area relationship for this basin (SWMM basin HUA1-3). Photograph 21 was taken at the elliptical pipe outfall at the end of Bay Road. The depth of the flow and wetted perimeter of the pipe can be seen. This observation helped in validating the boundary condition for the 5-year stillwater elevation that was used in the model.

Photographs were taken at other locations of the study area to assist with model validation. Photographs 7 and 8 (previously described and shown on page 2-11) were used to estimate the flooding area and depth at the intersection of Madison Court and Estero Boulevard. In Photograph 10 previously described and shown on page 2-12) at the intersection of Andre Mar Drive and Estero Boulevard, although depth of flooding was not measured during the storm event, flood depth could be estimated and used to map extent and area of local flooding for this basin (SWMM basin HUA2-11). It should be noted that pictures depict flooding at a particular time, which is not necessarily the maximum flooding that occurred. Better topographic data for depressional areas would be needed to further refine the model. Photograph 15 (previously described and shown on page 2-13) shows flooding at the intersection of St. Peters Drive and Estero Boulevard. The flooding was observed on both sides of Estero Boulevard and was estimated to be approximately 3-inches in depth. Anchorage Street was included in the same basin (SWMM basin HUA2-12) with St. Peters Drive.

Photograph 21: Elliptical Pipe Outfall at the end of Bay Road, 12/12/2008 rain event.

Photograph 18 (previously described and shown on page 2-14) shows flooding at the intersection of Sterling Avenue and Estero Boulevard. The overland flow was observed to convey westward towards Lazy Way. The photograph was used to estimate depth of flooding applied to the model's stage-area relationship for this basin (SWMM basin HUA3-1).

2.10 Flooding Model Results

Problem areas were analyzed to determine which peak flood stages exceeded an acceptable level of service (LOS) for existing conditions. As previously discussed in Section 1, the Town adopted an interim set of LOS goals until further defined as part of the stormwater master plan. Therefore, the first step to evaluating flooding was to establish realistic LOS goals as part of this project. Based on the goals set, peak flood stages at various locations in the three problem areas were tabulated and compared to estimated centerlines (road crown) and land elevations to determine the relative severity of flooding and LOS provided.

2.10.1Recommended Level of Service Goals

The primary purpose of the LOS criteria is to protect public safety and property. The LOS criteria are first used to identify and define potential problem areas using the stormwater model developed for this study. The LOS criteria are then used to evaluate the effectiveness of improvements. LOS decisions will directly affect the size and cost of proposed improvement alternatives

The Town of Fort Myers Beach is similar in characteristics to other urbanizing coastal communities regarding stormwater service. Many of the Town's older stormwater systems provide inadequate flood protection of streets and provide little or no treatment of the runoff prior to discharge. The LOS for the stormwater system establishes the performance standard, and LOS can vary for new development versus retrofit conditions where various physical and cost constraints can create a situation of diminishing returns.

As a starting point to define LOS goals for the Town, the recommended goals for retrofit of the Town's existing stormwater system were based on experience in the Town of Fort Myers Beach and similar programs such as Collier County (Gordon River) and the cities of Jacksonville, Atlantic Beach, Daytona Beach, Miami, and Ormond Beach. To test if these recommendations were reasonable goals for the Town to adopt, a model simulation of the best case alternative to alleviate flooding was made. The best case alternative was based on using the largest reasonable pipes in the three problems and is Alternative 3 described in Section 4.

Based on the simulation, the "best case" LOS for streets and intersections in the three problem areas was tabulated and reviewed with Town staff. The 5-year, 24-hour event (5.7-inches of rainfall) was identified as a critical event to evaluate stormwater system performance in both existing and future conditions. Based on the results and discussion with Town staff, a few modifications to the initial LOS goals were made and are provided in **Table 2-2.**

Table 2-2 Recommended Level of Service Goals for Town of Fort Myers Beach

Rain Event	1-Year (2.5-inches)#		2-Year (5-inches)*		5-Year (5.7-inches)*		10-Year (9.5-inches)*		25-Year (11.5-inches)*		100-Year (15-inches)*	
Structure/Facility	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**
Houses/Buildings	<FFE (1)	D	<FFE	D	<FFE	D	<FFE	D	<FFE	D	<FFE	D
Evacuation Route (2)	1/2 W (3)	B	1/2 W	B	1/2 W	B	1/2 W	C	1/2 W	D	1/2 W	D
Other Roads (4)	< 3 in.	B	< 3 in.	B	< 6 in.	C	< 9 in.	D	> 9 in.	NA	> 9 in.	NA
Critical Elevation (5)	< 3 in.	B	< 3 in.	B	< 6 in.	C	< 9 in.	D	> 9 in.	NA	> 9 in.	NA

Class A: Full conveyance of storm runoff and maintains full width of evacuation route clear of flooding.

Class B: Manages erosion and maintains half of width of evacuation route clear of flooding and other roads to less than 3 inches.

Class C: Provides control of flood waters to less than 6 inches over evacuation routes and other roads.

Class D: Provides flood protection of first-floor elevations (FFE) and control of flood waters to less than 9 inches over evacuation routes.

Class NA: There is no level of service class that applies to this flood depth.

(1) Peak flood stages less than the FFE based on available data.

(2) Emergency and Evacuation routes as defined by town. (E.g. Estero Boulevard)

(3) Flood inundation limited to each side of the road such that half of the roadway width (W) or one travel lane width is not flooded.

(4) Other roads which are not critical for evacuation, but that will be used to estimate encroachment of FFEs.

(5) Critical elevations such as parking lots, yards and other areas defined as critical by the town.

Refers to FDOT Florida Department of Transportation's 1-Year, 2.5-inch rainfall event.

* Refers to SFWMD South Florida Water Management District's rainfall events as provided in Table 2-1 on page 2-21.

Based on **Table 2-2**, the 1-year and 2-year LOS was defined as no road flooding greater than 3 inches for the 1-year and 2-year, 24-hour events. Similarly a 5-year LOS was defined as no road flooding greater than 3 inches for evacuation routes and no greater than 6 inches of flooding for other roads during a 5-year, 24-hour event. The LOS assigned to each node is based on the overall system response to specific design storms. For example, if there is no road flooding at a given node for the 5-year, 24-hour event, the 5-year LOS rating for that node would be Class A. If there is less than 3 inches of road flooding at a given node for the 5-year, 24-hour event, the 5-year LOS rating for that node is assigned Class B.

A point of diminishing returns is sometimes reached with respect to the benefits derived for the capital costs spent. By balancing public safety with available funding, LOS requirements can be set based on realistic and balanced goals. For example, a 5-year LOS may be a realistic benchmark for a retrofit system that has very flat topography and lacks a well-connected stormwater collection infrastructure. Providing a 100-year LOS to serve evacuation routes, fire and police safety routes, and hospitals might be an ideal goal but in most cases cannot be attained unless multi-million dollar projects are implemented.

2.10.2 Evaluation of Flooding in the Existing System

Based on the recommended LOS goals provided in Table 2-2, Table 2-3 shows the peak stages and LOS provided by the existing system at select locations throughout the study area. The first results column in the table presents the peak stage in ft-NAVD for each of the storm events. The second column shows the flood depth measured in inches above the road crown or reference elevation. The third column indicates the road LOS goal for that specific type of road. The fourth column reports whether the location met the LOS goal. This was determined by comparing the predicted flooding depths with the LOS criteria. For example, the existing system LOS for SWMM node A2-3S (Estero and Madison) is shown on the fifth row of Table 2-3. For the 2-year storm the flood depth of 8.6 inches is assigned a Class D and does not meet the LOS goal of Class C (less than 6-inches) set in Table 2-2. For the 2.5-inch storm less than half of the selected locations presented in Table 2-3 were able to meet the LOS goals set in Table 2-2.

Peak stage results for all locations can be found in **Table A-7** of Appendix A.

Table 2-3 Peak Stage, Flood Depth and LOS for Existing Conditions at Select Locations

				2.5-Inch Storm				2-Year Storm				5-Year Storm			
Node	Location	Type	Road[1] Crown or Ref Elev. (ft-NAVD)	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.5	0.4	B	Y	5.6	0.8	B	Y	5.6	1.0	B	Y
A1-3S	Bay Rd	Other Road	4.5	5.1	7.6	D	N	5.2	8.9	D	N	5.3	9.1	NA	N
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.5	3.5	C	N	5.6	4.4	C	N	5.6	4.7	C	Y
A1-7S	Wachovia	Critical Elev	4.8	5.2	4.8	C	N	5.3	6.1	D	N	5.3	6.4	D	N
A1-8S	Lovers Lane	Other Road	4.2	4.3	2.0	B	Y	4.4	3.4	C	N	4.5	3.6	C	N
A2-2S	Voorhis St	Other Road	3.4	3.8	4.9	C	N	4.2	9.8	NA	N	4.3	10.3	NA	N
A2-3S	Estero & Madison	Evacuation	3.5	4.1	7.7	D	N	4.2	8.6	D	N	4.3	9.1	NA	N
A2-4S	Jefferson St	Other Road	3.4	3.6	2.3	B	Y	3.9	5.4	C	N	4.0	7.6	D	N
A2-5S	Estero & Mid Island	Evacuation	3.5	3.8	3.5	C	N	3.9	5.0	C	N	4.0	6.1	D	N
A2-10N	Anchorage St	Other Road	3.2	3.3	0.8	B	Y	3.9	8.3	D	N	4.0	10.0	NA	N
A2-10S	Andre Mar Dr	Other Road	3.7	3.8	1.1	B	Y	4.1	4.2	C	N	4.1	5.0	C	Y
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.0	5.5	C	N	4.0	6.5	D	N	4.1	7.4	D	N
A2-12S	Estero & St Peters	Evacuation	3.5	4.0	5.6	C	N	4.1	6.6	D	N	4.1	7.3	D	N
A3-1S	Estero & Sterling	Evacuation	4.0	4.4	4.3	C	N	4.5	5.6	C	N	4.5	5.9	C	Y
A3-2S	Lazy Way	Other Road	3.2	2.8	-	A	Y	3.3	1.3	B	Y	3.5	3.5	C	Y
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.8	4.0	C	N	4.2	8.8	D	N	4.2	8.9	D	N
A3-5N	Sterling & Falkirk	Other Road	4.0	3.5	-	A	Y	3.6	-	A	Y	3.6	-	A	Y

				10-Year Storm				25-Year Storm				100-Year Storm			
Node	Location	Type	Road[1] Crown or Ref Elev. (ft-NAVD)	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	Peak Stage (ft-NAVD)	Flood Depth (in)	Class	Meets LOS?
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.6	1.3	B	Y	5.6	1.6	B	Y	5.7	1.8	B	Y
A1-3S	Bay Rd	Other Road	4.5	5.3	9.6	NA	N	5.3	10.0	NA	NA	5.4	10.6	NA	NA
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.7	4.9	C	Y	5.7	5.2	C	Y	5.7	5.5	C	Y
A1-7S	Wachovia	Critical Elev	4.8	5.3	6.6	D	N	5.3	7.0	D	Y	5.4	7.4	D	Y
A1-8S	Lovers Lane	Other Road	4.2	4.5	4.3	C	Y	4.6	4.8	C	Y	4.6	5.4	C	Y
A2-2S	Voorhis St	Other Road	3.4	4.4	12.0	NA	N	4.5	13.0	NA	N	4.6	14.4	NA	N
A2-3S	Estero & Madison	Evacuation	3.5	4.4	10.8	NA	N	4.5	11.8	NA	N	4.6	13.2	NA	N
A2-4S	Jefferson St	Other Road	3.4	4.4	12.0	NA	N	4.5	13.0	NA	N	4.6	14.4	NA	N
A2-5S	Estero & Mid Island	Evacuation	3.5	4.4	10.8	NA	N	4.5	11.8	NA	N	4.6	13.2	NA	N
A2-10N	Anchorage St	Other Road	3.2	4.4	13.8	NA	N	4.4	14.8	NA	NA	4.6	16.2	NA	NA
A2-10S	Andre Mar Dr	Other Road	3.7	4.4	8.4	D	Y	4.5	9.6	NA	NA	4.6	11.0	NA	NA
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.4	10.8	NA	N	4.5	12.0	NA	NA	4.6	13.4	NA	NA
A2-12S	Estero & St Peters	Evacuation	3.5	4.4	10.8	NA	N	4.5	11.9	NA	NA	4.6	13.4	NA	NA
A3-1S	Estero & Sterling	Evacuation	4.0	4.6	6.8	D	Y	4.6	7.1	D	Y	4.6	7.4	D	Y
A3-2S	Lazy Way	Other Road	3.2	4.0	10.1	NA	N	4.2	11.8	NA	NA	4.3	13.7	NA	NA
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.4	10.7	NA	N	4.4	10.9	NA	NA	4.5	11.4	NA	NA
A3-5N	Sterling & Falkirk	Other Road	4.0	3.8	-	A	Y	3.9	-	A	Y	3.9	-	A	Y

1) Road crown, reference and critical elevations were estimated from LiDAR.

Table 2-3 Peak Stage, Flood Depth and LOS for Existing Conditions at Select Locations

Node	Location	Type	Road[1] Crown or Ref Elev. (ft-NAVD)	2.5-Inch Storm Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	2-Year Storm Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	5-Year Storm Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.5	0.4	B	Y	5.6	0.8	B	Y	5.6	1.0	B	Y
A1-3S	Bay Rd	Other Road	4.5	5.1	7.6	D	N	5.2	8.9	D	N	5.3	9.1	NA	N
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.5	3.5	C	N	5.6	4.4	C	N	5.6	4.7	C	Y
A1-7S	Wachovia	Critical Elev	4.8	5.2	4.8	C	N	5.3	6.1	D	N	5.3	6.4	D	N
A1-8S	Lovers Lane	Other Road	4.2	4.3	2.0	B	Y	4.4	3.4	C	N	4.5	3.6	C	N
A2-2S	Voorhis St	Other Road	3.4	3.8	4.9	C	N	4.2	9.8	NA	N	4.3	10.3	NA	N
A2-3S	Estero & Madison	Evacuation	3.5	4.1	7.7	D	N	4.2	8.6	D	N	4.3	9.1	NA	N
A2-4S	Jefferson St	Other Road	3.4	3.6	2.3	B	Y	3.9	5.4	C	N	4.0	7.6	D	N
A2-5S	Estero & Mid Island	Evacuation	3.5	3.8	3.5	C	N	3.9	5.0	C	N	4.0	6.1	D	N
A2-10N	Anchorage St	Other Road	3.2	3.3	0.8	B	Y	3.9	8.3	D	N	4.0	10.0	NA	N
A2-10S	Andre Mar Dr	Other Road	3.7	3.8	1.1	B	Y	4.1	4.2	C	N	4.1	5.0	C	Y
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.0	5.5	C	N	4.0	6.5	D	N	4.1	7.4	D	N
A2-12S	Estero & St Peters	Evacuation	3.5	4.0	5.6	C	N	4.1	6.6	D	N	4.1	7.3	D	N
A3-1S	Estero & Sterling	Evacuation	4.0	4.4	4.3	C	N	4.5	5.6	C	N	4.5	5.9	C	Y
A3-2S	Lazy Way	Other Road	3.2	2.8	-	A	Y	3.3	1.3	B	Y	3.5	3.5	C	Y
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.8	4.0	C	N	4.2	8.8	D	N	4.2	8.9	D	N
A3-5N	Sterling & Falkirk	Other Road	4.0	3.5	-	A	Y	3.6	-	A	Y	3.6	-	A	Y

Node	Location	Type	Road[1] Crown or Ref Elev. (ft-NAVD)	10-Year Storm Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	25-Year Storm Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	100-Year Storm Peak Stage (ft-NAVD)	Flood Depth (in)	Class	Meets LOS?
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.6	1.3	B	Y	5.6	1.6	B	Y	5.7	1.8	B	Y
A1-3S	Bay Rd	Other Road	4.5	5.3	9.6	NA	N	5.3	10.0	NA	NA	5.4	10.6	NA	NA
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.7	4.9	C	Y	5.7	5.2	C	Y	5.7	5.5	C	Y
A1-7S	Wachovia	Critical Elev	4.8	5.3	6.6	D	N	5.3	7.0	D	Y	5.4	7.4	D	Y
A1-8S	Lovers Lane	Other Road	4.2	4.5	4.3	C	Y	4.6	4.8	C	Y	4.6	5.4	C	Y
A2-2S	Voorhis St	Other Road	3.4	4.4	12.0	NA	N	4.5	13.0	NA	N	4.6	14.4	NA	N
A2-3S	Estero & Madison	Evacuation	3.5	4.4	10.8	NA	N	4.5	11.8	NA	N	4.6	13.2	NA	N
A2-4S	Jefferson St	Other Road	3.4	4.4	12.0	NA	N	4.5	13.0	NA	N	4.6	14.4	NA	N
A2-5S	Estero & Mid Island	Evacuation	3.5	4.4	10.8	NA	N	4.5	11.8	NA	N	4.6	13.2	NA	N
A2-10N	Anchorage St	Other Road	3.2	4.4	13.8	NA	N	4.4	14.8	NA	NA	4.6	16.2	NA	NA
A2-10S	Andre Mar Dr	Other Road	3.7	4.4	8.4	D	Y	4.5	9.6	NA	NA	4.6	11.0	NA	NA
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.4	10.8	NA	N	4.5	12.0	NA	NA	4.6	13.4	NA	NA
A2-12S	Estero & St Peters	Evacuation	3.5	4.4	10.8	NA	N	4.5	11.9	NA	NA	4.6	13.4	NA	NA
A3-1S	Estero & Sterling	Evacuation	4.0	4.6	6.8	D	Y	4.6	7.1	D	Y	4.6	7.4	D	Y
A3-2S	Lazy Way	Other Road	3.2	4.0	10.1	NA	N	4.2	11.8	NA	NA	4.3	13.7	NA	NA
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.4	10.7	NA	N	4.4	10.9	NA	NA	4.5	11.4	NA	NA
A3-5N	Sterling & Falkirk	Other Road	4.0	3.8	-	A	Y	3.9	-	A	Y	3.9	-	A	Y

1) Road crown, reference and critical elevations were estimated from LiDAR.

Section 3
Water Quality Evaluations

3.1 Watershed Management Model (WMM)

This section provides a description of the Watershed Management Model (WMM), and its application to the three problem areas identified for the Town of Fort Myers Beach SWMP. CDM applied the WMM to the study area for existing land use (year 2004) and future land use (year 2025) conditions. These simulations included stormwater runoff and baseflow. The stormwater flows and loads consider existing and future BMPs.

WMM was used in this project to estimate the annual and seasonal pollution loads from non-point sources (NPS) and point sources (PS) and compare them in relative magnitude among the hydrologic units (HUs) defined by the water quantity model in Section 3 for the three problem areas. WMM is public domain model that has been proven to readily provide a "big picture" evaluation of the relative levels of pollutant load increases (impacts) and effectiveness of potential changes in land use and BMPs.

NPS pollutant load, as opposed to PS, is ubiquitous throughout the basin. Typical NPSs include stormwater runoff from different land uses, baseflow, atmospheric deposition, and septic tanks. WMM considers all of these sources except for atmospheric deposition, which is accounted for in the land use-based loading. Direct pollutant load discharges from man-made wastewater treatment plants and industrial sources are typical PSs included in WMM.

Input parameters and processed data required to use the WMM include: average annual and monthly precipitation, baseflow, pervious and impervious runoff coefficients overall and per hydrologic unit, land use and associated imperviousness, Event Mean Concentrations (EMCs) for each pollutant type and land use, average baseflow concentrations, areas served by septic systems and septic system failure rates, wastewater treatment plant (WWTP) flows and pollutant concentrations, and other stream flows and concentrations. WMM processes all these input data through a simple database platform to estimate annual and/or wet-dry seasonal pollutant loads within a watershed.

A watershed comprised by several subbasins or HUs constitutes a project area in WMM. WMM evaluates and estimates pollutant loads for each HU for which the user has specified land use, septic tank, and BMP coverages, and point sources flows and concentrations. WMM allows the user to create scenarios for variants of these input data that could describe potential land use conditions and/or BMP implementations to evaluate alternatives of onsite and regional pollutant loading reduction strategies. Strategies that may be identified using the WMM include: nonstructural controls (e.g., land use controls and buffer zones); and structural controls (e.g., onsite and regional wet detention ponds, grassed swales, dry detention basins, and retention-infiltration basins and buffers).

WMM produces estimates of annual and seasonal flow volumes, pollution loads, and concentrations for nutrients (total phosphorus (TP), dissolved phosphorus (DP), total nitrogen (TN), ammonia plus organic nitrogen via total Kjeldahl nitrogen (TKN) method), heavy metals (lead (Pb), copper (Cu), zinc (Zn), cadmium (Cd)), and oxygen demand and sediment (biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and total dissolved solids (TDS)).

WMM does not directly account for physical, chemical, and/or biological growth or decay processes characteristic of in-stream flow. For simplicity, WMM applies a delivery ratio from 0 to 1 to account for reduction in runoff pollution load due to uptake, transformation, and/or removal in the stream courses. This parameter is typically used for calibration of estimated loads using available stream flow and concentration data.

In summary, WMM constitutes a tool for planning-level evaluations of the long-term (annual or seasonal) watershed pollution loads and the relative benefits of pollution managements strategies to reduce these loads. This relative loading model provides practitioners with information to make decisions for implementation of BMP projects and management criteria based on the relative contribution of pollution loadings from various areas within a watershed (e.g., agriculture versus urban land use).

3.1.1 Rainfall/Runoff Relationships

WMM calculates annual runoff volumes for the pervious/impervious areas in each land use category by multiplying the average annual rainfall volume by a runoff coefficient.

The total average annual surface runoff from land use L is calculated by weighting the impervious and pervious area runoff factors for each land use category as follows:

$$R_L = C \times P$$

In which, C (runoff coefficient) can be expressed in terms of composite value of pervious and impervious runoff coefficients as in:

$$R_L = \left[C_P(1 - IMP_L) + C_I \times IMP_L\right] \times P$$

Or as:

$$R_L = \left[C_P + (C_I - C_P)IMP_L\right] \times P$$

Where:

R_L = total average annual surface runoff from land use L (in/yr/unit area);

IMP_L = fractional imperviousness of land use L;
P = long-term average annual and seasonal precipitation (in/yr);
C_P = pervious area runoff coefficient; and
C_I = impervious area runoff coefficient.

Total runoff in a basin is the area-weighted sum of R_L for all land uses.

3.1.2 Non-point Pollution Loading Factors

WMM estimates pollutant loadings based upon non-point pollution loading factors (expressed as pounds per acre per year) that vary by land use and the percent imperviousness associated with each land use. The pollution loading factor M_L is computed for each land use L by the following equation:

$$M_L = EMC_L * R_L * K$$

Where:

M_L = Loading factor for land use L (lbs/ac/yr);

EMC_L = Event mean concentration of runoff from land use L (mg/L).

EMC_L varies by land use and by water quality constituent. Land use EMCs are derived from monitoring data of flow-weighted average concentrations for a storm event from single land use catchments. EMCs are defined as the sum of individual measurements of stormwater constituent loads divided by the storm runoff volume.

R_L = Total average annual surface runoff from land use L (computed from annual precipitation, land-use imperviousness, and runoff coefficients (in/yr); and

K = 0.2266 (this is a conversion constant)

By multiplying the pollutant loading factor for each land use by the acreage in each land use and then summing for all land uses, the total annual pollution load from a water quality basin can be computed. Land use specific event mean concentrations were applied to the existing and future land use scenarios within the study area.

3.1.3 Watershed Characteristics

3.1.3.1 Tributary Area

Three problem areas identified for this project are described in Section 2 for the water quantity evaluations. To facilitate using the incorporating the water quality and quantity results and alternatives together, WMM uses the same areas and hydrologic units (HU) defined for SWMM as previously described and shown in **Figures 2-5 to 2-8**. The HUs are comprised by mostly urban areas where no streams, canals, or any type of waterbody is present.

3.1.3.2 Land Use

Land use is used to develop pollutant loading rates for the WMM analysis. The land use types and their associated loading rates are based on the Estero Bay-Caloosahatchee River Nutrient Loading Assessment Study in order to be consistent with the 2007 SFWMD study. The WMM analysis was completed for both current and future land use scenarios. As previously shown in Figure 2-9 and described in Section 2.6, the SFWMD existing land use data was obtained. This was compared to the 2025 future land use from the SFWMD and information from Fort Myers Beach as shown in **Table 3-1**.

The SFWMD 2025 future land use indicates a land use transition for some parcels from residential high density (RHD) to residential medium density (RMD). Based on information from the Town staff, this transition from high to low density is not likely to occur by 2025. Therefore, for this study the future land use does not include this transition, but does include other future land use changes such as residential areas becoming commercial and institutional as shown in **Figure 3-1** and the last column of Table 3-1.

Table 3-1. Existing and Future Land Use Conditions for Problem Areas 1, 2, and 3

Land Use Category	Existing Land Use (per SFWMD)	Future Land Use: 2025 (per SFWMD)	Future Land Use: This Study (per Town)
	(%)	(%)	(%)
Residential Medium Density (RMD)	22%	50%	20%
Residential High Density (RHD)	70%	28%	59%
Commercial and Services (COM)	7%	15%	15%
Institutional (INST)	2%	7%	7%
Total (109.5 ac)	100%	100%	100%

* Percent difference is estimated with respect the existing land use acreage of each category.

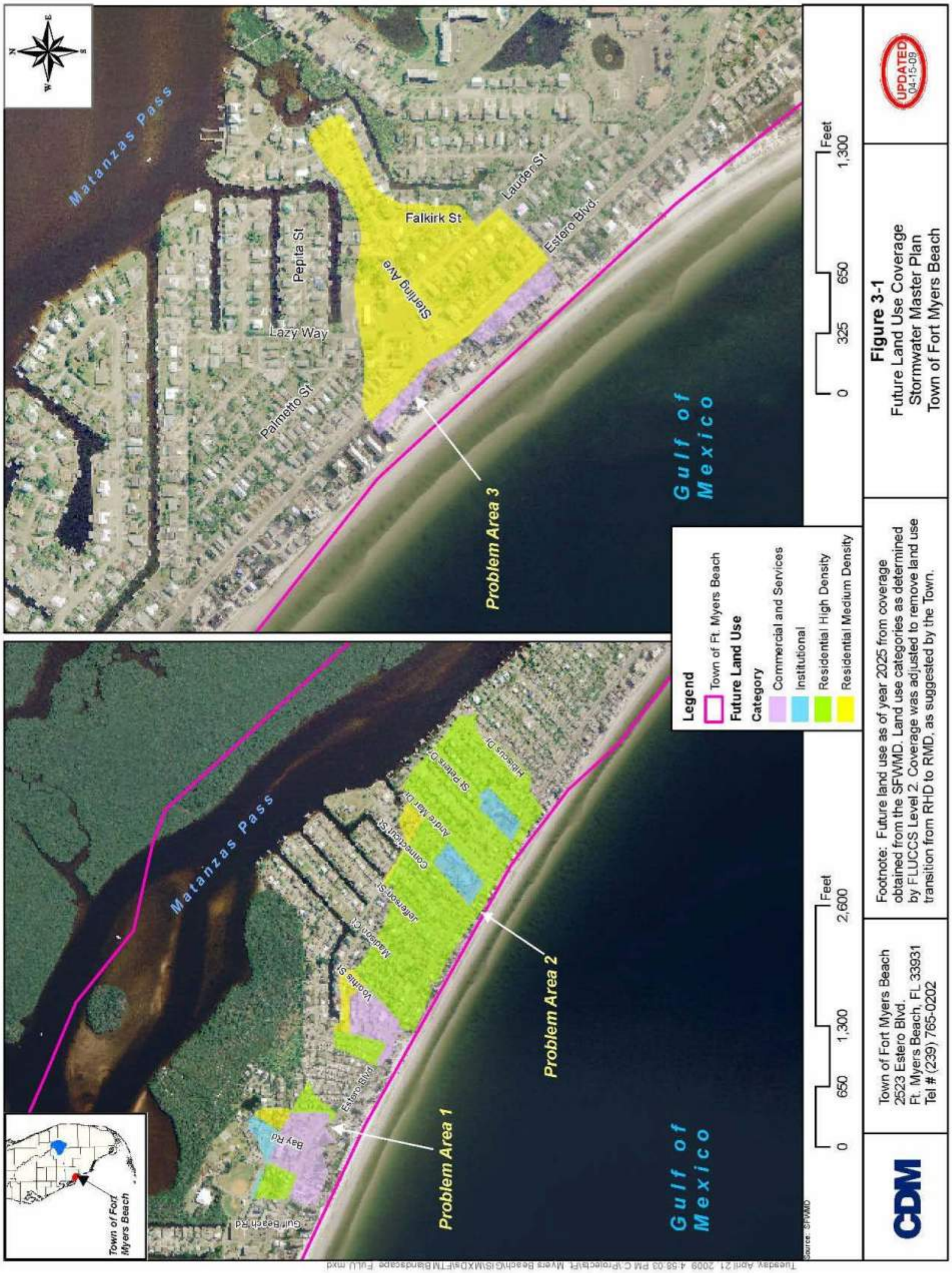


Figure 3-1
Future Land Use Coverage
Stormwater Master Plan
Town of Fort Myers Beach

3.1.3.3 Topography and Soils

In Figure 2-1, the LiDAR data collected for the project was represented in a 1-meter digital elevation model (DEM). This DEM, generally, shows high elevations around Estero Boulevard except in problem area 2 which seems to be part of a low-lying area extending over Mid Island Drive, Jefferson Street, Washington Avenue, and Voorhis Street enclosed in the north by Shell Mound Boulevard. The maximum difference in elevation between high and low areas at this particular location is of approximately 2 feet. Another low-lying area is enclosed by Estero Boulevard and the waterbody part of the Estero Bay called Matanzas Pass, extending from Connecticut Street to Bay Mar Drive.

The NRCS soil distribution according to the hydrologic soil group classification is presented in Figure 2-10 and summarized in Table A-3 in Appendix A.

3.1.3.4 BMP Coverage and Efficiency

Best management practices (BMPs) are nonstructural and structural measures oriented to reduce pollutant loading from stormwater runoff. Nonstructural BMPs include reduction of DCIA, fertilizer management in agricultural lands and in residential areas, planning and regulatory tools, conservation and water recycling, and education and outreach programs. Typical structural BMPs include grassed swales, wet/dry retention or detention ponds, exfiltration trenches, green rooftops, porous pavement, wetlands, and onsite separation devices (e.g., baffle boxes, oil-water separators).

WMM modifies the land use loading rates for BMP-treated areas according to water quality parameter removal efficiencies characteristic of each BMP type. Therefore, by defining the BMP coverage for the problem areas WMM accounts for the benefit provided by these loading reduction systems. There is not an actual BMP database available but information on existing stormwater loading reduction systems may be gathered from Environmental Resource Permits (ERPs) and Management and Storage of Surface Water (MSSW) Permits required by the SFWMD since early 1980s. These GIS databases were downloaded and copies of permits of interest to this project were obtained online. The Town provided information on the location of swales, which was complemented with site inspection of the three problem areas.

Three MSSW permits overlap the three problem areas:

- Permit No. 36-00888-S: This project area is located within the Bay Oaks Park next to the Fort Myers Beach Elementary School for which the Town has already located the existing swales in the area. The project currently serves to the Bay Oak Park, the Fort Myers Beach Elementary School, and the Fort Myers Beach Pool.

- Permit No. 36-01745-S: This project is located along Gulfview Avenue and is meant to improve beach access from this site. Its overlapping area with problem area 2 was considered to have swales for this water quality evaluation.

- Permit No. 36-02656-S: This project provided beach access improvements from Bayview Avenue and Gulf Drive, which entailed a stormwater system of 0.026 ac-ft of dry retention. Its overlapping area with problem area 3 was considered to be treated by a dry retention system.

The information on swales provided by the Town, which was complemented by field inspection, was processed to determine a tributary area for each swale to be implemented in the WMM. The tributary area was delineated by including half of the parcel adjacent to the swale and the road adjacent to the swale.

In the EBCRNLAP, the BMP coverage was developed applying a historical land use method to identify areas that have been constructed after the implementation of the statewide MSSW stormwater rule in December, 1983. In order to be consistent with EBCRNLAP, a historical land use approach was also implemented for this project. A historical land use coverage from the year 1988, the closest available to the stormwater rule implementation year, was obtained from the SFWMD. Land use categories of urban development from the existing land use coverage were compared against the historical coverage to identify recently developed areas. The result of this comparison was null, i.e., since 1988 no new developments or significant changes in land use have occurred in the three problem areas.

Therefore, the only existing BMPs identified within the study area are the MSSW project permit locations described above and the swales GIS layer provided by the Town. **Figure 3-2** shows the existing BMP coverage used in this project. This existing BMP coverage was implemented in WMM applying the removal efficiencies listed in **Table 3-2**.

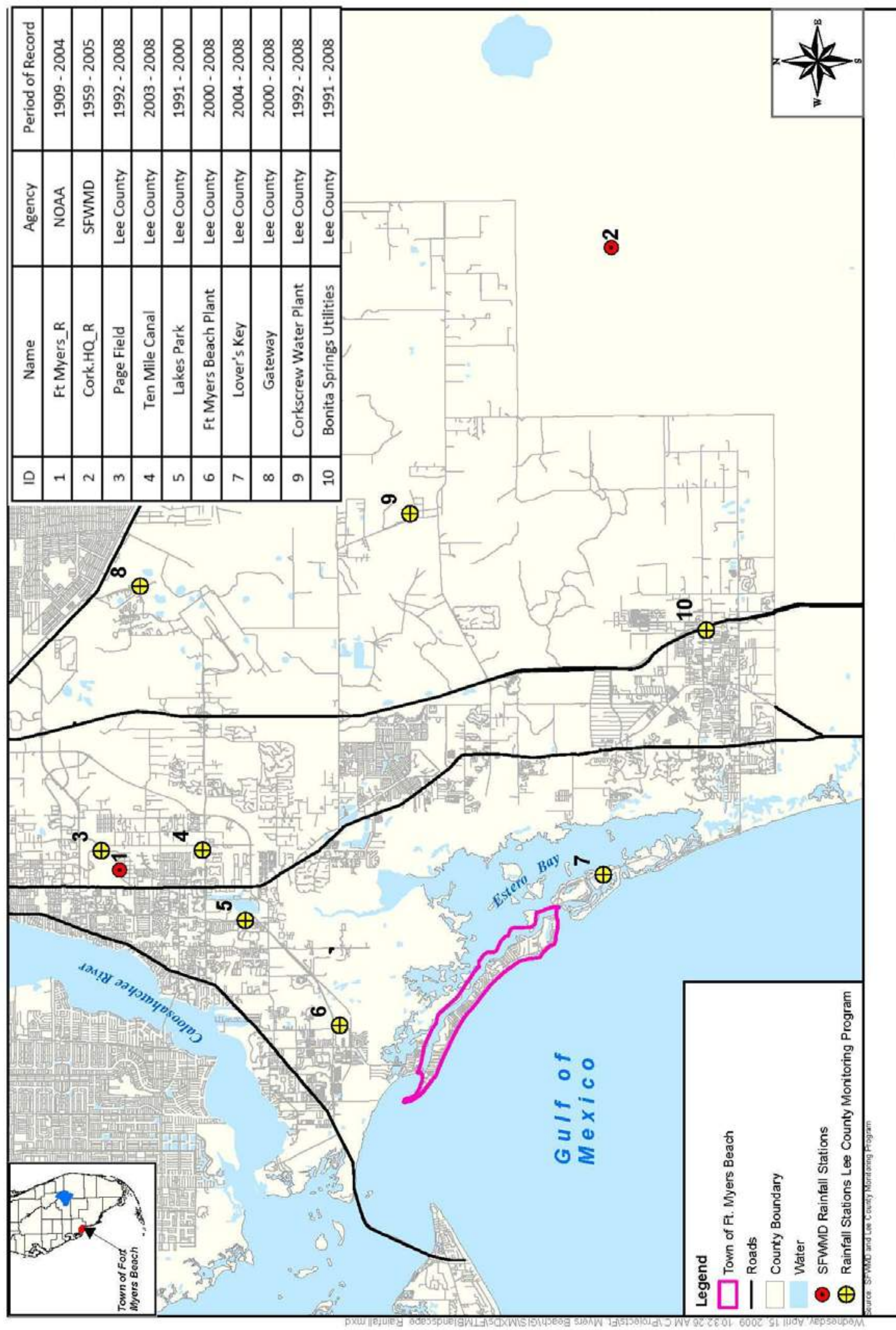
3.1.4 WMM Input Parameters

Physical characteristics of the watershed such as rainfall, pervious runoff coefficients, selected land use loading rates for the study area, baseflow, and other WMM parameters are described in this section.

3.1.4.1 Rainfall

Average monthly values of precipitation are used to estimate the average annual and seasonal precipitation in the study area to be implemented in WMM. For this purpose, two major sources of data were consulted: the SFWMD hydrological database (DBHYDRO) and the Lee County Monitoring Program. **Figure 3-3** shows the location of the rainfall stations located in the vicinity of the Town.


Matanzas Pass
Gulf of Mexico
Problem Area 1
Problem Area 2
Problem Area 3
Estero Blvd.
Bay Rd
Gulf Beach Rd
Voorhis St
Madison Ct
Jefferson St
Connecticut St
Andre Mar Dr
St Peters Dr
Hibiscus Dr
Lazy Way
Pepita St
Palmetto St
Falkirk St
Sterling Ave
Lauder St
Town of Fort Myers Beach
Legend
Town of Ft. Myers Beach
HUCs
Existing BMPs
BMP Type
Dry Detention
Swale
0 650 1,300 2,600 Feet
0 325 650 1,300 Feet
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Footnote: Existing BMP coverage was developed based on information provided by the Town and SFWMD stormwater permit database.
Figure 3-2
Existing BMP Coverage
Stormwater Master Plan
Town of Fort Myers Beach
UPDATED 04-20-09
CDM



ID	Name	Agency	Period of Record
1	Ft Myers_R	NOAA	1909 - 2004
2	Cork.HQ_R	SFWMD	1959 - 2005
3	Page Field	Lee County	1992 - 2008
4	Ten Mile Canal	Lee County	2003 - 2008
5	Lakes Park	Lee County	1991 - 2000
6	Ft Myers Beach Plant	Lee County	2000 - 2008
7	Lover's Key	Lee County	2004 - 2008
8	Gateway	Lee County	2000 - 2008
9	Corkscrew Water Plant	Lee County	1992 - 2008
10	Bonita Springs Utilities	Lee County	1991 - 2008

Figure 3-3
Rainfall Stations
Stormwater Master Plan
Town of Fort Myers Beach

Table 3-2. BMP Removal Efficiencies for each Water Quality Parameter.

Parameter	Grassed Swales [(1)]	Extended Dry Detention [(1)]	Retention	Exfiltration Trenches
BOD	30	30	90	70
COD	30	30	90	30
TSS	80	90	90	90
TDS	10	0	90	50
TP	40	30	90	50
DP	10	0	90	50
TKN	40	20	90	50
NO2/NO3	40	0	90	50
Pb	75	80	90	90
Cu	50	60	90	90
Zn	50	50	90	90
Cd	65	80	90	90

[(1)] Watershed Management Model Version 3.0 User's Manual, CDM, 1998.

The rainfall stations located at the Fort Myers Beach Plant and Lover's Key are the closest to the study area; however, their period of record is only of 8 and 4 years, respectively. Lakes Park station, the next closest to the study area, provides 19 years of record. Annual rainfall in Florida during the decade of 1990s has been documented to be higher than the average due to the effect of the El Niño phenomenon. Among the rainfall stations that included broader periods of record, is Ft Myers_R and Cork.HQ_R. The former was used by the EBCRNLAP as the rainfall gauge to determine the average annual precipitation in the Estero Bay and Tidal Caloosahatchee portion of the model.

Based on the collected information, the Ft Myers_R gauge located at the Page Field Airport and managed by the National Oceanic and Atmospheric Administration (NOAA) provides the longest (95 years) and most reliable period of record in the area. Therefore, the average annual and seasonal rainfall for this project was determined based on the Ft Myers_R gauge (DBKEY: 06193). **Figure 3-4** shows the monthly and annual variability of rainfall presented in a box-and-whisker plot for the Ft Myers_R station. The average dry and wet seasonal rainfall, 11.4 and 42.4 inches, respectively were estimated for the project based on Figure 3-4.

3.1.4.2 Impervious Coverage Percentage

The amount of runoff expected from each land use is directly related to its estimated impervious area. The relation between the impervious component of any land use area and runoff is defined by the impervious runoff coefficient (C_I), which is typically constant for all land use categories. However, the impervious coverage varies for each land use. At the same time, not all the impervious area of each land use ends up as runoff, part of it drains to pervious land, where it may evaporate or infiltrate into the ground and never reach a surface waterbody. The portion that runs off as surface water until intersecting a stormwater network or waterbody is known as DCIA. The DCIA is less than the impervious coverage.

The values used in this project for impervious coverage percentage (as described in section 2.6.3) and their resulting DCIA are presented in **Table 3-3**.

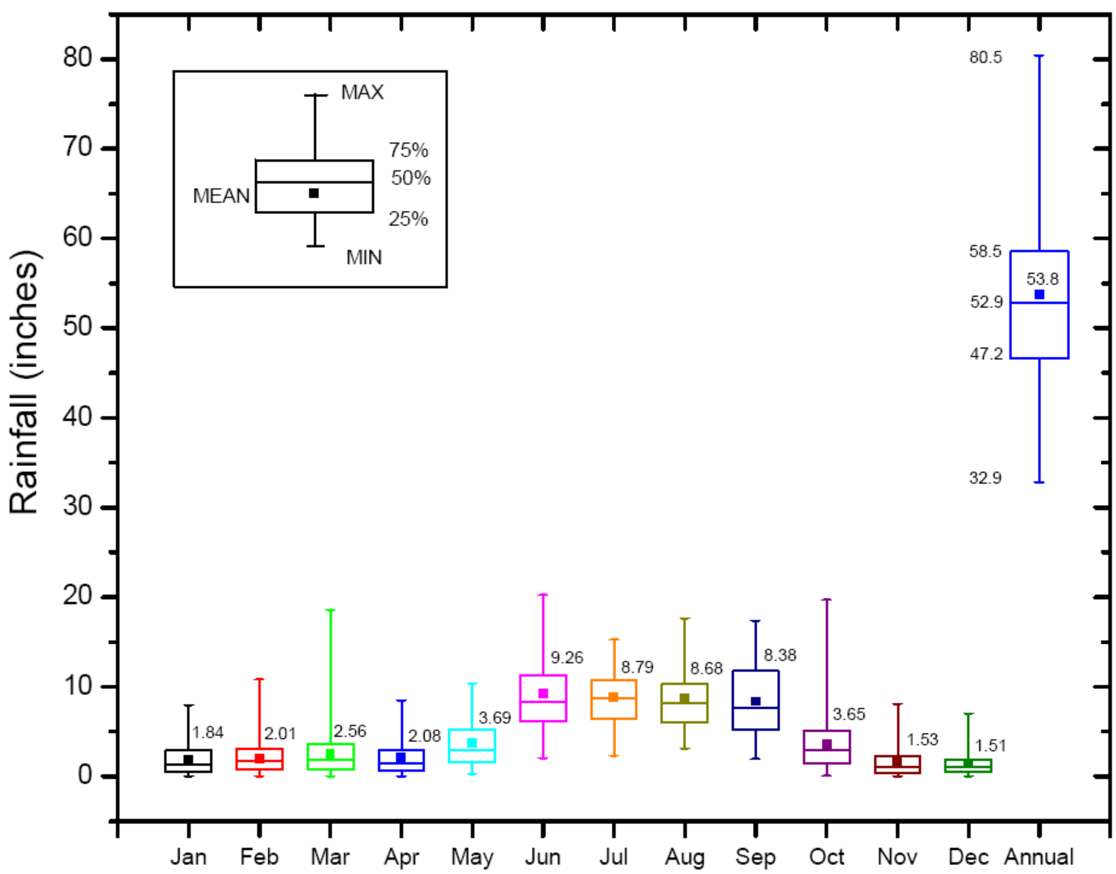


Figure 3-4. Box-Whisker Plot of Annual Precipitation at the Ft Myers_R Gage (Page Field Airport). Monthly Mean Values are also Shown for each Month.

Table 3-3. Land Use Impervious Coverage Percentage and DCIA.

Land Use Category	Impervious Coverage (%)	DCIA (%)
Medium Density Residential (RMD)	35	23
High Density Residential (RHD)	40	30
Commercial and Services (COM)	90	81
Institutional (INST)	15	10

3.1.4.3 Runoff Coefficients

The runoff coefficient directly determines the amount of runoff expected from each land use. The runoff coefficient for each land use is estimated as a composite of the impervious and pervious runoff coefficient fractions of their respective areas in the land use. The relation of the pervious component of the area with runoff is determined by the pervious runoff coefficient (Cp), which is in turn, highly dependant upon soils drainage capacity. The drainage capacity is a soil property typically represented by the hydrological soil group, identified in Table A-3 of Appendix A for the study area. **Table 3-4** provides a summary of the estimated composite runoff coefficient used for each land use in this project.

Pervious runoff coefficients (Cp) for land uses overlaying type A soils according to the HSG classification were assigned a lower runoff coefficient to account for their better drainage capacity. Specifically, HSGs A, B, C, and D were assigned 0.05, 0.10, 0.15, and 0.20, respectively. An area-weighted average value of pervious runoff coefficient was used for each HU.

3.1.4.4 Event Mean Concentrations

Once runoff is estimated in WMM for each land use, it is multiplied for the land use-specific loading rate of each water quality parameter. Event mean concentrations (EMCs) are typically the loading rates specified in WMM for each water quality parameter and land use. EMCs are determined by sampling at different intervals of storm events and identifying the average concentration of the composite sample. The sampling locations are carefully chosen to target a specific land use within a watershed. EMCs constitute an important parameter in the NPS characterization within a watershed.

Table 3-4. Runoff Coefficients per Land Use Categories.

Land Use Category	Impervious Runoff Coefficient	Pervious Runoff Coefficient	Runoff Coefficient Composite Value [1]
Medium Density Residential	0.95	0.15	0.33
High Density Residential	0.95	0.15	0.39
Commercial and Services	0.95	0.15	0.80
Institutional	0.95	0.15	0.33

[1] Composite runoff coefficient = (C_I x Imp%) + (C_P x (1-Imp%))

Nationwide and local studies have reported EMC values for selected land use categories. The nationwide urban runoff program (NURP) was a research project conducted between 1978 and 1983 oriented to evaluate the impact of stormwater runoff in waterbodies and the performance of the implementation of stormwater management practices. CDM has also played a significant role in compiling, documenting, and creating an EMC database at national and regional levels.

The CDM Southeast US EMC database, with 44 stations in Florida, was completed in 2001 for the most common developed and undeveloped land use categories. Environmental Research and Design has also collected EMC data in Central and South Florida and documented it in several reports (Harper, 1992; Harper, 2003). The aforementioned references and several others were consulted to define the EMC set of values to use in the project.

A summary of the selected EMC values for the twelve NPDES parameters and for each land use category is provided in **Table 3-5**.

Table 3-5. Event Mean Concentrations (mg/L) for Annual Load Calculations per Land Use Category

LAND USE CATEGORY	DCIA (%)	BOD	COD	TSS	TDS	Source	TP	DP	TKN	NO2+ NO3	Source	Pb	Cu	Zn	Cd	Source
Forest/Rural Open	1	1	51	11	100	A,D	0.05	0.004	0.86	0.30	A,B	0.001	0.001	0.000	0.001	J,D
Agricultural/Pasture/Golf Course	1	4	51	13	100	A,D,H	0.64	0.26	2.62	0.56	H,C	0.005	0.004	0.023	0.000	I
Recreational	1	13	71	27	117	J,B,E	0.39	0.24	1.39	0.63	C,B,E	0.016	0.012	0.051	0.002	B,E
Low Density Residential	10	13	71	27	117	J,B,E	0.39	0.24	1.39	0.63	C,B,E	0.016	0.012	0.051	0.002	B,E
Medium Density Residential	35	9	65	59	117	B,E,I	0.39	0.24	1.79	0.55	C,B,E	0.016	0.023	0.073	0.001	B,E
Institutional	35	9	65	59	117	B,E,I	0.39	0.24	1.79	0.55	C,B,E	0.016	0.023	0.073	0.001	B,E
High Density Residential	40	8	53	72	73	B,E	0.37	0.17	1.82	0.63	C,B,E	0.015	0.031	0.065	0.001	B,E
Urban and Built Up	50	10	69	63	120	K	0.37	0.23	1.73	0.52	K	0.017	0.023	0.085	0.001	K
Extractive	30	14	83	77	130	J,E	0.28	0.20	1.47	0.40	E	0.023	0.024	0.132	0.002	J,E
Commercial	81	14	83	77	130	J,E	0.28	0.20	1.47	0.40	E	0.023	0.024	0.132	0.002	J,E
Industrial	75	14	83	77	130	J,E	0.28	0.20	1.47	0.40	E	0.023	0.024	0.132	0.002	J,E
Water/Wetlands	25	2	51	5	100	A,B,G	0.06	0.03	0.72	0.24	A,B,G	0.000	0.000	0.000	0.000	A,B,G
Highways	90	11	99	121	189	J,E	0.40	0.15	1.51	0.61	E	0.040	0.024	0.207	0.002	J,E

Notes

(1) Land use categories highlighted in yellow are present in the three Problem Areas within the Town of Fort Myers Beach.

(2) Agricultural/Pasture/Golf Course DP estimated from TP as the DP/TP ratio of Forest, Open, Park

(3) Dissolved P concentration for Water/Wetlands were estimated as 55 % of the Total P concentrations (Harper, 1992; Florida NPDES data 1992-1993).

(4) TKN and NO2+NO3 concentrations for non-urban land use categories were assumed to be 75 % and 25 % respectively of the TN concentrations (Florida NPDES data 1992-1993)

(5) Average values are derived from parametric statistics with a lognormal distribution. Concentrations reported below the detection limit were assumed to be 50 % of detection limit.

Sources

A - "Estimation of Stormwater Loading Rate Parameters" Table 21. Harvey H. Harper, 1992.

B - "Evaluation of Alternative Stormwater Regulations for Southwest Florida" Table 5, Table 6, and Table 7. Harvey H. Harper, ERD, 2003.

C - "Proposed Total Maximum Daily Load Development For the Northern and Central Indian River Lagoon and Banana River Lagoon, Florida -Nutrients, Chl a and DO" EPA Region 4, Table 7, pg.21, 2003.

D - Nationwide Urban Runoff Program (NURP), 1983.

E - NPDES Part II Stormwater Permit Applications for Sarasota County, Palm Beach County, Jacksonville, St. Petersburg, and Orlando. 1992-93.

F - Washington Metorpolitan Area Urban Runoff Demonstration Project. Northern Virginia Planning District Commission . January 1983, Table 24.

G - Mean wetfall concentration - Tampa NURP Study.

H - Point and Non-Point Source Loading Assessment. Phase II. Sarasota Bay National Estuary Program.

I - CDM Data Compilation of 192 NPDES MS4 Permit Application Results (EMC used - Medium Density TDS)

J - CDM Southeast US EMC Database with 44 Stations in Florida (2001)

K - 80% medium density residential and 20% commercial

3.1.4.5 Flow and Water Quality Monitoring Data

WMM estimated loads may be calibrated to match measured values at flow and water quality stations located within or downstream of the evaluated subwatersheds. Typically, long-term daily measured flows and concentrations are averaged to estimate average measured loads of each sampled water quality parameter, which are compared against WMM load estimates. There are no stream gages or water quality stations measuring runoff in the Town.

3.1.4.6 Baseflow and Baseflow Loading Factors

WMM considers baseflow to the portion of rainfall loss through infiltration on pervious areas that intersects a waterbody. In large watersheds with broad extensions of non-urban or undeveloped land uses, baseflow may constitute the second largest source of flow, and thereby, load in a waterbody. However, in small watersheds highly dominated by urban-type of land uses, the effect of baseflow is not significant. The latter is the case of the study area, which has the important characteristic of not having an embedded waterbody that the baseflow could discharge and contribute to watershed loading. Being this the case, baseflow and baseflow loading factors were not considered in the study area.

The baseflow and baseflow loading factor values used in the EBCRNLAP were included in WMM as reference but were not implemented in the simulation runs presented in this report.

3.1.4.7 Delivery Ratio

The WMM loading estimates attempt to represent the total NPS and PS loading generated within the HU and are geographically located at the outlet of the HU. The delivery ratio is used to account for the transport of the estimated load to a downstream location from the HU outlet. During transport is expected that under relatively calm streamflow conditions part of the particulate material will settle reducing the level of concentration of water parameters that may be attached to the settling material. These calm streamflow conditions are particular to large watersheds where the turbulent effect in streamflow of a storm event is no longer observed after a few hours of its occurrence. On the other hand, for small watersheds, turbulent flow is characteristic throughout the watershed never reaching conditions favoring settling. The load associated to the storm event will leave the watershed remaining unchanged. For this latter case, the assigned delivery ratio is 1; for large watersheds, instead, the delivery ratio would vary between 0 and 1.

The delivery ratio is a calibration parameter of WMM estimated loads. The determination of the delivery ratio is typically based on the traveling time needed from the HU outlet to the calibration location.

Considering that the size of the watersheds of the study area is small, a delivery ratio of 1 was used for all the HUs which corresponds to 100% delivery of the load to the HU and watershed outlets.

3.1.4.8 Point Sources

Point sources such as discharges from domestic and industrial wastewater treatment plants (WWTPs) can be considered in WMM. Generally, average flow discharges and monitored parameter concentrations are determined for each WWTP by consulting their discharge monitoring reports (DMRs) that are submitted on a monthly basis to FDEP. After reviewing NPDES and other point source databases, none of these facilities is present within the problem areas. Therefore, no point source data was incorporated in WMM for this project.

3.1.4.9 Septic Tanks

Another NPS that could be included in WMM is the loading contribution due to septic tanks. WMM accounts for the septic tank loading by increasing the EMC values of the selected land uses served by septic tanks by a factor selected by the user that could be low, medium, or high depending upon observed septic tank effluent concentrations typical of the study area.

The Florida's Department of Health (FDOH) maintains a database of septic tanks that have been recently constructed (from 1995 onward) or repaired. This database is in GIS format and is continuously updated with information collected locally by local departments of health officers. The FDOH database has been widely used in other similar studies in Florida. However, no septic tanks were identified using this database within the three problem areas and the Town of Fort Myers Beach. Therefore, septic tank loadings were not included in the simulation runs for this report.

3.2 Best Management Practices (BMPs)

As mentioned previously, structural and non-structural BMPs are measures used for the protection of natural resources and to comply with established water quality regulations for new and existing developments. The following is a description of widely used BMPs in Florida identifying their advantages, limitations, and design criteria for their implementation.

3.2.1 Potential BMPs

This section describes the function, advantages and disadvantages of BMPs commonly used for new development and retrofit of existing development. The BMPs are grouped as structural (constructed facilities) and non-structural (regulation, ordinances or practices). The following BMPs are described in this section:

Structural Stormwater Controls:

- Wet detention pond
- Dry detention basins
- Exfiltration trenches
- Shallow grassed swales
- Retention basins
- Water quality inlets and baffle boxes
- Porous pavement
- Underdrains and stormwater filter systems
- Alum injection
- Skimmers

Non-Structural Source Controls:

- Land use planning
- Public information programs (e.g., stakeholder meeting process)
- Stormwater management ordinance requirements
- Fertilizer application controls
- Pesticide and herbicide use controls
- Solid waste management
- Street sweeping
- DCIA minimization
- Erosion and sediment control on construction sites
- Operation and maintenance

The use of a specific BMP depends on site conditions and objectives such as water quality protection, flood control, aquifer recharge, or volume control. In many cases, there are multiple goals or needs for a given project. Therefore, BMPs can be "mixed and matched" to develop a "treatment train". The treatment train concept maximizes the use of available site conditions from the point of runoff generation to the receiving water discharge in order to maximize water quantity (flood control), water quality (pollutant load reduction), aquifer recharge, and wetlands benefits. **Figure 3-5** shows a schematic flowchart of the treatment train concept. The following comparative discussion of BMPs presents discussion on benefits and limitations of each BMP type.

3.2.2 Structural BMPs

Detention refers to the temporary onsite storage of excess runoff prior to a gradual release, after the peak of the storm inflow has passed. Runoff is held for a period of time and is slowly released to a natural or manmade watercourse, usually at a rate no greater than the pre-development peak discharge rate. For water quantity, detention facilities will not reduce the total volume of runoff, but will redistribute the rate of runoff over a longer period of time by providing temporary storage for the stormwater. Another objective of a detention facility is to remove pollutants produced from the tributary area.

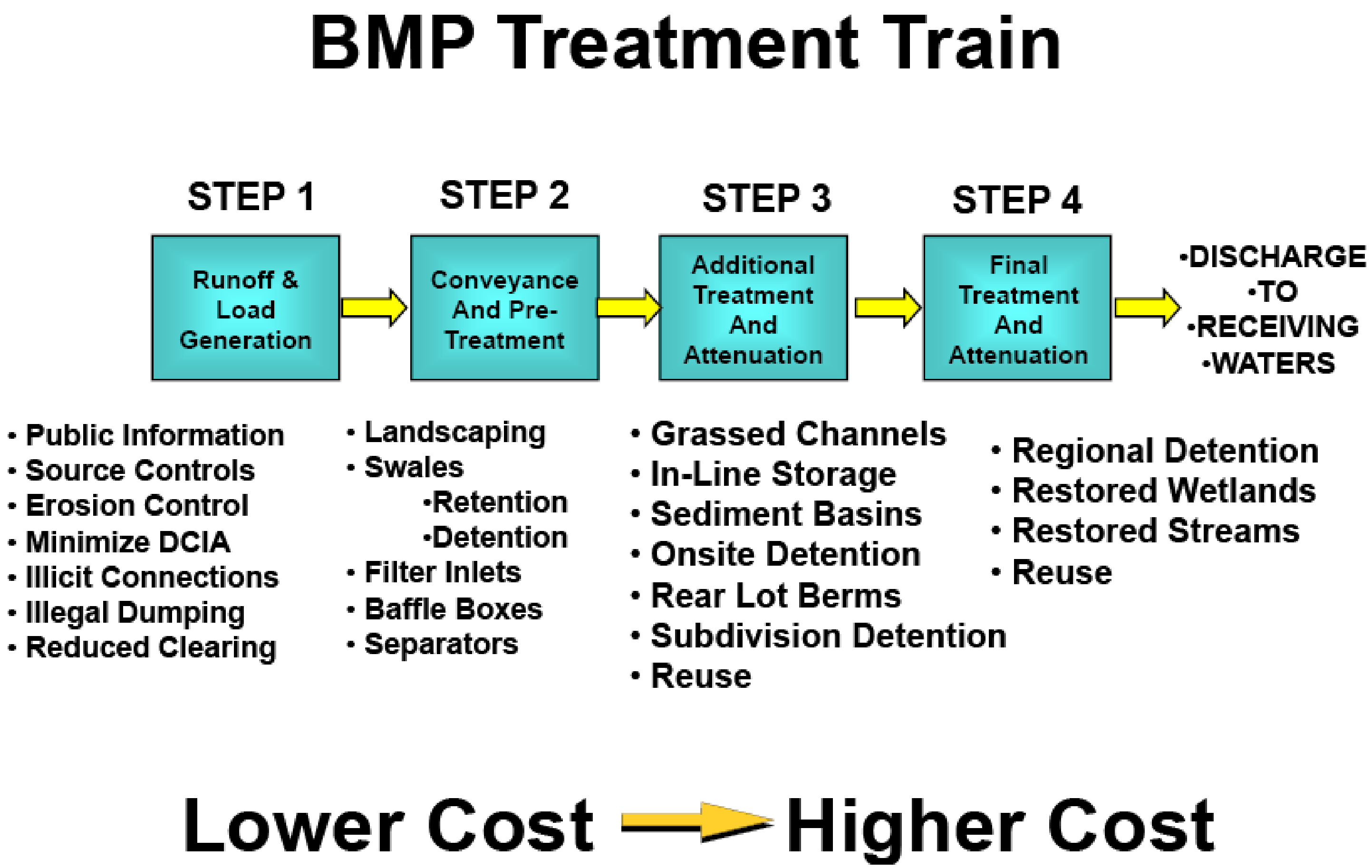


Figure 3-5. BMP Treatment Train

3.2.2.1 Wet Detention Ponds

A wet detention system includes a permanent pool of water, often a shallow littoral zone with aquatic plants, and the capacity to provide detention for an extended time necessary for the treatment of a required volume of runoff. In wet detention basins, pollutant removal occurs primarily within a permanent pool during the period of time between storm events. They are typically sized to provide at least a 2-week hydraulic residence time during the wet season. The primary mechanism for the removal of particulate forms of pollutants in wet detention basins is sedimentation.

Wet detention basins can also achieve substantial reductions in soluble nutrients due to biological and physical/chemical processes within the permanent pool, as shown on **Figure 3-6**. Uptake by algae and rooted aquatic plants is probably the most important process for the removal of nutrients. As may be seen, the facility consists of a permanent storage pool (i.e., section of the basin that holds water at all times), and, for new developments or where site conditions allow, an overlying zone of temporary storage to accommodate the attenuation of peak flows. Since basins that exhibit thermal stratification (i.e., separation of the permanent pool into an upper layer of high temperature and a lower layer of low temperature) are likely to exhibit anaerobic bottom waters during the summer months, relatively shallow (< 12 feet deep) permanent pools that maximize vertical mixing are preferable to relatively deep basins. Water depth should be great enough to prohibit nuisance aquatic plant species in the open water portion of the basin (> six feet deep). A minimum depth of 6 to 12 inches should also be maintained in the littoral zone of the permanent pool to support a fish population capable of controlling mosquito larvae. Wet detention facilities are particularly well suited for high groundwater conditions, as the groundwater serves to maintain water in the littoral zone during the dry season.

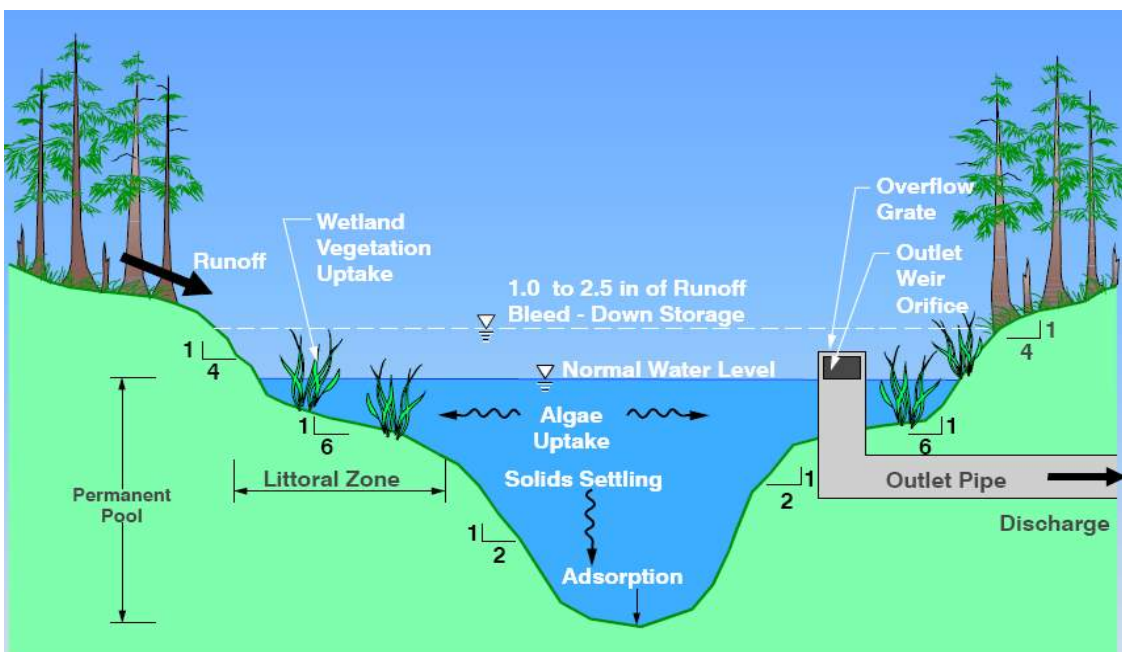


Figure 3-6. Wet Detention Pond Cross Section and Design Components.

Wet detention BMPs do offer some other advantages that should be considered in BMP selection. Wet detention basins are usually more visually appealing than dry basins, particularly if there is desirable wetland vegetation around the perimeter of the permanent pool. When properly designed and constructed, wet detention basins are actually considered as property value amenities in many areas. Also, wet detention basins offer the advantage that sediment and debris accumulate within the permanent pool. Since these accumulations are out-of-sight and well below the basin outlet, wet detention basins tend to require less frequent clean-outs to maintain an attractive appearance and prevent clogging. Sediment forebay areas (or sumps) are recommended whenever possible to facilitate cleaning.

Potential Benefits of a Wet Detention Basin

- Reduction of downstream flooding problems by attenuating the peak rate of flow.
- Reduction in pollutant loadings to receiving waters for dissolved and suspended pollutants.
- Reduction in cost for downstream conveyance facilities.
- Creation of local wildlife habitat.
- Enhanced property values as an aesthetic annuity for lots adjacent to properly designed, constructed, and maintained basins.
- Creation of fill that can be used on site or be sold.
- Low frequency of failure.
- Can be used in areas with high water tables and less permeable soils.
- Pollutant removal can be optimized with pretreatment such as retention swales, baffle boxes, or alum injection.

Potential Limitations of a Wet Detention Basin

- Potential safety hazards, if not designed and constructed properly (safety bench is desirable).
- Occasional nuisance problems such as odors, algae, debris, and mosquitoes.
- Regular maintenance of the littoral zone is required to prevent nuisance plant species from dominating this zone.
- Eventual need for sediment removal from the permanent pool or sediment forebay.

SFWMD Wet Detention Design Criteria

- *"Live" Detention Volume* — A bleed-down, or live storage volume, should be greater than 1.0 inch of runoff from the developed project area, or 2.5 inches times the percentage of impervious area. Minimum area is 0.5 acres. Commercial or industrial areas must provide 0.5 inches of pretreatment through dry detention or retention prior to discharge to a wet detention facility.

- *Live Detention Storage Recovery* - Basin outlets should be designed to discharge no more than 0.5 inches of the detention volume in the first 24 hours following a storm event. Perforated standpipes or orifice control structures are commonly used with an emergency overflow weir or spillway. This gradual release also controls erosion.
- *Minimum Width* - The minimum width is 100 feet for linear areas in excess of 200 feet in length. Irregular areas must average at least 100 feet in width
- *Side Slopes* — Side slopes cannot be steeper than 4:1 out to a depth of two feet below the control elevation. (Alternative criteria regulate wet detention facilities on golf courses). A minimum operational easement of 20 feet in width is required.
- *Wetland Littoral Zones* are shallow areas provided for biological removal or wetland habitat. These areas must be less than 6 feet in depth (below the control elevation). The minimum area is the lesser of 20 percent of the wet retention/ detention area, or 2.5 percent of the treatment area and contributing area.
- *Maximum Permanent Pool Depths*. SFWMD recommends that wet detention/ retention area should be at least 12 feet deep.
- *Skimmers* - Facilities that receive stormwater from contributing areas with greater than 50 percent impervious surface, or that are a potential source of oil and grease contamination must include a baffle, skimmer, and grease trap to prevent these substances from being discharged from the facility.

General Recommendation for Wet Detention Design

- *Inlet Structures* should be designed to dissipate the energy of waters entering the facility and to help prevent short-circuiting.
- *Length to Width Ratio* - By maximizing the distance between the inlet and outlet point of a detention basin, the greatest opportunity of suspended solids settling is obtained. Therefore, a minimum length to width ratio of 3:1 is recommended. A length to width ratio of 4:1 to 7:1 is preferred (Youseff et al., 1990). Note that length is defined by the distance from the inflow point to the outflow point, and width is defined as the surface area divided by the length. To avoid short-circuiting, diversion barriers can be incorporated into the basin design. These barriers may be created by small islands, peninsulas, or concrete baffles.
- *A Sediment Forebay* is often used to provide pretreatment and reduce maintenance costs.
- *Side Slopes* - Side slopes should be 6:1 or flatter to provide a littoral shelf and safety bench from the side of the facility out to a point 2 to 3 feet below the permanent pool elevation. Side slopes above the littoral zone should be no steeper than 4:1. Side slopes below the littoral zone can be 2:1 in order to maximize permanent pool volumes where needed.

3.2.2.2 Dry Detention Basins

Dry detention basins (and extended dry detention basins) are designed to increase detention times of runoff to provide treatment for the captured first-flush runoff to enhance solids settling and the removal of suspended pollutants. The basins are designed to be dry prior to the storm event and to recover to a dry condition after holding the runoff for a period of time. In an extended dry detention facility, runoff is detained longer than in a simple detention system. The captured runoff is slowly released through a control structure at a rate that is slow enough to achieve maximum pollutant removal by sedimentation. These types of detention basins can be designed to achieve heavy metal loading reductions (e.g., 75 percent for lead and 45 percent for zinc) that are similar to wet detention basins, since heavy metals in urban runoff tend to be primarily in suspended form. Dry detention basins require much less storage, and they cost less than wet detention basins because they rely solely upon sedimentation processes, without the expense of additional storage for the pool (Le., portion of the basin that holds water at all times). Extended dry detention may be useful in areas where retrofit of BMPs is required. **Figure 3-7** shows an example of a dry detention basin. Dry detention basins appear to be falling out of favor with some regulatory agencies and permitting feasibility should be confirmed prior to design phase.

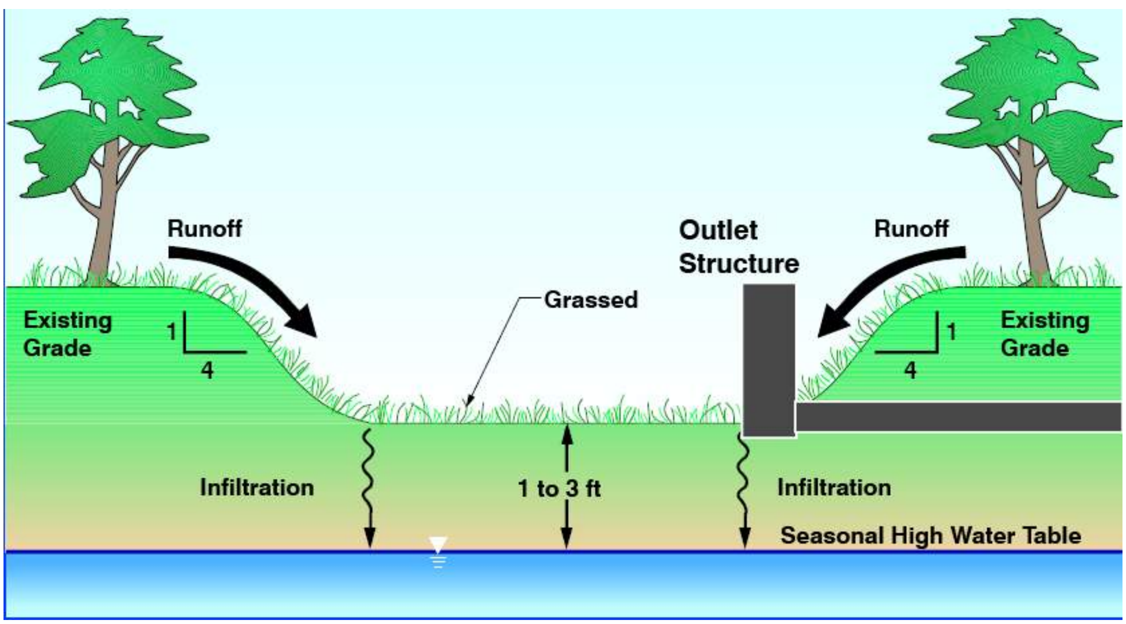


Figure 3-7. Dry Detention Pond Cross Section and Design Criteria.

Potential Benefits of a Dry Detention Basin

- Reduction of downstream flooding problems by attenuating the peak rate of flow.
- Some removal of pollutant loadings to receiving bodies of water for suspended pollutants.
- Reduction in cost for downstream channel improvements.

- Creation of fill that may be used on site or be sold (basin sediment removal).
- Low frequency of failure as compared with exfiltration and retention systems.

Potential Limitations of a Dry Detention Basin

- Does not remove dissolved pollutants (nutrients).
- Requires frequent clean-outs to minimize "eye-sore" potential.
- Potential safety hazards, if not designed and constructed properly.
- No permanent pool to store sediment inflow.
- Occasional nuisance problems such as debris and mosquitoes.
- Regular maintenance is required to prevent nuisance plant species from emerging and to remove accumulated sediments.
- Must have reasonably good depth to seasonally high water table in order to have dry conditions.

SFWMD Dry Detention Design Criteria

- *Treatment Volume* - The dry detention treatment volume shall be 75 percent of the treatment volume required for wet detention (e.g. the greater of 0.75 inches of runoff from the project or 1.9 inches times the percent impervious.) Commercial or industrial projects must provide a 0.5-inch retention/ detention pretreatment prior to discharge into a dry retention facility.
- *Detention Volume Recovery* - Basin outlets should be designed to discharge no more than 0.5 inches of the detention volume in the first 24 hours following a storm event.
- *Skimmers* — Facilities that receive stormwater from contributing areas with greater than 50 percent impervious surface, or that are a potential source of oil and grease contamination must include a baffle, skimmer, and grease trap to prevent these substances from being discharged from the facility.

3.2.2.3 Exfiltration Trenches

An exfiltration trench is the onsite retention of stormwater accomplished through underground exfiltration. The trench can be off-line or online, with online volume requirements being greater than off-line. The subsurface retention facilities most commonly used are excavated trenches with perforated pipe backfilled with coarse graded aggregate. Stormwater runoff is collected for temporary storage and infiltration. Water is exfiltrated from the pipe and trench walls for groundwater recharge and treatment. The addition of the pipe increases the storage available in the system and helps promote infiltration by causing the runoff waters to be more effectively and evenly distributed over the entire length of the trench.

Exfiltration trenches are used to retain the “first flush" of stormwater runoff. This promotes pollutant load reductions to receiving waters, reduces the runoff volume and peak discharge rate from a site, filters suspended pollutants out of groundwater discharges, and promotes the recharge of groundwater.

While exfiltration trenches can have limited application in areas with a shallow groundwater table, due to the highly permeable soils (Hydrologic Soil Group A) at Fort Myers Beach, the subsoil can be sufficiently permeable to provide a reasonable rate of infiltration where the water table is sufficiently lower than the design depth of the facility to allow for recovery of the storage prior to the next storm event (generally required in 72 hours). It is frequently used for the disposal of runoff from roof drains, parking lots, and roadways. This practice is not recommended where runoff water contains high concentrations of suspended materials, unless a pre-settling or filtering mechanism is provided. Likewise, grease and oil traps are also highly recommended prior to discharge to these systems. Providing sediment sumps in inlets or raising inlet tops above grade for pretreatment in swales will reduce sediment buildup in the trench. These precautions are primarily for maintenance, since exfiltration systems are very susceptible to clogging and sediment buildup, which reduces their hydraulic efficiency and storage capacity to unacceptable levels. **Figure 3-8** shows a profile view of a typical exfiltration trench.

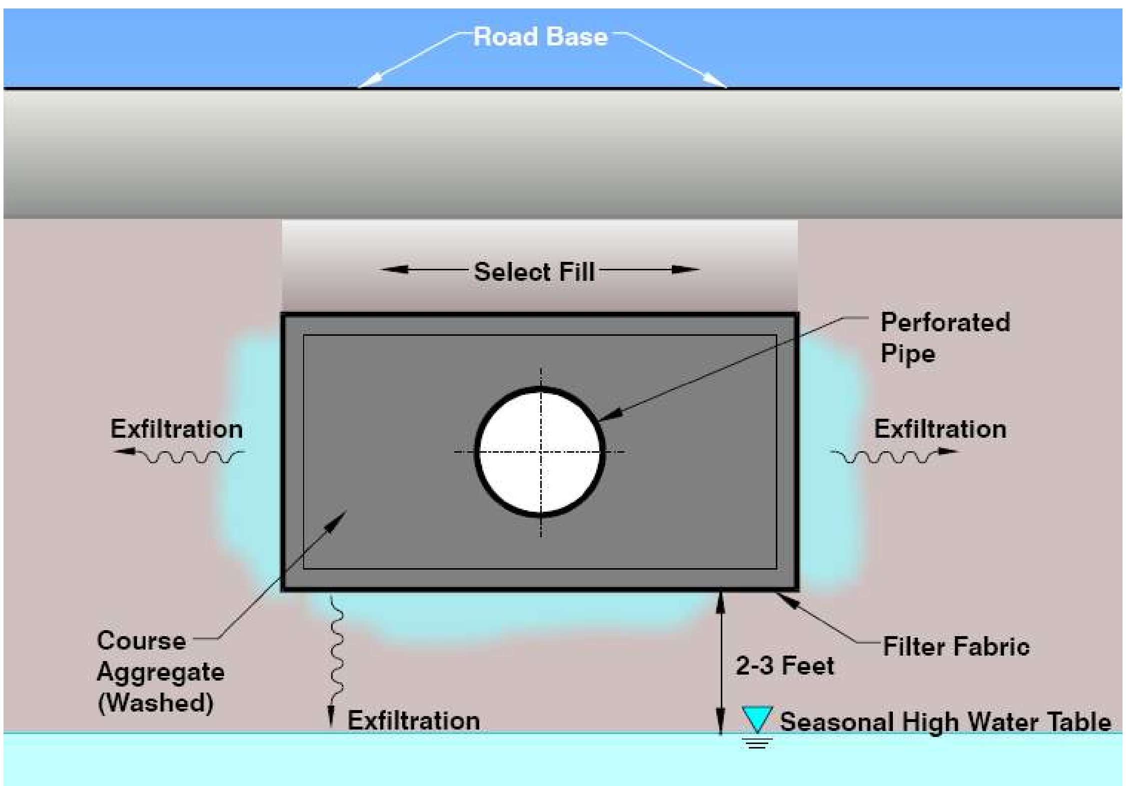


Figure 3-8. Exfiltration Trench Cross Section and Design Criteria.

Potential Benefits of an Exfiltration Trench

- They mimic the natural groundwater recharge capabilities of the site.
- Are relatively easy to fit into the margins, perimeters, and other space-constrained areas of a development site, including under pavement.
- Can provide offline treatment for environmentally sensitive waters.
- Can be used to retrofit already developed sites where space is limited.

Potential Limitations of an Exfiltration Trench

- Very susceptible to clogging. Have relative short life spans, before replacement or extensive restoration/ maintenance of system is required.
- Require highly permeable soils to function properly.
- Difficulties in keeping sediment out of the structure during site construction.
- Not recommended for clayey or highly erodible soils.
- Not recommended for area with shallow bedrock.
- Often more costly than other treatment alternatives, especially when operation and maintenance costs are considered.

SFWMD Design Criteria for Exfiltration Trench

- *Treatment Volume* - Exfiltration trenches must have the same treatment volume as retention systems. The retention treatment volume shall be 50 percent of the treatment volume required for wet detention (e.g., the greater of 0.5 inches of runoff from the project or 1.25 inches times the percent impervious). Commercial or industrial projects must provide a 0.5-inch of retention/ detention pretreatment prior to discharge into a dry retention facility,
- Minimum Pipe Diameter - The minimum pipe diameter shall be 12 inches.
- Trench Width - The minimum trench width must be 3 feet.
- Filter Media - Rock in the trench must be enclosed in filter material on top and sides.
- Exfiltration Rate - Must exfiltrate treatment volume over one hour, prior to overflow.

3.2.2.4 Shallow Grassed Swales

Shallow grassed swales are shallow trenches shaped or gradually graded to required dimensions and planted with suitable vegetation for the storage, treatment, and potentially the conveyance of runoff. A swale can be defined as a manmade trench that:

- Has a top width-to-depth ratio of the cross section equal to or greater than 6:1, or side slopes equal to or greater than three feet horizontal to one foot vertical.
- Contains contiguous areas of standing or flowing water only following a rainfall event.

- Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake.
- Is designed to take into account the soil erodability, soil percolation, slope length, and drainage area to prevent erosion and reduce the pollutant concentration of any discharge.

Swales are normally used for conveyance systems to transport runoff off site or to a stormwater facility. They are best suited for major highways and at sites with soils of moderate-to-high infiltration capacity (usually Hydrologic Soil Groups A or B). With slight modification (e.g., check dams, raised inlets, or swale blocks), swales can be used to add retention storage, control erosion, provide aquifer recharge, and/ or further reduce the pollutant load from concentrated stormwater runoff in urban areas. They also may be used as pretreatment in the overall treatment train stormwater system. Implementation examples of swales include outlet channels from detention systems, stormwater collection and treatment along roadways or residential areas, and pretreatment to reduce stormwater pollutant loads before conveying stormwater or other management practices or off site. **Figure 3-9** shows an example of a typical swale.

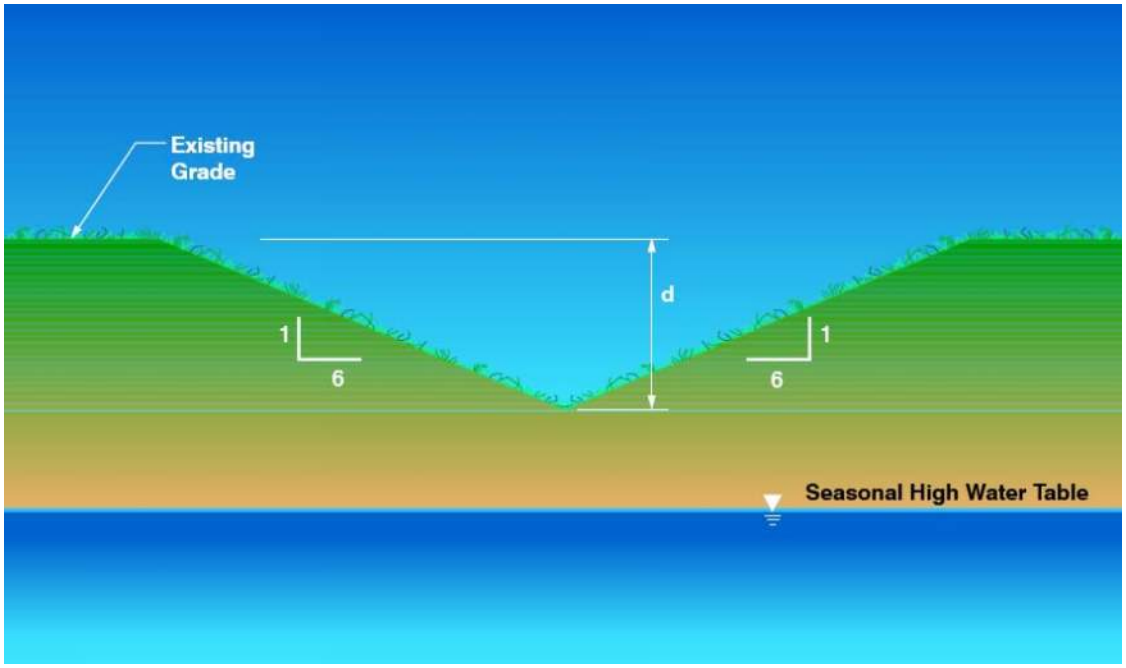


Figure 3-9. Grassed Swale Cross Section and Design Criteria.

Potential Benefits of Shallow Grassed Swales

- Usually less expensive than installing curb and gutters, and usually less expensive than other water quality treatment controls.
- Hardly noticeable if shallow swales (0.5 to 1.0 foot maximum depth) are designed and constructed with gradual slopes (4:1 to 6:1).

- Can provide offline treatment for environmentally sensitive waters.
- Can reduce peak rates of discharge by storing, detaining, or attenuating flows.
- Can reduce the volume of runoff discharged from a site by infiltrating runoff with a raised inlet or check dam.
- Maintenance can be performed by the adjacent owner.
- Can be used in space-constrained areas such as along lot lines, rear of lots, and along roadside.
- Can be used as water quality treatment or pretreatment with other BMPs in a treatment train.
- Recovers storage and treatment volumes quickly where soils are permeable.
- Can be used as recessed residential or commercial landscape areas (part of green space requirement), and runoff collection becomes the source for irrigation and some nutrients (saving money), provided the use does not impact long-term maintenance or impact existing trees.

Potential Limitations of Shallow Grassed Swales

- Effective only as a conveyance system in unsuitable soils.
- Possible nuisances such as odors, mosquitoes, or nuisance plant species can occur if not designed, constructed, or maintained properly.
- Aesthetically unpleasing if improperly designed and constructed (deep with steep side slopes - looks like a ditch).
- May not be suitable or may require geotextile matting in areas that serve as vehicle parking areas.

3.2.2.5 Infiltration Basins and Retention Basins

A retention basin is an infiltration system designed to retain stormwater on site, thus reducing pollution, recharging groundwater, and controlling flood waters. Typically, these basins have dry bottoms covered with native grasses. The site characteristics where retention basins function best are where soils are highly permeable and the seasonal high water table is situated well below the soil surface (at least 2 to 3 feet below basin bottom). These systems can be incorporated into multipurpose park areas when designed with very gradual slopes. As discussed earlier, retention basins need to be inspected regularly to check for infiltration capacity.

Infiltration controls are typically best suited for onsite applications (off-line from the primary stormwater conveyance system) where the contributing area is limited to a single development site or subdivision (e.g., 1 to 50 acres). To be most effective, retention controls must be an integral part of the initial design and construction of a site. Retention BMPs may be suitable for use at individual urban redevelopment or retrofit sites within the basin. The application of retention BMPs should be considered on a case-by-case basis within the study area, where soils and water table conditions are suitable.

Potential Benefits of a Retention Basin

- Mimics the natural water balance of a site by promoting groundwater recharge close to the point of runoff generation.
- Can provide offline or online treatment for environmentally sensitive waters.
- Reduces peak rate and volume of flood discharge by retaining water on site.
- Can be used as sediment traps during the construction phase of a project.
- Are reasonably cost-effective in comparison with other BMPs for both construction and maintenance costs (where soils are favorable).
- Effectively reduce pollutant loadings to receiving waters.

Potential Limitations of a Retention Basin

- Susceptible to clogging due to accumulation of fine suspended solids and oil and grease in the upper layers of the basin floor.
- Require well drained soils to function properly.
- Not appropriate in areas with shallow bedrock.
- Unsuitable soils limit drawdown capacity, thereby reducing pollutant removal and flood control capacity.
- Soluble pollutants can be conveyed into groundwater.
- Possible nuisances such as odors, mosquitoes, and nuisance vegetation can occur if not designed, constructed, or maintained properly.

SFWMD Retention Design Criteria

- *Treatment Volume* - The retention treatment volume shall be 50 percent of the treatment volume required for wet detention (e.g. the greater of 0.5 inches of runoff from the project or 1.25 inches times the percent impervious.) Commercial or industrial projects must provide a 0.5-inch retention/ detention pretreatment prior to discharge into a dry retention facility.
- *Retention Volume Recovery* - Basin outlets should be designed to discharge no more than a 0.5-inch of the retention volume in the first 24 hours following a storm event.
- *Skimmers* - Facilities that receive stormwater from contributing areas with greater than 50 percent impervious surface, or t.hat are a potential source of oil and grease contamination must include a baffle, skimmer, and grease trap to prevent these substances from being discharged from the facility.

3.2.2.6 Water Quality Inlets, Baffle Boxes, and Oil-Water Separators

Water quality inlets are designed to prevent sediment, oil, and grease from entering storm drains and stormwater infiltration systems. Water quality inlets are typically installed at catch basins, and baffle boxes are typically installed further downstream in the storm sewer.

Two basic designs of baffle boxes are described by Schueler (MWCOG, 1987): the Montgomery County (Maryland) design and the Rockville (Maryland) design.

- The Montgomery County design consists of a rectangular concrete box divided into three chambers where sediment, grit, and oil are separated from stormwater runoff as it passes through the chambers before exiting through an outlet to the storm drain system. The first chamber is designed for sediment trapping, and the second chamber is designed for oil separation. Each chamber contains a permanent pool and is accessible through manhole covers.

- The Rockville design also consists of three chambers. However, runoff is allowed to exfiltrate into the subsoil through weep holes located at the bottom of the chambers. These holes prevent the formation of permanent pools and provide additional pollutant removal through exfiltration.

Baffle boxes, when used in conjunction with pretreatment measures such as street sweeping, may be the most feasible water quality control device in areas where the other more traditional measures, discussed previously, may not be applicable due to various constraints. The design of a baffle box is identical to a primary clarifier with the addition of a skimmer for floatables. Target pollutant sizes are fine sands and larger size particles. There are limited pollutant removal data on these devices, but the quantity removed can be quantified, when the box is cleaned of sediment and debris.

Precast oil/water separators are also available and can be installed on small commercial and industrial sites. The new coalescent plate separators are relatively efficient (50 percent to 80 percent removals are reported). These could be used for gas station and industrial area applications.

Water quality inlets are generally designed for sites of one acre or less. These inlets are typically used on commercial sites where high loads of sediments and/ or oil and grease are generated (e.g., gas stations, commercial stores, and small parking lots). Applications in residential areas are also becoming more frequent. Water quality inlets are typically designed to trap heavy sediments and/ or oil and grease. Removal mechanisms are usually settling, filtration, and/ or adsorption.

Maintenance requirements vary by device and application, but generally require cleaning the chambers four to six times a year to remove pollutants. Frequent maintenance is essential for the effective removal of pollutants using these systems. The cleaning process from these devices includes pumping out the contents of each chamber into a tank truck. If the entire contents are pumped out as a slurry, they are then transferred to a sewage treatment system. If the runoff is separated from the sediments by onsite siphoning, the sediments can be trucked to a landfill for final disposal.

The Continuous Deflective Separation (CDS), Stormceptor and Vortechs units are relatively smaller, but still require a significant space for installation. For example, the smallest Stormceptor, currently listed, extends 5.3 feet below the pipe invert. The incoming stormwater and pollutants enter a diversion chamber where oils and floatable particulate matter rise to the surface and sediments settle out to the bottom. During high flow events, the excess stormwater bypasses the lower treatment chamber and flows directly to the downstream storm drain system.

The Stormceptor is divided into two water quality chambers. Stormwater flows into the upper chamber and is diverted by a V-shaped weir down a drop pipe and into the lower chamber, from where it is directed horizontally around the circular walls to an oulet pipe.

The Vortechs system consists of four chambers. The chambers sequentially remove particulate material through settling, trapping oil, controlling flow, and discharging incoming flow.

3.2.2.7 Porous Pavement

A porous pavement generally consists of a layer of porous or pervious concrete, overlying an underground reservoir filled with stone aggregates. It is mainly designed to treat rain that falls on the pavement. After stormwater runoff infiltrates through the pavement, it is collected in reservoirs where it infiltrates into the subsoil. Porous pavements are typically used in the construction of parking lots as a built-in stormwater treatment device.

The design of a porous pavement can be modified to enable the system to accept runoff from surrounding areas and rooftops. This modification includes the installation of perforated inflow pipes to distribute the runoff throughout the stone reservoir. In addition, a pretreatment system is needed to remove trash, sediment, oil, and grease to prevent them from clogging the reservoirs. The FDEP has found these surfaces to be very effective in certain applications (FDEP, Livingston, personal communication).

The cost-effectiveness of porous pavement can be estimated by determining the additional expenses incurred for constructing a parking lot with a porous pavement instead of conventional pavement, and by deducting the savings resulting from reduced land consumption and elimination of the need for additional BMPs. Porous pavements reduce stormwater volumes discharged to surface waters, thereby reducing pollutant loadings and increasing groundwater recharge. This is achieved by sorption, trapping and straining, bacterial reduction, and groundwater diversion.

Porous pavements are not intended for the removal of coarse particulate pollutants; however, they are efficient in the removal of fine particulate pollutants. Estimates of cost-effectiveness can be made on a case-by-case basis only because of variables such as parking lot dimension, site size, amount of offsite runoff, and pretreatment requirements. In general, porous pavements are more cost-effective on sites between 3 acres and 10 acres in size.

The construction of a porous pavement system requires that rigorous construction practices be implemented. Adequate field testing and subgrade preparation are required before construction. Sediment control is needed before, during, and after construction. If regular maintenance is ignored, then the pores will clog and will not allow infiltration. Monthly (and possibly bi-monthly) vacuuming may be required.

Also, porous pavement does not stand up very well against heavy traffic loads. Porous pavements are best suited for sites with the following features:

- Infiltration rate greater than 0.3 inches per hour.
- Soil with clay content less than 30 percent.
- Slope less than 5 percent.
- Minimum of 2- to 4-foot clearance between the bottom of the reservoir and the seasonally high water table.

3.2.2.8 Underdrains and Stormwater Filter Systems

These types of systems typically consist of a settling basin and a filter. The settling basin is essential to avoid rapid clogging of the filter. Treated water that passes through the filter bed is discharged through an underdrain. The biggest concern with this type of system is clogging of the filter bed. This system also tends to work better off-line so there is no continuous base flow. This allows the system to dry out, which allows for the raking/ removal of debris from the filter bed and promotes proper pollutant removal mechanisms (aeration).

3.2.2.9 Alum Injection Systems

Alum injection is a chemical treatment process that uses coagulation to achieve a reduction in colloidal or fine suspended matter from stormwater. The alum is applied upstream of a treatment basin by means of an injection system. The basin must be designed to provide sufficient detention time, to allow the alum and coagulated particles to settle out.

There are both benefits and concerns when using an alum injection system. Benefits are significant reductions in solids and some nutrients. Concerns are the added capital/ operating costs and the alum sludge that is accumulated over time. This can be very effective for colloidal solids that are difficult to settle through typical physical processes.

3.2.2.10 Skimmers

Oil and grease skimmers are a cost-effective method of prohibiting oil and grease from flowing onto receiving waterbodies. Oil and grease skimmers are easily installed and maintained. Skimmers should also be considered in the design phase of all storage/ treatment facilities such as the wet detention basins.

3.2.2.11 Maintenance of Structural Controls

Inspections should be performed at regular intervals to assure that the detention basin is operating as designed. Semi-annual inspection should be considered at a minimum, with additional inspections following storm events. For the inspection following a major storm, the inspector should visit the site at the end of the specified drawdown period to ensure that the extended detention device is draining properly. Some inspections can be arranged to coincide with scheduled maintenance visits in order to minimize site visits and to ascertain that maintenance activities are performed satisfactorily. At the time of all site visits, the inspector should check the accumulations of debris and sediment. The weir or controlling structure and side slopes of the basin should be checked to ensure that they do not show signs of erosion, settlement, slope failure, or vehicular damage.

Vegetated littoral zones should be inspected to ensure that water level elevations are appropriate to enhance vegetative growth that acceptable survival rates for planted species are maintained, and that vegetative coverage is at acceptable limits.

Routine Maintenance

Routine or preventive maintenance refers to scheduled procedures which are performed on a regular basis in order to keep the basin in proper working order. Routine maintenance should include debris removal, silt/ sediment removal, and clearing of vegetation around the extended detention control device to prevent clogging. For wet detention basins, it is recommended that clean-outs be performed every four to ten years, while dry detention basins should be cleaned every one to two years.

Mowing

The side slopes, embankments, emergency spillways, and other grassed areas of stormwater facilities must be periodically mowed to prohibit woody growth and control weeds. More frequent mowing may be required in residential areas by adjacent homeowners. Mowing usually constitutes the largest routine maintenance expense. The use of native or introduced grasses which are water-tolerant, pest-tolerant, and slow growing are recommended.

Debris and Litter Removal

Debris and litter accumulate near stormwater facility control structures and should be removed during regular mowing operations. Particular attention should be paid to floatable debris that can eventually clog the control structure or riser. Trash screens or racks can be strategically placed near inflow or outflow points to capture debris.

Sediment Removal and Disposal

Sediment removal is a very important maintenance activity for detention basins, because these facilities are designed to remove pollutants by sedimentation.

Sediments collect at the bottom of the basin, reduce storage volume, and increase the likelihood of clogging the orifices of the extended detention outlet structure. Dry extended detention basins may have to be cleaned out more frequently than wet detention basins for aesthetic reasons.

Sediment deposition should be regularly monitored. Sediments removed from detention basins, especially in highly urbanized areas may contain high levels of toxins (e.g., heavy metals, organics). In addition to monitoring sediment deposition rates, core samples from detention basins every few years could be used to monitor the buildup of pollutants. If bottom sediment concentrations approach levels which would restrict disposal on site or in local landfills, then clean-out may be required more frequently than every four to ten years.

Under existing EPA regulations (40 CFR 261), material cleaned from a detention basin should periodically be screened with the Extraction Procedure (EP) toxicity test. This test should be carried out on accumulated sediment within the basin. If the sediment fails the test, it is subject to the Resource Conservation and Recovery Act (RCRA) regulations, and must be disposed of in an approved manner at an RCRA-approved facility. If the EP toxicity test is negative, then sediments are subject to state and local solid waste disposal regulations.

For sediment, which is not classified as a hazardous waste, two major options of disposal are available: onsite and landfill disposal. The area required for onsite disposal must be determined to assure adequate space for sediment disposal. The disposal area should be large enough to stockpile two sediment clean-outs, assuming the area can accept a 12-inch depth of wet sediment for each clean-out (MWCOG, 1987). Any onsite disposal areas must be protected with sediment control measures to prevent material from re-entering the watercourses. The disposal area should be neither in the 100-year floodplain nor in wetlands.

If onsite disposal areas are not available or are inadequate in size, then steps must be taken to transport the material to local landfills. Detention basin sediment is typically accepted at landfills by local government departments of solid waste, if the material has been sufficiently dried to be a "workable material" and can pass an EP toxicity test.

Non-Routine Maintenance

Non-routine or corrective maintenance refers to a rehabilitative activity that is not performed on a regular basis. This would include control structure replacement or a major harvesting of aquatic vegetation.

Erosion and Structural Repair

Areas of erosion and slope failure should be filled and compacted, if necessary, and reseeded (or sodded) as soon as possible. Eroded areas near the inlet or outlet should be revegetated and, if necessary, be filled, compacted, and revegetated or lined with riprap. Damaged side slopes and embankments should be repaired using fill dirt of adequate permeability. Any major damage to outlet structures should be repaired as soon as possible.

Access to detention basins is necessary for excavating equipment, trucks, mowers, and personnel for routine maintenance and erosion repair and for the removal of sediment accumulation. Where access is particularly difficult or impractical, basins should be over-designed to allow for additional sediment accumulation to extend the maintenance interval.

3.2.3 Nonstructural BMPs

3.2.3.1 Land Use Planning

Land use planning and management during redevelopment present an important opportunity to reduce / minimize pollutants in stormwater runoff and control flooding. Management measures may include modification or restrictions of certain land use activities, or requirements regarding onsite flood control. Greater restrictions may be warranted where development can affect impaired, threatened, or significant waterbodies. Because increased pollutant loadings and flooding correspond to increase in impervious coverage, land use planning can become an effective control measure.

3.2.3.2 Public Information Program

A public information and participation plan provides the Town with a strategy for informing its employees, the public, and businesses about the importance of protecting stormwater from improperly used, stored, and disposed pollutants. Many people do not realize that yard debris or trash thrown into ditches today will worsen tomorrow's flooding and pollute surface waters. Municipal employees must be trained, especially those that work in departments not directly related to stormwater, but whose actions affect stormwater. Residents must become aware that a variety of hazardous products are used in the home, and that its improper use and disposal can pollute stormwater. Likewise, improper disposal of oils, antifreeze, paints, and solvents can end up in streams and lakes, poisoning fish and wildlife. If care is taken by individuals to properly dispose of yard debris, trash, and hazardous materials, many problems can be reduced in magnitude or avoided. Increased public awareness also facilitates public scrutiny of industrial and municipal activities and will likely increase public reporting of incidents. Businesses, particularly smaller ones that may not be regulated by Federal, State, or local regulations, must be informed of ways to reduce their potential to pollute stormwater.

3.2.3.3 Fertilizer Application Control

Overuse of fertilizers can cause excessive runoff of nutrients to surface waters, thereby wasting money for the homeowner and potentially degrading the receiving waterbody. This is especially true during heavy rainfall periods that produce yard and neighborhood flooding. In 2008, the Town enacted Ordinance No. 08-15 that provides a fertilizer control program to preserve and protect the nearby waters. The ordinance applies to all fertilizer applications within the town and limits the types that can be used, how and where it can be applied, and the times of the year that it can be applied. It also includes an educational outreach program to the public on the ordinance and the importance of following it. Finally, the ordinance provides enforcement authority.

3.2.3.4 Pesticide Use Control

Some pesticides are priority pollutants (e. g., Endrin, Lindane, and Silvex), which can be toxic. Overuse of these chemicals can cause excessive runoff to surface waters and entry into the food chain. Many professional applicators of pesticides are using approved pesticides in a safe and proper manner. The Town of Fort Myers Beach already has an ordinance that provides a pesticides control program.

3.2.3.5 Solid Waste Management

In some instances, problems can arise from trash and other debris flowing into, and obstructing, open channels, culverts, and storm sewers. It is recommended that additional public information be provided to advise citizens of the adverse impacts of littering and poor solid waste management, including pet droppings, and illegal dumping into storm drains, wooded areas, and ditches. Pet droppings can be a source of coliform bacteria and other pathogens.

3.2.3.6 DCIA Minimization

Another non-structural BMP option available is to minimize the amount of DCIA on a site and promote the use of green buffer zones around paved areas for infiltration. For example, roof runoff from structures can be directed to green buffer zones or shallow swales around houses instead of driveways, leading directly to the street. In addition, parking lots and driveways can be graded to landscaped/grassed areas or swales, reducing direct runoff to the storm drainage system.

3.2.3.7 Street Sweeping

Street sweeping can be an effective method of improving street aesthetics in developed areas and, depending on the type of equipment used, can be an effective pretreatment method of water quality control. In 2009, the Town purchased a new vacuum sweeper that use both brushes and high-powered vacuums. These newer sweepers have been shown to provide a relatively high level of pollutant removal (Sutherland, 1995).

3.2.3.8 Erosion and Sediment Control on Construction Sites

Erosion and sediment control on construction sites provides for the protection of receiving waters from sediment loads. Proper control during construction can be accomplished with gravel filter weirs, sediment fences, and temporary berms or swales for pretreatment and detention areas (temporary or permanent) for down slope control. The Town has inspectors on staff to verify these practices are being used at construction sites.

3.2.3.9 Operation and Maintenance (O&M)

Experience has shown that many treatment facilities are not properly maintained and, therefore, do not provide the intended pollutant removal effectiveness. Because of this, one of the most effective non-structural BMPs is routine maintenance of existing treatment facilities. Therefore, the Town is moving forward with a routine O&M program that builds upon the work already being done by focusing on areas where a

For publicly owned treatment facilities, routine maintenance and inspection should be performed at least quarterly. For privately owned facilities, maintenance is not typically performed by a municipality. There are several options that can be pursued by a municipality to help ensure that proper maintenance is being conducted. These options include a certification program, initiated by a municipality, that requires all approved subdivision ponds (private) to be recertified by the owner on a predetermined time interval (e.g., annually). The recertification may be done by a state certified/trained inspector or engineer. Enforcement of maintenance is one of the most difficult problems for privately owned facilities.

Under the NPDES Phase II stormwater permitting program, the Town is liable for the quality from private facilities, if the private facility discharges into a conveyance system, owned and operated by the Town. Potential enforcement measures may include intervention (after sufficient notification), where critical maintenance is done by the Town, and the cost of the maintenance is billed to the owner or by other means, as deemed necessary to the municipality. Another option would be to consider the assessment of fines.

3.3 Model Results and Analysis

While no calibration was performed for this study, all the parameters incorporated in WMM for this project are the same as those developed for the calibrated model of the Estero Bay - Caloosahatchee River Nutrient Loading Assessment Study (EBCRNLAP). Therefore, it is expected that the estimation of pollutant loads for the HUs in this project are comparable with that from the EBCRNLAP.

Results for existing and future land use conditions are provided in the following sections, as well as dry and wet season estimates for the existing condition. The WMM estimated annual flow and load are provided in an output text file in acre-feet per year (acre-feet/year) and in pounds per year (lb/year) for each HU.

3.3.1 Existing Conditions Model

Table 3-6 provides a summary of WMM estimated average annual flows and loads for each HU and per problem area. As stated previously, the results presented in Table 3-8 include only runoff as pollutant loading source reduced by existing BMPs; septic tanks and point sources were not identified in the study area; and, baseflow was not considered in the simulation runs. The WMM estimated flow and loads were standardized by their respective HU area to create unit area loads (UALs) allowing direct comparison among HUs. Therefore, the UALs units become lb/year/acre for the water quality parameters; and, inches/year for the average annual flow. The UALs allowed the identification of different levels of concentration that were defined by those equal or below the 25^{th} percentile, for the lower than average level of concentration; between the 25^{th} and 75^{th} percentile, for the medium level of concentration; and, those equal or above the 75^{th} percentile, for the higher than average levels of concentration.

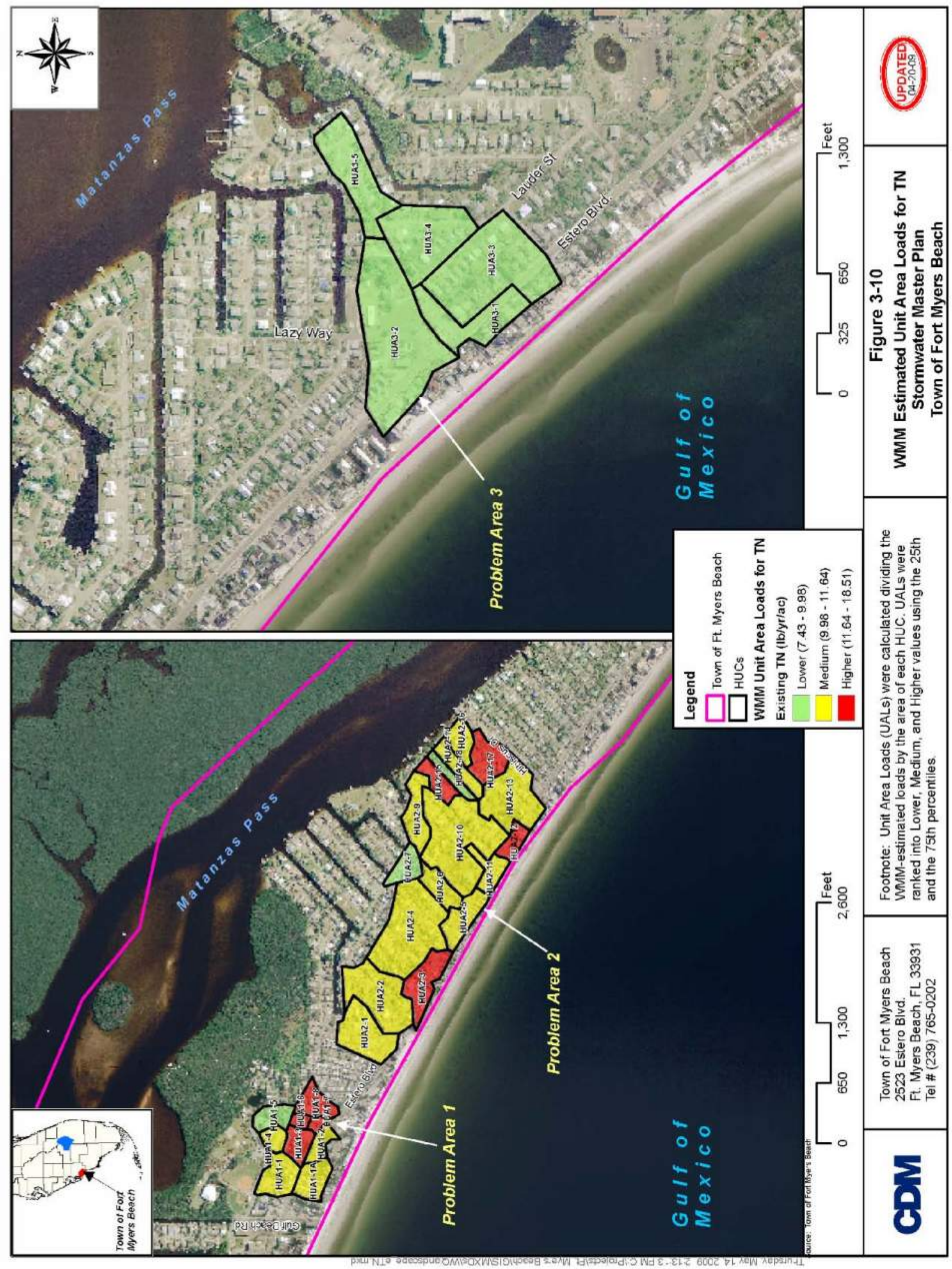
The UALs classification previously described is represented in **Figure 3-10** through **Figure 3-12** for total nitrogen (TN), TP, and BOD, respectively, which provides an insight on the HUs and general areas where above-average loadings are expected. The higher load areas identified in red should be the focus of attention to have a significant impact in nutrient loading reduction. The fact that HUs are relatively small, makes them highly sensitive to small differences in land use from one HU to the next. The sources of expectedly high loads of TN and TP in urban land uses are mostly associated to the use of fertilizers, plant matter, and road runoff. These nutrients typically are present in stormwater runoff in either dissolved (40%–50%) or particulate state (50%-60%). BMPs such as swales, dry retention, dry detention, and wet detention have removal efficiencies of these constituents as high as 40 percent, 90 percent, 30 percent, and 30 to 50 percent, respectively.

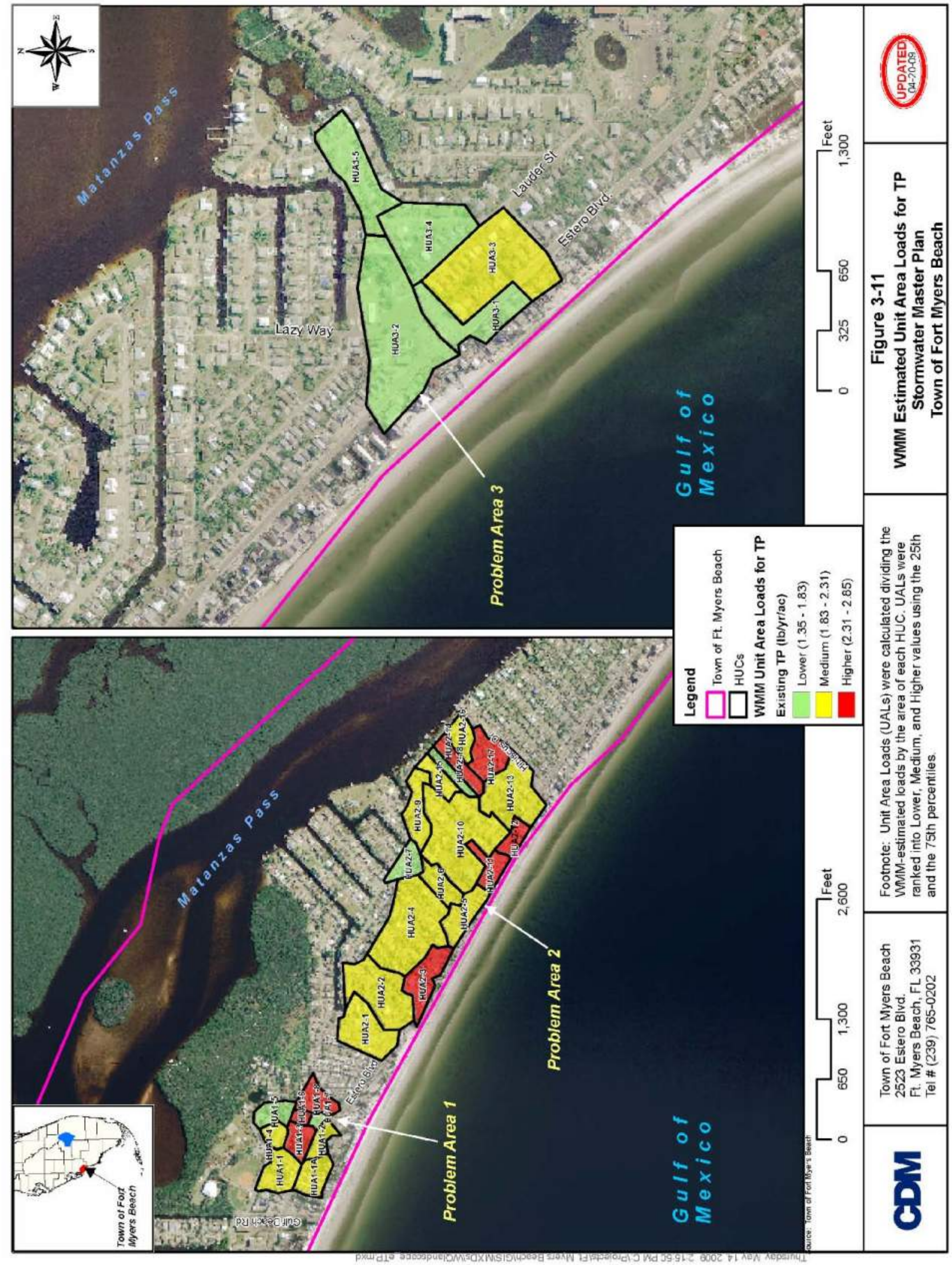
Table 3-6 indicates that even though problem area 1 is smaller than problem area 3, the total annual estimated load in this area is greater for every water quality parameter than in problem area 3, which is most likely due to the predominance of land uses with higher impervious area.

Table 3-6. Average Calibrated Annual Loads for the Three Problem Areas in Fort Myers Beach – Existing Land Use

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
Problem Area 1																
1. HUA1-1	3.7	29.4%	1.1	6.0	131	0.0	871	0.5	5.0	10.0	1.0	2,461	29	8	994	1.0
2. HUA1-1A	3.0	30.0%	0.9	5.0	115	0.0	764	0.5	4.0	9.0	1.0	2,033	26	7	1,038	0.9
3. HUA1-2	1.8	30.1%	0.5	3.0	67	0.0	444	0.3	3.0	5.0	0.7	1,178	15	4	602	0.6
4. HUA1-3	2.2	79.9%	1.8	8.0	298	0.0	1,768	0.5	4.0	9.0	0.5	2,782	32	6	1,645	3.0
5. HUA1-4	1.5	39.0%	0.6	3.0	86	0.0	548	0.2	2.0	4.0	0.2	1,274	12	3	395	0.7
6. HUA1-5	2.2	27.6%	0.6	4.0	88	0.0	603	0.2	3.0	5.0	0.2	1,648	15	4	415	0.7
7. HUA1-6	0.7	81.0%	0.6	3.0	96	0.0	567	0.2	1.0	3.0	0.2	888	10	2	526	0.9
8. HUA1-7	0.5	80.2%	0.4	2.0	74	0.0	436	0.1	1.0	2.0	0.1	686	8	1	406	0.7
9. HUA1-8	2.6	45.5%	1.2	6.0	189	0.0	1,186	0.4	4.0	8.0	0.6	2,341	26	6	1,150	2.0
Subtotal	**18.3**	**42.0%**	**7.7**	**40.0**	**1,144**	**0.1**	**7,187**	**2.7**	**27.0**	**55.0**	**4.5**	**15,291**	**173.0**	**41.0**	**7,171**	**10.5**
Problem Area 2																
10. HUA2-1	6.2	29.3%	1.8	11.0	236	0.0	1,574	0.9	9.0	18.0	2.0	4,198	53	14	2,067	2.0
11. HUA2-10	14.6	30.0%	4.4	25.0	548	0.1	3,634	2.0	21.0	43.0	6.0	9,740	124	33	4,841	4.0
12. HUA2-11	2.5	30.0%	0.7	4.0	94	0.0	623	0.4	4.0	7.0	1.0	1,657	21	6	846	0.8
13. HUA2-12	1.7	30.0%	0.5	3.0	65	0.0	428	0.3	2.0	5.0	0.7	1,141	15	4	579	0.5
14. HUA2-13	8.1	30.0%	2.4	14.0	292	0.0	1,935	1.0	11.0	23.0	3.0	5,338	65	18	2,386	2.0
15. HUA2-14	1.5	30.0%	0.4	3.0	41	0.0	272	0.1	2.0	3.0	0.2	903	8	2	140	0.3
16. HUA2-15	2.2	30.0%	0.7	4.0	84	0.0	554	0.3	3.0	7.0	0.9	1,475	19	5	753	0.7
17. HUA2-16	2.3	30.0%	0.7	4.0	89	0.0	590	0.4	3.0	7.0	1.0	1,570	20	5	802	0.7
18. HUA2-17	3.9	30.0%	1.2	7.0	148	0.0	978	0.6	6.0	12.0	2.0	2,602	34	9	1,329	1.0
19. HUA2-18	2.5	30.0%	0.7	4.0	94	0.0	620	0.4	4.0	7.0	1.0	1,665	21	6	824	0.8
20. HUA2-2	8.6	29.3%	2.5	15.0	313	0.0	2,087	1.0	12.0	24.0	3.0	5,741	69	19	2,562	2.0
21. HUA2-3	4.5	30.0%	1.4	8.0	172	0.0	1,138	0.7	6.0	14.0	2.0	3,028	39	11	1,546	1.0
22. HUA2-4	13.2	30.0%	4.0	23.0	491	0.1	3,255	2.0	19.0	38.0	5.0	8,774	111	30	4,275	4.0
23. HUA2-5	3.7	30.0%	1.1	6.0	138	0.0	917	0.5	5.0	11.0	1.0	2,460	31	8	1,219	1.0
24. HUA2-6	2.7	30.0%	0.8	5.0	93	0.0	618	0.3	4.0	7.0	0.9	1,744	21	6	710	0.7
25. HUA2-7	2.4	28.9%	0.7	4.0	76	0.0	511	0.3	3.0	5.0	0.6	1,522	16	4	464	0.6
26. HUA2-9	4.0	27.4%	1.1	7.0	148	0.0	1,014	0.5	5.0	11.0	1.0	2,717	32	8	1,200	1.0
Subtotal	**84.5**	**29.7%**	**25.1**	**147.0**	**3,122**	**0.4**	**20,748**	**11.5**	**119.0**	**242.0**	**31.2**	**56,275**	**699.0**	**188.0**	**26,543**	**22.9**
Problem Area 3																
27. HUA3-1	2.3	23.0%	0.5	3.0	85	0.0	612	0.2	3.0	5.0	0.4	1,656	17	4	555	0.7
28. HUA3-2	7.0	23.0%	1.6	10.0	251	0.0	1,809	0.6	8.0	15.0	1.0	4,956	50	12	1,595	2.0
29. HUA3-3	5.4	23.0%	1.3	8.0	199	0.0	1,440	0.5	6.0	12.0	0.9	3,900	40	10	1,306	2.0
30. HUA3-4	3.4	23.0%	0.8	5.0	122	0.0	884	0.3	4.0	7.0	0.5	2,406	24	6	791	1.0
31. HUA3-5	2.8	23.0%	0.6	4.0	101	0.0	728	0.3	3.0	6.0	0.4	1,974	20	5	659	0.8
Subtotal	**20.8**	**23.0%**	**4.8**	**30.0**	**758**	**0.1**	**5,473**	**1.9**	**24.0**	**45.0**	**3.2**	**14,892**	**151.0**	**37.0**	**4,906**	**6.5**
Total	**123.6**	**30.4%**	**37.6**	**217**	**5,024**	**0.6**	**33,408**	**16**	**170**	**342**	**39**	**86,458**	**1,023**	**266**	**38,620**	**40**

Notes: 1. Flow includes stormwater runoff only (septic tank, baseflow, and point source were not included).
2. Existing BMPs are included.
3. The total percent impervious is an area-weighted composite.


Matanzas Pass
Matanzas Pass
Lazy Way
Lauder St
Estero Blvd.
Estero Blvd
Gulf Beach Rd
Problem Area 1
Problem Area 2
Problem Area 3
Gulf of Mexico
Gulf of Mexico
Town of Fort Myers Beach
0 650 1,300 2,600 Feet
0 325 650 1,300 Feet
Legend
Town of Ft. Myers Beach
HUCs
WMM Unit Area Loads for TN
Existing TN (lb/yr/ac)
Lower (7.43 - 9.98)
Medium (9.98 - 11.64)
Higher (11.64 - 18.51)
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Footnote: Unit Area Loads (UALs) were calculated dividing the WMM-estimated loads by the area of each HUC. UALs were ranked into Lower, Medium, and Higher values using the 25th and the 75th percentiles.
Figure 3-10
WMM Estimated Unit Area Loads for TN
Stormwater Master Plan
Town of Fort Myers Beach
UPDATED 04-20-09
CDM


Matanzas Pass
Lazy Way
Lauder St
Estero Blvd.
HUA3-1
HUA3-2
HUA3-3
HUA3-4
HUA3-5
Problem Area 3
Gulf of Mexico
0 325 650 1,300 Feet
Matanzas Pass
Estero Blvd
Gulf Beach Rd
Problem Area 1
Problem Area 2
Gulf of Mexico
Town of Fort Myers Beach
0 650 1,300 2,600 Feet
Legend
Town of Ft. Myers Beach
HUCs
WMM Unit Area Loads for TP
Existing TP (lb/yr/ac)
Lower (1.35 - 1.83)
Medium (1.83 - 2.31)
Higher (2.31 - 2.85)
Footnote: Unit Area Loads (UALs) were calculated dividing the WMM-estimated loads by the area of each HUC. UALs were ranked into Lower, Medium, and Higher values using the 25th and the 75th percentiles.
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
UPDATED 04-20-09
Figure 3-11
WMM Estimated Unit Area Loads for TP
Stormwater Master Plan
Town of Fort Myers Beach

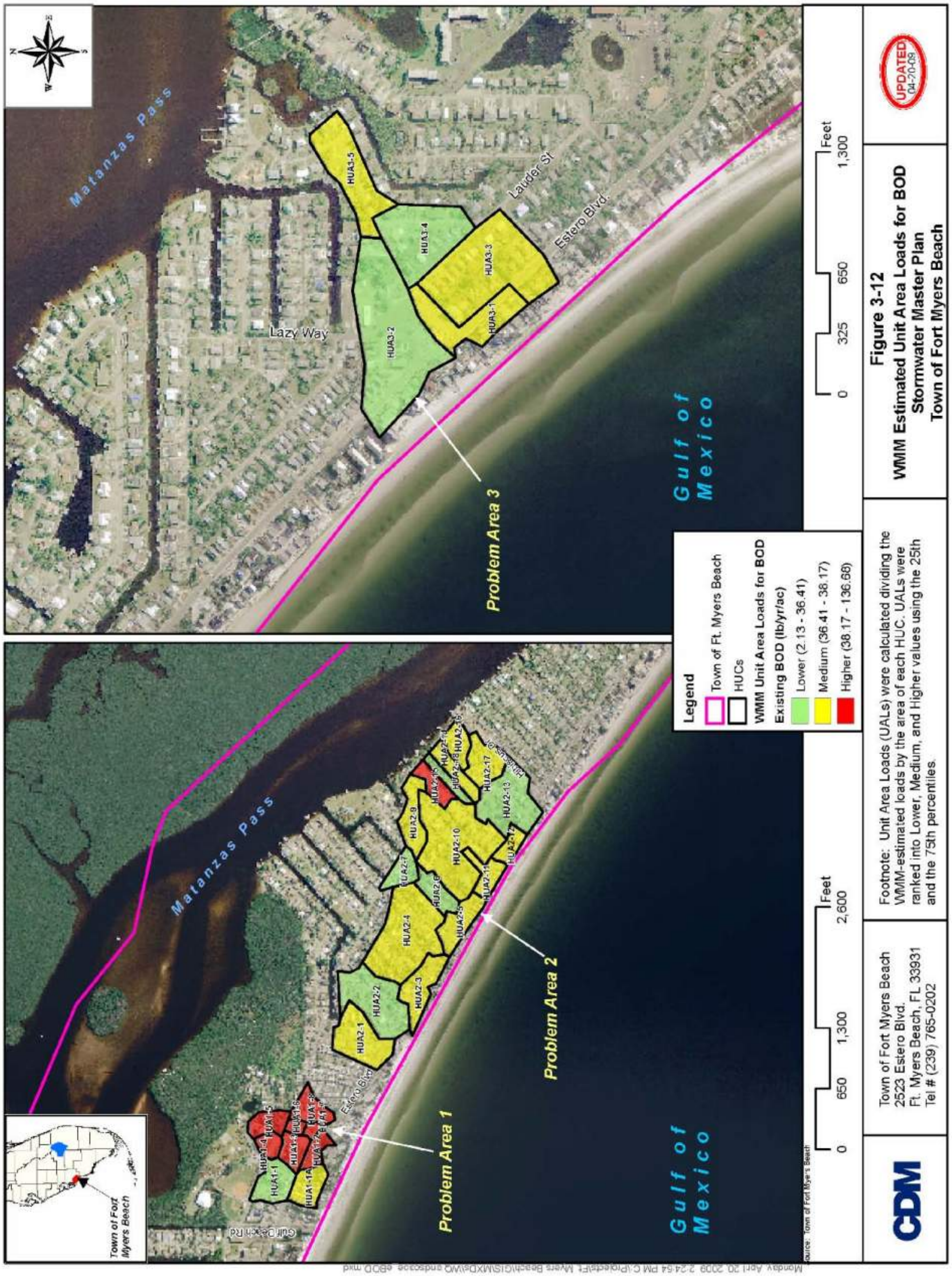


Figure 3-12
WMM Estimated Unit Area Loads for BOD
Stormwater Master Plan
Town of Fort Myers Beach
Legend
Town of Ft. Myers Beach
HUCs
WMM Unit Area Loads for BOD
Existing BOD (lb/yr/ac)
Lower (2.13 - 36.41)
Medium (36.41 - 38.17)
Higher (38.17 - 136.68)
Footnote: Unit Area Loads (UALs) were calculated dividing the WMM-estimated loads by the area of each HUC. UALs were ranked into Lower, Medium, and Higher values using the 25th and the 75th percentiles.
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Problem Area 1
Problem Area 2
Problem Area 3
Matanzas Pass
Gulf of Mexico
Lazy Way
Lauder St
Estero Blvd.
Feet
0
325
650
1,300
2,600
UPDATED 04-20-09

3.3.2 Wet and Dry Seasonal Models

Wet and dry seasonal periods were determined in Section 3.1.3.1 for the study area using historical rainfall data from the Ft Myers_R gauge located at the Page Field Airport, in Fort Myers. Wet season comprises the period from May through October, whereas, the dry season period season starts from November through April. As stated previously, the wet season accounts for 79 percent of the average annual rainfall in the study area. Flows and loads for each season are distributed accordingly to the rainfall ratio of the season with respect to the average annual rainfall.

Table 3-7 provides flows and loads of selected water quality parameters for wet and dry seasons.

3.3.3 Future Condition Model

Similarly as for the existing conditions model, the future land use coverage was incorporated into WMM and respective EMCs were applied for estimating average annual loads. Information regarding future BMPs was not identified for the study area; therefore, the coverage of existing BMPs was also used for the future conditions. This simulation run, with the existing BMP coverage, is considered from this point forward in the report as the future base run to which future condition runs of proposed BMPs will be compared against.

Table 3-8 provides a summary of WMM estimated flows and loads for the future base condition for each HU. **Figure 3-13** and **Figure 3-14** show the spatial distribution of TN and BOD UALs, respectively, for the future base condition. For comparison purposes, the thresholds defining the lower, medium, and higher levels of concentrations were kept the same as in the existing condition scenario. These results were generated based on the future land use as provided by the SFWMD and including the adjustment to the land use transition suggested by the Town.

As shown in Figures 3-13 and 3-14, an increase in nutrient loading is expected in areas where a land use transition from high density residential to commercial land use will occur in the future conditions. These areas are located within HUA1-1A and HUA1-2; and HUA2-1 through HUA2-3. **Table 3-9** suggests that a higher increase in BOD and metals is expected than nutrients such as TN and TP.

Table 3-7. WMM Seasonal Flow and Loads for each HU and Selected Parameters.

Hydrologic Units	Runoff (cfm)			Total Nitrogen (lb/yr)			Total Phosphorus (lb/yr)			Biochemical Oxygen Demand (lb/yr)			Zinc (lb/yr)			Lead (lb/yr)		
	Wet	Dry	Total	Wet	Dry	Total	Wet	Dry	Total	Wet	Dry	Total	Wet	Dry	Total	Wet	Dry	Total
Problem Area 1																		
1 HUA1-1	0.41	0.08	0.50	31.0	8.0	39.0	6.0	2.0	8.0	103	28	131	0.8	0.2	1.0	0.95	0.25	1.00
2 HUA1-1A	0.33	0.08	0.41	28.0	8.0	35.0	6.0	1.0	7.0	91	24	115	0.7	0.2	0.9	0.99	0.27	1.00
3 HUA1-2	0.17	0.05	0.25	16.0	4.0	20.0	3.0	0.9	4.0	53	14	67	0.4	0.1	0.6	0.57	0.15	0.72
4 HUA1-3	0.50	0.17	0.66	32.0	9.0	41.0	5.0	1.0	6.0	235	63	298	2.0	0.6	3.0	0.40	0.11	0.51
5 HUA1-4	0.17	0.05	0.25	13.0	3.8	16.0	2.0	0.6	3.0	68	18	86	0.6	0.2	0.7	0.13	0.03	0.16
6 HUA1-5	0.25	0.06	0.33	16.0	4.0	20.0	3.0	0.8	4.0	69	19	88	0.5	0.1	0.7	0.19	0.05	0.24
7 HUA1-6	0.17	0.04	0.25	10.0	2.6	13.0	2.0	0.4	2.0	75	20	96	0.7	0.2	0.9	0.12	0.03	0.16
8 HUA1-7	0.17	0.03	0.17	8.0	2.5	10.0	1.0	0.3	1.0	58	16	74	0.6	0.2	0.7	0.10	0.03	0.12
9 HUA1-8	0.41	0.08	0.50	27.0	8.0	34.0	5.0	1.0	6.0	149	40	189	1.0	0.4	2.0	0.47	0.13	0.60
Subtotal	**2.57**	**0.66**	**3.32**	**0.0**	**0**	**0.0**	**33.0**	**7.9**	**41.0**	**901**	**242**	**1,144**	**7.3**	**2.1**	**10.5**	**3.9**	**1.05**	**4.51**
Problem Area 2																		
10 HUA2-1	0.66	0.17	0.91	56.0	15.0	71.0	11.0	3.0	14.0	186	50	236	2.0	0.4	2.0	2.00	0.51	2.00
11 HUA2-10	1.66	0.41	2.07	132.0	35.0	167.0	26.0	7.0	33.0	432	116	548	3.0	0.9	4.0	5.00	1.00	6.00
12 HUA2-11	0.25	0.08	0.33	23.0	7.0	28.0	5.0	1.0	6.0	74	20	94	0.6	0.2	0.8	0.81	0.22	1.00
13 HUA2-12	0.17	0.05	0.25	16.0	4.0	20.0	3.0	0.8	4.0	51	14	65	0.4	0.1	0.5	0.55	0.15	0.70
14 HUA2-13	0.91	0.25	1.16	69.0	19.0	88.0	14.0	4.0	18.0	230	62	292	2.0	0.5	2.0	2.00	0.62	3.00
15 HUA2-14	0.17	0.05	0.25	8.0	2.6	11.0	2.0	0.5	2.0	32	9	41	0.2	0.1	0.3	0.15	0.04	0.20
16 HUA2-15	0.25	0.07	0.33	20.0	5.0	26.0	4.0	1.0	5.0	66	18	84	0.5	0.1	0.7	0.72	0.19	0.91
17 HUA2-16	0.25	0.07	0.33	22.0	5.0	27.0	4.0	1.0	5.0	70	19	89	0.6	0.2	0.7	0.76	0.21	0.97
18 HUA2-17	0.41	0.08	0.58	35.0	9.0	46.0	7.0	2.0	9.0	116	31	148	1.0	0.3	1.0	1.00	0.34	2.00
19 HUA2-2	0.25	0.08	0.33	23.0	6.0	28.0	4.0	1.0	6.0	74	20	94	0.6	0.2	0.8	0.79	0.21	1.00
20 HUA2-3	0.99	0.25	1.24	74.0	20.0	93.0	15.0	4.0	19.0	246	66	313	2.0	0.5	2.0	2.00	0.65	3.00
21 HUA2-4	0.50	0.17	0.66	42.0	11.0	53.0	8.0	2.0	11.0	135	36	172	1.0	0.3	1.0	1.00	0.40	2.00
22 HUA2-5	1.49	0.41	1.91	117.0	32.0	149.0	24.0	6.0	30.0	387	104	491	3.0	0.8	4.0	4.00	1.00	5.00
23 HUA2-6	0.41	0.08	0.50	34.0	9.0	42.0	7.0	2.0	8.0	109	29	138	0.9	0.2	1.0	1.00	0.31	1.00
24 HUA2-7	0.33	0.08	0.41	22.0	6.0	28.0	4.0	1.0	6.0	73	20	93	0.6	0.2	0.7	0.69	0.19	0.87
25 HUA2-9	0.25	0.07	0.33	17.0	4.0	21.0	3.0	0.9	4.0	60	16	76	0.4	0.1	0.6	0.43	0.12	0.55
26 HUA2-9	0.41	0.08	0.58	33.0	9.0	43.0	7.0	2.0	8.0	117	31	148	1.0	0.3	1.0	0.99	0.27	1.00
Subtotal	**9.37**	**2.45**	**12.18**	**0.0**	**0.0**	**0.0**	**148.0**	**39.2**	**188.0**	**2,458**	**661**	**3,122**	**19.7**	**5.3**	**22.9**	**23.9**	**6.4**	**31.2**
Problem Area 3																		
26 HUA3-1	0.00	0.00	0.00	17.0	5.0	22.0	3.0	0.9	4.0	67	18	85	0.5	0.2	0.7	0.29	0.08	0.37
27 HUA3-2	0.25	0.06	0.25	51.0	13.0	65.0	10.0	3.0	12.0	197	53	251	2.0	0.4	2.0	0.83	0.22	1.00
28 HUA3-3	0.66	0.17	0.83	41.0	11.0	52.0	8.0	2.0	10.0	157	42	199	1.0	0.3	2.0	0.68	0.18	0.86
30 HUA3-4	0.50	0.17	0.66	25.0	7.0	31.0	5.0	1.0	6.0	96	26	122	0.8	0.2	1.0	0.41	0.11	0.52
31 HUA3-5	0.33	0.08	0.41	21.0	5.0	26.0	4.0	1.0	5.0	79	21	101	0.6	0.2	0.8	0.34	0.09	0.44
Subtotal	**0.25**	**0.07**	**0.33**	**0.0**	**0**	**0.0**	**30.0**	**7.9**	**37.0**	**596**	**160**	**758**	**5.0**	**1.3**	**6.5**	**2.6**	**0.7**	**3.2**
Total	**1.99**	**0.55**	**2.49**	**1,079**	**289**	**1,365**	**211.0**	**55**	**266**	**3,955**	**1,063**	**5,024**	**32.0**	**8.7**	**39.9**	**30.4**	**8.2**	**38.9**

Notes: 1. Flow includes stormwater runoff only (septic tank, baseflow, and point source were not included).
2. Existing BMPs are included.
3. The total percent impervious is an area-weighted composite.
4. Wet season corresponds to the months of May through October.
5. Dry season corresponds to the months of November through April.

3.3.4 Proposed BMPs in WMM

In Section 4 of this report, a number of BMPs for each problem area are proposed to provide infiltration and treatment as well as conveyance. A summary of the proposed BMPs is presented in **Appendix E, Table E-2**. Details on the calculations presented in Appendix E are included in Section 4.

In order to apply these proposed BMP systems into WMM, a footprint of the tributary area to each system must be defined. For this purpose, and using the general conditions specified in Section 4 and formulae included in the calculations for Table E-1, the 1-year 2.5-inch storm volume was used to back-calculate the tributary area for each BMP. The tributary area was delineated based on topography, vicinity to the proposed BMP system, and the existing stormwater infrastructure.

Figure 3-15 shows the delineation of the tributary areas of the proposed BMPs.

3.3.5 Future Condition Model with Proposed BMPs

After developing the tributary areas for the proposed BMPs, detailed in Section 4 of this report, a new BMP coverage was developed including existing and proposed treatment systems to be included in WMM. The simulations presented in this section include this new BMP coverage applied to the future land use conditions.

Figure 3-16 and **Figure 3-17** show the spatial distribution of TN and BOD UALs, respectively, for the future land use condition and the estimated benefit of the proposed BMPs. Comparing Figure 3-16 and Figure 3-17 with their respective figures for the future base and existing scenarios, it suggests that the treatment provided by the proposed BMPs outweighs the increase in loading expected from the future base scenario.

Table 3-9 provides a comparison of UALs for the existing, future base, and future with proposed BMPs scenarios, for selected water quality parameters. The results provided in Table 3-9 not only verify the fact that this scenario outweighs the increase in loading from the future base scenario, but also suggest that by implementing the proposed BMPs, it is expected to reduce the existing loading levels by 5 and 8% in nutrient loading as TN and TP, respectively.

Table 3-8. Average Calibrated Annual Loads for the Three Problem Areas in Fort Myers Beach – Future Use

Hydrologic Units	Area (acres)	Imp. Area (%)	Imp. Area (acres)	Flow (ac-ft/yr)	BOD (lbs/yr)	Cd (lbs/yr)	COD (lbs/yr)	Cu (lbs/yr)	DP (lbs/yr)	NO23 (lbs/yr)	Pb (lbs/yr)	TDS (lbs/yr)	TKN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Zn (lbs/yr)
Problem Area 1																
1. HUA1-1	3.7	38.5%	1.4	8.0	189	0.0	1,203	0.5	5.0	10.0	1.0	2,849	32	8	1,179	2.0
2. HUA1-1A	3.0	80.4%	2.4	11.0	409	0.1	2,428	0.7	6.0	12.0	0.7	3,814	43	8	2,257	4.0
3. HUA1-2	1.8	81.0%	1.4	6.0	239	0.0	1,416	0.4	3.0	7.0	0.4	2,218	25	5	1,313	2.0
4. HUA1-3	2.2	81.0%	1.8	8.0	303	0.0	1,794	0.5	4.0	9.0	0.5	2,810	32	6	1,664	3.0
5. HUA1-4	1.5	37.3%	0.5	3.0	81	0.0	524	0.2	2.0	4.0	0.2	1,250	12	3	373	0.7
6. HUA1-5	2.2	25.9%	0.6	4.0	81	0.0	565	0.2	2.0	5.0	0.2	1,609	15	3	380	0.6
7. HUA1-6	0.7	81.0%	0.6	3.0	96	0.0	567	0.2	1.0	3.0	0.2	888	10	2	526	0.9
8. HUA1-7	0.5	81.0%	0.4	2.0	74	0.0	441	0.1	1.0	2.0	0.1	691	8	1	410	0.7
9. HUA1-8	2.6	44.9%	1.2	6.0	172	0.0	1,068	0.5	4.0	8.0	0.9	2,178	27	6	1,190	2.0
Subtotal	**18.3**	**56.9%**	**10.4**	**51.0**	**1,644**	**0.2**	**10,006**	**3.2**	**28.0**	**60.0**	**4.2**	**18,307**	**204.0**	**42.0**	**9,292**	**15.9**
Problem Area 2																
10. HUA2-1	6.2	51.4%	3.2	16.0	502	0.1	3,084	1.0	10.0	21.0	2.0	5,817	68	15	3,158	5.0
11. HUA2-10	14.6	28.4%	4.1	25.0	544	0.1	3,671	2.0	20.0	41.0	5.0	9,886	120	32	4,508	4.0
12. HUA2-11	2.5	29.5%	0.7	4.0	94	0.0	625	0.4	3.0	7.0	1.0	1,665	21	6	827	0.8
13. HUA2-12	1.7	28.8%	0.5	3.0	64	0.0	430	0.2	2.0	5.0	0.6	1,153	14	4	547	0.5
14. HUA2-13	8.1	28.0%	2.3	14.0	276	0.0	1,866	0.9	11.0	20.0	2.0	5,356	59	16	2,018	2.0
15. HUA2-14	1.5	30.0%	0.4	3.0	41	0.0	272	0.1	2.0	3.0	0.2	903	8	2	139	0.3
16. HUA2-15	2.2	30.0%	0.7	4.0	84	0.0	555	0.3	3.0	7.0	0.9	1,475	19	5	753	0.7
17. HUA2-16	2.3	30.0%	0.7	4.0	89	0.0	590	0.4	3.0	7.0	1.0	1,570	20	5	802	0.7
18. HUA2-17	3.9	30.0%	1.2	7.0	148	0.0	978	0.6	6.0	12.0	2.0	2,602	34	9	1,329	1.0
19. HUA2-18	2.5	30.0%	0.7	4.0	94	0.0	620	0.4	4.0	7.0	1.0	1,665	21	6	821	0.8
20. HUA2-2	8.6	47.5%	4.1	21.0	609	0.1	3,777	1.0	13.0	26.0	2.0	7,643	85	19	3,597	5.0
21. HUA2-3	4.5	30.0%	1.4	8.0	172	0.0	1,138	0.7	6.0	14.0	2.0	3,028	39	11	1,546	1.0
22. HUA2-4	13.2	30.0%	4.0	23.0	491	0.1	3,255	2.0	19.0	38.0	5.0	8,774	111	30	4,275	4.0
23. HUA2-5	3.7	29.5%	1.1	6.0	138	0.0	920	0.5	5.0	11.0	1.0	2,471	31	8	1,192	1.0
24. HUA2-6	2.7	30.0%	0.8	5.0	93	0.0	618	0.3	4.0	7.0	0.9	1,744	21	6	710	0.7
25. HUA2-7	2.4	29.0%	0.7	4.0	76	0.0	510	0.3	3.0	5.0	0.6	1,520	16	4	464	0.5
26. HUA2-9	4.0	27.4%	1.1	7.0	148	0.0	1,014	0.5	5.0	11.0	1.0	2,717	32	8	1,201	1.0
Subtotal	**84.5**	**32.7%**	**27.6**	**158.0**	**3,663**	**0.5**	**23,923**	**11.5**	**119.0**	**242.0**	**28.1**	**59,989**	**719.0**	**186.0**	**27,887**	**28.9**
Problem Area 3																
27. HUA3-1	2.3	41.6%	1.0	5.0	158	0.0	1,014	0.3	3.0	6.0	0.4	2,063	22	5	932	1.0
28. HUA3-2	7.0	30.5%	2.1	12.0	340	0.0	2,297	0.8	8.0	17.0	1.0	5,448	56	13	2,053	3.0
29. HUA3-3	5.4	28.5%	1.5	9.0	250	0.0	1,718	0.6	6.0	13.0	0.9	4,181	43	10	1,567	2.0
30. HUA3-4	3.4	23.0%	0.8	5.0	122	0.0	884	0.3	4.0	7.0	0.5	2,406	24	6	791	1.0
31. HUA3-5	2.7	23.0%	0.6	4.0	100	0.0	724	0.3	3.0	6.0	0.4	1,962	20	5	655	0.8
Subtotal	**20.8**	**29.0%**	**6.0**	**35.0**	**970**	**0.1**	**6,637**	**2.2**	**24.0**	**49.0**	**3.3**	**16,060**	**165.0**	**39.0**	**5,998**	**7.8**
Total	**123.6**	**35.6%**	**44.1**	**244**	**6,277**	**0.8**	**40,566**	**17**	**171**	**351**	**36**	**94,356**	**1,088**	**267**	**43,177**	**53**
% Diff. with Existing	**0%**	**17%**	**17%**	**12%**	**25%**	**28%**	**21%**	**5%**	**1%**	**3%**	**-9%**	**9%**	**6%**	**0%**	**12%**	**32%**

Notes: 1. Flow includes stormwater runoff only (septic tank, baseflow, and point source were not included).
2. Existing BMPs are included.
3. The total percent impervious is an area-weighted composite.

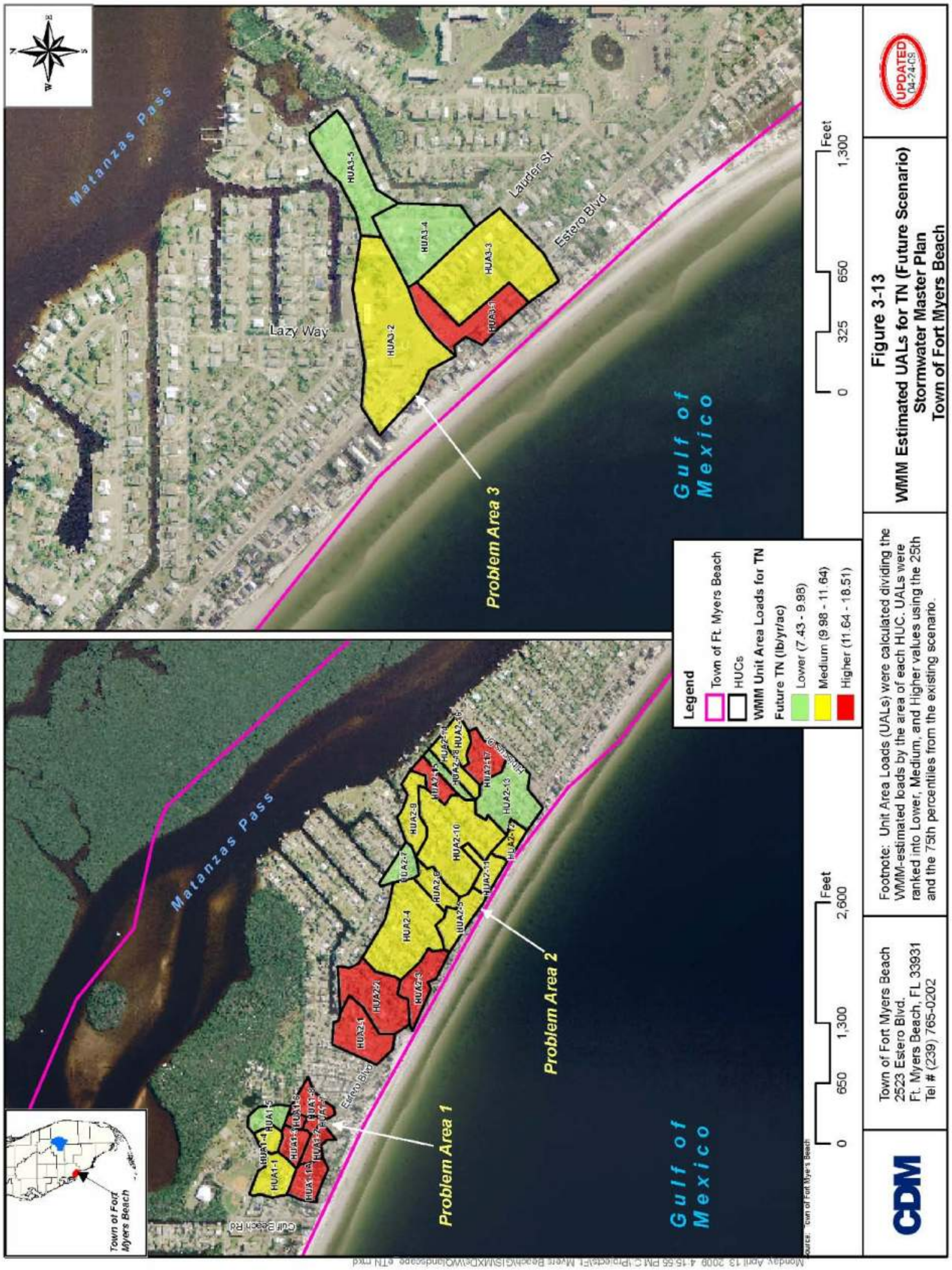
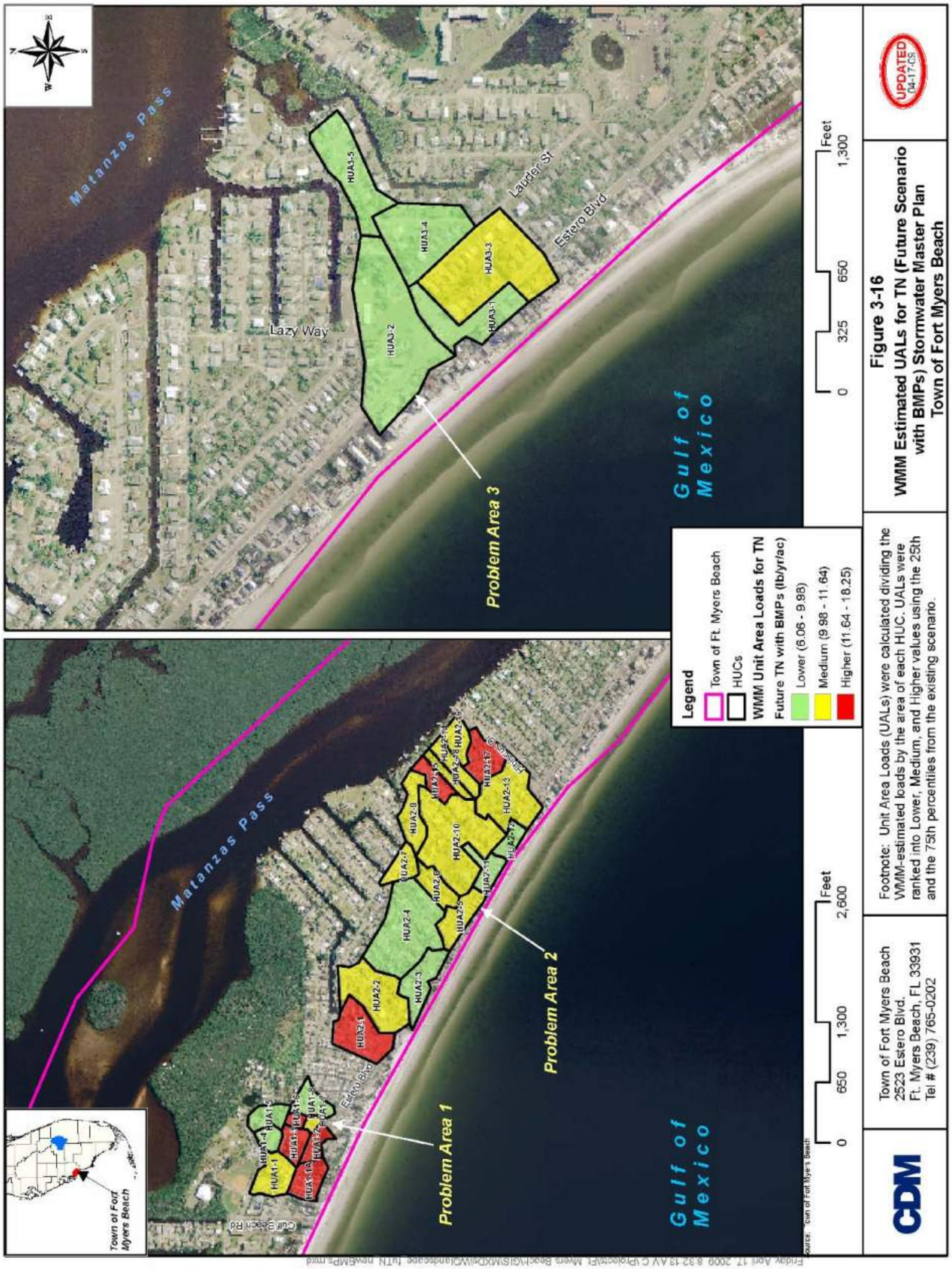


Figure 3-13
WMM Estimated UALs for TN (Future Scenario)
Stormwater Master Plan
Town of Fort Myers Beach

Figure 3-14
WMM Estimated UALs for BOD (Future Scenario)
Stormwater Master Plan
Town of Fort Myers Beach


Matanzas Pass
Lazy Way
Lauder St
Estero Blvd
Problem Area 3
Gulf of Mexico
HUA3-1
HUA3-2
HUA3-3
HUA3-4
HUA3-5
0
325
650
1,300
Feet
Legend
HUCs
Town of Ft. Myers Beach
Dry Detention
Exfiltration and Baffle Box
Swale
Retention
Matanzas Pass
Problem Area 1
Problem Area 2
Gulf of Mexico
Gulf Beach Rd
Estero Blvd
Town of Fort Myers Beach
0
650
1,300
2,600
Feet
CDM
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Footnote: Tributary areas estimated based on expected level of treatment for the 1-year 2.5-inch FDOT storm.
Figure 3-15
Estimated Tributary Areas for Proposed BMPs
Stormwater Master Plan
Town of Fort Myers Beach
UPDATED 04-20-09


Matanzas Pass
Gulf of Mexico
Problem Area 1
Problem Area 2
Problem Area 3
Estero Blvd
Lauder St
Lazy Way
Gulf Beach Rd
Town of Fort Myers Beach
Legend
Town of Ft. Myers Beach
HUCs
WMM Unit Area Loads for TN
Future TN with BMPs (lb/yr/ac)
Lower (6.06 - 9.98)
Medium (9.98 - 11.64)
Higher (11.64 - 18.25)
0 650 1,300 2,600 Feet
0 325 650 1,300 Feet
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Footnote: Unit Area Loads (UALs) were calculated dividing the WMM-estimated loads by the area of each HUC. UALs were ranked into Lower, Medium, and Higher values using the 25th and the 75th percentiles from the existing scenario.
Figure 3-16
WMM Estimated UALs for TN (Future Scenario with BMPs) Stormwater Master Plan
Town of Fort Myers Beach
UPDATED 04-17-09
CDM

Footnote: Unit Area Loads (UALs) were calculated dividing the WMM-estimated loads by the area of each HUC. UALs were ranked into Lower, Medium, and Higher values using the 25th and the 75th percentiles from the existing scenario.

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Figure 3-17
WMM Estimated UALs for BOD (Future Scenario with BMPs) Stormwater Master Plan
Town of Fort Myers Beach

UPDATED 04-17-09

Table 3-9. Comparison of Unit Area Loads Among the Scenarios

	Hydrologic Units	Area	Unit Area Loads (lb/yr/ac) for Existing Scenario					Future Scenario (% Difference with Respect to Existing)					Future Scenario with Proposed BMPs (% Difference with Respect to Existing)				
		(acres)	TP	TN	BOD	Zn	Pb	TP	TN	BOD	Zn	Pb	TP	TN	BOD	Zn	Pb
	Problem Area 1																
1	HUA1-1	3.7	2.1	10.4	35	0.27	0.27	0%	8%	44%	100%	0%	-13%	8%	21%	0%	-42%
2	HUA1-1A	3.0	2.3	11.5	38	0.31	0.33	14%	57%	256%	326%	-31%	14%	54%	242%	326%	-40%
3	HUA1-2	1.8	2.3	11.4	38	0.31	0.41	25%	60%	257%	264%	-46%	25%	60%	251%	264%	-49%
4	HUA1-3	2.2	2.7	18.5	134	1.35	0.23	0%	0%	2%	0%	-2%	-33%	-34%	-48%	-67%	-75%
5	HUA1-4	1.5	2.0	10.9	59	0.49	0.11	0%	0%	-6%	-6%	0%	-33%	-38%	-55%	-72%	-63%
6	HUA1-5	2.2	1.8	9.0	40	0.31	0.11	-25%	0%	-8%	-10%	0%	-25%	-20%	-27%	-32%	-38%
7	HUA1-6	0.7	2.8	18.5	137	1.28	0.23	0%	0%	0%	0%	0%	0%	-8%	-20%	-33%	-56%
8	HUA1-7	0.5	1.8	18.3	135	1.26	0.22	0%	0%	0%	1%	0%	-11%	-40%	-39%	-39%	-42%
9	HUA1-8	2.6	2.3	13.2	73	0.77	0.23	0%	3%	-9%	0%	53%	-33%	-41%	-50%	-60%	-7%
	Total	**18.3**	**20**	**121.7**	**689**	**6.4**	**2.1**	**2%**	**12%**	**29%**	**32%**	**-8%**	**-12%**	**-10%**	**-4%**	**-14%**	**-45%**
	Problem Area 2																
10	HUA2-1	6.2	2.2	11.4	38	0.32	0.32	7%	25%	113%	150%	0%	7%	25%	113%	150%	0%
11	HUA2-10	14.6	2.3	11.5	38	0.27	0.41	-3%	-4%	-1%	0%	-17%	-15%	-11%	-14%	-25%	-33%
12	HUA2-11	2.5	2.4	11.3	38	0.31	0.40	0%	0%	0%	0%	-2%	-33%	-25%	-39%	-61%	-84%
13	HUA2-12	1.7	2.3	11.7	38	0.31	0.41	0%	-5%	-2%	0%	-10%	-25%	-20%	-20%	-25%	-26%
14	HUA2-13	8.1	2.2	10.9	36	0.25	0.37	-11%	-10%	-5%	0%	-33%	-11%	-7%	-9%	0%	0%
15	HUA2-14	1.5	1.4	7.4	28	0.17	0.14	0%	0%	0%	0%	0%	50%	55%	37%	84%	205%
16	HUA2-15	2.2	2.3	11.8	38	0.31	0.41	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
17	HUA2-16	2.3	2.1	11.5	38	0.31	0.41	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
18	HUA2-17	3.9	2.3	11.9	38	0.26	0.52	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
19	HUA2-18	2.5	2.4	11.2	38	0.30	0.40	0%	0%	0%	0%	-1%	0%	4%	1%	3%	0%
20	HUA2-2	8.6	2.2	10.8	36	0.23	0.35	0%	19%	95%	150%	-33%	-11%	5%	54%	100%	-33%
21	HUA2-3	4.5	2.4	11.7	38	0.22	0.44	0%	0%	0%	0%	0%	-27%	-26%	-34%	-23%	-50%
22	HUA2-4	13.2	2.3	11.3	37	0.30	0.38	0%	0%	0%	0%	0%	-13%	-12%	-17%	-25%	-20%
23	HUA2-5	3.7	2.2	11.4	37	0.27	0.27	0%	0%	0%	0%	0%	0%	-2%	-7%	0%	0%
24	HUA2-6	2.7	2.2	10.5	35	0.27	0.33	0%	0%	0%	0%	0%	0%	11%	10%	17%	15%
25	HUA2-7	2.4	1.7	8.9	32	0.23	0.23	0%	0%	0%	-2%	0%	25%	29%	16%	29%	58%
26	HUA2-9	4.0	2.0	10.9	37	0.25	0.25	0%	0%	0%	0%	0%	0%	0%	-1%	0%	0%
	Total	**84.5**	**37**	**186.1**	**621**	**4.6**	**6.0**	**0%**	**2%**	**12%**	**18%**	**-6%**	**-5%**	**0%**	**4%**	**11%**	**-9%**
	Problem Area 3																
27	HUA3-1	2.3	1.7	9.5	37	0.30	0.16	25%	27%	86%	45%	11%	-25%	-36%	-40%	-74%	-86%
28	HUA3-2	7.0	1.7	9.3	36	0.29	0.14	8%	12%	35%	50%	0%	-17%	-9%	-8%	0%	-53%
29	HUA3-3	5.4	1.8	9.6	37	0.37	0.16	0%	8%	26%	0%	5%	0%	6%	23%	0%	-2%
30	HUA3-4	3.4	1.8	9.2	36	0.29	0.15	0%	0%	0%	0%	0%	0%	-6%	-7%	-12%	-17%
31	HUA3-5	2.8	1.8	9.4	37	0.30	0.16	0%	0%	-1%	-1%	-2%	0%	0%	-1%	-1%	-2%
	Total	**20.8**	**9**	**47.1**	**182**	**2**	**0.8**	**6%**	**10%**	**29%**	**18%**	**3%**	**-8%**	**-9%**	**-6%**	**-17%**	**-32%**
	Total	**123.6**	**66**	**355**	**1,492**	**12.5**	**9.0**	**1%**	**6%**	**22%**	**25%**	**-6%**	**-8%**	**-5%**	**-1%**	**-5%**	**-19%**

Notes: 1. Existing BMPs are included in the three scenarios.
2. The third scenario includes existing and proposed BMPs.

Section 4
Evaluation of Alternatives

4.1 Introduction

In this section, conceptual improvement alternatives that address flooding problem areas are presented and evaluated. These improvements apply to flooding problems associated with design rainfall events concurrent with a tidal stillwater elevation of 2-ft NAVD. They do not apply to flooding problems associated with extreme tidal surges (due to tropical storms and hurricanes, for example). Tidal surges of over 15-ft NAVD can occur for hurricanes. This is more than five feet above the highest elevation in the study area and therefore impractical to design for such a scenario.

The alternatives analyzed as part of this master plan are for the three problem areas described in Section 1 that were investigated and modeled as described in Sections 2 and 3 for flooding and water quality issues. Town staff selected these three areas for detailed analysis as being representative of other flooding and water quality issues island-wide. Based on their characteristics, findings for the three areas can be used to provide general master planning recommendations island-wide.

Specifically, Area 1 at Estero Boulevard and Bay Road represents mixed commercial, residential high density, and residential medium density development. Area 1 also includes one institutional development for the elementary school and one private parking lot drainage for a commercial development. Area 2 stretches from Voorhis Street to St. Peters Drive and represents typical flooding along Estero Boulevard and neighborhood streets in a high density residential area. Area 2 also includes a mix of some streets with existing stormwater infrastructure in place (such as swales, inlets, and outfall) and some streets with no existing infrastructure. Area 3 represents residential medium density development with flooding along Estero Boulevard and neighborhood streets.

The alternatives presented in this section apply to existing stormwater system improvements. A total of three alternatives were evaluated as summarized below:

1. Clean and maintain existing stormwater system.

2. Fully connect existing stormwater system.

3. Fully connect and upgrade existing stormwater system.

Alternative 1 was an operation and maintenance option that involved no capital improvements within the study area. Alternatives 2 and 3 were designed to meet a specific level of service (LOS) criteria or analyze the possibility of a phased approach for road flooding. Many of the building finished floor elevations may be near (or in some cases even lower than) road centerlines. Although LOS goals generally desire to aim for protection of 100-year building flooding elevations wherever practicable, the primary goal of this section is to identify solutions that will reduce flooding of problem areas and increase LOS based on topography and potential upgrades to the existing stormwater system. Alternatives 2 and 3 also included Best Management Practices (BMPs) to treat runoff from the three problem areas.

LOS decisions will directly affect the size and cost of proposed improvement alternatives. In the first scenario (Alternative 2), those locations of the study area that lacked connectivity to the existing stormwater system were provided with new piping or some type of overland flow (e.g., swale). The system was then evaluated on its ability to receive and convey the flow through the existing collection system and onward to the existing outfalls. Some reduction of flooding was observed but overall improvement to LOS to the problem areas was limited. A second scenario (Alternative 3) evaluated upsizing the existing collection system and outfalls to at least 24-inch pipes where feasible. The results were considered the best-case scenario and used as the criteria for setting LOS goals summarized in Table A-6.

The following sections describe each alternative in detail, the benefits in terms of peak flood stage reductions, LOS improvements, flood duration, and estimated costs.

4.2 Alternative 1 — Clean and Maintain Existing System

The proper operation and maintenance of the stormwater system is a critical element for the Town to achieve its desired LOS goals. The intent of proper operation and maintenance is to maintain stormwater management systems as closely as possible to design conditions. Operation and maintenance items include:

- Repair and/or removal of sediment and debris from pipes, ditches, inlets, and roadside swales.
- Establish regular inspection and maintenance of the existing system. An annual Town-wide inspection program can help to establish the frequency and priority of such maintenance items.
- Mowing and/or re-grading of roadside swales as necessary.

The costs associated with cleaning the system, most likely utilizing vacuum trucks and high pressure water jetting, were based on unit costs made available by the FDOT. The cost per linear foot (lf) varies based on pipe size as follows:

- Pipe diameter zero to 27 inches: $7/lf
- Pipe diameter 25 to 36 inches: $12/lf
- Pipe diameter 42to 48 inches: $16/lf
- Pipe diameter 54 to 60 inches: $20.5/lf

The costs associated with mowing and/or re-grading of roadside swales was estimated to be as follows:

- Swales and open channels: $3/lf

Stormwater pipe system and swale data collected during the field inventory performed by CDM was used to estimate the conceptual costs of maintaining the system. In the study area there were no pipes greater than 24-inches in diameter. Maintenance of the approximately 7,000 feet of pipe and 10,000 feet of swales located within the study area (three problem areas) is a very cost effective means of helping to mitigate peak flood stages. The focus of the cleaning should be on the removal of sand and leaves from pipes, inlets, and swales. The estimated cost for Alternative 1 is given in **Table 4-1**. These costs could be incurred in a maintenance plan that completes half of the system in the first year and the remainder in the second year.

Table 4-1 Alternative 1: Maintenance of Existing System

Activity	Feet	$/Foot	Cost/Year
Clean Inlets and Pipes	7,000	$7	$49,000
Mow/Regrade Roadside Swales	10,000	$3	$30,000
Total			**$79,000**

The SWMM results for Alternative 1 is basically the same as for existing conditions (See Section 2.11) and estimates that the existing stormwater system has been fully and properly maintained. In the existing conditions model (Alternative 1), only conduit A1-3S was modeled as plugged-based on field observations. All other pipes were modeled (i.e., unplugged pipes, full capacity). For Alternatives 2 and 3, the existing pipes were modeled in their original, new condition.

4.3 Alternative 2 – Fully Connect Existing Stormwater System

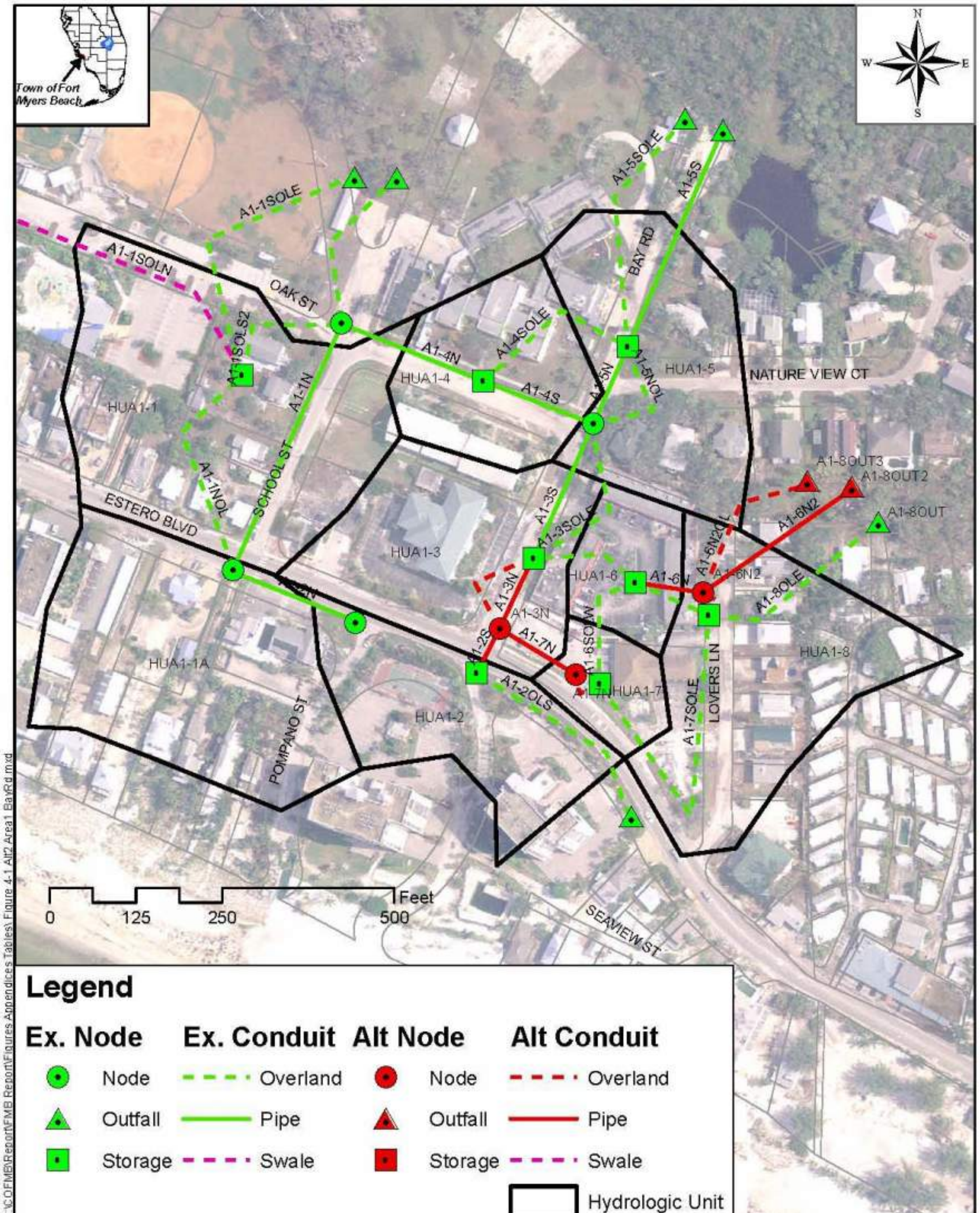
In Alternative 2, new pipes and/or overland flow conduits were connected from the flooding areas to the existing piping of the stormwater system. This scenario evaluates the ability of the existing system to fully receive and convey runoff from the entire contributing area. The SWMM schematics showing locations of nodes and conduits for Alternative 2 are shown in **Figures 4-1 through 4-5**. For pipe sizes and locations for each of the alternatives see **Table A-8** of **Appendix A**.

Area 1

Within Area 1, Alternative 2 has two sub-alternatives, 2a and 2b. Alternative 2a proposes more effective flood control in Lovers Lane while Alternative 2b proposes improvements fully within existing rights-of-way. As indicated in **Figure 4-1,** Alternative 2a proposes new pipes from Wachovia Bank (A1-7N) to a new inlet in Bay Road and from Sea Grape Plaza (A1-6N and A1-6N2) to a new outfall (A1-8OUT2) approximately 200 feet east of Lovers Lane. This scenario utilizes existing piping in Sea Grape Plaza (A1-6N) that currently dead ends in Lovers Lane with no outfall. An easement would need to be obtained for the new outfall proposed at the end of Lovers Lane. Additionally, any new outfalls would need to be permitted by the SFWMD. In **Figure 4-2** Alternative 2b routes flooding from Sea Grape Plaza through two new sections of pipes with inlets (A1-6S and A1-6S2) and connects to the existing piping in Bay Road. Since Alternative 2b cannot address the flooding problems in Lovers Lane, Alternative 2a is more desirable if easements and permits can be obtained.

Area 2

Figure 4-3 shows the west section of problem area 2. New pipes (A2-3S) are proposed in Estero Boulevard that would convey runoff from Washington Street, Madison Court and Eucalyptus Court to new piping in Voorhis Street (A2-3S2). Additionally, new piping in Estero Boulevard is proposed to convey runoff from Connecticut Street and Mid Island Drive to existing piping in Jefferson Street (A2-5N2). **Figure 4-4** shows the east section of problem area 2. New pipes (A2-11N and A2-10S) and swales (A2-11S) are proposed in Andre Mar Drive that would convey runoff from Estero Boulevard to the existing outfall at the end of Andre Mar Drive (node A2-9S). New piping is proposed in St. Peters Drive (A2-13N2) that would route flooding from Estero Boulevard to new piping in Anchorage Street (A2-10N and A2-10N2). A field survey would be required to verify the feasibility of the section in Anchorage Street. A second option could be to install new piping between the houses on St. Peters Drive and Anchorage Street, the current location of a swale (A2-13N). The town has expressed an interest in the possibility of utilizing the location of this swale for stormwater improvements since an easement is already secured.



Source: Town of Fort Myers Beach

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Figure 4-1
SWMM Schematic
Area 1- Estero Boulevard & Bay Road
Alternative 2a

UPDATED 04-10-09

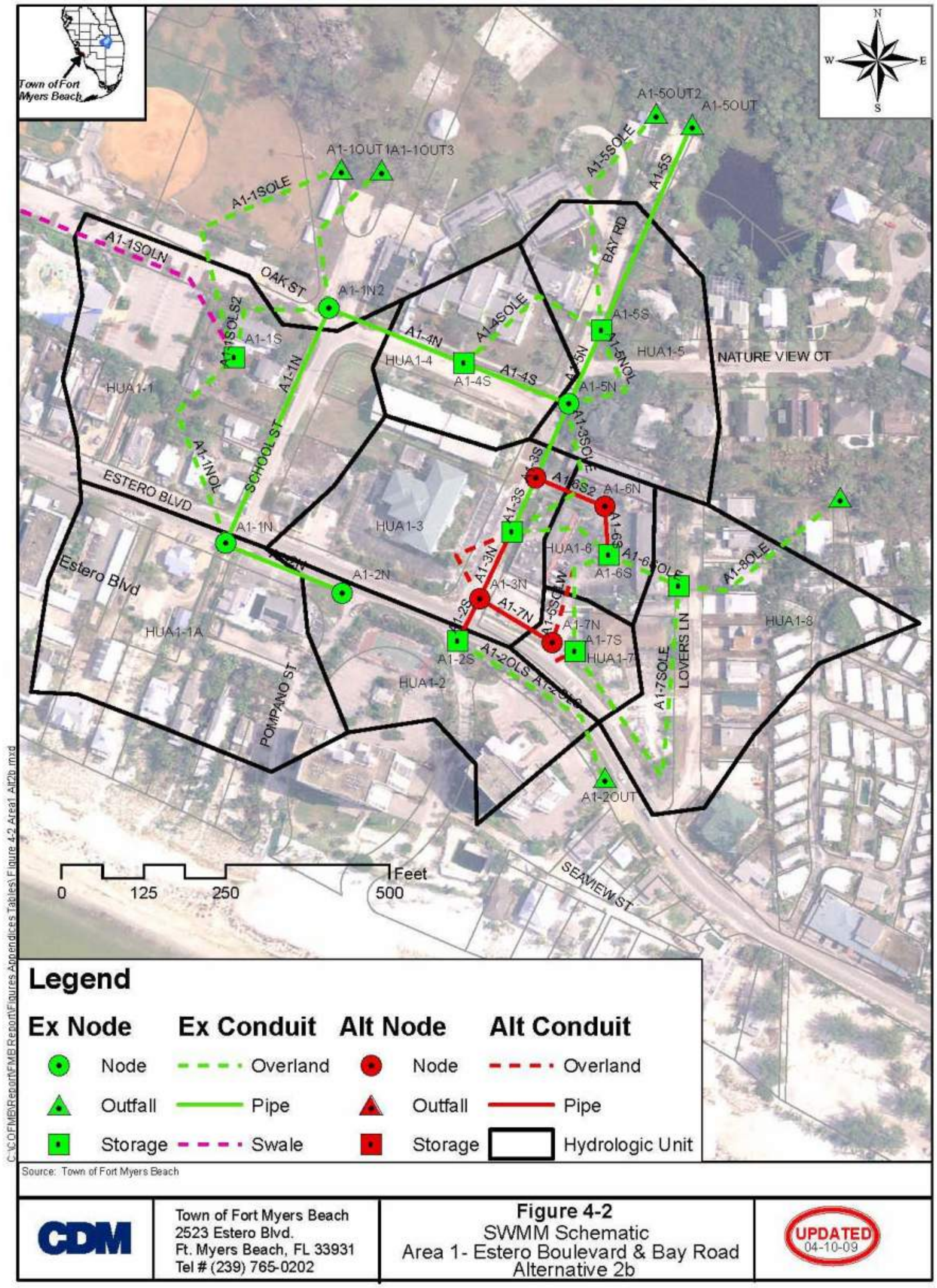
Town of Fort Myers Beach
A1-1OUT1
A1-1OUT3
A1-5OUT2
A1-5OUT
A1-1SOLE
A1-1SOLN
OAK ST
A1-1N2
A1-1S
A1-1N
HUA1-1
SCHOOL ST
A1-1NOL
ESTERO BLVD
Estero Blvd
A1-1N
A1-2N
HUA1-1A
POMPANO ST
HUA1-2
HUA1-3
HUA1-4
A1-4N
A1-4S
A1-4SOLE
A1-5SOLE
A1-5S
BAY RD
HUA1-5
NATURE VIEW CT
A1-5N
A1-5NOL
A1-3S
A1-6N
HUA1-6
A1-6S
A1-3N
A1-7N
A1-7S
HUA1-7
A1-2S
A1-2OLS
A1-7SOLE
LOVERS LN
A1-8OLE
HUA1-8
A1-2OUT
SEAVIEW ST
0
125
250
500
Feet
Legend
Ex Node
Node
Outfall
Storage
Ex Conduit
Overland
Pipe
Swale
Alt Node
Node
Outfall
Storage
Alt Conduit
Overland
Pipe
Hydrologic Unit
Source: Town of Fort Myers Beach
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Figure 4-2
SWMM Schematic
Area 1- Estero Boulevard & Bay Road
Alternative 2b
UPDATED
04-10-09

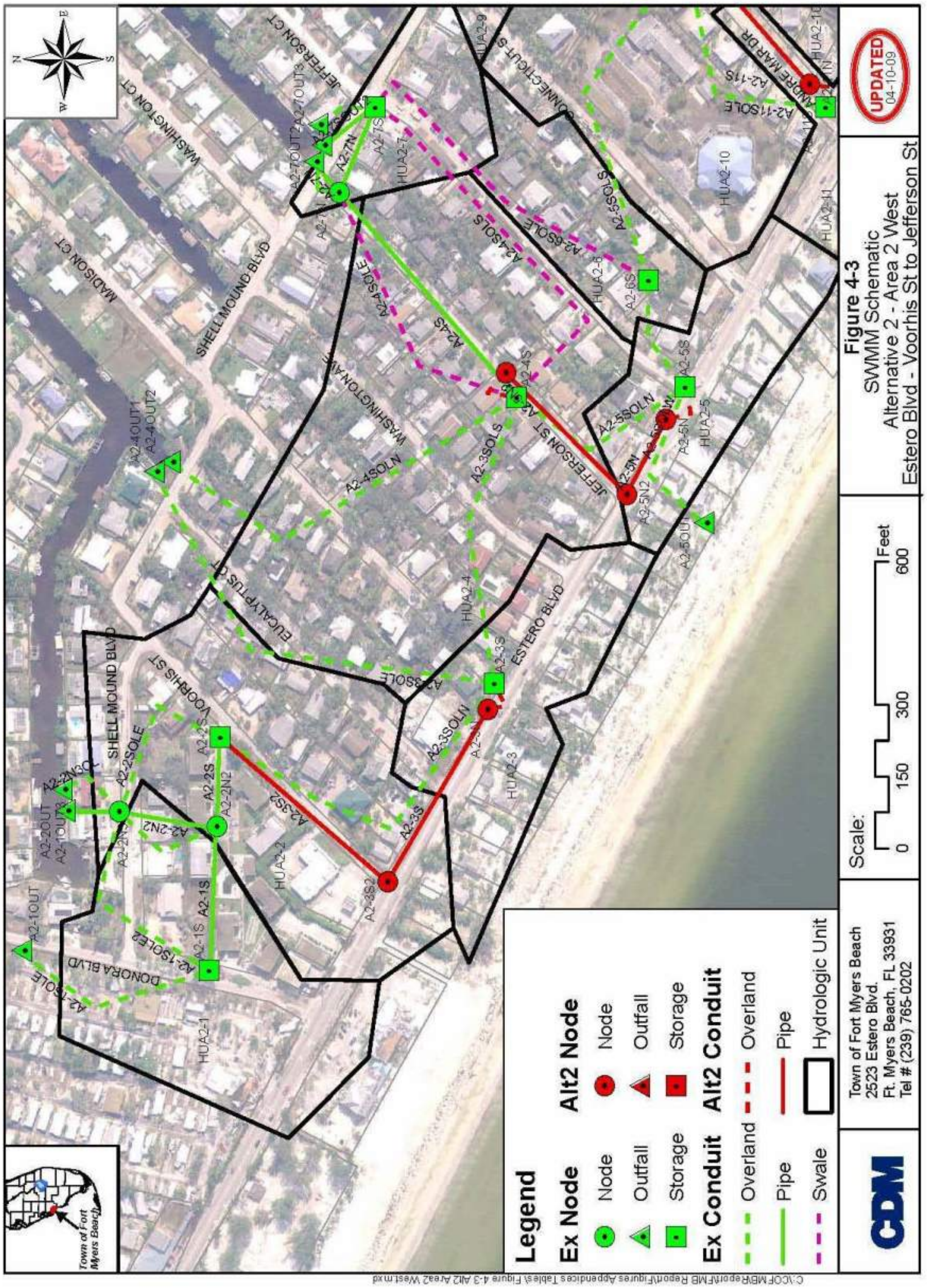
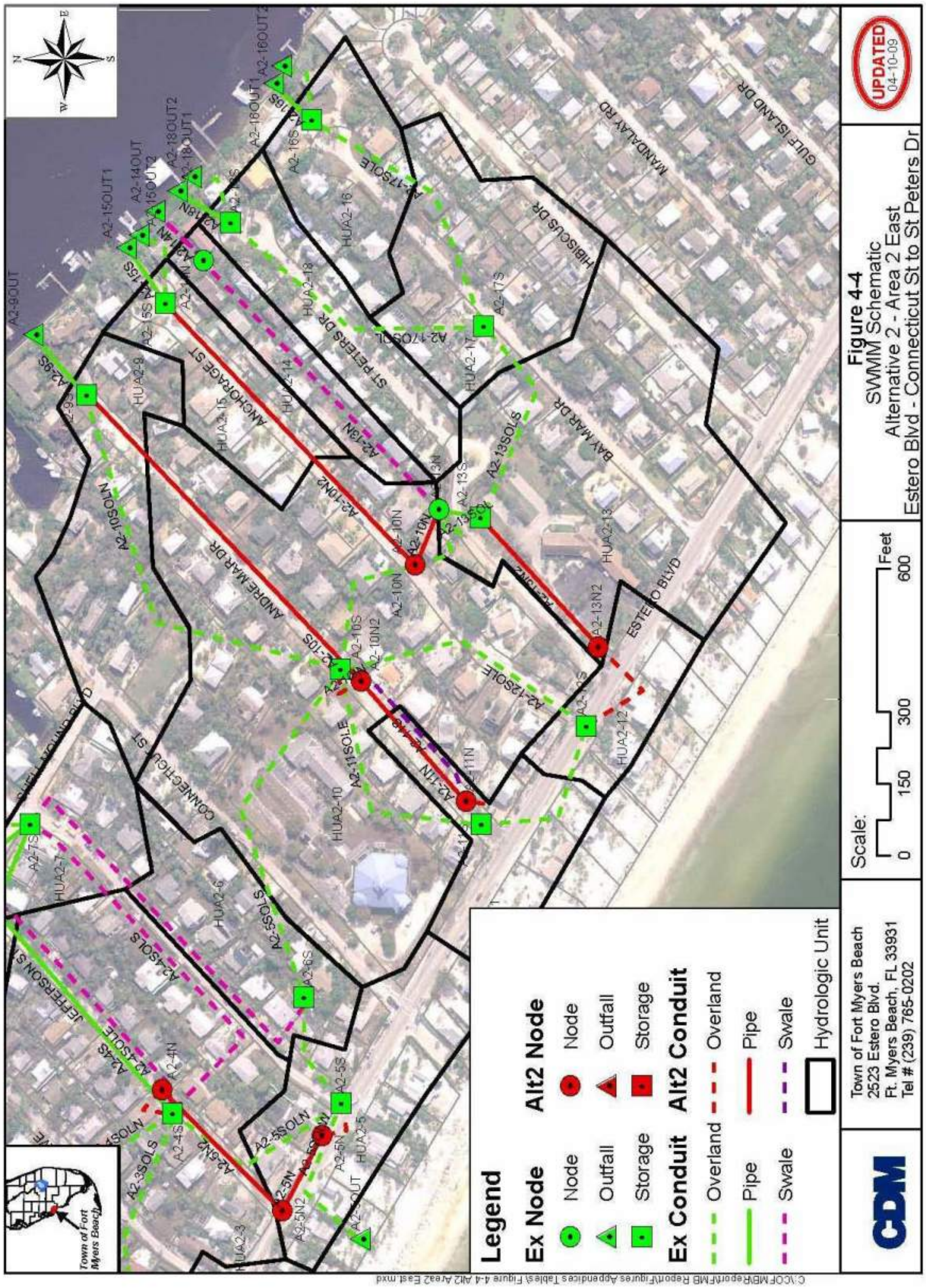


Figure 4-3
SWMM Schematic
Alternative 2 - Area 2 West
Estero Blvd - Voorhis St to Jefferson St


Legend
Ex Node
Node
Outfall
Storage
Ex Conduit
Overland
Pipe
Swale
Alt2 Node
Node
Outfall
Storage
Alt2 Conduit
Overland
Pipe
Swale
Hydrologic Unit
Scale:
0
150
300
600
Feet
Figure 4-4
SWMM Schematic
Alternative 2 - Area 2 East
Estero Blvd - Connecticut St to St Peters Dr
UPDATED
04-10-09
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CDM
ESTERO BLVD
ANDRE MAR DR
ANCHORAGE ST
ST PETERS DR
BAY MAR DR
HIBISCUS DR
MANDALAY RD
GULF ISLAND DR
CONNECTICUT ST
JEFFERSON ST

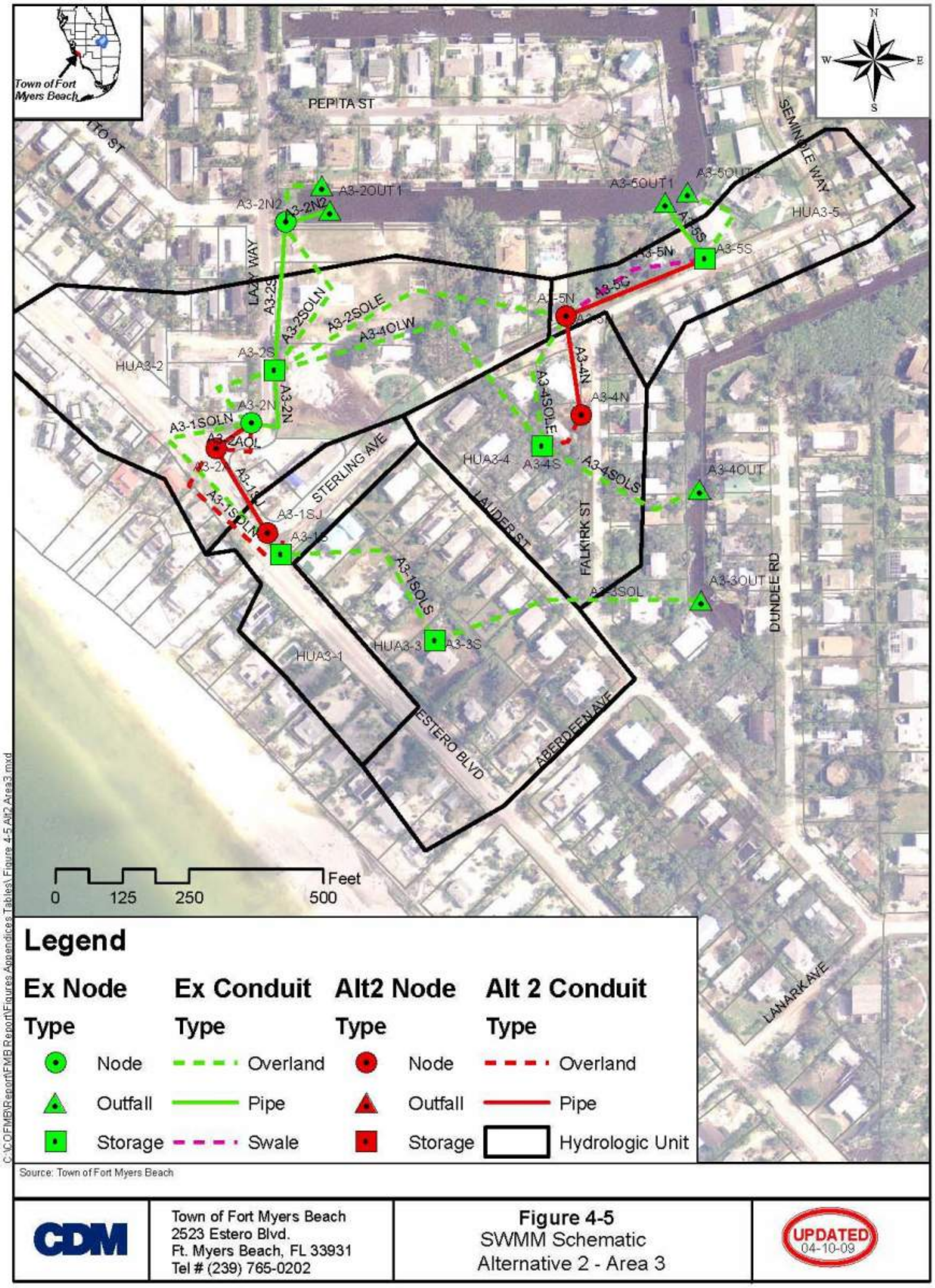

Figure 4-5
SWMM Schematic
Alternative 2 - Area 3

Area 3

Figure 4-5 shows the SWMM schematic for area 3. New conduits (A3-1SJ and A3-2A) are proposed in Estero Boulevard and Lazy Way that collect runoff from the intersection of Sterling Avenue and Estero Boulevard and convey it via existing pipes in Lazy Way (A3-2N). Additionally, new piping (A3-4N) was proposed near the intersection of Falkirk Street and Sterling Avenue that would collect runoff from a low lying area in the triangle (storage unit A3-4S) between the streets and convey it to an existing outfall at A3-5S. New piping is also proposed in Sterling Avenue (A3-5C) to increase conveyance capacity from this flooding area.

Results

Table 4-2 summarizes the resulting peak stages and LOS estimates for Alternative 2 for all three problem areas. As indicated in the table, for the 2.5-inch storm the model shows 2 locations with flooding. For the 2-year storm all but 4 of the 18 select locations reported flooding. For the 2-year storm of the 14 locations that reported flooding, 7 met the LOS goals set in Table A-6. This shows that the stormwater system has limitations in its ability to convey small rain events being collected from the flooding areas by new pipes. For the 5-year storm, 14 of the 18 locations reported flooding while 7 of these 14 locations still met the LOS goals. This lower LOS is because the 5-year storm has Class C goals (< 3 inches) for evacuation routes rather than Class B (< 6 inches) for other roads.

Because Area 1 has two sub-alternatives (2a and 2b) a separate table was prepared to analyze the results between the two options. **Table 4-3** compares 5-year storm peak stages for both options. The table indicates that Alternative 2a has a noticeable reduction in peak stage for the 5-year storm compared with Alternative 2b for the two select locations.

Table 4-3 Results for Alternative 2a and 2b for 5-year storm

Node	Alt 2a Peak Stage (ft-NAVD)	Alt 2b Peak Stage (ft-NAVD)
A1-6S	4.7	5.1
A1-8S	4.2	4.3

The Alternative 2 cost estimates for each of the problem areas are given in **Appendix F**.

Table 4-2: Peak Stages and LOS for Alternative 2 at Select Locations

Node	Location	Type	Road [1] Crown or Ref. Elev. (ft-NAVD)	2.5-Inch Storm Peak Stage (ft-NAVD)	2.5-Inch Storm Flood Depth (in)	2.5-Inch Storm LOS Class	2.5-Inch Storm Meets LOS?	2.5-Inch Storm Duration of Flooding (hours)	2-Year Storm Peak Stage (ft-NAVD)	2-Year Storm Flood Depth (in)	2-Year Storm LOS Class	2-Year Storm Meets LOS?	2-Year Storm Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	4.0	-	A	Y		4.6	-	A	Y	-
A1-3S	Bay Rd	Other Road	4.5	4.4	-	A	Y		4.8	3.7	C	N	2
A1-6S	Sea Grape Plaza	Critical Elev	5.3	4.6	-	A	Y		4.7	-	A	Y	-
A1-7S	Wachovia	Critical Elev	4.8	4.6	-	A	Y		4.9	2.0	B	Y	2
A1-8S	Lovers Lane	Other Road	4.2	4.1	-	A	Y		4.2	1.1	B	Y	3
A2-2S	Voorhis St	Other Road	3.4	3.5	1.3	B	Y	2	4.1	7.9	D	N	8
A2-3S	Estero & Madison	Evacuation	3.5	3.4	-	A	Y		4.1	7.3	D	N	9
A2-4S	Jefferson St	Other Road	3.5	3.4	-	A	Y		3.8	3.2	C	N	4
A2-5S	Estero & Mid Island	Evacuation	3.5	3.7	2.0	B	Y	2	3.9	4.3	C	N	6
A2-10N	Anchorage St	Other Road	3.2	3.1	-	A	Y		3.4	2.0	B	Y	7
A2-10S	Andre Mar Dr	Other Road	3.7	3.5	-	A	Y		3.8	1.3	B	Y	3
A2-11S	Estero & Andre Mar	Evacuation	3.5	3.5	-	A	Y		3.8	3.6	C	N	3
A2-12S	Estero & St Peters	Evacuation	3.5	3.5	-	A	Y		3.8	3.6	C	N	2
A3-1S	Estero & Sterling	Evacuation	4.0	3.6	-	A	Y		4.0	0.2	B	Y	1
A3-2S	Lazy Way	Other Road	3.2	2.7	-	A	Y		3.4	2.4	B	Y	3
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.1	-	A	Y		3.6	1.2	B	Y	2
A3-5N	Sterling & Falkirk	Critical Elev	3.5	2.3	-	A	Y		3.2	-	A	Y	-
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.0	-	A	Y		2.1	-	A	Y	-

Node	Location	Type	Road [1] Crown or Ref. Elev. (ft-NAVD)	5-Year Storm Peak Stage (ft-NAVD)	5-Year Storm Flood Depth (in)	5-Year Storm LOS Class	5-Year Storm Meets LOS?	5-Year Storm Duration of Flooding (hours)	10-Year Storm Peak Stage (ft-NAVD)	10-Year Storm Flood Depth (in)	10-Year Storm LOS Class	10-Year Storm Meets LOS?	10-Year Storm Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	4.6	-	A	Y	-	4.6	-	A	Y	-
A1-3S	Bay Rd	Other Road	4.5	4.9	4.8	C	Y	2	5.1	6.7	D	Y	2
A1-6S	Sea Grape Plaza	Critical Elev	5.3	4.7	-	A	Y	-	4.7	-	A	Y	-
A1-7S	Wachovia	Critical Elev	4.8	5.0	3.2	C	Y	2	5.1	4.7	C	Y	2
A1-8S	Lovers Lane	Other Road	4.2	4.3	1.2	B	Y	4	4.3	1.7	B	Y	4
A2-2S	Voorhis St	Other Road	3.4	4.2	9.2	D	N	10	4.5	13.3	NA	N	15
A2-3S	Estero & Madison	Evacuation	3.5	4.1	7.6	D	N	9	4.2	8.5	D	N	13
A2-4S	Jefferson St	Other Road	3.5	3.9	4.6	C	N	7	4.2	8.5	D	N	9
A2-5S	Estero & Mid Island	Evacuation	3.5	4.0	5.4	C	N	6	4.2	8.9	D	N	10
A2-10N	Anchorage St	Other Road	3.2	3.7	6.5	D	N	10	4.2	11.6	NA	N	17
A2-10S	Andre Mar Dr	Other Road	3.7	3.9	2.6	B	Y	6	4.3	6.7	D	Y	8
A2-11S	Estero & Andre Mar	Evacuation	3.5	3.9	4.9	C	Y	10	4.3	9.1	NA	N	12
A2-12S	Estero & St Peters	Evacuation	3.5	3.9	4.9	C	Y	4	4.3	9.0	D	N	5
A3-1S	Estero & Sterling	Evacuation	4.0	4.3	3.8	C	Y	2	4.6	7.2	D	Y	4
A3-2S	Lazy Way	Other Road	3.2	3.6	4.7	C	Y	6	4.1	10.3	NA	N	11
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.7	2.6	B	Y	2	4.2	8.0	D	Y	4
A3-5N	Sterling & Falkirk	Critical Elev	3.5	3.2	-	A	Y	-	3.6	0.7	B	Y	2
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.2	-	A	Y	-	2.5	-	A	Y	-

Table 4-2: Peak Stages and LOS for Alternative 2 at Select Locations

Node	Location	Type	Road[1] Crown or Ref. Elev. (ft-NAVD)	25-Year Storm Peak Stage (ft-NAVD)	25-Year Storm Flood Depth (in)	25-Year Storm LOS Class	25-Year Storm Meets LOS?	25-Year Storm Duration of Flooding (hours)	100-Year Storm Peak Stage (ft-NAVD)	100-Year Storm Flood Depth (in)	100-Year Storm LOS Class	100-Year Storm Meets LOS?	100-Year Storm Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	4.5	4.6	-	A	Y	-	4.7	-	A	Y	-
A1-3S	Bay Rd	Other Road	5.3	5.1	7.7	D	Y	3	5.2	8.8	D	Y	3
A1-6S	Sea Grape Plaza	Critical Elev	4.8	4.8	-	A	Y	-	4.8	-	A	Y	-
A1-7S	Wachovia	Critical Elev	4.2	5.2	5.4	C	Y	3	5.3	6.1	D	Y	3
A1-8S	Lovers Lane	Other Road	3.4	4.3	1.9	B	Y	6	4.3	2.2	B	Y	6
A2-2S	Voorhis St	Other Road	3.5	4.6	14.4	NA	N	20	4.7	15.8	NA	N	26
A2-3S	Estero & Madison	Evacuation	3.5	4.2	8.9	D	Y	20	4.4	10.4	NA	N	26
A2-4S	Jefferson St	Other Road	3.5	4.3	9.4	NA	N	10	4.4	10.7	NA	N	12
A2-5S	Estero & Mid Island	Evacuation	3.2	4.3	9.4	NA	N	12	4.4	10.7	NA	N	14
A2-10N	Anchorage St	Other Road	3.7	4.3	13.0	NA	N	20	4.4	14.5	NA	N	24
A2-10S	Andre Mar Dr	Other Road	3.5	4.4	7.8	D	Y	10	4.5	9.2	NA	NA	15
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.4	10.2	NA	NA	15	4.5	11.6	NA	NA	23
A2-12S	Estero & St Peters	Evacuation	4.0	4.4	10.2	NA	NA	7	4.5	11.6	NA	NA	8
A3-1S	Estero & Sterling	Evacuation	3.2	4.7	8.2	D	Y	5	4.9	10.2	NA	NA	6
A3-2S	Lazy Way	Other Road	3.5	4.2	11.8	NA	NA	11	4.3	13.1	NA	NA	12
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.3	9.2	NA	NA	5	4.4	10.2	NA	NA	7
A3-5N	Sterling & Falkirk	Critical Elev	4.0	3.7	1.9	B	Y	3	3.9	4.6	C	Y	4
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.6	-	A	Y	-	2.5	-	A	Y	-

1) Road crown, reference and critical elevations were estimated from LiDAR.

2) All events were modeled with a boundary condition of 2.0 ft-NAVD stillwater elevation. These LOS should not be expected during periods of extreme high tides.

3) 10, 25 and 100-year events are 72-hour duration. 2.5-inch and 5-year events are 24-hour duration.

4.4 Alternative 3 – Fully Connect and Upsize Existing Stormwater Pipes

In Alternative 3, existing stormwater pipes were upsized to a maximum equivalent diameter of 24-inches (based on cover allowance) to achieve a higher LOS. This was the largest feasible diameter pipe based on pipe cover constraints and shallow groundwater levels. This scenario evaluates the ability of a higher level system to receive and convey flows and assist with the establishment of LOS goals. The SWMM schematics showing locations of nodes and conduits for Alternative 3 are shown in **Figures 4-6 through 4-10**. For pipe sizes and locations for each of the alternatives see **Table A-8** of **Appendix A**.

Area 1

As in Alternative 2, Alternative 3 has two sub-alternatives, 3a and 3b. Alternative 3a proposes more effective flood control while Alternative 3b proposes improvements fully within existing right-of-way. As indicated in **Figures 4-6 and 4-7** Alternatives 3a and 3b, SWMM conduits A1-5S, A1-5N and A1-3S have all been upsized to an equivalent of a 24-inch circular pipe. Conduit A1-3N has been upsized to an equivalent of an 18-inch circular pipe. The proposed piping in Sea Grape Plaza for both Alternatives 3a and 3b have been upsized to an equivalent of a 24-inch circular pipe.

Area 2

Figure 4-8 shows the west section of problem area 2. Some of the new pipes proposed in Alternative 2 have been upsized. Existing piping from Voorhis Street (A2-3S2) to pipe A2-2N2 near Shell Mound Boulevard has been upsized from their existing diameter to an equivalent of a 24-inch circular pipe. Additionally, the existing 12-inch piping in Jefferson Street (A2-4S) was upsized to an equivalent of a 24-inch circular pipe. **Figure 4-9** shows the east section of problem area 2. All piping in Andre Mar Drive (A2-11N, A2-10S) has been upsized to an equivalent of a 24-inch circular pipe. In Anchorage Street A2-10N2 has been upsized to an equivalent of a 24-inch circular pipe. St. Peters Drive A2-13S and A213N2 have been upsized to an equivalent of an 18-inch circular pipe.

Area 3

Figure 4-10 shows the proposed piping for Area 3. All existing piping in Lazy Way (A3-2N2, A3-2S, A3-2N, A3-2A) has been upsized to an equivalent of a 24-inch circular pipe while the section in Estero (A3-1SJ) has been upsized to an 18-inch equivalent. Falkirk Street and Sterling Avenue conveyance pipes (A3-5C, A3-4N) have been upsized from a 15-inch to an equivalent 18-inch.

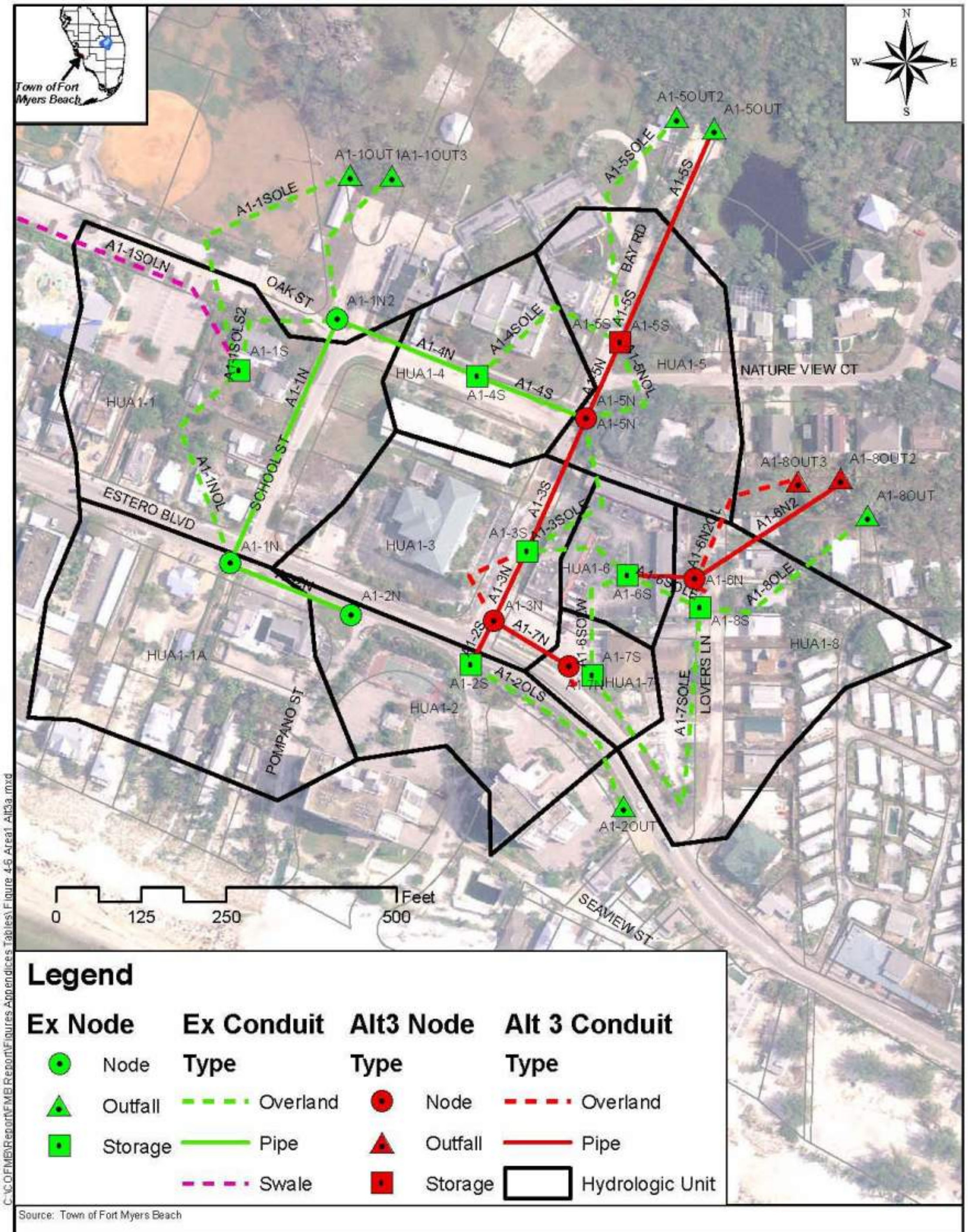

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Figure 4-6
SWMM Schematic
Area 1- Estero Boulevard & Bay Road
Alternative 3a

UPDATED 04-10-09

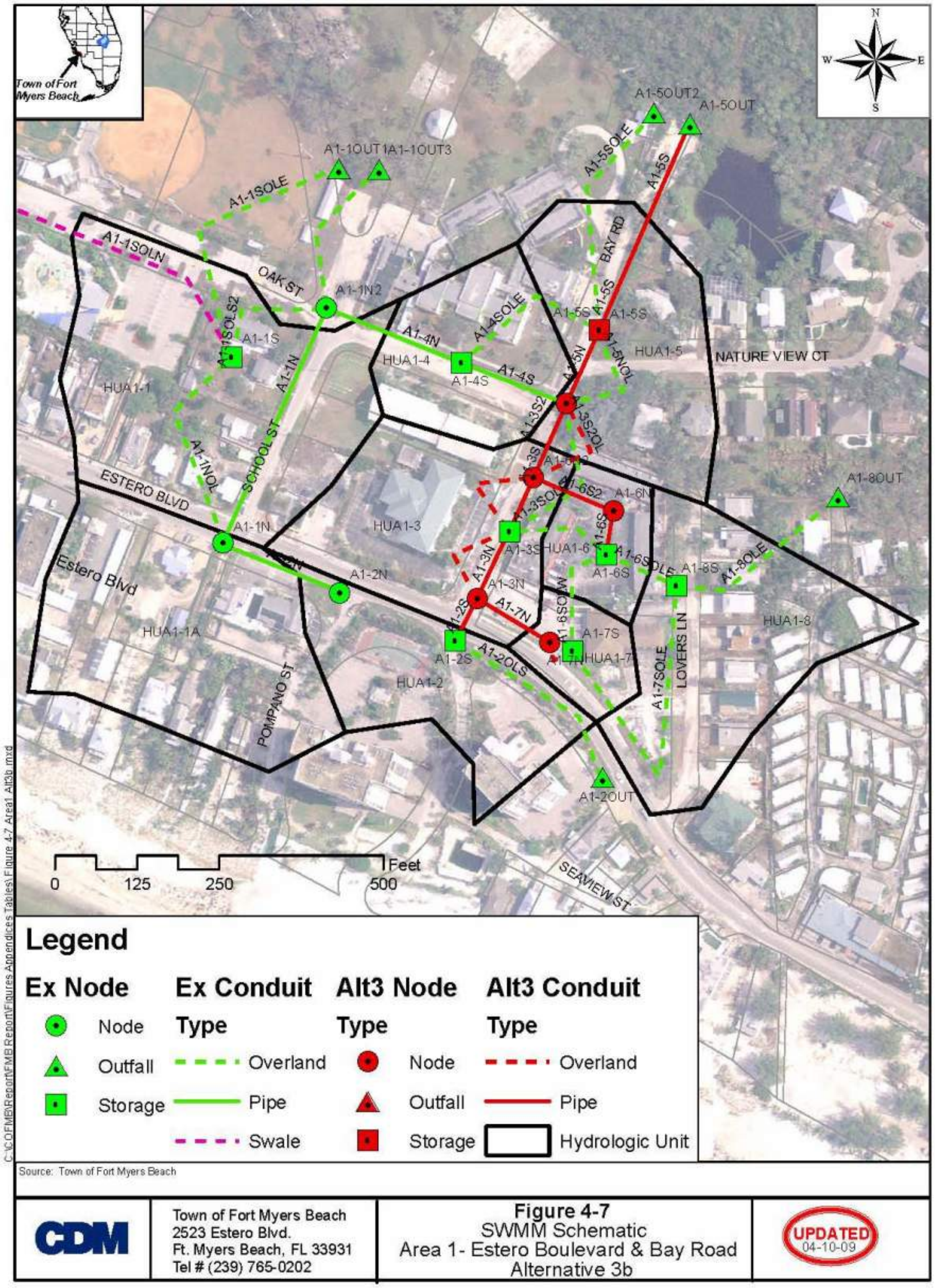

Figure 4-7
SWMM Schematic
Area 1- Estero Boulevard & Bay Road
Alternative 3b

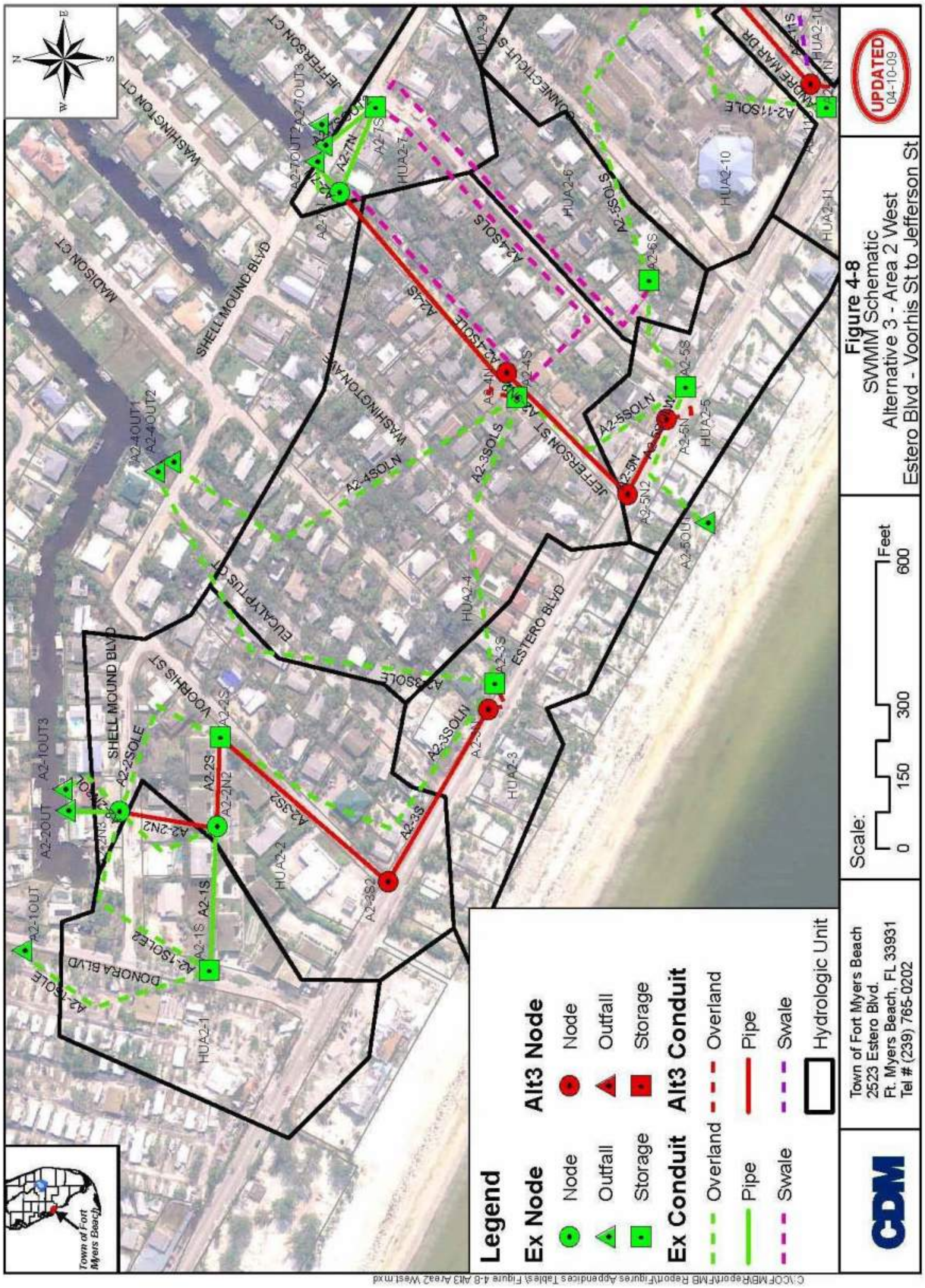
Figure 4-8
SWMM Schematic
Alternative 3 - Area 2 West
Estero Blvd - Voorhis St to Jefferson St
Legend
Ex Node
Node
Outfall
Storage
Ex Conduit
Overland
Pipe
Swale
Alt3 Node
Node
Outfall
Storage
Alt3 Conduit
Overland
Pipe
Swale
Hydrologic Unit
Scale:
0 150 300 600 Feet
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
UPDATED
04-10-09

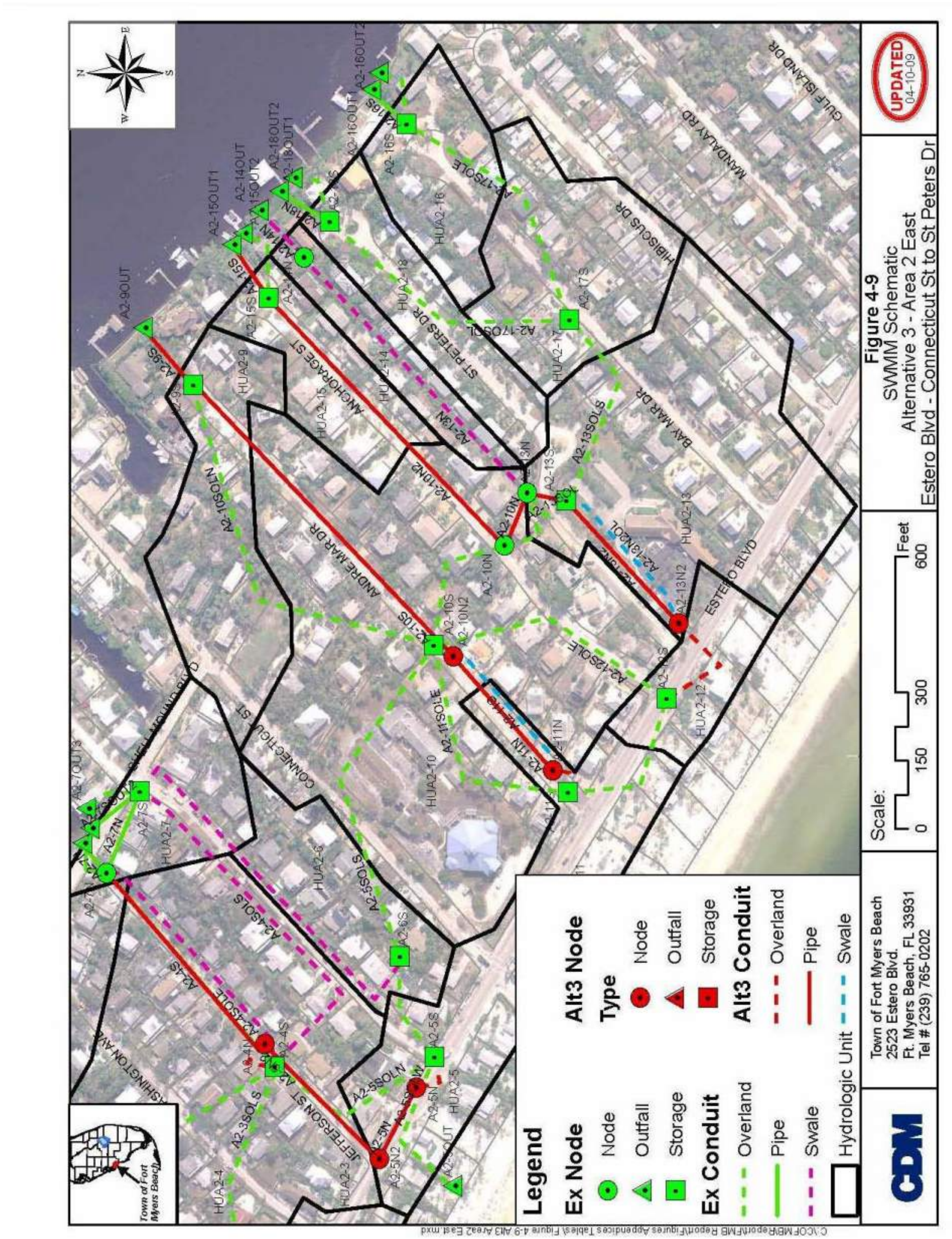
Legend
Ex Node
Node
Outfall
Storage
Ex Conduit
Overland
Pipe
Swale
Hydrologic Unit
Alt3 Node
Type
Node
Outfall
Storage
Alt3 Conduit
Overland
Pipe
Swale
Scale:
0 150 300 600 Feet
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
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Figure 4-9
SWMM Schematic
Alternative 3 - Area 2 East
Estero Blvd - Connecticut St to St Peters Dr
UPDATED 04-10-09
ESTERO BLVD
ANDRE MAR DR
ANCHORAGE ST
ST PETERS DR
BAY MAR DR
HIBISCUS DR
MANDALAY RD
GULF ISLAND DR
JEFFERSON ST
CONNECTICUT ST

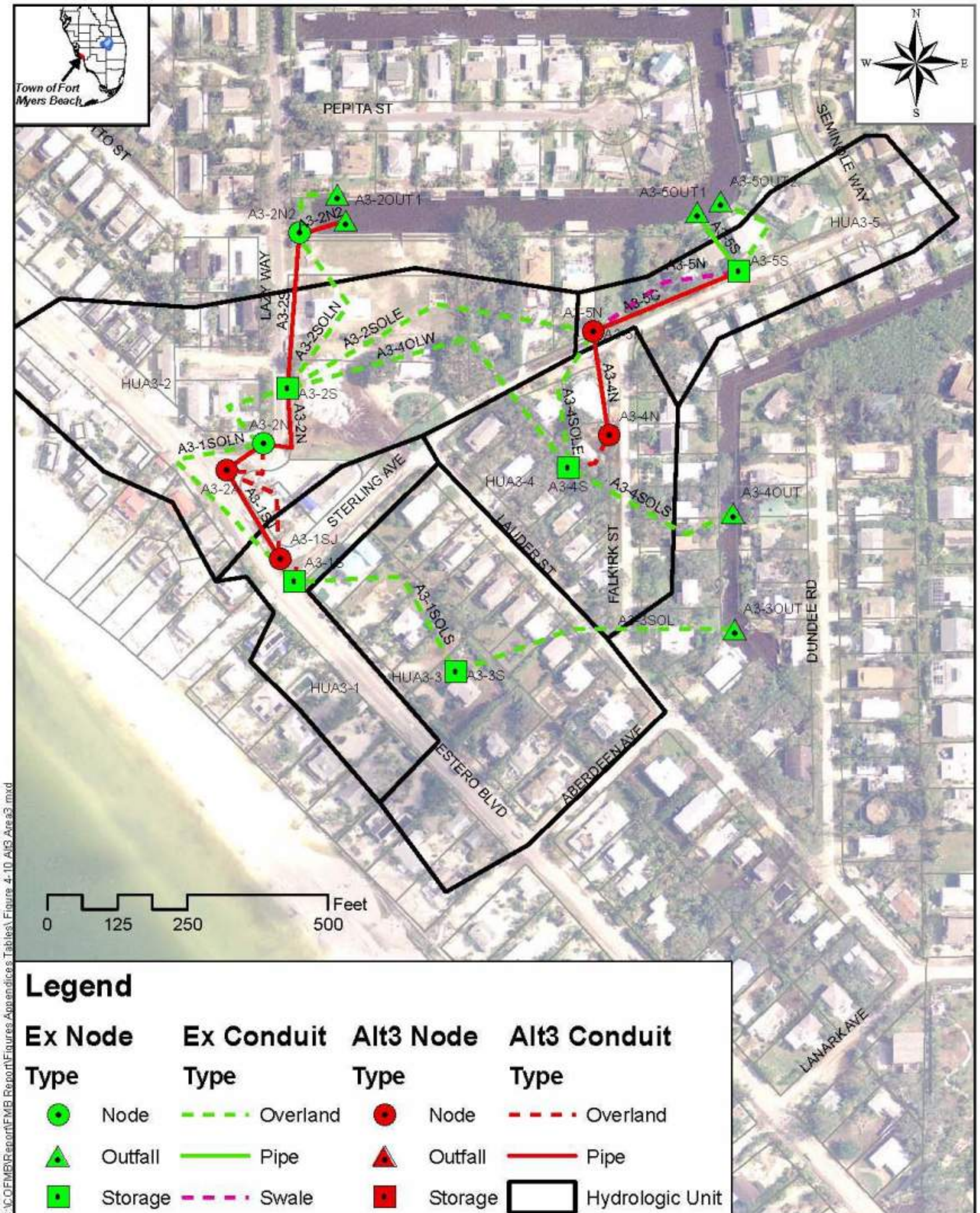

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Figure 4-10
SWMM Schematic
Alternative 3 - Area 3

UPDATED 04-10-09

Results

Table 4-4 summarizes the resulting peak stages, flooding depths and LOS estimates for Alternative 3 and 3a (Area 1). As indicated in the table the model shows that for the 2.5-inch storm, no flooding occurs. For the 2-year storm only 7 of the 18 select locations reported flooding with only one location failing to meet the LOS goals. For the 5-year storm, 12 of the 18 locations reported flooding and 3 failed to meet the LOS goals. This shows that an upsized stormwater system is in most cases capable of providing a 5-year LOS as set in the LOS goals (Table A-6). For this reason, the 5-year storm and its associated flood depths is recommended as a practical benchmark for LOS goals.

Because Area 1 has two sub-alternatives (3a and 3b) a separate table was prepared to analyze the results between the two options. **Table 4-5** compares peak stage results for the 5-year storm for Alternatives 3a and 3b. The table indicates that upsizing pipes in Bay Road improves the conveyance of flooding out of the low area in Sea Grape Plaza (node A1-6S) for Alternative 3b. Peak stage differences for Lovers Lane (node A1-8S) remain the same as Alternatives 2a and 2b.

Table 4-5: Results for Alternative 3a and 3b for 5-year storm

Node	Alt 3a Peak Stage (ft)	Alt 3b Peak Stage (ft)
A1-6S	4.7	4.4
A1-8S	4.2	4.3

The Alternative 3 cost estimates for each of the problem areas are given in **Appendix G**.

Table 4-4: Peak Stages and LOS for Alternative 3 at Select Locations

Node	Location	Type	Road [1] Crown or Ref. Elev. (ft-NAVD)	2.5-Inch Storm Peak Stage (ft-NAVD)	2.5-Inch Storm Flood Depth (in)	2.5-Inch Storm LOS Class	2.5-Inch Storm Meets LOS?	2.5-Inch Storm Duration of Flooding (hours)	2-Year Storm Peak Stage (ft-NAVD)	2-Year Storm Flood Depth (in)	2-Year Storm LOS Class	2-Year Storm Meets LOS?	2-Year Storm Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	2.8	-	A	Y	-	4.2	-	A	Y	-
A1-3S	Bay Rd	Other Road	4.5	4.4	-	A	Y	-	4.5	0.4	B	Y	0.5
A1-6S	Sea Grape Plaza (Alt 3a)	Critical Elev	5.3	4.6	-	A	Y	-	4.7	-	A	Y	-
A1-7S	Wachovia	Critical Elev	4.8	4.6	-	A	Y	-	4.6	-	A	Y	-
A1-8S	Lovers Lane	Other Road	4.2	4.1	-	A	Y	-	4.2	1.1	B	Y	2
A2-2S	Voorhis St	Other Road	3.4	2.6	-	A	Y	-	3.4	-	A	Y	-
A2-3S	Estero & Madison	Evacuation	3.5	3.5	-	A	Y	-	3.5	-	A	Y	-
A2-4S	Jefferson St	Other Road	3.5	3.3	-	A	Y	-	3.7	2.3	B	Y	2
A2-5S	Estero & Mid Island	Evacuation	3.5	3.5	-	A	Y	-	3.8	3.0	B	N	3
A2-10N	Anchorage St	Other Road	3.2	2.1	-	A	Y	-	3.3	0.8	B	Y	3
A2-10S	Andre Mar Dr	Other Road	3.7	3.4	-	A	Y	-	3.7	-	A	Y	-
A2-11S	Estero & Andre Mar	Evacuation	3.5	3.5	-	A	Y	-	3.7	2.4	B	Y	2
A2-12S	Estero & St Peters	Evacuation	3.5	3.5	-	A	Y	-	3.7	1.8	B	Y	1
A3-1S	Estero & Sterling	Evacuation	4.0	3.4	-	A	Y	-	3.6	-	A	Y	-
A3-2S	Lazy Way	Other Road	3.2	2.4	-	A	Y	-	3.2	-	A	Y	-
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.1	-	A	Y	-	3.4	-	A	Y	-
A3-5N	Sterling & Falkirk	Critical Elev	3.5	2.3	-	A	Y	-	2.1	-	A	Y	-
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.0	-	A	Y	-	2.0	-	A	Y	-

Node	Location	Type	Road [1] Crown or Ref. Elev. (ft-NAVD)	5-Year Storm Peak Stage (ft-NAVD)	5-Year Storm Flood Depth (in)	5-Year Storm LOS Class	5-Year Storm Meets LOS?	5-Year Storm Duration of Flooding (hours)	10-Year Storm Peak Stage (ft-NAVD)	10-Year Storm Flood Depth (in)	10-Year Storm LOS Class	10-Year Storm Meets LOS?	10-Year Storm Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	4.5	-	A	Y	-	4.6	-	A	Y	-
A1-3S	Bay Rd	Other Road	4.5	4.6	0.7	B	Y	1	4.7	2.8	B	Y	1
A1-6S	Sea Grape Plaza (Alt 3a)	Critical Elev	5.3	4.7	-	A	Y	-	4.7	-	A	Y	-
A1-7S	Wachovia	Critical Elev	4.8	4.6	-	A	Y	-	4.9	2.3	B	Y	1
A1-8S	Lovers Lane	Other Road	4.2	4.3	1.2	B	Y	2	4.3	1.7	B	Y	2
A2-2S	Voorhis St	Other Road	3.4	3.6	1.9	B	Y	1	4.1	7.9	D	N	3
A2-3S	Estero & Madison	Evacuation	3.5	3.5	0.1	B	Y	0.5	4.1	7.3	D	N	5
A2-4S	Jefferson St	Other Road	3.5	3.8	3.6	C	Y	3	4.1	7.7	D	N	5
A2-5S	Estero & Mid Island	Evacuation	3.5	3.9	4.2	C	N	4	4.1	7.7	D	N	6
A2-10N	Anchorage St	Other Road	3.2	3.3	1.3	B	Y	5	4.0	9.7	NA	N	6
A2-10S	Andre Mar Dr	Other Road	3.7	3.8	1.7	B	Y	3	4.2	5.9	C	Y	4
A2-11S	Estero & Andre Mar	Evacuation	3.5	3.9	4.2	C	N	5	4.2	8.3	D	Y	5
A2-12S	Estero & St Peters	Evacuation	3.5	3.9	4.2	C	N	2	4.2	8.3	D	Y	3
A3-1S	Estero & Sterling	Evacuation	4.0	3.9	-	A	Y	-	4.5	6.1	D	Y	3
A3-2S	Lazy Way	Other Road	3.2	3.3	1.3	B	Y	1	3.8	7.1	D	Y	3
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.7	2.2	B	Y	2	4.1	7.2	D	Y	3
A3-5N	Sterling & Falkirk	Critical Elev	3.5	3.0	-	A	Y	-	3.3	-	A	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.3	-	A	Y	-	2.5	-	A	Y	-

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Table 4-4: Peak Stages and LOS for Alternative 3 at Select Locations

				25-Year Storm					100-Year Storm				
Node	Location	Type	Road [1] Crown or Ref. Elev. (ft-NAVD)	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	Duration of Flooding (hours)	Peak Stage (ft-NAVD)	Flood Depth (in)	LOS Class	Meets LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	4.6	-	A	Y	-	4.7	-	A	Y	-
A1-3S	Bay Rd	Other Road	4.5	4.9	4.2	C	Y	1	5.0	6.4	D	Y	2
A1-6S	Sea Grape Plaza (Alt 3a)	Critical Elev	5.3	4.8	-	A	Y	-	4.8	-	A	Y	-
A1-7S	Wachovia	Critical Elev	4.8	5.1	3.8	C	Y	1	5.2	5.3	C	Y	1
A1-8S	Lovers Lane	Other Road	4.2	4.3	1.8	B	Y	3	4.3	2.2	B	Y	4
A2-2S	Voorhis St	Other Road	3.4	4.3	10.6	NA	N	4	4.5	13.6	NA	N	5
A2-3S	Estero & Madison	Evacuation	3.5	4.2	8.2	D	Y	7	4.3	9.8	NA	N	8
A2-4S	Jefferson St	Other Road	3.5	4.2	8.9	D	Y	6	4.3	10.1	NA	N	7
A2-5S	Estero & Mid Island	Evacuation	3.5	4.2	8.9	D	Y	7	4.3	10.1	NA	N	10
A2-10N	Anchorage St	Other Road	3.2	4.2	11.5	NA	N	7	4.3	13.3	NA	N	8
A2-10S	Andre Mar Dr	Other Road	3.7	4.3	7.0	D	Y	5	4.4	8.5	D	Y	6
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.3	9.4	NA	NA	7	4.4	10.9	NA	NA	8
A2-12S	Estero & St Peters	Evacuation	3.5	4.3	9.4	NA	NA	3	4.4	10.9	NA	NA	5
A3-1S	Estero & Sterling	Evacuation	4.0	4.6	7.3	D	Y	3	4.8	9.1	NA	NA	3
A3-2S	Lazy Way	Other Road	3.2	3.9	8.6	D	Y	4	4.1	11.2	NA	NA	4
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.2	8.9	D	Y	4	4.3	10.0	NA	NA	5
A3-5N	Sterling & Falkirk	Critical Elev	3.5	3.4	-	A	Y		3.7	1.9	B	Y	1
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.6	-	A	Y	-	2.7	-	A	Y	-

1) Road crown, reference and critical elevations were estimated from LiDAR.

2) All events were modeled with a boundary condition of 2.0 ft-NAVD stillwater elevation. These LOS should not be expected during periods of extreme high tides.

3) 10, 25 and 100-year events are 72-hour duration. 2.5-inch and 5-year events are 24-hour duration.

4.5 Comparison of Alternatives

Table 4-6 shows a comparison of peak flood stages between existing conditions and Alternatives 2 and 3 for select locations. The peak flood stage for each design storm event is given for each alternative and compared to the existing conditions. Increasing benefits in terms of flood stage reduction are shown for Alternatives 2 and 3. Alternative 1 is an enhanced O&M condition and is considered to be a base for Alternatives 2 and 3.

Table 4-7 shows a comparison of flood depth and LOS between existing conditions and Alternatives 2 and 3. As the second footnote in the table indicates, all LOS criteria are related to the combination of stormwater runoff and a 2.0-feet NAVD tidal stillwater elevation. Therefore, these alternatives should not be expected to provide the same LOS during extreme tidal surge conditions. The flood depth, flood duration and whether the location meets the LOS goals is given for each alternative and compared to the existing conditions. As indicated in Table 4-7 for the 2.5-inch storm, the model shows that no flooding was reported. For the 2-year storm 7 of the 18 select locations failed to meet the LOS goals for Alternative 2, while only 1 of 18 locations failed for Alternative 3. For the 5-year storm 7 of the 18 select locations failed to meet the LOS goals for Alternative 2. LOS goals for alternative 3 are for the most part achievable since only 3 of 18 locations fell short by 1.2 inches. The 5-year model in Alternative 3 also estimated a substantial reduction in flood duration for many of the locations compared to Alternative 2. For this reason the 5-year storm was chosen as a practical baseline in setting LOS goals for the Town of Fort Myers Beach. The results for the 10-year, 25-year and 100-year storms for both alternatives show a trend of diminishing LOS performance in both flood depth and duration.

Table 4-6: Comparison of Alternatives 2 and 3 (Peak Stage)

				2.5-Inch Storm					2-Year Storm				
Node	Location	Type	Road1 Elevation (ft-NAVD)	Existing Peak Stage (ft-NAVD)	Alt2 Peak Stage (ft-NAVD)	difference (ft)	Alt3 Peak Stage (ft-NAVD)	difference (ft)	Existing Peak Stage (ft-NAVD)	Alt2 Peak Stage (ft-NAVD)	difference (ft)	Alt3 Peak Stage (ft-NAVD)	difference (ft)
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.5	4.0	-1.6	2.8	-2.8	5.6	4.6	-1.0	4.2	-1.4
A1-3S	Bay Rd	Other Road	4.5	5.1	4.4	-0.8	4.4	-0.8	5.2	4.8	-0.4	4.5	-0.7
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.5	4.6	-1.0	4.6	-1.0	5.6	4.7	-0.9	4.7	-0.9
A1-7S	Wachovia	Critical Elev	4.8	5.2	4.6	-0.6	4.6	-0.6	5.3	4.9	-0.3	4.6	-0.6
A1-8S	Lovers Lane	Other Road	4.2	4.3	4.1	-0.2	4.1	-0.2	4.4	4.2	-0.2	4.2	-0.2
A2-2S	Voorhis St	Other Road	3.4	3.8	3.5	-0.3	2.6	-1.2	4.2	4.1	-0.2	3.4	-0.9
A2-3S	Estero & Madison	Evacuation	3.5	4.1	3.4	-0.7	3.5	-0.6	4.2	4.1	-0.1	3.5	-0.7
A2-4S	Jefferson St	Other Road	3.4	3.6	3.4	-0.2	3.3	-0.3	3.9	3.8	-0.1	3.7	-0.2
A2-5S	Estero & Mid Island	Evacuation	3.5	3.8	3.5	-0.3	3.5	-0.3	3.9	3.8	-0.1	3.8	-0.2
A2-10N	Anchorage St	Other Road	3.2	3.3	3.1	-0.2	2.1	-1.2	3.9	3.4	-0.5	3.3	-0.6
A2-10S	Andre Mar Dr	Other Road	3.7	3.8	3.5	-0.3	3.4	-0.4	4.1	3.8	-0.2	3.7	-0.4
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.0	3.5	-0.5	3.5	-0.5	4.0	3.8	-0.2	3.7	-0.3
A2-12S	Estero & St Peters	Evacuation	3.5	4.0	3.5	-0.5	3.5	-0.5	4.1	3.8	-0.3	3.7	-0.4
A3-1S	Estero & Sterling	Evacuation	4.0	4.4	3.6	-0.8	3.4	-1.0	4.5	4.0	-0.5	3.6	-0.9
A3-2S	Lazy Way	Other Road	3.2	2.8	2.7	-0.1	2.4	-0.4	3.3	3.4	0.1	3.2	-0.1
A3-5S	Sterling & Falkirk	Other Road	4.0	2.0	2.0	0.0	2.0	0.0	2.0	2.1	0.1	2.0	0.0
A3-4S	Sterling & Falkirk	Critical Elev	3.5	3.8	3.1	-0.7	3.1	-0.7	4.2	3.6	-0.6	3.4	-0.8
A3-5N	Sterling & Falkirk	Critical Elev	3.5	3.5	2.3	-1.2	2.3	-1.2	3.6	3.2	-0.4	2.1	-1.5

				5-Year Storm					10-Year Storm				
			Road1 Elevation (ft-NAVD)	Existing Peak Stage (ft-NAVD)	Alt2 Peak Stage (ft-NAVD)	difference (ft)	Alt3 Peak Stage (ft-NAVD)	difference (ft)	Existing Peak Stage (ft-NAVD)	Alt2 Peak Stage (ft-NAVD)	difference (ft)	Alt3 Peak Stage (ft-NAVD)	difference (ft)
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.6	4.6	-1.0	4.5	-1.1	5.6	4.6	-1.0	4.6	-1.0
A1-3S	Bay Rd	Other Road	4.5	5.3	4.9	-0.4	4.6	-0.7	5.3	5.1	-0.2	4.7	-0.6
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.6	4.7	-0.9	4.7	-0.9	5.7	4.7	-0.9	4.7	-0.9
A1-7S	Wachovia	Critical Elev	4.8	5.3	5.0	-0.3	4.6	-0.6	5.3	5.1	-0.2	4.9	-0.4
A1-8S	Lovers Lane	Other Road	4.2	4.5	4.3	-0.2	4.3	-0.2	4.5	4.3	-0.2	4.3	-0.2
A2-2S	Voorhis St	Other Road	3.4	4.3	4.2	-0.1	3.6	-0.7	4.4	4.5	0.1	4.1	-0.3
A2-3S	Estero & Madison	Evacuation	3.5	4.3	4.1	-0.1	3.5	-0.8	4.4	4.2	-0.2	4.1	-0.3
A2-4S	Jefferson St	Other Road	3.4	4.0	3.9	-0.2	3.8	-0.2	4.4	4.2	-0.2	4.1	-0.3
A2-5S	Estero & Mid Island	Evacuation	3.5	4.0	3.9	-0.1	3.9	-0.2	4.4	4.2	-0.2	4.1	-0.3
A2-10N	Anchorage St	Other Road	3.2	4.0	3.7	-0.3	3.3	-0.7	4.4	4.2	-0.2	4.0	-0.3
A2-10S	Andre Mar Dr	Other Road	3.7	4.1	3.9	-0.2	3.8	-0.3	4.4	4.3	-0.1	4.2	-0.2
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.1	3.9	-0.2	3.9	-0.3	4.4	4.3	-0.1	4.2	-0.2
A2-12S	Estero & St Peters	Evacuation	3.5	4.1	3.9	-0.2	3.9	-0.3	4.4	4.3	-0.2	4.2	-0.2
A3-1S	Estero & Sterling	Evacuation	4.0	4.5	4.3	-0.2	3.9	-0.6	4.6	4.6	0.0	4.5	-0.1
A3-2S	Lazy Way	Other Road	3.2	3.5	3.6	0.1	3.3	-0.2	4.0	4.1	0.0	3.8	-0.3
A3-5S	Sterling & Falkirk	Other Road	4.0	2.1	2.2	0.2	2.3	0.2	2.3	2.5	0.2	2.5	0.2
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.2	3.7	-0.5	3.7	-0.6	4.4	4.2	-0.2	4.1	-0.3
A3-5N	Sterling & Falkirk	Critical Elev	3.5	3.6	3.2	-0.3	3.0	-0.5	3.8	3.6	-0.3	3.3	-0.5

1) Road crown, reference and critical elevations were estimated from LiDAR.

Table 4-6: Comparison of Alternatives 2 and 3 (Peak Stage)

				25-Year Storm					100-year Storm				
			Road[1] Elevation (ft-NAVD)	Existing Peak Stage (ft-NAVD)	Alt2 Peak Stage (ft-NAVD)	difference (ft)	Alt3 Peak Stage (ft-NAVD)	difference (ft)	Existing Peak Stage (ft-NAVD)	Alt2 Peak Stage (ft-NAVD)	difference (ft)	Alt3 Peak Stage (ft-NAVD)	difference (ft)
A1-2S	Estero & Bay Rd	Evacuation	5.5	5.6	4.6	-1.0	4.6	-1.0	5.7	4.7	-1.0	4.7	-1.0
A1-3S	Bay Rd	Other Road	4.5	5.3	5.1	-0.2	4.9	-0.5	5.4	5.2	-0.1	5.0	-0.4
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.7	4.8	-0.9	4.8	-0.9	5.7	4.8	-0.9	4.8	-0.9
A1-7S	Wachovia	Critical Elev	4.8	5.3	5.2	-0.1	5.1	-0.3	5.4	5.3	-0.1	5.2	-0.2
A1-8S	Lovers Lane	Other Road	4.2	4.6	4.3	-0.2	4.3	-0.3	4.6	4.3	-0.3	4.3	-0.3
A2-2S	Voorhis St	Other Road	3.4	4.5	4.6	0.1	4.3	-0.2	4.6	4.7	0.1	4.5	-0.1
A2-3S	Estero & Madison	Evacuation	3.5	4.5	4.2	-0.2	4.2	-0.3	4.6	4.4	-0.2	4.3	-0.3
A2-4S	Jefferson St	Other Road	3.4	4.5	4.3	-0.2	4.2	-0.2	4.6	4.4	-0.2	4.3	-0.3
A2-5S	Estero & Mid Island	Evacuation	3.5	4.5	4.3	-0.2	4.2	-0.2	4.6	4.4	-0.2	4.3	-0.3
A2-10N	Anchorage St	Other Road	3.2	4.4	4.3	-0.1	4.2	-0.3	4.6	4.4	-0.1	4.3	-0.2
A2-10S	Andre Mar Dr	Other Road	3.7	4.5	4.4	-0.2	4.3	-0.2	4.6	4.5	-0.2	4.4	-0.2
A2-11S	Estero & Andre Mar	Evacuation	3.5	4.5	4.4	-0.2	4.3	-0.2	4.6	4.5	-0.2	4.4	-0.2
A2-12S	Estero & St Peters	Evacuation	3.5	4.5	4.4	-0.1	4.3	-0.2	4.6	4.5	-0.2	4.4	-0.2
A3-1S	Estero & Sterling	Evacuation	4.0	4.6	4.7	0.1	4.6	0.0	4.6	4.9	0.2	4.8	0.1
A3-2S	Lazy Way	Other Road	3.2	4.2	4.2	0.0	3.9	-0.3	4.3	4.3	0.0	4.1	-0.2
A3-5S	Sterling & Falkirk	Other Road	4.0	2.4	2.6	0.1	2.6	0.1	2.6	2.5	-0.1	2.5	-0.1
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.4	4.3	-0.1	4.2	-0.2	4.5	4.4	-0.1	4.3	-0.1
A3-5N	Sterling & Falkirk	Critical Elev	3.5	3.9	3.7	-0.2	3.4	-0.5	3.9	3.9	0.0	3.7	-0.3

1) Road crown, reference and critical elevations were estimated from LiDAR.

Table 4-7: Comparison of Results for Alternatives 2 and 3

2.5-Inch Storm				Existing Conditions		Alternative 2			Alternative 3		
Node	Location	Type	Road[1] Elevation (ft-NAVD)	Flood Depth (in)	Meets[2] LOS?	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	0.4	Y	-	Y		-	Y	
A1-3S	Bay Rd	Other Road	4.5	7.6	N	-	Y		-	Y	
A1-6S	Sea Grape Plaza	Critical Elev	5.3	3.5	N	-	Y		-	Y	
A1-7S	Wachovia	Critical Elev	4.8	4.8	N	-	Y		-	Y	
A1-8S	Lovers Lane	Other Road	4.2	2.0	Y	-	Y		-	Y	
A2-2S	Voorhis St	Other Road	3.4	4.9	N	1.3	Y	2	-	Y	
A2-3S	Estero & Madison	Evacuation	3.5	7.7	N	-	Y		-	Y	
A2-4S	Jefferson St	Other Road	3.5	2.3	Y	-	Y		-	Y	
A2-5S	Estero & Mid Island	Evacuation	3.5	3.5	N	2.0	Y	2	-	Y	
A2-10N	Anchorage St	Other Road	3.2	0.8	Y	-	Y		-	Y	
A2-10S	Andre Mar Dr	Other Road	3.7	1.1	Y	-	Y		-	Y	
A2-11S	Estero & Andre Mar	Evacuation	3.5	5.5	N	-	Y		-	Y	
A2-12S	Estero & St Peters	Evacuation	3.5	5.6	N	-	Y		-	Y	
A3-1S	Estero & Sterling	Evacuation	4.0	4.3	N	-	Y		-	Y	
A3-2S	Lazy Way	Other Road	3.2	-	Y	-	Y		-	Y	
A3-4S	Sterling & Falkirk	Critical Elev	3.5	4.0	N	-	Y		-	Y	
A3-5N	Sterling & Falkirk	Critical Elev	3.5	-	Y	-	Y		-	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	-	Y	-	Y		-	Y	

2-Year Storm				Existing Conditions		Alternative 2			Alternative 3		
Node	Location	Type	Road[1] Elevation (ft-NAVD)	Flood Depth (in)	Meets[2] LOS?	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	0.8	Y	-	Y		-	Y	
A1-3S	Bay Rd	Other Road	4.5	8.9	N	3.7	N	2	0.4	Y	0.5
A1-6S	Sea Grape Plaza	Critical Elev	5.3	4.4	N	-	Y		-	Y	
A1-7S	Wachovia	Critical Elev	4.8	6.1	N	2.0	Y	2	-	Y	
A1-8S	Lovers Lane	Other Road	4.2	3.4	N	1.1	Y	3	1.1	Y	2
A2-2S	Voorhis St	Other Road	3.4	9.8	N	7.9	N	8	-	Y	
A2-3S	Estero & Madison	Evacuation	3.5	8.6	N	7.3	N	9	-	Y	
A2-4S	Jefferson St	Other Road	3.5	5.4	N	3.2	N	4	2.3	Y	2
A2-5S	Estero & Mid Island	Evacuation	3.5	5.0	N	4.3	N	6	3.0	N	3
A2-10N	Anchorage St	Other Road	3.2	8.3	N	2.0	Y	7	0.8	Y	3
A2-10S	Andre Mar Dr	Other Road	3.7	4.2	N	1.3	Y	3	-	Y	
A2-11S	Estero & Andre Mar	Evacuation	3.5	6.5	N	3.6	N	3	2.4	Y	2
A2-12S	Estero & St Peters	Evacuation	3.5	6.6	N	3.6	N	2	1.8	Y	1
A3-1S	Estero & Sterling	Evacuation	4.0	5.6	N	0.2	Y	1	-	Y	
A3-2S	Lazy Way	Other Road	3.2	1.3	Y	2.4	Y	3	-	Y	
A3-4S	Sterling & Falkirk	Critical Elev	3.5	8.8	N	1.2	Y	2		Y	
A3-5N	Sterling & Falkirk	Critical Elev	3.5	0.7	Y	-	Y		-	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.8	Y	-	Y		-	Y	

1) Road Crown Elevations were estimated from LIDAR since no survey was provided for study areas.
2) All events were modeled with a boundary condition of 2.0 ft-NAVD stillwater elevation. These LOS should not be expected during periods of extreme high tides.

Table 4-7: Comparison of Results for Alternatives 2 and 3

5-Year Storm				Existing Conditions		Alternative 2			Alternative 3		
Node	Location	Type	Road[1] Elevation (ft-NAVD)	Flood Depth (in)	Meets[2] LOS?	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	1.0	Y	-	Y		-	Y	
A1-3S	Bay Rd	Other Road	4.5	9.1	N	4.8	Y	2	0.7	Y	1
A1-6S	Sea Grape Plaza	Critical Elev	5.3	4.7	Y	-	Y		-	Y	
A1-7S	Wachovia	Critical Elev	4.8	6.4	N	3.2	Y	2	-	Y	
A1-8S	Lovers Lane	Other Road	4.2	3.6	Y	1.2	Y	4	1.2	Y	2
A2-2S	Voorhis St	Other Road	3.4	10.3	N	9.2	N	10	1.9	Y	1
A2-3S	Estero & Madison	Evacuation	3.5	9.1	N	7.6	N	9	0.1	Y	0.5
A2-4S	Jefferson St	Other Road	3.5	7.6	N	4.6	Y	7	3.6	Y	3
A2-5S	Estero & Mid Island	Evacuation	3.5	6.1	N	5.4	N	6	4.2	N	4
A2-10N	Anchorage St	Other Road	3.2	10.0	N	6.5	N	10	1.3	Y	5
A2-10S	Andre Mar Dr	Other Road	3.7	5.0	Y	2.6	Y	6	1.7	Y	3
A2-11S	Estero & Andre Mar	Evacuation	3.5	7.4	N	4.9	N	10	4.2	N	5
A2-12S	Estero & St Peters	Evacuation	3.5	7.3	N	4.9	N	4	4.2	N	2
A3-1S	Estero & Sterling	Evacuation	4.0	5.9	N	3.8	N	2	-	Y	
A3-2S	Lazy Way	Other Road	3.2	3.5	Y	4.7	Y	6	-	Y	
A3-4S	Sterling & Falkirk	Critical Elev	3.5	8.9	N	2.6	Y	2	2.2	Y	2
A3-5N	Sterling & Falkirk	Critical Elev	3.5	1.0	Y	-	Y		-	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	2.9	Y	-	Y		-	Y	

10-Year Storm				Existing Conditions		Alternative 2			Alternative 3		
Node	Location	Type	Road[1] Elevation (ft-NAVD)	Flood Depth (in)	Meets[2] LOS?	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	1.3	Y	-	Y		-	Y	
A1-3S	Bay Rd	Other Road	4.5	9.6	N	6.7	Y	2	2.8	Y	1
A1-6S	Sea Grape Plaza	Critical Elev	5.3	4.9	Y	-	Y		-	Y	
A1-7S	Wachovia	Critical Elev	4.8	6.6	Y	4.7	Y	2	2.3	Y	1
A1-8S	Lovers Lane	Other Road	4.2	4.3	Y	1.7	Y	4	1.7	Y	2
A2-2S	Voorhis St	Other Road	3.4	12.0	N	13.3	N	15	7.9	Y	3
A2-3S	Estero & Madison	Evacuation	3.5	10.8	N	8.5	N	13	7.3	N	5
A2-4S	Jefferson St	Other Road	3.5	12.0	N	8.5	Y	9	7.7	Y	1
A2-5S	Estero & Mid Island	Evacuation	3.5	10.8	N	8.9	N	10	7.7	N	6
A2-10N	Anchorage St	Other Road	3.2	13.8	N	11.6	N	17	9.7	N	6
A2-10S	Andre Mar Dr	Other Road	3.7	8.4	Y	6.7	Y	8	5.9	Y	4
A2-11S	Estero & Andre Mar	Evacuation	3.5	10.8	N	9.1	N	12	8.3	N	5
A2-12S	Estero & St Peters	Evacuation	3.5	10.8	N	9.0	N	5	8.3	N	3
A3-1S	Estero & Sterling	Evacuation	4.0	6.8	N	7.2	N	4	6.1	N	3
A3-2S	Lazy Way	Other Road	3.2	10.1	N	11.3	N	11	7.1	Y	3
A3-4S	Sterling & Falkirk	Critical Elev	3.5	10.7	N	8.0	Y	4	7.2	Y	3
A3-5N	Sterling & Falkirk	Critical Elev	3.5	4.0	Y	0.7	Y	2	-	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	4.7	Y	-	Y		-	Y	

1) Road Crown Elevations were estimated from LIDAR since no survey was provided for study areas.
2) All events were modeled with a boundary condition of 2.0 ft-NAVD stillwater elevation. These LOS should not be expected during periods of extreme high tides.

Table 4-7: Comparison of Results for Alternatives 2 and 3

25-Year Storm				Existing Conditions		Alternative 2			Alternative 3		
Node	Location	Type	Road[1] Elevation (ft-NAVD)	Flood Depth (in)	Meets[2] LOS?	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	1.6	Y	-	Y		-	Y	
A1-3S	Bay Rd	Other Road	4.5	10.0	NA	7.7	Y	3	4.2	Y	1
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.2	Y	-	Y		-	Y	
A1-7S	Wachovia	Critical Elev	4.8	7.0	Y	5.4	Y	3	3.8	Y	1
A1-8S	Lovers Lane	Other Road	4.2	4.8	Y	1.9	Y	6	1.8	Y	3
A2-2S	Voorhis St	Other Road	3.4	13.0	NA	14.4	NA	20	10.6	NA	4
A2-3S	Estero & Madison	Evacuation	3.5	11.8	N	8.9	Y	20	8.2	Y	7
A2-4S	Jefferson St	Other Road	3.5	13.0	NA	9.4	NA	10	8.9	Y	6
A2-5S	Estero & Mid Island	Evacuation	3.5	11.8	N	9.4	N	12	8.9	Y	7
A2-10N	Anchorage St	Other Road	3.2	14.8	NA	13.0	NA	20	11.5	NA	7
A2-10S	Andre Mar Dr	Other Road	3.7	9.6	NA	7.8	Y	10	7.0	Y	5
A2-11S	Estero & Andre Mar	Evacuation	3.5	12.0	N	10.2	N	15	9.4	N	7
A2-12S	Estero & St Peters	Evacuation	3.5	11.9	N	10.2	N	7	9.4	N	3
A3-1S	Estero & Sterling	Evacuation	4.0	7.1	Y	8.2	Y	5	7.3	Y	3
A3-2S	Lazy Way	Other Road	3.2	11.8	NA	11.8	NA	11	8.6	Y	4
A3-4S	Sterling & Falkirk	Critical Elev	3.5	10.9	NA	9.2	NA	5	8.9	Y	4
A3-5N	Sterling & Falkirk	Critical Elev	3.5	4.4	Y	1.9	Y	3	-	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	4.9	Y	-	Y		-	Y	

100-Year Storm				Existing Conditions		Alternative 2			Alternative 3		
Node	Location	Type	Road[1] Elevation (ft-NAVD)	Flood Depth (in)	Meets[2] LOS?	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)	Flood Depth (in)	Meets[2] LOS?	Duration of Flooding (hours)
A1-2S	Estero & Bay Rd	Evacuation	5.5	1.8	Y	-	Y		-	Y	
A1-3S	Bay Rd	Other Road	4.5	10.6	NA	8.8	Y	3	6.4	Y	2
A1-6S	Sea Grape Plaza	Critical Elev	5.3	5.5	Y	-	Y		-	Y	
A1-7S	Wachovia	Critical Elev	4.8	7.4	Y	6.1	Y	3	5.3	Y	1
A1-8S	Lovers Lane	Other Road	4.2	5.4	Y	2.2	Y	6	2.2	Y	2
A2-2S	Voorhis St	Other Road	3.4	14.4	NA	15.8	NA	26	13.6	NA	5
A2-3S	Estero & Madison	Evacuation	3.5	13.2	N	10.4	N	26	9.8	N	8
A2-4S	Jefferson St	Other Road	3.5	14.4	NA	10.7	NA	12	10.1	NA	7
A2-5S	Estero & Mid Island	Evacuation	3.5	13.2	N	10.7	N	14	10.1	N	10
A2-10N	Anchorage St	Other Road	3.2	16.2	NA	14.5	NA	24	13.3	NA	8
A2-10S	Andre Mar Dr	Other Road	3.7	11.0	NA	9.2	NA	15	8.5	Y	6
A2-11S	Estero & Andre Mar	Evacuation	3.5	13.4	N	11.6	N	23	10.9	N	8
A2-12S	Estero & St Peters	Evacuation	3.5	13.4	N	11.6	N	8	10.9	N	5
A3-1S	Estero & Sterling	Evacuation	4.0	7.4	Y	10.2	N	6	9.1	N	3
A3-2S	Lazy Way	Other Road	3.2	13.7	NA	13.1	NA	12	11.2	NA	4
A3-4S	Sterling & Falkirk	Critical Elev	3.5	11.4	NA	10.2	NA	7	10.0	NA	5
A3-5N	Sterling & Falkirk	Critical Elev	3.5	5.0	Y	4.6	Y	4	-	Y	
A3-5S	Sterling & E. Falkirk	Other Road	4.0	5.4	Y	-	Y		-	Y	

1) Road Crown Elevations were estimated from LIDAR since no survey was provided for study areas.

2) All events were modeled with a boundary condition of 2.0 ft-NAVD stillwater elevation. These LOS should not be expected during periods of extreme high tides.

4.6 BMP Implementation Considerations for Problem Areas

In determining the best stormwater management facility or combination of facilities (treatment train), several factors, such as the following, need to be considered:

- Physical constraints or requirements of the site, such as permeability of the soil, the location of the wet season high water table, and the amount of land available on the site to construct the facility.
- Permitting constraints (e.g., wetlands disturbance).
- The benefits provided by the facility, such as control of peak discharge for flood control, reduction in the total volume of discharge, groundwater recharge, erosion control, wetlands management, reduction of pollutant loads to receiving waters, and or optimized maintenance.
- Cost.

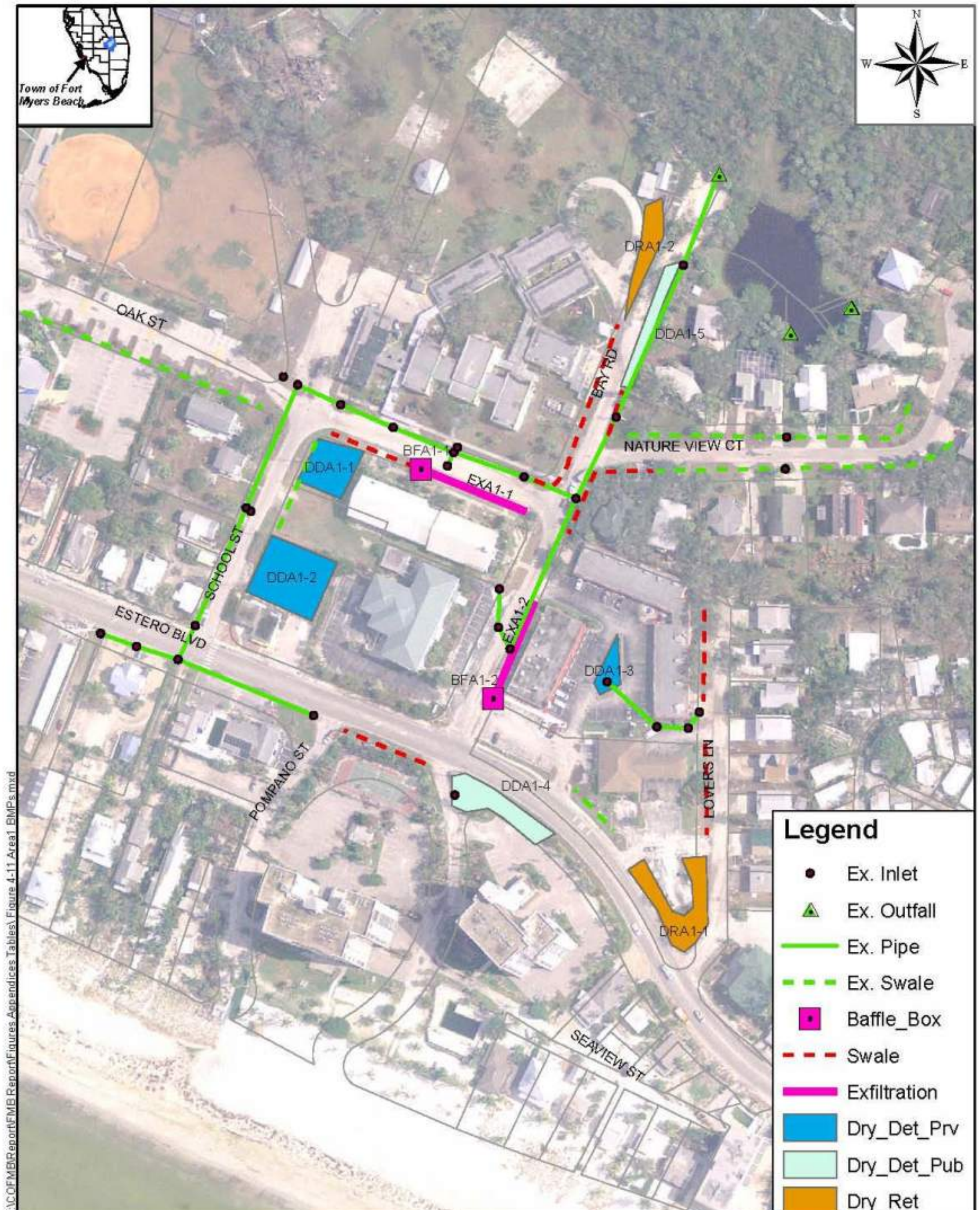
Selection of BMPs for the problem areas is largely constrained by the shallow depth to the seasonal high water table (or SHW) and a lack of topographic relief. Based on these limitations and considering the site conditions for each alternative, the following set of BMPs are being proposed for the three problem areas: baffle boxes combined with exfiltration trenches, swales, dry detention and retention.

Combining exfiltration trenches with baffle boxes intends to supplement the lack of nutrient removal provided by implementing the baffle boxes alone. Exfiltration trenches are generally applied on higher ground areas in the vicinity of the existing drainage system to facilitate infiltration and treatment as well as conveyance.

Dry detention areas and swales are proposed generally on low-lying areas where runoff can be captured and conveyed by gravity to an existing adjacent swale or stormwater pipe via a weir-type structure. Proposed dry detention areas were identified as being public or private facilities depending upon the footprint they overlay. This distinction is a measure of feasibility of such a facility to be constructed.

Retention areas are proposed in areas where the groundwater table is below grade and infiltration could be provided near or upgrade from known flooding areas.

Figures 4-11 through **4-13** show the location of the proposed BMP systems in problem areas 1, 2, and 3, respectively.



Source: Town of Fort Myers Beach

CDM	Town of Fort Myers Beach 2523 Estero Blvd. Ft. Myers Beach, FL 33931 Tel # (239) 765-0202	**Figure 4-11** Proposed BMPs Area 1 Estero Boulevard & Bay Road	UPDATED 04-10-09

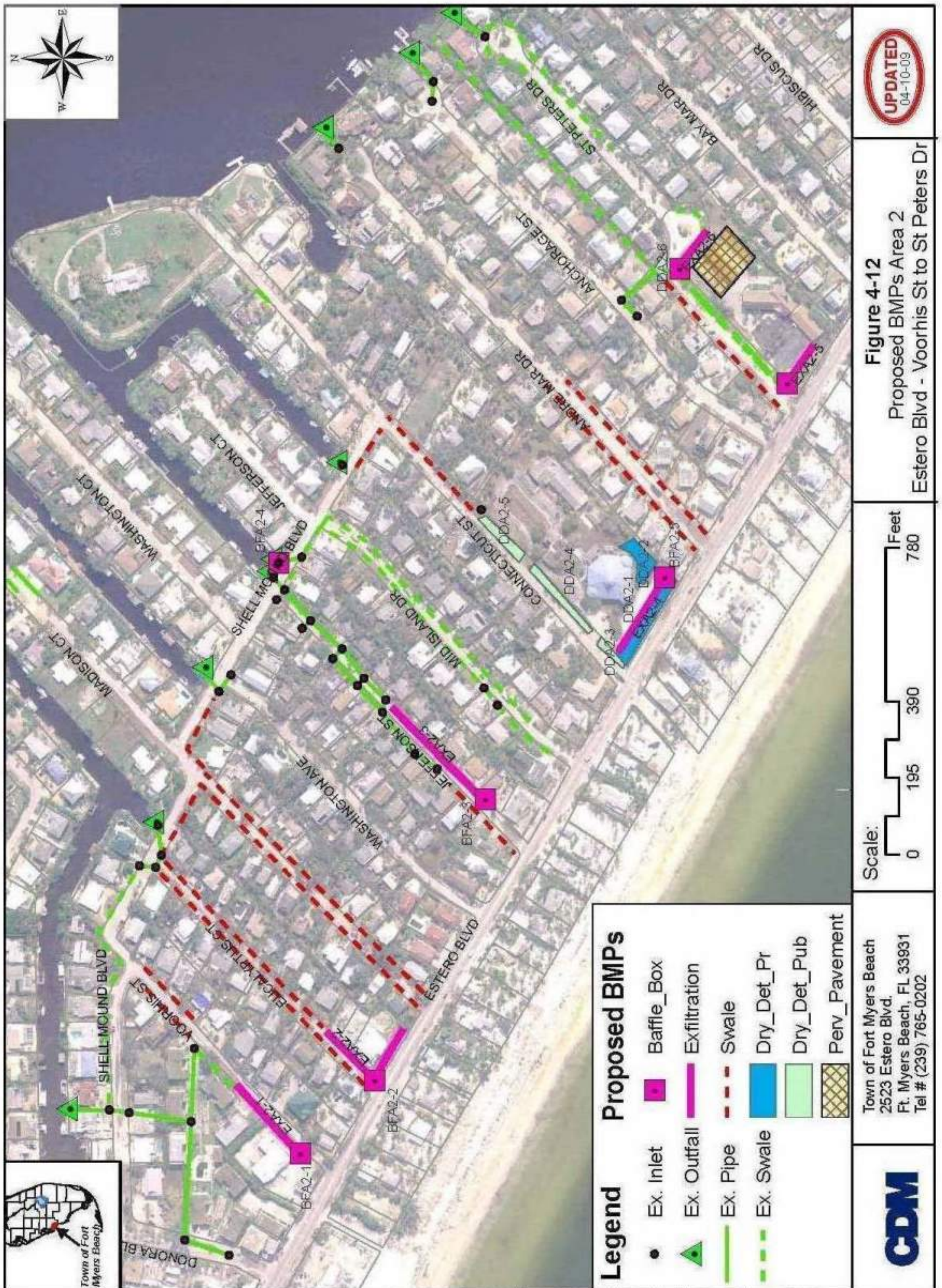

Legend
Ex. Inlet
Ex. Outfall
Ex. Pipe
Ex. Swale
Proposed BMPs
Baffle_Box
Exfiltration
Swale
Dry_Det_Pr
Dry_Det_Pub
Perv_Pavement
Scale:
0
195
390
780
Feet
Figure 4-12
Proposed BMPs Area 2
Estero Blvd - Voorhis St to St Peters Dr
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
UPDATED
04-10-09
CDM
Town of Fort Myers Beach
ESTERO BLVD
SHELL MOUND BLVD
DONORA BLVD
VOORHIS ST
WASHINGTON AVE
JEFFERSON ST
MID ISLAND DR
CONNECTICUT ST
ANDRE MAR DR
ANCHORAGE ST
ST PETERS DR
BAY MAR DR
HIBISCUS DR
MADISON CT
WASHINGTON CT
JEFFERSON CT
BFA2-1
BFA2-2
BFA2-3
BFA2-4
DDA2-1
DDA2-3
DDA2-4
DDA2-5
DDA2-6

Figure 4-13
Proposed BMPs Area 3
Sterling Avenue and Lazy Way

4.7 Water Quality Treatment for Problem Areas

To quantify the effect of the proposed BMPs in the overall water quality treatment provided at all the problem areas, the following general estimates were made to calculate the expected treatment volume of each BMP type:

- Swale – For the predominant HSG type C in the study area, an infiltration rate of 0.1 inch/hour was used, which is equivalent to an infiltration rate of 2.4 inches/day. A vertical to horizontal swale side slope of 6:1 was used for these calculations.

- Exfiltration – The exfiltration trench volume equation available from the SFWMD's ERP Information Manual Volume IV (2007) was used to calculate the expected design treatment volume.

- Dry Detention - Detention areas of 1-foot depth were considered for these volumetric calculations.

- Dry Retention – As with swales, an infiltration rate of 0.1 inch/hour was used for treatment volume calculations.

Table E-1 in **Appendix E** provides a summary of the water quality treatment volume calculations. In the process of meeting the water quality treatment requirements stipulated by the SFWMD, credits are granted by the agency for retention and dry detention systems:

- Double treatment volume credit is given for dry retention (i.e., 50% of required by wet detention to obtain a wet detention equivalent),

- Twenty five percent (25%) additional treatment volume credit is given for dry detention (i.e., 75% of required by wet detention to obtain a wet detention equivalent).

The calculations presented in Table E-1 do include these potentially additional credits. These water quality BMP credits will need to be negotiated with the SFWMD. According to Table E-1, problem area 1 followed by problem area 3 will have the largest BMP credit coverage with respect to the 1-inch volume used treatment criteria for these calculations. **Table E-2 in Appendix E** provides a summary of the proposed BMP systems for the study area.

4.8 Project Cost Analysis

Project cost/benefit analysis is summarized in **Table 4-8** by alternative and problem area. See **Appendices F and G** for a complete breakdown of the cost estimates for Alternatives 2 and 3 for each of the problem area.

Table 4-8: Project Cost/Benefit Analysis by Alternative and Area

Alternative	Area	Cost	LOS	Benefit
Alt 2a	1	$430,000	<2-Year	- 3 to 12-inch reduction in flooding for 2-yr storm - improved LOS to Lovers Lane
Alt 2b	1	$450,000	<2-Year	- 3 to 12-inch reduction in flooding for 2-yr storm - no easements required for Lovers Lane
Alt 2	2	$1,600,000	<2-Year	- 1 to 2-inch reduction in flooding for 2-yr storm
Alt 2	3	$560,000	<2-Year	- 0 to 6-inch reduction in flooding for 2-yr storm
Alt 3a	1	$550,000	5-Year	- 2 to 13-inch reduction in flooding for 5-yr storm - improved LOS to Lovers Lane
Alt 3b	1	$520,000	5-Year	- 2 to 13-inch reduction in flooding for 5-yr storm - no easements required for Lovers Lane
Alt 3	2	$2,000,000	5-Year	- 2 to 10-inch reduction in flooding for 5-yr storm
Alt 3	3	$730,000	5-Year	- 2 to 7-inch reduction in flooding for 5-yr storm

Notes:
1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table 4-9 below summarizes the cost estimates by alternative.

Table 4-9: Project Cost by Alternative

Alternative	Cost	LOS
Alt 2	$2.7 M	<2-Year
Alt 3	$3.3 M	5-Year

Notes:
1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Alternative 1 should be considered a necessary step before implementing Alternatives 2 and 3. Alternative 2 will provide some improvement to LOS, but nuisance flooding will continue to be an issue in some of the problem areas.

Alternative 3 provides an improvement in LOS and flood duration that Alternative 2 cannot achieve, albeit at an extra cost. Some combination of Alternatives 2 and 3 might be the most cost-effective solution for the long term. For instance Alternative 2 locations that show some improvement in LOS might not require upsizing of existing piping in that section of the collection system. In other locations swales might be a better option than pipes if there is sufficient horizontal space for installation and adequate vertical slope to convey flow from the flooding areas. A topographic survey would be required to confirm the feasibility of swales over pipes.

Table 4-10 summarizes the O&M future costs for maintaining existing and proposed piping systems associated with the alternatives.

Table 4-10: Existing and Alternatives 2,3 Operation and Maintenance Cost

Activity	Feet	$/Foot	Cost/Year
Clean Inlets and Pipes	13,000	$7	$91,000
Mow/Regrade Roadside Swales	19,000	$3	$57,000
Total			**$148,000**

4.9 Capital Improvement Financing

The Town currently funds its stormwater program from ad valorem taxes through the General Fund. This reflects the traditional source of funding for stormwater systems. As shown in the previous sections the capital cost has been estimated at $2.7M for Alternative 2 and $3.3 M for Alternative 3. In addition, both alternatives also have annual operations and maintenance (O&M) costs estimated at $148,000/year for the three areas studied. In addition, the demands on the Town's General Fund have increased annually while the economy has continued to be under considerable stress. Also, the Town Charter has provisions that restrict its ability to issue debt for a term longer than three years.

Funding for and understanding the critical functions performed under the O&M budget is vital to the budgeting process. Many times municipalities highlight the capital cost needs without an equal understanding of O&M funding required.

The Town's current and potential annual budgets for stormwater are summarized in **Table 4-11**. The combined cost impacts of the O&M and capital needs identified for the three areas of concern suggest the need to identify optional forms of funding available for consideration. Initially and simultaneously it is important to consider and aggressively access all forms of program assistance. It is important to note there are no outside forms of assistance for O&M cost needs. There are a few Federal and State assistance programs for capital needs. All of these programs are driven by a grant application process. The findings of this report are a vital element of this process.

Table 4-11. Current and Potential Stormwater Budget Items

Fiscal Year	Budget	Description
FY 10	$ 650,000	Twelve Roads design/construction
	$ 25,000	Street sweeping
	$ 10,000	Inspection and maintenance
	$ 75,000	Master Plan implementation
	$ 50,000	Miscellaneous improvements
	$ 2,380,370	North Estero construction
FY 11	$ 640,000	Twelve Roads construction
	$ 50,000	Street sweeping
	$ 15,000	Inspection and Maintenance
	$ 100,000	Master Plan implementation
	$ 150,000	North Estero Construction
FY12	$ 640,000	Twelve Roads construction
	$ 50,000	Street sweeping
	$ 30,000	Inspection and Maintenance
	$ 400,000	Master Plan implementation

4.9.1 FEMA Grants

FEMA funding can be secured for capital improvement projects that seek to reduce flooding in locations that experience historic or repeated flooding. **Figure 4-14** provides a graphical representation of those locations in the study area that have experienced repetitive losses through FEMA. Over half of the 31 locations identified on the figure would experience an improvement in LOS based on the alternatives proposed in this report. Based on this information, FEMA funding should be considered a viable option for capital improvement financing.

There are 4 different FEMA grant programs which relate to flood hazard mitigation. Three of them are competitive by state, so the top proposals in a state are entitled to a set amount of funding, while one is nationally competitive. The grants range from a few thousand dollars to more than a $1M, depending on the program. For example, the Flood Mitigation Assistance program is usually over $500k but less than $1M. The amount of funding per year per state per program varies.

Hazard Mitigation Grant Program. Funding under this program is disaster specific and identified by Congress at time of disaster declaration or soon after. FEMA will pay up to 75 percent, with State or grantee paying 25 percent match (cash and in-kind). Application due dates for the Hazard Mitigation Grant Program are disaster dependent.

The Town has been successful at obtaining two grants through program grants related to Hurricanes Charlie and Wilma. These ongoing projects to design and construct stormwater improvements are the North Estero Boulevard and Neighborhood Basin Based Flood Mitigation projects. Grant funding was established under this program for Tropical Storm Fay, but the application deadline has passed. Another grant for Hurricane Gustav was established, but is not available in Lee County.

Flood Mitigation Assistance Program: This program includes funding for measures which reduce flooding risk to buildings, such as Flood Mitigation Plans or property purchase**.** By comparison for FY10, funding for FY09 is anticipated to be an additional $5M, although it hasn't been finalized. The grant funds projects at 75 percent/25 percent (Federal/non-Federal cost share).

Repetitive Flood Claims Program: This program provides funding for purchasing/demolishing buildings and property which have filed multiple flood-loss claims. Funding for FY09 was $80M nationwide, $9M of which went to Florida. FEMA may contribute 100 percent of cost if other sources are not available.

Pre-disaster Mitigation Program: This program provides funding for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. The data for available funding for this grant is not available.


Area 1
Area 2
Area 3
Estero Bay
Gulf of Mexico
Legend
Repetitive Loss Location
Hydrologic Units
Source: Town of Fort Myers Beach
Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202
Scale:
0
600
1,200
2,400
Feet
Figure 4-14
Repetitive Loss Locations
Problem Areas 1, 2 and 3
UPDATED 04-10-09
Town of Fort Myers Beach
ESTERO BLVD
LOVERS LANE
OAK ST
BAY RD
DONORA BLVD
MADISON CT
WASHINGTON CT
WASHINGTON AVE
JEFFERSON ST
VOORHIS ST
MID ISLAND DR
ANDRE MAR DR
ANCHORAGE ST
BAY MAR DR
HIBISCUS DR
MANDALAY RD
LAZY WAY
PEPITA ST
AVENIDA PESCADORA
WILLIAMS DR
RANDY LN
LAUDER ST
FALKIRK ST
STERLING AVE
DUNDEE RD
INDIAN BAYOU DR
BAY VILLAGE DR
GULF RD

4.9.2 Section 319h Clean Water Act

The other Federal grant program is administered by FDEP under Section 319h of the Clean Water Act. These grants are very limited, but can be applied for.

4.9.3 State Funding

State funding is administered through the SFWMD. The Town has been successful at obtaining a grant from the SFWDM for the North Estero Boulevard project. The State Revolving Fund (SRF) program can also be used to obtain low interest loans. However, the Town Charter limits debt to three years or less.

4.9.4 Department of Transportation

Another option that has been shown to provide possible valuable assistance is the Lee County Department of Transportation (DOT). The Town has reached previous agreements with the County to funding from the Gas Tax in support of stormwater improvements and surveying of the County owned Estero Boulevard.

4.9.5 Development of a Stormwater Utility

All possible sources of grant funding should be evaluated. However, experience has shown that a permanent, reliable, sustainable, and fair funding source is needed. A common and successful stormwater funding option utilized by most of the cities and counties throughout Florida as well as throughout the country is a Stormwater Utility.

Typically, a stormwater utility program is funded by a user fee. A stormwater utility is similar to water and wastewater utilities that are based on a service provided. In a stormwater utility a fee is charged based on the services provided on a communitywide bases. While in water and wastewater utilities the fee is based on the volume, the typical stormwater utility bases its fee on the amount of impervious areas on each parcel of developed property. The billing unit is typically the equivalent residential unit (ERU).

As previously noted stormwater utilities have been in full operation throughout Florida for many years. The City of Tallahassee established a stormwater utility in 1985. Florida Statues Chapter 403 authorizes the establishment of a stormwater utility through local government ordinance adoption.

Central to the establishment of a stormwater utility is identifying the number and types of development units. Therefore, in order to develop a stormwater utility, the Town of Fort Myers Beach would need to identify the number of single family units, multi-family units, condo units, commercial units, and institutional units. These numbers could then be used to develop Equivalent Residential Units (ERU). Based upon CDM's extensive experience with the establishment and implementation of Stormwater Utilities, a user fee that is based on Equivalent Residential Units can produce roughly $100,000 /$1/ERU. Addressing the capital needs for Alternative 3 of $3.3 million and in keeping with the Town Charter of limiting the term of indebtedness, all three problem areas can be achieved with a monthly user charge of $5/ERU within two three-year cycles (based on preliminary information for number of units from the appraiser office).

Many communities that have established Stormwater Utilities have dedicated the revenue generated by the utility to capital improvements while continuing the funding of Administration and Maintenance through the General Fund.

Municipalities can bond projects or programs against the stormwater utility. There are three options the Town has for funding projects through a stormwater utility:

- Perform work as money becomes available.
- Short or long term bonds.
- Special Assessments – bonds could be sold against stormwater utility revenues, but would require a vote for specific projects.

4.9.6 Summary

In addressing the best fit for the Town at this time it is critical that a grass roots program be initiated that involves all levels of the community, including elected officials, property owners, and interest groups. Utilizing the results of this report it is essential to conduct site specific workshops addressing issues and their solutions in order to establish a proper level of understanding of the budget needs. This level of public involvement has been shown to be vital to the success of any public works program. Once the public has understood the issues and their potential solutions (and costs), an effective discussion on funding options can occur. Establishing the public's proper understanding of specific needs before presenting funding options is critical for successful implementation.

APPENDIX A

Hydraulic Analysis

Table A-1: Overland Flow Parameter Calculation

Hydrologic Unit		Overland Flow Path 1				Overland Flow Path 2				Overland Flow Path 3				Area Weighted Flow Parameters			
Basin	Area	Max Elev (ft)	Min Elev (ft)	Weight	Path Length (ft)	Max Elev (ft)	Min Elev (ft)	Weight	Path Length (ft)	Max Elev (ft)	Min Elev (ft)	Weight	Path Length (ft)	Total Weight	Slope (ft/ft)	Length (ft)	Width (ft)
HUA1-1	3.7	6.0	3.0	0.3	300	6.0	3.0	0.4	210	6.0	3.0	0.3	280	1.00	0.0119	258	633
HUA1-1A	3.0	6.0	5.0	0.3	300	6.0	5.0	0.4	280	6.0	5.0	0.3	120	1.00	0.0049	238	555
HUA1-2	1.8	6.0	5.0	0.3	180	6.0	5.0	0.4	190	6.0	5.0	0.3	180	1.00	0.0054	184	415
HUA1-3	2.2	6.0	5.0	0.3	270	6.0	5.0	0.4	190	6.0	5.0	0.3	120	1.00	0.0057	193	501
HUA1-4	1.5	6.0	4.0	0.3	110	6.0	4.0	0.4	100	5.0	4.0	0.3	120	1.00	0.0160	109	587
HUA1-5	2.2	5.0	3.0	0.3	150	5.0	3.0	0.4	280	4.0	3.0	0.3	140	1.00	0.0090	199	487
HUA1-6	0.7	6.0	5.0	0.3	110	6.0	5.0	0.4	100	6.0	5.0	0.3	90	1.00	0.0101	100	306
HUA1-7	0.5	6.0	5.0	0.3	90	6.0	5.0	0.4	70	6.0	5.0	0.3	70	1.00	0.0133	76	313
HUA1-8	2.6	6.0	4.0	0.3	150	5.0	4.0	0.4	180	7.0	4.0	0.3	200	1.00	0.0107	177	635
HUA2-1	6.2	6.0	4.0	0.3	300	5.0	4.0	0.4	250	5.0	4.0	0.3	210	1.00	0.0050	253	1071
HUA2-10	14.6	5.0	3.0	0.2	250	5.0	3.0	0.5	630	5.0	3.0	0.3	300	1.00	0.0052	455	1396
HUA2-11	2.5	5.0	3.0	0.3	250	5.0	3.0	0.4	190	4.0	3.0	0.3	200	1.00	0.0081	211	510
HUA2-12	1.7	5.0	4.0	0.3	170	5.0	4.0	0.4	260	5.0	4.0	0.3	130	1.00	0.0056	194	382
HUA2-13	8.1	5.0	3.0	0.3	315	7.0	3.0	0.3	265	5.0	3.0	0.4	360	1.00	0.0087	318	1110
HUA2-14	1.5	4.0	3.0	0.3	100	4.0	3.0	0.4	100	4.0	3.0	0.3	90	1.00	0.0103	97	665
HUA2-15	2.2	5.0	4.0	0.3	140	5.0	4.0	0.4	180	5.0	4.0	0.3	130	1.00	0.0067	153	626
HUA2-16	2.3	5.0	3.0	0.3	190	5.0	3.0	0.4	220	4.0	3.0	0.3	170	1.00	0.0086	196	521
HUA2-17	3.9	5.0	3.0	0.3	230	5.0	3.0	0.4	270	4.0	3.0	0.3	170	1.00	0.0073	228	742
HUA2-18	2.5	4.0	3.0	0.3	180	4.0	3.0	0.4	170	4.0	3.0	0.3	180	1.00	0.0057	176	618
HUA2-2	8.6	5.0	3.0	0.3	330	6.0	3.0	0.2	320	5.0	3.0	0.5	520	1.00	0.0056	423	890
HUA2-3	4.5	5.0	4.0	0.3	440	5.0	4.0	0.4	230	5.0	4.0	0.3	310	1.00	0.0034	317	621
HUA2-4	13.2	5.0	3.0	0.4	580	5.0	3.0	0.3	440	5.0	3.0	0.3	430	1.00	0.0041	493	1164
HUA2-5	3.7	5.0	3.0	0.3	180	4.0	3.0	0.4	200	5.0	4.0	0.3	320	1.00	0.0063	230	698
HUA2-6	2.7	5.0	3.0	0.3	100	5.0	3.0	0.4	130	5.0	3.0	0.3	220	1.00	0.0149	148	788
HUA2-7	2.4	5.0	4.0	0.3	200	5.0	4.0	0.4	180	5.0	4.0	0.3	190	1.00	0.0053	189	545
HUA2-9	4.0	5.0	4.0	0.3	300	5.0	4.0	0.4	180	5.0	4.0	0.3	470	1.00	0.0039	303	568
HUA3-1	2.3	6.0	5.0	0.3	140	6.0	5.0	0.4	150	6.0	5.0	0.3	300	1.00	0.0058	192	524
HUA3-2	7.0	5.0	3.0	0.3	270	5.0	3.0	0.4	415	7.0	3.0	0.3	470	1.00	0.0067	388	781
HUA3-3	5.4	5.0	3.0	0.3	250	5.0	3.0	0.4	330	5.0	3.0	0.3	140	1.00	0.0091	249	952
HUA3-4	3.4	4.0	3.0	0.3	210	4.0	3.0	0.4	200	4.0	3.0	0.3	180	1.00	0.0051	197	744
HUA3-5	2.8	4.0	2.0	0.3	220	3.0	2.0	0.4	270	4.0	2.0	0.3	170	1.00	0.0077	225	534

Table A-2: Land Use Parameter Calculations

Hydrologic Parameter	Land Use Category								
	OPN	LDR	MDR	HDR	INST	COM	IND	WET	WAT
Impervious n	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.100	0.024
Pervious n	0.400	0.250	0.250	0.250	0.250	0.250	0.250	0.400	0.060
Impervious Ia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.50	0.10
Pervious Ia	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.50	0.10
% Impervious	5.0	15.0	35.0	40.0	15.0	90.0	90.0	100.0	100.0
% DCIA	1.0	7.5	23.0	30.0	7.5	81.0	81.0	100.0	100.0
% NDCIA	4.0	7.5	12.0	15.0	7.5	9.0	9.0	0.0	0.0
% Pervious	95.0	85.0	65.0	55.0	85.0	10.0	10.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Code	Land Use Category
OPN	Open Space
LDR	Low Density Residential (<2 dwelling units per acre)
MDR	Medium Density Residential (2-5 dwelling units per acre)
HDR	High Density Residential (>5 dwelling units per acre)
INST	Institutional
COM	Commercial
IND	Industrial
WET	Wetland
WAT	Water Body

Sub Basin	Percent By Land Use Category									Total	% Pervious	% NDCIA	% DCIA	Manning's N		Initial Abstr. (in.)	
	OPN	LDR	MDR	HDR	INST	COM	IND	WET	WAT					DCIA	Pervious NDCIA	DCIA	Pervious NDCIA
HUA1-1	0.0	0.0	0.0	91.0	9.0	0.0	0.0	0.0	0.0	100	57.7	14.3	28.0	0.015	0.203	0.10	0.22
HUA1-2	0.0	0.0	0.0	99.8	0.0	0.2	0.0	0.0	0.0	100	54.9	15.0	30.1	0.015	0.200	0.10	0.22
HUA1-3	0.0	0.0	0.0	2.1	0.0	97.9	0.0	0.0	0.0	100	10.9	9.1	79.9	0.015	0.143	0.10	0.18
HUA1-4	0.0	0.0	0.2	0.0	72.2	27.5	0.0	0.0	0.0	100	64.3	7.9	27.8	0.015	0.224	0.10	0.23
HUA1-5	0.0	0.0	67.4	0.0	24.7	8.0	0.0	0.0	0.0	100	65.5	10.7	23.8	0.015	0.217	0.10	0.23
HUA1-6	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100	10.0	9.0	81.0	0.015	0.139	0.10	0.18
HUA1-7	0.0	0.0	0.0	1.7	0.0	98.3	0.0	0.0	0.0	100	10.7	9.1	80.2	0.015	0.142	0.10	0.18
HUA1-8	0.0	0.0	43.9	19.8	0.0	36.4	0.0	0.0	0.0	100	43.0	11.5	45.5	0.015	0.200	0.10	0.22
HUA2-1	0.0	0.0	9.4	90.6	0.0	0.0	0.0	0.0	0.0	100	55.9	14.7	29.3	0.015	0.201	0.10	0.22
HUA2-10	0.0	0.0	0.2	99.8	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-11	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-12	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-13	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-14	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-15	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-16	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-17	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-2	0.0	0.0	10.2	89.8	0.0	0.0	0.0	0.0	0.0	100	56.0	14.7	29.3	0.015	0.201	0.10	0.22
HUA2-3	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-4	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-5	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-6	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-7	0.0	0.0	15.0	85.0	0.0	0.0	0.0	0.0	0.0	100	56.5	14.5	28.9	0.015	0.202	0.10	0.22
HUA2-9	0.0	0.0	37.8	62.2	0.0	0.0	0.0	0.0	0.0	100	58.8	13.9	27.4	0.015	0.205	0.10	0.22
HUA3-1	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100	65.0	12.0	23.0	0.015	0.213	0.10	0.23
HUA3-2	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100	65.0	12.0	23.0	0.015	0.213	0.10	0.23
HUA3-3	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100	65.0	12.0	23.0	0.015	0.213	0.10	0.23
HUA1-1A	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA2-18	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	100	55.0	15.0	30.0	0.015	0.200	0.10	0.22
HUA3-4	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100	65.0	12.0	23.0	0.015	0.213	0.10	0.23
HUA3-5	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100	65.0	12.0	23.0	0.015	0.213	0.10	0.23

Table A-3: Soil Parameter Calculations

Soil Type	Max Infilt. Rate (in/hr)	Min Infilt. Rate (in/hr)	Infilt Decay Rate (1/sec)
A	12.00	1.00	2.00
B	9.00	0.50	2.00
C	6.00	0.25	2.00
D	4.00	0.10	2.00

	Percent By Hydrologic Unit										
HUC	Group A	Group B	Group C	Group D	Total	Percent Pervious %	Percent NDCIA %	Max Infilt. Rate (in/hr)	Min Infilt. Rate (in/hr)	Infil. Decay Rate (1/hr)	Soil Storage Capacity (in)
HUA1-1	0.0	0.0	97.8	2.2	100	57.7	14.3	4.77	0.20	0.00056	3.00
HUA1-2	0.0	0.0	100	0.0	100	54.9	15.0	4.71	0.20	0.00056	2.99
HUA1-3	0.0	0.0	100	0.0	100	10.9	9.1	3.27	0.14	0.00056	2.07
HUA1-4	0.0	0.0	100	0.0	100	64.3	7.9	5.34	0.22	0.00056	3.38
HUA1-5	0.0	0.0	100	0.0	100	65.5	10.7	5.16	0.22	0.00056	3.27
HUA1-6	0.0	0.0	100	0.0	100	10.0	9.0	3.16	0.13	0.00056	2.00
HUA1-7	0.0	0.0	100	0.0	100	10.7	9.1	3.25	0.14	0.00056	2.06
HUA1-8	0.0	0.0	100	0.0	100	43.0	11.5	4.73	0.20	0.00056	3.00
HUA2-1	0.0	0.0	100	0.0	100	55.9	14.7	4.75	0.20	0.00056	3.01
HUA2-10	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-11	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-12	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-13	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-14	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-15	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-16	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-17	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-2	0.0	0.0	100	0.0	100	56.0	14.7	4.75	0.20	0.00056	3.01
HUA2-3	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-4	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-5	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-6	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-7	0.0	0.0	100	0.0	100	56.5	14.5	4.77	0.20	0.00056	3.02
HUA2-9	0.0	0.0	100	0.0	100	58.8	13.9	4.85	0.20	0.00056	3.07
HUA3-1	0.0	0.0	100	0.0	100	65.0	12.0	5.06	0.21	0.00056	3.21
HUA3-2	0.0	0.0	100	0.0	100	65.0	12.0	5.06	0.21	0.00056	3.21
HUA3-3	0.0	0.0	100	0.0	100	65.0	12.0	5.06	0.21	0.00056	3.21
HUA1-1A	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA2-18	0.0	0.0	100	0.0	100	55.0	15.0	4.71	0.20	0.00056	2.99
HUA3-4	0.0	0.0	100	0.0	100	65.0	12.0	5.06	0.21	0.00056	3.21
HUA3-5	0.0	0.0	100	0.0	100	65.0	12.0	5.06	0.21	0.00056	3.21

Table A-4: SWMM Node Inventory

Existing Conditions- Nodes				
Name	**Location**	**Node Type**	**Invert (ft-NGVD)**	**Initial Stage (ft-NGVD)**
A1-1N	Corner of School St and Estero Blvd	Storage Unit	3.0	3.0
A1-1N2	Corner of School St and Oak St	Storage Unit	1.8	2.0
A1-1S	SW of Corner of School St and Oak St	Storage Unit	1.8	2.0
A1-2N	Corner of Estero Blvd and Pompano St	Node	3.5	3.5
A1-2S	Corner of Estero Blvd and Seaview St	Storage Unit	5.0	5.0
A1-3S	Bay Rd, N of Estero Blvd	Storage Unit	1.7	2.0
A1-4S	Oak St between Bay Rd and School St	Storage Unit	1.7	2.0
A1-5N	Corner of Bay Rd and Oak St	Storage Unit	1.6	2.0
A1-5S	Near Corner of Bay Rd and Nature View Ct	Storage Unit	1.5	2.0
A1-6S	Center Island of Shopping Center	Storage Unit	5.0	5.0
A1-7S	West of Wachovia Bank	Storage Unit	4.5	4.5
A1-8S	Lovers Lane, N of Estero Blvd	Storage Unit	4.0	4.0
A2-10N	Anchorage St, N of Estero Blvd	Storage Unit	1.8	2.0
A2-10S	Andre Mar Dr, N of Estero Blvd	Storage Unit	2.5	2.5
A2-11S	Corner of Andre Mar Dr and Estero Blvd	Storage Unit	3.5	3.5
A2-12S	Corner of St Peters Dr and Estero Blvd	Storage Unit	3.5	3.5
A2-13N	St Peters Dr, N of Estero Blvd	Storage Unit	1.7	2.0
A2-13N2	Near corner of St Peters Dr and Estero Blvd	Node	2.1	2.1
A2-13S	St Peters Dr, N of Estero Blvd	Storage Unit	2.0	2.0
A2-14N	Backyard Swale between Andre Mar Dr & St Peters Dr	Node	1.5	2.0
A2-15S	End of Anchorage St	Storage Unit	1.5	2.0
A2-16S	End of Bay Mar Dr	Storage Unit	1.5	2.0
A2-17S	Bay Mar Dr, N of Estero Blvd	Storage Unit	2.5	2.5
A2-18S	End of St Peters Dr	Storage Unit	1.5	2.0
A2-1S	Donara Blvd, N of Estero Blvd	Storage Unit	1.7	2.0
A2-2N2	Apartments between Donara Blvd and Voorhis St	Storage Unit	1.6	2.0
A2-2N3	Shell Mound Blvd between Donora Blvd and Voorhis St	Storage Unit	1.5	2.0
A2-2S	Voorhis St, N of Estero Blvd	Storage Unit	1.7	2.0
A2-3S	Corner of Madison Ct and Estero Blvd	Storage Unit	3.5	3.5
A2-4S	Jefferson St, N of Estero Blvd	Storage Unit	2.0	2.0
A2-5S	Corner of Mid Island Dr and Estero Blvd	Storage Unit	3.5	3.5
A2-6S	Low area between Mid Island Dr and Connecticut St	Storage Unit	2.0	2.0
A2-7N	Corner of Jefferson St and Shell Mound Blvd	Storage Unit	1.5	2.0
A2-7S	Corner of Mid Island Dr and Shell Mound Blvd	Storage Unit	1.5	2.0
A2-9S	End of Andre Mar Dr	Storage Unit	1.5	2.0
A3-1S	Corner of Sterling Av and Estero Blvd	Storage Unit	4.0	4.0
A3-2N	Near corner of Lazy Way and Estero Blvd	Storage Unit	1.7	2.0
A3-2N2	Corner of Lazy Way and Palmetto St	Storage Unit	1.5	2.0
A3-2S	Lazy Way, N of Estero Blvd	Storage Unit	1.6	2.0
A3-3S	Low Area between Lauder St & Estero Blvd	Storage Unit	3.0	3.0
A3-4S	Low Area between Falkirk St & Sterling Av	Storage Unit	3.5	3.5
A3-5N	Corner of Sterling Av and Falkirk St	Node	3.5	3.5
A3-5S	Sterling Av between Falkirk St and Seminole Way	Storage Unit	1.5	2.0
A1-1OUT1	School St behind Elementart School	Outfall	0.0	2.0
A1-1OUT2	Oak St behind baseball fields	Outfall	0.0	2.0
A1-1OUT3	School St behind Elementart School	Outfall	0.0	2.0
A1-2OUT	Estero Blvd near Lovers Lane	Outfall	0.0	2.0
A1-5OUT	End of Bay Road	Outfall	0.0	2.0
A1-5OUT2	End of Bay Road	Outfall	0.0	2.0

Table A-4: SWMM Node Inventory

Existing Conditions- Nodes				
Name	**Location**	**Node Type**	**Invert (ft-NGVD)**	**Initial Stage (ft-NGVD)**
A1-8OUT	Lovers Lane behind Red Coconut	Outfall	0.0	2.0
A2-14OUT	Swale between Andre Mar and St Peters Dr	Outfall	0.0	2.0
A2-15OUT1	End of Anchorage St	Outfall	0.0	2.0
A2-15OUT2	End of Anchorage St	Outfall	0.0	2.0
A2-16OUT1	End of Bay Mar Dr	Outfall	0.0	2.0
A2-16OUT2	End of Bay Mar Dr	Outfall	0.0	2.0
A2-18OUT1	End of St Peters Dr	Outfall	0.0	2.0
A2-18OUT2	End of St Peters Dr	Outfall	0.0	2.0
A2-1OUT	Donora Blvd, N of Shell Mound Blvd	Outfall	0.0	2.0
A2-1OUT3	Shell Mound Blvd between Donora Blvd and Voorhis St	Outfall	0.0	2.0
A2-2OUT2	Shell Mound Blvd between Donora Blvd and Voorhis St	Outfall	0.0	2.0
A2-4OUT1	Shell Mound Blvd near Eucalyptus Ct	Outfall	0.0	2.0
A2-4OUT2	Shell Mound Blvd near Eucalyptus Ct	Outfall	0.0	2.0
A2-5OUT	Estero Blvd near Jefferson St	Outfall	0.0	2.0
A2-7OUT1	Shell Mound Blvd at Jefferson St	Outfall	0.0	2.0
A2-7OUT2	Shell Mound Blvd at Jefferson St	Outfall	0.0	2.0
A2-7OUT3	Shell Mound Blvd at Jefferson St	Outfall	0.0	2.0
A2-9OUT	End of Andre Mar Dr	Outfall	0.0	2.0
A3-2OUT1	Lazy Way and Palmetto St	Outfall	0.0	2.0
A3-2OUT2	Lazy Way and Palmetto St	Outfall	0.0	2.0
A3-2OUT3	Lazy Way and Palmetto St	Outfall	0.0	2.0
A3-3OUT	Flakirk St and Lauder St	Outfall	0.0	2.0
A3-4OUT	Flakirk St and Lauder St	Outfall	0.0	2.0
A3-5OUT1	Sterling Av between Falkirk St and Seminole Way	Outfall	0.0	2.0
A3-5OUT2	Sterling Av between Falkirk St and Seminole Way	Outfall	0.0	2.0

Table A-5: SWMM Conduit Inventory

Existing Conditions - Conduits							
Conduit Name	Link Type	Depth (ft)	Width (ft)	Length (ft)	Manning's Roughness	U/S Inv. (ft NGVD)	D/S Inv. (ft NGVD)
A1-1N	Ellipse	1.0	1.7	390	0.014	3.0	2.3
A1-1N2OLE	Overland	N/A	N/A	50	0.010	3.5	3.4
A1-1NOL	Overland	N/A	N/A	50	0.010	5.5	5.4
A1-1SOLE	Overland	N/A	N/A	50	0.010	3.6	3.5
A1-1SOLN	Overland	N/A	N/A	250	0.010	3.3	3.0
A1-1SOLS2	Overland	N/A	N/A	157	0.010	3.6	3.5
A1-2N	Circular	0.7	N/A	194	0.014	3.5	3.0
A1-2OLS	Overland	N/A	N/A	50	0.010	5.5	4.5
A1-3S	Filled Conduit	0.9	0.86	215	0.014	1.7	1.6
A1-3SOLE	Overland	N/A	N/A	50	0.010	5.0	4.9
A1-4N	Ellipse	1.0	1.67	220	0.014	1.8	1.7
A1-4S	Ellipse	1.0	1.67	170	0.014	1.7	1.6
A1-4SOLE	Overland	N/A	N/A	50	0.010	4.2	4.1
A1-5N	Ellipse	1.0	1.5	120	0.014	1.6	1.5
A1-5NOL	Overland	N/A	N/A	125	0.010	4.6	3.2
A1-5S	Circular	1.3	N/A	220	0.024	1.5	0.0
A1-5SOLE	Overland	N/A	N/A	50	0.010	3.6	3.5
A1-6SOLE	Overland	N/A	N/A	50	0.010	5.5	5.4
A1-6SOLN	Overland	N/A	N/A	50	0.010	5.5	5.4
A1-6SOLW	Overland	N/A	N/A	50	0.010	5.4	5.3
A1-7SOLE	Overland	N/A	N/A	50	0.010	5.0	4.9
A1-8OLE	Overland	N/A	N/A	50	0.010	4.2	4.1
A2-10N	Circular	1.0	N/A	120	0.014	1.8	1.7
A2-10NOL	Overland	N/A	N/A	50	0.014	3.3	3.2
A2-10SOLN	Overland	N/A	N/A	300	0.010	4.2	4.1
A2-10SOLS	Overland	N/A	N/A	50	0.014	3.3	3.2
A2-11SOLE	Overland	N/A	N/A	50	0.010	4.0	3.9
A2-12SOLE	Overland	N/A	N/A	50	0.010	4.0	3.9
A2-12SOLN	Overland	N/A	N/A	50	0.010	3.9	3.8
A2-12SOLS	Overland	N/A	N/A	50	0.010	4.0	3.9
A2-13N	Swale	N/A	N/A	700	0.010	1.7	1.7
A2-13N2	Swale	N/A	N/A	350	0.010	2.1	2.0
A2-13S	Circular	1.3	N/A	50	0.014	2.0	1.7
A2-13SOL	Overland	N/A	N/A	70	0.010	4.0	3.9
A2-13SOLS	Overland	N/A	N/A	50	0.010	3.8	3.7
A2-14N	Swale	N/A	N/A	100	0.010	1.5	0.0
A2-15OUT2	Overland	N/A	N/A	100	0.010	4.0	3.9
A2-15S	Circular	1.5	N/A	100	0.014	1.5	0.0
A2-16OUT2	Overland	N/A	N/A	50	0.010	3.5	2.9
A2-16S	Circular	1.5	N/A	100	0.014	2.0	0.0
A2-17SOLE	Overland	N/A	N/A	50	0.010	4.2	4.6
A2-18N	Circular	1.5	N/A	100	0.014	1.5	0.0
A2-18OUT2	Overland	N/A	N/A	50	0.010	3.5	3.4
A2-1S	Circular	1.0	N/A	298	0.014	1.7	1.6
A2-1SOLE	Overland	N/A	N/A	50	0.010	4.3	4.2
A2-1SOLE2	Overland	N/A	N/A	50	0.010	4.4	4.3
A2-2N2	Circular	1.3	N/A	212	0.014	1.6	1.5
A2-2N2OL	Overland	N/A	N/A	200	0.010	5.0	4.9

Table A-5: SWMM Conduit Inventory

Existing Conditions - Conduits							
Conduit Name	Link Type	Depth (ft)	Width (ft)	Length (ft)	Manning's Roughness	U/S Inv. (ft NGVD)	D/S Inv. (ft NGVD)
A2-2N3	Circular	2.0	N/A	120	0.014	1.5	0.0
A2-2N3OL	Overland	N/A	N/A	50	0.010	5.0	4.9
A2-2S	Ellipse	1.0	1.5	185	0.014	1.7	1.6
A2-2SOLE	Overland	N/A	N/A	50	0.010	4.4	4.3
A2-3SOLE	Overland	N/A	N/A	50	0.010	4.2	4.1
A2-3SOLN	Overland	N/A	N/A	50	0.010	4.1	4.0
A2-3SOLS	Overland	N/A	N/A	50	0.010	4.2	4.1
A2-4S	Circular	1.0	N/A	390	0.014	2.0	1.7
A2-4SOLE	Swale	N/A	N/A	390	0.010	3.0	2.9
A2-4SOLN	Overland	N/A	N/A	50	0.010	4.5	4.4
A2-4SOLS	Swale	N/A	N/A	430	0.010	3.0	2.9
A2-5SOLE	Overland	N/A	N/A	50	0.010	3.6	3.5
A2-5SOLN	Overland	N/A	N/A	50	0.010	4.0	3.9
A2-5SOLS	Overland	N/A	N/A	50	0.010	4.3	4.2
A2-5SOLW	Overland	N/A	N/A	50	0.010	4.3	4.2
A2-6SOLE	Swale	N/A	N/A	385	0.010	3.0	2.9
A2-7OUT3OL	Overland	N/A	N/A	50	0.010	4.7	4.6
A2-7SOUT1	Circular	2.0	N/A	70	0.014	1.5	0.0
A2-7SOUT2	Circular	1.3	N/A	50	0.014	1.5	0.0
A2-9S	Circular	1.5	N/A	80	0.014	1.5	0.0
A3-1SOLN	Overland	N/A	N/A	50	0.010	4.2	4.1
A3-1SOLS	Overland	N/A	N/A	50	0.010	4.4	4.3
A3-2N	Circular	1.5	N/A	130	0.014	1.7	1.6
A3-2N2	Circular	2.0	N/A	50	0.014	1.5	0.0
A3-2N2OL	Overland	N/A	N/A	100	0.010	3.0	2.9
A3-2NOL	Overland	N/A	N/A	100	0.010	3.0	2.9
A3-2S	Circular	1.5	N/A	270	0.014	1.6	1.5
A3-2SOLE	Overland	N/A	N/A	50	0.010	4.3	4.2
A3-2SOLN	Overland	N/A	N/A	275	0.010	3.0	2.9
A3-3SOL	Overland	N/A	N/A	50	0.010	3.8	3.7
A3-4OLW	Overland	N/A	N/A	50	0.010	4.2	4.1
A3-4SOLE	Overland	N/A	N/A	50	0.010	4.2	4.1
A3-4SOLS	Overland	N/A	N/A	50	0.010	4.2	4.1
A3-5N	Swale	N/A	N/A	290	0.010	3.5	3.4
A3-5S	Circular	2.0	N/A	100	0.014	3.5	0.0
A3-5SOUT2	Overland	N/A	N/A	50	0.010	4.5	2.4

Table A-6
Town of Fort Myers Beach
Water Quantity Level of Service
Flood Protection Goals and Classes

Rain Event	1-Year (2.5-inches)[#]		2-Year (5-inches)[*]		5-Year (5.7-inches)[*]		10-Year (9.5-inches)[*]		25-Year (11.5-inches)[*]		100-Year (15-inches)[*]	
Structure/Facility	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**	**Depth**	**Class**
Houses/Buildings	<FFE (1)	D	<FFE	D	<FFE	D	<FFE	D	<FFE	D	<FFE	D
Evacuation Route (2)	1/2 W (3)	B	1/2 W	B	1/2 W	B	1/2 W	C	1/2 W	D	1/2 W	D
Other Roads (4)	< 3 in.	B	< 3 in.	B	< 6 in.	C	< 9 in.	D	> 9 in.	NA	> 9 in.	NA
Critical Elevation (5)	< 3 in.	B	< 3 in.	B	< 6 in.	C	< 9 in.	D	> 9 in.	NA	> 9 in.	NA

Class A: Full conveyance of storm runoff and maintains full width of evacuation route clear of flooding.

Class B: Manages erosion and maintains half of width of evacuation route clear of flooding and other roads to less than 3 inches.

Class C: Provides control of flood waters to less than 6 inches over evacuation routes and other roads.

Class D: Provides flood protection of first-floor elevations (FFE) and control of flood waters to less than 9 inches over evacuation routes.

Class NA: There is no level of service class that applies to this flood depth.

(1) Peak flood stages less than the FFE based on available data.

(2) Emergency and Evacuation routes as defined by town. (E.g. Estero Boulevard)

(3) Flood inundation limited to each side of the road such that half of the roadway width (W) or one travel lane width is not flooded.

(4) Other roads which are not critical for evacuation, but that will be used to estimate encroachment of FFEs.

(5) Critical elevations such as parking lots, yards and other areas defined as critical by the town.

Refers to FDOT Florida Department of Transportation's 1-Year, 2.5-inch rainfall event.

* Refers to SFWMD South Florida Water Management District's rainfall events as provided in Table 2-1 on page 2-21.

Table A-7: Existing Conditions Peak Stages

Node	Location	FDOT 2.5in Peak Stage (ft-NAVD)	2-Year Peak Stage (ft-NAVD)	5-Year Peak Stage (ft-NAVD)	10-Year Peak Stage (ft-NAVD)	25-Year Peak Stage (ft-NAVD)	100-year Peak Stage (ft-NAVD)
A1-1N	Corner of School St and Estero Blvd	3.54	4.37	4.71	5.56	5.60	5.64
A1-1N2	Corner of School St and Oak St	3.09	3.75	3.78	3.86	3.91	3.97
A1-1OUT1	School St behind Elementart School	2.00	2.00	2.00	2.00	2.00	2.00
A1-1OUT2	Oak St behind baseball fields	2.00	2.00	2.00	2.00	2.00	2.00
A1-1OUT3	School St behind Elementart School	2.00	2.00	2.00	2.00	2.00	2.00
A1-1S	SW of Corner of School St and Oak St	3.61	3.75	3.78	3.86	3.91	3.97
A1-2N	Corner of Estero Blvd and Pompano St	3.54	4.38	4.71	5.57	5.60	5.64
A1-2OUT	Estero Blvd near Lovers Lane	2.00	2.00	2.00	2.00	2.00	2.00
A1-2S	Corner of Estero Blvd and Seaview St	5.53	5.57	5.58	5.61	5.63	5.65
A1-3S	Bay Rd, N of Estero Blvd	5.13	5.24	5.26	5.30	5.33	5.38
A1-4S	Oak St between Bay Rd and School St	3.07	3.90	4.12	4.35	4.40	4.46
A1-5N	Corner of Bay Rd and Oak St	3.05	3.96	4.29	4.68	4.72	4.77
A1-5OUT	End of Bay Road	2.00	2.00	2.00	2.00	2.00	2.00
A1-5OUT2	End of Bay Road	2.00	2.00	2.00	2.00	2.00	2.00
A1-5S	Near Corner of Bay Rd and Nature View Ct	2.87	3.44	3.61	3.88	3.97	4.09
A1-6S	Center Island of Shopping Center	5.54	5.62	5.64	5.66	5.68	5.71
A1-7S	West of Wachovia Bank	5.15	5.26	5.28	5.30	5.33	5.37
A1-8OUT	Lovers Lane behind Red Coconut	2.00	2.00	2.00	2.00	2.00	2.00
A1-8S	Lovers Lane, N of Estero Blvd	4.32	4.43	4.45	4.51	4.55	4.60
A2-10N	Anchorage St, N of Estero Blvd	3.27	3.89	4.03	4.35	4.43	4.55
A2-10S	Andre Mar Dr, N of Estero Blvd	3.79	4.05	4.12	4.40	4.50	4.62
A2-11S	Corner of Andre Mar Dr and Estero Blvd	3.96	4.04	4.12	4.40	4.50	4.62
A2-12S	Corner of St Peters Dr and Estero Blvd	3.97	4.05	4.11	4.40	4.49	4.62
A2-13N	St Peters Dr, N of Estero Blvd	3.15	3.74	3.95	4.31	4.39	4.51
A2-13N2	Near corner of St Peters Dr and Estero Blvd	3.19	3.97	4.10	4.40	4.49	4.62
A2-13S	St Peters Dr, N of Estero Blvd	3.19	3.97	4.08	4.31	4.39	4.51
A2-14N	Backyard Swale between Andre Mar Dr & St Peters Dr	2.06	2.38	2.48	2.89	3.05	3.24
A2-14OUT	Swale between Andre Mar and St Peters Dr	2.00	2.00	2.00	2.00	2.00	2.00
A2-15OUT1	End of Anchorage St	2.00	2.00	2.00	2.00	2.00	2.00
A2-15OUT2	End of Anchorage St	2.00	2.00	2.00	2.00	2.00	2.00
A2-15S	End of Anchorage St	2.01	2.30	2.56	3.62	4.02	4.19
A2-16OUT1	End of Bay Mar Dr	2.00	2.00	2.00	2.00	2.00	2.00
A2-16OUT2	End of Bay Mar Dr	2.00	2.00	2.00	2.00	2.00	2.00
A2-16S	End of Bay Mar Dr	2.01	2.31	2.58	3.53	3.75	4.00
A2-17S	Bay Mar Dr, N of Estero Blvd	3.81	3.96	4.03	4.19	4.25	4.33
A2-18OUT1	End of St Peters Dr	2.00	2.00	2.00	2.00	2.00	2.00
A2-18OUT2	End of St Peters Dr	2.00	2.00	2.00	2.00	2.00	2.00
A2-18S	End of St Peters Dr	2.01	2.72	3.25	3.66	3.70	3.75
A2-1OUT	Donora Blvd, N of Shell Mound Blvd	2.00	2.00	2.00	2.00	2.00	2.00
A2-1OUT3	Shell Mound Blvd between Donora Blvd and Voorhis St	2.00	2.00	2.00	2.00	2.00	2.00
A2-1S	Donara Blvd, N of Estero Blvd	4.13	4.39	4.45	4.59	4.64	4.71
A2-2N2	Apartments between Donara Blvd and Voorhis St	3.55	3.84	3.87	3.94	3.97	4.16

Table A-7: Existing Conditions Peak Stages

Node	Location	FDOT 2.5in Peak Stage (ft-NAVD)	2-Year Peak Stage (ft-NAVD)	5-Year Peak Stage (ft-NAVD)	10-Year Peak Stage (ft-NAVD)	25-Year Peak Stage (ft-NAVD)	100-year Peak Stage (ft-NAVD)
A2-2N3	Shell Mound Blvd between Donora Blvd and Voorhis St	2.04	2.06	2.08	2.33	2.48	3.13
A2-2OUT2	Shell Mound Blvd between Donora Blvd and Voorhis St	2.00	2.00	2.00	2.00	2.00	2.00
A2-2S	Voorhis St, N of Estero Blvd	3.81	4.22	4.26	4.40	4.48	4.60
A2-3S	Corner of Madison Ct and Estero Blvd	4.14	4.22	4.26	4.40	4.48	4.60
A2-4OUT1	Shell Mound Blvd near Eucalyptus Ct	2.00	2.00	2.00	2.00	2.00	2.00
A2-4OUT2	Shell Mound Blvd near Eucalyptus Ct	2.00	2.00	2.00	2.00	2.00	2.00
A2-4S	Jefferson St, N of Estero Blvd	3.59	3.85	4.03	4.40	4.48	4.60
A2-5OUT	Estero Blvd near Jefferson St	2.00	2.00	2.00	2.00	2.00	2.00
A2-5S	Corner of Mid Island Dr and Estero Blvd	3.79	3.92	4.01	4.40	4.48	4.60
A2-6S	Low area between Mid Island Dr and Connecticut St	3.56	3.91	4.01	4.40	4.48	4.60
A2-7N	Corner of Jefferson St and Shell Mound Blvd	2.00	2.02	2.11	2.55	2.91	3.62
A2-7OUT1	Shell Mound Blvd at Jefferson St	2.00	2.00	2.00	2.00	2.00	2.00
A2-7OUT2	Shell Mound Blvd at Jefferson St	2.00	2.00	2.00	2.00	2.00	2.00
A2-7OUT3	Shell Mound Blvd at Jefferson St	2.00	2.00	2.00	2.00	2.00	2.00
A2-7S	Corner of Mid Island Dr and Shell Mound Blvd	2.03	2.51	2.72	3.19	3.33	3.71
A2-9OUT	End of Andre Mar Dr	2.00	2.00	2.00	2.00	2.00	2.00
A2-9S	End of Andre Mar Dr	2.01	2.32	2.57	3.79	4.14	4.33
A3-1S	Corner of Sterling Av and Estero Blvd	4.36	4.47	4.49	4.57	4.59	4.62
A3-2N	Near corner of Lazy Way and Estero Blvd	2.77	3.34	3.52	4.04	4.18	4.34
A3-2N2	Corner of Lazy Way and Palmetto St	2.04	2.05	2.08	2.23	2.31	2.43
A3-2OUT1	Lazy Way and Palmetto St	2.00	2.00	2.00	2.00	2.00	2.00
A3-2OUT2	Lazy Way and Palmetto St	2.00	2.00	2.00	2.00	2.00	2.00
A3-2OUT3	Lazy Way and Palmetto St	2.00	2.00	2.00	2.00	2.00	2.00
A3-2S	Lazy Way, N of Estero Blvd	2.76	3.31	3.49	4.04	4.18	4.34
A3-3OUT	Flakirk St and Lauder St	2.00	2.00	2.00	2.00	2.00	2.00
A3-3S	Low Area between Lauder St & Estero Blvd	3.28	3.72	3.84	4.06	4.18	4.33
A3-4OUT	Flakirk St and Lauder St	2.00	2.00	2.00	2.00	2.00	2.00
A3-4S	Low Area between Falkirk St & Sterling Av	3.83	4.23	4.24	4.39	4.41	4.45
A3-5N	Corner of Sterling Av and Falkirk St	3.50	3.56	3.58	3.83	3.87	3.92
A3-5OUT1	Sterling Av between Falkirk St and Seminole Way	2.00	2.00	2.00	2.00	2.00	2.00
A3-5OUT2	Sterling Av between Falkirk St and Seminole Way	2.00	2.00	2.00	2.00	2.00	2.00
A3-5S	Sterling Av between Falkirk St and Seminole Way	2.00	2.03	2.07	2.32	2.43	2.56

Table A-8: Pipe Sizes and Locations for Existing and Alternatives 2 and 3

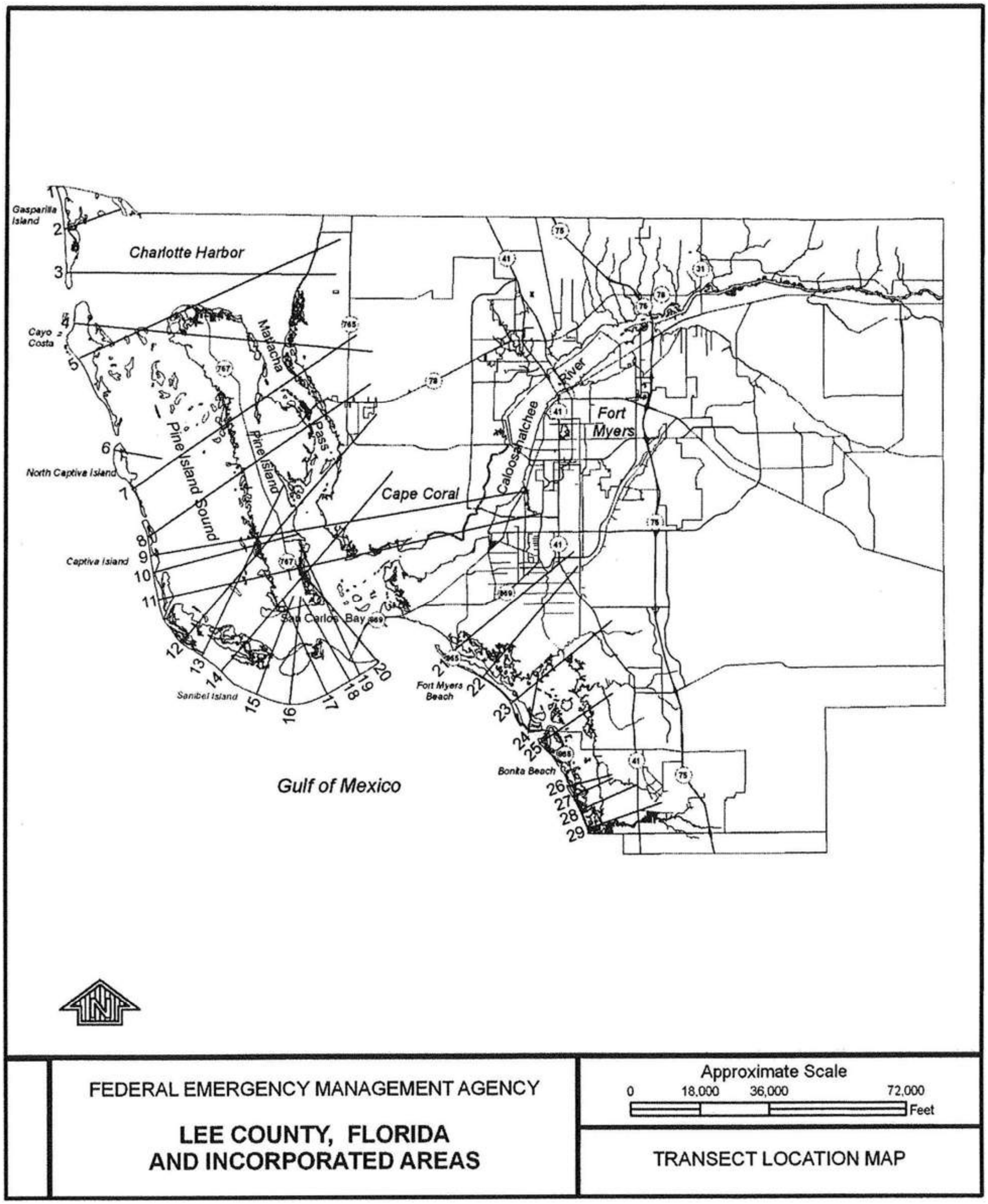
		Exist. Conditions		Alt 2		Alt 3	
Area 1 Estero/Bay Rd							
Conduit	**Location**	**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A1-5S	Bay Rd	15" RCP	existing	15" RCP	existing	19"x30" ellip	new
A1-5N	Bay Rd	12"x18" ellip	existing	12"x18" ellip	existing	19"x30" ellip	new
A1-3S	Bay Rd	10"x18" ellip	existing	10"x18" ellip	existing	19"x30" ellip	new
A1-3N	Bay Rd			12"x18" ellip	new	14"x23" ellip	new
A1-2S	Estero Blvd Crossing			12"x18" ellip	new	12"x18" ellip	new
A1-7N	Wachovia			12"x18" ellip	new	12"x18" ellip	new
A1-6N	Sea Grape (alt 2a only)			12"x18" ellip	existing	19"x30" ellip	new
A1-6N2	Lovers Lane (alt 2a only)			12"x18" ellip	new	19"x30" ellip	new
A1-6S	Sea Grape (alt 2b only)			12"x18" ellip	new	19"x30" ellip	new
A1-6S2	Sea Grape (alt 2b only)			12"x18" ellip	new	19"x30" ellip	new
Area 2 Voorhis/Madison/Eucalyptus		**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A2-2N3	Voorhis	24" RCP outfall	existing	24" RCP outfall	existing	24" RCP outfall	existing
A2-2N2	Voorhis	15" RCP	existing	15" RCP	existing	19"x30" ellip	new
A2-2S	Voorhis	12"x18" ellip	existing	12"x18" ellip	existing	19"x30" ellip	new
A2-3S2	Voorhis			12"x18" ellip	new	19"x30" ellip	new
A2-3S	Estero - Madison to Voorhis			12"x18" ellip	new	14"x23" ellip	new
Area 2 Estero/Mid Island/ Jefferson		**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A2-7N	Jefferson	24" RCP outfall	existing	24" RCP outfall	existing	24" RCP outfall	existing
A2-4S	Jefferson	12" RCP	existing	12" RCP	existing	19"x30" ellip	new
A2-5N2	Jefferson			12"x18" ellip	new	19"x30" ellip	new
A2-5N	Estero - Mid Island to Jefferson			12"x18" ellip	new	14"x23" ellip	new
Area 2 Estero/Andre Mar		**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A2-9S	Andre Mar	15" RCP outfall	existing	15" RCP outfall	existing	19"x30" ellip	new
A2-10S	Andre Mar			12"x18" ellip	new	19"x30" ellip	new
A2-11N	Andre Mar			12"x18" ellip	new	19"x30" ellip	new
Area 2 Estero/ St Peters		**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A2-15S	Anchorage	18" RCP outfall	existing	18" RCP outfall	existing	19"x30" ellip	new
A2-10N2	Anchorage			14"x23" ellip	new	19"x30" ellip	new
A2-10N	Anchorage			14"x23" ellip	new	14"x23" ellip	new
A2-13S	St Peters	15" RCP	existing	15" RCP	existing	14"x23" ellip	new
A2-13N2	St Peters			12"x18" ellip	new	14"x23" ellip	new
Area 3 Sterling/ Lazy Way		**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A3-2N2	Lazy Way	18" RCP outfall	existing	18" RCP outfall	existing	19"x30" ellip	new
A3-2S	Lazy Way	18" RCP	existing	18" RCP	existing	19"x30" ellip	new
A3-2N	Lazy Way	18" RCP	existing	18" RCP	existing	19"x30" ellip	new
A3-2A	Lazy Way			14"x23" ellip	new	19"x30" ellip	new
A3-1SJ	Estero - Sterling to Lazy Way			12"x18" ellip	new	14"x23" ellip	new
Area 3 Sterling/Falkirk		**Pipe Size**	**Status**	**Pipe Size**	**Status**	**Pipe Size**	**Status**
A3-5S	Sterling	24" RCP outfall	existing	24" RCP outfall	existing	24" RCP outfall	existing
A3-5C	Sterling			12"x18" ellip	new	14"x23" ellip	new
A3-4N	Falkirk to Sterling			12"x18" ellip	new	14"x23" ellip	new

1) 12"x18" elliptical pipe has the equivalent cross sectional area of a 15" circular pipe.
2) 14"x23" elliptical pipe has the equivalent cross sectional area of an 18" circular pipe.
3) 19"x30" elliptical pipe has the equivalent cross sectional area of a 24" circular pipe.

APPENDIX B

FEMA Information

Figure B-1. FEMA Transect Location Map for Lee County (2008)



(*note there is no Table B-1)

Table B-2
Coastal Flood Insurance Zone Data

Location	Stillwater Elevation (ft-NAVD) 10-Year	50-Year	100-Year	500-Year
Estero Bay, Transect 21	2.5	N/A	9.4	13.2
Gulf of Mexico, Transect 21	4.9	9.7	11.3[1]	14.3
Estero Bay, Transect 21.5	2.5	N/A	9.4	13.2
Gulf of Mexico, Transect 21.5	4.9	9.7	11.3[1]	14.3
Estero Bay, Transect 22	2.5	N/A	9.4	13.2
Gulf of Mexico, Transect 22	4.9	9.7	11.3[1]	14.3
Estero Bay, Transect 23	2.5	N/A	9.3	13.2
Gulf of Mexico, Transect 23	4.9	9.6	11.2[1]	14.3

N/A = Not available
[1]Does not include wave setup of 1.5 feet

Source: FEMA, 2008

Table B-3
Summary of Tidal
Stillwater Equations for
Fort Myers Beach

Location	Stillwater Elevation (FT-NAVD)
Transect 21	+1.0
Transect 21.5	+1.0
Transect 22	+1.0
Transect 23	+1.0

Log-linear regression equations for the following areas:

Transect 21

Stillwater elevation = 1.0069*(return period)$^{0.4356}$; R^2 = 0.949
For 1-year return period stillwater elevation = +1.0 feet

Transect 21.5

Stillwater elevation = 1.0069*(return period)$^{0.4356}$; R^2 = 0.949
For 1-year return period stillwater elevation = +1.0 feet

Transect 22

Stillwater elevation = 1.0069*(return period)$^{0.4356}$; R^2 = 0.949
For 1-year return period stillwater elevation = +1.0 feet

Transect 23

Stillwater elevation = 1.0047*(return period)$^{0.4353}$; R^2 = 0.952
For 1-year return period stillwater elevation = +1.0 feet

Note: As a conservative approach, a sensitivity analysis was completed (see **Section XXX**) that partially incorporated the extrapolated Gulf of Mexico 1-year stillwater elevation and the extrapolated Estero Bay 1-year stillwater elevation.

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NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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COASTAL BARRIER RESOURCES SYSTEM (CBRS) LEGEND

10-01-1983 CBRS Area

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER OCTOBER 1, 1983, IN DESIGNATED CBRS AREAS.

11-16-1990 CBRS Area

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER NOVEMBER 16, 1990, IN DESIGNATED CBRS AREAS.

11-16-1991 Otherwise Protected Area (OPA)

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER NOVEMBER 16, 1991, IN DESIGNATED OPAs WITHIN THE CBRS.

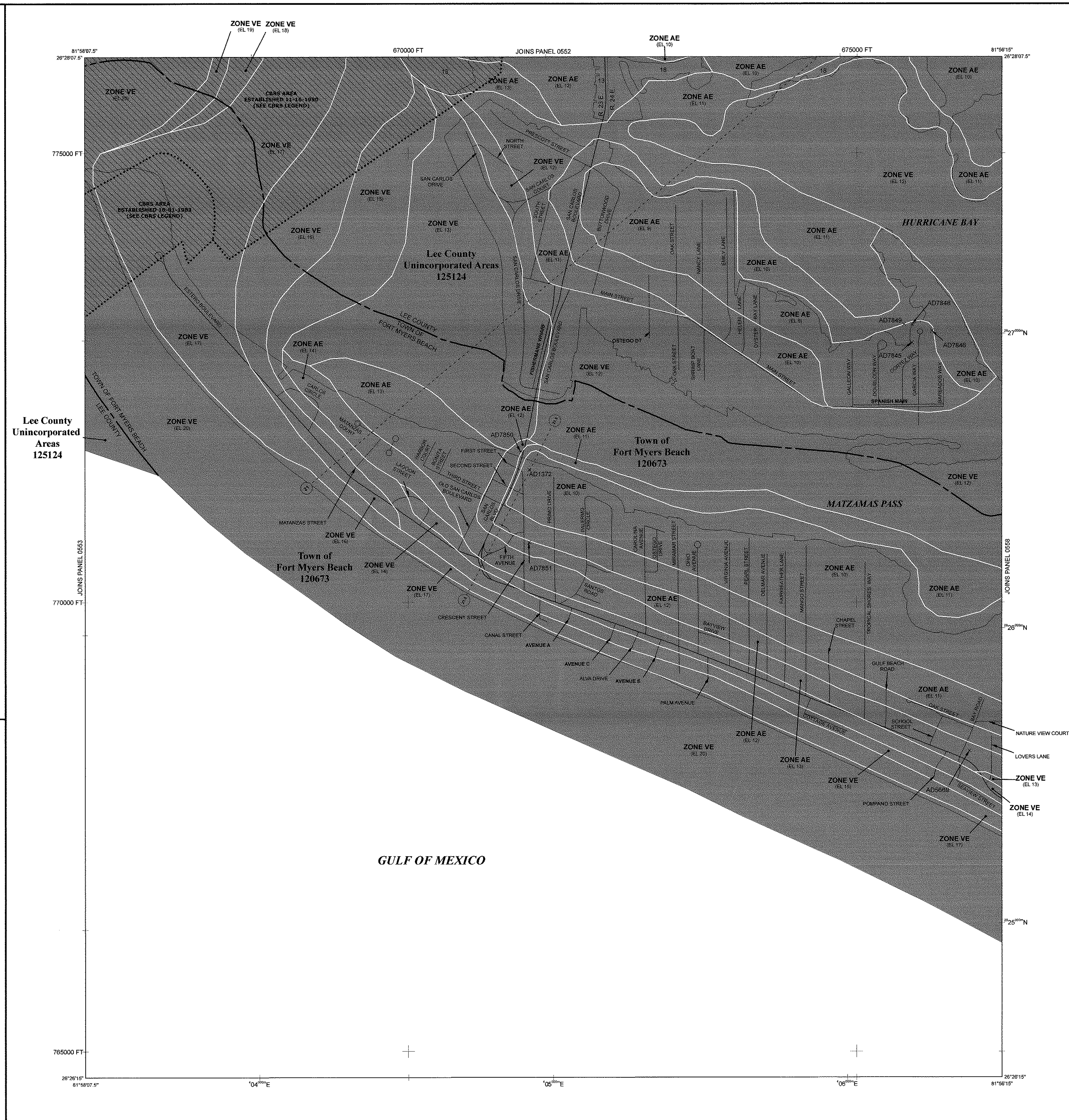
2-24-1997 CBRS Area

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER FEBRUARY 24, 1997, IN DESIGNATED CBRS AREAS.

10-27-2000 Otherwise Protected Area (OPA)

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER OCTOBER 27, 2000, IN DESIGNATED OPAs WITHIN THE CBRS.

Boundaries of the John H. Chafee Coastal Barrier Resources System (CBRS) shown on this FIRM were transferred from the official CBRS source map(s) for this area and are depicted on this FIRM for informstional purposes only. The official CBRS maps are enacted by Congress via the Coastal Barrier Resources Act, as amended, and maintained by the U.S. Fish and Wildlife Service (FWS). The official CBRS maps used to determine whether or not an area is located within the CBRS are available for download at http://www.fws.gov. For an official determination of whether or not an area is located within the CBRS, or for any questions regarding the CBRS, please contact the FWS field office for this area at (772) 562-3909.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)——(A)	Cross section Line
(23)- - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 17
600000 FT	5000-foot grid ticks: Florida State Plane coordinate system, West zone (FIPSZONE 0902), Transverse Mercator projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 28, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0554F

FIRM

FLOOD INSURANCE RATE MAP

LEE COUNTY, FLORIDA
AND INCORPORATED AREAS

PANEL 554 OF 685

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FORT MYERS BEACH, TOWN OF	120673	0554	F
LEE COUNTY	125124	0554	F

- NOTE -
THIS MAP INCLUDES BOUNDARIES OF THE COASTAL BARRIER RESOURCES SYSTEM ESTABLISHED UNDER THE COASTAL BARRIER RESOURCES ACT OF 1982 AND/OR SUBSEQUENT ENABLING LEGISLATION.

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
12071C0554F

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

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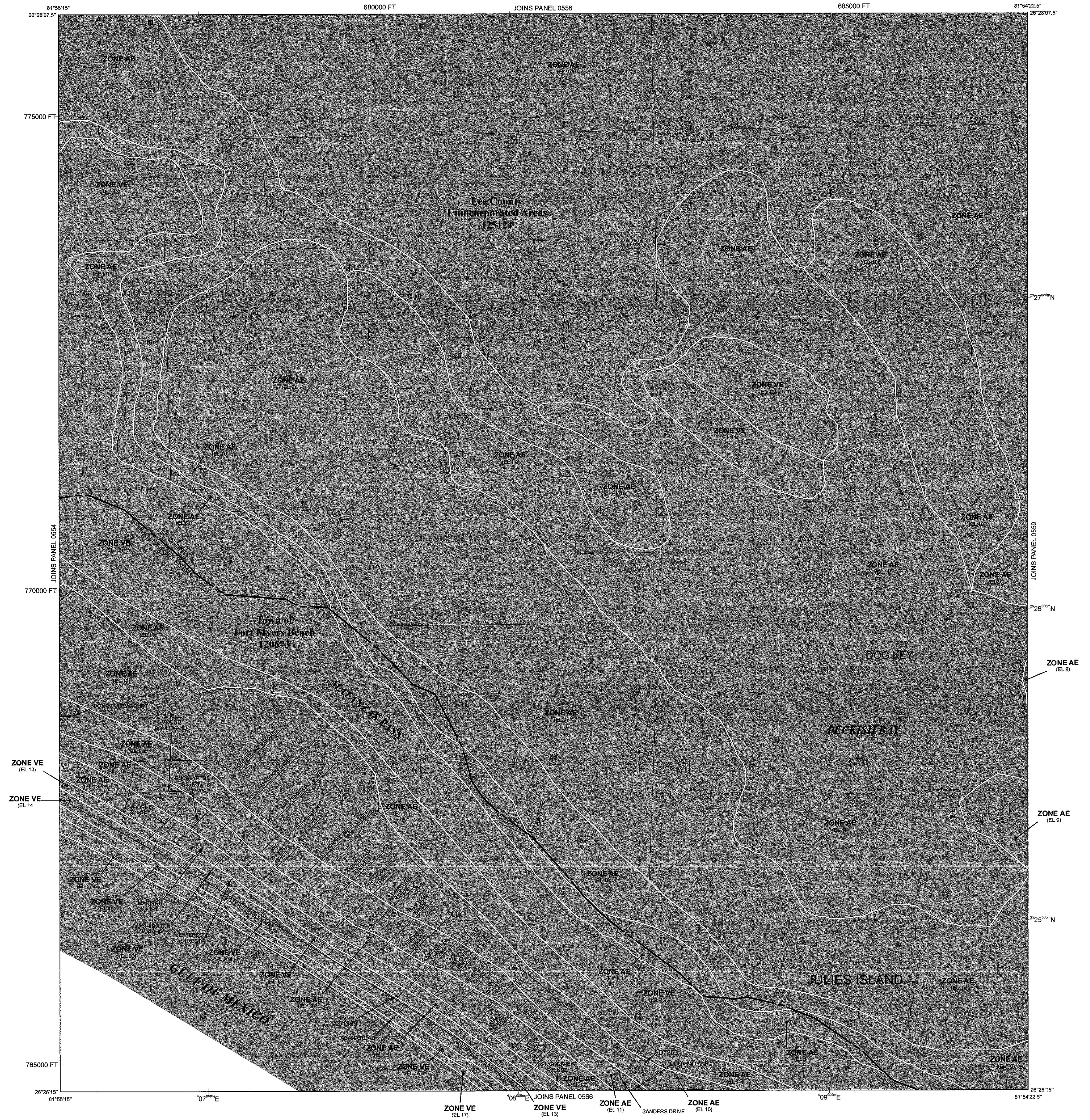

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0558F

FIRM
FLOOD INSURANCE RATE MAP

LEE COUNTY, FLORIDA
AND INCORPORATED AREAS

PANEL 558 OF 685

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

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LEE COUNTY	125124	0558	F

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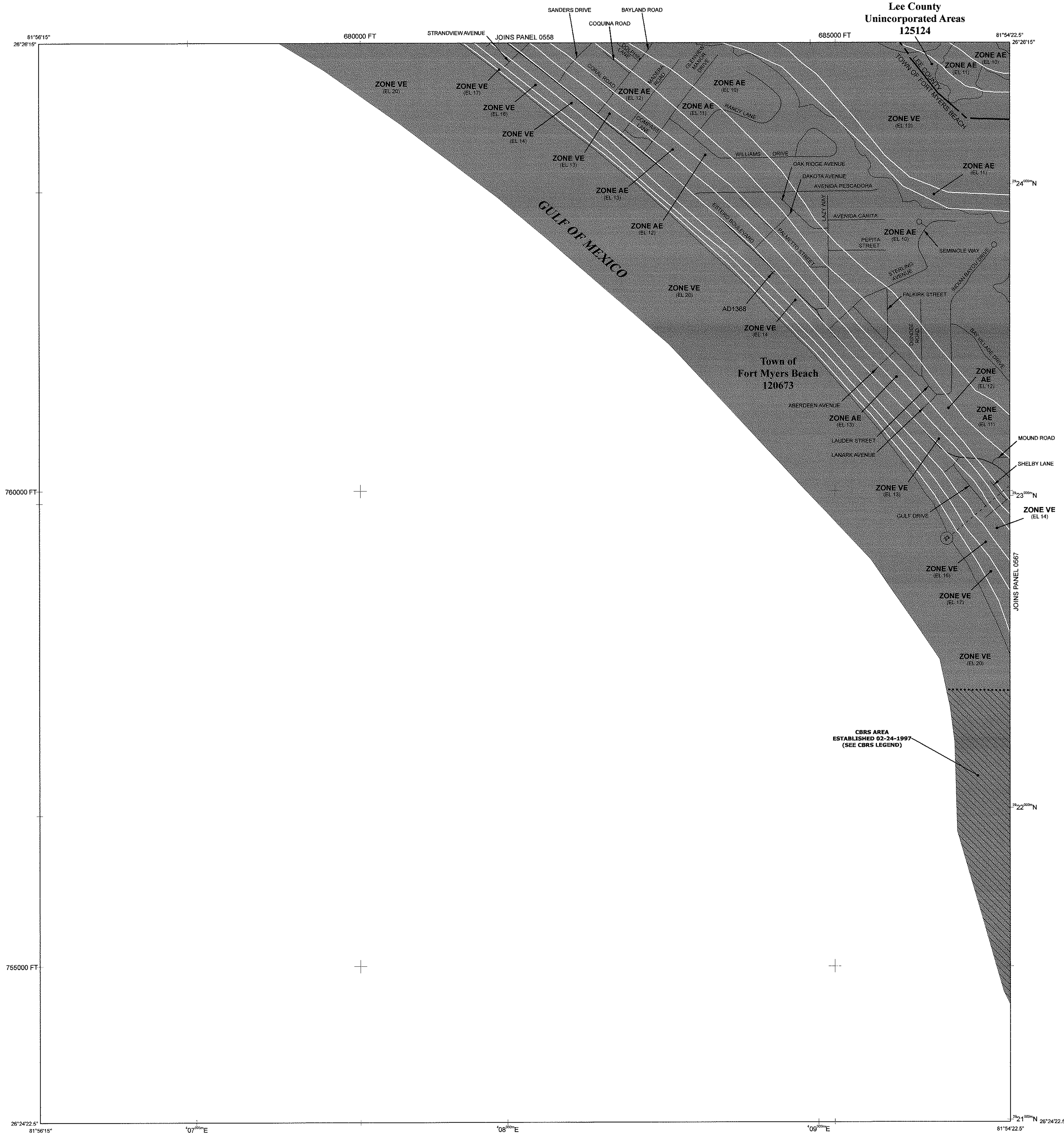
10-27-2000 Otherwise Protected Area (OPA)

FLOOD INSURANCE NOT AVAILABLE FOR STRUCTURES NEWLY BUILT OR SUBSTANTIALLY IMPROVED ON OR AFTER OCTOBER 27, 2000, IN DESIGNATED OPAs WITHIN THE CBRS.

Boundaries of the John H. Chafee Coastal Barrier Resources System (CBRS) shown on this FIRM were transferred from the official CBRS source map(s) for this area and are depicted on this FIRM for informational purposes only. The official CBRS maps are enacted by Congress via the Coastal Barrier Resources Act, as amended, and maintained by the U.S. Fish and Wildlife Service (FWS). The official CBRS maps used to determine whether or not an area is located within the CBRS are available for download at http://www.fws.gov. For an official determination of whether or not an area is located within the CBRS, or for any questions regarding the CBRS, please contact the FWS field office for this area at (772) 562-3909.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)——(A)	Cross section Line
(23)- - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 17
600000 FT	5000-foot grid ticks: Florida State Plane coordinate system, West zone (FIPSZONE 0902), Transverse Mercator projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 28, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0566F

FIRM

FLOOD INSURANCE RATE MAP

LEE COUNTY, FLORIDA AND INCORPORATED AREAS

PANEL 566 OF 685

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FORT MYERS BEACH, TOWN OF	120673	0566	F
LEE COUNTY	125124	0566	F

- NOTE -
THIS MAP INCLUDES BOUNDARIES OF THE COASTAL BARRIER RESOURCES SYSTEM ESTABLISHED UNDER THE COASTAL BARRIER RESOURCES ACT OF 1982 AND/OR SUBSEQUENT ENABLING LEGISLATION.

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 12071C0566F

EFFECTIVE DATE AUGUST 28, 2008

Federal Emergency Management Agency

Appendix B - Cover only of FIS

FLOOD INSURANCE STUDY

VOLUME 1 OF 2

LEE COUNTY, FLORIDA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
BONITA SPRINGS, CITY OF	120680
CAPE CORAL, CITY OF	125095
FORT MYERS, CITY OF	125106
FORT MYERS BEACH, TOWN OF	120673
LEE COUNTY (UNINCORPORATED AREAS)	125124
SANIBEL, CITY OF	120402

EFFECTIVE:
AUGUST 28, 2008

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
12071CV001A

APPENDIX C

Photographs


Estero and Sterling
Looking East down Sterling
Laundromat to the left


Estero and Sterling
STOP


Estero and Lazy
Looking West
Laundromat to the left
Flooding from Sterling drains over
here to Lazy storm system to the Bay


Sterling Av
Estero and Sterling


Estero
drainage from Sterling
drains to inlet
Lazy
drains under Lazy


Estero and Sterling
Looking North up Estero
AAIM
Realty Group, Inc
Flooding
drains to
north around
corner


Drains to Bay
Lazy
Looking East from
Estero


MID-ISLAND
Laundry · Car Wash
Dry Cleaning
Estero
Flooding on Sterling drains to Lazy
Lazy


Sterling and Lauder


Lazy
Estero


Driveway flooding along Lauder


Estero
STOP
Estero
Other Estero flow
that drains to Lazy
Lazy


runoff
Submerged inlet in front of church on Bay appears
to have no flow moving to it (see video clip)


Driveway flooding along Lauder


Estro and Bay
Looking east down Bay
Library on left
Shopping center on right


Ester and Bay
Looking West down Bay
Estero
Bay


Estero and
Seaview


Submerged inlet in front of Methodist church on Bay
appears to have no flow moving to it (see video clip)

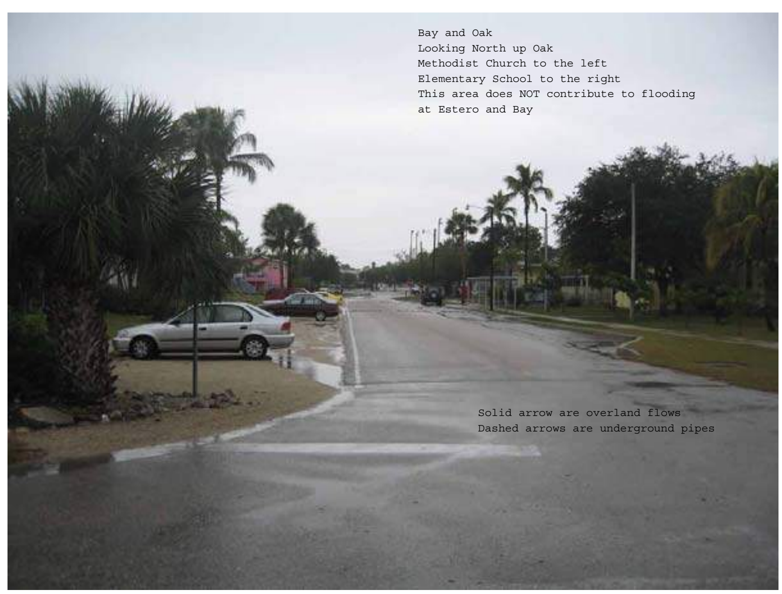

Bay and Oak
Looking east down Bay towards the outlet
Slow but noticeable flow
Slow but noticeable flow
No observable flow coming
from Bay and Estero inlets


Estero and Bay
Looking North on Estero
New Pervious Pavement put in by Town


Bay and Oak
Looking west down Bay
towards Estero and Bay flooding
Estero
Bay


Estero and Bay
Looking west on Bay towards Estero
Flow divide


Bay
Bay
Inlet just upstream of outlet on Bay
Looking west toward Oak and Estero
Slow but noticeable flow observed


Bay and Oak
Looking North up Oak
Methodist Church to the left
Elementary School to the right
This area does NOT contribute to flooding
at Estero and Bay
Solid arrow are overland flows
Dashed arrows are underground pipes


Bay outfall


Outfall
on Bay


Bay outfall


Bay Looking East
towards Oak and Estero


Bay outfall with slower than expected
flow. Wetland level may limit flow


Overflow to Bay
overflow to bank


Estero and Bay
Drainage at bank appears to go nowhere
then spills over to Bay and Estero


Shopping inlet supposed to drain
here but is stagnant


Drainage in shopping lot does not
drain. Then spills over to bank area
then to Bay and Estero
Overflow to bank


no flow from
lot inlet
that is
submerged


Submerged inlet in
shopping lot does not drain


Lovers St. behind shopping area
Looking west to Estero
Bank
Estero
Lover St.


Lovers St.


Library
AHEAD
WACHOVIA
Estero


Library
SEA GRAPE PLAZA
Bay
submerged bank inlet- no apparent flow
Estero


Estero and Madison
Looking North up Estro


Estero and Bay
Looking North down Ester
Flooding on west side of Estero


Estero and Madison
looking South down Estero


Estero and Bay Flooding
Looking east down Bay
Library


Estero
Madison


Estero and
Seaview
across for
Bay


Andre Mar and Ester
looking east down Andre Mar
Andre Mar


Estero
Andre Mar
Flooding drains to properties


Estero and Andre Mar
Looking South down Estero
Flow divide
Estero


Flooding on Andre Mar drains to properties


Flow divide between
Andre Mar and Anchorage
on Estero


Estero
Andre Mar


St. Peters
Estero


Estero and Anchorage
Looking south down Estero
Estero


St. Peters and Estero
Looking North up Estero
Estero


St. Peters and Estero
St. Peters


St. Peters
Estero


Ester and Anchorage
Flooding connected to flooding
at St. Peters and Estero
UP TO
$500 FIN
FOR
LITTERING
HIGHWAY
F.S.S. 403.413

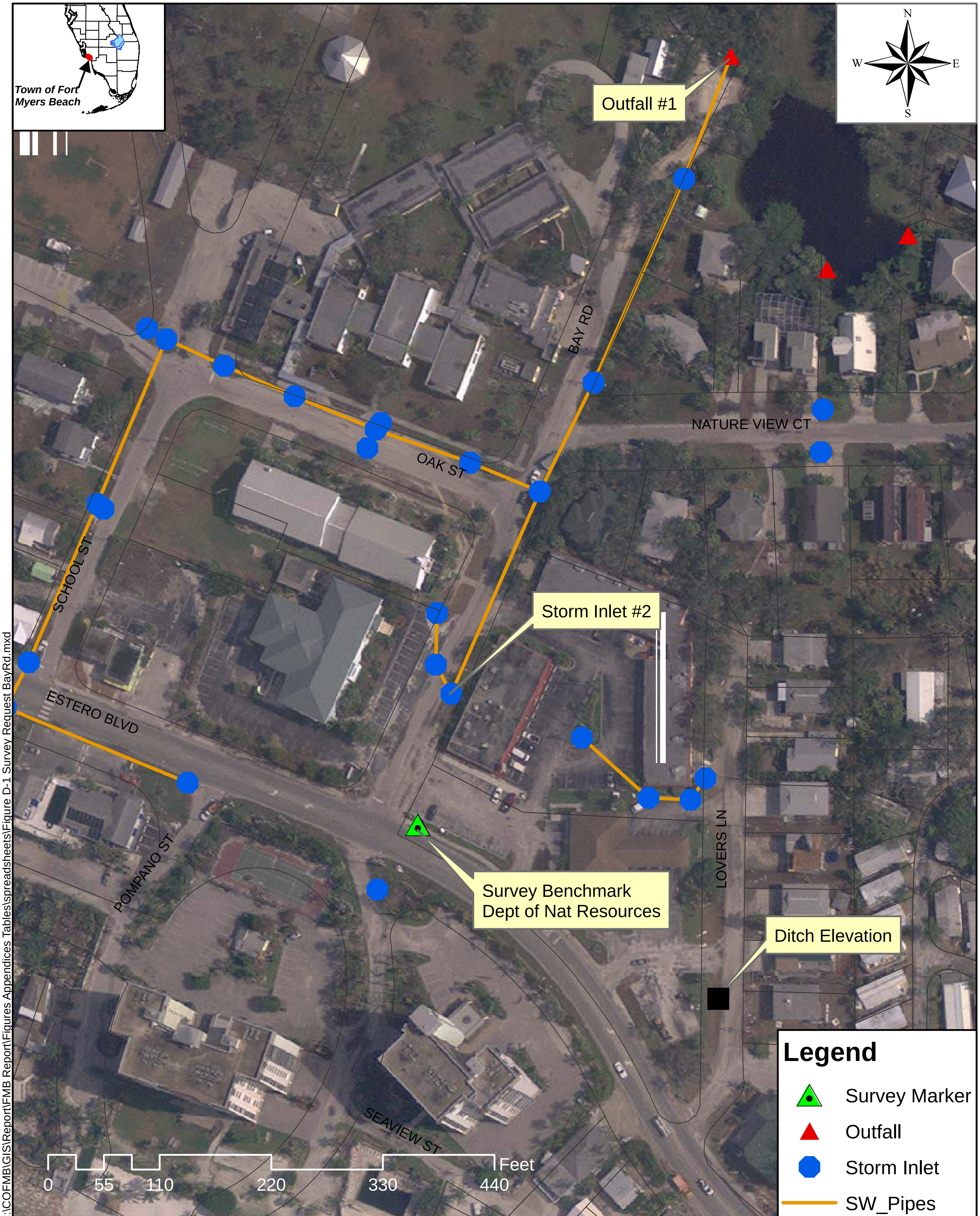

Estero flooding on west side
Looking North up Estro
Estero


Estero
St. Peters


St. Peters
Church driveway

APPENDIX D

Surveys



Source: Town of Fort Myers Beach

CDM

Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure D-1
Estero Boulevard & Bay Road
Survey Request Locations

UPDATED
02-12-09

Source: Town of Fort Myers Beach

CDM

Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure D-2
Estero Boulevard & Madison Ct
Survey Request Locations

UPDATED 02-12-09

Source: Town of Fort Myers Beach

CDM

Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure D-3
Estero Boulevard & Jefferson St
Survey Request Locations

UPDATED
02-12-09

C:\COFMB\SWMP\Report\FMB Report\Figures Appendices\Figure D-4 Survey Request StPeters.mxd

Source: Town of Fort Myers Beach

CDM

Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure D-4
Estero Boulevard & St Peters Drive
Survey Request Locations

UPDATED
02-12-09

C:\COFMB\GIS\Report\FMB Report\Figures Appendices Tables\spreadsheets\Figure D-5 Survey Request Sterling.mxd

Source: Town of Fort Myers Beach

CDM

Town of Fort Myers Beach
2523 Estero Blvd.
Ft. Myers Beach, FL 33931
Tel # (239) 765-0202

Figure D-5
Estero Boulevard & Sterling Avenue
Survey Request Locations

UPDATED
02-12-09

Table D-1: Survey Results for Estero Boulevard & Bay Rd

Estero Boulevard & Bay Road	Location	**Rim Elev (ft)**	**MH Depth (ft)**	**Pipe Inlet Depth (ft)**	**Pipe Inlet Diameter (in)**	**Pipe Inlet Direction (N,S,E,W)**
Storm Inlet #2	Bay Road near Library	3.07	1.68	1.85	12"x18"	N
		Surface Elev (ft)	**Comments**			
B.M. Dept of Nat Resources	Corner of Bay Road & Estero Blvd	4.47	NE Quad in sidewalk			
Ditch	Lovers Lane (north side of road)	6.77	55' north of bank entrance/exit			
		Invert Elev (ft)	**Pipe Diameter (in)**	**Comments**		
Outfall #1	Bay Road End of road	0.75	19"x30"	Mitered end north end of Bay Road		

Table D-2: Survey Results for Estero Boulevard & Madison Ct

Type	Location	Rim Elev (ft)	MH Depth (ft)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)
Storm Inlet #7	Voorhis Street	3.27	1.92	1.93	12"x18"	N	1.95	12"x18"	E
Storm Inlet #8	Eucalyptus & Shell Mound	2.82	0.23	0.27	18"	N	0.24	18"	SSE
		Surface Elev (ft)	**Comments**						
B.M. Lee County Benchmark	Corner of Voorhis St & Estero Blvd	3.995	Nail PKD 4919 SW Quad						
B.M. Lee County Benchmark	Corner of Eucalyptus & Estero Blvd	4.41	Marker aluminum disk 4919 Lee County Public Works						
B.M. Lee County Benchmark	Corner of Madison & Estero Blvd	4.205	Nail PKD 4919 NE Quad						
B.M. Lee County Benchmark	Corner of Eucalyptus & Shell Mound	4.01	Nail PKD						
Low point of Voorhis St at Estero	Corner of Voorhis St & Estero Blvd	3.64	NW Quad						
Low point of Eucalyptus St at Estero	Corner of Eucalyptus & Estero Blvd	4.03	SE Quad						
Low point of Madison Ct St at Estero	Corner of Madison & Estero Blvd	3.85	SE Quad						
		Invert Elev (ft)	**Pipe Diameter (in)**	**Comments**					
Outfall #2	Back Yard residence on Shell Mound	0.06	24"						

Table D-3: Survey Results for Estero Boulevard & Jefferson St

Type	Location	Rim Elev (ft)	MH Depth (ft)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)
Storm Inlet #11	Eucalyptus & Shell Mound	3.49	1.99	2.08	12"x18"	W	2.09	12"x18"	E
		Surface Elev (ft)	**Comments**						
B.M. Lee County Benchmark	Corner of Washington & Estero Blvd	3.92	Nail PKD 4919 NE Quad						
B.M. Lee County Benchmark	Corner of Jefferson & Estero Blvd	3.955	Nail PKD 4919 NE Quad						
B.M. Lee County Benchmark	Corner of Mid Island & Estero Blvd	3.98	Nail PKD 4919 NE Quad						
B.M. Lee County Benchmark	Corner of Connecticut & Estero Blvd	4.145	Nail PKD 4919 NE Quad						
Low point of Washington at Estero	Corner of Washington & Estero Blvd	3.62	NE Quad						
Low point of Jefferson at Estero	Corner of Jefferson & Estero Blvd`	3.79	SE Quad						
Low point of Mid Island at Estero	Corner of Mid Island & Estero Blvd	3.68	SE Quad						
Low point of Connecticut at Estero	Corner of Connecticut & Estero Blvd	3.91	SE Quad						
		Invert Elev (ft)	**Pipe Diameter (in)**	**Comments**					
Outfall #4	Shell Mound near Jefferson	-1.26	18"	Corrugated PVC					
Outfall #5	Shell Mound south of Jefferson	0.58	15"	RCP					

Table D-4: Survey Results for Estero Boulevard & St Peters Dr

Type	Location	Rim Elev (ft)	MH Depth (ft)	Pipe Inlet Depth (ft)	Invert Elev (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)	Comments
Storm Inlet #12	End of Andre Mar	2.16	0.39	0.42	1.74	15"	E				Inlet grate
Storm Inlet #13	End of Anchorage ST (private driveway)	3.29	1.22	1.17	2.12	18"	SE				Inlet grate
Storm Inlet #14	End of St Peters Dr			2.39		19"x30"	E				mitered end
		Surface Elev (ft)	**Comments**								
B.M. Lee County Benchmark	Corner of Andre Mar & Estero Blvd	4.085	Nail PKD 4919 NE Quad								
B.M. Lee County Benchmark	Corner of Anchorage & Estero Blvd	4.195	Nail PKD 4919 NE Quad								
B.M. Lee County Benchmark	Corner of St Peters & Estero Blvd		Aluminum disk 4919 Lee County Public Works, NE Quad								
Low point of Andre Mar at Estero	Corner of Andre Mar & Estero Blvd	3.75	SE Quad								
Low point of St Peters at Estero	Corner of Anchorage & Estero Blvd	4.97	NE Quad								
Backyard swale	30 feet NE of culvert in St Peters Dr	1.97	10'+/- south of rear property corner 158, 166 Anchorage St								
		Invert Elev (ft)	**Pipe Diameter (in)**	**Comments**							
Culvert St Peters Dr	St Peters Dr 450 feet east of Estero	1.99	15"	RCP							

Table D-5: Survey Results for Estero Boulevard & Sterling Ave

Type	Location	Rim Elev (ft)	MH Depth (ft)	Pipe Inlet Depth (ft)	Invert Elev (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)	Pipe Inlet Direction (N,S,E,W)	Pipe Inlet Depth (ft)	Pipe Inlet Diameter (in)
Storm Inlet #17	Lazy Way near Estero	3.00	0.07	0.24	0.24	15"	NNE	0.33	15"	WNW	0.07	15"
Storm Inlet #18	Sterling Av, 200 ft east of Falkirk	1.29	-0.71	-0.63	-0.63	18"	NNE					
Storm Inlet #19	Lauder & Aberdeen	3.56	-0.50	-0.25	-0.25	18"	E	-0.24	24"	W		
		Surface Elev (ft)	Comments									
B.M. Lee County Benchmark	Corner of Lazy Way & Estero Blvd	3.99	Aluminum disk 4919 Lee County Public Works, NE Quad									
B.M. Lee County Benchmark	Corner of Sterling & Estero Blvd	3.59	Nail Aluminum disk 4919 Lee County Public Works, SE Quad									
B.M. Lee County Benchmark	Corner of Lauder & Aberdeen	4.04	Nail PKD 4919 SW Quad									
Low point of Lazy Way at Estero	Corner of Lazy Way & Estero Blvd	3.14	SE Quad									
Low point of Sterling Av at Estero	Corner of Sterling & Estero Blvd	3.35	NE Quad									
Road Crown of Sterling at Falkirk	C/L of Road Sterling at Falkirk	3.01										
		Invert Elev (ft)	Pipe Diameter (in)	Comments								
Outfall #9	East side of Lazy Way near Palmetto	-1.53	18"	Pipe only, no mitered end or headwall								

APPENDIX E

Water Quality Analysis

Table E-1. Water Quality Treatment Volume Calculations for Proposed BMPs - City of Fort Myers Beach

HUC	BMP Credit Spreadsheet			Treatment Volume Criterion			Volume Criteria		Swale BMP Credits			BMP Credits					
	acre	imperv %	imperv area (ac)	2.5" x imperv imperv area (Ac-ft)	1" x area total area (Ac-ft)	Higher of both cases (Ac-ft)	1" volume (Ac-ft)	1/2" volume (Ac-ft)	Grassy Inlet (Ac-ft)	Swales (Ac-ft)	#Swale or Grass Inlet (Ac-ft)	Dry Retention (Ac-ft)	Dry Det Public (Ac-ft)	Dry Det Private (Ac-ft)	Perv Pavement (Ac-ft)	Exfiltration Public (Ac-ft)	Exfiltration Private (Ac-ft)
HUA1-1	3.7	28	1.04	0.22	0.31	0.31	0.31	0.15	0.02	0.00	0.02	0.00	0.00	0.22		0.00	0.00
HUA1-1A	3	30	0.90	0.19	0.25	0.25	0.25	0.13	0.02	0.00	0.02	0.00	0.00	0.00		0.00	0.00
HUA1-2	1.8	30.1	0.54	0.11	0.15	0.15	0.15	0.08	0.01	0.00	0.01	0.00	0.10	0.00		0.00	0.00
HUA1-3	2.2	79.9	1.76	0.37	0.18	0.37	0.37	0.18	0.04	0.00	0.04	0.00	0.00	0.04		0.09	0.00
HUA1-4	1.5	27.8	0.42	0.09	0.13	0.13	0.13	0.06	0.01	0.00	0.01	0.00	0.00	0.01		0.10	0.00
HUA1-5	2.2	23.8	0.52	0.11	0.18	0.18	0.18	0.09	0.01	0.01	0.01	0.00	0.05	0.00		0.00	0.00
HUA1-6	0.7	81	0.57	0.12	0.06	0.12	0.12	0.06	0.01	0.00	0.01	0.00	0.00	0.03		0.00	0.00
HUA1-7	0.5	80.2	0.40	0.08	0.04	0.08	0.08	0.04	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.00
HUA1-8	2.6	45.5	1.18	0.25	0.22	0.25	0.25	0.12	0.02	0.00	0.02	0.02	0.00	0.00		0.00	0.00
				Required Volume per Criteria:			**1.83**	**0.92**	**Treatment Volume:**		**0.15**	**0.03**	**0.15**	**0.31**	**0.00**	**0.19**	**0.00**
PROBLEM AREA 1 -->>								**Total Proposed Treatment Volume:**				**0.83**					
							% Covered of 1"-Volume:			**45%**	**% Covered of 0.5"-Volume:**			**90%**			
HUA2-1	6.2	29.3	1.82	0.38	0.52	0.52	0.52	0.26	0.04	0.00	0.04	0.00	0.00	0.00		0.00	0.00
HUA2-10	14.6	30	4.38	0.91	1.22	1.22	1.22	0.61	0.09	0.00	0.09	0.00	0.20	0.18		0.00	0.15
HUA2-11	2.5	30	0.75	0.16	0.21	0.21	0.21	0.10	0.02	0.01	0.02	0.00	0.00	0.06		0.00	0.00
HUA2-12	1.7	30	0.51	0.11	0.14	0.14	0.14	0.07	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.04
HUA2-13	8.1	30	2.43	0.51	0.68	0.68	0.68	0.34	0.05	0.00	0.05	0.00	0.03	0.00	0.33	0.07	0.02
HUA2-14	1.5	30	0.45	0.09	0.13	0.13	0.13	0.06	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.00
HUA2-15	2.2	30	0.66	0.14	0.18	0.18	0.18	0.09	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.00
HUA2-16	2.3	30	0.69	0.14	0.19	0.19	0.19	0.10	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.00
HUA2-17	3.9	30	1.17	0.24	0.33	0.33	0.33	0.16	0.02	0.00	0.02	0.00	0.00	0.00		0.00	0.00
HUA2-18	2.5	30	0.75	0.16	0.21	0.21	0.21	0.10	0.02	0.00	0.02	0.00	0.00	0.00		0.00	0.00
HUA2-2	8.6	29.3	2.52	0.52	0.72	0.72	0.72	0.36	0.05	0.01	0.05	0.00	0.00	0.00		0.16	0.04
HUA2-3	4.5	30	1.35	0.28	0.38	0.38	0.38	0.19	0.03	0.00	0.03	0.00	0.00	0.00		0.00	0.18
HUA2-4	13.2	30	3.96	0.83	1.10	1.10	1.10	0.55	0.08	0.02	0.08	0.00	0.00	0.00		0.22	0.00
HUA2-5	3.7	30	1.11	0.23	0.31	0.31	0.31	0.15	0.02	0.00	0.02	0.00	0.01	0.05		0.00	0.00
HUA2-6	2.7	30	0.81	0.17	0.23	0.23	0.23	0.11	0.02	0.00	0.02	0.00	0.00	0.00		0.00	0.00
HUA2-7	2.4	28.9	0.69	0.14	0.20	0.20	0.20	0.10	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.00
HUA2-9	4	27.4	1.10	0.23	0.33	0.33	0.33	0.17	0.02	0.00	0.02	0.00	0.00	0.00		0.00	0.00
				Required Volume per Criteria:			**7.05**	**3.53**	**Treatment Volume:**		**0.52**	**0.00**	**0.24**	**0.29**	**0.33**	**0.46**	**0.43**
PROBLEM AREA 2 -->>								**Total Proposed Treatment Volume:**				**2.28**					
							% Covered of 1"-Volume:			**32%**	**% Covered of 0.5"-Volume:**			**65%**			
HUA3-1	2.3	23	0.53	0.11	0.19	0.19	0.19	0.10	0.01	0.00	0.01	0.00	0.00	0.00		0.12	0.00
HUA3-2	7	23	1.61	0.34	0.58	0.58	0.58	0.29	0.03	0.00	0.03	0.00	0.00	0.26		0.23	0.00
HUA3-3	5.4	23	1.24	0.26	0.45	0.45	0.45	0.23	0.03	0.00	0.03	0.00	0.00	0.00		0.00	0.00
HUA3-4	3.4	23	0.78	0.16	0.28	0.28	0.28	0.14	0.02	0.01	0.02	0.00	0.00	0.00		0.00	0.00
HUA3-5	2.8	23	0.64	0.13	0.23	0.23	0.23	0.12	0.01	0.00	0.01	0.00	0.00	0.00		0.00	0.00
				Required Volume per Criteria:			**1.74**	**0.87**	**Treatment Volume:**		**0.10**	**0.00**	**0.00**	**0.26**	**0.00**	**0.35**	**0.00**
PROBLEM AREA 3 -->>								**Total Proposed Treatment Volume:**				**0.71**					
							% Covered of 1"-Volume:			**41%**	**% Covered of 0.5"-Volume:**			**82%**			
				Required Volume per Criteria:			**10.62**	**5.31**	**Treatment Volume:**		**0.78**	**0.03**	**0.40**	**0.85**	**0.33**	**1.00**	**0.43**
PROBLEM AREA 1,2,3 -->>								**Total Proposed Treatment Volume:**				**3.82**					
							% Covered of 1"-Volume:			**36%**	**% Covered of 0.5"-Volume:**			**72%**			

Credit for Swale or Grassy Inlet is selcted based on the higher number of the two choices for maximum credit.

Dry Detention
Private

HUs	Area (ac)	Depth (ft)	Volume (ac-ft)	Volume (ac-in
HUA1-1	0.225	1	0.22	2.69
HUA1-1A	0.000	1	0.00	0.00
HUA1-2	0.000	1	0.00	0.00
HUA1-3	0.041	1	0.04	0.49
HUA1-4	0.007	1	0.01	0.09
HUA1-5	0.000	1	0.00	0.00
HUA1-6	0.033	1	0.03	0.40
HUA1-7	0.000	1	0.00	0.00
HUA1-8	0.000	1	0.00	0.00
HUA2-1	0.000	1	0.00	0.00
HUA2-10	0.183	1	0.18	2.20
HUA2-11	0.056	1	0.06	0.67
HUA2-12	0.000	1	0.00	0.00
HUA2-13	0.000	1	0.00	0.00
HUA2-14	0.000	1	0.00	0.00
HUA2-15	0.000	1	0.00	0.00
HUA2-16	0.000	1	0.00	0.00
HUA2-17	0.000	1	0.00	0.00
HUA2-18	0.000	1	0.00	0.00
HUA2-2	0.000	1	0.00	0.00
HUA2-3	0.000	1	0.00	0.00
HUA2-4	0.000	1	0.00	0.00
HUA2-5	0.051	1	0.05	0.62
HUA2-6	0.000	1	0.00	0.00
HUA2-7	0.000	1	0.00	0.00
HUA2-9	0.000	1	0.00	0.00
HUA3-1	0.000	1	0.00	0.00
HUA3-2	0.258	1	0.26	3.09
HUA3-3	0.000	1	0.00	0.00
HUA3-4	0.000	1	0.00	0.00
HUA3-5	0.000	1	0.00	0.00

1) Assume 1 foot of depth from bottom to oufall elevation

Dry Detention
Public

HUs	Area (ac)	Depth (ft)	Volume (ac-ft)	Volume (ac-in)
HUA1-1	0.000	1	0.00	0.00
HUA1-1A	0.000	1	0.00	0.00
HUA1-2	0.102	1	0.10	1.22
HUA1-3	0.000	1	0.00	0.00
HUA1-4	0.000	1	0.00	0.00
HUA1-5	0.052	1	0.05	0.62
HUA1-6	0.000	1	0.00	0.00
HUA1-7	0.000	1	0.00	0.00
HUA1-8	0.000	1	0.00	0.00
HUA2-1	0.000	1	0.00	0.00
HUA2-10	0.202	1	0.20	2.42
HUA2-11	0.000	1	0.00	0.00
HUA2-12	0.000	1	0.00	0.00
HUA2-13	0.032	1	0.03	0.38
HUA2-14	0.000	1	0.00	0.00
HUA2-15	0.000	1	0.00	0.00
HUA2-16	0.000	1	0.00	0.00
HUA2-17	0.000	1	0.00	0.00
HUA2-18	0.000	1	0.00	0.00
HUA2-2	0.000	1	0.00	0.00
HUA2-3	0.000	1	0.00	0.00
HUA2-4	0.000	1	0.00	0.00
HUA2-5	0.011	1	0.01	0.13
HUA2-6	0.000	1	0.00	0.00
HUA2-7	0.000	1	0.00	0.00
HUA2-9	0.000	1	0.00	0.00
HUA3-1	0.000	1	0.00	0.00
HUA3-2	0.000	1	0.00	0.00
HUA3-3	0.000	1	0.00	0.00
HUA3-4	0.000	1	0.00	0.00
HUA3-5	0.000	1	0.00	0.00

1) Assume 1 foot of depth from bottom to oufall elevation

DRY RETENTION

HUs	Area (ac)	Infiltration Depth (ft)	Volume (ac-ft)	Volume (ac-in)
HUA1-1	0.000	0.2	0.00	0.00
HUA1-1A	0.000	0.2	0.00	0.00
HUA1-2	0.000	0.2	0.00	0.00
HUA1-3	0.000	0.2	0.00	0.00
HUA1-4	0.000	0.2	0.00	0.00
HUA1-5	0.017	0.2	0.00	0.04
HUA1-6	0.000	0.2	0.00	0.00
HUA1-7	0.000	0.2	0.00	0.00
HUA1-8	0.124	0.2	0.02	0.30
HUA2-1	0.000	0.2	0.00	0.00
HUA2-10	0.000	0.2	0.00	0.00
HUA2-11	0.000	0.2	0.00	0.00
HUA2-12	0.000	0.2	0.00	0.00
HUA2-13	0.000	0.2	0.00	0.00
HUA2-14	0.000	0.2	0.00	0.00
HUA2-15	0.000	0.2	0.00	0.00
HUA2-16	0.000	0.2	0.00	0.00
HUA2-17	0.000	0.2	0.00	0.00
HUA2-18	0.000	0.2	0.00	0.00
HUA2-2	0.000	0.2	0.00	0.00
HUA2-3	0.000	0.2	0.00	0.00
HUA2-4	0.000	0.2	0.00	0.00
HUA2-5	0.000	0.2	0.00	0.00
HUA2-6	0.000	0.2	0.00	0.00
HUA2-7	0.000	0.2	0.00	0.00
HUA2-9	0.000	0.2	0.00	0.00
HUA3-1	0.000	0.2	0.00	0.00
HUA3-2	0.000	0.2	0.00	0.00
HUA3-3	0.000	0.2	0.00	0.00
HUA3-4	0.000	0.2	0.00	0.00
HUA3-5	0.000	0.2	0.00	0.00

1) Assume 0.2 feet will infiltrate over 24 hours based on soil type

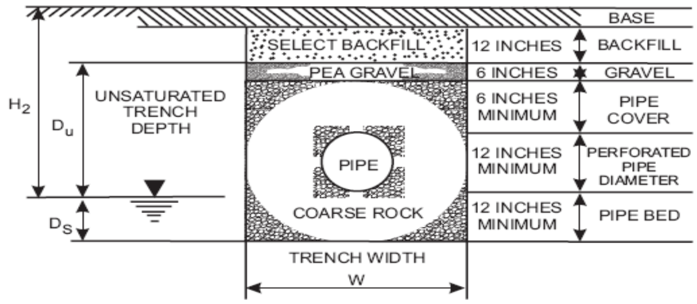
Project: Fort Myers Beach Stormwater Master Plan
Task: Calculation of Exfiltration Trench
Method: South Florida Water Management District
Source: C-V-10 Permit Information Manual

Calculate Exfiltration trench (SFWMD method)

$$V = L\ [K(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s) + (1.39\ \ x10^{-4})\ WD_u]$$

where:

K = Hydraulic Conductivity (cfs/ft^2 per ft head)
W = Width of trench (feet)
H_2 = Height above water table (feet)
D_s = Saturated trench depth (feet)
D_u = Unsaturated trench depth (feet)
L = Length of Exfiltration Trench (feet)
V = Volume of water (acre-inches)



Exfiltration (Private)

HUs	L Length feet	H_2 Height WT feet	D_u Unsat Depth feet	D_s Sat Depth feet	K Hyd Cond cfs/ft2/ft	W Trench Width feet	V Volume ac-in	V Volume ac-ft
HUA1-1	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-1A	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-2	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-3	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-4	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-5	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-6	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-7	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-8	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-1	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-10	226	2.7	2	1	0.0003	4	1.81	0.15
HUA2-11	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-12	66	2.7	2	1	0.0003	4	0.53	0.04
HUA2-13	35	2.7	2	1	0.0003	4	0.28	0.02
HUA2-14	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-15	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-16	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-17	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-18	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-2	53	2.7	2	1	0.0003	4	0.43	0.04
HUA2-3	267	2.7	2	1	0.0003	4	2.14	0.18
HUA2-4	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-5	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-6	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-7	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-9	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-1	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-2	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-3	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-4	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-5	0	2.7	2	1	0.0003	4	0.00	0.00

Source for K, Hydraulic Conductivity from ECT report

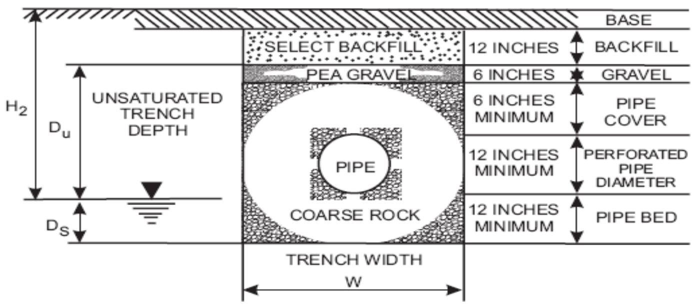
Project: Fort Myers Beach Stormwater Master Plan
Task: Calculation of Exfiltration Trench
Method: South Florida Water Management District
Source: C-V-10 Permit Information Manual

Calculate Exfiltration trench (SFWMD method)

$$V = L\ [K(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s) + (1.39\ \ x10^{-4})\ WD_u]$$

where:

K = Hydraulic Conductivity (cfs/ft^2 per ft head)
W = Width of trench (feet)
H_2 = Height above water table (feet)
D_s = Saturated trench depth (feet)
D_u = Unsaturated trench depth (feet)
L = Length of Exfiltration Trench (feet)
V = Volume of water (acre-inches)



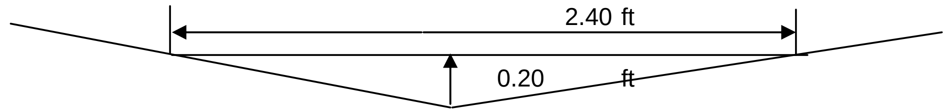
Exfiltration (Public)

HUs	L Length feet	H_2 Height WT feet	D_u Unsat Depth feet	D_s Sat Depth feet	K Hyd Cond cfs/ft2/ft	W Trench Width feet	V Volume ac-in	V Volume ac-ft
HUA1-1	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-1A	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-2	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-3	130	2.7	2	1	0.0003	4	1.04	0.09
HUA1-4	148	2.7	2	1	0.0003	4	1.18	0.10
HUA1-5	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-6	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-7	0	2.7	2	1	0.0003	4	0.00	0.00
HUA1-8	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-1	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-10	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-11	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-12	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-13	110	2.7	2	1	0.0003	4	0.89	0.07
HUA2-14	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-15	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-16	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-17	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-18	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-2	242	2.7	2	1	0.0003	4	1.94	0.16
HUA2-3	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-4	336	2.7	2	1	0.0003	4	2.69	0.22
HUA2-5	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-6	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-7	0	2.7	2	1	0.0003	4	0.00	0.00
HUA2-9	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-1	182	2.7	2	1	0.0003	4	1.46	0.12
HUA3-2	348	2.7	2	1	0.0003	4	2.79	0.23
HUA3-3	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-4	0	2.7	2	1	0.0003	4	0.00	0.00
HUA3-5	0	2.7	2	1	0.0003	4	0.00	0.00

Source for K, Hydraulic Conductivity from ECT report

SWALES

soil type: C
infil rate [1] 0.1 in/hr
24-hr inf rate 2.4 in



HUs	Length (ft)	Location	Slope 1:	Wetted Width (ft)	Infil Depth (ft)	Area (sq-ft)	Volume (ac-ft)	Volume (ac-in)	
HUA1-1	0		6	2.4	0.2	0.48	0.000	0.000	
HUA1-1A	0		6	2.4	0.2	0.48	0.000	0.000	
HUA1-2	119		6	2.4	0.2	0.48	0.001	0.016	
HUA1-3	0		6	2.4	0.2	0.48	0.000	0.000	
HUA1-4	98		6	2.4	0.2	0.48	0.001	0.013	
HUA1-5	472		6	2.4	0.2	0.48	0.005	0.062	
HUA1-6	0		6	2.4	0.2	0.48	0.000	0.000	
HUA1-7	0		6	2.4	0.2	0.48	0.000	0.000	
HUA1-8	248		6	2.4	0.2	0.48	0.003	0.033	936.79
HUA2-1	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-10	415		6	2.4	0.2	0.48	0.005	0.055	
HUA2-11	665		6	2.4	0.2	0.48	0.007	0.088	
HUA2-12	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-13	46		6	2.4	0.2	0.48	0.001	0.006	
HUA2-14	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-15	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-16	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-17	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-18	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-2	730		6	2.4	0.2	0.48	0.008	0.097	
HUA2-3	324		6	2.4	0.2	0.48	0.004	0.043	
HUA2-4	2206		6	2.4	0.2	0.48	0.024	0.292	
HUA2-5	161		6	2.4	0.2	0.48	0.002	0.021	
HUA2-6	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-7	0		6	2.4	0.2	0.48	0.000	0.000	
HUA2-9	0		6	2.4	0.2	0.48	0.000	0.000	4546.21
HUA3-1	0		6	2.4	0.2	0.48	0.000	0.000	
HUA3-2	0		6	2.4	0.2	0.48	0.000	0.000	
HUA3-3	0		6	2.4	0.2	0.48	0.000	0.000	
HUA3-4	1114		6	2.4	0.2	0.48	0.012	0.147	
HUA3-5	0		6	2.4	0.2	0.48	0.000	0.000	1113.94

1) Assume 0.2 feet will infiltrate over 24 hours based on soil type

Table E-2: BMP Identification Chart

ID	BMP Type	Pub or Prv	Unit	Quantity	Location
BFA2-7	Baffle Box	Public	EA	1	St Peters N of Lutheran Church
BFA2-4	Baffle Box	Public	EA	1	Jefferson St and Shell Mound Blvd
BFA2-2	Baffle Box	Private	EA	1	Eucalyptus Ct and Estero Blvd
BFA1-2	Baffle Box	Public	EA	1	Bay Road, in front of Library
BFA2-5	Baffle Box	Private	EA	1	Estero near Conn St, on Baptist Church Property
BFA2-3	Baffle Box	Public	EA	1	Jefferson Street, N of Estero Blvd
BFA1-1	Baffle Box	Public	EA	1	Oak St, in front of Methodist Church
BFA2-6	Baffle Box	Private	EA	1	St Peters and Estero, on Lutheran Church Property
BFA2-1	Baffle Box	Public	EA	1	Voorhis St and Estero Blvd
BFA3-1	Baffle Box	Public	EA	1	Lazy Way on Mosquito Control District
BFA3-2	Baffle Box	Public	EA	1	Lazy Way on Mosquito Control District
BFA3-3	Baffle Box	Public	EA	1	Sterling Ave and Estero Blvd
EXA2-6	Exfiltration	Public	FT	110	St Peters Dr, N of Lutheran Church Property
EXA2-2	Exfiltration	Private	FT	320	Eucalyptus Ct and Estero Blvd on EMBARQ Property
EXA1-2	Exfiltration	Public	FT	130	Bay Road, in front of Library
EXA2-4	Exfiltration	Private	FT	226	Estero Blvd, on Baptist Church Property
EXA2-3	Exfiltration	Public	FT	336	Jefferson St, N of Estero Blvd
EXA1-1	Exfiltration	Public	FT	148	Oak St, in front of Methodist Church
EXA2-1	Exfiltration	Public	FT	242	Voorhis St, N of Estero Blvd
EXA2-5	Exfiltration	Private	FT	101	Estero Blvd, on Lutheran Church Property
EXA3-1	Exfiltration	Public	FT	174	Lazy Way on Mosquito Control District Property
EXA3-2	Exfiltration	Public	FT	174	Lazy Way on Mosquito Control District Property
EXA3-3	Exfiltration	Public	FT	182	Sterling Ave and Estero Blvd
DDA1-3	Dry Detention	Private	AC	0.03	Sea Grape Plaza
DDA2-1	Dry Detention	Private	AC	0.19	Estero Blvd, on Baptist Church Property
DDA1-1	Dry Detention	Private	AC	0.09	School St, on Methodist Church Prop
DDA2-2	Dry Detention	Private	AC	0.10	Estero Blvd, on Baptist Church Property
DDA1-2	Dry Detention	Private	AC	0.18	School St, Behind Library on Prv Prop
DDA3-1	Dry Detention	Private	AC	0.26	Lazy Way on Womens Club Property
DDA2-6	Dry Detention	Public	AC	0.03	St Peters Dr, N of Estero Blvd
DDA1-5	Dry Detention	Public	AC	0.06	Bay Road, N of Nature View Ct
DDA1-4	Dry Detention	Public	AC	0.10	Seaview St and Estero Blvd
DDA2-4	Dry Detention	Public	AC	0.10	Connect. N of Estero, W of Baptist Church Property
DDA2-5	Dry Detention	Public	AC	0.08	Connect. N of Estero, W of Baptist Church Property
DDA2-3	Dry Detention	Public	AC	0.04	Connect. N of Estero, W of Baptist Church Property
DRA1-2	Dry Retention	Public	AC	0.07	End of Bay Road
DRA1-1	Dry Retention	Public	AC	0.12	Lovers Lane and Estero Blvd, Wachovia
PPA2-1	Pervious Pavement	Private	AC	0.22	St Peters Dr, on Lutheran Church Property

APPENDIX F

Cost Estimates for Alternative 2

Table F-1: Cost Estimates for Alternative 2

Area 1, Alternative 2a: Fully Connect to Existing Stormwater System

Item	Unit	Quantity	Unit	Total
12"x18" elliptical RCP	FT	200	$50	$10,000
14"x23" elliptical RCP	FT	100	$65	$6,500
19"x30" elliptical RCP	FT	300	$80	$24,000
Catch Basins	EA	5	$5,000	$25,000
Utility Relocation	LS	1	$10,000	$10,000
Exfiltration	LF	278	$195	$54,300
Swale/sodding/seed	CY	52	$12	$700
Dry Detention (Private)	CY	490	$10	$5,000
Dry Detention (Public)	CY	250	$10	$3,000
Dry Retention	CY	50	$10	$1,000
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	790	$2	$2,000
Sun Tree Box	EA	2	$35,000	$70,000
Pervous Pavement Parking Lot	SY	0	$100	$0
Pavement Rem/Base[1]	SY	267	$12	$4,000
Asphaltic Concrete	TN	20	$125	$3,000
Silt Fences	FT	10,000	$1	$10,000
Mobilization	LS	1	$20,000	$20,000
Traffic Control	LS	1	$20,000	$20,000
			Sub Total	$284,000
			Contingency (30%)	$86,000
			Sub Total	$370,000
			Engineering, Survey, Permitting (15%)	$56,000
			Total	**$430,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table F-1: Cost Estimates for Alternative 2

Area 1, Alternative 2b: Fully Connect to Existing Stormwater System				
Item	**Unit**	**Quantity**	**Unit**	**Total**
12"x18" elliptical RCP	FT	300	$50	$15,000
14"x23" elliptical RCP	FT	200	$65	$13,000
19"x30" elliptical RCP	FT	300	$80	$24,000
Catch Basins	EA	5	$5,000	$25,000
Utility Relocation	LS	1	$10,000	$10,000
Exfiltration	LF	278	$195	$54,300
Swale/sodding/seed	CY	52	$12	$700
Dry Detention (Private)	CY	490	$10	$5,000
Dry Detention (Public)	CY	250	$10	$3,000
Dry Retention	CY	50	$10	$1,000
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	790	$2	$2,000
Sun Tree Box	EA	2	$35,000	$70,000
Pervous Pavement Parking Lot	SY	0	$100	$0
Pavement Rem/Base[1]	SY	267	$12	$4,000
Asphaltic Concrete	TN	20	$125	$3,000
Silt Fences	FT	10,000	$1	$10,000
Mobilization	LS	1	$20,000	$20,000
Traffic Control	LS	1	$20,000	$20,000
			Sub Total	$295,000
			Contingency (30%)	$89,000
			Sub Total	$384,000
			Engineering, Survey, Permitting (15%)	$58,000
			Total	**$450,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table F-1: Cost Estimates for Alternative 2

Area 2, Alternative 2: Fully Connect to Existing Stormwater System

Item	Unit	Quantity	Unit	Total
12"x18" elliptical RCP	FT	2,984	$50	$149,200
14"x23" elliptical RCP	FT	750	$65	$48,800
19"x30" elliptical RCP	FT	0	$80	$0
Catch Basins	EA	12	$5,000	$60,000
Utility Relocation	LS	1	$20,000	$20,000
Exfiltration	LF	1,335	$195	$260,400
Swale/sodding/seed	CY	253	$12	$3,100
Dry Detention (Private)	CY	470	$10	$5,000
Dry Detention (Public)	CY	400	$10	$4,000
Dry Retention	CY	0	$10	$0
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	870	$2	$2,000
Sun Tree Box	EA	7	$35,000	$245,000
Pervous Pavement Parking Lot	SY	550	$100	$55,000
Pavement Rem/Base[1]	SY	1,660	$12	$20,000
Asphaltic Concrete	TN	124	$125	$16,000
Silt Fences	FT	20,000	$1	$20,000
Mobilization	LS	1	$50,000	$50,000
Traffic Control	LS	1	$50,000	$50,000
			Sub Total	$1,024,000
			Contingency (30%)	$308,000
			Sub Total	$1,332,000
			Engineering, Survey, Permitting (15%)	$200,000
			Total	**$1,600,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table F-1: Cost Estimates for Alternative 2

Area 3, Alternative 2: Fully Connect to Existing Stormwater System				
Item	**Unit**	**Quantity**	**Unit**	**Total**
12"x18" elliptical RCP	FT	590	$50	$29,500
14"x23" elliptical RCP	FT	120	$65	$7,800
19"x30" elliptical RCP	FT	0	$80	$0
Catch Basins	EA	7	$5,000	$35,000
Utility Relocation	LS	1	$10,000	$10,000
Exfiltration	LF	530	$195	$103,400
Swale/sodding/seed	CY	181	$12	$2,200
Dry Detention (Private)	CY	420	$10	$5,000
Dry Detention (Public)	CY	0	$10	$0
Dry Retention	CY	0	$10	$0
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	420	$2	$1,000
Sun Tree Box	EA	3	$35,000	$105,000
Pervous Pavement Parking Lot	SY	0	$100	$0
Pavement Rem/Base[1]	SY	316	$12	$4,000
Asphaltic Concrete	TN	24	$125	$3,000
Silt Fences	FT	10,000	$1	$10,000
Mobilization	LS	1	$20,000	$20,000
Traffic Control	LS	1	$20,000	$20,000
			Sub Total	$371,000
			Contingency (30%)	$112,000
			Sub Total	$483,000
			Engineering, Survey, Permitting (15%)	$73,000
			Total	**$560,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

APPENDIX G

Cost Estimates for Alternative 3

Table G-1: Cost Estimates for Alternative 3

Area 1, Alternative 3a: Fully Connect to Existing Stormwater System

Item	Unit	Quantity	Unit	Total
12"x18" elliptical RCP	FT	270	$50	$13,500
14"x23" elliptical RCP	FT	100	$65	$6,500
19"x30" elliptical RCP	FT	855	$80	$68,400
Abandon/remove existing pipe	FT	440	$5	$2,200
Catch Basins	EA	8	$5,000	$40,000
Utility Relocation	LS	1	$20,000	$20,000
Exfiltration	LF	278	$195	$54,300
Swale/sodding/seed	CY	52	$12	$700
Dry Detention (Private)	CY	490	$10	$5,000
Dry Detention (Public)	CY	250	$10	$3,000
Dry Retention	CY	50	$10	$1,000
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	790	$2	$2,000
Sun Tree Box	EA	2	$35,000	$70,000
Pavement Rem/Base[1]	SY	544	$12	$7,000
Asphaltic Concrete	TN	41	$125	$6,000
Silt Fences	FT	10,000	$1	$10,000
Mobilization	LS	1	$20,000	$20,000
Traffic Control	LS	1	$20,000	$20,000
			Sub Total	$365,000
			Contingency (30%)	$110,000
			Sub Total	$475,000
			Engineering, Survey, Permitting (15%)	$72,000
			Total	**$550,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table G-1: Cost Estimates for Alternative 3

Area 1, Alternative 3b: Fully Connect to Existing Stormwater System

Item	Unit	Quantity	Unit	Total
12"x18" elliptical RCP	FT	370	$50	$18,500
14"x23" elliptical RCP	FT	100	$65	$6,500
19"x30" elliptical RCP	FT	555	$80	$44,400
Abandon/remove existing pipe	FT	440	$5	$2,200
Catch Basins	EA	8	$5,000	$40,000
Utility Relocation	LS	1	$20,000	$20,000
Exfiltration	LF	278	$195	$54,300
Swale/sodding/seed	CY	52	$12	$700
Dry Detention (Private)	CY	490	$10	$5,000
Dry Detention (Public)	CY	250	$10	$3,000
Dry Retention	CY	50	$10	$1,000
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	790	$2	$2,000
Sun Tree Box	EA	2	$35,000	$70,000
Pavement Rem/Base[1]	SY	456	$12	$6,000
Asphaltic Concrete	TN	34	$125	$5,000
Silt Fences	FT	10,000	$1	$10,000
Mobilization	LS	1	$20,000	$20,000
Traffic Control	LS	1	$20,000	$20,000
			Sub Total	$344,000
			Contingency (30%)	$104,000
			Sub Total	$448,000
			Engineering, Survey, Permitting (15%)	$68,000
			Total	**$520,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table G-1: Cost Estimates for Alternative 3

Area 2, Alternative 3: Fully Connect to Existing Stormwater System

Item	Unit	Quantity	Unit	Total
12"x18" elliptical RCP	FT	440	$50	$22,000
14"x23" elliptical RCP	FT	1,104	$65	$71,800
19"x30" elliptical RCP	FT	3,842	$80	$307,400
Abandon/remove existing pipe	FT	1,300	$5	$6,500
Catch Basins	EA	15	$5,000	$75,000
Utility Relocation	LS	1	$20,000	$20,000
Exfiltration	LF	1,335	$195	$260,400
Swale/sodding/seed	CY	253	$12	$3,100
Dry Detention (Private)	CY	470	$10	$5,000
Dry Detention (Public)	CY	400	$10	$4,000
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	1,123	$2	$3,000
Sun Tree Box	EA	7	$35,000	$245,000
Pervous Pavement Parking Lot	SY	550	$100	$55,000
Pavement Rem/Base[1]	SY	2,394	$12	$29,000
Asphaltic Concrete	TN	180	$125	$23,000
Silt Fences	FT	20,000	$1	$20,000
Mobilization	LS	1	$60,000	$60,000
Traffic Control	LS	1	$60,000	$60,000
			Sub Total	$1,286,000
			Contingency (30%)	$386,000
			Sub Total	$1,672,000
			Engineering, Survey, Permitting (15%)	$251,000
			Total	**$1,930,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

Table G-1: Cost Estimates for Alternative 3

Area 3, Alternative 3: Fully Connect to Existing Stormwater System

Item	Unit	Quantity	Unit	Total
12"x18" elliptical RCP	FT	0	$50	$0
14"x23" elliptical RCP	FT	600	$65	$39,000
19"x30" elliptical RCP	FT	720	$80	$57,600
Abandon/remove existing pipe	FT	600	$5	$3,000
Catch Basins	EA	9	$5,000	$45,000
Utility Relocation	LS	1	$20,000	$20,000
Exfiltration	LF	530	$195	$103,400
Swale/sodding/seed	CY	62	$12	$800
Dry Detention (Private)	CY	100	$10	$1,000
Dry Detention (Public)	CY	555	$10	$6,000
Clearing & Grubbing	AC	1	$15,000	$15,000
Sodding	CY	655	$2	$2,000
Sun Tree Box	EA	3	$35,000	$105,000
Pavement Rem/Base[1]	SY	587	$12	$8,000
Asphaltic Concrete	TN	44	$125	$6,000
Silt Fences	FT	10,000	$1	$10,000
Mobilization	LS	1	$30,000	$30,000
Traffic Control	LS	1	$30,000	$30,000
			Sub Total	$482,000
			Contingency (30%)	$145,000
			Sub Total	$627,000
			Engineering, Survey, Permitting (15%)	$95,000
			Total	**$730,000**

Notes:

1. Estimate of cost is in $ 2009.
2. Cost are for stormwater facilities and do not include water, sewer or other utility repairs/replacements.
3. Estimate of cost does not include property acquisition or easments.
4. Does not include potential hazardous material remediation or wetlands mitigation.

APPENDIX H

Example Ordinances

Town of Fort Myers Beach
Stormwater Master Plan

LPA Meeting Handout

October 20, 2008
Fort Myers Beach Council Chambers
10:30 am

As part of the ongoing Stormwater Mast Plan, this handout is provided by CDM to summarize ordinances currently in place that limit impervious surfaces on residential lots for coastal communities. The following table provides key elements of the ordinances reviewed. For each of the municipalities listed in the table, the following pages provide the related ordinances as listed at: http://www.municode.com/.

Summary of Ordinances Limiting Imperviousness on Residential Lots for Coastal Communities

Municipality	Residential Impervious Limits	Other Notes
St. Augustine Beach, FL	40% and 50% for low and medium density residential respectively	Porous paving material does not count as impervious
Siesta Key, Sarasota County, FL	50% for any residential type	None
Key West, FL	40% and 50% for low and medium density residential respectively	Porous material may be used subject to approval by city.
Neptune Beach, FL	50%; 35% for apartments complexes	Semi-pervious surfaces and water detention systems encouraged and not counted as impervious; Higher percentages allowed if runoff calculations sealed by P.E. indicate no net increase in runoff.
Atlantic Beach, FL	50% for any residential type	Does not include roof and balcony overhangs; does not include swimming pools; Pervious paving areas only count as 50% towards impervious area
Satellite Beach, FL	50% plus additional 10% for pavers	Swimming pools exempt
Kure Beach, NC	36% for all areas within 575 feet designated as shell fishing waters or critical water supply watershed	None
Surfside Beach, SC	40, 45, and 50% for low, medium and high density residential respectively	None

St. Augustine Beach, Fl

Sec. 6.01.02. Impervious surface coverage.

A. *Generally.* Impervious surface on a development site shall not exceed the ratios provided in the table in paragraph D. of this section.

B. *Ratio calculation.* The impervious surface ratio is calculated by dividing the total impervious surface by the gross site area.

C. *Alternative paving materials.* If porous paving materials are used, then the area covered with porous paving materials shall not be counted as impervious surface.

D. *Table of impervious surface ratios.*

TABLE INSET:

Land Use District	Maximum Impervious Surface Ratio 1
Low density residential	0.40
Medium residential	0.50
High density residential	0.70
Commercial	0.70

1 The maximum impervious surface ratio is given for each district, regardless of the type of use proposed and allowable pursuant to Article III.

(Ord. No. 91-7, § 2)

Sec. 2.00.00. Definitions as used in this Appendix.

Impervious Surface--A surface that has been compacted or covered with a layer of material so that it is highly resistant to infiltration by water. It includes, but is not limited to, semi-impervious surfaces such as compacted clay, as well as most conventionally surfaced streets, roofs, sidewalks, parking lots, swimming pools and other similar structures.

Sarasota County, FL (Siesta Key District)

4.10. Special Purpose Overlay Districts.
4.10.4. *Siesta Key Overlay District (SKOD).*

i. *Maximum Impervious Coverage on a Lot.* The maximum impervious coverage in any residential district, including but not limited to RE/SKOD, RSF/SKOD, or RMF/SKOD, shall be 50 percent of the area of a lot or parcel. For the purpose of this section, impervious coverage shall include roof structures, swimming pools and pool decks, as well as concrete, asphalt, pavers and other surfaces that substantially prevent water from penetrating into the ground. This does not include grass, shell or other surfaces that allow water to substantially penetrate into the ground. Nonconforming lots of record zoned RMF shall also comply with Section 8.4.5

Key West, FL

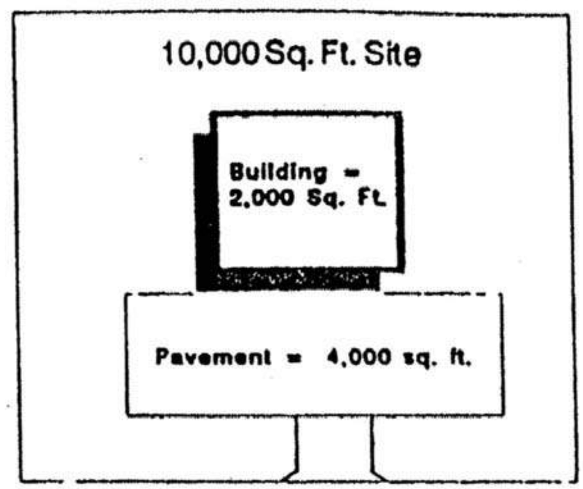
Sec. 122-1143. Impervious surface requirements for all uses.

(a) *Definition; scope.* The term " impervious surface" is defined as that portion of the land which is covered by buildings, pavement, nonporous fill, or other cover through which water cannot penetrate. The impervious surface ratio requirement controls the intensity of development, by restricting the amount of the land covered by any type of impervious surface.

(b) *Calculation.* The impervious surface ratio (ISR) is calculated for the gross site by dividing the total impervious surface by the gross site area. Waterbodies are impervious and shall be included as such in the ISR calculation.

ISR = Total Impervious Surface/Total Lot Area = 2,000 + 4,000/10,000 = 60%

Impervious Surface Ratio (ISR) Illustration



Cluster development or other site design alternatives may result in individual lots exceeding the ISR, while other lots may be devoted entirely to open space. The city may require, as a condition of approval, deed restrictions or covenants which guarantee the maintenance of such open space in perpetuity. The ISR requirement shall not be bypassed or reduced. However, the intent is to allow maximum flexibility through calculating ISR on the gross site, and not on a lot-by-lot basis.

(c) *Use of porous material.* Porous concrete, porous asphalt, turf block, or similar materials may be used subject to approval of the city engineer.

(d) *Compliance with ISR.* All proposed development shall comply with the standards given in the table of impervious surface ratios in the table in section 122-1151. Where a proposed development is donating or dedicating land based on a plan approved by the city, the gross site before dedication or donation shall be used to calculate ISR. This does not relieve the applicant from providing all required on-site buffers, landscaping, stormwater management areas, minimum, and other required project amenities.

(Ord. No. 97-10, § 1(2-5.9(C)), 7-3-1997)

Sec. 122-1151. Size and dimension.
Size and dimension regulations for zoning districts shall be as follows:

TABLE OF SIZE AND DIMENSION REGULATIONS

District	Minimum Area (sq. ft.)	Minimum Width (sq. ft.)	Minimum Depth (sq. ft.)	Impervious Surface Ratio	Maximum Building Coverage
Residential					
LDR-C low density residential coastal	1 acre	100	100	50	40
MDR-C medium density residential coastal 4	1/2 acre	70 5	100	50	40
SF single-family residential 4	6,000 7 1/2 acre 4	50 100	100 100		
MDR medium density residential	1/2 acre 1 acre	70 5 80	100 100	50 60	35 40
HDR high density residential	1 acre 1 acre	70 5 80	100	60	40
Commercial					
CL limited commercial	10,000	70	100	60	40
CG general commercial	15,000	150	100	60	40
CT tourist commercial	30,000	150	100	60	40
RO residential/office	10,000	70	100	60	40
PRD planned redevelopment/development 10	1 acre	n/a	n/a	60	40
HMDR historic medium density residential	4,000	40	90	60	40
HHDR historic high density residential	4,000	40	90	60	50
HRCC-1 historic commercial core, Duval GS	4,000	40	100	70	50
HRCC-2 historic commercial core, KW Bight 12	5,000	50	100	60 12	50
HRCC-3 historic commercial core Duval OS	4,000	40	90	60	50
HNC-1 historic neighborhood commercial	4,000	40	100	60	50
HNC-2 historic neighborhood commercial	4,000	40	90	60	40
HNC-3 historic neighborhood commercial	4,000	40	90	60	40
HCT historic commercial tourist 17	10,000	75	100	70	50
HRO historic residential office	5,000	50	100	60	50
HPS historic public/semipublic service	5,000	50	100	50	40
HPRD historic planned redevelopment/development	1 acre	50	100	50	40
PS public/semipublic service	6,000	50	100	50	40
A airport	n/a	n/a	n/a	n/a	n/a
C conservation	10 acres	n/a	n/a	5	5

Neptune Beach, FL

Sec. 27-238. Maximum lot coverage.

(a) The impervious surface on any lot, or parcel of land, shall not exceed the maximum area as provided for below, and for purposes of calculation, shall include all impervious areas, such as pool areas, hot tubs, and driveways.

(1) R-1 district: Fifty (50) percent of gross site area.

(2) R-2 district: Fifty (50) percent of gross site area.

(3) R-3 district: Fifty (50) percent of gross site area.

(4) R-4 district: Fifty (50) percent of gross site area.

(5) R-5 district: For apartment complexes, thirty-five (35) percent of gross site area. For single family dwellings, fifty (50) percent of gross site area.

(6) C-1 district: Sixty (60) percent of gross site area unless otherwise specified in the table 27-229-1.

(7) C-2 district: Seventy (70) percent of gross site area unless otherwise specified in the table 27-229-1.

(8) C-3 district: Seventy-five (75) percent of gross site area unless otherwise specified in the table 27-229-1.

(9) CBD district: Eighty-five (85) percent of gross site area.

(10) Conservation district: Twenty-five (25) percent of gross site area.

(b) Semi-pervious surfaces, pavers, and engineered water detention systems are encouraged in all zoning districts and shall be credited with a percentage of the covered area, as determined by the building official or licensed professional engineer, using area and volume calculations. The techniques or systems used for a credited area must be installed for long-term effect.

If the applicant desires to increase the impervious area beyond the percent coverage prescribed in this section, drainage runoff calculations shall be provide that indicate no increase in runoff between the pre-construction and post construction condition. This calculation shall be prepared, signed, and sealed by a licensed professional engineer, registered in the State of Florida.

(c) Additionally, all stormwater management requirements of the St. Johns River Water Management District shall be met.

(Ord. No. 2004-10, § 1, 10-4-04; Ord. No. 2006-13, § 3, 7-10-06)

Atlantic Beach, FL

Sec. 24-103.5. Residential, single-family--Large lot districts. (RS-L)
Sec. 24-105. Residential, single-family districts (RS-2).
Sec. 24-106. Residential general, two-family districts (RG-1 and RG-1A).
Sec. 24-107. Residential general, multi-family (RG-2 and RG-3).
Sec. 24-108. Residential mobile home districts (RMH).

(f) *Building restrictions.* Additional building restrictions within the RS-L zoning districts shall be as follows.

(1) *Maximum impervious surface:* Fifty (50) percent.

Sec. 24-109. Commercial, professional and office (CPO).

(g) *Building restrictions.* The building restrictions within the CPO zoning districts shall be as follows.

(1) *Maximum impervious surface:* Seventy (70) percent. The maximum impervious surface shall not apply to infill development or redevelopment of previously developed sites; however, required landscaping shall be provided in accordance with division 8 of this chapter. Stormwater management requirements shall apply to infill development and to redevelopment projects involving exterior site changes.

Sec. 19-7. Construction of driveways in rights-of-way.

The construction of a new driveway in the city's right-of-way, or the modification of an existing driveway in a right-of-way, shall require a construction permit within city rights-of-way and easements. Said permit shall be issued subject to the following requirements:

(a) The proposed driveway shall not create more than fifty (50) percent impervious area within the right-of-way.

Sec. 24-17. Definitions.

Impervious surface shall mean those surfaces that prevent the entry of water into the soil. Common impervious surfaces include, but are not limited to, rooftops, sidewalks, patio areas, driveways, parking lots, and other surfaces made of concrete, asphalt, brick, plastic, or any surfacing material with a base or lining of an impervious material. Wood decking elevated two or more inches above the ground shall not be considered impervious provided that the ground surface beneath the decking is not impervious. Pervious areas beneath roof or balcony overhangs that are subject to inundation by stormwater and which allow the percolation of that stormwater shall not be considered impervious areas. Swimming pools shall not be considered as impervious surfaces because of their ability to retain additional rainwater, however, decking around a pool may be considered impervious depending upon materials used. Surfaces using pervious concrete or other similar open grid paving systems shall be calculated as fifty (50) percent impervious surface, provided that no barrier to natural percolation of water shall be installed beneath such material. Open grid pavers must be installed on a sand base, without liner, in order to be considered fifty (50) percent impervious. Solid surface pavers. (e.g., brick or brick appearing pavers as opposed to open grid pavers) do not qualify for any reduction in impervious area, regardless of type of base material used.

Unless otherwise and specifically provided for in these land development regulations, or within another ordinance, or by other official action establishing specific impervious surface limits for a particular lot or development project, the fifty-percent impervious surface limit shall be the maximum impervious surface limit for all new residential development and redevelopment. In such cases where a previously and lawfully developed residential lot or development project exceeds the fifty-percent limit, redevelopment or additions to existing residential development shall not exceed the preconstruction impervious surface limit, provided the stormwater and drainage requirements of section 24-66 are met.

Satellite Beach, FL

Sec. 30-407. R-1A, single-family residential district.
Sec. 30-408. R-1, single-family residential district.
Sec. 30-409. R-2, single-family residential district.
Sec. 30-410. R-3, single-family residential district.
Sec. 30-411. R-4, single-family residential district.
Sec. 30-412. R-5, single-family residential district.
Sec. 30-413. RM-1, two-family residential district.

(d) *Property development regulations.* Property development regulations are as follows:
(6) Maximum lot coverage: 50 percent.
(7) Maximum impervious area: 50 percent plus an additional ten percent for pavers.
Exemption: Swimming pools are exempt from the requirements for impervious area percentages.

Sec. 30-414. RM-2, multiple-family residential district.
Sec. 30-415. RM-3, residential-mixed use district.

(d) *Property development regulations.* Property development regulations are as follows:
(6) Maximum lot coverage: 30 percent.
(7) Maximum impervious area: 70 percent
Exemption: Swimming pools are exempt from the requirements for impervious area percentages.

Sec. 30-416. C, commercial district.

(e) *Property development regulations.* Property development regulations are as follows:
(5) Maximum lot coverage: 70 percent.
(6) Maximum impervious area: 70 percent.

Kure Beach, NC

302 IMPERVIOUS SURFACE REQUIREMENTS .

(A) Setback requirement

All impervious surfaces, except for roads, paths, and water dependent structures, shall be located at least 30 feet landward of all perennial and intermittent surface waters.

A perennial or intermittent surface water shall be deemed present if the feature is shown on either the most recent version of the soil survey map prepared by the Natural Resources Conservation Service of the United States Department of Agriculture (USDA) or the most recent complete version of the 1:24,000 scale (7.5 minute) quadrangle topographic maps prepared by the United States Geologic Survey (USGS). An exception to this requirement may be allowed when surface waters are not present in accordance with the provisions of 15A NCAC 2B .0233 (3)(a) or similar site-specific determination made using *Division*-approved methodology.

(B) Land draining to shellfish waters

All development activities that are located within 575 feet of waters designated by the Environmental Management Commission as shellfishing waters shall be limited to a maximum impervious surface density of 36 percent.

(C) Development in Critical Area of Water Supply Watersheds

All development activities that are located within the area designated by the Environmental Management Commission as a Critical Area of a Water Supply Watershed shall be limited to a maximum impervious surface density of 36 percent.

Surfside Beach, NC

Section 17-277. Impervious Coverage in R-1, R-2, and R-3 districts.

On any lot within a residential district the maximum impervious coverage shall not exceed the percentage of the total area of such lot as set forth below:

R-1 District Forty Percent (40.0%)
R-2 District Forty-five Percent (45.0%)
R-3 District Fifty Percent (50.0%)