# City of North Port

**Professional Engineering Services for the**
**Big Slough Flood Reduction Study**

**Agreement #2016-48**
**Department of Public Works**

## STORMWATER MANAGEMENT PLAN

**February 2019**

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water resources and civil engineering

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# Big Slough Flood Reduction Study

## STORMWATER MANAGEMENT PLAN REPORT

The purpose of this report is to present a conceptual stormwater management master plan for drainage system improvements covering flood-prone areas in the Big Slough Watershed within the City of North Port. This report expands upon the North Port/Big Slough Watershed Management Program project (Ardaman & Associates, Inc., 2003-2014) and includes, as appendices, copies of selected reports including interim project reports by DeLoach Engineering Science, PLLC (DES) that have documented progress toward development of a viable stormwater management plan. Elements carried over from prior reports, including text, figures, and tables, have been updated to include new and better information and, where different, supersede information contained in those prior reports. A set of project deliverables, including updated geodatabase, collected field data, model input and output data, and digital library of prior reports and presentations, accompanies this report. These materials provide information in support of a request for conceptual approval of a Statewide Environmental Resource Permit (SWERP) application.

## INTRODUCTION

The Big Slough Flood Reduction Study, which was cooperatively funded by and between the City of North Port and the Southwest Florida Water Management District (SWFWMD), was performed for the Department of Public Works under City of North Port Agreement #2016-48. Notice to Proceed to conduct the flood study was issued to DES on October 13, 2016. Per the Project Plan (Appendix A), DES evaluated feasibility and cost effectiveness of various solutions intended to reduce flooding in the City within the Big Slough Watershed. The Big Slough Flood Reduction Feasibility Study was comprised of two distinct parts:

- Part 1 was to evaluate localized flooding along Myakkahatchee Creek in two specific flood-prone areas and recommend construction projects or other methods to mitigate flooding. The I-75 and Jockey Club areas along Myakkahatchee Creek were initially designated for this work. However, collection and conveyance system improvements conceived and performed by the City of North Port stormwater department proved effective at reducing flooding within the Jockey Club area prior to this project getting underway. Consequently, the nearby flood-prone Dorothy Avenue area was instead targeted along with the I-75 area for Part 1 analysis and stormwater planning.
- Part 2 was to evaluate preliminary regional concepts including, but not limited to, those previously developed by others, with the intent to advance large scale conceptual solutions to mitigate flooding throughout the City of North Port.

Localized solutions to recurrent flooding were found to be ineffective in the selected Part 1 project areas. Larger-scale solutions thus became the focus of all flood reduction planning. To the extent that the proposed improvements can be implemented by the City independent of adjacent landowners, the stormwater plan meets Part 1 objectives. Plan components which require authorizations from adjacent land owners/managers will be implemented over a longer period of time and satisfy Part 2 objectives.

**Prior Work Completed**

The Big Slough watershed and City of North Port stormwater management system have been the subjects of prior investigations. Reference has been made by DES to the following reports:

- North Port Water Control District Phase I Report, Inventory and Approach to Analysis, for General Development Utilities, Inc., by R. D. Ghioto & Associates, Inc. (1984) presents data and information that describes NPWCD facilities, their function and condition.
- City of North Port Big Slough Watershed Study Phase III Task 2 Final Report, Stormwater Management Master Plan, by Camp, Dresser & McKee, Inc. (1993) presents conceptual solutions for flooding as well as assessments of potential water supplies and of nonpoint source pollution and describes a stormwater management plan to reduce flooding during extreme storm events.
- Watershed Management Program (WMP) Consulting Services in the Big Slough Watershed (K883), Best Management Practices (BMP) Analysis Final Report, for Southwest Florida Water Management District and City of North Port, by Ardaman & Associates, Inc. (2014) evaluates BMP alternatives to address flooding based on effectiveness, permittability, and economic viability.

The 1993 Stormwater Management Master Plan by CDM was partially implemented, providing increased local conveyance through replacement of culvert structures at four locations. Those improvements are accounted for in more recent model development. Other plan components were not completed including those for storage and flow diversion, apparently due to regulatory and financial constraints of that time.

Two important reports from the Ardaman WMP project are reproduced in Appendix B and Appendix C. Under the WMP project, an “existing condition” (2004 land use) model was developed and six regional BMP alternatives evaluated that could potentially reduce flooding through combinations of conveyance improvements, stormwater management storage areas, flood proofing, and flow diversion. Although the regional alternatives developed under the WMP project were not incorporated into a specific plan for implementation, the work provided insight to the system’s hydraulic response and BMP limitations.

Additionally, hydraulic performance and effects of potential local conveyance improvements were analyzed under the WMP project at the following sites:

- R-36 Canal at I-75
- Myakkahatchee Creek at I-75
- R-36 Canal at Tropicaire Boulevard
- Myakkahatchee Creek at Tropicaire Boulevard
- WCS-162 location on the R-36 Canal (possibility of adding gates to the existing structure)
- Price Boulevard drainage system (five alternative sets of improvements)

Importantly, BMP evaluation results were compared to the 1-Day 100-Year existing condition model only.

The current Big Slough Flood Reduction Study builds upon all prior work to advance previously developed and new concepts to achieve flood mitigation in areas where residential structures are shown as flooding in the recently updated Flood Insurance Rate Maps (FIRMs). Performance of proposed improvements will be considered relative to lesser storm events from mean annual up to and including the 100-year storm event to evaluate cost and benefit relationships across a broader range of conditions.

## PROJECT AREA DESCRIPTION

The Big Slough Watershed (Figure 1) is located in southeastern Sarasota County and is tributary to the Myakka River. Portions of the City of North Port located east of the Myakka River are within the southern portion of the Big Slough Watershed. The Big Slough Canal (also called Myakkahatchee Creek in its lower reaches) passes from north to south and receives inflows from numerous waterways within the City.

Discharge of waters from the City and upstream offsite areas occurs primarily via Myakkahatchee Creek as it passes beneath US 41. Lesser discharges occur southward through several open weirs, drop structures, and culverts along Hillsborough Boulevard into waterways which continue through Port Charlotte. Several of those downstream waterways are controlled by structures while others are tidally influenced.

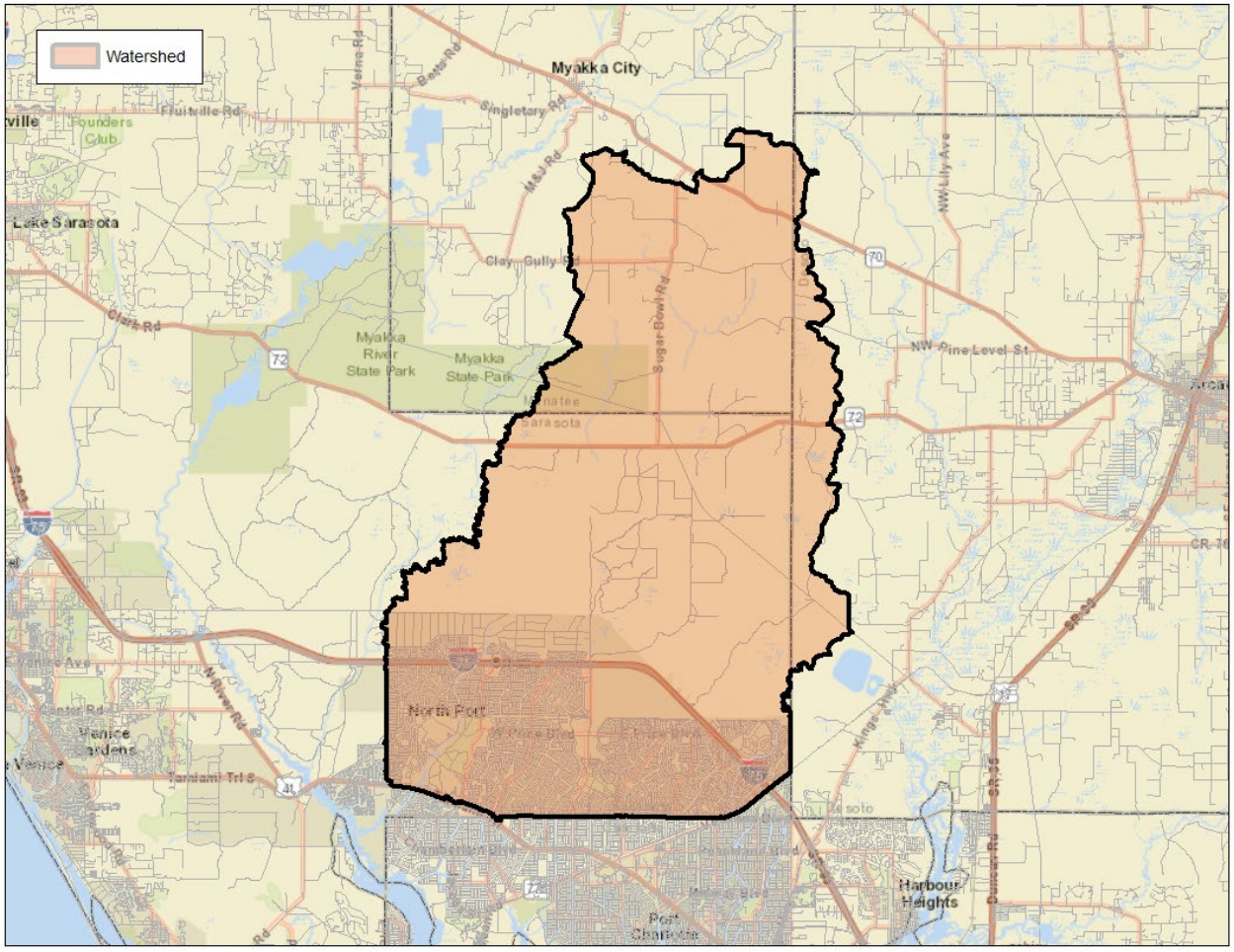


**Figure 1: The Big Slough Watershed**

## Soil Conditions

Figure 2 and Figure 3 illustrate the spatial distribution of hydrologic soil groups in the I-75 and Dorothy Avenue project areas, respectively, based upon Soil Surveys published by the U.S. Department of Agriculture, Natural Resource Conservation Service (USDA-NRCS).

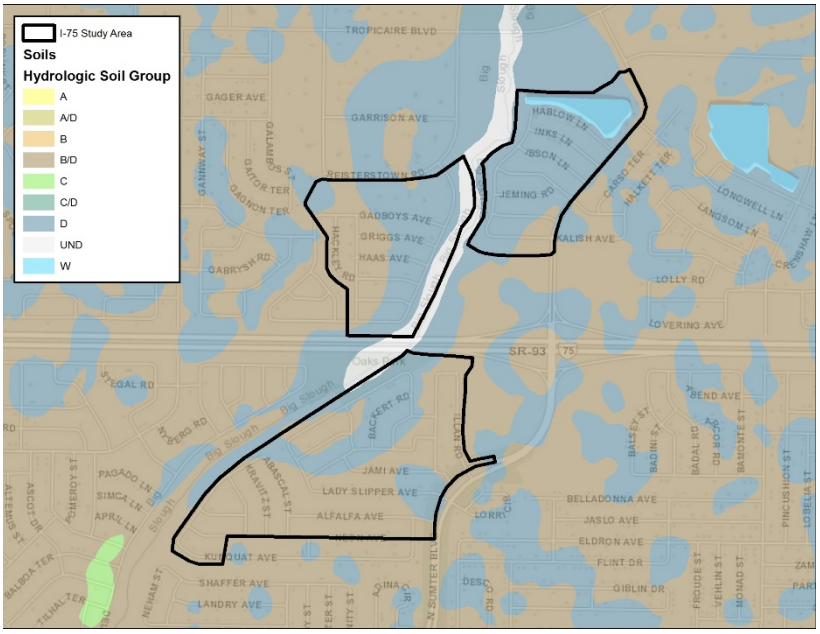


**Figure 2: Hydrologic Soil Groups, I-75 Area**

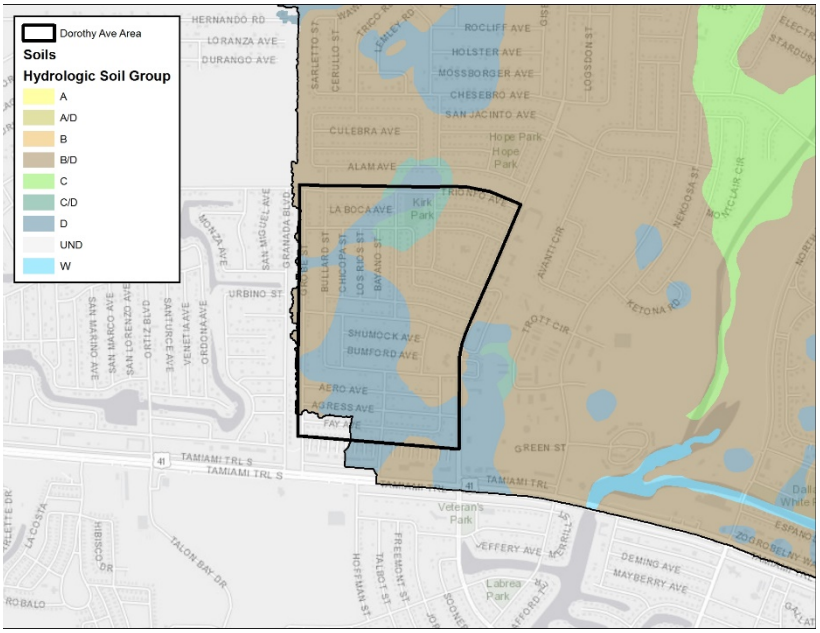


**Figure 3: Hydrologic Soil Groups, Dorothy Avenue Area**

Low permeability, hydric soils associated with depressional areas and floodplains are predominant in areas immediately adjacent to Myakkahatchee Creek and the Big Slough canal and throughout much of the Dorothy Avenue area. These soils are classified as being in Hydrologic Soil Group (HSG) "D", exhibiting low infiltration rates and available storage capacity. These soils are located in areas that have historically been prone to flooding.

Soils throughout much of the watershed fall into the dual HSG A/D, B/D, and C/D categories. In developed areas where extensive ditching may keep surficial aquifer water levels low, these soils may provide higher infiltration rates and maintain greater soil storage capacity than occur naturally. Water level control structures which maintain higher water level in canals, however, may reverse this effect, resulting in significantly higher runoff potential in these soils. While North Port contains an extensive ditch system, water level control structures maintain higher normal water levels to meet local or regional water supply purposes and/or to mitigate environmental impacts of dewatering.

## Land Use Conditions

Figure 4 and Figure 5 illustrate conditions in the I-75 and Dorothy Avenue areas, respectively. Both are comprised primarily of single-family residential land use, ranging from low to high density, with some commercial areas. Much of the I-75 area is undeveloped, primarily due to frequent and severe flooding.

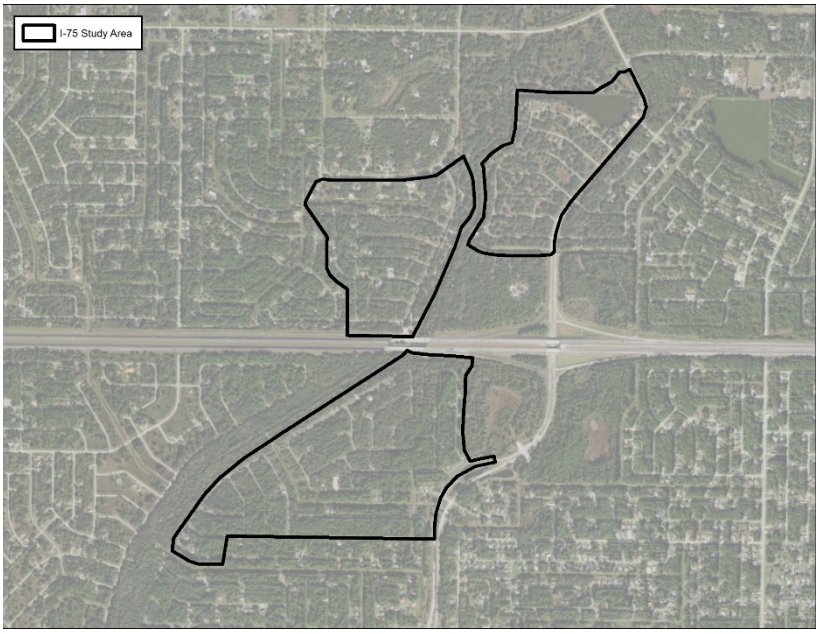


**Figure 4: Land Use (Aerial), I-75 Area**

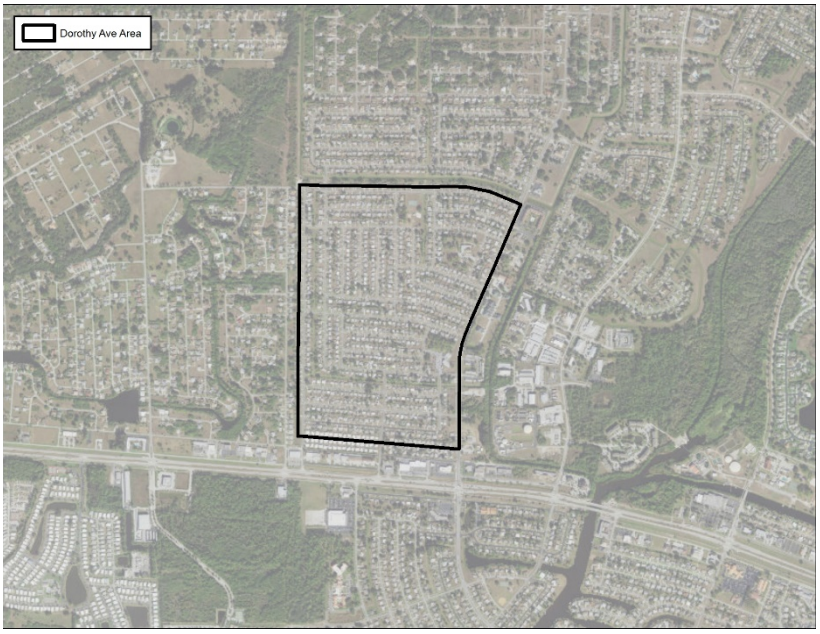


**Figure 5: Land Use (Aerial), Dorothy Avenue Area**

Boundaries of various land use categories were provided by the SWFWMD in GIS format for use in hydrologic model development and are based upon the Florida Land Use Cover and Forms Classification (FLUCCCS) system. Impervious values are derived for various land use categories and are an important factor in determining runoff generation from rainfall.

There is a wide variety of land use and land cover in the Big Slough watershed, including a significant amount of urban land (nearly 40%) which occurs primarily in the lower half of the watershed. A large amount of agricultural land, open range, and conservation lands are in the upper half of the watershed.

The Dorothy Avenue area is one of the earliest constructed residential communities in North Port and is comprised of high-density single family residential land use. The large amount of imperviousness (roads, driveways, and rooftops) generates high runoff rates and volumes, and local flooding results from inadequate collection and conveyance systems. Flooding during large events is exacerbated by overflows from the R-36 canal into R-231 at Trionfo Avenue.

## Historical Flooding

Figure 6 and Figure 7 illustrate the extents of flood inundation in the I-75 and Dorothy Avenue areas, respectively, for the mean annual, 10-year, and 100-year storm events. Flood areas are based on storm event modeling results using the updated existing condition model and mapping on a LiDAR-based terrain.

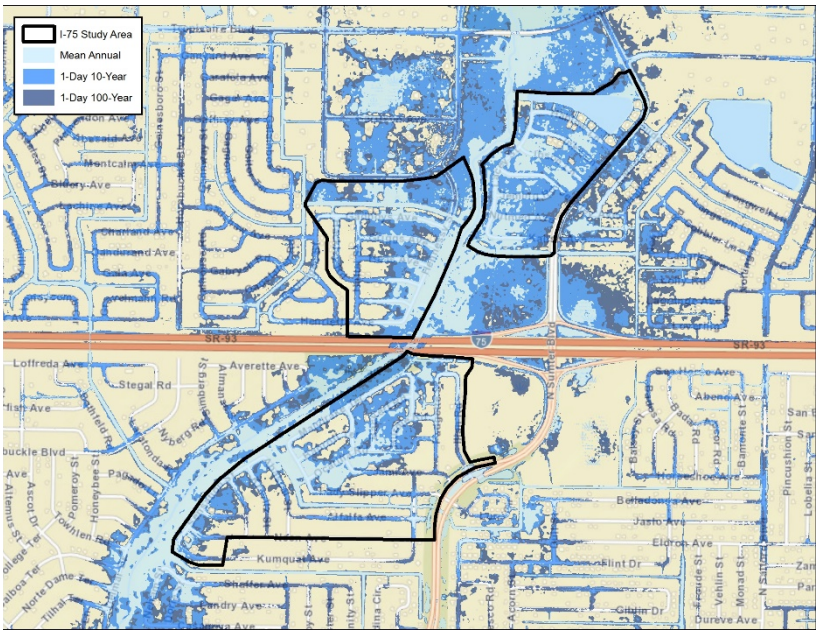


**Figure 6: Flood Inundation Areas, I-75 Area**

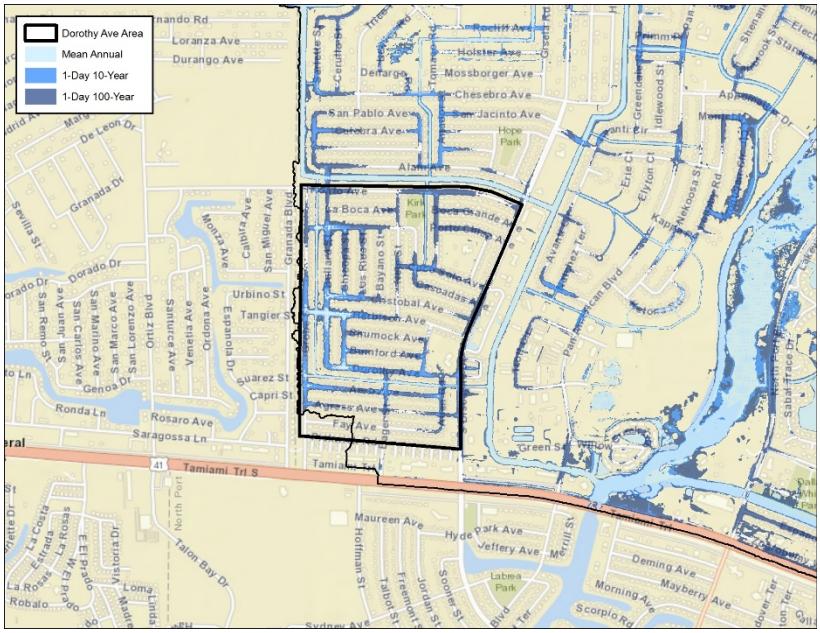


**Figure 7: Flood Inundation Areas, Dorothy Avenue Area**

The City of North Port has often experienced flooding in the Big Slough Watershed, including in the areas near Myakkahatchee Creek north and south of I-75, where the depth and very long duration of flooding has required emergency evacuation of many residents. Moderate to extreme flooding of streets occurs throughout older portions of the City in the vicinity of Dorothy Avenue. The nature of flooding in both of these areas, and particularly around I-75, is such that regional improvements are required to achieve significant and cost-effective flood reduction.

DES and City of North Port staff had opportunities to observe and record flooding conditions on several occasions over the past decade. The mapped inundation areas shown here accurately portray observed flooding under similar historic rainfall conditions.

Simulation results were validated and peer review performed prior to Governing Board approval of the model and flood mapping. The model represents best available information upon which to develop baseline information for design and permitting of drainage improvements in North Port.

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## PREVIOUS BMP EVALUATIONS AND FINDINGS

The Big Slough watershed and City of North Port stormwater management system have been subjects of several prior investigations (Appendix D). Two projects of the past 25 years, in which rigorous evaluations were undertaken to solve recurrent, large-scale flooding problems in the City, are briefly described here.

**Stormwater Management Master Plan (1993)**

As part of the City of North Port's stormwater improvement program, Camp Dresser & McKee, Inc. (CDM) developed a Stormwater Management Master Plan for the Big Slough watershed. The plan, which was conducted in three phases, sought to evaluate flooding problems and determine engineering solutions. The third phase included analyses of various alternatives for flood reduction. Detailed modeling was conducted to assess potential flood reduction afforded by those alternatives. A cost/benefit analysis was also conducted to evaluate and recommend a plan for detailed design.

The Phase III Task 1 interim report (CDM, 1992) outlined conceptual solutions to identified flooding problems. Preliminary stormwater model runs were conducted to provide an initial assessment of each solution's effectiveness in reducing flooding. Results and preliminary cost estimates were presented for each solution. The costs and benefits of each conceptual solution were compared in a matrix. Solutions considered in the preliminary evaluation included the following:

- Acquisition: Purchase of flooded lands would preclude flooding damage by preventing the development of the property but would not prevent roadway flooding.
- Storage: Construction of stormwater detention basins would detain flow from the agricultural areas north of the city and would reduce and attenuate peak inflow rates.
- Diversion: Stormwater flows would be diverted into an adjacent watershed to the west (Deer Prairie Slough), thus reducing flow through the city.
- Conveyance: Increased conveyance capacity of the city's hydraulic system would include excavating existing channels, resizing culverts at stream crossings, cleaning existing channels, and constructing relief channels parallel to existing channels.

Based upon preliminary analyses, purchase of flooded lands was removed from consideration and the three remaining alternatives, and combinations of those alternatives, were examined in more detail.

The Phase III Task 2 Final Report, Stormwater Management Master Plan (CDM, 1993) presents conceptual solutions for flooding as well as assessments of potential water supplies and nonpoint source pollution and describes a stormwater management plan to reduce flooding during extreme events. The set of alternatives evaluated in greater detail included: culvert improvements; stormwater diversion by pumping; stormwater diversion by channel; upstream detention; and relief channel construction. The recommended plan included diversion pumping to the Futrell tract, located west of R-36 and south of I-75, coupled with culvert improvements and construction of a relief channel adjacent to Myakkahatchee Creek. This plan provided the greatest flood protection benefit and could be phased. The 1993 Stormwater Management Master Plan was partially implemented, providing increased local conveyance through replacement of culvert structures at four locations. Those improvements are accounted for in the current Existing Conditions model. Other plan components were not completed including those for storage and flow diversion, apparently due to regulatory and financial constraints.

**Watershed Management Program Consulting Services in the Big Slough Watershed (2014)**

Ardaman & Associates, Inc. evaluated various BMP alternatives to address flooding conditions based on effectiveness, permittability, and economic viability. Under the WMP project, an Existing Conditions model was developed and regional BMP alternatives evaluated to reduce flooding through combinations of conveyance improvements, stormwater management storage areas, flood proofing, and flow diversion.

Simulations were performed of six regional BMP scenarios to evaluate the impact of various large-scale flood mitigation concepts. The benchmark scenario for comparison and performance evaluation was the SWFWMD Governing Board-approved 100-year 24-hour existing condition model.

- Remove structures throughout City of North Port waterways. The objective of evaluating this BMP was to understand primary drainage system capacity assuming no losses due to water control structures or drop structures. Additional connectivity was provided among a few R canals southwest of the I-75 corridor to transferring some of the existing load to less compromised areas. Results indicate flood stage reduction immediately north of Price Blvd and along Bass Point waterway while increasing flooding between S Toledo Blvd and S Sumter Blvd. Also, improvements are observed southwest of I-75 where new canal connectivity was provided. It was noted that structure removal is not feasible due to loss of potable water supply, fish and wildlife habitat, and wetlands.

- Constrain Flow Entering City of North Port at Big Slough Canal. The objective of this BMP was to constrain the volume of water coming from offsite areas through the Big Slough canal prior to entering the north section of the City in the Estates area. The BMP would involve real estate acquisition, maintenance activities, dam construction, and removal of existing hydraulic structures. Results indicate approximately 0.5 feet flood stage reduction near the Big Slough canal from the City's northern boundary to just south of I-75 while flood stages increase approximately 1.0 foot in offsite areas in Carlton Ranch north of the R-36 and R-580 waterways.

- Diversion Alternative. The purpose of this BMP is to divert flows from offsite areas via the existing R-36 canal, by increasing its capacity and improving its hydraulic connectivity with Deer Prairie Slough canal. This BMP would involve construction of new structures, maintenance activities, real estate acquisition, and detailed hydrologic and hydraulic evaluation of the western boundary (Deer Prairie Slough watershed). Results indicate flood reduction throughout the Estates area, along the Big Slough Canal between the R-36 canal and I-75 corridor as well as in the localized area along Big Slough south of I-75, with flood stage reductions between 0.1 foot and 1.0 foot throughout those areas. Impacts of additional flow into Deer Prairie Slough were not considered.

- R-580 Improvements. The purpose of this BMP is to induce additional flows through Creighton waterway by improving conveyance capacity in the R-580 waterway. Results indicate small improvements near Big Slough. However, inducing additional flow through Creighton Waterway causes additional flooding near I-75.

- Increase Capacity on Southern Boundary. The objective of this alternative was to evaluate system response when doubling the southern boundary discharge capacity along the County line into Port Charlotte. The BMP would involve conveyance improvements, construction of new

structures and/ or reconditioning of existing structures, maintenance activities, real estate acquisition, and evaluation of the receiving waters through hydrologic and hydraulic modeling. Results indicate that improvements relative to house flooding were not significant. However, roads experienced a considerable flood reduction between S Sumter Blvd and Atwater Drive. This alternative was evaluated for information purposes only, as it is understood that allowing additional flows into Port Charlotte may not be desirable.

- Upstream Detention Alternative. The objective of this analysis is to examine the effects when attenuating peak flow rates in agricultural areas along the Big Slough canal with a series of new detention facilities. This BMP would involve construction of stormwater management storage areas, maintenance activities, and real estate acquisition. Results indicate relatively small reduction in peak water surface elevations on the order of 0.1 to 0.6 feet along Big Slough. The extent of flooding for this BMP is essentially the same as the existing scenario with few flood reduction areas along the Big Slough canal.

Although the regional alternatives developed under the WMP project were not incorporated into a specific plan for implementation, the work provides valuable insight to the system's hydraulic response and BMP limitations.

Performance of several additional, site-specific BMPs were also evaluated and discussed.

- BMP Evaluation of Four Road Crossings. Simulations were performed to assess hydraulic performance and effects of potential conveyance improvements at: R-36 Canal at I-75, Myakkahatchee Creek at I-75, R-36 Canal at Tropicaire Boulevard, and Myakkahatchee Creek at Tropicaire Boulevard. A systematic evaluation was conducted to understand existing hydraulic behavior at each of the four crossings under various synthetic storm events.

- WCS-162 Evaluation. WCS-162 is located on the R-36 Canal, north of Interstate 75, and immediately upstream of Tropicaire Boulevard. The City opens the gate in anticipation of a storm event to lower the water level in the R-36 canal to minimize potential upstream flooding; otherwise, the gate remains closed. This investigation was performed to determine if adding gates would help draw down the canal more quickly and increase conveyance capacity.

- Price Boulevard LOS Improvements. The objective of this series of BMPs is to mitigate flooding along the stretch of West Price Boulevard near the Indian burial ground to meet the existing City of North Port LOS criteria. Five different BMP alternatives were considered.

The WMP project did not result in a plan for improvements. It was recommended that the City of North Port purchase the small number of habitable structures in which flooding is predicted for the 100-year event. Purchasing the affected properties may be more cost effective than implementing BMPs evaluated under the WMP project.

## BIG SLOUGH WATERSHED MODEL DESCRIPTION

As previously discussed, this current project builds upon prior work performed. The SWFWMD Governing Board-Approved North Port / Big Slough WMP Watershed Model (Ardaman & Associates, Inc.) was used, with minor updates, to develop a stormwater management plan for flood reduction in the I-75 and Dorothy Avenue areas and to demonstrate that the proposed improvements will not result in adverse impacts to adjacent properties in response to mean annual, 10-, 25- and 100-year 24-hour storm events. The model was developed under a cooperative agreement between the City of North Port and SWFWMD.

**Governing Board Approval (use as best available information)**

The North Port / Big Slough WMP watershed model uses CHAN (Version 2.03, Aquarian Software, Inc.) to simulate the hydrologic and hydrodynamic response of the watershed to rainfall. Having been constructed over several years according to SWFWMD Guidelines and Specifications, the WMP model was validated using historical flood information. Approved by the Governing Board on May 22, 2012, it is considered best available information for local use in environmental resource permitting at the SWFWMD.

This same model has been used successfully for other design and permitting in the North Port/Big Slough watershed area. Most recently, the same model was used for design and permitting of the WCS-106 structure replacement.

**Model Updates**

While the base model for this project was originally planned to be the SWFWMD Governing Board-approved 2012 Version of 2004 Condition model, City of North Port staff requested, and DES agreed, that a specific set of model features reflecting existing conditions be updated in that 2012 Version of the watershed model (Appendix E). Specifically, those updates included:

- adding a single 24-inch PVC pipe from Public Works site to Creighton WW;
- utilizing available as-built survey data and adding two (2) gates at WCS 101;
- incorporating available survey and storm pipe data in Price Blvd area;
- changing a 30-inch ADS pipe, flowing from Price Blvd to R-32, to a 36-inch ADS; and
- adding three (3) 48-inch CMP culverts beneath Appomattox Blvd.

Upon review, some of those revisions were found to have been implemented by Ardaman over the period from 2012 through 2014, with the SWFWMD Governing Board-approved 2012 Version of 2004 Condition model as a base. For example, Ardaman had already incorporated field survey data that was collected at Water Control Structure WCS-162 and throughout the vicinity of Price Boulevard.

Therefore, to expedite the 2016 model update, Ardaman's 2014 version of the 2004 Condition model was used as a starting point. An added benefit to using this model as a starting point is that model element naming conventions are preserved and will match all references in reports, notes, and correspondence generated by Ardaman during the period from 2012 through 2014.

DES staff reviewed and supplemented the 2014 model revisions as discussed in the following.

- Add a single 24-inch PVC pipe from Public Works site to Creighton WW

  The Ardaman 2014 model was found to contain the 24-inch PVC pipe. Specifically, model Reach RI0016 from Node NI0016 to Node NI0020 contains a 77-foot 24-inch pipe with upstream invert 20.21 feet, NAVD, and downstream invert 17.65 feet, NAVD. A Network_Arc feature was added to the geodatabase as the pipe was not included in the Ardaman geodatabase.

- Utilize available as-built survey data and add two (2) gates at WCS 101

  The Ardaman 2014 model does not contain up to date control structure data for the additional gates. As-built drawings provided to DES by the City of North Port were used to update model reach data for the gates as well as to correct adjacent weir lengths. No changes were made to RB1060A representing the four original gates, RB1060B was added to represent two new gates, and weir reaches RB1060E, F, and G were replaced with RB1060C. Network_Arcs were edited in the Geodatabase to reflect these changes.

- Incorporate available survey and storm pipe data in Price Blvd area

  The Ardaman 2014 model was found to incorporate site-specific field survey data collected in the Price Boulevard area. Model input was compared to survey drawings (Van Buskirk / Fish & Associates, June 17, 2014) for consistency, and no revisions were deemed necessary.

- Change 30-inch ADS pipe, flowing from Price Blvd to R-32, to 36-inch ADS

  The Ardaman 2014 model was found to correctly reflect a 36-inch diameter pipe with inverts as indicated on field survey Sheet 5 of 7 Van Buskirk / Fish & Associates dated June 17, 2014.

- Add three (3) 48-inch CMP beneath Appomattox Blvd (Stantec plans available)

  The Ardaman 2014 model does not include these conveyance features. Three (3) 48-inch CMP were added at model Reach RH0110A from Node NH0110 to Node NH0130, with upstream inverts 3.09, 2.92, and 2.87 feet, NAVD, and downstream inverts 2.51, 2.79, and 2.76 feet, NAVD. Information was taken from Stantec design drawings for Phase 3 Reclaimed Water Main Extension Appomattox Drive (2014), assuming NAVD as the vertical datum and estimating 100-ft pipe lengths. One Network_Arc was added to the Geodatabase to reflect pipe connectivity.

## FLOOD REDUCTION CONCEPTS AND CANDIDATE PLANS

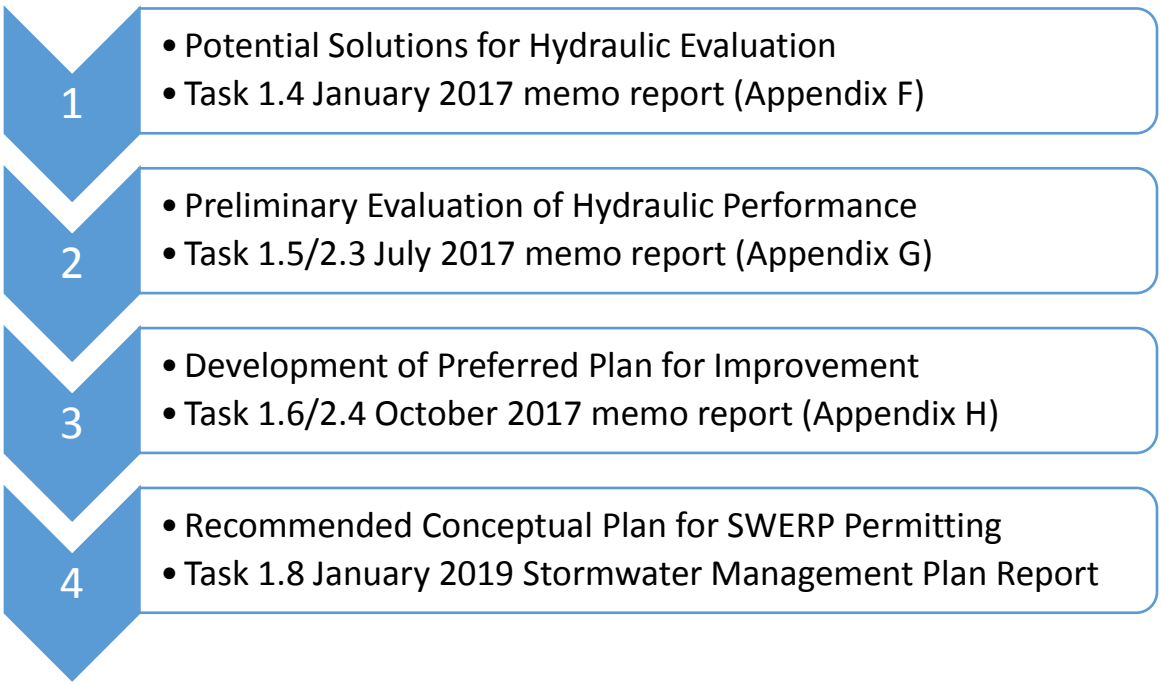
Development of a stormwater management plan to achieve flood reduction in the Big Slough watershed included:

- identification and discussion of potential solutions or plan components;
- preliminary evaluation of alternative solutions;
- assembly of promising solutions into candidate plans for testing;
- identification of a preferred plan;
- and development of the preferred plan into a stormwater management master plan.

Flood reduction solutions that were considered and discussed by the project team included internal flow diversion and increased conveyance capacity; external flow diversion; off-site storage; gate operations; flood-proofing; property acquisition; and elevation of roadways. As potential solutions were considered, a set of alternatives were selected for hydraulic evaluation as stand-alone or combined improvements.

*Note: Team meeting notes are reproduced in the following section(s) to generally describe the plan development process. Not all discussion points, comments, and considerations contained in these notes are fully addressed in this Stormwater Management Plan report. The reader is directed to prior reports, memoranda, and presentations for discussion of relevant plan development and evaluation topics.*

**Development of the Stormwater Management Plan and Related Reports**



**Potential Solutions for Hydraulic Evaluation**

A set of alternatives were selected for preliminary hydraulic evaluation to determine effectiveness of the individual solutions and point the way toward a cost-effective plan for flood reduction. Specifically, the following set of alternatives were selected by the project team for preliminary hydraulic evaluation.

***Internal Flow Diversion and Increased Conveyance Capacity***

- Parallel Relief Channel Construction
  A new, parallel canal could be constructed from the northern City boundary to Price Boulevard within Tier 1 and/or Tier 2 lots along either side of the Myakkahatchee Creek. The additional conveyance may reduce flow rate and peak stages along the main channel from start to end of the parallel relief channel.

- Channel Improvements along R-580
  The R-580 waterway's bottom profile could be reconfigured, creating a more uniform and hydraulically efficient conveyance way. Improvement of the R-580 Waterway would induce more flow eastward from Big Slough along the City's northern boundary toward Creighton Waterway, resulting in reduced flows and flood stages in Myakkahatchee Creek.

- R-36 Improvements to South of WCS-101
  A whole series of improvements could be made to canal segments and structures to enhance the overall conveyance capacity of the R-36 waterway system. The additional stormwater conveyance capacity may induce higher westward flow out of Big Slough at the north boundary of the City. Diverting those higher flows southward to WCS-101 would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.

- Snover Waterway to Cocoplum Waterway
  Improvements could be made to existing structures along Snover Waterway and beneath Price Boulevard to increase flow through canals that connect with Cocoplum Waterway. The additional conveyance capacity may induce higher eastward flow out of Big Slough into Snover Waterway. Diverting those higher flows southward to Cocoplum Waterway would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.

- Other Miscellaneous Improvements
  Evaluations of canals and structures throughout the area for opportunities to increase conveyance.

***External Flow Diversion***

- Connection to Deer Prairie Slough
  Stormwater flows could be diverted westward to the adjacent Deer Prairie Slough watershed, reducing flow through the City. Several variations could be considered, including gravity and pumped diversions both with and without added storage facilities.

- Enhanced Discharges Along Southern Boundary to Port Charlotte – Tidal Outfalls Only
  Structures located within the Cocoplum Waterway and discharging beneath Hillsborough Boulevard could be improved to increase discharges into the Port Charlotte conveyance system. Additional conveyance capacity would divert stormwater southward and reduce flooding in the southern portion of the City.

***Offsite Storage***

- Constrain Inflows to City with Increased Upstream Floodplain Storage
  Raise existing earthen berms on the northwest City boundary at the intersection of Big Slough canal with R-36 and R- 580 waterways. Also, raise earthen weirs farther north at the intersection of Big Slough canal and Power Line Road. Improvements would leave the Big Slough canal as the only conveyance system into the western portion of the City. Inflows would be reduced, dropping stages along Myakkahatchee Creek.

- Creation of Upstream Detention, Reservoirs, or Joint Use Facilities
  One or more detention ponds, reservoirs, or joint-use facilities could be constructed to provide offsite stormwater detention. The facilities would reduce inflow rates and stages along Myakkahatchee Creek.

***Acquisition***

- Purchase of Flood Prone Lands and/or Flood Prone Structures
  Some communities turn to property acquisition to mitigate flood risk by establishing permanent, public open space and to get homeowners in flood-prone areas permanently out of harm's way. In North Port, many lots have been acquired on the west side of the Myakkahatchee Creek to serve as a linear park. Additional acquisition may be considered to remove other lands from the 100-year floodplain. Removal of those properties would reduce future flood-related damages but would not impact flood levels.

**Preliminary Evaluation of Hydraulic Performance**

The above selected alternatives were combined and incorporated into the Big Slough watershed model in various configurations to allow for an initial screening-level review of hydraulic performance. Proposed condition simulations were performed for the mean annual, 10-year, and 100-year 24-hour storm events, with stages and flows compared to the existing condition. Flood inundation areas for each simulation were also mapped and used to depict areas removed from, or added to, the existing condition floodplain.

Flood reduction concepts were effective to varying degrees at reducing flood levels in the watershed, particularly in the I-75 study area, given assumptions and simplifications made while developing the screening-level models. Potential adverse impacts could also be seen in mapping the simulation results. These preliminary simulation results provided general information on potential performance characteristics of each of the tested flood reduction concepts for comparison and discussion.

A Team Meeting was held to discuss concepts and preliminary hydraulic performance. The following summarizes notable points that were raised during the team meeting and the important issues that were subsequently addressed as the project moved forward.

- Refinement and future performance evaluations of structure modifications at the upstream inflow point (to constrain and reduce inflows to the City of North Port) should consider a wider range of control elevations and results used by the District for decision-making on allowable changes to area, depth, and duration of inundation in upstream District lands.
- Refinement and future performance evaluations of the R-36 conceptual plan for improvements should consider channel widening with and without culvert structure improvements providing additional conveyance beneath Tropicaire and I-75.
- Refinement of the R-36 conceptual plan for improvements should include matching pre/post discharge rates westward into the Deer Prairie system, so as to minimize increased flows

downstream in the City of North Port. Preliminary modeling did not make full use of available discharge capacity to the west. No increase in rate of discharge to the Deer Prairie system should be considered, at this time.

- Refinement of the R-36 conceptual plan for improvements should consider (and preferably conform to) existing rights-of-way and drainage easements. City of North Port can provide existing ROW information as depicted on drainage system as-builts. However, acquisition of additional drainage easements along the western boundary from Sarasota County is not out of the question.
- Refinement of the R-36 conceptual plan for improvements should look more closely at existing bridge crossings and available right-of-way for channel enlargement to its confluence with R-226 and further downstream to Myakkahatchee Creek.
- Two culvert locations on the west boundary of Jockey Club should be evaluated and recommendations made regarding sufficiency and/or modifications needed to reduce flooding in the Jockey Club area (considering any increase in water levels that may result from the R-36 improvements and associated re-routing of flows).
- Refinement and future performance evaluations of the parallel bypass canal should include a more accurate representation of the combined conveyance and should eliminate double accounting of conveyance as a result of overlapping open channel cross sections. A request has been made to the District for cross section source data, cross section extents, surveyed point locations, conveyance way boundaries, etc., from the District's North Port/Big Slough WMP project files (including intermediate deliverables).
- Only two Price Boulevard drop structures are scheduled to be replaced with the widening project. City of North Port will identify those structures and the other remaining structures will be revised to again match the existing condition model configuration. Future performance evaluations will include the two identified structures as operable gates.

Team input in review and discussion of the screening-level model results contributed greatly to model development and the subsequent assembly and testing of candidate plans for drainage improvement.

**Development of a Preferred Plan for Improvement**

Through the preliminary evaluation of hydraulic performance it was determined that the Big Slough Flood Reduction Study preferred plan for improvement would be comprised of: internal flow diversion and increased conveyance capacity; external flow diversion; offsite storage; and/or property acquisition. Those basic plan components were considered by the Project Team to be most promising, based on review of preliminary hydraulic evaluations, and were merged into a small number of Candidate Plans for more rigorous consideration.

***Plan Components and Candidate Plan Development***

More specifically, the following alternatives were considered by the team for detailed evaluation.

- *Offsite Storage.* Flood reduction would be achieved in part by construction of a gated water control structure located at the FPL easement just north of the northern City boundary to limit high flows entering the City. Low flows will remain unchanged as a four-foot opening in the upstream face of the structure would extend fully to the existing channel bottom.

- *Internal Flow Diversion and Increased Conveyance Capacity.* Flood reduction would be achieved in part by construction of a parallel relief (bypass) channel alongside Myakkahatchee Creek within Tier 1 lots that have been acquired by the City of North Port, and through widening of the R-36 canal. Wide and Narrow options were considered for each channel improvement concept.
- *External Flow Diversion.* Flood reduction would be achieved in part through higher discharges westward to Deer Prairie Slough. Large increases are considered infeasible as SWFWMD has already restored the slough system and likely will not permit higher inflows to the slough. Therefore, the Preferred Plan will be adjusted to meet pre/post discharge rates and District staff will be asked at an upcoming coordination meeting if those rates can be increased.
- *Additional drainage improvements* may be achieved through upsizing R-36 culverts at Tropicaire, water control structure replacement during the widening of Price Boulevard, and improvements to the R-580 canal. The effect of Price Boulevard improvements will be localized. Widening of the R-36 and R-580 canals is expected to require additional and perhaps extensive downstream drainage system improvements to eliminate bottlenecks in other flood prone areas of the City.
- *Acquisition* would reduce losses through purchase of flood prone lands and/or building structures.

Numerous configurations were developed which incorporated various versions and combinations of the "Offsite Storage" and the "Internal Flow Diversion and Increased Conveyance Capacity" concepts described above. While a large number of configurations were evaluated (e.g., offsite storage with flow control set at a lower, 10-year event peak, stage), if performance was not superior to other configurations then they were not advanced as Candidate Plans.

After a Preferred Plan is selected from among the Candidate Plans, other alternative components can again be considered during finalization of the stormwater plan. For example, discussion with District land management staff may allow for adjustments to the offsite inflow control as well as external flow diversions to Deer Prairie Slough. These final plan modifications may have a small (but not insignificant) impact on performance which will be accounted for in final performance and benefit/cost evaluations.

***Candidate Plan Descriptions and Performance***

While a large number of configurations were assembled and tested in a preliminary fashion, a total of eight candidate plans were deemed most promising and carried forward through rigorous evaluation. Each of the eight candidate plans was comprised of one or more of the following components:

- *Offsite Storage/Control of Inflow in Myakkahatchee Creek*
  Existing: No hydraulic control of inflow in Myakkahatchee Creek from upstream offsite areas.
  Low Control: 150-foot concrete weir with crest at elevation 24.0 feet for overtopping of high flows. 4-foot wide slot open to existing channel bottom to allow normal low flows.
  High Control: 150-foot concrete weir with crest at elevation 25.5 feet for overtopping of high flows. 4-foot wide slot open to existing channel bottom to allow normal low flows.

- *Internal flow diversion via R-36*
  Existing: No improvements to existing ditch along northwestern and western city boundary.
  Narrow: Widen ditch to maximum extent within existing drainage easement/right of way.
  Wide: Widen ditch to 60-foot bottom with 4:1 side slopes, easement acquisition as-needed.

- *Internal flow diversion via R-580*
  Existing: No improvements to existing ditch along northern city boundary east of Big Slough.
  Narrow: Widen ditch to maximum extent within existing drainage easement/right of way.
  Wide: Widen ditch to 60-foot bottom with 4:1 side slopes, easement acquisition as-needed.

- *Internal flow diversion via Bypass*
  Existing: No bypass. All flow within Big Slough Canal/Myakkahatchee Creek and floodplain.
  Narrow: Excavate bypass ditch with 20- to 50-foot bottom 4:1 side slopes for flow diversion.
  Wide: Excavate bypass ditch with 50-foot bottom 4:1 side slopes for flow diversion.

Proposed condition simulations were performed for the mean annual, 10-year, and 100-year 24-hour storm events. Flood reduction performance of each plan was compared to the existing condition.

- The "wide" Internal Flow Diversion via Bypass component, comprised of excavating a bypass ditch within Tier 1 lots along the Myakkahatchee Creek with 50-foot bottom width and 4:1 side slopes, provided the majority of flood reduction benefits in each of the four best-performing Plans, with added improvement resulting from configurations of R-36 improvements and inflow control.

- Widening of R-36 provided benefits in terms of flood reduction in the I-75 area, but additional improvements (culvert pipe upsizing and modification of some secondary collection systems) would be required to mitigate increased water levels along R-36 south of Tropicaire Boulevard. Furthermore, acquisition of additional easement would be difficult along R-36 and it would therefore be desirable to keep within the existing easement with any improvements.

- Restriction of inflows from the north also reduced flood levels in the I-75 area, although to a lesser extent than the bypass construction and R-36 widening concepts, while improvements to R-580 provided very little flood reduction benefit.

***Benefit and Cost Comparison of Candidate Plans***

Screening-level estimates of project benefits (flood damage reduction) were developed to allow initial comparisons of rough Benefit to Cost Ratio (BCR) values across Candidate Plans. Benefits considered cost avoidance for road repair and for residential structure damages for mean annual, 10-year, and 100-year storms. Cost calculations were also performed to develop preliminary order of magnitude estimates of probable construction costs, which could be compared across Candidate Plans to aid in selecting a Preferred Plan. A ratio of annualized benefits to annualized costs was calculated and that BCR assigned to each Candidate Plan for rough comparison to aid in selecting a Preferred Plan. Based on the screening-level estimates of Candidate Plan benefits, several plans are recommended for consideration.

***Flood Reduction Comparison of Candidate Plans***

Flood inundation areas for each simulation were mapped to depict areas removed from the floodplain. Flood reduction scenarios incorporating the wide bypass component were more effective in reducing flood levels in the watershed, particularly in the I-75 study area, than other Candidate Plans. Candidate Plans, as initially configured, may also result in increased flooding in downstream areas. Plan refinements and additional improvements were developed for the selected plan to relieve downstream bottlenecks and accommodate increased flows that result from the wider R-36 or addition of the Bypass.

***Evaluation of Cost for Acquisition***

A summary of combined "just value" for flood-prone parcels in the I-75 area (Figure 8) was presented to the Project Team. Flood risk was based on Existing Condition simulation of the 10-year storm event, with inundation areas mapped on a LiDAR-based terrain model. Parcels inundated 50% or were selected.

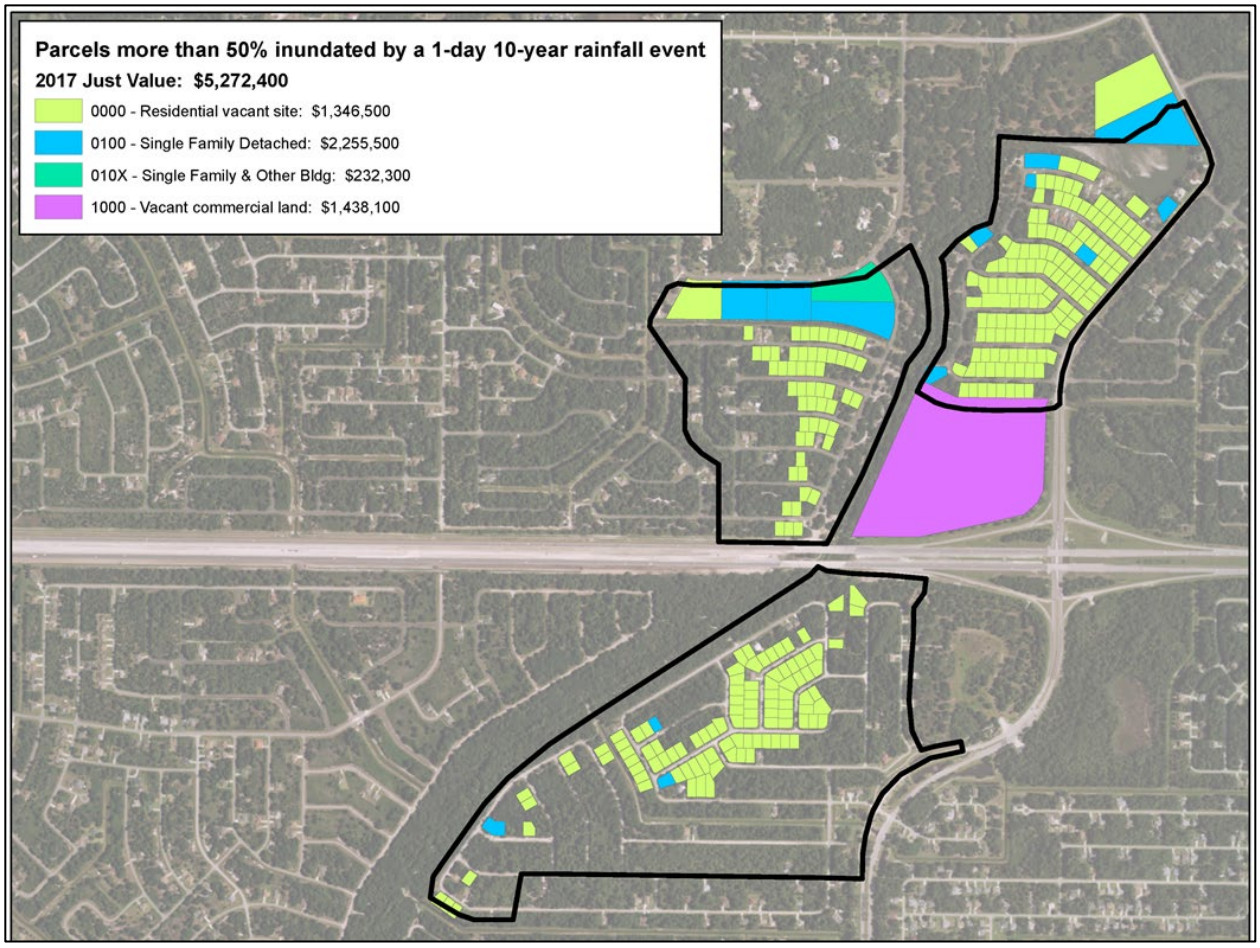



**Figure 8**

While it is understood that a land purchase option would be developed based on a more rigorous protocol, the cost assessment summarized below provides order of magnitude information for consideration.

| | Preliminary Estimate of Acquisition Cost (Based on Sarasota County Property Appraiser 2017, projected at 4% inflation) | | | | |
|---|---|---|---|---|---|
| | 2017 | 2020 | 2025 | 2030 | 2035 |
| Estimated Property Value* | $ 5,272,400 | $ 5,930,733 | $ 7,215,643 | $ 8,778,934 | $ 10,680,915 |
| Estimated Annualized Cost** | $ 382,037 | $ 429,740 | $ 522,844 | $ 636,120 | $ 773,937 |

* Combined "Just Value" of properties inundated 50% or more by flooding from the 10-year 24-Hour Storm Event
** Cost annualized over 50 years at 7%, 13.8 PV Annuity Factor (estimated acquisition cost only)

***Identification of the Preferred Plan for Flood Reduction***

Based upon the Project Team's review and discussion of preliminary hydraulic evaluation results, a set of alternatives were advanced for development of improvements to achieve flood reduction through internal flow diversion and increased conveyance capacity, external flow diversion, offsite storage, and acquisition. Those concepts were refined and combined into a small number of Candidate Plans for evaluation of hydraulic performance, preliminary cost estimates, and screening-level benefit estimates.

This interim report, meetings, and team discussion provides a basis for evaluation of the Candidate Plans. The Project Team selected from among these Candidate Plans and the Preferred Plan was evaluated more rigorously for permittability, costs, and benefits, resulting in a recommended plan for SWERP permitting.

***Plan Coordination with Offsite Property Owners/Managers***

The City of North Port is coordinating with both Sarasota County and SWFWMD regarding planned improvements for flood reduction. Coordination with those agencies, being responsible for management of the affected adjacent properties, is required to demonstrate that the proposed stormwater system modifications would not have an adverse impact and to seek authorizations and/or easements required for permit approval and project implementation.

- Regarding the restriction of inflows, it can be shown that normal flows will not be impacted by the proposed water control structure and that peak stage increases will be inconsequential in terms of environmental or other offsite impacts.
- Regarding the increase of outflows, historical flow patterns toward the Deer Prairie Slough/Creek system were interrupted decades ago by construction of R-36. While significant amounts of stormwater are currently discharged westward from the R-36 canal when it exceeds its bank, it may be allowable or even desirable to increase and/or redistribute those flows without causing adverse impacts.

In a joint meeting it was determined that additional time was needed to fully address existing conservation easements, offsite storage and discharge requirements, and potential impacts. Some options would require revisions to be made to the District's existing model of the Deer Prairie Slough area for proper evaluation. Because discussions are expected to continue for some time, those plan elements requiring offsite easements should be scheduled for later phases of implementation.

***SWERP Pre-application Meeting with SWFWMD***

City of North Port staff attended a pre-application meeting with staff of the SWFWMD in November 2018, during which a description of flood problems, the preferred plan of improvements, and flood reduction performance was provided. Comments and input were solicited regarding permitting requirements and other matters. It was agreed that requesting Conceptual Approval of the Stormwater Management Master Plan through submittal of a SWERP application for the entire project, followed by timely submittals of applications for construction of project components in a phased manner, would be the appropriate approach to permitting. Summary notes of the pre-application meeting are provided in Appendix I.

## RECOMMENDED STORMWATER MANAGEMENT MASTER PLAN

The recommended Stormwater Management Master Plan, as presented by DES staff to the North Port City Commission on December 6, 2018 (Appendix J), has the following major components:

- Improvements to the existing retention ditch/conveyance system and upsizing road crossing culverts in the Dorothy Avenue area.
- Construction of a new bypass canal parallel to the Myakkahatchee Creek within a portion of the City's Tier 1 lots from south of Tropicaire Boulevard to north of Price Boulevard.
- Increasing conveyance capacity through canal widening and upsizing pipe culverts in the R-36 retention ditch/conveyance system along the northern and western boundary of the city.
- Restriction/reduction of high flow into Myakkahatchee Creek near the north City Boundary.

**Dorothy Avenue Improvements**

***Purpose***: Improvements in the Dorothy Avenue area are proposed to serve two purposes:

- Under an initial phase, the extent and duration of localized flooding could be reduced by providing additional storage and conveyance capacity in the existing R-231, R-70, and R-69 canal systems. In this instance, a single box culvert should suffice to replace culverts at Trionfo Avenue, Porto Bello Avenue, Herbison Avenue, Eager Street, Allen Road, and South Biscayne Drive.
- Under the full plan, this conveyance system also serves to receive and convey higher flows passed southward via the improved R-36 ditch system. In order to handle higher flows from the north, three (3) box culverts will be required at each of the above road crossings.

Models were tested for both conditions to ensure suitable performance under phased implementation.

***Configuration***: For conceptual permitting purposes, the stormwater management plan includes:

- widening the existing ditches passing through the area, with bottoms ranging between fourteen and twenty feet in width and relatively steep (2:1) side slopes consistent with other stable ditches in the area, while lowering the ditch bottoms to elevation 1.5 feet, NAVD, and
- replacing existing culverts with triple 6'x4' box culverts at each road crossing.

**Bypass Canal Construction**

***Purpose***: Construction of a bypass canal is proposed to provide regional storage and conveyance capacity to reduce flooding in the I-75 project area and other portions of the City. This can be accomplished through excavation of a wide trapezoidal bypass channel within the extents of Tier 1 lots already acquired by the City between Tropicaire Boulevard and Price Boulevard. The bypass canal would be constructed on either the east or west set of Tier 1 lots. Alternate configurations may address or include the following:

- A simple, trapezoidal cross section that is sodded for erosion protection is preferred as it would allow for maximum storage and conveyance capacity with reduced construction cost and minimal maintenance requirements. Some portions of the bypass canal may have other characteristics to

meet various goals. For example, segments may contain wet pools, some types and amounts of wetland vegetation, etc., as required to achieve water quality improvement, mitigate for wetland encroachments, or mitigate/avoid surficial aquifer impacts (dewatering) in adjacent areas.

- Existing lateral ditches (R-23, R-5, R-1, and unnamed interconnections), which currently discharge to the Myakkahatchee Creek may be intercepted by the bypass, piped beneath the bypass, or allowed to flow through breaks in the bypass ditch. The latter configuration would require additional structural connections be constructed between the bypass and Myakkahatchee Creek at points upstream and downstream of the existing lateral inflows. It is recommended (and proposed condition model construction assumes) that those inflows be intercepted by the bypass
- Exchange of flow between the Myakkahatchee Creek and the bypass canal will be limited to higher flows in order to maintain minimum flows and levels. Exchange may either be limited to discrete points, with a berm constructed along the creek-side bank of the bypass to prevent overflows, or overtopping may be allowed at existing overflows located between the creek and bypass canal. Detailed topographic ground survey is required to establish existing overflow elevations.
- There are no structural weirs being proposed at this time. Conveyance between the bypass channel and existing creek will be via large openings in the bank that runs between the two. These connector features are easily located at the endpoints of each bypass segment in the plan and profile and depicted in the typical sections provided in the accompanying Conceptual Plan set. Sheet D-3 provides a conceptual-level details of the bypass channel and bypass weir configurations in plan and section views.
- Elevations shown in the Conceptual Plan set (Sheets S-2 and S-3) are approximate as they are based on LiDAR-based terrain information and will change when more-detailed survey is collected to support design of the system. For modeling and future design purposes, the bypass channel is placed approximately one foot above the adjacent creek bottom and the connecting weirs (located at bypass segment endpoints) is placed one foot above the bypass channel bottom (two feet above the creek bottom). This configuration allows the creek to carry two feet of normal flow before any flow exchange occurs into the bypass.
- The bypass canal may shift from one side of the Myakkahatchee Creek to the other for various reasons, such as to accommodate other Tier 1 lot uses (parks, etc.), avoid local impacts (such as archaeological or wetland conditions) or reduce cost and/or complexity of construction (such as in some large meanders of the Myakkahatchee Creek).

Models were tested for all of the above conditions to ensure suitable performance under a range of implementation conditions. For example, manning's roughness values were varied from 0.040 to 0.150 to reflect changes in vegetation cover in the bypass channel (sodded versus wetland vegetation), all three interconnectivity options for lateral ditches were evaluated, exchange between the creek and canal was allowed across topographic saddles (from LiDAR-based terrain) and restricted with a constructed berm, and the final (downstream) segment of the bypass canal was tested on both the east and west side of the Myakkahatchee Creek in anticipation of possible construction issues just upstream of Price Boulevard.

These alternatives were generally discussed during pre-application meetings held with SWFWMD for the Statewide Environmental Resource Permit (SWERP) application and details will be worked out during subsequent design and permitting (i.e., in phased SWERP applications for construction approval)

***Configuration***: For conceptual permitting purposes, the stormwater management plan includes:

- construction of a sodded trapezoidal bypass canal on the west side (switching to the east side in the lower segment to avoid meanders of the Myakkahatchee Creek), utilizing the full width of Tier 1 lots from Tropicaire Boulevard to north of Price Boulevard, with bottoms ranging between fifty and eighty feet in width and moderate (4:1) side slopes, excavated to elevations one foot above the existing Creek bottom, and intercepting lateral surface inflows (from R-23, R-5, R-1, etc.).
- exchange between Myakkahatchee Creek and the bypass is allowed only at discrete flow diversion points, where 150-foot wide broad-crested weirs allow high flows to move out of and back into the Creek at elevations two feet above the Creek bottom, with the diversion structures to be comprised of either earthen or structural berms, with structure design and erosion protection to be determined based on flow conditions, site characteristics, and geotechnical recommendations.

**R-36 Improvements**

***Purpose***: Improvements to the existing R-36 canal and culvert structures are proposed to increase storage and conveyance capacity of that system, allowing diversion of higher flows from north of the City around its western perimeter and thereby reducing flooding near I-75 and in other flood prone areas. This is the "narrow" improvement option, which constrains canal widening to existing drainage easements.

Changes to flow rate and/or volume at existing overflows westward to Deer Prairie Slough require agency coordination between the City of North Port, SWFWMD, and Sarasota County. While the current conceptual design does not increase peak flows to the west, the conceptual approval of the SWERP should recognize and allow for this future improvement. Changes in the design configuration from the current plan will require detailed topographic survey of the western bank and natural grade outside (west) of the R-36 canal, detailed modeling of both the Big Slough and Deer Prairie watersheds, and a modification of the North Port/Big Slough Stormwater Management Master Plan and SWERP.

***Configuration***: For conceptual permitting purposes, the stormwater management plan includes:

- Widening the existing R-36 canal section to the maximum extent possible while remaining within the existing drainage easement, with bottom widths ranging from 30 to 65 feet and relatively steep (2:1) side slopes consistent with existing bank conditions along R-36, while maintaining the ditch bottoms at their current elevations. Assume 20% of total length of improved (widened) channel will require rip-rap erosion protection, for cost estimating purposes.
- Enlarging WCS-162 and installing two additional 60" culverts at Tropicaire Boulevard
- Installing two additional 48" culverts at I-75

Proposed features are depicted in plan and profile, cross section, and detail sheets in the accompanying Conceptual Plan set.

To develop cross section data for the R-36 canal system, the SWFWMD LiDAR-based terrain model was first adjusted using available bottom elevation information in order to better describe existing geometry. A proposed condition terrain model was then developed by applying proposed channel geometry for various design configurations (e.g., combinations of bottom width and side slope). Using the terrain models and other available information, such as aerial photos and property boundaries downloaded from the Sarasota County property appraiser, aided in the development of proposed condition channel geometry by confirming that the proposed system could be constructed within site constraints.

The hydraulic model and conceptual plan set depictions of channel sections are in close agreement, given that geometry for both was taken from the same set of terrain models. For model development, cross sections were cut from existing and proposed condition terrain models at the reach midpoint for each modeled channel segment. Cross sections shown in the conceptual plan drawings Sheets S-1 to S-4 were taken from the existing and proposed condition terrain models at various locations for general depiction and cost evaluation (used for quantity takeoffs, etc.) of the proposed work.

Because the model is constructed with cross sections cut from the terrain model at discrete points, there will be some small variation in storage between the two. This level of accuracy is adequate and appropriate for conceptual-level plan development, modeling, performance evaluation, and cost estimating. Construction-level design and permitting will be based on thorough site-specific survey of channel features with model updates being performed in order to confirm existing and proposed condition performance.

**Inflow Control Structure**

***Purpose***: Improvements at the inflow point north of the City are proposed to reduce flows and thereby drop peak stages along the Myakkahatchee Creek. A gated control structure will be installed at the FPL Power Line Road with an open bay at the creek bottom to allow low flows to pass unimpeded. The gated structure will cause higher flows to be attenuated with increased upstream storage on undeveloped lands. While a “high” control option is currently recommended, with overtop at elevation 25.5 feet NAVD, the degree to which inflows are restricted, upstream flood storage is increased, and downstream stages are reduced will depend on the outcome of ongoing agency coordination regarding storage on those lands.

Models were tested for a range of configurations to ensure suitable performance. The current stormwater management plan is conservative and results in a relatively small increase in upstream inundation.

***Configuration***: For conceptual permitting purposes, the stormwater management plan includes:

- construction of a gated water control structure on the upstream side of Power Line Road with a four-foot opening at existing channel bottom at 17.5 feet, NAVD, and with gates closed overflow and adjacent structure overtop elevations at 25.5 feet, NAVD.
- Existing culverts at Power Line Road converted to risers with control elevation 25.5 feet, NAVD.
- Power Line Road surface smoothed and low points filled to elevation 26.0 feet, NAVD.

The control structure may be located immediately upstream or downstream of the FPL roadway, and the number and size of gates are to be determined, with the single open gate for unimpeded low flows.

## Engineer's Opinion of Probable Cost

Estimated project costs including engineering design, permitting, and construction are based on RS Means 2017 Heavy Construction Costs with national average values adjusted to the Ft Myers/Sarasota County area. Estimates include a 30% contingency and were projected to future years (up to 2035) assuming 4% inflation. Combined costs for each of those projections were annualized over 50 years at 7%.

| | Engineer's Estimate of Probable Construction Cost (Based on RS Means 2017, with costs projected at 4% inflation) | | | | |
|---|---|---|---|---|---|
| | 2017 | 2020 | 2025 | 2030 | 2035 |
| Dorothy (Triple Box Culvert) | $ 5,628,495 | $ 6,331,291 | $ 7,702,984 | $ 9,371,858 | $ 11,402,298 |
| R-36 Improvements | $ 15,379,020 | $ 17,299,306 | $ 21,047,251 | $ 25,607,199 | $ 31,155,073 |
| Bypass (flowway, n = 0.040) | $ 17,121,876 | $ 19,259,782 | $ 23,432,470 | $ 28,509,182 | $ 34,685,779 |
| Reduce Northern Inflows | $ 2,575,105 | $ 2,896,643 | $ 3,524,209 | $ 4,287,739 | $ 5,216,690 |
| Estimated Combined Cost | $ 40,704,496 | $ 45,787,022 | $ 55,706,913 | $ 67,775,978 | $ 82,459,840 |
| Estimated Annualized Cost* | $ 2,949,442 | $ 3,317,721 | $ 4,036,515 | $ 4,911,037 | $ 5,975,028 |

** Combined construction cost annualized over 50 years at 7%, 13.8 PV Annuity Factor (capital cost only, excludes O&M)*

## Benefits and Benefit to Cost Ratio (BCR)

Benefits are based upon flood reduction achieved across a range of simulated storm events compared to the existing condition. For roadway removed from floodplain, benefits reflect avoidance of repair costs at a rate of $50,000 per mile. For parcels removed from the floodplain, benefits reflect avoidance of $6,300 per occurrence, based on historical NFIP claims statistics reduced by 85 percent to account for lot vacancy.

| | Flood Reduction (acres) | Road Flood Reduction (miles) | Parcels Reduction (centroid) |
|---|---|---|---|
| 2.33-year | 244 | 7.8 | 234 |
| 5-year | 359 | 12.9 | 405 |
| 10-year | 460 | 18.3 | 538 |
| 25-year | 495 | 20.7 | 542 |
| 50-year | 518 | 21.1 | 562 |
| 100-year | 557 | 24.5 | 558 |

Annual benefit is calculated by multiplying total project benefits for a storm event simulation by the event probability then summing across events simulated. In the case of the full stormwater management plan, annualized benefits accrue to $1,977,742 with a BCR of 67 percent. Future enhancements (e.g., allowing greater inflow restriction or diversions to Deer Prairie) may increase the flood reduction performance and BCR of the full plan. In the meantime, a much higher BCR can be achieved through partial (Phase I) implementation of the master plan to include the Dorothy Avenue and Bypass components, only, where annualized project benefits would accrue to $1,842,132 for an excellent BCR of 138 percent.

**Flood Area Reduction for 1-Day Mean Annual Event in the I-75 Area**

Figure 8 illustrates reduced extents of inundation in the I-75 area for the Mean Annual storm event for the full stormwater management master plan model.

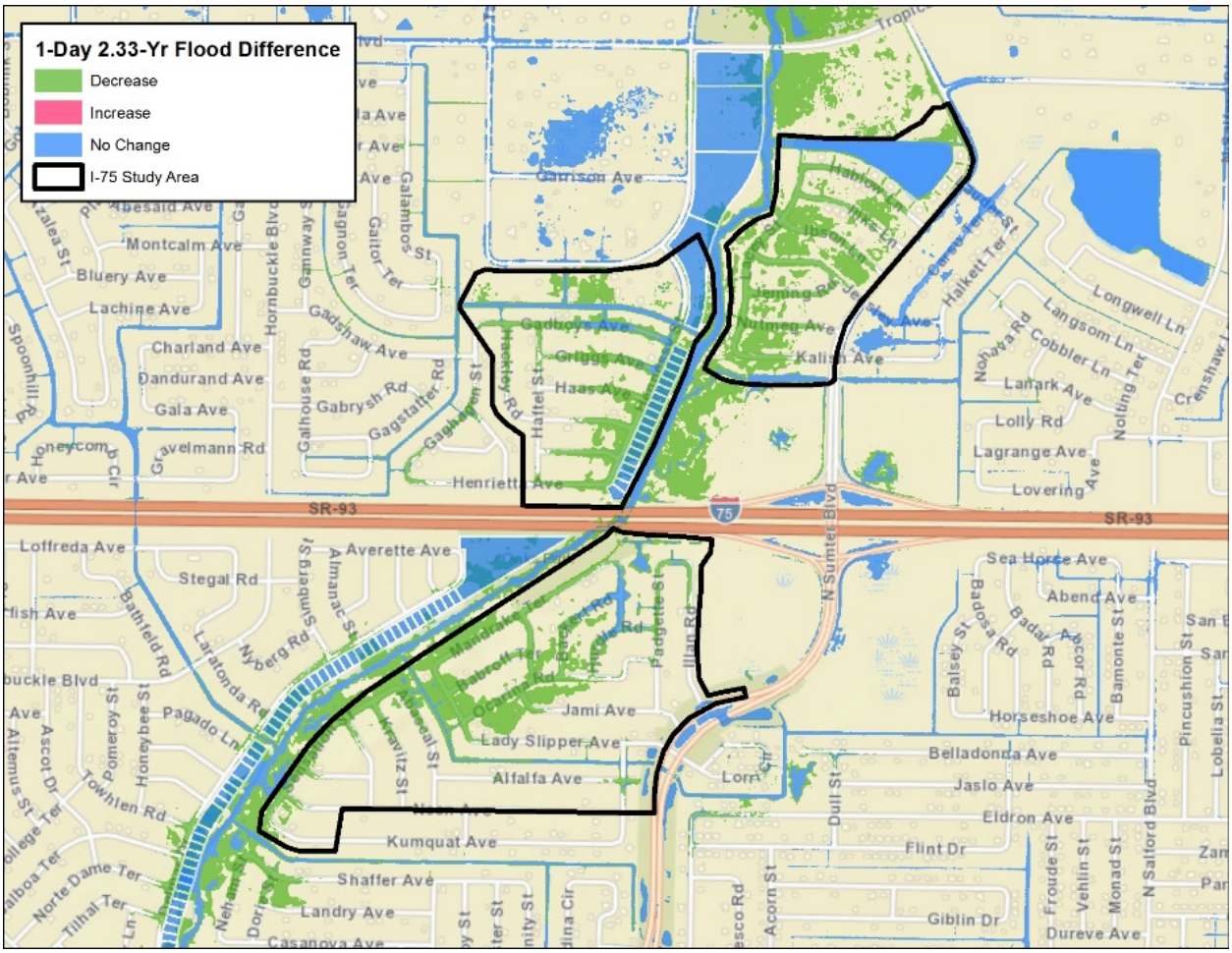



**Figure 9: 1-Day 2.33-Year Flood Difference Map, I-75 Area**

**Flood Area Reduction for 1-Day 5-Year Event in the I-75 Area**

Figure 9 illustrates reduced extents of inundation in the I-75 area for the 1-Day 5-Year storm event for the full stormwater management master plan model.

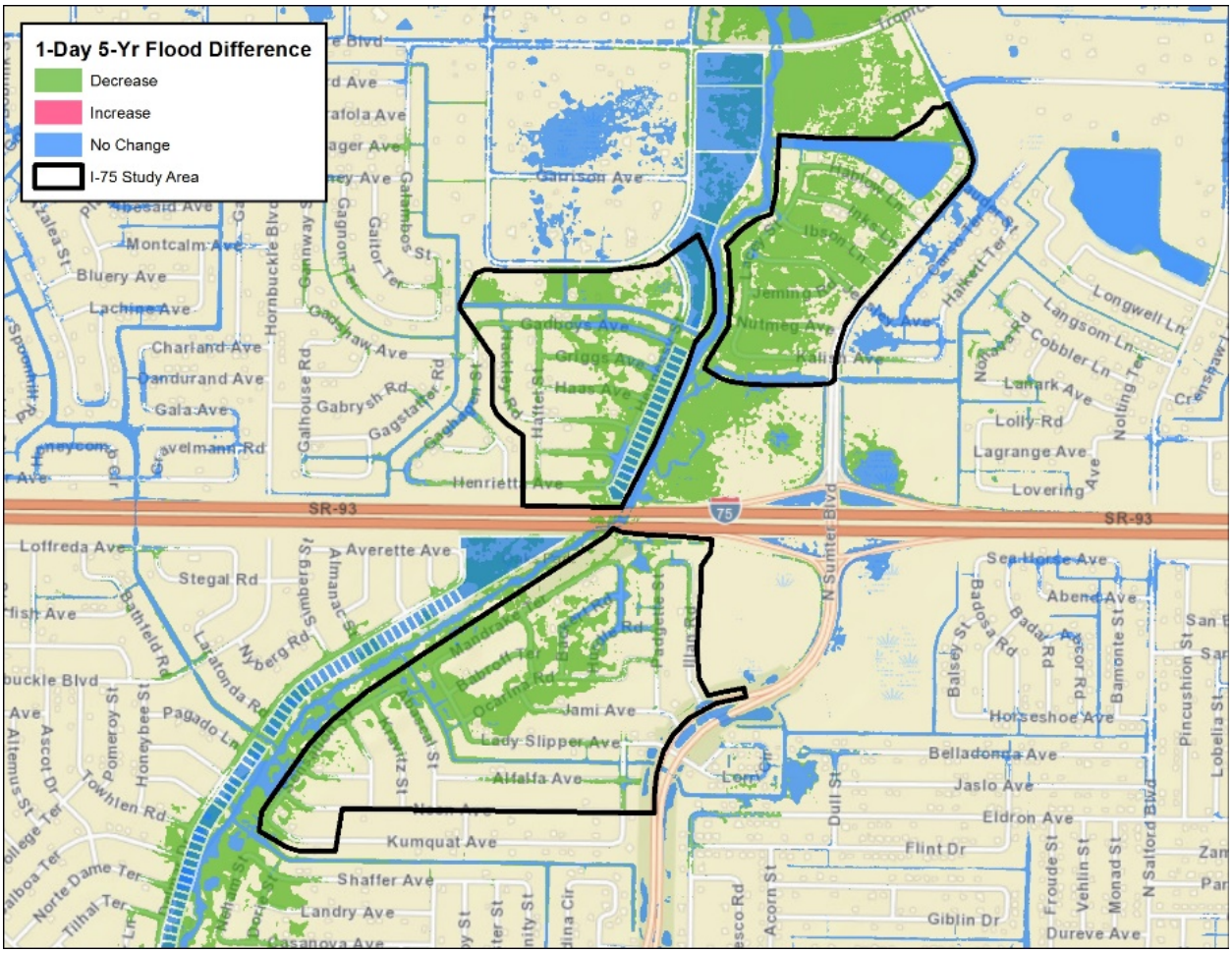



**Figure 10: 1-Day 5-Year Flood Difference Map, I-75 Area**

**Flood Area Reduction for 1-Day 10-Year Event in the I-75 Area**

Figure 10 illustrates reduced extents of inundation in the I-75 area for the 1-Day 10-Year storm event for the full stormwater management master plan model.

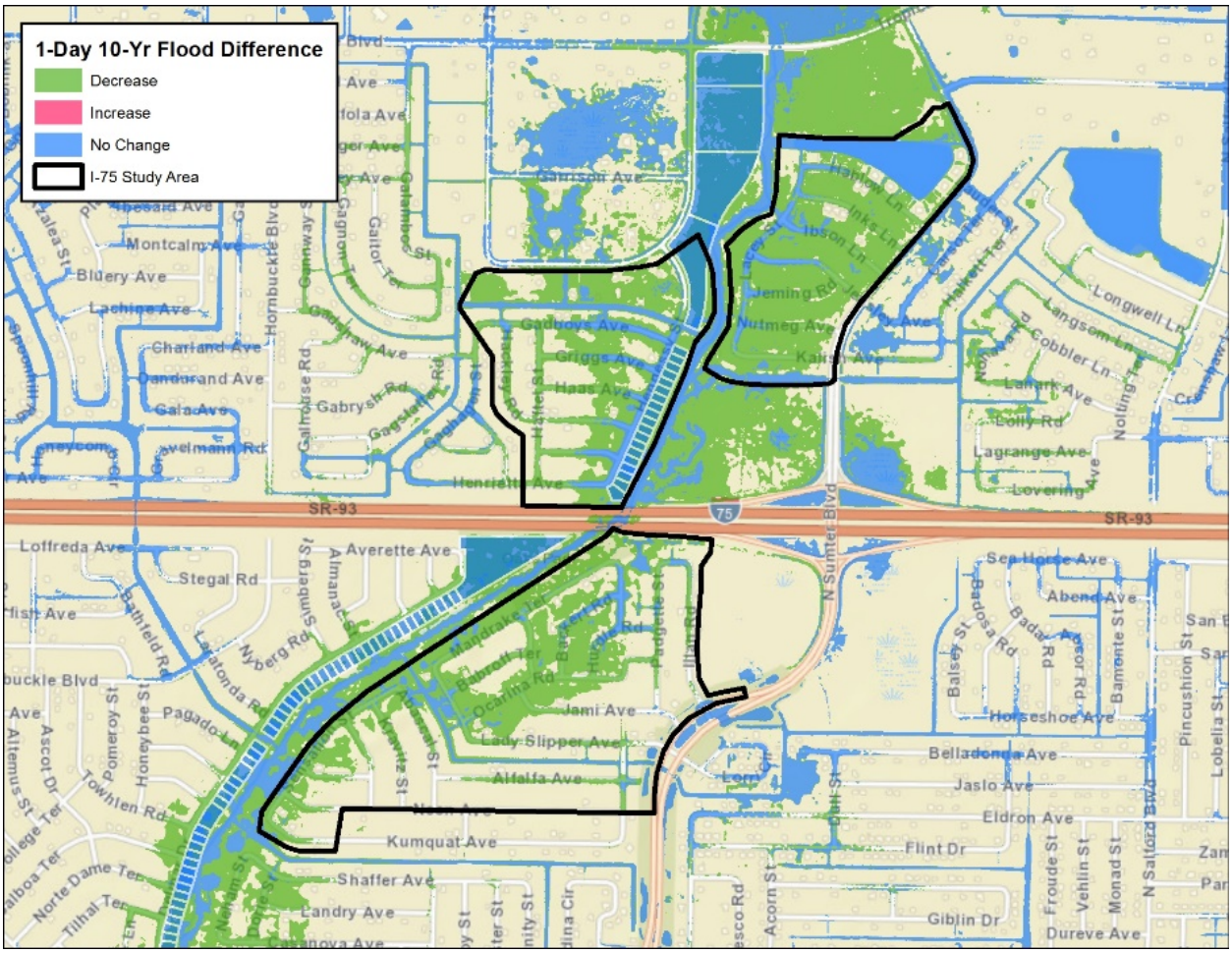



**Figure 11: 1-Day 10-Year Flood Difference Map, I-75 Area**

**Flood Area Reduction for 1-Day 25-Year Event in the I-75 Area**

Figure 11 illustrates reduced extents of inundation in the I-75 area for the 1-Day 25-Year storm event for the full stormwater management master plan model.

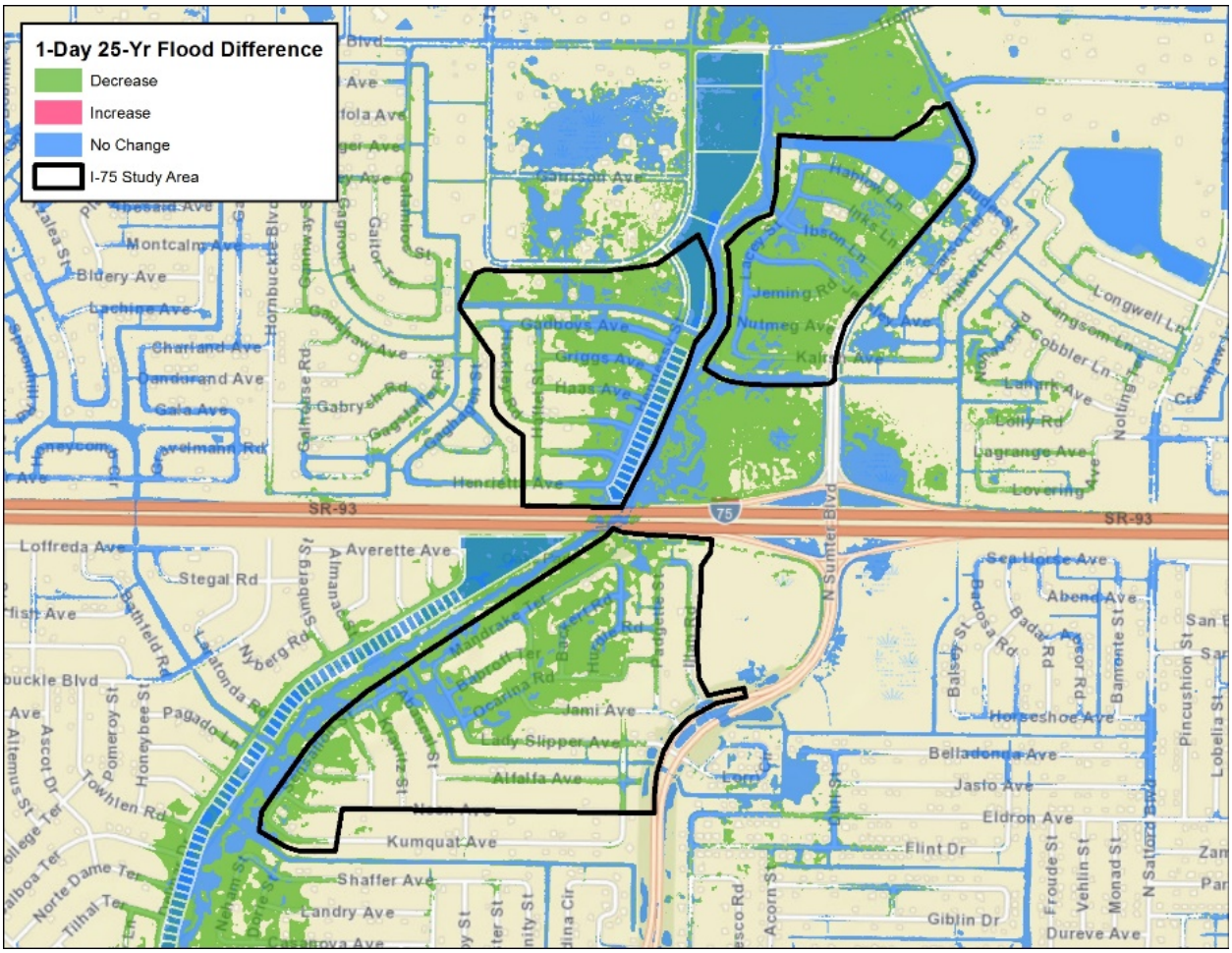



**Figure 12: 1-Day 25-Year Flood Difference Map, I-75 Area**

**Flood Area Reduction for 1-Day 50-Year Event in the I-75 Area**

Figure 12 illustrates reduced extents of inundation in the I-75 area for the 1-Day 50-year storm event for the full stormwater management master plan model.

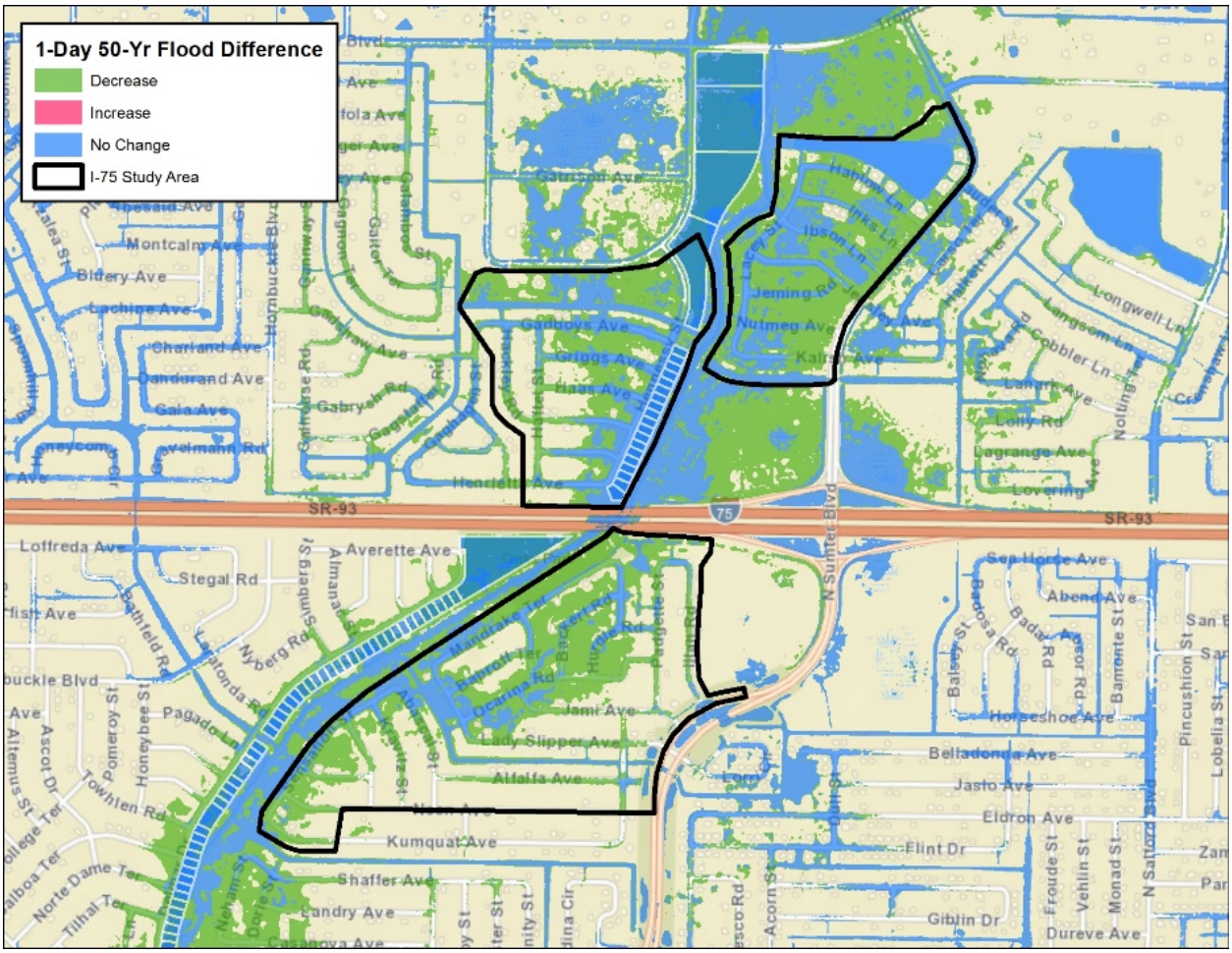



**Figure 13: 1-Day 50-Year Flood Difference Map, I-75 Area**

**Flood Area Reduction for 1-Day 100-Year Event in the I-75 Area**

Figure 13 illustrates reduced extents of inundation in the I-75 area for the 1-Day 100-Year storm event for the full stormwater management master plan model.

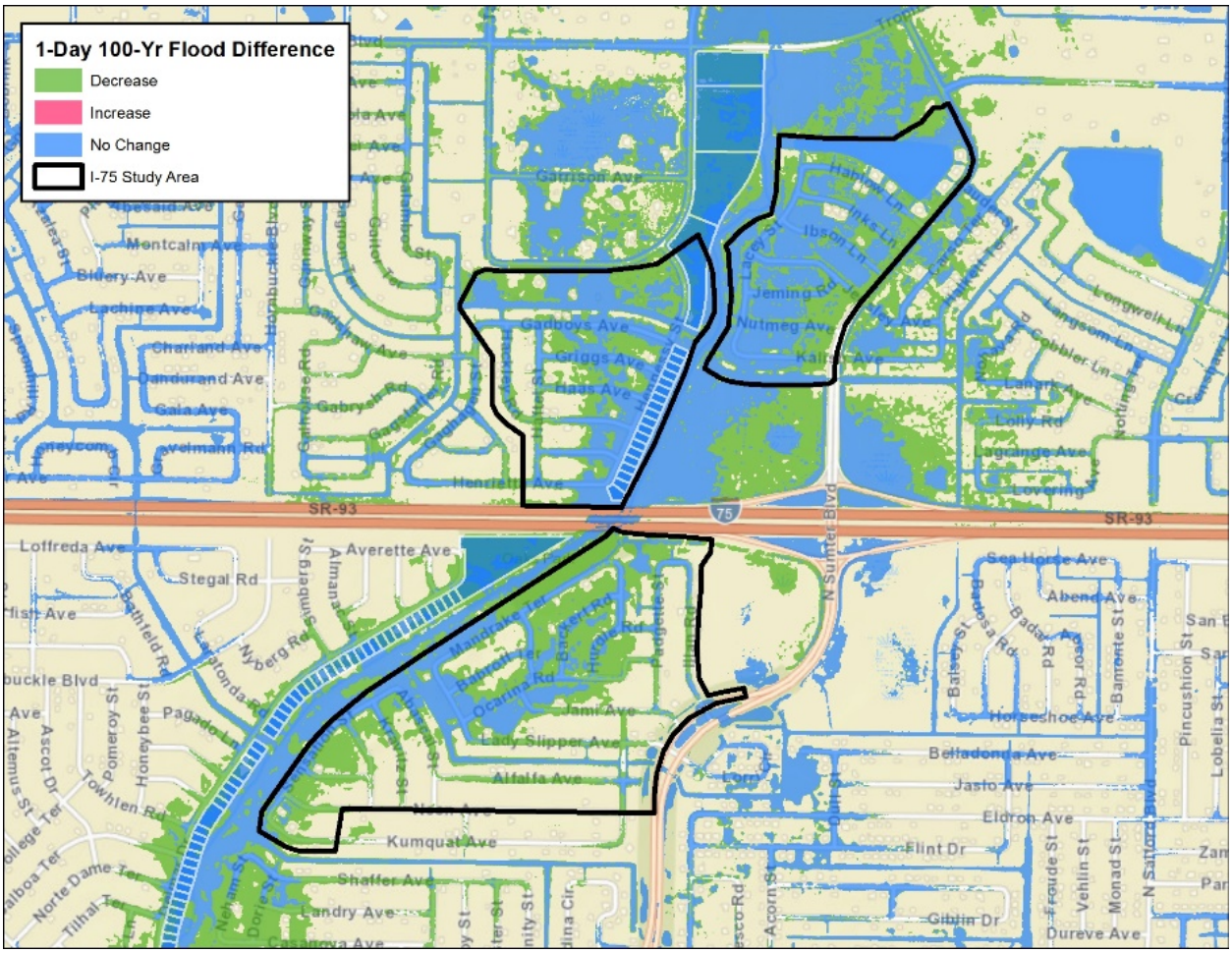



**Figure 14: 1-Day 100-Year Flood Difference Map, I-75 Area**

**Flood Area Reduction for 1-Day Mean Annual Event in the Dorothy Avenue Area**

Figure 14 illustrates reduced extents of inundation in the Dorothy Avenue area for the Mean Annual storm event for the full stormwater management master plan model.

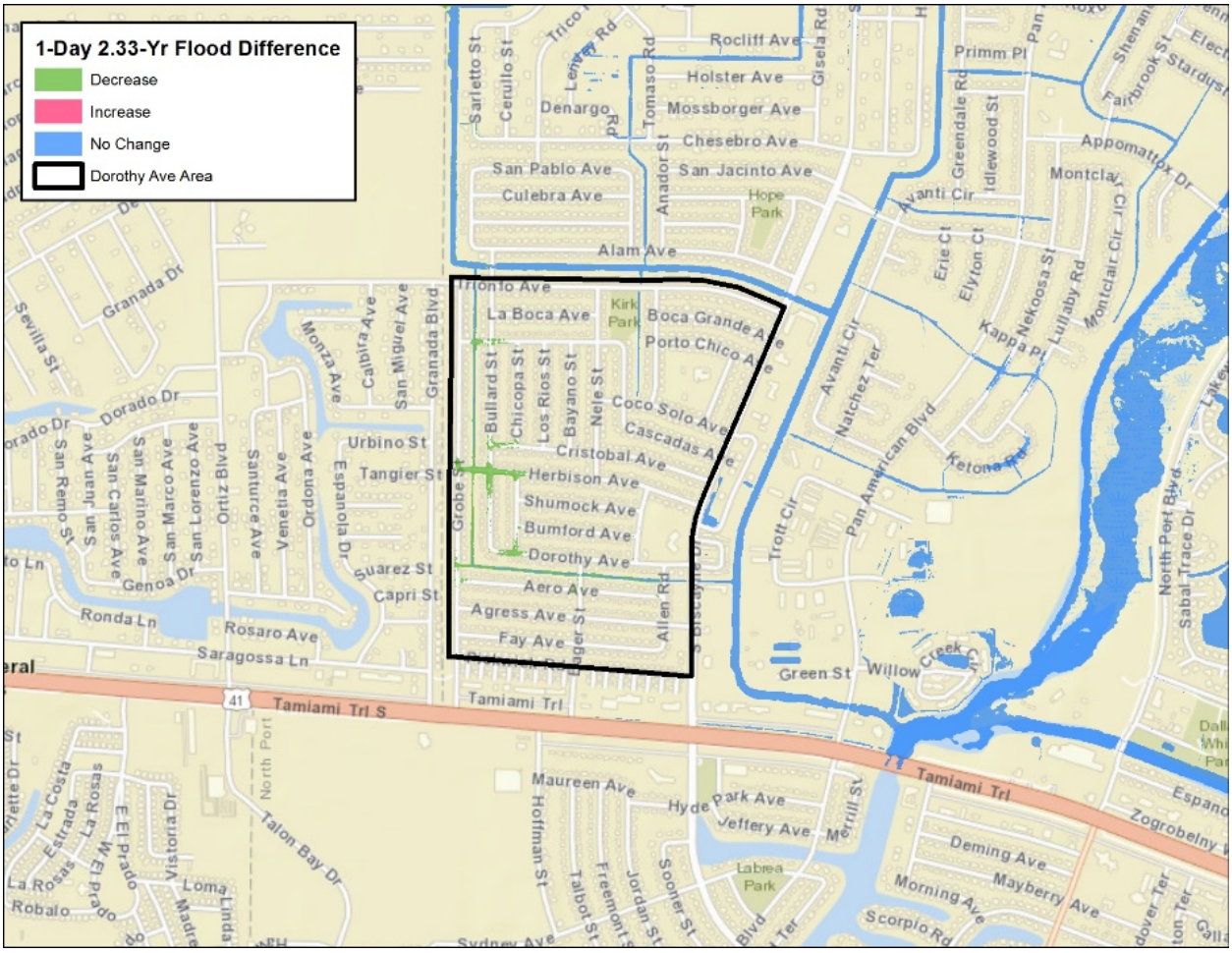



**Figure 15: 1-Day 2.33-Year Flood Difference Map, Dorothy Avenue Area**

**Flood Area Reduction for 1-Day 5-Year Event in the Dorothy Avenue Area**

Figure 15 illustrates reduced extents of inundation in the Dorothy Avenue area for the 1-Day 5-Year storm event for the full stormwater management master plan model.

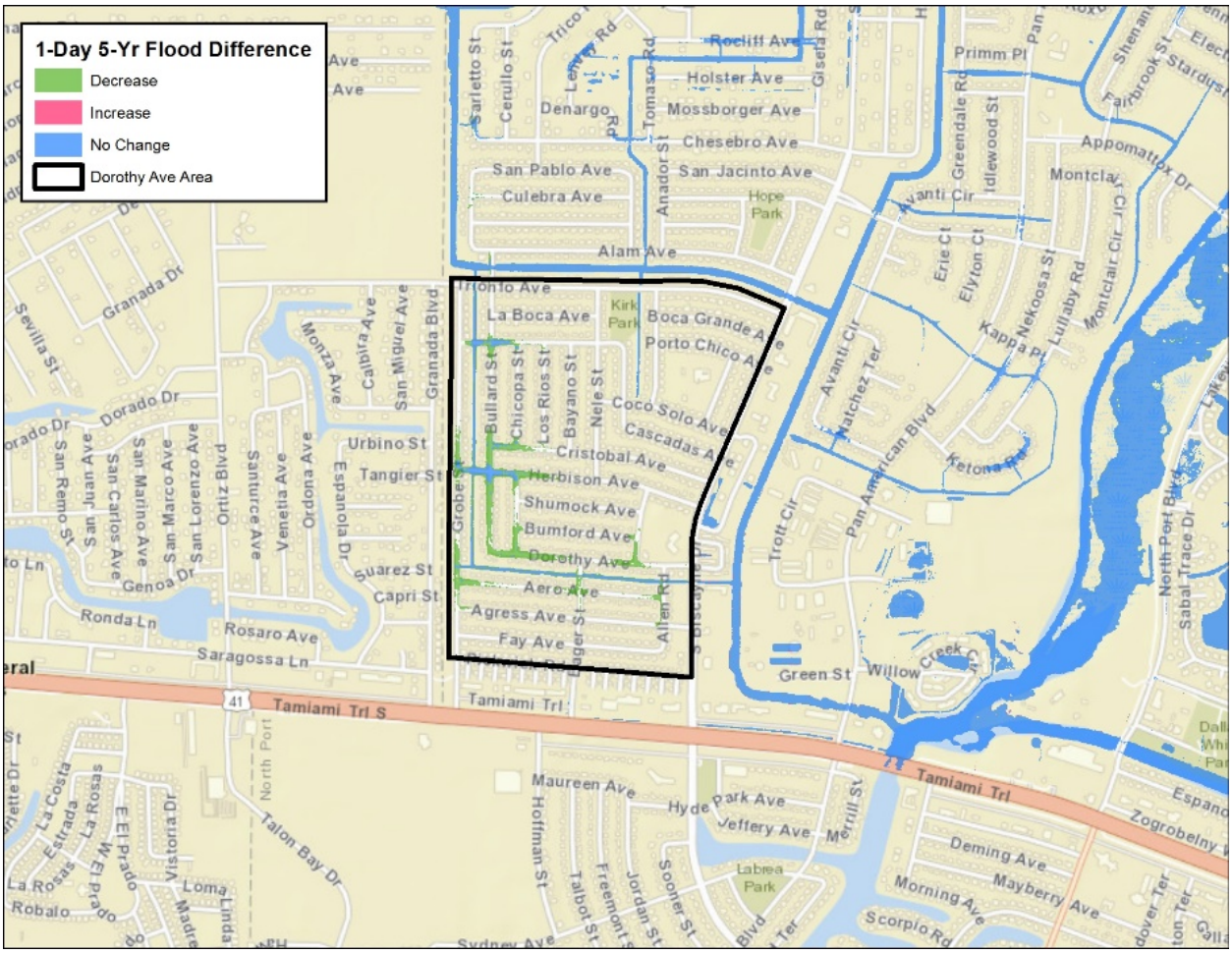



**Figure 16: 1-Day 5-Year Flood Difference Map, Dorothy Avenue Area**

**Flood Area Reduction for 1-Day 10-Year Event in the Dorothy Avenue Area**

Figure 16 illustrates reduced extents of inundation in the Dorothy Avenue area for the 1-Day 10-Year storm event for the full stormwater management master plan model.

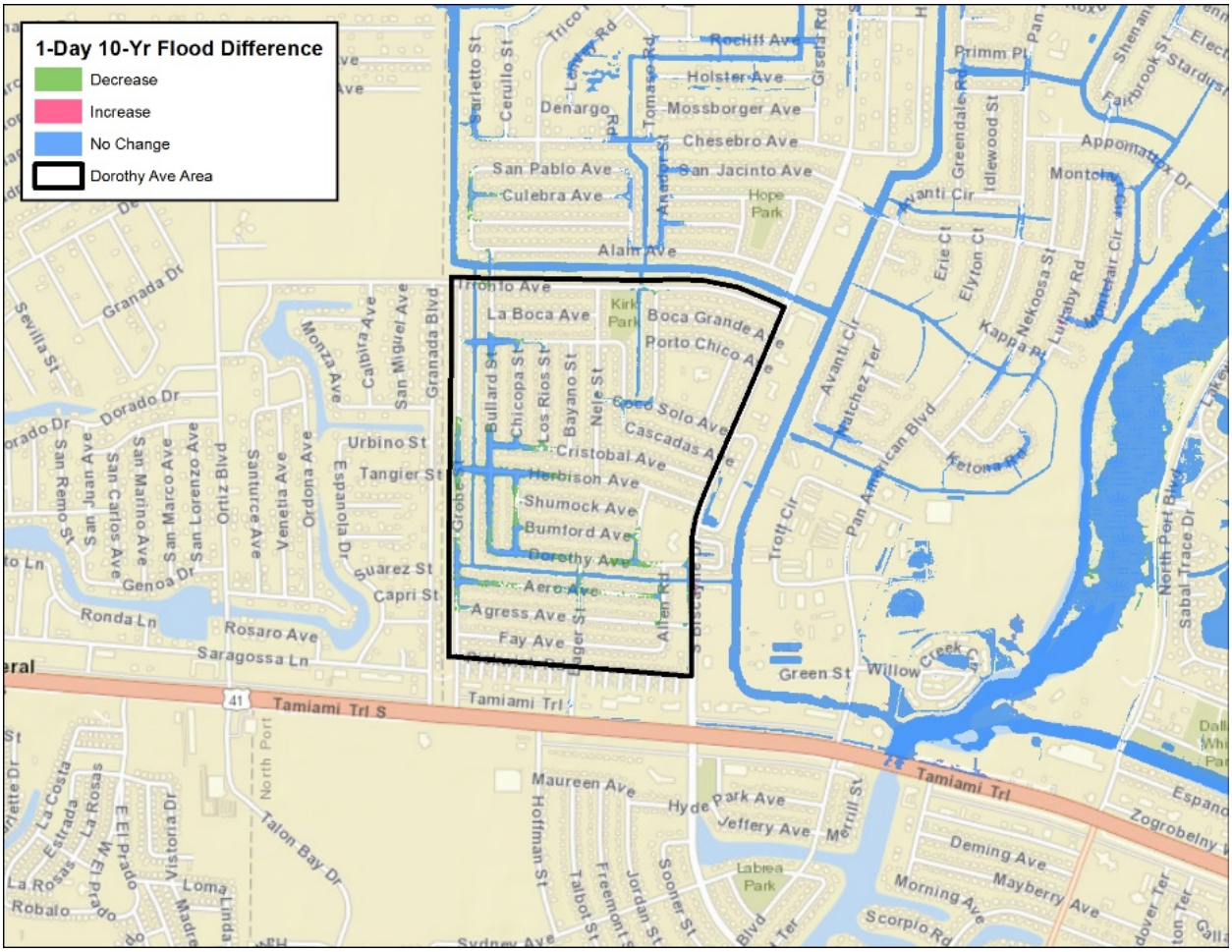



**Figure 17: 1-Day 10-Year Flood Difference Map, Dorothy Avenue Area**

**Flood Area Reduction for 1-Day 25-Year Event in the Dorothy Avenue Area**

Figure 17 illustrates reduced extents of inundation in the Dorothy Avenue area for the 1-Day 25-Year storm event for the full stormwater management master plan model.

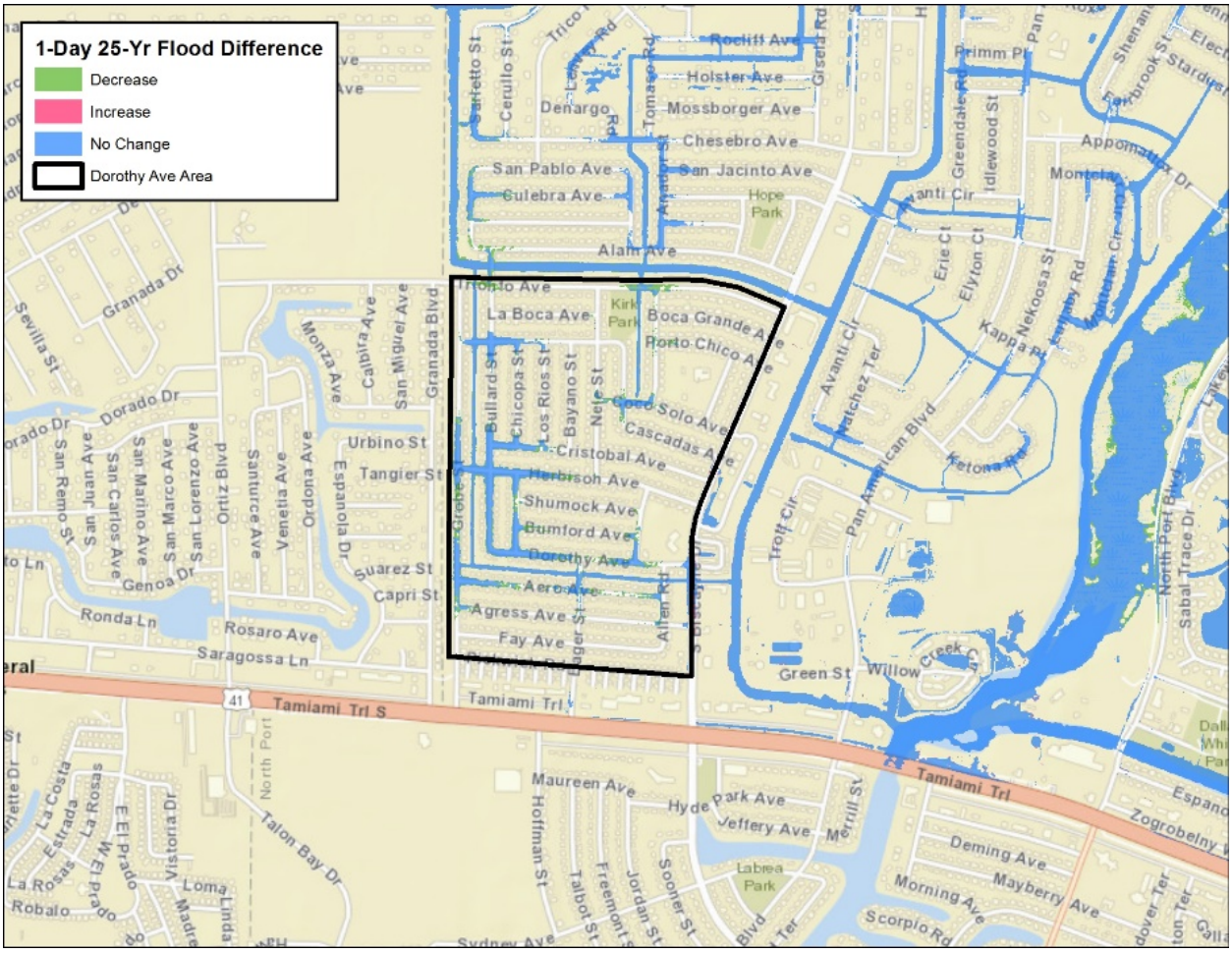



**Figure 18: 1-Day 25-Year Flood Difference Map, Dorothy Avenue Area**

**Flood Area Reduction for 1-Day 50-Year Event in the Dorothy Avenue Area**

Figure 18 illustrates reduced extents of inundation in the Dorothy Avenue area for the 1-Day 50-year storm event for the full stormwater management master plan model.

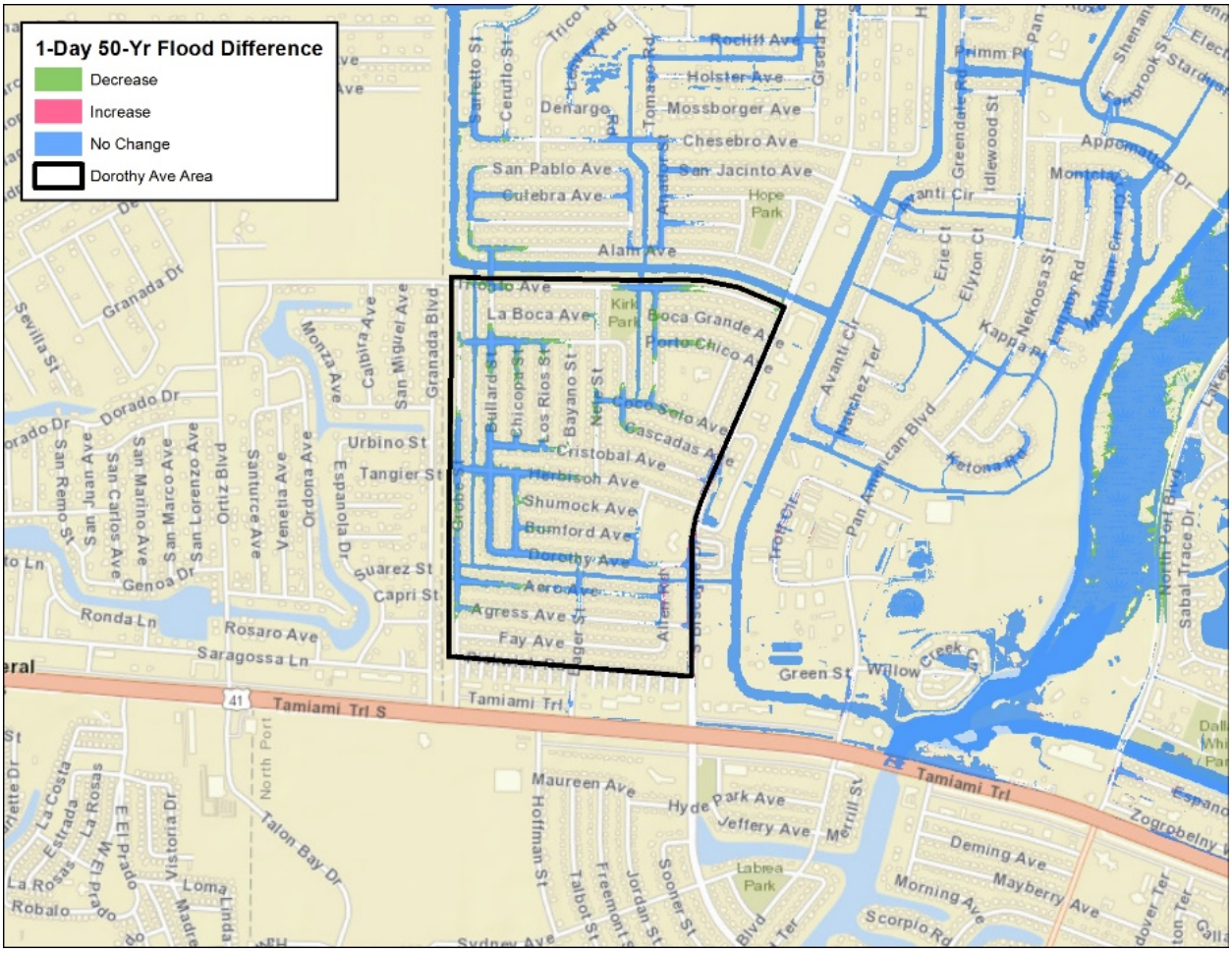



**Figure 19: 1-Day 50-Year Flood Difference Map, Dorothy Avenue Area**

**Flood Area Reduction for 1-Day 100-Year Event in the Dorothy Avenue Area**

Figure 19 illustrates reduced extents of inundation in the Dorothy Avenue areas for the 1-Day 100-Year storm event for the full stormwater management master plan model.

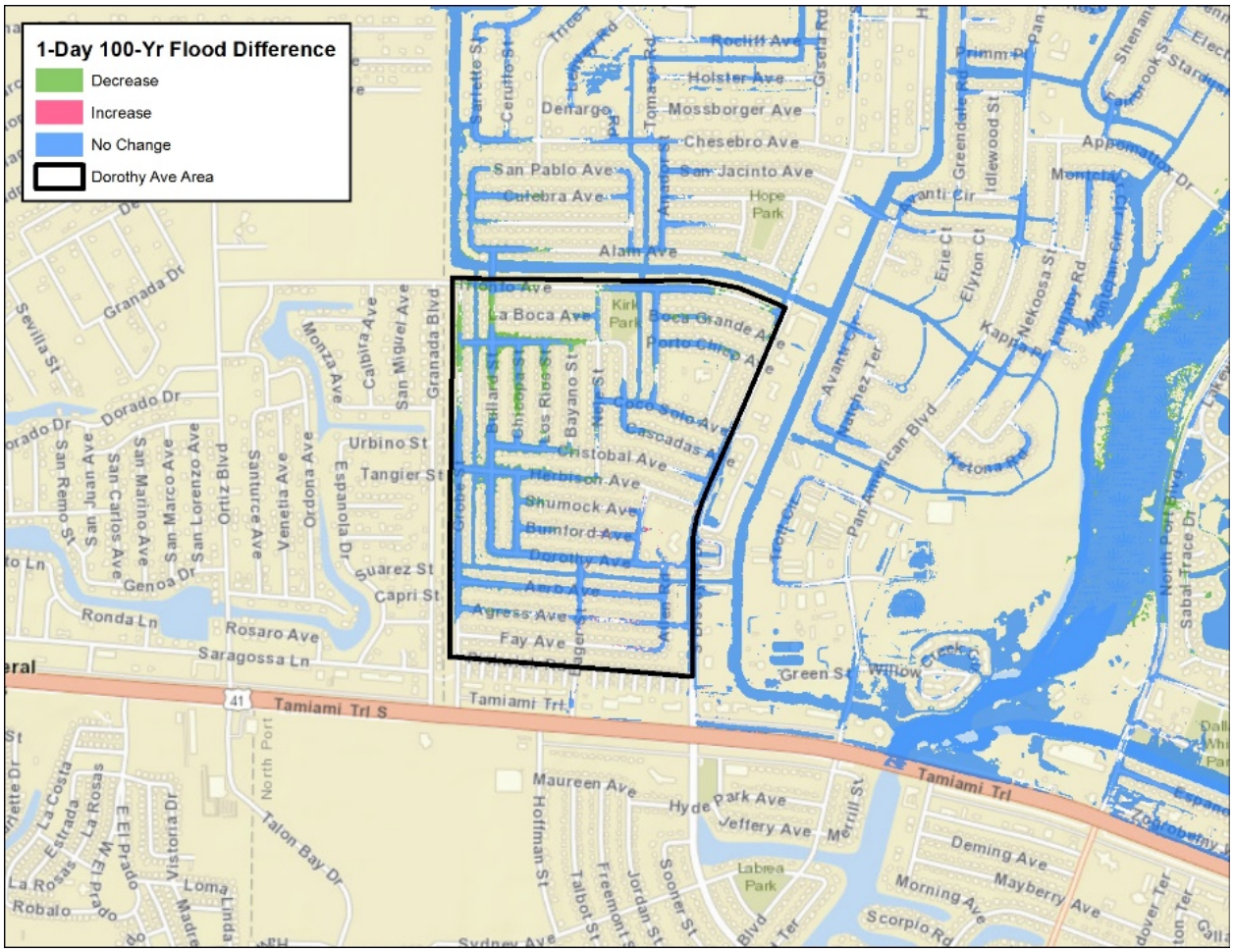



**Figure 20: 1-Day 100-Year Flood Difference Map, Dorothy Avenue Area**

It should be noted that the set of improvements proposed for the Dorothy Avenue area were conceived to carry higher inflows that would result from R-36 widening, with the primary objective being to carry those inflows without increasing localized flooding. As designed, the Dorothy Avenue area will also see flood reduction benefits. Those local flood reduction benefits are more noticeable for smaller storms. If R-36 widening is not performed, the Dorothy Avenue improvements could be adjusted to provide for local improvement only at lower cost and perhaps improved local flood reduction performance. Additionally, the local collection system was not evaluated for improvement. It is possible that additional flood reduction benefits could be achieved through local collection system improvements in this and other areas affected by the proposed primary conveyance system improvements.

# Appendix A

**Professional Engineering Services for the Big Slough Flood Reduction Study - Project Plan**

DeLoach Engineering Science, PLLC., November 2016

**Appendix B**

**Floodplain Justification Report for Big Slough/City of North Port**

**Sarasota County, Florida**

Ardaman & Associates, Inc., January 2011

**Appendix C**

**Watershed Management Program Consulting Services in the Big Slough Watershed (K883), Best Management Practices (BMP) Analysis Final Report**

Ardaman & Associates, Inc., September 2014

**Appendix D**

**Task 1.1.3 Big Slough Flood Reduction Study, Summary of Prior BMP Evaluations**

DeLoach Engineering Science, PLLC., November 2016

**Appendix E**

**Task 1.2 Big Slough Flood Reduction Study, Definition of Existing Flooding Problems**

DeLoach Engineering Science, PLLC., January 2017

**Appendix F**

**Task 1.4 Big Slough Flood Reduction Study, Potential Solutions for Hydraulic Evaluation**

DeLoach Engineering Science, PLLC., January 2017

# Appendix G

## Tasks 1.5 and 2.3 Big Slough Flood Reduction Study, Evaluate Performance of Selected Set of Alternatives

DeLoach Engineering Science, PLLC., May 2017

**Appendix H**

**Tasks 1.6 and 2.4 Big Slough Flood Reduction Study, Refine and Summarize Preferred Plan(s) for Improvement (interim status report)**

DeLoach Engineering Science, PLLC., October 2017

# Appendix I

## SWFWMD Resource Regulation Division Pre-Application Meeting Notes

## City of North Port – Flooding Alternatives PreApp

Southwest Florida Water Management District, November 2018

**Appendix J**

**North Port Big Slough Flood Reduction Study, Presentation to the North Port City Commission**

DeLoach Engineering Science, PLLC., December 2018