CITRUS COUNTY, FLORIDA
AND INCORPORATED AREAS
VOLUME 1 OF 2

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</tr>
<tr>
<td>INVERNESS, CITY OF</td>
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EFFECTIVE: September 26, 2014

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
12017CV001A
NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

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<td>C</td>
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APPENDIX

Appendix – Summary of Stillwater Elevations by Watershed and Junction
1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Citrus County, Florida including the Cities of Crystal River and Inverness and the unincorporated areas of Citrus County (referred to collectively herein as Citrus County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence, and the State (or other jurisdictional agency) will be able to explain them.

The Digital Flood Insurance Rate Map (DFIRM) and FIS Report for this countywide study have been produced in digital format. Flood hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM database specifications and geographic information standards. This information is provided in a digital format so that it can be incorporated into a local Geographic Information System (GIS) and be accessed more easily by the community.

1.2 Authority and Acknowledgments

1.2.1 Precountywide Analyses

Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below:

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Analysis Details</th>
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<tr>
<td>Citrus County (Unincorporated Areas):</td>
<td>The hydrologic and hydraulic analyses for the 1984 FIS report were performed by Gee &amp; Jenson Engineers-Architects-Planners, Inc., for FEMA under Contract No. H-4779. Flood elevation data for the Withlacoochee River and the Tsala Apopka Chain of Lakes was obtained from material prepared by the Southwest Florida Water Management District. That study was completed in March 1981 (FEMA, 1984a).</td>
</tr>
<tr>
<td>Crystal River, City of</td>
<td>The hydrologic and hydraulic analyses for the 1984 FIS report were performed by Gee &amp; Jenson Engineers-Architects-Planners, Inc., for FEMA under Contract No. H-4779. That study was completed in March 1981 (FEMA, 1984b).</td>
</tr>
<tr>
<td>Inverness, City of</td>
<td>The hydrologic and hydraulic analyses for the 1981 FIS report were performed by Gee &amp; Jenson Engineers-Architects-Planners, Inc. for FEMA under Contract No. H-4779. That study was completed in August 1980 (FEMA, 1981). A floodplain study on the Tsala Apopka Chain of Lakes was prepared by the Southwest Florida Water Management District (SWFWMD) in May 1977. That report gives lake stages for significant storms that were utilized in the 1981 FIS report.</td>
</tr>
</tbody>
</table>

1.2.2 This Countywide Analysis

For this countywide FIS, revised hydrologic and hydraulic analyses were prepared for FEMA by SWFWMD under Contract No. EMA-2006-CA-5613. Revisions to the hydrologic and hydraulic analyses were prepared for four watersheds by SWFWMD and several engineering firms (SWFWMD Contractors) as detailed below.

The hydrologic and hydraulic analyses for the Cardinal Lane Watershed, in Citrus County, Florida, were performed by Environmental Consulting & Technology,
Inc. (ECT) for the SWFWMD, under Agreement No. 07CC0000028. The work was completed in September 2012.

The hydrologic and hydraulic analyses for the Center Ridge Watershed, in Citrus County, Florida, were performed by Dyer, Riddle, Mills, and Precourt, Inc. (DRMP) for the SWFWMD, under Agreement No. 07CC0000026. The work was completed in August 2011.

The hydrologic and hydraulic analyses for the Crystal River Watershed, in Citrus County, Florida, were performed by Jones Edmunds & Associates, Inc. for the SWFWMD, under Agreement No. 07CC0000003. The work was completed in August 2010.

The hydrologic and hydraulic analyses for the Tsala-Apopka Watershed, in Citrus County, Florida, were performed by Brown & Caldwell (BC) for the SWFWMD. This project was authorized under SWFWMD Agreement Numbers 07CC0000044 (Floral City/Withlacoochee), 07CC0000012 (Inverness), and 07CC0000009 (Tsala-Apopka Outlet) for Watershed Management Program Consulting Services for Citrus County. The work was completed in December 2011.

Base map information shown on the Flood Insurance Rate Map (FIRM) was provided in digital format by the SWFWMD. The original orthophotographic base imagery was provided in color with a one-foot pixel resolution at a scale of 1” = 200’ from photography flown January – February 2011. The projection used in the preparation of this map was State Plane Florida West, and the horizontal datum used was HARN, GRS1980 spheroid, Geodetic Reference System 1980 (GRS80) Spheroid.

A countywide Light Detection and Ranging (LiDAR) coverage was used as the basis of the detailed hydrologic analyses as well as floodplain delineations. The countywide LiDAR is comprised of 2 different LiDAR projects. The first was flown by EarthData International, Inc. in February 2004, and processing was completed in May 2005. The second was flown by Woolpert, Inc. between January and March 2006, and the processing was complete by April 2007. Quality control for the LiDAR data was performed for the EarthData as well as the Woolpert data to ensure the vertical and horizontal accuracy meet FEMA standards.

1.3 Coordination

An initial meeting is held with representatives from FEMA, the community, and the study contractor to explain the nature and purpose of the FIS and to identify the streams to be studied or restudied. A final CCO (often referred to as the
Preliminary DFIRM Community Coordination, or PDCC, meeting) is held with representatives of the communities, FEMA, and the study contractors to review the results of the study.

1.3.1 Precountywide Analyses

The initial and final meeting dates for previous FIS reports for Citrus County and its communities are listed in Table 1: “Initial and Final Meeting Dates for Previous FIS Reports.”

Table 1: Initial and Final Meeting Dates for Previous FIS Reports

<table>
<thead>
<tr>
<th>Community</th>
<th>FIS Date</th>
<th>Initial Meeting</th>
<th>Final Meeting</th>
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<tr>
<td>Citrus County (Unincorporated Areas)</td>
<td>February 15, 1984</td>
<td>May 3, 1978</td>
<td>April 14, 1983</td>
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</table>

1.3.2 This Countywide Analysis

The scoping meeting was held on April 26, 2007, and attended by representatives of FEMA, the SWFWMD, and the communities.

The final CCO meeting was held on September 26, 2013 to review and accept the results of this FIS. Those who attended this meeting included representatives of Southwest Florida Water Management District (SWFWMD), the Study Contractor, FEMA, and the communities. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Citrus County, Florida, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.
2.1.1 Precountywide Analyses

A detailed storm surge and wave height analysis of the entire shoreline of Citrus County (115.3 miles) along the Gulf of Mexico, as presented in the 1984 FIS reports for the unincorporated areas of Citrus County and the City of Crystal River, was performed. Both the open coast surge and its inland propagation were studied. In addition, the added effects of wave heights were also considered.

The 1984 FIS for the unincorporated areas of Citrus County also included a detailed study of the Withlacoochee River, from its confluence with the Gulf of Mexico to the Citrus/Hernando County border, by the U.S. Army Corps of Engineers. A detailed study of the Tsala Apopka Lake system was included in this FIS as well. Remaining areas of the county having a low development potential or a minimal flood hazard were studied using approximate methods.

For the 1981 FIS report for the City of Inverness, detailed shallow flooding studies were performed on Grant and White Lakes as well as on numerous low lying areas throughout the city. In addition, a previous study for the Tsala Apopka Lake system based on stages from Southwest Florida Water Management District report was incorporated in this report. Approximate methods of analyses were used to study the remainder of the city since those areas had a low development potential and a minimal flood hazard.

2.1.2 This Countywide Analysis

For this countywide FIS, previous effective FIS reports and FIRMs were converted to countywide format, and the flooding information for the entire county, including both incorporated and unincorporated areas, is shown. Also, the vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD29) to the North American Vertical Datum of 1988 (NAVD88). The conversion was performed on a watershed-by-watershed basis and can be found in section 3.4 “Vertical Datum,” of this countywide FIS. All new hydrologic modeling, surveys, topographic data, and mapping will reference NAVD88 with vertical units measured in U.S. feet. All spatial data will be projected to the State Plane Coordinate System, Florida West, and will reference the High Accuracy Reference Network (HARN) with horizontal units measured in U.S. feet.

Although there are 20 watersheds in Citrus County, only four watersheds were studied in new detail: Cardinal Lane, Crystal River, Center Ridge and Tsala Apopka Watersheds, which cover approximately 34% of the County.

Final Floodplain Analysis Reports that were prepared for each of the above mentioned detailed watersheds (SWFWMD and Citrus County October 2012, November 2011, June 2011, July 2010, and March 2012) contain the hydrology
and hydraulics methodology used in detailed model development and their associated Geographic Watershed Information System (GWIS) databases contain the digital floodplain mapping as well as the relative watershed infrastructure data. Base flood elevations of these ponding areas studied in detail have been labeled on the FIRMs to the nearest tenth-of-a-foot.

Separate approximate analyses were not performed as part of this study; however, the four watersheds chosen for detailed analysis may contain basins that have areas of spackling which are not assigned Base Flood Elevations. Those approximate zones (spackle) are a result of the same detailed ICPR model study, but because these flood polygons are disconnected from the modeled node, it is not possible to determine the elevation of the flooding at those locations; therefore, they would be considered approximate zones. The scope and methods of study were proposed to and agreed upon by FEMA and Citrus County.

The Withlacoochee River was redelineated from its confluence with the Gulf of Mexico to the Citrus/Hernando County boundary. The redelineation was based upon updated topographic information and used the Watershed Information System (WISE) in conjunction with ArcGIS software to complete the process.

No streams were studied by detailed methods as part of this countywide FIS.

For this countywide FIS, coastal zones were redelineated and a datum shift from NGVD1929 to NAVD1988 was applied. This value can be found in section 3.4, “Vertical Datum.”

This countywide FIS also incorporates the determination of letters issued by FEMA, resulting in Letters of Map Change as shown in Table 2, “Letters of Map Change (LOMCs).”

**Table 2: Letters of Map Change (LOMCs)**

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<thead>
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<td>92-04-033P</td>
<td>March 13, 1992</td>
<td>Gulf of Mexico – V-zone determination for lots 41 &amp; 42 -- Dixie Shores, Unit 1</td>
</tr>
<tr>
<td>92-04-090P</td>
<td>November 4, 1992</td>
<td>Tsala Apopka lake</td>
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2.2 Community Description

Citrus County occupies an area of approximately 773 square miles (with about 100 square miles of inland surface-water area) on the western coast of Florida. The county stretches approximately 115 miles along the Gulf of Mexico from Hernando County on the south to Levy County on the north. Marion County borders on the northeast and Sumter County borders on the east. The City of Inverness, the county seat, is located approximately 61 miles northwest of Orlando, 62 miles north of Tampa, and 27 miles southwest of Ocala. There are only two incorporated cities in Citrus County, Inverness, and Crystal River.

The U.S. Census Bureau estimated the 2011 population of Citrus County at 141,031, which represented an increase of approximately 19.4 percent over the 2000 census of 118,085 (U.S. Census Bureau, 2012). According to the Comprehensive Plan, the County has experienced the most substantial growth in the past 20 to 25 years and is one of the fastest growing counties in Florida as well as the U.S. The county’s population is projected at 165,400 by 2020 (Citrus County, 2012).

While the population of Citrus County has been growing, much of the County is still rural. More than 60,000 acres, or approximately 33% of Citrus County, have been set aside for conservation and wildlife preservation, protection of surface and groundwater, and recreation; these areas include the Crystal River and Chassahowitzka National Wildlife Refuges, Withlacoochee State Forest, Lake Rousseau State Recreation Area, Flying Eagle Ranch, and Potts Preserve (the last two were Save Our Rivers projects purchased through the South Florida Water Management District). Agriculture/silviculture land use has decreased to approximately 19% of the land use (in 2004) in the unincorporated areas of the county, but this component continues to be a significant component of the local economy; agriculture and silviculture primarily consists of production of citrus and diversified produce, timber, and cattle. Residential and commercial land use makes up approximately 19% of the unincorporated area of the county. Residential developments are scattered throughout the county, with commercial development along major highways near concentrations of residential development. Residential development occupies approximately 22% of the land use in the City of Inverness (in 1995) and approximately 13% in Crystal City (in 1996).

The major streams within the county are the Withlacoochee River in the north and east and the Crystal River in the west.

The Withlacoochee River is a black water river originating from the headwaters of the Green Swamp in Pasco, Sumter, Polk, and Lake Counties. This river flows northwesterly and westerly approximately 160 miles to the Gulf of Mexico near
Yankeetown and forms the eastern and northern boundaries of the county. The river's drainage area encompasses approximately 1,980 square miles. Lake Rousseau, located in the extreme north portion of the County, results from impoundment of the Withlacoochee River. Citrus County includes a short section of the Cross Florida Barge Canal from the Gulf of Mexico to Lake Rousseau; this canal was planned to connect the Gulf Mexico and the Atlantic Ocean, but the project was cancelled and only portions were built.

The Crystal River flows in a northwesterly direction, extending approximately six to seven miles to the Gulf of Mexico from its headwaters in the coastal lowlands of the county. This is a spring-fed river with a relatively small drainage area. The Homosassa River, Halls River, and Chassahowitzka River are similar spring-fed rivers extending from the coastal lowlands west to the Gulf.

The Tsala Apopka Chain of Lakes has a total area of about 24,000 acres, and includes three separate pools designated as Floral City, Inverness, and Hernando. The pools generally flow northwesterly through the Hernando Pool and the Tsala Apopka Outfall Canal to the Withlacoochee River.

Citrus County can be divided into four topographic regions: coastal swamps, Gulf coastal lowlands, the Brooksville Ridge, and the Tsala Apopka Plain. The coastal swamps extend inland about two to five miles and include tidal marshes and coastal swamps, with elevations from sea level to about 9 feet NAVD. The Gulf coastal lowlands lie to the east between the coastal swamps and the Brooksville Ridge and are about eight miles in width. These areas are characterized by poorly drained low relief, with extensive swamps, marshes, and terraces. The Brooksville Ridge extends north-south in the central portion of the county, varying from 17 miles in width at the southern end to five miles in width in the north. This area consists of sandhills and limestone ridges modified by karst activity; the maximum elevation in the county is found here at 236 feet NAVD. The Tsala Apopka Plain lies between the Brooksville Ridge and the Withlacoochee River. This area is characterized by gently rolling terrain, ranging from 34 to 74 feet NAVD, with peninsulas and islands divided by a large number of interconnected lakes.

Citrus County is at the northern edge of the humid subtropical climate regime. Much of the rainfall occurs in summer between June and September and coincides with the hurricane season. Mean annual rainfall is approximately 56 inches, but annual rainfall ranges from 36 to 86 inches (based on data for Inverness from 1915 through 1985). Maximum monthly rainfall was recorded at 17.4 and maximum daily rainfall was recorded at 10.5 inches. The mean annual temperature is approximately 71 degrees Fahrenheit (F.). The highest average monthly temperature occurs in August at 82 degrees F. The lowest average monthly temperature occurs in January at 60 degrees F.
Vegetation in the study area is typically subtropical. Vegetation varies from salt marshes and mangrove communities along the coast; to freshwater hardwood swamps and marshes in low lying areas; to oak/maritime hammock uplands, South Florida Flatwoods, and pine/oak scrub communities in more upland areas.

The following has been provided in an effort to explain in more detail the community descriptions specifically belonging to the watersheds studied in detail within Citrus County for this countywide FIS.

The Cardinal Lane Watershed, located in Citrus County, Florida, has an area of 56.8 square miles (36,343 acres). The watershed is bound by the Homosassa River Watershed to the north, the Central Ridge Watershed to the east, and the Chassahowitzka River Watershed to the south. U.S. Highway No. 19/98 (U.S. 19/98) crosses the watershed in a north-south direction in the western part of the watershed, and County Road 491/Lecanto highway (CR 491) crosses the watershed in a north-south direction in the eastern part of the watershed. Cardinal Lane runs east-west of the watershed. The part of the watershed west of U.S. 19/98 is primarily wetlands and estuarine marshes. Along the U.S. 19/98 corridor, the watershed is mainly urbanized and land use includes primarily commercial, institutional, industrial, and residential areas of various densities. Sugarmill Woods subdivision, a high density residential area, is located east of U.S. 19/98 in the southern part of the watershed. The central area of the watershed is a patchwork of low density residential areas. From CR 491 to the eastern boundary, the watershed is mostly forested, primarily long leaf pines mixed with oaks. Lecanto Government Complex, Lecanto High School, and Lecanto Community College are located west of CR 491 near the northern edge of the watershed. An active mining plant is located east of CR 491 close to the Lecanto Government Complex. The watershed is a typical “deranged” watershed, that is, with no discernible stream, river, or creek network.

The Center Ridge watershed is approximately 35,307 acres (55 square miles) in size and is generally located between the city of Inverness and the Lecanto area. The Center Ridge Watershed is bound by the Tsala Apopka Watershed to the east, the Chassahowitzka River Watershed to the south, the Cardinal Lane, Homosassa South Fork, and Crystal River Watersheds to the west and the Withlacoochee River Watershed to the north. The Center Ridge watershed is characterized by sparsely developed, mostly wooded areas in the south, and rural land uses of improved pastures and forests interspersed with residences and settlements to the north. A grid-like pattern of unpaved access roads runs through the less developed areas to the south. A collection of larger commercial and industrial buildings can be found along SR44, which acts as the divide between the more developed and less developed portion of the watershed. An urbanized corridor traverses through the watershed along CR 486 highlighted by several housing developments and commercial buildings. The topography is
characterized by depressional areas that are almost entirely isolated and land-locked. The largest body of water is the Lake Nina (also known as Hog Pond), which is located in the east. The watershed falls completely within Citrus County.

The Crystal River Watershed encompasses approximately 72 square miles in the western portion of Citrus County. The watershed boundary was amended as SWFWMD requested in early 2009 to include 2.2 square miles of the Ozello watershed, which neighbors Crystal River to the south. The watershed is bordered on the west by Kings Bay and the Crystal River. Adjacent watersheds include Ozello, Homosassa North, Homosassa South Fork, Center Ridge, the Withlacoochee River, and Red Level. The watershed is bisected by an approximately 10-mile long, 350-foot-wide power easement from the northwest to the southeast. The watershed consists of primarily closed and a few dendritic sub-basins. Nearly half of the watershed has been developed. Classification of the remaining area is mostly split between upland forests and wetlands with some agricultural areas present. The topography is characterized by higher elevations in the eastern portion of the watershed sloping downward toward Kings Bay in the west.

The original Tsala Apopka watershed consisted of the City of Inverness, Floral City, residential areas, agricultural areas (primarily described as crop and pasture land), and many marshes and lakes including Big Spivey Lake, Bradley Lake, Floral City Lake, Henderson lake, Hernando Lake, and Lake Tsala Apopka. The Tsala Apopka model and floodplain files, however, were only developed for the 79.2 square miles of the upland portion of the watershed due to the complex interaction between the Withlacoochee River and the Tsala Apopka chain of lakes. The lakes will be modeled separately as part of the Withlacoochee River model by others and are not included in this study. The upland portion of the former Tsala Apopka watershed became known as the Tsala Apopka watershed and the remaining portions were merged with the Withlacoochee River Basin. The revised Tsala Apopka watershed is bordered by the Withlacoochee River Watershed to the north and east (the Withlacoochee River Watershed includes former watersheds Tsala-Apopka Outlet, Inverness, Floral City, Shinn Ditch, and Leslie Heifner Canal), Mckethan Lake Outlet to the south, Lizzie Hart Sink and Chassahowitzka River watersheds to the southwest, and Center Ridge to the west.

2.3 Principal Flood Problems

General flooding in Citrus County results from periods of intense rainfall causing ponding and sheet-runoff in low, poorly-drained areas.
The northern and eastern portions of the county lie within the floodplain of the Withlacoochee River and have been subject to several historical floods during high river stages. In recent years, floods causing significant damage along the Withlacoochee River are reported to have occurred in 1934, 1950 and 1960 (SWFWMD, 1975). The United States Geological Survey (USGS) gage records at Croom, Florida, indicate that the 1934 and 1950 storms had a magnitude that would occur on the average once in 75 and 60 years, respectively (75 and 60 year recurrence intervals). The Tsala Apopka Chain of Lakes is subject to flooding during periods of intense rainfall or during periods of high Withlacoochee River stages. Flooding occurs in the City of Inverness as a result of the increase in stages of the adjoining lakes and as a result of ponding in depressed areas.

Coastal flooding in Citrus County, including the City of Crystal River, results primarily from tidal surge caused by hurricanes and tropical storms, and from overflow of the streams caused by rainfall and runoff. Not all storms which pass close to the study area produce extremely high tides. Similarly, storms which produce extreme conditions in one area may not necessarily produce critical conditions in other parts of the study area.

Tropical storms and hurricanes passing Florida in the vicinity of Citrus County have produced severe floods as well as structural damage. Citrus county has been affected by tropical weather systems over 130 times since 1886 (Citrus County, 2010). A brief description of several significant tropical storms provides historic information to which coastal and riverine flood hazards and projected flood depths can be compared (FEMA, 1981; FEMA, 1984a; FEMA, 1984b; Citrus County, 2010; NOAA, 2012).

1950 (Hurricane Easy)

Heavy flooding was recorded after nearly 40 inches of rain.

March 15-18, 1960

Between March 15 and 18, 1960, exceptionally heavy rains fell on most of the Florida Peninsula. The NOAA Weather Station in Inverness recorded 14.58 inches of rainfall for this period. This heavy rainfall raised the Lake Tsala Apopka stage to 42.54 feet on March 29, 1960. Although the rainfall at Inverness was estimated to be a 90-year storm (a storm which would occur on the average, once in 90 years), the stage on Lake Tsala Apopka only related to a 30-year flooding event.

September 1964 (Hurricane Dora)

Reports from local residents in Crystal River indicate that flooding occurred in September 1964 as a result of Hurricane Dora. Dora was the first hurricane of
record to move inland from the east over extreme northeastern Florida. High water marks reported by local residents and surveyed by Moorehead Engineering Company showed high water elevations of about 5 feet above NGVD in the City of Crystal River, a stage that would occur on the average about once every 20 years (approximately a 20-year recurrence).

June 25-28, 1974

During the storm of 1974, an estimated 17.74 inches of rain resulted in severe flooding.

March 12-16, 1993

A March 1993 storm event resulted tidal surges between 8 and 12 feet. More than 3,100 homes in Citrus County were damaged. The City of Crystal River’s offices were flooded, damaging important documents and the entire fleet of fire trucks. Businesses along Citrus Avenue and US 19 were also damaged.

October 1996 (Tropical Storm Josephine)

Severe flooding caused property damages that exceeded $2.9 million.

January – April, 1998

The Withlacoochee River at Holder crested at 10.5 feet (2.5 feet above flood stage of 8 feet). Up to 200 homes in the Arrowhead subdivision near SR 200 were damaged by floodwaters and property damages exceeded $3.625 million.

June 2003

The records used for the Cardinal Lane Watershed model calibration and verification for this countywide FIS came from observations during and after the storm event of June 2003.

The City of Crystal River and Citrus County staff took photographs of flooded properties and roads after a large rainfall event occurring on June 20, 2003. Most photographs were taken on June 22 or June 23. Points were collected at locations of known flooding as well as lines to show roadways with standing water. In addition, residents of Citrus County provided Special Flood Reports to the SWFWMD reporting property flooding. Because this rain event provided much better data than Hurricane Dennis for the Crystal River Watershed, it was used for the Crystal River Watershed model verification. According to NEXRAD data obtained from the District website, the June 20, 2003 storm event, which actually covers June 18-23, dropped an average of 11.6 inches of rain on the Crystal River area in the 120-hour period.
August – September, 2004 (Hurricanes Charley, Frances, Ivan, Jeanne)

In 2004, four consecutive hurricanes hit Florida, impacting Citrus County, the City of Crystal River, and the City of Inverness. Hurricane winds pushed water up the Withlacoochee River, which overflowed its banks and flooded structures and roads. The river exceeded flood stage (29 feet) at 30.41 feet at Dunnellon on September 27 and reached a record high of 10.86 feet at Holder on September 30. Widespread flooding also occurred due to excessive rainfall and saturated soils.

Hurricane Dennis (July 9-11, 2005)

Hurricane Dennis was originally suggested to be used as a verification run for the Crystal River Watershed for this countywide FIS report; however, according to the National Weather Service, less than 3.5 inches of rain fell on the Crystal River area as a result of Hurricane Dennis. Flooding witnessed after that event was mostly attributed to storm surge from the bay. Because of this, Hurricane Dennis was not used for verification purposes of the Crystal River Watershed ICPR model for this countywide FIS report.

August 21, 2008 (Tropical Storm Fay)

Widespread heavy rain of 6-9 inches fell across the county. Scattered tree damage was found throughout the county but no major damage was reported. Minor flooding due to above normal tides was reported in Old Homosassa and Crystal River.

June 23, 2009

NEXRAD rainfall was obtained from the SWFWMD and processed into ICPR compatible format. Most flooding reports after this event were maintenance related, however, 26 complaints were identified with comments such as “DRA overwhelmed”, “historic problem”, etc, that indicated flooding resulted from heavy rainfall and were considered potential verification locations. The June 23, 2009 storm event had a non-uniform rainfall distribution over the Tsala Apopka Watershed. Depending on location, the total rainfall volume varied from 1 inch to 5.9 inches. The storm had a peak intensity of about 3.2 in/hr at the verification locations.

March 28-31, 2011

Another set of verification information for the Cardinal Lane Watershed came for this countywide FIS came from a set of 14 photos taken by District engineers on March 31, 2011 after a large storm event of 9.32 inches occurred.
This rainfall event was also used for verification purposes for the Tsala Apopka Watershed for this countywide FIS. The storm event had a total rainfall of over 8 inches in many areas of the watershed. The peak intensity at the verification locations was 2.5 in/hr.

May 29, 2012 (Tropical Storm Beryl)

Tropical Storm Beryl produced an area of 5 to 8 inches of rain that caused flooding in an area bounded by Brooksville to Inverness to Homosassa Springs. One home in the 5600 block of South Hills Point had 31 inches of water in the home. Several other homes in the area had 8-14 inches of water in the home.

June 25-26, 2012 (Tropical Storm Debbie)

NEXRain grid rainfall data was provided by the SWFWMD for tropical storm Debbie. Based on this data, the amount of rain that fell within Citrus County during this storm event over the period of June 23, 2012 to June 27, 2012 ranged between 8.2 and 13.2 inches. The SWFWMD also had infrared aerial photography flown approximately two days after this storm event to document flooding in the most impacted portions of the County. The Kings Bay neighborhood had significant flooding and several streets were flooded in Homosassa with up to 2 feet of water covering roadways.

2.4 Flood Protection Measures

The Southwest Florida Water Management District maintains and operates 15 water level control structures in Citrus County. These structures help provide flood protection, manage lake water levels and prevent salt water from flowing up freshwater streams and creeks.

The Bradley Water Control Structure is located just off CR 48 in Floral City. Its gate can be manually operated to help maintain water levels on Lake Bradley.

The Brogden Bridge Culvert is located just east of Brogden Bridge on East Turner Camp Road in Inverness. It is a manually operated stop log structure that maintains water levels within the Inverness and Hernando pools of the Tsala Apopka Chain of Lakes.

The Brogden Bridge Water Control Structure is located just north of Brogden Bridge on East Turner Camp Road in Inverness. The structure’s gates can be remotely operated to control flow between the Inverness and Hernando pools of the Tsala Apopka Chain of Lakes.
The Bryant Slough Water Control Structure is located east of Inverness on SR 44. Its gates can be remotely operated to help maintain water levels in the Inverness pool of the Tsala Apopka Chain of Lakes.

The Consuella Water Control Structure is located on CR 48 in Floral City. Stop logs are used to help maintain water levels in Lake Consuella.

The Floral City Water Control Structure is located on the Orange State Canal east of Floral City. The structure’s gate, which is normally closed, can be remotely operated to allow water from the Withlacoochee River into the Tsala Apopka Chain of Lakes.

The Flying Eagle Berm is located east of Inverness inside the Flying Eagle Preserve. The structure is part of a two-year project to assess flow rates and total volume of water that might be diverted from the Withlacoochee River to the Floral City pool of the Tsala Apopka Chain of Lakes. It is a manually operated stop log structure.

The Golf Course Water Control Structure is located on East Sandpiper Drive in the Inverness Golf & Country Club. The structure’s gates can be remotely operated to help maintain water levels in the Floral City and Inverness pools of the Tsala Apopka Chain of Lakes.

The Inglis Main Dam is located at the west end of Lake Rousseau, spanning the Withlacoochee River in Citrus and Levy counties. The gates of the Main Dam are normally closed while the Inglis Bypass Spillway is used to maintain water levels. During periods of increased flows that exceed the operating capacity of the Bypass Spillway, the Main Dam will be operated to discharge the excess flow into the Gulf of Mexico. Its gates can be remotely operated, and a generator supplies backup electrical power to the structure in the event of a power outage.

The Leslie Heifner Water Control Structure is located east of Floral City on the Leslie Heifner Canal at Trails End Road. The structure’s gate, which is normally closed, can be remotely operated to allow water from the Withlacoochee River into the Tsala Apopka Chain of Lakes.

The Moccasin Slough Water Control Structure is located east of Inverness on East Moccasin Slough Road. The structure’s gates can be remotely operated to help maintain water levels between the Floral City and Inverness pools of the Tsala Apopka Chain of Lakes.

The Orange State Water Control Structure is located east of Floral City, just off East Trails End Road, and it connects the Orange State Canal with the Withlapopka Island area. Stop logs can be removed to allow water to flow from
the Orange State Canal to the Withlapopka Island wetlands; but during flood conditions, stop logs are installed to help prevent flooding downstream.

The S-353 Flood Control Structure is located on the Tsala Apopka outfall canal, between the northern limit of the Hernando pool of the Tsala Apopka Chain of Lakes and the Withlacoochee River. Its gates can be remotely operated to maintain optimum water levels in the Hernando pool of the Tsala Apopka chain. The canal serves as the outfall for the lake chain during potential flood events.

The Van Ness Water Control Structure is located at the northern end of the Hernando pool of the Tsala Apopka Chain of Lakes on the outfall of Two Mile Prairie. When sufficient water is available, the structure can be remotely operated to manage local water levels.

The Wysong-Coogler Water Conservation Structure is located at the District’s Wysong Park in Lake Panasoffkee. The structure spans the Withlacoochee River in Citrus and Sumter counties just north of the Lake Panasoffkee Outlet River. The structure’s inflatable dam can be remotely operated to help maintain water levels in Lake Panasoffkee and the Tsala Apopka Chain of Lakes. This structure also has a boat lock and an airboat slide to allow navigation of the Withlacoochee River.

During non-flooding conditions, the Leslie Heifner and Floral City water control structures, and the Flying Eagle Culverts, will be operated to maximize the diversion of the Withlacoochee River flows into the Tsala Apopka Chain of Lakes consistent with any applicable minimum flows established for the Withlacoochee River, or other environmental protection requirements. Once opened the Leslie Heifner and Floral City water control structures will typically remain in the full open position for navigation until such time flow reversal is imminent, at which time the structures will be closed until positive flow conditions return. The Flying Eagle Culverts will typically remain open, but will be closed to prevent the loss of water from Floral City Pool to the river.

The Golf Course and/or Moccasin Slough structures will be operated in concert with one another to allow two-thirds (2/3) of the diverted river water to pass into the Inverness Pool, and one-third (1/3) of the diverted river water will be allowed to pass through the Brogden Bridge Structure into the Hernando Pool. Structure gate settings will be adjusted, as needed, to maintain the equal 1/3 – 1/3 – 1/3 apportionment of the river inflows between the three pools.

The latest SWFWMD operation schedule was established on June 15, 2012. Please note that the operation schedule is under control of the SWFWMD and can be modified at any time. For the most current schedule, contact the SWFWMD at 352.796.7211 or www.watermatters.org.
Numerous structures (culverts and inlets) have been built along U.S. 19/98 and the Sugarmill Woods subdivision to control surface runoff within the Cardinal Lane Watershed. Complete drainage networks of pipes and detention ponds have been built in the area in and around Lecanto Government Complex, Lecanto High School, and Lecanto Community College (located west of CR 491 near the northern edge of the watershed).

The remainder of the county has no measures designed and constructed specifically for the purpose of flood protection other than small surface water management systems constructed with new development. The coastal region, which is subject to flooding due to storm surges caused by hurricanes, has some inherent protection offered by vegetation and terrain characteristics and existing highways such as U.S. 98 which has been taken into account in this study.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analysis

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting Citrus County, including both riverine and coastal sources.

3.1.1 Methods for Flooding Sources Incorporated from Previous Studies

Hydrologic analyses were carried out for Grant and White Lakes and other large depressed areas studied in the City of Inverness. Rainfall for the 100-year, 5-day storm was derived from U.S. Weather Bureau Technical Publications 40 and 49.
(U.S. Weather Bureau, 1978; U.S. Weather Bureau, 1965), and was determined to be 15.8 inches. The runoff from areas draining into each lake or depression produced by this rainfall was computed by using methods presented in the Soil Conservation Service Technical Release #55, and National Engineering Handbook, Chapter 4 (NEH-4) (U.S. Department of Agriculture, 1975; U.S.D Department of Agriculture, 1972).

The hydrologic data for the Withlacoochee River was taken from Flood Hazard Information, Withlacoochee River, Nobleton to Gulf of Mexico, Florida dated August 1976 (USACE, 1976b). The report presented flood profiles for the mean annual, 10-, 4-, 2-, and 1-percent-annual-chance floods, and the Standard Project Flood. The 0.2-percent-annual-chance flood profile was determined by plotting the various frequency floods on probability paper at various locations on the river and extrapolating the 0.2-percent-annual-chance flood elevation. Standard peak discharge-drainage area relationship information for the Withlacoochee River was not included in the Citrus County Unincorporated Areas February 15, 1984 Flood Insurance Study, therefore, could not be incorporated into this Countywide Flood Insurance Study.

The hydrologic data for the Tsala Apopka Chain of Lakes was taken from “Flood Plain Information on the Tsala Apopka Chain of Lakes, Citrus County, Florida” dated May 1977 (Southwest Florida Water Management District, May 1977). The report presented flood elevations for the various recurrence intervals for the three pools in the Tsala Apopka Chain of Lakes presented in Table 3.

Table 3: Summary of Stillwater Elevations

<table>
<thead>
<tr>
<th>Flooding Source and Location</th>
<th>Elevation (feet NAVD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-Percent-Annual-Chance</td>
</tr>
<tr>
<td>Tsala Apopka</td>
<td></td>
</tr>
<tr>
<td>Henderson and Little Spivey Lakes at Inverness</td>
<td>41.0</td>
</tr>
<tr>
<td>White Lake</td>
<td>*</td>
</tr>
<tr>
<td>Grant Lake</td>
<td>*</td>
</tr>
<tr>
<td>Floral City</td>
<td>42.6</td>
</tr>
<tr>
<td>Hernando</td>
<td>39.7</td>
</tr>
</tbody>
</table>

*Data Not Available
Coastal storm frequencies (number of occurrences per year) were determined using the Joint Probability Method as developed by Vance Myers, and recommended by the National Academy of Sciences (NOAA, 1970). The Joint Probability Method enables one to create a number of simulated storms based on an analysis of historical records. Characteristics analyzed included the frequency at which storms enter the study area, and the probabilities associated with the size and intensity of a given storm.

A statistical analysis was performed to derive the probability distributions (range of parameter values versus their associated probabilities) for the principal parameters which describe a hurricane or tropical storm; these are the central barometric pressure (measures intensity of a storm), the radius to maximum winds (measures the lateral extent of a storm), the forward speed, and the direction of travel. An analysis was also performed to determine the frequency with which hurricanes and tropical storms penetrate the west Florida coast or pass offshore if parallel to the coast.


By combination of all parameters each with its associated probability, a large number of simulated storms can be numerically modeled, each with its own unique probability (Joint Probability). The probability of each resulting storm surge is then combined with the storm recurrence rate (frequency at which storms strike the coast) and the corresponding frequency (events of this surge height per year) for each storm surge determined. This procedure permits the simulation of many years of record, from which reliable estimates of flood recurrence intervals can be made. As a final step in the calculations, the astronomic tide of the study area was combined with the computed storm surge to yield recurrence intervals of total water level. Where the potential for generation of storm waves greater than one foot existed, an analysis of wave heights was also performed and the computed wave heights were combined with the total water level to yield base flood elevations. Reduction in stillwater level as the storm surge moved inland was also calculated taking into account topography and vegetation characteristics.

The values representing the parameters and their assigned probabilities are shown in Table 4.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>29.47</th>
<th>29.20</th>
<th>28.94</th>
<th>28.67</th>
<th>28.41</th>
<th>28.14</th>
<th>27.88</th>
<th>27.61</th>
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<tbody>
<tr>
<td>Central Pressure Depression (in. Hg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability: Enter</td>
<td>0.31</td>
<td>0.31</td>
<td>0.12</td>
<td>0.07</td>
<td>0.07</td>
<td>0.05</td>
<td>0.02</td>
<td>0.05</td>
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<tr>
<td>Exiting</td>
<td>0.32</td>
<td>0.32</td>
<td>0.07</td>
<td>0.07</td>
<td>0.11</td>
<td>0.07</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Parallel</td>
<td>0.26</td>
<td>0.26</td>
<td>0.07</td>
<td>0.12</td>
<td>0.11</td>
<td>0.10</td>
<td>0.04</td>
<td>0.04</td>
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<tr>
<td>Storm Radius (nautical miles)</td>
<td>15.0</td>
<td>22.5</td>
<td>30</td>
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<tr>
<td>Probability</td>
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<td>0.20</td>
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<tr>
<td>Forward Speed (knots)</td>
<td>6.0</td>
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<tr>
<td>Probability: Enter</td>
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<td>0.36</td>
<td>0.40</td>
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<tr>
<td>Exiting</td>
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<td>0.32</td>
<td>0.13</td>
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</tr>
<tr>
<td>Parallel</td>
<td>0.41</td>
<td>0.40</td>
<td>0.19</td>
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<td>Crossing Angle (degrees)(^1)</td>
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<td>300</td>
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</tr>
<tr>
<td>Probability: Enter</td>
<td>0.19</td>
<td>0.61</td>
<td>0.07</td>
<td>0.13</td>
<td>0.00</td>
<td></td>
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</tr>
<tr>
<td>Exiting</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of Occurrence:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land falling/Exiting (storms/nm/year)</td>
<td>0.0035</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Alongshore (storms/nm/year)</td>
<td>0.0011</td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

\(^1\) Degrees clockwise from north
3.1.2 Method for Flooding Sources with New or Revised Analyses in Current Study

The hydrologic model used to calculate Base Flood Elevations in the Cardinal Lane Watershed, the Center Ridge Watershed, the Crystal River Watershed, and the Tsala Apopka Watershed was ICPR (Inter-Connected Pond Routing) with PercPack option, by Streamline Technologies. The ICPR model has been widely tested in Florida since its inception more than 25 years ago. Many federal and state agencies, including the Federal Emergency Management Agency (FEMA) and the State water management districts, have accepted the use of the ICPR model for watershed studies and floodplain modeling. ICPR is an unsteady state one-dimensional single event stormwater model. Its mathematical framework is based on a link-node concept where stages are calculated at nodes through conservation of mass principles and flows are calculated for links based on stages at the nodes. To incorporate the groundwater element into the model, an optional plug-in PercPack was developed to simulate the interaction between the surface water and groundwater.

The storm event used for floodplain modeling and delineation was the 100 year event using the 24 hour duration. This storm event has a 1% probability of occurring in any given year. In a few areas, the multi-day events were used to modify the base map because the 100-year, 24-hour storm was less than the floodplain of the verification storm. There were a few nodes in the Crystal River and Cardinal Lane watershed that used the 5 day storm for floodplain delineation. Also a few nodes in the Center Ridge watershed used the 7 day storm for floodplain delineation. Flooding from the multi-day storms was used in these cases because it more closely matched the flooding seen in the 2003 verification model results.

The ICPR model consists of five primary parts: basins, nodes, and links for surface water; and nodes and links for groundwater. Stormwater runoff hydrographs are generated for basins and then assigned to nodes representing the basins in the drainage network. Nodes are used to represent ponds, inlets and outlets, specific locations along channels, streams, and rivers, and junctions of existing pipe systems. Links represent streams, channels, pipes, and overflow weirs that connect two nodes. Flow entering each node is hydraulically routed through the links into the next downstream node.

Sub-basin delineations for each watershed were created using automated GIS-based tools in ArcGIS then manually edited where necessary. All delineations were manually reviewed to adhere to SWFWMD Guidelines and Specification (SWFWMD, 2002).

GIS and ArcHydro tools were used in determining aerial relevant parameters such
as soil and land use distribution, NEXRAD rainfall, longest flow path for Time of Concentration (Tc), and Green-Ampt infiltration parameters. All of the parameters were saved in GWIS databases before model development. The Tc was determined using the methodology outlined in the U.S. Department of Agriculture’s (USDA) Urban Hydrology for Small Watersheds, Technical Release of TR-55 manual. Impervious areas in each sub-basin were divided into Directly Connected Impervious Areas (DCIA) and Non-Directly Connected Impervious Areas (NDCIA). The SWFWMD developed a lookup table for the percentage of DCIA and Impervious Area for different land use categories. In cases where sub-basins had multiple land use, an area-weighted average DCIA and NDCIA were used.

Green-Ampt soil parameters based on the NRCS SSURGO dataset, available geotechnical data, and a lookup table of Green-Ampt parameters were developed by SWFWMD and used to generate runoff hydrographs in ICPR. Green-Ampt infiltration parameters include area, impervious area percent, directly connected impervious area percent, cutoff depth of soil, hydraulic conductivity of soil, effective porosity of soil, and suction head of soil. These parameters were provided in a lookup table by the SWFWMD.

Three rainfall distributions were selected for rainfall-runoff analysis in the study area: the SCS Type II Florida-Modified 24-hour distribution, the SWFWMD 120-hour rainfall distribution, and the FDOT 168-hour rainfall distribution. 24-hour, 120-hour, and 168-hour rainfall-intensity-duration relationships were developed for the study area. The total rainfall depths were obtained from depth-duration-frequency curves. The rainfall depth-duration-frequency relationships were applied in this study revision as follows:

- SCS Type II Florida-Modified 24-hour Rainfall Distribution: for the 1-percent-annual chance design storm;
- SWFWMD 120-hour Rainfall Distribution: for the 1-percent-annual-chance design storm.
- FDOT 168-hr Rainfall Distribution: for the 1-percent-annual-chance design storm in Center Ridge watershed.

Total rainfall values for each detailed watershed included in this FIS are shown in Table 5, “Rainfall Values.”
Table 5: Rainfall Values

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Datum Offset (ft)</th>
<th>Study Type</th>
<th>1 Day Rainfall (in)</th>
<th>Multi-Day Rainfall Used</th>
<th>Date of Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardinal Lane</td>
<td>-0.83</td>
<td>Detailed</td>
<td>11.5</td>
<td>16.3</td>
<td>09/25/12</td>
</tr>
<tr>
<td>Center Ridge</td>
<td>-0.84</td>
<td>Detailed</td>
<td>11.2</td>
<td>17.5</td>
<td>08/30/11</td>
</tr>
<tr>
<td>Crystal River</td>
<td>-0.87</td>
<td>Detailed</td>
<td>11.5</td>
<td>16.3</td>
<td>08/24/10</td>
</tr>
<tr>
<td>Tsala Apopka</td>
<td>-0.85</td>
<td>Detailed</td>
<td>11.0</td>
<td>-</td>
<td>12/20/11</td>
</tr>
</tbody>
</table>

Spatial parameters were calculated using the ArcHydro and GIS tools. Excess rainfall was calculated in ICPR as mentioned below. Soil and Land Use lookup tables used in calculating rainfall were downloaded from the District website. The Green-Ampt method was used in the excess rainfall calculation, and was calculated by the ICPR model using a SCS Unit Hydrograph with a shape factor of 256.

**Cardinal Lane Watershed**

The Cardinal Lane Watershed was delineated into 1,084 sub-basins. Basin nodes were set as stage/area nodes and boundary nodes were set as time/stage nodes. The stage/area relationship was developed using ArcHydro tool – Drainage Area Characterization with a slice increment of a maximum of 1 foot. No streams or channels are found in the Cardinal Lane Watershed.

The Cardinal Lane Watershed contains a variety of different land use types. West of U.S.19/98, the watershed is primarily wetlands and estuarine marshes. Along U.S.19/98, the watershed is urbanized with commercial, institutional, industrial, and residential areas. The central area of the watershed is a patchwork of low density residential areas and from CR 491 to the eastern boundary, the watershed is mostly forested.

For sub-basins located in the highly urbanized areas along U.S. 19/98, a manual re-calculation of DCIA was conducted for each basin to get a more accurate
result.

A large storm event occurred in June 2003 and was used in model calibration and verification. The District’s 15-minute NEXRAD rain data provided a detailed rainfall distribution of the storm over the watershed. The accumulated rainfall of the 2003 event varies from 14.5 inches to 10.3 inches between June 15 and June 24, 2003. The Citrus County Public Works Department received about 40 flooding related reports during and after the storm. The modeled flood area and surface water stages were compared with the reported flood area and stages.

**Center Ridge Watershed**

The Center Ridge Watershed was divided into four (4) sub-watersheds or tributaries named ‘A’ thru ‘D’ ranging in size from 6,241 acres to 13,877 acres. The land use classifications for Center Ridge originated from the SWFWMD GIS land use coverage and were modified based on current aerial coverage and other development information. These classifications were developed by the Florida Department of Transportation (FDOT) using the Florida Land Use and Cover Classification System (FLUCCS). The sub-basins were delineated as catchments using ArcHydro as derived from a 5-foot DEM representing the LiDAR terrain surface. Times of Concentration were calculated from an automated process within the GIS program, HEC-GeoHMS. Excess runoff was generated using the Green-Ampt method with a GIS tool developed by SWFWMD for direct input into an AdICPR model using version 3.1 (with PercPack). DCIA and non-DCIA was determined specific to each unique land use type within the watershed.

Tributary ‘A’ (7,247 acres) covers the northern portion of the Center Ridge watershed. The sub-basins within Tributary ‘A’ range in size from 0.8 acres to 266 acres with the majority being on the smaller end of this range. This tributary area includes developments known as Pine Ridge and Citrus Springs and a section of CR 491. The drainage patterns of this tributary are characterized by a number of landlocked depressions, some of which are internally drained by swales and culverts. In Tributary ‘A’, multiple land uses exist along CR 491 including transportation, commercial, recreational, and residential areas low and medium density. Other parts of this tributary are forested with occasional areas of rural open land. This tributary also includes a golf course. There area approximately 125 DRA’s scattered throughout this tributary.

Tributary ‘B’ (7,906 acres) is located southeast of Tributary ‘A’. The sub-basins within Tributary ‘B’ range in size from 0.3 acres to 249 acres. This tributary area includes developments known as Beverly Hills and Brentwood villas, and a section of CR 486. The drainage patterns of this tributary are characterized by a number of depressional areas. A natural pond, believed to be well connected to the Floridian aquifer, located in the center of Tributary ‘B’ serves as the main low
point for this tributary. The normal water surface elevation is approximately 10 feet. A developed corridor exists along CR 486 including transportation, commercial and services, and residential areas. There is a large forested area in this tributary classified as Longleaf Pine – Xeric Oak as well as two golf courses. There are approximately 110 DRA’s scattered throughout the tributary.

Tributary ‘C’ (6,241 acres) is located south of Tributary ‘B’. The sub-basins within this tributary range in size between 0.4 acres to 350 acres. This tributary area includes a development known as Citrus Hills, and the section of SR 44 that is within the watershed. The drainage pattern for this tributary is characterized by a general flow of water downward from the high ridges into several depressional areas. Lake Nina (also know as Hog Pond) is located in the east side of this tributary and serves as the collection point for water in the southeast portion of this tributary. There is a developed corridor along SR 44 with commercial and services and residential areas. Most of the residential areas are low to medium density. The east portion of this tributary contains a large area of cropland / pastureland. There are approximately 125 DRA’s scattered throughout the tributary as well as a golf course located in the northern portion of Tributary ‘C’.

Tributary ‘D’ (13,877 acres) is located south of Tributary ‘C’. The sub-basins within this tributary range in size between 0.9 acres to 1,226 acres. Tributary ‘D’ is mainly comprised of the Withlacoochee State Forest. The drainage pattern is characterized by water flowing from the high points and ridges to the low points and intercepted by depressional areas along the way. The majority of Tributary ‘D’ is forested (Longleaf Pine – Xeric Oak as well as Upland Coniferous and hardwood Coniferous). There are a few residential areas (low density) within this tributary as well as a few strips of tree plantations, shrub, brush, and open land.

Approximately 98.5% of the Center Ridge Watershed is composed of Type ‘A’ soils well-drained soils. Type ‘D’ soils can be found within the State Forest in Tributary ‘D’.

**Crystal River Watershed**

The Crystal River Watershed was divided into 2,288 sub-basins ranging in size from 0.06 to 442.33 acres.

The land use coverage was created using the 2006 SWFWMD land use shapefile based on the Florida Land Use and Cover Classification System (FLUCCS). The watershed is primarily urbanized (containing low-density and medium density residential land use types). Upland forests and wetlands cover most of the remaining area.

Soil information was obtained from the United States Department of
Agriculture/Natural Resource Conservation Service (formerly USDA/SCS) soil survey maps. The watershed is bisected from northwest to southeast by a 10-mile long, 350-ft wide power easement. The watershed is characterized by Type A well-drained soils to the east of the power easement and type B/D and D soils in to the west of it.

No surveyed high water marks were available in the Crystal River watershed to verify results. Photographs and data points collected by the City of Crystal River, citizens of Citrus County, and Citrus County staff were used for comparison to model results. Pictures were taken after a large rainfall event that occurred on June 20, 2003. The storm dropped an average of 11.6 inches of rain on the Crystal River area over a 120-hour period. In addition, the mean-annual 24-hour rainfall event was used to generally verify the Special Flood Reports submitted by Citrus County residents.

Tsala-Apopka

The overall Tsala Apopka Watershed was comprised of a total of 3,492 sub-basins. Due to the size and complexity of the watershed, it was sub-divided into 4 separate sub-watersheds (A, B, C, and D). The watershed was broken up along ridgelines where it was estimated that there would not be any interflow from one sub-watershed to the adjacent one. This allowed for a more streamlined model development process.

The latest land use data (2006) from the SWFWMD was used to characterize the watershed. These data use the Florida Land Use and Cover Classification System (FLUCCS). The primary land uses are agriculture, forest and various types of urban land uses.

The soils within the Tsala Apopka watershed were identified using the Soil Survey Geographic (SSURGO) database provided by the SWFWMD which was derived from the United States Department of Agriculture Natural Resources Conservation Service. The primary hydrologic soil group in the watershed was “A” soils which are predominantly deep sands with a high infiltration capacity. Due to the predominance of deep, type ‘A’ soils, the SCS unit hydrograph method using Green-Ampt infiltration was selected for the Tsala Apopka Watershed.

The SWFWMD and others developed typical percent impervious and DCIA values for various developed and non-developed land uses. These typical values seemed appropriate for the non-developed areas within the watershed, but did not seem discrete enough for the developed areas. Values for impervious percent and DCIA were manually assigned by water resources engineers based on visual inspection of the aerials for the developed areas in the Tsala Apopka watershed.
The Tsala Apopka Watershed ICPR models were verified using available data that included a flood complaint database maintained by Citrus County, newspaper accounts of flooding, SWFWMD field visit notes and photographs and the storm event of June 2003 Citrus County flood complaint data.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Locations of selected cross sections are shown on the Flood Profiles (Exhibit 1).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.2.1 Methods for Flooding Sources Incorporated from Previous Studies

Hydraulic analyses were carried out to establish the 1-percent-annual chance peak stages for Grant and White Lakes, and other large depressed areas studied in the City of Inverness. The volume of runoff was compared to the stage vs. surface storage curve developed for each area from a one foot contour map of the city to determine the resultant flood stages.

Water-surface elevations of floods of the selected recurrence intervals for the Withlacoochee River and the Tsala Apopka Chain of Lakes were determined from analysis of stream and staff gages which have sufficiently long periods of record (USACE, 1976b; SWFWMD, 1977). A statistical analysis of the gage data was performed to verify the stages of the Tsala Apopka Chain of Lakes as taken from the report prepared by SWFWMD (SWFWMD, 1977). Flood profiles for the Withlacoochee River were drawn showing water-surface elevations for floods of the selected recurrence intervals.

Located on the Gulf of Mexico, the shoreline areas of Citrus County including the City of Crystal River are primarily subject to coastal storm surge flooding from hurricanes and tropical storms. Detailed hydraulic analyses of the shoreline characteristics were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. The U.S. Department of Housing and Urban
The numerical model for this region consisted of five nautical mile square grids extending 200 nautical miles in the north-south direction, and 200 nautical miles in the east-west direction. Water depths for the offshore regions were taken from selected National Ocean Survey (NOS) Hydrographic Surveys with various dates and scales, and NOS Bathymetric Maps at a scale of 1 to 250,000 with bathymetric contour intervals at 2 and 10 meters depending on depth (NOAA NOS, dates unknown). Additional topographic sources were utilized in conjunction with the storm surge model (USGS, various dates; SWFWMD, various dates).

Because of the development in Citrus County, a finer-grid numerical model was applied to determine surge reductions inland from the coast.
The inland model consisted of one nautical mile square grids extending 35 nautical miles in the north-south direction, centered near the mouth of the Withlacoochee River and 20 nautical miles in the east-west direction, centered near the mouth of the Crystal River.

Water depths for the fine grid model were obtained from NOS Hydrographic Surveys with various dates and scales (NOAA NOS, various dates). Land elevations for the model were obtained from USGS 7.5 minute series topographic quadrangles and from aerial topographic maps obtained from the Southwest Florida Water Management District (SWFWMD, various dates).

Roughness values (the "n" factor for Manning's formula) used in the fine grid computations were chosen based on the percentage of ground cover, which was determined from aerial photography (1979) and field inspection (1980 and 1981). Typical values ranged from 0.06 for the tidal marsh areas to 0.40 for dense wooded uplands. The assigned values for typical vegetation types were obtained from standard roughness coefficient tables, such as those given in Open Channel Hydraulics (Chow, 1959), and from an unpublished U.S. Army Corps of Engineers report on the evaluation of Manning's "n" in vegetated areas.

The computed stillwater flood elevations for Crystal River are shown in the Coastal Flood Insurance Zone Data Table (see Section 5.2). The 1-percent-annual-chance stillwater elevations for the region, as determined using the Joint Probability Method are shown in Figure 1. These elevations reflect the combination of storm parameters, bathymetric and other features that produce the storm surge elevation with a recurrence interval of 100 years at specific locations along the coast. The variation of the stillwater elevations along the coast is mainly attributed to the offshore bathymetry and the orientation of the shoreline. Other features such as constrictive bays, passes, and shoals have localized effects on the surge elevations.
LEGEND

INDICATES APPROXIMATE REACH OF
STILLWATER FLOOD ELEVATIONS IN NGVD
AT EVERY FOOT ON THE HALF FOOT
SEAWARD OF THE SHORELINE.

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITRUS COUNTY, FL
AND INCORPORATED AREAS
100 YEAR COASTAL STILLWATER FLOOD ELEVATIONS

SCALE IN MILES
3.2.2 Method for Flooding Sources with New or Revised Analyses in Current Study

The hydraulic model used to route and calculate Base Flood Elevations was Inter-Connected Pond Routing (ICPR) with PercPack option by Streamline Technologies. This model was preferred by SWFWMD because of its ability to accurately model ponding areas and ease of use. Instabilities in the models were reviewed and addressed in several ways to ensure that peak flood stage results were reasonable.

Depression storage was represented in ICPR by stage/area nodes. ICPR nodes were generally located at the basin low point. The stage/area relationship for each sub-basin was calculated using a GIS-based tool that extracts volume and area from a triangulated irregular network. The ICPR model requires hydraulic boundary conditions at all outflow and inflow points in the model network. Stage/time nodes were used to simulate boundary conditions.

The majority of the hydraulic conveyance in the watersheds is non-dendritic, which means a sub-basin drains to the adjacent sub-basin only after it exceeds its storage capacity. This overland flow between sub-basins is typically modeled using a weir. Overland weirs were simulated in ICPR as vertical weirs using an irregular cross-section. Weirs in ICPR are linked to irregular cross-sections developed using the LiDAR-generated DTM. The low point of the cross-section was used for the irregular weir invert and control elevations.

Retention pond and natural depression percolation was modeled using the PercPack add-on for ICPR. Percolation is used to describe the ‘loss’ of surface water runoff through the bottom and sides of retention ponds or natural depressions.

Cardinal Lane Watershed

For natural ponds, wetlands, and lakes, the starting water levels were assumed to be the “Seasonal High Water Elevation” (SHW). This assumption supposes that pre-rainfall already raises the water level in the storage to a high point. For storage facilities with a control structure, the starting water level was assumed to be the crest elevation of the control weir. The crest elevation was obtained from Environmental Resource Permit (ERP). If ERP was unavailable, the elevation was measured in field surveys. For dry retention ponds, the starting water level was assumed to be the elevation of the pond bottom, which was determined from the DEM.

The groundwater elevation was determined by combining the well data and the District’s groundwater database. Twelve monitoring wells are located within or near the Cardinal Lane Watershed. A groundwater elevation contour map was
drawn based on averaging the measured elevation of each station.

The Cardinal Lane watershed is bounded on the east by Central Ridge watershed, north by Homosassa River watershed, south by Chassahowitzka River watershed, and west by the Homosassa Bay. Ten boundary reaches of different sub-basins define the boundary between Cardinal Lane and the Central Ridge watersheds. There are no structural connections between the two watersheds. No flow is anticipated to flow in or out of the Central Ridge watershed to Cardinal Lane watershed due to the high relief in the boundary area. To model any potential pop-off flow in extreme events, stage-time boundary conditions were set up to the pop-off area and links were modeled as overflow weirs. Sixty-five boundary reaches define the boundary between Cardinal Lane and Homosassa River watersheds. Two culverts respectively on the east and west sides of the U.S. 19/98 connect the two watersheds. Those two culverts were modeled as pipes. A stage-time tailwater condition was set for the two boundary nodes through an iterative process until the result of the boundary nodes was the same as the neighboring nodes within the watershed. Forty-six boundary reaches define the boundary between Cardinal Lane watershed and Chassahowitzka River watershed. Tidal elevation in the Homosassa Bay directly affects surface and groundwater conditions, and thus flooding depth on the west side of U.S. 19/98. Data from NOAA (National Oceanic and Atmospheric Administration) station #8727348 in Twin Rivers Marina, Crystal River was used in determining the tidal level. The Highest Observed Water Level (HOWL) was used as a constant stage-time tailwater condition for the storm event of 2003 and the 100-year 24-hour design storm.

The conveyance structures in the watershed consisted of culverts, weirs, lakes, and ponds. There were no streams or channels in the watershed. The physical parameters of the conveyance structures were obtained from ERPs, roadway design plans, professional survey data, field measurements, or GPS measurement.

Roughness coefficient (Manning’s n) is related to structure size, shape, and materials. Loss coefficient is related to the end treatment. The values were determined by referring to literature such as the TR-55 Manual, Open Channel Hydraulics by Van Te Chow, and others.

Road overtopping and overland flow were represented by overland flow weirs in modeling. Irregular cross-sections of the sub-basin boundary define the overland flow between two adjacent sub-basins. The link that connects two sub-basins passes through the lowest point of the overland flow weirs. The irregular cross-sections were developed using the ArcHydro tool – Irregular Cross-section. Roughness coefficients for overland weirs were determined according to land use and land cover.
For some basins, a percolation link was applied to account for percolation into the groundwater. Percolation was applied to basins containing a majority of hydrological “A” soils, no pond, wetland, or lake, no impervious area in the basin sink, and depth to water table greater than 3-5 feet. Percolation links were not applied to basins located in the Withlacoochee State Forest unless the basin contains or lies next to CR 491. An iterative process is used to determine the geometry of the percolation polygon. In using the PercPack, water table elevation was determined by piezometric data provided by the District and modified by well data. Aquifer base elevation was set at water table elevation minus 25 feet. Layer thickness was determined by subtracting water table elevation from ground surface elevation. If the result is less than 5 feet, it was manually overridden to equal 5 feet. Other parameters, such as Vertical and Horizontal Conductivities, Effective Porosity, and Suction Head were determined from the District’s soil database.

Model calibration and verification was performed using the District’s 15-minute NEXRAD rain data for a large storm event that occurred in June 2003. This data provided a detailed rainfall distribution of the storm over the watershed. The Citrus County Public Works Department received about 40 flooding related reports during and after that storm event. Those reports provided useful information for model calibration and verification. The model was also adjusted based on reports from County engineers after a site visit of problem areas. On March 31, 2011, District engineers took 14 photos of flooding areas after a rain event of March 28 to March 31, 2011. The photos were used for further verification of the model.

**Center Ridge**

Drainage structures and systems data was collected using various sources including field survey, Environmental Resource Permit (ERP) files at SWFWMD, and Citrus County development files. In the Center Ridge Watershed, conveyance features that were inventoried for hydraulic modeling are mainly comprised of roadway cross-drains and DRA outfalls. The Center Ridge Watershed is categorically considered a closed watershed, and additionally, each of the four tributaries within this watershed is considered closed sub-watersheds. The large majority of DRA’s and natural depressions within this watershed are considered land-locked.

Stage-area relationships were developed using ArcHydro with calculations made on the 5-foot DEM. Initial stages were developed with utilization of the best available data that including seasonal high water determinations from design calculations of development projects from ERP or County files, interpretation of wetlands vegetation from aerials, soils data, recorded water level data, or others. Hydraulic structures were incorporated into the model from data collected by a
combination of review of ERP files, Citrus County files, and field inventory. Overland weirs were developed from one or more terrain sources as needed to represent actual connectivity between sub-basins. The cross-sections for these overland weirs will be cut from the 5-foot DEM using the GIS tool supplied by SWFWMD.

The Center Ridge Watershed is comprised of many depressional areas with sandy soils and deep water tables that are exhibit high rates and volumes of percolation. Runoff generation was based on Green-Ampt methodology and percolation areas were modeled as separate outfalls in storage areas located in Hydrologic Soil Group (HSG) Type “A” soils.

Rainfall data was collected using Doppler radar estimates that were recorded continuously at 15 minute intervals. The floodplain mapping storm event was chosen to be the 100 year 24 hour storm with the exception of two areas where a 100 year 7 day storm was used (Lake Nina and Lake Beverly).

**Crystal River Watershed**

Conveyance features within the Crystal River watershed include culverts, inlets, overland weirs, a bridge, and open channels. All modeled pipes included a road overflow to accurately simulate flooding during larger storms. Routing also occurs as a result of the interconnection of closed basin depressions by sub-basin saddles. These saddles were modeled as vertical broad-crested weirs using the Mavis equation because results from this equation were more stable than the results from the typical broad-crested weir equation, the Fread equation. The choice of weir equation did not affect the maximum node stage.

The Crystal River watershed has three main channels discharging into Kings Bay and one small channel in Ozello discharging to the coastal marshlands. Channel cross-sections were surveyed by registered land surveyors. Channel storage was removed from depression storage by the use of manually delineated exclusion polygons in ArcGIS.

Starting elevations for stage/area nodes were set using aerial photography, ERP information and the LiDAR data. Starting elevations for wet depressions (including wetlands) were determined on a case by case basis. In some cases it was appropriate to set starting elevations immediately below the outfall elevation. Starting elevations for dry depressions were set to the lowest elevation in the sub-basin.

Channel storage was removed from depression storage by exclusion polygons manually delineated in ArcGIS.

Retention pond and natural depression percolation within the Crystal River
watershed was modeled using the PercPack add-on for ICPR. Percolation is used to describe the ‘loss’ of surface water runoff through the bottom and sides of retention ponds or natural depressions. Inundation areas for the 100-year, 24-hour storm were initially developed throughout the watershed without considering percolation to identify the potential percolation sites.

The Crystal River watershed discharges to Kings Bay. The average of all recorded mean high water levels for USGS gage 02310750 was assigned as the boundary condition: 1.14 feet (NAVD88).

There were no surveyed high water marks within the watershed that could be used for model verification. Photographs and data points collected by the City of Crystal River, citizens of Citrus County, and Citrus County staff were used for comparison to model results. Photos were taken after a large rainfall event occurring on June 20, 2003 (most photographs were taken on June 22 or June 23). The County also documented locations in which flooding occurred during that storm in the form of ArcGIS shapefiles. In addition, residents of Citrus County provided Special Flood Reports to the District reporting flooding of their property.

According to NEXRAD data obtained from the SWFWMD, the storm occurring on June 20, 2003 dropped an average of 11.6 inches of rain on the Crystal River area in the 120-hour period. Sub-basins were assigned recorded 15-minute NEXRAD data by pixel location using 64 pixels covering the Citrus County Crystal River watershed. In addition to the June 20, 2003 storm, the mean-annual 24-hour rainfall event (4.9 inches of rain over 24-hours using the Florida Modified Type II Distribution in ICPR) was used to generally verify the Special Flood Reports submitted by Citrus County residents.

For the Crystal River watershed, the peak stages resulting from the 100-year, 24-hour rainfall event were typically used to determine the 100-year floodplain. The multi-day (100-year, 5-day) was used in a few areas of the watershed due to the fact that it better represented flooding reports recorded by members of the County. The flooding of US 19 near the Best Western Resort in the City of Crystal River, 576 nodes located in the in the vicinity of the large swath bisecting the watershed (running north to south), and a channel system within the city limits of Crystal River that drains the watershed to Kings Bay were areas selected for use of the 5-day event to map the 100-year floodplain.

Tsala Apopka Watershed

The vast majority of the basins in the Tsala Apopka Watershed have a single node within their boundary; however, multiple nodes were required to properly represent certain features within some basins. Instances where multiple nodes
were required include: culvert runs with multiple segments contained within a single basin and bubbler systems. The ArcHydro Drainage Area Characterization tool was used to develop stage/area relationships for each node. While most nodes were set up as stage/area nodes in the ICPR model, stage/time nodes were used to simulate boundary conditions.

The initial stage of the stage/area nodes were initially set to the low point in the stage/area relationship. These were modified as appropriate based on groundwater levels, aerial imagery, water body levels, ERP data, and field reconnaissance. Initial stages of manholes were set to the low invert of the connecting culvert. The initial stage of stage/time (boundary nodes) was set to the boundary condition elevation.

Initial channels, swales, and overland flow weirs were determined by using ArcHydro. Thirty-six structural weirs were modeled in the Tsala Apopka watershed. Thirty-five weirs represented drop structures and one represented a concrete flume. A weir coefficient of 3.2 was used for structural weirs. The orifice discharge coefficient was set to 0.6.

A total of 423 culverts were identified in the Tsala Apopka watershed. This included individual road crossings and pipe networks. Physical characteristics such as length, invert elevations, geometry, rise and span were primarily obtained from survey data, design plans, or field visits. All culverts allowed flow in both directions.

A bridge was identified along Railroad Street which separates a small lobe on the Inverness Pool from the main portion. The bridge is over 40-feet wide and does not appear to be a flow constriction.

Overland weirs were simulated in ICPR as vertical weirs using an irregular cross-section. The low point of the cross-section was used for the irregular weir invert and control elevations. A weir coefficient of 2.6 was used for these pop-offs.

There were 16 channels identified in the Tsala Apopka watershed. Irregular cross-sections were developed to extend to at least the estimated 100-year floodplain plus 1-ft in elevation. Manning’s roughness values were developed based on observed field data. To prevent double counting of storage, a channel exclusion feature class was developed and populated for each channel.

The boundary conditions for the Tsala Apopka models were the Hernando, Inverness, and Floral City Pools. The Hernando Pool is the boundary condition for nodes in sub-watersheds A and B. It has a boundary elevation of 37.91 feet NAVD88. The Inverness Pool is the boundary condition for nodes in the sub-watershed B and has a boundary elevation of 39.41 feet NAVD88. The Floral
City Pool is the boundary condition for nodes in sub-watersheds B, C, and D. A boundary elevation of 41.41 feet NAVD88 was selected for this pool.

To appropriately account for high infiltration rates of the soils found in the Tsala Apopka watershed, percolation links were added to each sub-watershed model. The percolation links were added for DRAs and natural depressional areas with the following characteristics: “A” soils, layer thickness greater than 3 feet, ponded areas greater than 2,500 square feet, and the flooded area was not primarily composed of impervious area. The DRA percolation links included only vertical flow percolation while the natural depressional areas were simulated with both vertical and horizontal flow.

The Tsala Apopka Watershed ICPR models were verified using a flood complaint database maintained by Citrus County, newspaper accounts of flooding, SWFWMD field visit notes and photographs, and the storm event of June 2003 Citrus County flood complaint data. NEXRAD rainfall data obtained from the SWFWMD for storm events on June 23, 2009, and March 28-31, 2011, were used for verification purposes.

3.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (NAS, 1977). The method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The second major concept is that wave height may be diminished due to the presence of obstructions such as sand dunes, dikes and seawalls, buildings and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in the aforementioned National Academy of Sciences report. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) that were located along the coastal areas, as illustrated in Figure 2, in accordance with the Users Manual for Wave (NAS, 1977).
The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended to the inland limit of tidal flooding. The transects were continued inland until the wave was dissipated or until flooding from another source with equal or greater elevation was reached. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation and physical features. The stillwater elevations for the 1-percent-annual-chance flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect.

Figure 3 is a profile for a hypothetical transect showing the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being diminished by obstructions, such as buildings, vegetation and rising ground elevations and being increased by open, unobstructed wind fetches. Actual wave conditions in the Citrus County may not necessarily include all the situations illustrated in Figure 3.
After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various data sources were used in the interpolation, including aerial topography obtained from the Southwest Florida Water Management District with a one-foot contour interval (SWFWMD, various dates) and aerial topography flown in 1979 (Abrams, 1979a) with a one-foot contour interval, as well as engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

Coefficients for inland wave height reduction (transmission coefficients) were determined from aerial photography (1978 and 1979) and by field inspection (1979, 1980, and 1981). Fetch factors for wave build-up in unobstructed wind fetches were determined from, the above sources and from standard tables and figures. The results showed that a significant decrease in wave height did occur in the wooded swamp areas of Citrus County.

Computed wave elevations are based upon existing topography, vegetation, and current development patterns and will require recomputation if significant changes occur in any of the above factors.

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD88). Elevation reference marks used in this study are shown and described on the map.

A listing of the transect locations, starting stillwater surge elevations, and initial wave crest elevations is provided in Table 7, “Transect Locations, Stillwater Starting Elevations, and Initial Wave Crest Elevations.”

Figure 3 – Transect Schematic
Table 7: Transect Locations, Stillwater Elevations, and Initial Wave Crest Elevations

<table>
<thead>
<tr>
<th>Transect</th>
<th>Location</th>
<th>Stillwater</th>
<th>1-percent-annual-chance Elevation (Feet NAVD88)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Citrus County – beginning at the mouth of Johns Creek and heading northeast</td>
<td>12.6</td>
<td>20.0</td>
</tr>
<tr>
<td>2</td>
<td>Citrus County – at Everett Island, heading east</td>
<td>12.6</td>
<td>20.0</td>
</tr>
<tr>
<td>3</td>
<td>Citrus County – at the Crystal River Nuclear Power Plant, heading east</td>
<td>12.3</td>
<td>19.5</td>
</tr>
<tr>
<td>4</td>
<td>Citrus County – at the mouth of the Crystal River, heading east-northeast</td>
<td>12.1</td>
<td>19.2</td>
</tr>
<tr>
<td>5</td>
<td>Citrus County – beginning approximately 3/4 of a mile south of Shell Island, heading east-northeast</td>
<td>12.0</td>
<td>19.0</td>
</tr>
<tr>
<td>6</td>
<td>Citrus County – beginning approximately 1.3 miles south of Shell Island, heading east</td>
<td>12.0</td>
<td>19.0</td>
</tr>
<tr>
<td>7</td>
<td>Citrus County – beginning approximately 2.0 miles south of Shell Island, heading east</td>
<td>11.9</td>
<td>18.9</td>
</tr>
<tr>
<td>8</td>
<td>Citrus County – beginning approximately 2.5 miles south of Shell Island, heading east</td>
<td>11.9</td>
<td>18.9</td>
</tr>
<tr>
<td>9</td>
<td>Citrus County – beginning at Mullet Key, heading east</td>
<td>11.9</td>
<td>18.9</td>
</tr>
<tr>
<td>10</td>
<td>Citrus County – beginning north of the mouth of Fish Creek, heading east</td>
<td>11.6</td>
<td>18.4</td>
</tr>
</tbody>
</table>
Table 7: Transect Locations, Stillwater Elevations, and Initial Wave Crest Elevations (continued)

<table>
<thead>
<tr>
<th>Transect</th>
<th>Location</th>
<th>Stillwater</th>
<th>Initial Wave Crest</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Citrus County – approximately 3/4 of a mile north of the Little Homosassa River, heading east</td>
<td>11.6</td>
<td>18.4</td>
</tr>
<tr>
<td>12</td>
<td>Citrus County – approximately 3/4 of a mile south of the Little Homosassa River, heading east</td>
<td>11.5</td>
<td>18.3</td>
</tr>
<tr>
<td>13</td>
<td>Citrus County – beginning approximately 1/2 mile south of the mouth of the Homosassa River, heading east-northeast</td>
<td>11.5</td>
<td>18.3</td>
</tr>
<tr>
<td>14</td>
<td>Citrus County – beginning approximately 3/4 of a mile south of the mouth of the Homosassa River, heading east</td>
<td>11.5</td>
<td>18.3</td>
</tr>
<tr>
<td>15</td>
<td>Citrus County – beginning approximately 1.3 miles north of Chassahowitzka Point, heading east</td>
<td>11.4</td>
<td>18.1</td>
</tr>
<tr>
<td>16</td>
<td>Citrus County – beginning approximately 1.2 miles south of Chassahowitzka Point, heading east</td>
<td>11.4</td>
<td>18.1</td>
</tr>
</tbody>
</table>
3.4 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. It is important to note that adjacent communities may be referenced to NGVD29, which may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities.

Some of the data used in this study was taken from the prior effective FIS reports and adjusted to NAVD88. The average conversion factor that was used to convert the data in this FIS report to NAVD88 was calculated for each watershed using the U.S. Army Corps of Engineers CORPSCON online utility (USACE, 2009). The vertical datum shifts for each watershed are shown in Table 8, “Vertical Datum Conversions.”

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Conversion from NGVD29 to NAVD88 (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardinal Lane</td>
<td>- 0.83</td>
</tr>
<tr>
<td>Center Ridge</td>
<td>- 0.84</td>
</tr>
<tr>
<td>Chassahowitzka River</td>
<td>- 0.82</td>
</tr>
<tr>
<td>Crystal River</td>
<td>- 0.87</td>
</tr>
<tr>
<td>Floral City</td>
<td>- 0.84</td>
</tr>
<tr>
<td>Homosassa North</td>
<td>- 0.84</td>
</tr>
<tr>
<td>Homosassa South</td>
<td>- 0.82</td>
</tr>
<tr>
<td>Homosassa South Fork</td>
<td>- 0.85</td>
</tr>
<tr>
<td>Inverness</td>
<td>- 0.85</td>
</tr>
<tr>
<td>Leslie Heifner Canal</td>
<td>- 0.85</td>
</tr>
</tbody>
</table>
Table 8: Vertical Datum Conversions (continued)

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Conversion from NGVD29 to NAVD88 (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lizzie Hart Sink</td>
<td>- 0.83</td>
</tr>
<tr>
<td>Lower Withlacooche</td>
<td>- 0.97</td>
</tr>
<tr>
<td>McKethan Lake Outlet</td>
<td>- 0.83</td>
</tr>
<tr>
<td>North of Barge Canal</td>
<td>- 0.98</td>
</tr>
<tr>
<td>Ozello</td>
<td>- 0.83</td>
</tr>
<tr>
<td>Red Level</td>
<td>- 0.85</td>
</tr>
<tr>
<td>Shinn Ditch</td>
<td>- 0.86</td>
</tr>
<tr>
<td>Tsala Apopka</td>
<td>- 0.85</td>
</tr>
<tr>
<td>Tsala Apopka Outlet</td>
<td>- 0.85</td>
</tr>
<tr>
<td>Withlacooche River</td>
<td>- 0.90</td>
</tr>
<tr>
<td>Coastal Zones</td>
<td>-0.87</td>
</tr>
<tr>
<td>Average</td>
<td>-.90</td>
</tr>
</tbody>
</table>

For additional information regarding conversion between NGVD and NAVD88, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

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

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.
4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Tables, and Summary of Stillwater Elevation Tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community.

For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections and in the overland flow and ponding areas, the boundaries were interpolated using elevations obtained from topographic data provided by the SWFWMD. Coastal zones were revised to account for the datum shift. The main topographic data used for this study was LiDAR data provided to SWFWMD by EarthData International in 2004 (EarthData International, 2004) and Woolpert, Inc. between January and March 2006 (Woolpert, Inc., 2006). The data was reviewed by BCI Engineers and Watershed Concepts and processed under separate projects.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, and VE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations, but
cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. The flatness of the terrain in Citrus County does not allow well-defined stream channels and floodplains to exist; therefore, no floodways were computed for this study.

4.3 Base Flood Elevations

Areas within the community studied by detailed engineering methods have BFEs established in AE and VE Zones. These are the elevations of the 1-percent-annual-chance (base flood) relative to NAVD88. In coastal areas affected by wave action, BFEs are generally greatest at the normal open shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in BFEs have been shown in 1-foot increments on the FIRM. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. BFEs shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is elevated to or above the BFE in AE and VE Zones.

4.4 Velocity Zones

The USACE has established the 3-foot wave height as the criterion for identifying coastal high hazard zones (USACE, 1975). This was based on a study of wave action effects on structures. This criterion has been adopted by FEMA for the determination of VE zones. Because of the additional hazards associated with high-energy waves, the NFIP regulations require much more stringent floodplain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in VE zones are higher than those in AE zones.

The location of the VE zone is determined by the 3-foot wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the VE zone to be established. The VE zone generally extends inland to the point where the 1-percent-annual-chance stillwater flood depth is insufficient to support a 3-foot wave.
5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or base flood depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile (sq. mi.), and areas protected from the base flood by levees. No BFEs or depths are shown within this zone.

Table 9, “Flood Insurance Zone Data,” summarizes the shallow flooding elevations for the Tsala Apopka Lakes (Floral City Pool, Inverness Pool, and Hernando Pool, Tsala Apopka, Henderson, and Little Spivey lakes), the Withlacoochee River Ponding Area, White Lake, and Grant Lake.

Table 10, “Coastal Flood Insurance Zone Data,” summarizes the stillwater flood elevations, flood insurance zones, and base flood elevations by transect for each coastal flooding source studied in detail in the community.
## TABLE 9: FLOOD INSURANCE ZONE TABLE

<table>
<thead>
<tr>
<th>Flooding Source and Location</th>
<th>Stillwater Elevation (Feet NAVD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-percent</td>
</tr>
<tr>
<td>TSALA APOPKA LAKES</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td></td>
</tr>
<tr>
<td>FLORAL CITY POOL</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>42.6</td>
</tr>
<tr>
<td>INVERNESS POOL</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>41.0</td>
</tr>
<tr>
<td>HERNANDO POOL</td>
<td></td>
</tr>
<tr>
<td>--</td>
<td>39.7</td>
</tr>
</tbody>
</table>
TABLE 10: COASTAL FLOOD INSURANCE ZONE DATA

<table>
<thead>
<tr>
<th>Community Name</th>
<th>Transect</th>
<th>Description</th>
<th>Starting Stillwater Elevations (feet NAVD 88)</th>
<th>Zone Designation and BFE (feet NAVD 88)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unincorporated Citrus County</td>
<td>1</td>
<td>Citrus County- beginning at the mouth of Johns Creek and heading Northeast</td>
<td>10% Annual Chance: 7.6, 5.2-7.6&lt;br&gt;2% Annual Chance: 11.2, 10.7-11.2&lt;br&gt;1% Annual Chance: 12.6, 10.2-12.6&lt;br&gt;0.2% Annual Chance: 15.1, 14.6-15.1</td>
<td>VE 14-19 AE 10-13</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>2</td>
<td>Citrus County- at Everett Island, heading east</td>
<td>10% Annual Chance: 7.6, 5.2-7.6&lt;br&gt;2% Annual Chance: 11.2, 10.7-11.2&lt;br&gt;1% Annual Chance: 12.6, 10.2-12.6&lt;br&gt;0.2% Annual Chance: 15.1, 14.6-15.1</td>
<td>VE 14-19 AE 10-13</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>3</td>
<td>Citrus County- at the Crystal River Nuclear Power Plant, heading east</td>
<td>10% Annual Chance: 7.4, 2.9-7.4&lt;br&gt;2% Annual Chance: 10.8, 6.3-10.8&lt;br&gt;1% Annual Chance: 12.1, 7.6-12.1&lt;br&gt;0.2% Annual Chance: 14.5, 10-14.5</td>
<td>VE 14-19 AE 7-13</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>4</td>
<td>Citrus County- at the mouth of the Crystal River, heading east-northeast</td>
<td>10% Annual Chance: 7.4, 3.4-7.4&lt;br&gt;2% Annual Chance: 10.8, 9.0-10.8&lt;br&gt;1% Annual Chance: 12.1, 8.1-12.1&lt;br&gt;0.2% Annual Chance: 14.5, 12.7-14.5</td>
<td>VE 14-19 AE 8-13</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>5</td>
<td>Citrus County-beginning approximately ¾ of a mile south of Shell Island, heading east-northeast</td>
<td>10% Annual Chance: 7.4, 3.2-7.4&lt;br&gt;2% Annual Chance: 10.8, 10.8&lt;br&gt;1% Annual Chance: 12.1, 7.8-12.1&lt;br&gt;0.2% Annual Chance: 14.5, 14.5</td>
<td>VE 12-19 AE 8-11</td>
</tr>
<tr>
<td>Community Name</td>
<td>Transect</td>
<td>Description</td>
<td>Latitude &amp; Longitude at Start of Transect</td>
<td>Starting Stillwater Elevations (feet NAVD 88)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Unincorporated</td>
<td>6</td>
<td>Citrus County- beginning approximately 1.3 miles south of Shell Island, heading east</td>
<td>(28.903, -82.696)</td>
<td>7.4</td>
</tr>
<tr>
<td>Unincorporated</td>
<td>7</td>
<td>Citrus County- beginning approximately 2.0 miles south of Shell Island, heading east</td>
<td>(28.893, -82.696)</td>
<td>7.2</td>
</tr>
<tr>
<td>Unincorporated</td>
<td>8</td>
<td>Citrus County- beginning approximately 2.5 miles south of Shell Island, heading east</td>
<td>(28.885, -82.696)</td>
<td>7.2</td>
</tr>
<tr>
<td>Unincorporated</td>
<td>9</td>
<td>Citrus County-beginning at Mullet Key, heading east</td>
<td>(28.881, -82.703)</td>
<td>7.2</td>
</tr>
<tr>
<td>Unincorporated</td>
<td>10</td>
<td>Citrus County- beginning north of the mouth of Fish Creek, heading east</td>
<td>(28.844, -82.734)</td>
<td>7.0</td>
</tr>
<tr>
<td>Community Name</td>
<td>Transect</td>
<td>Description</td>
<td>Latitude &amp; Longitude at Start of Transect</td>
<td>Starting Stillwater Elevations (feet NAVD 88)</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>11</td>
<td>Citrus County- approximately ¾ of a mile north of the Little Homosassa River, heading east</td>
<td>(28.808, -82.721)</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.6</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>12</td>
<td>Citrus County- approximately ¾ of a mile south of the Little Homosassa River, heading east</td>
<td>(28.787, -82.713)</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.5</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>13</td>
<td>Citrus County- beginning approximately ½ mile south of the mouth of the Homosassa River, heading east</td>
<td>(28.757, -2.699)</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.5</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>14</td>
<td>Citrus County-beginning approximately ¾ miles south of Chassahowitzka Point, heading east</td>
<td>(28.755, -82.699)</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.5</td>
</tr>
<tr>
<td>Unincorporated Citrus County</td>
<td>15</td>
<td>Citrus County- beginning approximately 1.3 miles north of Chassahowitzka Point, heading east</td>
<td>(28.734, 82.708)</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Citrus County-beginning approximately 1.2 miles south of Chassahowitzka point, heading east</td>
<td>(28.698, -82.683)</td>
<td>10.2</td>
</tr>
</tbody>
</table>
6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

To obtain more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, users are encouraged to consult the Flood Profiles and Summary of Stillwater Elevations tables contained within this report. Users should be aware that BFEs shown on the FIRM represent rounded tenth-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

The countywide FIRM presents flooding information for the entire geographic area of Citrus County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 11.
<table>
<thead>
<tr>
<th>COMMUNITY NAME</th>
<th>INITIAL IDENTIFICATION</th>
<th>FLOOD HAZARD BOUNDARY MAP REVISIONS DATE</th>
<th>FIRM EFFECTIVE DATE</th>
<th>FIRM REVISIONS DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal River, City of</td>
<td>March 26, 1976</td>
<td>November 30, 1979</td>
<td>August 15, 1984</td>
<td>None</td>
</tr>
<tr>
<td>Inverness, City of</td>
<td>January 13, 1978</td>
<td>None</td>
<td>May 17, 1982</td>
<td>None</td>
</tr>
</tbody>
</table>
7.0 OTHER STUDIES

The National Oceanic and Atmospheric Administration published a report titled, Storm Tide Frequency Analysis for the Gulf Coast of Florida, from Cape San Bias to St. Petersburg Beach (NOAA, 1975a). In that report, storm tide height frequency distributions were developed in the Crystal River area of the Gulf Coast by computing storm tides from a set of climatologically representative hurricanes using the National Weather Service hydrodynamic storm surge model (NOAA, 1974). Tide levels computed were for stillwater at the open coast only and compare within 0.5 foot of those computed by utilizing the model described in Coastal Flooding Storm Surge Model (U.S. HUD, 1978; U.S. HUD, 1979).

A previous study was prepared for the Federal Insurance Administration using approximate study methods. Flood Hazard Boundary Map No. H01-04 (FIA, 1978) was prepared from this study. The previous map does not identify areas of special flood hazard in the southwest portion of the City of Inverness. This report, however, through utilization of recently acquired topography, indicates several depressed areas as having special flood hazard. Flooding shown in this report in the areas of Grant and White Lakes, based on a detailed analysis, are not as extensive as that indicated in the previous Flood Hazard Boundary Map and determined by approximate study methods.

A Flood Plain Study on the Tsala Apopka Chain of Lakes was prepared by the Southwest Florida Water Management District in May 1977 (SWFWMD, 1977). This report used the SWFWMD study as the basis of the stages and flood boundaries along the lake and is therefore in agreement in these areas.

The USACE prepared a report on Four River Basins, Florida (USACE, 1961), which includes the Withlacoochee River Basin. The Tsala Apopka Chain of Lakes, however, was not discussed in the plan of improvements.

The Southwest Florida Water Management District and Citrus County tasked various engineering consulting firms to perform Watershed Management Studies on selected watersheds. Cardinal Lane Watershed Management study was prepared by Environmental Consulting and Technology, Inc. in October 2012. Center Ridge Watershed Management study was prepared by Dyer, Riddle, Mills, & Precourt, Inc. in November 2011. Crystal River (L657) Watershed Management study was prepared by Jones Edmunds and Associates, Inc. in July 2010. A Watershed Management study for Floral City (B037), Inverness (L660), and Tsala-Apopka Outlet (L658) Watersheds was prepared by Brown and Caldwell in March 2012. (SWFWMD, 2012 (2), 2011, 2010)

This report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for the purposes of the NFIP.
8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region IV, Koger-Center — Rutgers Building, 3003 Chamblee Tucker Road, Atlanta, GA 30341.

9.0 BIBLIOGRAPHY AND REFERENCES


31. National Oceanic and Atmospheric Administration, National Ocean Survey, Bathymetric Maps at a scale of 1 to 250,000 with two to ten meter intervals depending on depth. Datum mean low water, U.S. Department of Commerce, date unknown.


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