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Nassau River Basin Comprehensive Floodplain Management Study

Submitted to:

U.S. Army Corps of Engineers
Jacksonville District
Jacksonville, Florida

NASSAU RIVER
COMPREHENSIVE FLOODPLAIN MANAGEMENT STUDY

Prepared for:

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TABLE OF CONTENTS

FIGURES

TABLES

PLATES

EXECUTIVE SUMMARY

The Nassau River Basin drains approximately 418 square miles of northeast Florida. The basin includes four principal tributaries; Thomas, Alligator, Boggy, and Lofton creeks, which ultimately discharge into the Atlantic Ocean.

This report describes the data reconnaissance, model development, model calibration, and results of the hydrologic and hydraulic simulations of the Nassau River Basin using models maintained and distributed by the U.S. Army Corps of Engineers Hydraulic Engineering Center. These models include: 1) the Hydrologic Modeling System (HEC-HMS) for hydrologic simulation, 2) One-Dimensional Unsteady Flow Through a Full Network of Open Channels (UNET) for routing and tidal hydraulics and, 3) the Riverine Analysis System (HEC-RAS) for hydraulic simulation.

HEC-HMS replaces the HEC-1 hydrologic model. HEC-HMS accepts rainfall hyetographs and calculates rainfall excess. It employs several methods for calculating rainfall losses, performing runoff transformations, and basin routing. UNET is capable of routing the flows generated by HEC-HMS and accounting for storage and attenuation as the flood flows move down the channel. Although project hydraulics could have been modeled by UNET alone, HEC-RAS is better suited for floodplain management. HEC-RAS uses steady state conditions and is more easily modified to account for improvements or encroachments into the floodplain.

The model study included a reconnaissance task where data from various agencies were researched and gathered for model development and calibration. The data collected were sufficient to develop flood profiles accurate to approximately one foot. Further model refinements can be made through collection of additional data; especially survey, rainfall, and stream gaging.

The model developed for the Nassau River Basin includes simulation of 87 sub-basins, 22 aggregate land uses, and 14 reaches based on 63 channel and bridge opening cross-sections. Flows were calibrated for volume and peak discharge at two hydrologic model locations and for stage at one routing and hydraulic model location.

Model results were examined and compared with other estimates. Given the limited calibration data, the models prepared for the Nassau River Basin produce reasonable results and are suitable for the simulation of basin improvements and floodplain encroachments.

1.0 OBJECTIVES

The work completed for the Nassau River Basin Comprehensive Floodplain Management Study consisted of the development of hydrologic and hydraulic models for the 418 square mile basin located in Northeast Florida. The models compute discharges and water surface profiles for various locations within the Nassau River Basin. Simulated discharges were used to determine the 10-, 25-, and 100-year 24-hour flood profiles in the primary waterways. The models constitute the basic framework for development of this floodplain analysis and can be utilized for determining tailwater conditions for future development within the basin. The existing models can also be used for predicting future impacts to the watershed associated with land use changes.

2.0 STUDY AREA DESCRIPTION

The Nassau River Basin is located in the northeast part of Florida (see Figure 2.1). The Basin is approximately 418 square miles in size and ultimately discharges to the Atlantic Ocean to the east. The basin (see Figure 2.2) drains much of Nassau County and a portion of Duval County to the south. The main drainage features include the Nassau River, along with associated tidal estuary, four principal tributaries and numerous lesser tributaries. Larger communities within the Basin include Callahan, Hilliard, Yulee, and Fernandina Beach. These communities came into existence primarily due to railroads, lumbering, and navigation on the Nassau River in the early to mid 1800's.

The principal tributaries are Thomas Creek, Alligator Creek, Boggy Creek and Lofton Creek. Table 2.1 summarizes information regarding the Nassau River and it's tributaries. Thomas Creek provides drainage for the southwest portion of the Nassau River Basin. After crossing US 301 and US 1, Thomas Creek continues northeast to its confluence with the Nassau River just west of I-95. Thomas Creek is the largest of all the Nassau River tributaries.

Drainage for the west-central portion of the watershed is provided by Alligator Creek, which begins in the northwest part of the Nassau River Basin, flows southeast and then crosses US 1 on the north side of Callahan. Alligator Creek continues east approximately 9.5 miles to its confluence with the Nassau River. The downstream portion of Alligator Creek is also identified as Mills Creek on topographic maps. To avoid confusion with Boggy Creek, which is alternately identified as its major tributary Mills Creek, the Alligator/Mills Creek system will be simply identified hereafter as Alligator Creek.

Boggy Creek begins as Mills Creek and drains the northwest portion of the Nassau River Basin. Mills Creek flows mostly eastward and crosses US 1 several miles north of Callahan. Mills Creek then continues in a southeast direction, picking up several tributaries before becoming known as Boggy Creek upstream of its confluence with Alligator Creek forming the Nassau River.

Lofton Creek along with Plummer Creek drain the north-central portion of the Basin. Both Creeks flow south and discharge under tidal influence directly into the Nassau River. Tidal waterways drain the eastern portion of the Nassau River Basin. Larger tidal waterways include: Pumpkin Hill Creek, Edwards Creek , another Alligator Creek and the South Amelia River, through which the Intracoastal Waterway is maintained.

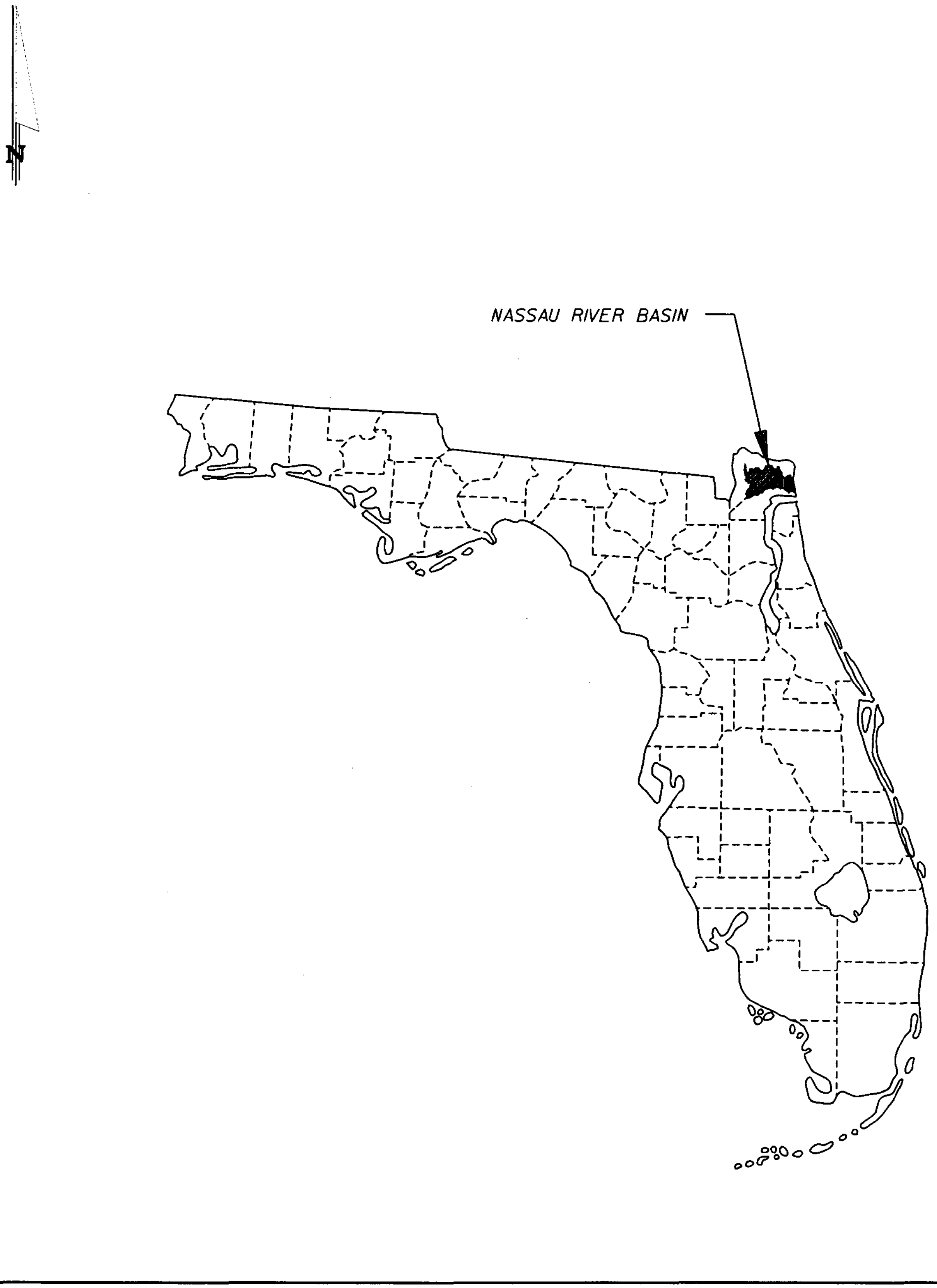


FIGURE 2.1
NASSAU RIVER BASIN LOCATION MAP

FIGURE 2.2
NASSAU RIVER BASIN

Table 2.1 Nassau River Basin Characteristics

Waterway	Drainage Area (mi^2)	S1 Channel Slope (ft/mile)	Principal Tributaries	Outfall
Nassau River	418	0.6	Thomas Creek Alligator Creek Boggy Creek Lofton Creek Plummer Creek Pumpkin Hill Creek South Amelia River Edwards Creek Tidal Alligator Creek	Atlantic Ocean
Thomas Creek	103	2.9	Ben Branch Seaton Creek	Nassau River
Boggy Creek	72	3.8	Mills Creek Little Boggy Creek Spell Swamp Tom Mann Swamp	Nassau River
Alligator Creek	64	5.0	Little Mills Creek Cushing Creek	Nassau River
Lofton Creek	57	1.3	McQueen Swamp	Nassau River
Plummer Creek	24	2.0	Plummer Swamp	Nassau River

2.1 Topography

Geomorphic features within the Nassau River are characterized by low lying coastal plains and tidal marshes to the east, and forested wetlands and uplands to the west and north. Average sub-basin slopes range from more than 1 percent in the western portion of the watershed to less than 0.1 percent for sub-basins located in the eastern portion of the basin. Surface elevations generally range from 35 to 80 feet NGVD within the westernmost sub-basins and 3 to 25 feet NGVD for eastern sub-basins near the Atlantic Ocean.

2.2 Soils

Soils within the Nassau River Basin were identified by the U.S. Natural Resource Conservation Service (NRCS) in the Nassau and Duval County soil surveys. Eighty-three (83) individual soil types were found within the Nassau River Basin. Each soil type has been assigned to one of the four hydrologic soil groups (HSG) based on infiltration and runoff potential. Table 2.2 presents the acreages and percentages of the HSGs within the basin. Many soils have been assigned a dual hydrologic soil grouping (e.g. A/D or B/D), representing a drained and undrained condition. The drained condition generally represents runoff improvements to the basin due to development or agricultural improvements. The Nassau River basin is predominantly unimproved, therefore, a HSG of "D" has been assigned to soils with the dual HSG. Consequently, approximately 86 → 88 percent of Basin soils are considered poorly drained. HSGs "A", "B" and "C" make up less than 10 percent of the basin.

Table 2.2 Nassau River Basin Hydrologic Soil Groups

HSG	**Area (Ac.)**	**Percent of Total %**
A	9,653	3.572
B	217	0.080
C	7,621	2.820
D	125,034	46.261
A/D	225	0.083
B/D	113,451	41.976
Urban	461	0.171
Excavated Pits	7	0.003
Water	13,589	5.028
Unknown	18	0.007
Total	**270,278**	**100.00**

2.3 Land Use

The land uses of the Nassau River Basin were identified by the Florida Department of Natural Resources. Eighty-one (81) individual Florida Land Use Classification Code Schemes (FLUCCS) were identified within the Nassau River Basin. The Nassau River Basin is predominantly undeveloped. Water and wetland areas accounted for approximately 38 percent of total basin area. Tree plantations were the next largest land use with over 36 percent of total basin area (see Table 2.3). Residential, commercial, and industrial uses occupy less than 8 percent of the total.

Table 2.3 Nassau River Basin Land Uses

#	Land Use Description	Area (ac.)	Percent of Total Area (%)
1	Low Density Residential	12,452	4.61
2	Medium Density Residential	7,085	2.62
3	High Density Residential	347	0.13
4	Commercial	336	0.12
5	Industrial	164	0.06
6	Extractive	59	0.02
7	Institutional	123	0.05
8	Recreational	953	0.35
9	Open Land	950	0.35
10	Agricultural	13,829	5.12
11	Rangeland	6,240	2.31
12	Hardwood Forest	10,933	4.05
13	Coniferous Forest	14,901	5.51
14	Tree Plantation	98,707	36.52
15	Water	12,451	4.61
16	Hardwood Forested Wetland	22,294	8.25
17	Coniferous Forested Wetland	1,449	0.54
18	Mixed Forested Wetland	28,442	10.52
19	Non-Forested Wetland	34,053	12.60
20	Non-Vegetated Wetland	1,284	0.48
21	Barren Land	520	0.19
22	Transportation, Communication, and Utilities	2,706	1.00
	Total	270,278	100.0

2.4 Climate

The climate of the Nassau River Basin is classified as humid subtropical, with an average summer maximum temperature of 90 degrees Fahrenheit. In the winter, the Nassau River Basin experiences below freezing temperatures an average of 3 to 10 times per year starting as early as November 1 and ending as late as March 31. The last severe freeze in Florida was during December 22 - 25, 1989, where temperatures in Jacksonville were reported in the low teens.

Average annual rainfall for the basin is approximately 52 inches with the wettest month of the year generally being in July. The maximum rainfall in 24 hours was 22 inches recorded in November of 1969 near Fernandina Beach. Since as far back as 1886, Hurricane Dora (Sept. 1964) has been the only hurricane to come near the Nassau River Basin. Hurricane Dora was rated as a 2 on the Saffir/Simpson Scale, which equates to wind speeds of 96 - 110 mph. The Florida Panhandle experiences the greatest number of hurricanes, with over 21 during this same time period. Pan evaporation is estimated at 54 inches annually (Henry et al., 1994). Over 65 percent of the annual rainfall occurs between June and October when convective activity, caused by density differences within the atmosphere, generates showers and thunderstorms often described as a “downpour”. Of the most important factors associated with convective rain in Florida is the “sea breeze”; characterized by the warming and cooling of the land and sea, resulting in convective currents.

3.0 DATA RECONNAISSANCE

Extensive data reconnaissance was required to define the physical features within the basin for the hydrologic and hydraulic simulation of the Nassau River Basin. The required data included topography, stream cross-sections, roadway crossings (bridge and culvert data), sub-basin area, land use, soils, etc. In addition, hydrologic and meteorological data are required to define input and calibrate the hydrologic and hydraulic models. The data was found through researching numerous sources and interviewing personnel at the St. Johns River Water Management District, U.S. Army Corps of Engineers - Jacksonville District, U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Florida Department of Transportation (FDOT), and other local governmental agencies. The data are described in the following subsections.

3.1 Topographic Maps

Topographic maps were used to delineate sub-basins within the watershed and to determine specific parameters in the hydrologic model (e.g. basin lag times, area, etc.). The Nassau River Basin covers, in whole or in part, fifteen 7.5 minute - 1:24,000 scale USGS quadrangle topographic maps. These maps are listed in Table 3.1 and Figure 3.1 illustrates the extents of their coverage of the Nassau River Basin.

Table 3.1 Nassau River Basin USGS Quadrangle Maps

Quadrangle Name	Contour Interval	Date Last Revised or Photo-inspected
Amelia City	5 ft	1988
Bryceville	5 ft	1976
Callahan	5 ft	1983
Dinsmore	5 ft	1983
Eastport	1.5 m	1992
Fernandina Beach	1.5 m	1992
Gross	1.5 m	1979
Hedges	5 ft	1988
Hilliard	5 ft	1970
Hilliard NE	5 ft	1983
Hilliard SW	5 ft	1984
Italia	5 ft	1988
Mayport	10 ft	1982
St. Mary's	5 ft	1993
Trout River	1.5 m	1992

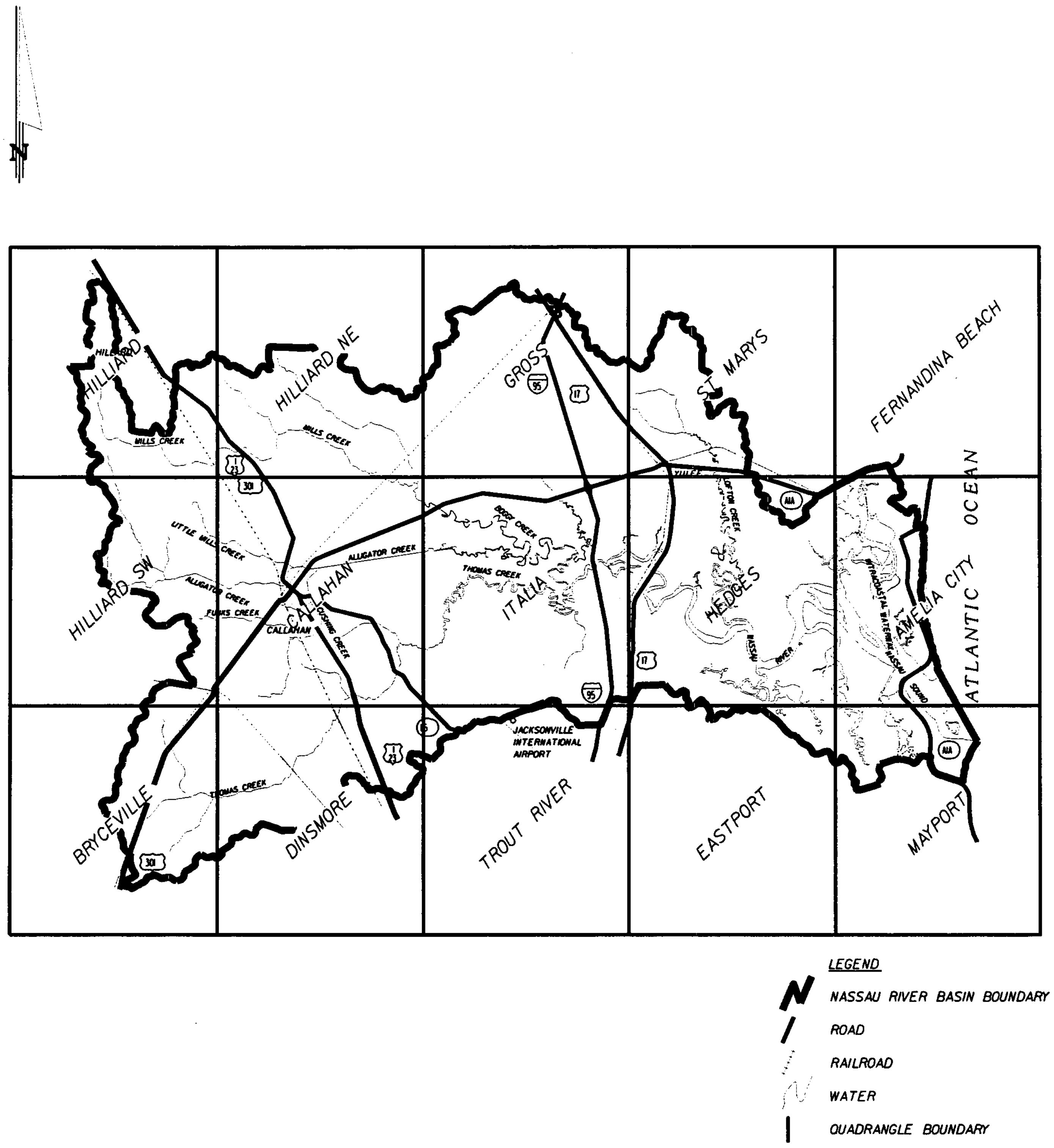


FIGURE 3.I
NASSAU RIVER BASIN USGS QUADRANGLE MAPS

3.2 Climate

3.2.1 Rainfall

In order to simulate the hydrology of the basin, rainfall data at short time intervals are necessary to reproduce the dynamics of changing rainfall intensity, soil infiltration, and runoff rates. Daily rainfall information was available from rainfall gage stations at Jacksonville International Airport, Fernandina Beach, and Hilliard. Hourly rainfall data was available for only the Jacksonville International Airport station. Figure 3.2 shows the location of these rainfall gages, and Table 3.2 summarizes their attributes.

Table 3.2 Nassau River Basin Rain Gages

Station I.D.	Location	Period of Record	Data Interval
4358	Jacksonville International Airport	1948-current year	Hourly
2944	Fernandina Beach	1948-current year	Daily
3978	Hilliard	1948-1956	Daily

3.2.2 Synthetic Storms

Discharges for a drainage basin are often calculated by rainfall-runoff models using hypothetical or synthetic storm data. Two basic components of a hypothetical storm are the total rainfall amount during the storm event (depth) and the time distribution of rainfall (rainfall distribution). Generalized rainfall distributions, developed by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA), have been extensively used throughout the United States.

Generalized distributions, however, lack accuracy because they are based on the rainfall distributions occurring over a large region. Site-specific distributions predict peak discharges more accurately and are therefore more desirable. Procedures for developing site-specific hypothetical storm distributions were described by Rao (1988a). Hypothetical rainfall distributions for the Nassau River Basin were developed by Rao (1991) and incorporated into this study.

Rainfall depths for a particular return period will vary spatially. Rao (1988) studied the variability of the rainfall depths and produced isohyetal maps (lines of equal rainfall) for the SJRWMD. Figures 3.3, 3.4, and 3.5 are the isohyetal maps for the 10-, 25-, and 100-year 24-hour rainfall depths, which were used in this study.

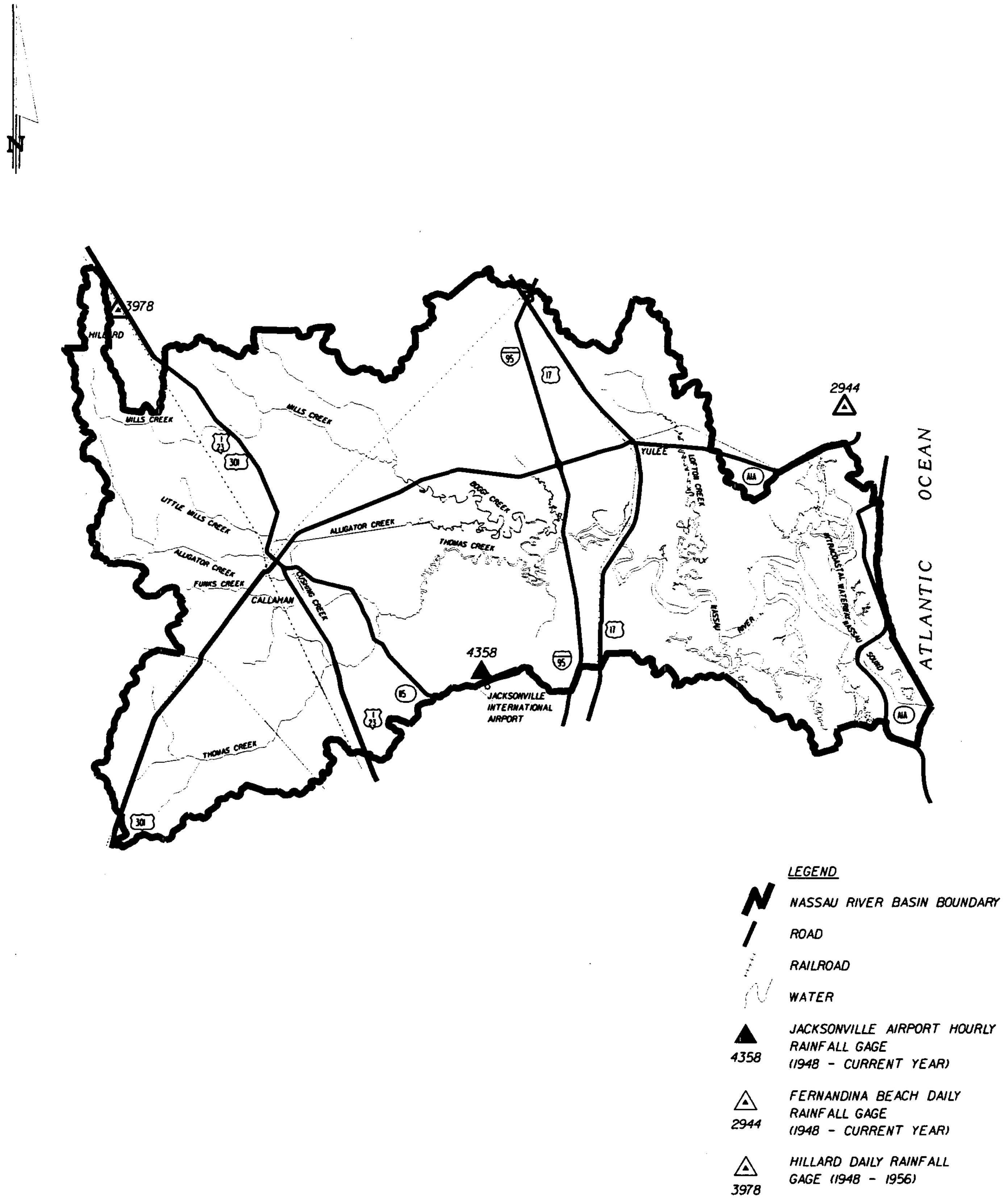


FIGURE 3.2
NASSAU RIVER BASIN RAIN GAGES

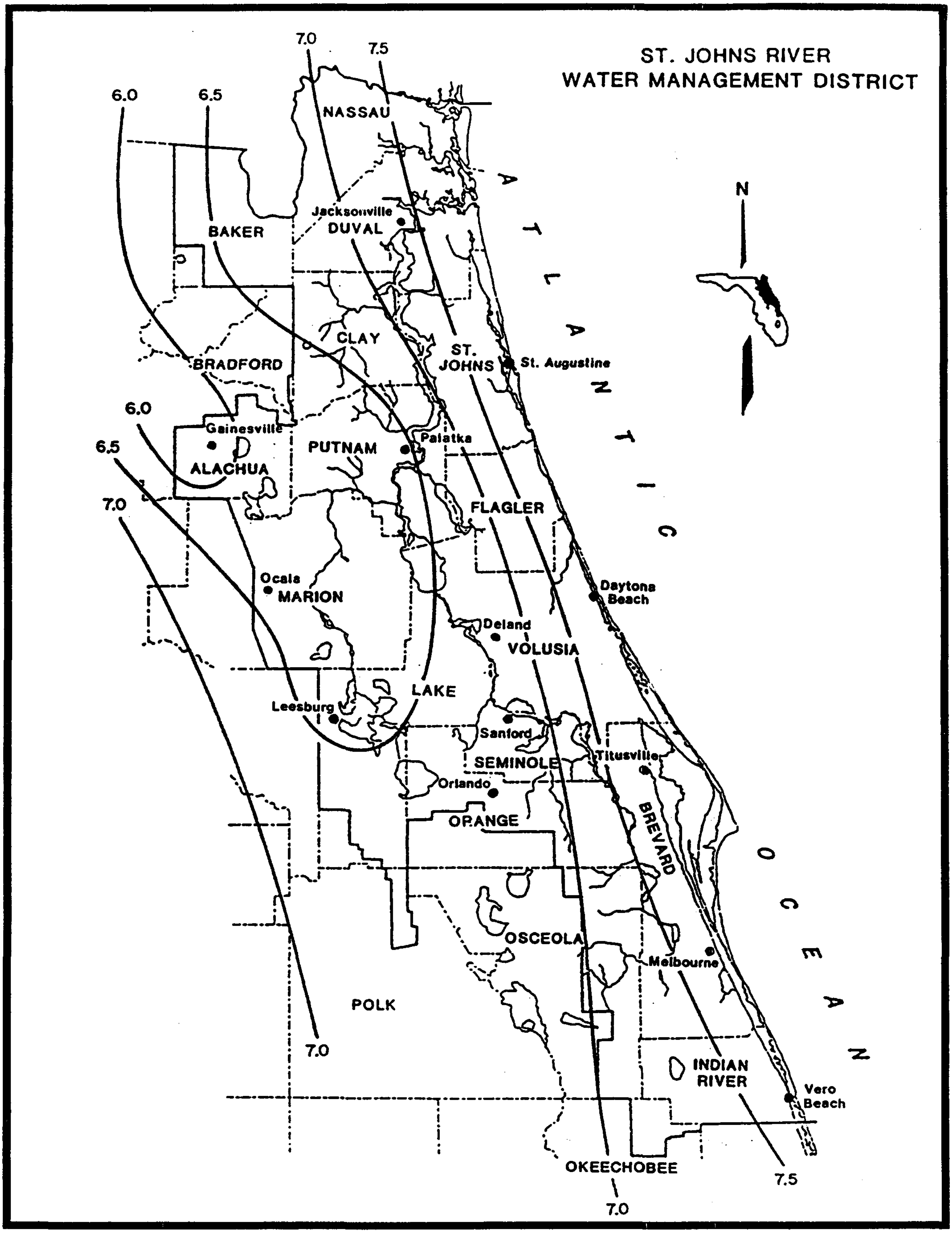


Figure 3.3: 10-Year 24-Hour Maximum Rainfall for Northeast Florida, Inches.
Source: Rao 1988a

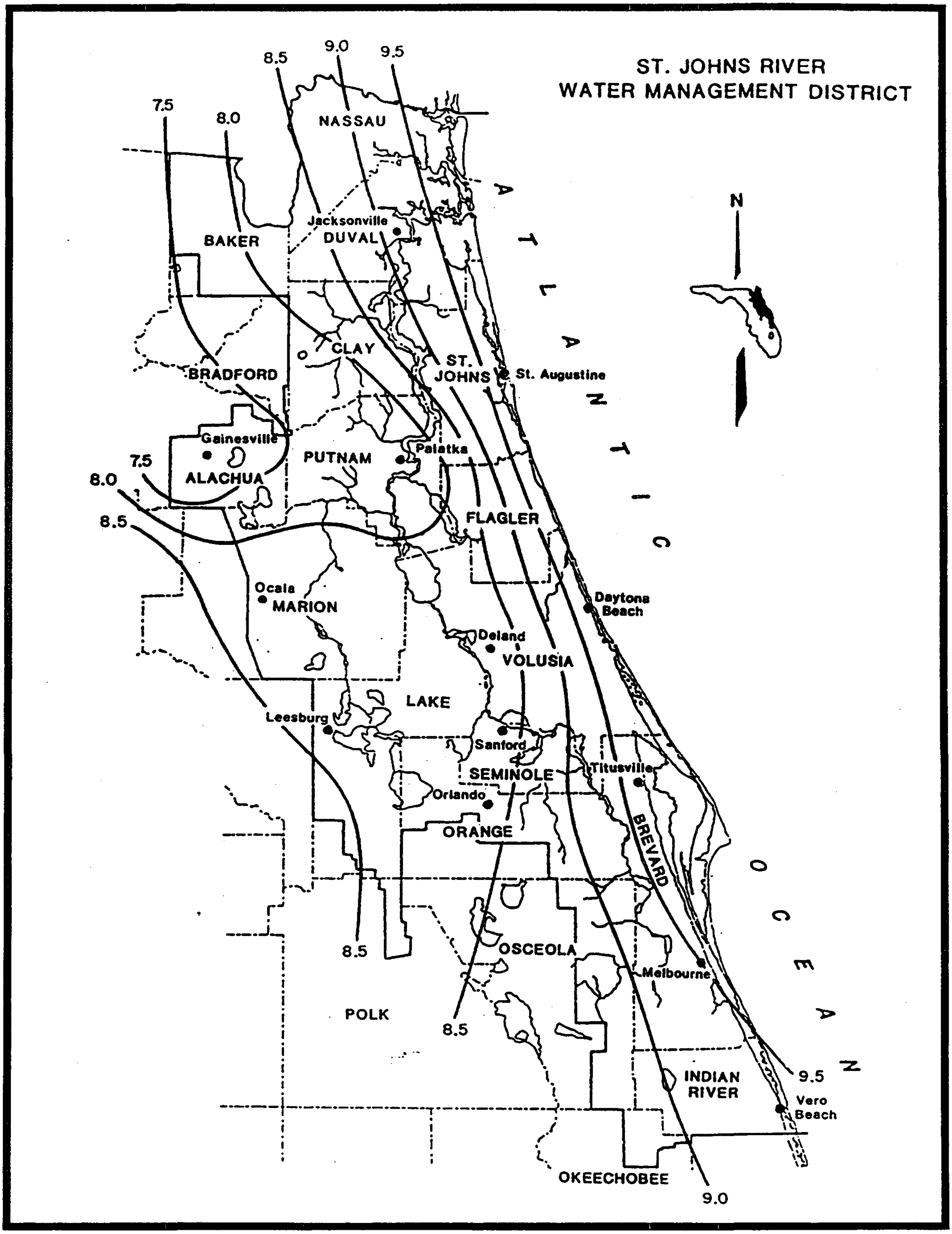


Figure 3.4: 25-Year 24-Hour Maximum Rainfall for Northeast Florida, Inches.
Source: Rao 1988a

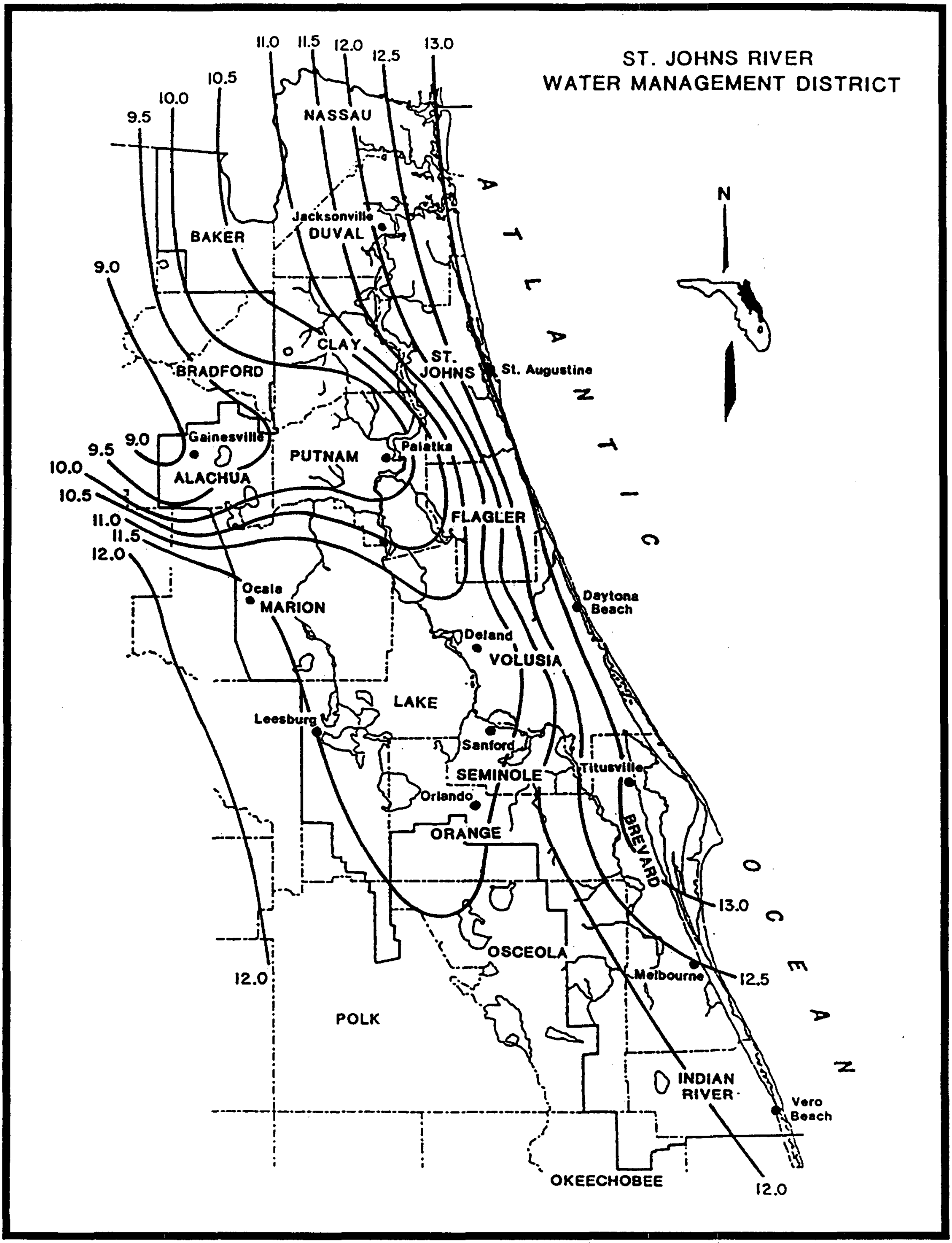


Figure 3.5: 100-Year 24-Hour Maximum Rainfall for Northeast Florida, Inches.
Source: Rao 1988a

3.3 Geographic Information System (GIS) Data

GIS software is capable of quickly querying and manipulating complex digital spatial information such as soils, land use, and related data. Therefore, digital soils, land use, and watershed sub-basin data were obtained from a GIS analysis of the Nassau River Basin.

3.3.1 Soils

Soils for the Nassau River Basin were provided in ARC/INFO coverage format by the SJRWMD. These data were digitized from 1:24,000-scale SSURGO data. Soils data for both Nassau and Duval Counties were needed for complete coverage of the study area and are current as of 1996 and 1997, respectively. Soils were coded with a Mapping Unit Identification Code (MUID) that combines a county's FIPS code and a soils identification number. Eighty-three (83) different soils were identified within the Nassau River Basin.

3.3.2 Land Use

The SJRWMD provided land-use information for the Nassau River Basin as an ARC/INFO coverage. The land-use data were compiled using the Florida Land Use Cover Classification Scheme (FLUCCS) developed by the Florida Department of Natural Resources. Land-use data for Nassau and Duval Counties were collected from 1:24,000-scale black and white aerial photographs taken in 1989 and 1988, respectively. The data were provided by the SJRWMD in USGS 1:24,000-scale quadrangle format. Eighty-one (81) different FLUCCS land uses were identified within the Nassau River Basin.

3.3.3 Sub-basin Boundaries

The Nassau River Basin was delineated into 47 sub-basins by the SJRWMD and provided to the study consultant in the GIS database. These sub-basins were plotted on mylar along with roads, water features, and the surveyed cross section locations. The mylar plots were then used as overlays on USGS 7.5 minute quadrangle sheets to refine the sub-basin delineation. The refinement resulted in a total of 87 sub-basins. The objectives of the refinement were to develop sub-basins that (1) accurately depict the drainage network within the basin, (2) provide additional detail in the area of Callahan, Florida, (3) include in sufficient detail all the upstream and lateral inflow hydrographs to the stormwater routing model (UNET, Barkau 1997), and (4) maintain relatively uniform topographic and land use characteristics. The sub-basin boundaries were digitized and imported into the GIS to determine sub-basin area, land use, and composite curve numbers for the hydrologic model, HEC-HMS.

3.4 Water Quantity Data

3.4.1 Stream Flow

There are four USGS gaging stations in the Nassau River Basin capable of providing stage/discharge data for model calibrations. Characteristics of the gages are shown in Table 3.3 and their locations are shown by Figure 3.6. Of these gages, two are suitable for hydrologic model (HEC-HMS) calibration and one is suitable for the stormwater routing model (UNET) and hydraulic model (HEC-RAS, HEC 1997) calibration. The Alligator Creek gage at Callahan and the Thomas Creek gage near Crawford each have recorded (hourly) hydrographs available for selected storms occurring in the 1990's. These gages are well suited for hydrologic model calibration with the one drawback that the nearest hourly rainfall gage (at the Jacksonville Airport) is 8 miles from the Thomas Creek gage and 10 miles from the Alligator Creek gage.

Only the Alligator Creek gage is suitable for the routing and hydraulic model calibration because the Thomas Creek gage is 4 miles upstream of the upstream extent of these models. The Alligator Creek gage provides discharge and stage records which can be used for UNET and HEC-RAS calibration. The remaining USGS stream flow gages only record mean daily discharge for a short gage record and are not useful for the model calibration.

Table 3.3 Nassau River Basin USGS Stream Flow Gages

USGS Gage #	Location	Period of Record	Drainage Area, sq miles	Mean Daily Discharge	Peak Discharge and Stage	Hourly Hydrographs for some events
02231268	Alligator Cr. at Callahan	1981 - Current Year	14.0	n	n	n
02231280	Thomas Creek nr Crawford	1965 - Current Year	29.9	n	n	n
022312672	Mills Creek nr Italia	1986 - 1988	56.6	n		
02231289	Nassau River nr Hedges	1983 - 1989	274	n		

3.4.2 Ocean Stage

Water surface stage at the ocean has no backwater effect on the Alligator Creek gage at Callahan, Florida. A suitable downstream (ocean) stage is, however, needed for the synthetic storm event simulations (10-, 25-, 100-year flood conditions). To determine a downstream water surface stage for the Nassau River Basin, the NOAA Tide Gages at the Nassau River Entrance and at Fernandina Beach were used. NOAA tide gages

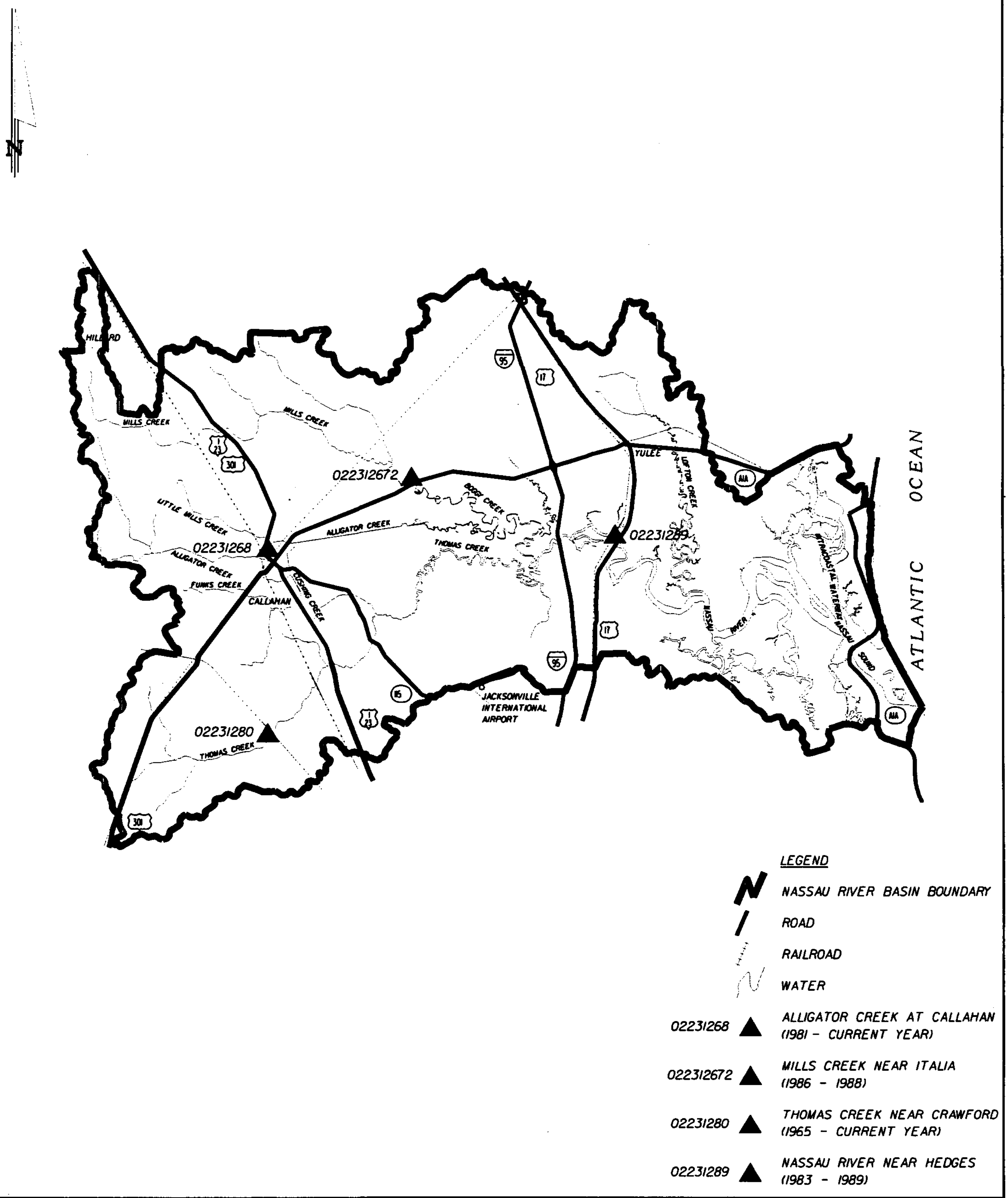


FIGURE 3.6
NASSAU RIVER BASIN STREAM GAGES

relate tide levels to the local Mean Lower Low Water level and some gages include a conversion to NGVD. Two low and two high tides occur daily along the coast of Florida. Mean Lower Low Water is the long-term average of the lower of the two low daily tides and Mean Higher High Water is the long-term average of the higher of the two high daily tides. Because Mean Higher High Water is a frequent yet reasonably high water surface, this level was selected as the downstream water surface for the extreme event modeling.

The Nassau River Entrance gage was active for only 3 months and a conversion to NGVD is not provided for this location. The Fernandina Beach gage on the South Amelia River was active for 18 years and is located approximately 12 miles north of the Nassau River entrance. The data for these tide gages are shown in Table 3.4. The Fernandina Beach gage also includes a conversion to NGVD. Based on this conversion, Mean Tide Level = 0.28 ft NGVD. It was assumed that this conversion can be applied to the Nassau River Entrance gage. Therefore, Mean Higher High Water at Nassau River Entrance can be estimated as 5.68 ft – 2.77 ft + 0.28 ft = 3.19 ft NGVD. This value was used as a constant downstream boundary water surface for the UNET and HEC-RAS modeling.

The fact that the Nassau River entrance gage was only operated for 3 months does not diminish the accuracy of the Mean Higher High Water prediction significantly. This is because temporary gages are related to local long term gages and the predictions are adjusted accordingly.

Table 3.4 Nassau River Basin NOAA Tide Gages

NOAA Tide Gage #	Location	Period of Record	Mean Lower Low Water (ft)	Mean Tide Level (ft)	Mean Higher High Water (ft)	Zero NGVD (ft)
872 0135	Nassau River Entrance	Jun, Sept-Oct 1978	0.00	2.77	5.68	-
872 0030	Fernandina Beach, Amelia R.	1960 - 1978	0.00	3.23	6.60	2.95

3.5 Hydraulic Data

The primary hydraulic modeling data are cross sections provided by the U.S. Army Corps of Engineers, Jacksonville District. The locations of the surveyed cross sections are shown in Figure 3.7. These cross sections include channel and floodplain elevations along the Nassau River, Boggy Creek, Thomas Creek, a tributary to Thomas Creek, Alligator Creek, Little Mills Creek, Cushing Creek, and a tributary to Cushing Creek. In addition to these cross sections, the UNET and HEC-RAS models include bridge and culvert geometry and road profiles for road and railroad crossings. The sources of the

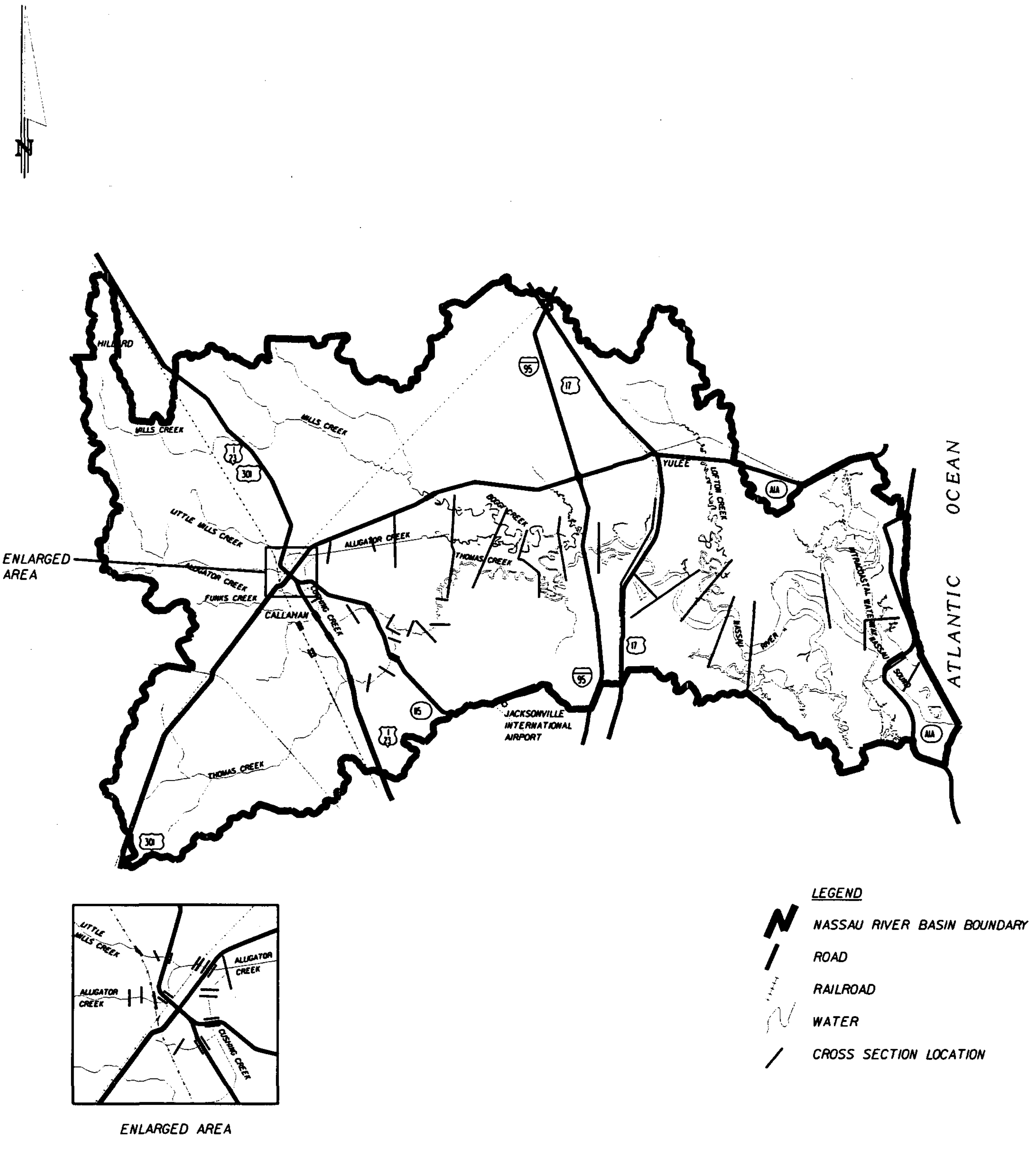


FIGURE 3.7
NASSAU RIVER BASIN CROSS-SECTION LOCATIONS

structure data include (1) bridge plans obtained from Florida Department of Transportation - District 2, (2) measurements taken during a site visit and (3) information from the USGS 7.5 minute quadrangles. USGS quadrangle maps were used to estimate the bridge length of the railroad bridge on Alligator Creek and to estimate the crest elevations of all railroad embankments and some roads. Because no as-built surveys are available for any of these structures, the bridge and culvert geometry included in the model is considered approximate. Observations and photographs taken during the site visit indicate that channel and floodplain flow resistance (Manning's n) is expected to be relatively high for all the tributary channels upstream of the Nassau River. Vegetation consists of thick stands of shrubs and trees in the floodplains and encroaches into the channels. Due to tidal influence, the Nassau River is a large channel with relatively little vegetation encroachment. The floodplain along the Nassau River consists primarily of a saltwater marsh which appears to be less resistant to flow at flood stages.

4.0 WATERSHED SIMULATION

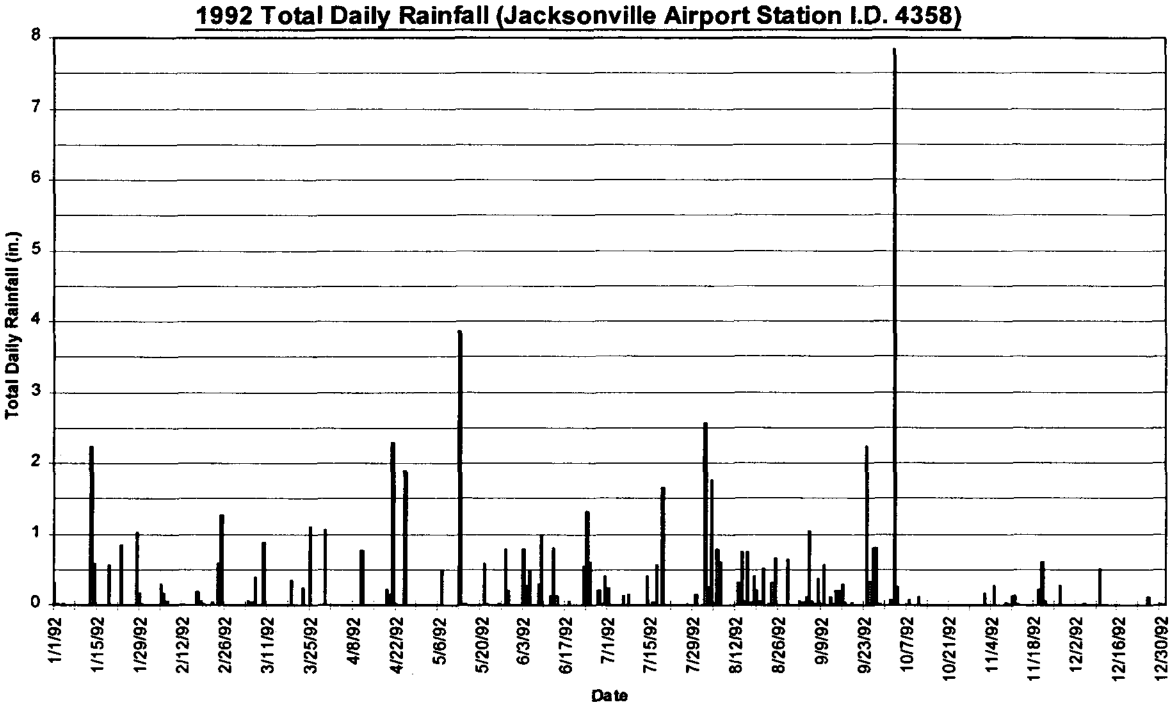
Watershed simulation for the Nassau River Basin was accomplished using several hydrologic and hydraulic models. These included the Hydrologic Modeling System (HEC-HMS, Version 1, HEC 1998) for the hydrologic simulation and HEC-RAS and UNET for the hydraulic simulation. The HEC-HMS software is the replacement software for HEC-1. HEC-RAS (HEC 1997) was used to determine hydraulic profiles in the upper reaches of the Basin, while UNET (Barkau, 1997) was used to simulate the hydrodynamic response of the tidally influenced and main channel area of the Nassau River. The flows and stages were calibrated to several storm events which occurred during 1992 and 1996. The calibrated model was used to predict peak flows and stages for the 10-, 25- and 100-year, 24-hour storm events.

4.1 Data

4.1.1 Meteorological

Rainfall

Hourly rainfall data was only found for the gage located at Jacksonville International Airport. Therefore, this gage was used exclusively for generating flows for the calibration events. The gages located at Fernandina Beach and Hilliard only had daily rainfall data. The Fernandina Beach and Jacksonville International Airport gages have been in service since 1948, whereas, the Hilliard gage was only in service from 1948 to 1956. Daily rainfall depths measured by the gages located at the Jacksonville International Airport and at Fernandina Beach were compared (see Figures 4.1 and 4.2). The comparison suggests that there may be substantial variation between rainfall depths at the two locations. For rainfall events greater than 1.5 inches, the measurements typically varied by 75 percent. For larger events with daily rainfalls greater than 3.0 inches, approximately 45 percent variation was indicated. Three rainfall events were chosen for model calibration. These events occurred in April and October of 1996 and during October of 1992. To account for the Antecedent Moisture Condition (AMC) corresponding with the calibration storm events, the SCS curve numbers were adjusted accordingly.



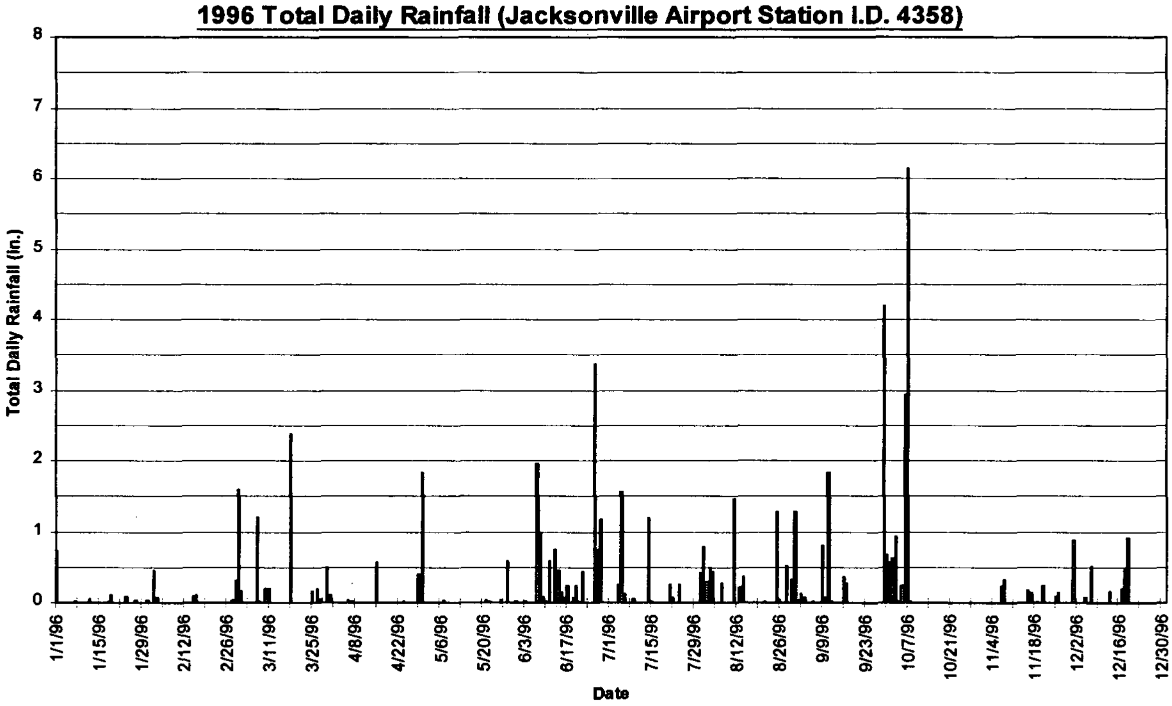
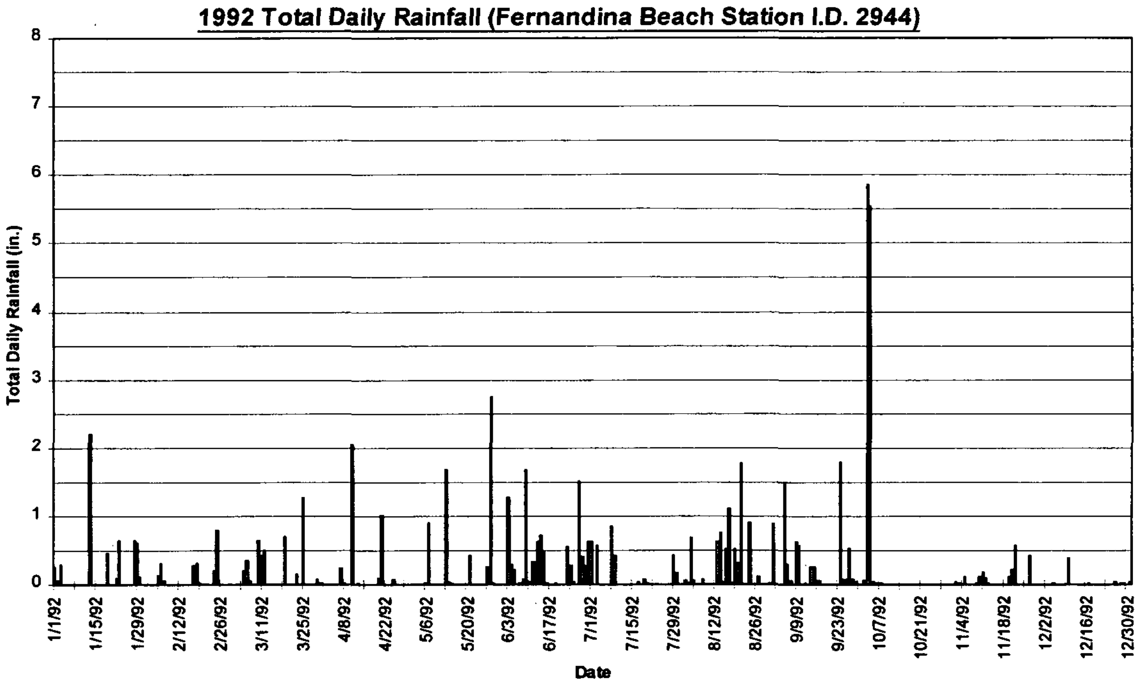


Figure 4.1: Jacksonville Airport Total Daily Rain (1192/1996)



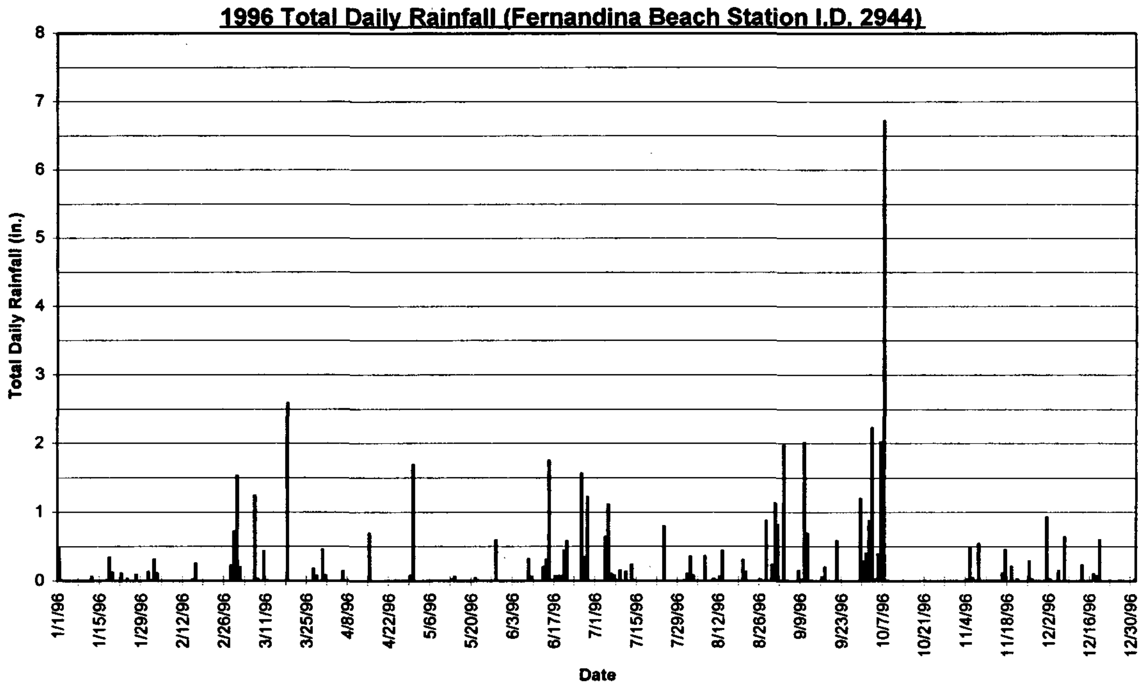


Figure 4.2: Fernandina Beach Total Daily Rain (1992/1996)

4.1.2 Hydrologic Data

Stream stage and discharge data sources included the USGS gages on Thomas Creek near Crawford (1965-1997), Alligator Creek at Callahan (1981-1997), Mills Creek near Italia (1986-1988) and Nassau River near Hedges (1985-1997). The gage data included the historical daily average stages and discharges, peak values, and selected hourly data used for model calibration. In addition, log-Pearson Type III, regression equation, and weighted flood estimates from the USGS Water Resource Investigations 82-4012 for the Thomas Creek gage location were consulted.

Average daily discharge data for the Alligator, Mills, and Thomas Creek gage locations were used to estimate stream base flows. Based on the 60 day minimum flows, a base flow of 0.5 cfs per square mile was used for HEC-HMS modeling.

The Nassau River gage near Hedges was found to be tidally controlled. Thus, it was not suitable for hydrologic calibration of the HEC-HMS model. Also, the gage on Mills Creek was in service for just two water years, in which no extreme events occurred. Finally, provisional gage data for water year 1998 was not included in this study; including two Alligator Creek peak flows in February 1998, which would have been ranked number 2 and 3 if included.

4.1.3 Watershed Data

Sub-basin Delineation

The original 47 sub-basins identified in Planning Unit 1A for the Nassau River Basin were further subdivided, using the USGS quadrangle maps, into a total of 87 sub-basins. Sub-basin boundaries are depicted by Figure 4.3. For a more in-depth discussion on the method and objectives of the refined delineation, see Section 3.3.3.

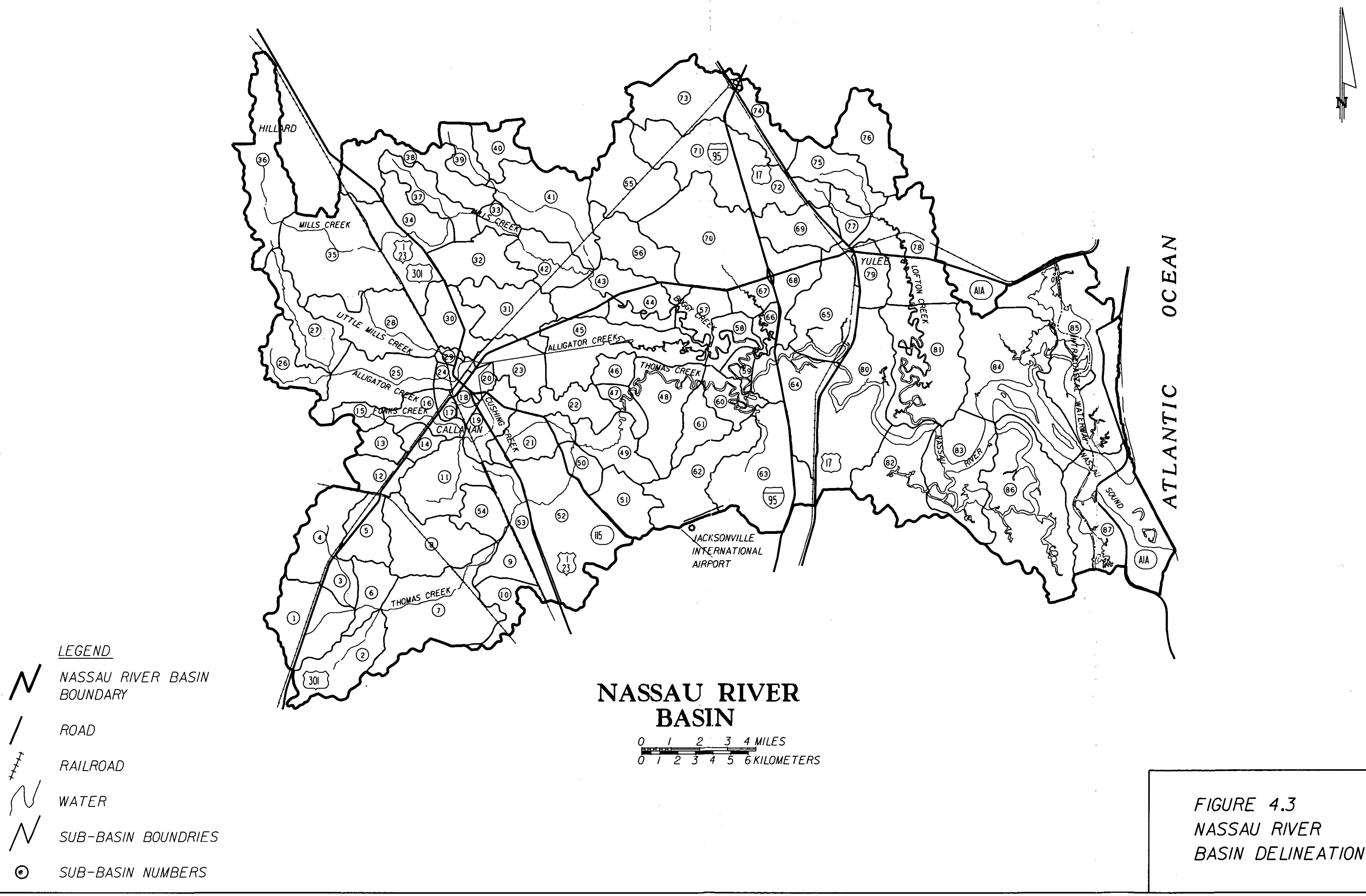


FIGURE 4.3
NASSAU RIVER
BASIN DELINEATION

Land Use

Land-use data for the Nassau River Basin were provided by the SJRWMD in USGS 1:24,000-scale quadrangle format (see Section 3.3.2). These files were joined and clipped to the Nassau River Basin boundary to form one seamless land-use coverage for the entire study area. GIS analysis of the land-use coverage indicated 81 existing FLUCCS land uses. These land uses are listed in Table 4.1.

The FLUCCS land uses were later aggregated into 22 aggregate land uses. Table 4.2 lists the aggregate land uses and their source FLUCCS codes. Differences in area between Tables 4.1 and 4.2 are insignificant (0.5% of the Nassau River Basin) and result from inconsistencies in the clipping process. The land-use data were aggregated to simplify the calculation of area-weighted basin and sub-basin composite curve numbers which were used as inputs to the hydrologic model. A map of aggregate land uses within the Nassau River Basin is included as Plate 1.

Soils

The soils GIS data for the Nassau River Basin were obtained from the SJRWMD (see Section 3.3.1), joined together, and clipped to form one seamless soils coverage. Several sliver polygons with no associated MUID resulted from this process and were identified. These areas comprise only 0.007% of the Nassau River Basin and are therefore insignificant.

Using ARC/INFO's relational database capabilities, a data file containing soils names and HSGs was joined to the existing soils coverage. In some cases, more than one HSG was assigned to a soil (ex. B-A). In these instances, a more conservative approach was followed and the HSG which yielded the greatest runoff was assigned. Other soils were coded a HSG for improved and unimproved conditions (ex. B/D and A/D). Due to the mostly rural landscape of the Nassau River Basin, these soils were assumed to be unimproved and coded D. All urban soils were assigned a D HSG and water areas were coded W to distinguish them from soil areas. All sliver polygons and excavated pits were coded with a null value because their soil type was unknown. A list of all soils and assigned HSGs is presented in Table 4.3. A map of assigned HSGs within the Nassau River Basin is included as Plate 2.

Table 4.1 Nassau River Basin Existing FLUCCS Land Uses

FLUCCS	Area (ac.)	Percent of Total (%)	Description
URBAN AND BUILT-UP			
1100	12,434	4.622	Residential, Low Density - < 2 Dwelling Units per Acre.
1120	19	0.007	Mobile Home Units
1200	7,085	2.634	Residential, Med. Density - 2 to 5 Dwelling Units per Acre.
1300	347	0.129	Residential, High Density
1400	316	0.117	Commercial and Services. Condos and Motels Combined.
1450	8	0.003	Tourist Services
1470	5	0.002	Mixed Commercial and Services
1480	7	0.003	Cemeteries
1500	43	0.016	Industrial
1520	54	0.020	Timber Processing
1550	63	0.024	Other Light Industry
1560	4	0.001	Other Heavy Industrial
1600	8	0.003	Extractive
1620	51	0.019	Sand and Gravel Pits
1700	116	0.043	Institutional
1750	7	0.003	Governmental
1800	51	0.019	Recreational
1810	51	0.019	Swimming Beach
1820	802	0.298	Golf Course
1830	42	0.016	Race Tracks
1850	6	0.002	Parks and Zoos
1900	277	0.103	Open Land
1920	673	0.250	Inactive Land with Street Pattern but Without Structures
AGRICULTURE			
2100	13	0.005	Cropland and Pastureland
2110	8,007	2.977	Improved Pastures
2120	699	0.260	Unimproved Pastures
2130	980	0.364	Woodland Pastures
2140	114	0.043	Row Crops
2150	1,729	0.643	Field Crops
2160	9	0.003	Mixed Crops
2200	41	0.015	Tree Crops
2210	98	0.037	Citrus Groves
2300	17	0.006	Feeding Operations
2310	417	0.155	Cattle Feeding Operations
2320	341	0.127	Poultry Feeding Operations
2400	1,132	0.421	Nurseries and Vineyards
2410	16	0.006	Tree Nurseries
2430	3	0.001	Ornamentals
2510	51	0.019	Horse Farms
2520	55	0.021	Dairies
2600	106	0.039	Other Open Lands - Rural

Table 4.1 Nassau River Basin Existing FLUCCS Land Uses (con't.)

RANGELAND			
3100	78	0.029	Herbaceous
3200	2,015	0.749	Shrub and Brushland
3300	4,147	1.542	Mixed Rangeland
UPLAND FORESTS			
4110	13,945	5.184	Pine Flatwoods
4120	956	0.355	Longleaf Pine - Xeric Oak
4200	22	0.008	Upland Hardwood Forest
4300	20	0.007	Upland Hardwood Forests Continued
4340	10,892	4.049	Hardwood and Conifer
4400	54,701	20.336	Tree Plantations
4410	81	0.030	Coniferous Pine
4430	43,925	16.330	Forest Regeneration
4460	1	0.000	
WATER			
5100	10,212	3.797	Streams and Waterways
5200	96	0.036	Lakes
5300	790	0.294	Reservoirs
5400	47	0.018	Bays and Estuaries
5510	13	0.005	
WETLANDS			
6110	382	0.142	Bay Swamps
6150	21,912	8.146	River/Lake Swamp (Bottomland)
6200	391	0.145	Wetland Coniferous Forest
6210	1,058	0.393	Cypress
6300	28,437	10.572	Wetland Forested Mixed
6310	1	0.000	
6350	3	0.001	
6400	3	0.001	Vegetated Non-Forested Wetlands
6410	733	0.272	Freshwater Marshes
6420	27,197	10.111	Saltwater Marshes
6430	415	0.154	Wet Prairies
6440	93	0.035	Emergent Aquatic Vegetation
6460	5,613	2.087	Mixed Scrub-Shrub Wetland
6500	1,284	0.477	Non-Vegetated Wetland

Table 4.1 Nassau River Basin Existing FLUCCS Land Uses (con't.)

BARREN LAND			
7100	19	0.007	Beaches other than Swimming Beaches
7200	112	0.041	Sand other than Beaches
7400	281	0.105	Disturbed Land
7430	108	0.040	Spoil Areas

TRANSPORTATION, COMMUNICATION, AND UTILITIES			
8110	691	0.257	Airports
8120	36	0.014	Railroads
8140	1,198	0.445	Roads and Highways
8200	21	0.008	Communications
8320	751	0.279	Electrical Power Transmission Lines
8330	8	0.003	Water Supply Plants
TOTALS			
Total	268,986	100.000	

Table 4.2 Nassau River Basin Aggregated Land Uses

Aggregate Land Use	Source FLUCCS code	Area (ac.)	Percent of Total (%)	Description
1	1100, 1120	12,452	4.61	Low Density Residential
2	1200	7,085	2.62	Medium Density Residential
3	1300	347	0.13	High Density Residential
4	1400, 1450, 1470-1480	336	0.12	Commercial
5	1500, 1520, 1550-1560	164	0.06	Industrial
6	1600, 1620	59	0.02	Extractive
7	1700, 1750	123	0.05	Institutional
8	1800-1830, 1850	953	0.35	Recreational
9	1900, 1920	950	0.35	Open Land
10	2100-2160, 2200-2210, 2300-2320,	13,829	5.12	Agricultural
	2400-2410, 2430, 2510-2520, 2600			
11	3100-3300	6,240	2.31	Rangeland
12	4200, 4300, 4340	10,933	4.05	Hardwood Forest
13	4110-4120	14,901	5.51	Coniferous Forest
14	4400-4410, 4430, 4460	98,707	36.52	Tree Plantation
15	5100-5400, 5510	12,451	4.61	Water
16	6110, 6150	22,294	8.25	Hardwood Forested Wetland
17	6200-6210	1,449	0.54	Coniferous Forested Wetland
18	6300-6310, 6350	28,442	10.52	Mixed Forested Wetland
19	6400-6440, 6460	34,053	12.60	Non-Forested Wetland
20	6500	1,284	0.48	Non-Vegetated Wetland
21	7100-7200, 7400, 7430	520	0.19	Barren Land
22	8110-8120, 8140, 8200, 8320-8330	2,706	1.00	Transportation, Communication, Utilities
Total		270,278	100.00	

Table 4.3 Nassau River Basin Soils and Hydrologic Soil Groupings

MUID	Area (Ac.)	Soil Name	HSG	Assigned HSG
NASSAU COUNTY				
089002	304	ARENTS	C	C
089003	57	BEACHES	D	D
089004	147	ECHAW	A	A
089005	350	FRIPP	A	A
089006	9,462	HURRICANE-POTTSBURG	C-B/D	D
089007	225	KINGSLAND	A/D	D
089008	191	KUREB	A	A
089009	20,461	LEON	B/D	D
089010	1,905	MANDARIN	C	C
089011	13,958	CHAIRES	B/D	D
089012	76	NEWHAN-COROLLA	A-D	D
089013	30,805	GOLDHEAD	B/D	D
089014	4,765	RUTLEGE	D	D
089015	16,282	BUCCANEER	D	D
089016	9,181	ELLABELLE	D	D
089017	159	URBAN	U	D
089018	652	LYNN-WESCONNETT-LEON	D-D-D	D
089019	553	LEON	D	D
089020	2,210	ORTEGA	A	A
089021	161	BLANTON	B	B
089022	8,671	SAPELO-LEON	D-B/D	D
089023	488	OCILLA	C	C
089024	8,952	KINGSFERRY	B/D	D
089025	3,882	MAUREPAS	D	D
089026	1,089	CENTENARY	A	A
089027	3,902	RIDGEWOOD	A	A
089028	13,463	TISONIA	D	D
089029	87	RESOTA	A	A
089030	568	KUREB-RESOTA	A-A	A
089031	140	KERSHAW	A	A
089032	237	AQUALFS	C	C
089033	8,771	GOLDHEAD-PLUMMER	D-D	D
089034	1,466	CROATAN	D	D
089036	10,840	BOULOGNE	B/D	D
089037	8,440	MEGGETT	D	D
089038	1,955	MEGGETT	D	D
089039	5,622	EVERGREEN-LEON	D-D	D
089040	1,033	BROOKMAN	D	D
089045	334	MEGGETT	D	D
089046	249	BUCCANEER	D	D
089047	142	LEEFIELD	C	C
089051	1,542	ALBANY	C	C
089053	248	PLUMMER	B/D	D
089054	75	SAPELO	D	D
089055	32	MEADOWBROOK-GOLDHEAD-MEGGETT	B/D-B/D-D	D
089056	57	BLANTON-ORTEGA	B-A	B
089057	393	PENNEY	A	A
089099	7,439	WATER	W	W

Table 4.3 Nassau River Basin Soils and Hydrologic Soil Groupings (con't)

DUVAL COUNTY				
726002	178	ALBANY	C	C
726007	261	ARENTS	C	C
726010	135	BEACHES	D	D
726014	1,455	BOULOGNE	B/D	D
726018	17	COROLLA	D	D
726019	367	CORNELIA	A	A
726022	988	EVERGREEN-WESCONNETT	D	D
726023	52	FRIPP-COROLLA	A-D	D
726024	945	HURRICANE-RIDGEWOOD	C-C	C
726025	20	KERSHAW	A	A
726029	133	KUREB	A	A
726032	7,459	LEON	B/D	D
726033	335	LEON	D	D
726035	1,433	LYNN HAVEN	B/D	D
726036	897	MANDARIN	C	C
726038	7,270	MASCOTTE	B/D	D
726040	572	MAUREPAS	D	D
726042	20	NEWHAN-COROLLA	A-D	D
726044	96	MASCOTTE-PELHAM	B/D-B/D	D
726046	57	ORTEGA	A	A
726049	391	PAMLICO	D	D
726051	8,484	PELHAM	B/D	D
726055	7	PITS	UNK	NULL
726058	488	POTTSBURG	C	C
726062	33	RUTLEGE	B/D	D
726063	3,594	SAPELO	D	D
726066	4,761	SURRENCY	D	D
726067	256	SURRENCY	D	D
726068	14,221	TISONIA	D	D
726069	302	URBAN LAND	U	D
726078	796	YONGES	D	D
726079	1,655	YULEE	D	D
726081	988	STOCKADE	B/D	D
726082	969	PELHAM	B/D	D
726086	2,195	YULEE	D	D
726087	25	DOROVAN	D	D
726088	234	LYNCHBURG	C	C
726099	6,150	WATER	W	W
SLIVER	18		UNK	NULL

Sub-basin Composite Curve Numbers

A GIS analysis, based on area-weighted averages, generated the sub-basin composite curve numbers from a land use/soils matrix. The matrix was created by overlaying the land-use and soils coverages. A table of curve numbers for different land uses and HSG's (Table 4.4) was developed based on the runoff curve number tables in the SCS National Engineering Handbook, and based on discussions with David Clapp of the SJRWMD. These curve numbers were then assigned to each polygon in the matrix.

Table 4.4 Typical Curve Number Matrix

#	Land Use Description	Hydrologic Soil Group			
		A	B	C	D
1	Low Density Residential	51	68	79	84
2	Medium Density Residential	57	72	81	86
3	High Density Residential	77	85	90	92
4	Commercial (85 % impervious)	89	92	94	95
5	Industrial (72 % impervious)	81	88	91	93
6	Extractive	77	86	91	94
7	Institutional	69	80	87	90
8	Recreational	49	69	79	84
9	Open Land	68	79	86	89
10	Agricultural	72	81	88	89
11	Rangeland	39	61	74	80
12	Hardwood Forest	36	60	73	79
13	Coniferous Forest	30	55	70	77
14	Tree Plantation	43	65	76	82
15	Water	100	100	100	100
16	Hardwood Forested Wetland	65	84	90	94
17	Coniferous Forested Wetland	63	80	87	94
18	Mixed Forested Wetland	70	85	91	97
19	Non-Forested Wetland	78	90	94	98
20	Non-Vegetated Wetland	87	95	97	99
21	Barren Land	77	86	91	94
22	Transportation, Communication, and Utilities	89	92	94	95

Sliver polygons and excavated pits (< 0.01% of Nassau River Basin) were assigned a curve number of 0 and were therefore ignored in the composite curve number calculation. Polygons with a land use of water were assigned a curve number of 100.

Sub-basin composite curve numbers were calculated using Equation 4.1.

$$B = (a / A) (CN) \qquad \text{(Equation 4.1)}$$

where B = area-weighted curve number for matrix polygon
a = area of matrix polygon
A = area of sub-basin in which matrix polygon resides
CN = curve number of matrix polygon

The sub-basin composite curve numbers were calculated by summing all matrix polygon B values within each sub-basin. Sub-basin composite curve numbers for the Nassau River Basin are listed in Table 4.5 and shown in Plate 3.

Basin Composite Curve Number

The basin composite curve number was computed by substituting different values into Equation 4.1. The area of each sub-basin and the total area of the Nassau River Basin were substituted for variables a and A, respectively. In addition, each sub-basin's composite curve number was substituted for CN. The results were summed to obtain a composite curve number of 86.49 for the Nassau River Basin.

4.1.4 Synthetic Rainfall

The flood stages in the modeled systems were simulated for three rainfall events, the 10-, 25-, and 100-year / 24-hour storms. The input for the three storms were developed as discussed in Section 3.2.2 from site-specific hypothetical rainfall distributions by Rao (1991). The Nassau River Basin has a significant variation in rainfall depths across the basin for varying return periods. Similarly the variation in rainfall will also result in a variation in the rainfall distribution. Based on this, the Nassau River Basin has been divided into two hydrologic basins located east and west of I-95 (see Figure 4.4). The cumulative rainfall depths for the three rainfall frequency distributions used in the study are listed in Tables 4.6 and 4.7. Similarly the unit rainfall mass curves for the 10-, 25-, and 100-year, 24-hour storms are illustrated in Figures 4.5 and 4.6.

The rainfall depths for each storm event were determined from the isohyetal maps of maximum rainfall (see Figures 3.3, 3.4, and 3.5). The rainfall depths determined for the 10-, 25-, and 100-year, 24-hour storm events were 7.2, 9.1 and 11.8 inches for Hydrologic Basin I and 7.5, 9.5 and 12.7 inches for Hydrologic Basin II.

Table 4.5 Nassau River Basin Curve Numbers for AMC-1, AMC-2, and AMC-3

	COMPOSITE CURVE NUMBER		
SUB-BASIN	AMC-1	AMC-2	AMC-3
1	66.4	82.4	92.4
2	68.3	83.8	93.3
3	57.5	75.4	88.2
4	68.7	84.0	93.4
5	71.4	85.9	94.3
6	56.6	74.7	87.8
7	70.9	85.6	94.2
8	71.5	86.0	94.4
9	75.3	88.3	95.3
10	73.7	87.3	94.9
11	71.7	86.1	94.4
12	73.1	86.9	94.8
13	69.9	84.9	94.0
14	76.5	89.1	95.6
15	70.8	85.5	94.2
16	72.3	86.4	94.6
17	71.2	85.7	94.3
18	75.9	88.7	95.5
19	70.5	85.3	94.1
20	78.0	90.0	96.0
21	71.6	86.0	94.4
22	69.9	84.9	94.0
23	73.2	87.0	94.8
24	72.6	86.6	94.6
25	67.1	82.9	92.8
26	75.1	88.2	95.3
27	72.5	86.6	94.6
28	67.8	83.4	93.1
29	72.9	86.8	94.7
30	72.1	86.3	94.5
31	70.4	85.2	94.1
32	71.0	85.6	94.2
33	73.8	87.4	95.0
34	72.2	86.4	94.6
35	68.4	83.9	93.3
36	74.0	87.5	95.0
37	67.3	83.1	92.8
38	69.3	84.5	93.7
39	68.0	83.6	93.2
40	69.1	84.3	93.6
41	69.7	84.8	93.9
42	71.6	86.0	94.4
43	71.0	85.6	94.3
44	77.0	89.4	95.7
45	73.6	87.2	94.9
46	71.0	85.6	94.3
47	73.6	87.2	94.9
48	73.9	87.5	95.0
49	73.4	87.1	94.8
50	77.3	89.6	95.8
51	71.3	85.8	94.3
52	74.1	87.6	95.0
53	75.2	88.2	95.3
54	73.3	87.1	94.8
55	71.3	85.8	94.3
56	71.3	85.8	94.3
57	74.9	88.1	95.2
58	78.9	90.5	96.2
59	88.2	95.5	98.2
60	79.6	90.9	96.3
61	67.7	83.4	93.0
62	69.4	84.6	93.8
63	70.5	85.3	94.1
64	80.9	91.6	96.6
65	76.0	88.8	95.5
66	79.6	90.9	96.3
67	71.4	85.9	94.4
68	73.2	87.0	94.8
69	69.5	84.6	93.8
70	72.1	86.3	94.5
71	70.0	85.0	94.0
72	69.6	84.7	93.8
73	69.5	84.7	93.8
74	71.0	85.6	94.2
75	64.5	81.1	91.6
76	61.1	78.4	90.0
77	61.1	78.4	90.0
78	62.5	79.6	90.8
79	71.7	86.1	94.4
80	76.8	89.2	95.7
81	70.9	85.5	94.2
82	76.9	89.3	95.7
83	88.5	95.6	98.2
84	80.0	91.1	96.4
85	75.5	88.5	95.4
86	80.0	91.1	96.4
87	77.2	89.5	95.8

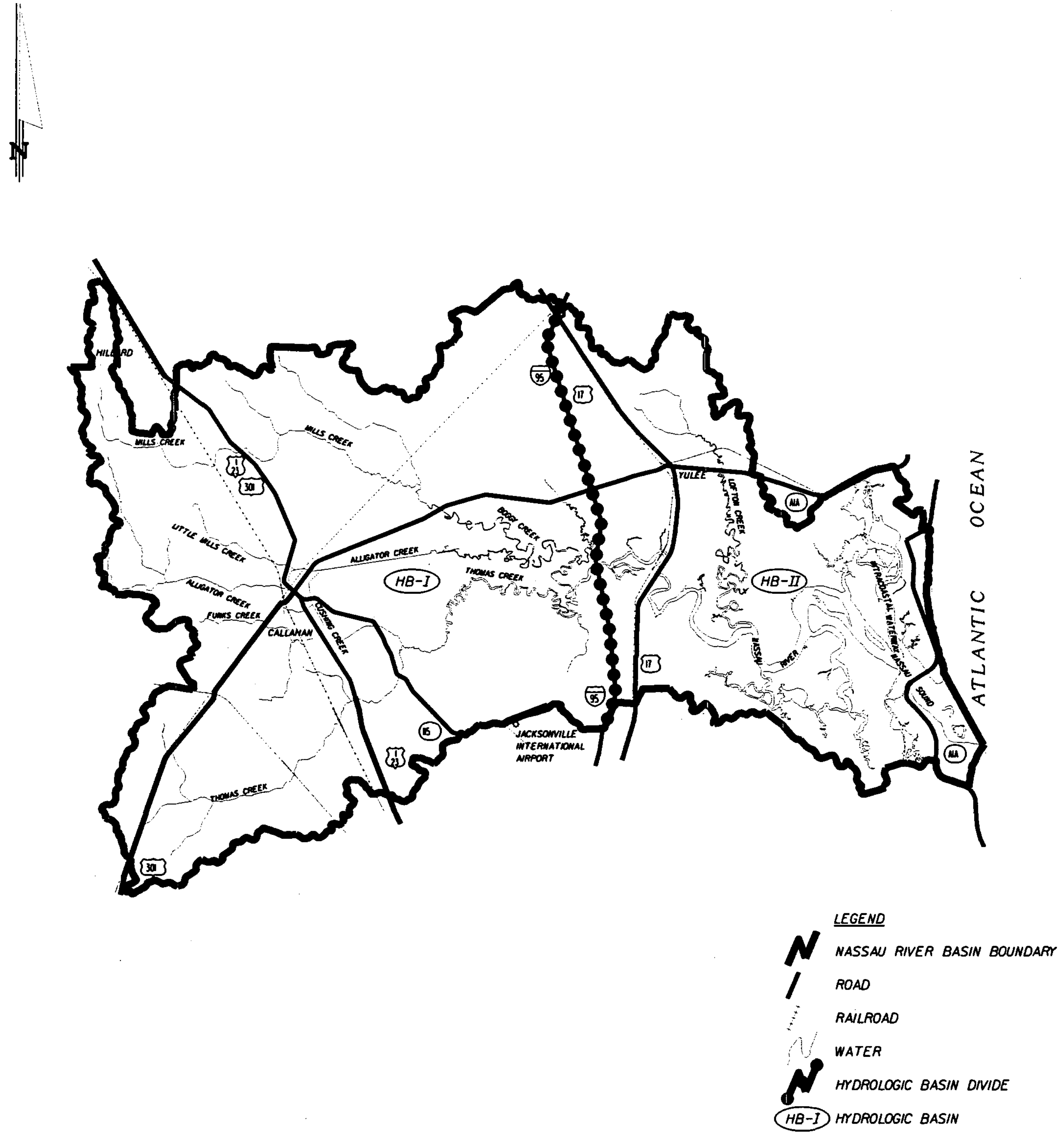


FIGURE 4.4

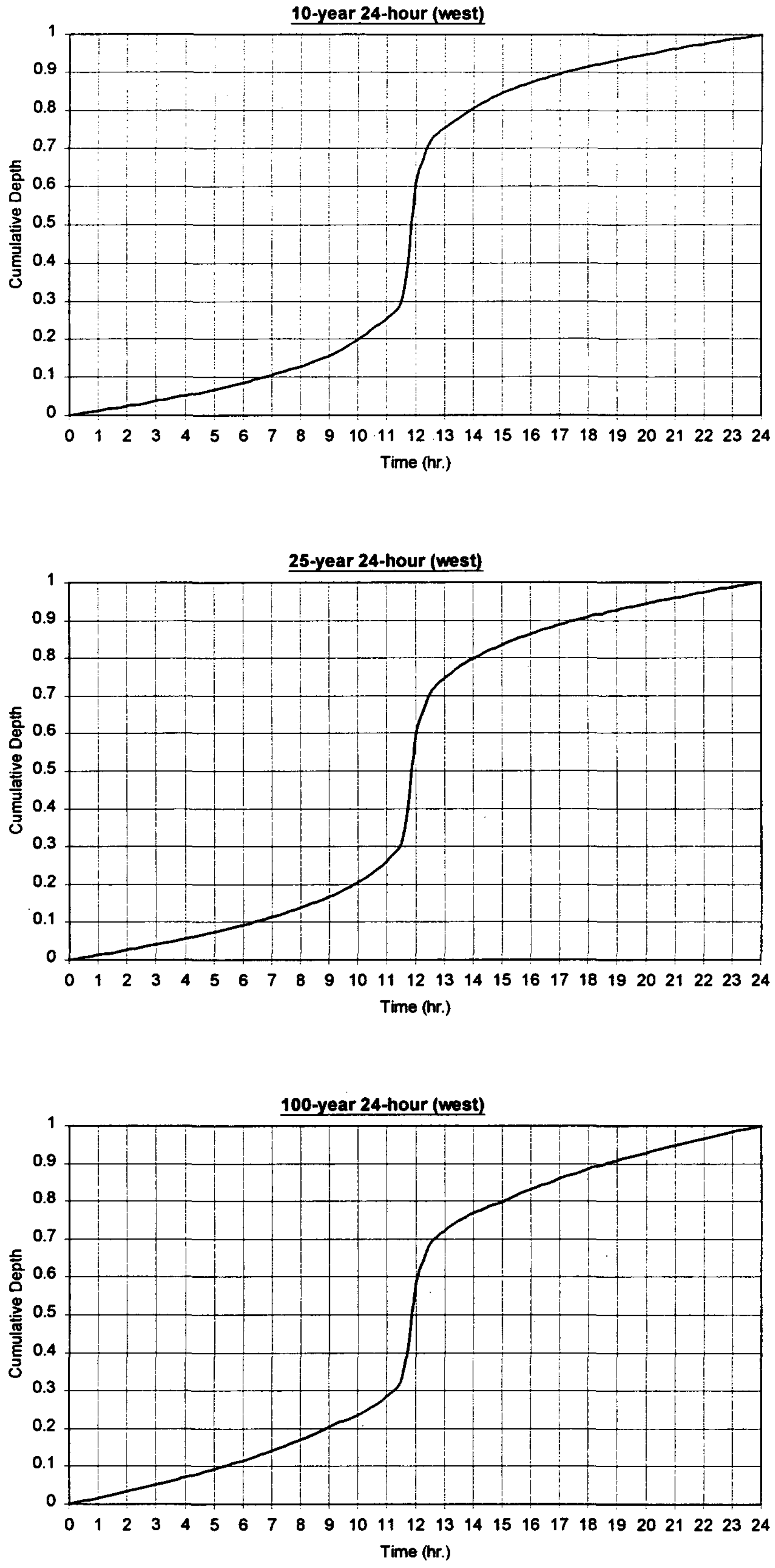
NASSAU RIVER BASIN HYDROLOGIC BASINS I & II

Table 4.6 Nassau River Rainfall Distributions (west of I-95)

Time	Cumulative Rainfall Distribution			Time	Cumulative Rainfall Distribution			Time	Cumulative Rainfall Distribution		
(hr.)	10-year	25-year	100-year	(hr.)	10-year	25-year	100-year	(hr.)	10-year	25-year	100-year
0.25	0.003	0.003	0.004	8.25	0.135	0.145	0.178	16.25	0.879	0.870	0.839
0.50	0.006	0.006	0.008	8.50	0.142	0.152	0.187	16.50	0.885	0.876	0.846
0.75	0.009	0.009	0.012	8.75	0.149	0.160	0.195	16.75	0.891	0.882	0.853
1.00	0.012	0.013	0.016	9.00	0.156	0.168	0.205	17.00	0.896	0.888	0.860
1.25	0.015	0.016	0.020	9.25	0.166	0.176	0.212	17.25	0.901	0.893	0.867
1.50	0.018	0.019	0.025	9.50	0.176	0.186	0.219	17.50	0.906	0.899	0.873
1.75	0.021	0.023	0.029	9.75	0.187	0.195	0.227	17.75	0.911	0.904	0.880
2.00	0.024	0.026	0.033	10.00	0.199	0.206	0.236	18.00	0.916	0.909	0.886
2.25	0.027	0.030	0.038	10.25	0.212	0.217	0.246	18.25	0.920	0.914	0.892
2.50	0.030	0.033	0.042	10.50	0.227	0.230	0.257	18.50	0.925	0.918	0.897
2.75	0.034	0.037	0.047	10.75	0.239	0.245	0.269	18.75	0.929	0.923	0.903
3.00	0.037	0.041	0.052	11.00	0.253	0.261	0.284	19.00	0.933	0.927	0.909
3.25	0.041	0.044	0.056	11.25	0.271	0.282	0.301	19.25	0.937	0.932	0.914
3.50	0.044	0.048	0.061	11.50	0.294	0.308	0.324	19.50	0.941	0.936	0.919
3.75	0.048	0.052	0.066	11.75	0.401	0.411	0.421	19.75	0.945	0.940	0.924
4.00	0.052	0.056	0.071	12.00	0.608	0.599	0.588	20.00	0.949	0.944	0.929
4.25	0.056	0.060	0.076	12.25	0.668	0.657	0.642	20.25	0.952	0.948	0.934
4.50	0.059	0.065	0.081	12.50	0.718	0.705	0.688	20.50	0.956	0.952	0.939
4.75	0.063	0.069	0.087	12.75	0.738	0.728	0.707	20.75	0.960	0.956	0.944
5.00	0.068	0.073	0.092	13.00	0.754	0.746	0.723	21.00	0.963	0.960	0.949
5.25	0.072	0.078	0.098	13.25	0.767	0.761	0.737	21.25	0.966	0.963	0.953
5.50	0.076	0.082	0.104	13.50	0.778	0.775	0.748	21.50	0.970	0.967	0.958
5.75	0.081	0.087	0.109	13.75	0.792	0.787	0.758	21.75	0.973	0.971	0.963
6.00	0.085	0.092	0.115	14.00	0.805	0.798	0.768	22.00	0.976	0.974	0.967
6.25	0.090	0.097	0.122	14.25	0.816	0.808	0.776	22.25	0.979	0.978	0.971
6.50	0.095	0.103	0.128	14.50	0.827	0.818	0.784	22.50	0.982	0.981	0.976
6.75	0.100	0.108	0.134	14.75	0.837	0.826	0.791	22.75	0.986	0.984	0.980
7.00	0.105	0.114	0.141	15.00	0.846	0.835	0.798	23.00	0.989	0.987	0.984
7.25	0.111	0.119	0.148	15.25	0.853	0.842	0.807	23.25	0.991	0.991	0.988
7.50	0.116	0.125	0.155	15.50	0.860	0.850	0.816	23.50	0.994	0.994	0.992
7.75	0.122	0.132	0.163	15.75	0.867	0.857	0.824	23.75	0.997	0.997	0.996
8.00	0.128	0.138	0.170	16.00	0.873	0.863	0.832	24.00	1.000	1.000	1.000

Table 4.7 Nassau River Rainfall Distributions (east of I-95)

Time	Cumulative Rainfall Distribution			Time	Cumulative Rainfall Distribution			Time	Cumulative Rainfall Distribution		
(hr.)	10-year	25-year	100-year	(hr.)	10-year	25-year	100-year	(hr.)	10-year	25-year	100-year
0.25	0.003	0.003	0.004	8.25	0.133	0.161	0.191	16.25	0.881	0.855	0.827
0.50	0.006	0.007	0.009	8.50	0.140	0.169	0.200	16.50	0.887	0.862	0.835
0.75	0.008	0.011	0.013	8.75	0.147	0.177	0.209	16.75	0.892	0.868	0.842
1.00	0.011	0.014	0.018	9.00	0.155	0.186	0.219	17.00	0.897	0.875	0.849
1.25	0.014	0.018	0.022	9.25	0.165	0.193	0.225	17.25	0.902	0.881	0.856
1.50	0.017	0.022	0.027	9.50	0.176	0.201	0.232	17.50	0.907	0.887	0.863
1.75	0.020	0.026	0.032	9.75	0.188	0.209	0.240	17.75	0.912	0.892	0.870
2.00	0.024	0.029	0.036	10.00	0.200	0.218	0.248	18.00	0.917	0.898	0.876
2.25	0.027	0.033	0.041	10.25	0.214	0.228	0.257	18.25	0.921	0.903	0.883
2.50	0.030	0.037	0.046	10.50	0.229	0.239	0.267	18.50	0.926	0.908	0.889
2.75	0.033	0.041	0.051	10.75	0.242	0.254	0.279	18.75	0.930	0.914	0.895
3.00	0.037	0.046	0.056	11.00	0.258	0.271	0.294	19.00	0.934	0.919	0.901
3.25	0.040	0.050	0.061	11.25	0.276	0.291	0.311	19.25	0.938	0.923	0.907
3.50	0.044	0.054	0.066	11.50	0.301	0.318	0.334	19.50	0.942	0.928	0.912
3.75	0.047	0.059	0.072	11.75	0.404	0.416	0.425	19.75	0.946	0.933	0.918
4.00	0.051	0.063	0.077	12.00	0.604	0.594	0.582	20.00	0.949	0.937	0.923
4.25	0.055	0.068	0.083	12.25	0.663	0.649	0.634	20.25	0.953	0.942	0.929
4.50	0.059	0.072	0.088	12.50	0.712	0.695	0.677	20.50	0.957	0.946	0.934
4.75	0.063	0.077	0.094	12.75	0.733	0.718	0.697	20.75	0.960	0.950	0.939
5.00	0.067	0.082	0.100	13.00	0.750	0.736	0.713	21.00	0.964	0.955	0.944
5.25	0.071	0.087	0.106	13.25	0.764	0.752	0.726	21.25	0.967	0.959	0.949
5.50	0.075	0.092	0.112	13.50	0.776	0.766	0.738	21.50	0.970	0.963	0.954
5.75	0.080	0.098	0.118	13.75	0.790	0.776	0.747	21.75	0.973	0.967	0.959
6.00	0.084	0.103	0.125	14.00	0.804	0.786	0.756	22.00	0.977	0.971	0.964
6.25	0.089	0.109	0.131	14.25	0.816	0.795	0.763	22.25	0.980	0.975	0.969
6.50	0.094	0.115	0.138	14.50	0.827	0.803	0.771	22.50	0.983	0.978	0.973
6.75	0.099	0.120	0.145	14.75	0.838	0.810	0.777	22.75	0.986	0.982	0.978
7.00	0.104	0.127	0.152	15.00	0.848	0.817	0.784	23.00	0.989	0.986	0.982
7.25	0.109	0.133	0.160	15.25	0.855	0.825	0.793	23.25	0.992	0.989	0.987
7.50	0.115	0.140	0.167	15.50	0.862	0.833	0.802	23.50	0.994	0.993	0.991
7.75	0.121	0.146	0.175	15.75	0.869	0.841	0.811	23.75	0.997	0.997	0.996
8.00	0.127	0.154	0.183	16.00	0.875	0.848	0.819	24.00	1.000	1.000	1.000



10-year 24-hour (west)

25-year 24-hour (west)

100-year 24-hour (west)

Figure 4.5: Nassau River Basin Rainfall Mass Curves (west of I-95)

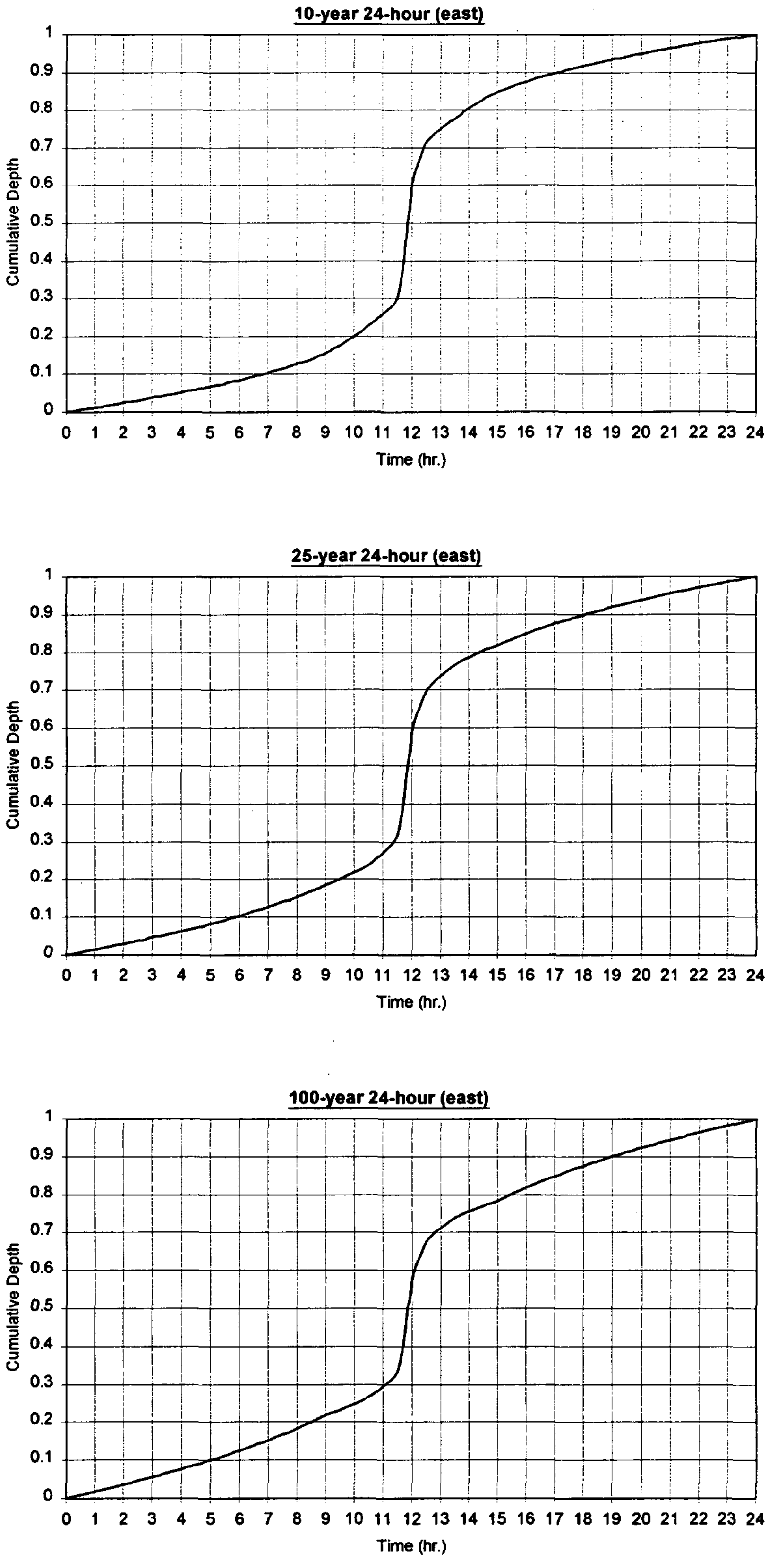


Figure 4.6: Nassau River Basin Rainfall Mass Curves (east of I-95)

4.2 Water Quantity Modeling

4.2.1 Model Framework

HYDROLOGIC MODELING

The precipitation - runoff conditions for the Nassau River Basin were simulated using HEC-HMS "Hydrologic Modeling System" (Version 1, March 1998), the USACE's replacement software for HEC-1. Like HEC-1, HEC-HMS includes several watershed-runoff and routing methods. Perhaps one of the greatest advantages of the HEC-HMS model is the Graphical User Interface (GUI) capabilities. As a result, watershed basins, reaches, junctions, etc. can be schematically represented as a network of hydrologic elements. HEC-HMS includes various methods for calculating losses, determining runoff transformation and routing from basin to basin.

HEC-HMS can calculate infiltration losses based on the Green and Ampt or the SCS Curve Number methods. Because of the availability of the land use and soils coverage's, the SCS Method was used for determining infiltration losses. Other losses included the initial abstraction or depressional storage for each sub-basin, a value of 0.2 was used for the synthetic storm simulations. However, for calibration this value was adjusted for varying antecedent moisture conditions (AMC).

The SCS and Snyder's methods were considered for transformation of rainfall excesses to runoff. In HEC-HMS the SCS method utilizes an invariable unit-hydrograph peaking factor of 484, which may not accurately describe the runoff characteristics of a flat, high-groundwater-table watershed such as this (Capece et al., 1984). Therefore, Snyder's method was selected for the ability to calibrate to an attenuated runoff response. Input variables used for the Snyder's method included lag time and peaking factor.

Initially the SCS Curve Number, Snyder's, and Velocity methods were used to calculate lag time. Based on calibration results, the velocity method was chosen. With the velocity method, the time of concentration, t_c, is first determined by summing travel times. The calculated t_c's are then multiplied by a factor of 0.6 to obtain an estimate of lag time. Calculation of t_c was done using USGS Quadrangle Maps to determine the slope of the longest overland flow path in the basin. The slope of the flow path was determined by dividing the change in elevation by the length. The velocity was then determined from available velocity versus slope relationships for various land uses. The velocity was then divided by the flow length to obtain the t_c. For channelized flow the t_c was determined based on estimating flow velocities for the given channel. Generally in the upper reaches of the basins where the Manning's n roughness is very high and the physical slope is very flat, a velocity of 0.5 to 1 fps was used. In other areas, where the physical slope was greater and the channel was well defined, 1 to 2 fps was used. The t_c was then calculated similarly to the overland flow method. The t_c for the entire sub-basin was then the sum of the overland and channelized flow t_c's.

The Snyder's peaking factor used for modeling the synthetic storm events was 0.28. This value was based on the calibration runs for Thomas and Alligator Creeks.

HEC-HMS affords several methods for routing subbasin flows through reaches. The Muskingum Cunge method was selected due to its versatility, in allowing the user to input an 8 point cross-section with Manning's n roughness coefficients for the main channel and left and right overbank.

HYDRAULIC MODELING

UNET (Barkau 1997) and HEC-RAS (HEC 1998) were used for the hydraulic modeling of the major channels within the Nassau River basin. UNET is capable of routing the flows generated by HEC-HMS, accounting for storage and attenuation as the flood flows move down the channel. Although UNET alone could have been used for this aspect of the project, the HEC-RAS model is better suited for floodplain management. HEC-RAS uses steady-state conditions and is more easily modified to account for improvements or encroachments into the floodplain. Figure 4.7 shows the reaches used for both UNET and HEC-RAS. The only difference between the models is that Reach 1 is not used in the HEC-RAS model. Reach 1 is located at the upstream ends of Reaches 5 and 6 in the UNET model where these reaches share a floodplain upstream of the Seaboard Railroad. The UNET model incorporates the surveyed channel geometry, bridge and culvert geometry, upstream hydrographs to Reaches 1, 2, 3, 4, 9 and 12, and lateral inflow hydrographs to all the reaches except Reach 1. The HEC-RAS model uses peak flows computed by UNET to perform a backwater analysis, also incorporating the channel, bridge and culvert geometries.

4.2.2 Model Calibration

HYDROLOGIC MODELING

Hydrologic calibration for the 418 square mile watershed was based on a 32 square mile area upstream of the Thomas Creek stage/discharge gage and a 15 square mile area upstream of the Alligator Creek stage/discharge gage. The calibration basin areas were no less than 8 miles removed from the rainfall gage location at Jacksonville International Airport. Both calibration basin areas include significant forested wetland areas. Consequently, potential storages were difficult to estimate due to the lack of extensive survey data and knowledge of basin conditions prior to the calibration storm events. The Thomas Creek calibration basin appears mostly unimproved. Based on NRCS Soil Survey aerials, the Alligator Creek calibration area includes substantial agricultural areas with dual hydrologic group (B/D) soils. The Alligator Creek calibration model

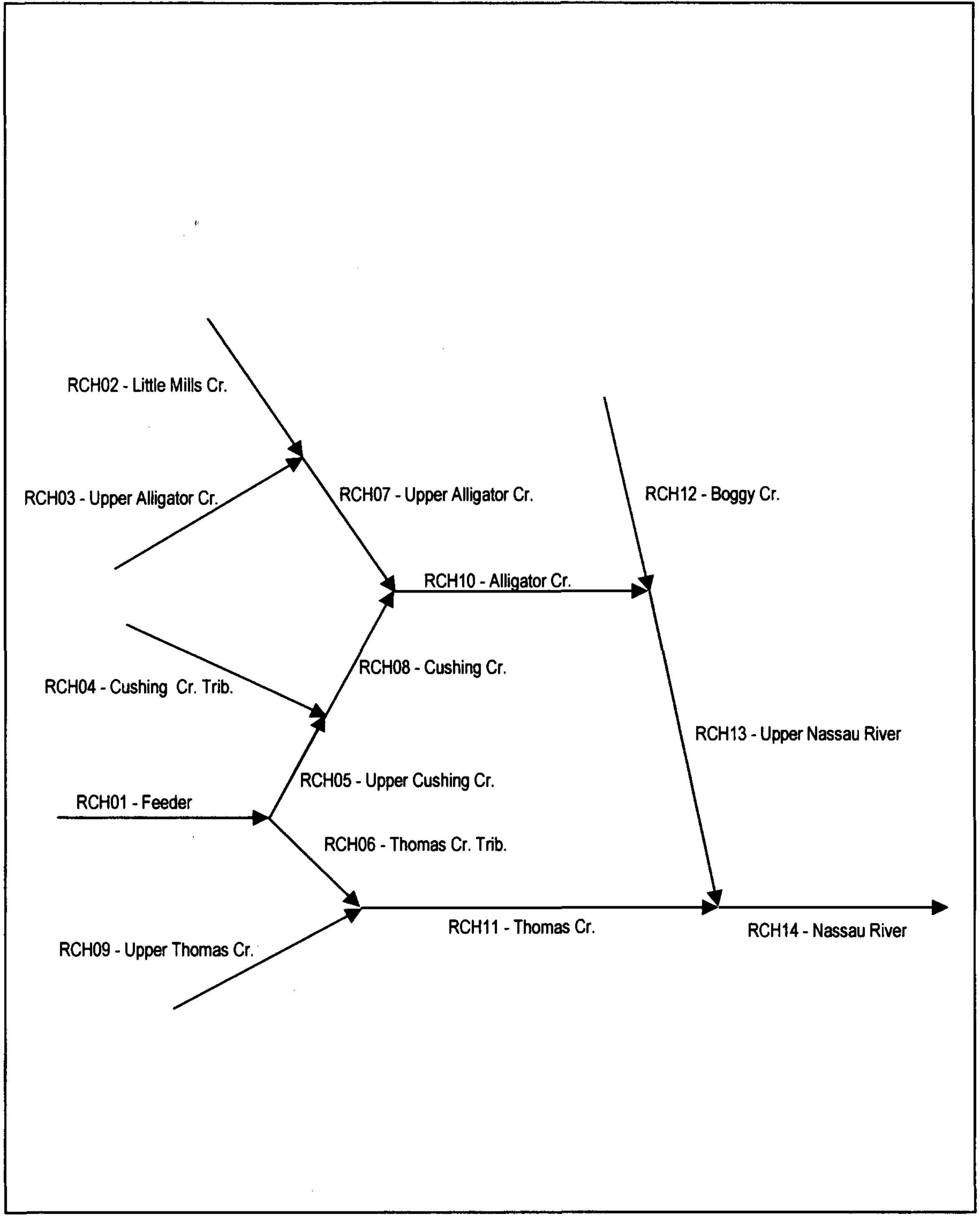


Figure 4.7 Nassau River Basin UNET / HEC-RAS Reach Schematic

assumes a conservative unimproved (D) hydrologic condition, which may not be the case.

During HEC-HMS calibration, the predicted runoff responses to the following potential calibration factors were investigated: Snyder's peaking factor (C_p), Snyder's lag time (T_p), Antecedent Moisture Condition (AMC), Initial Abstraction (I_a), and Manning's n. Of these factors, Snyder's peaking factor and lag time were the most extensively adjusted. Adjustment of C_p greatly influenced the shape of the computed runoff hydrograph. C_p's used during model calibration ranged from 0.14 to 0.35 with lower values producing a flatter runoff response indicative of greater sub-basin storage. Ultimately, a C_p of 0.28 was selected as the most appropriate value. The time to peak of the runoff hydrograph was adjusted using lag time. Based on adjustments made during calibration, the originally calculated lag times were increased. Antecedent Moisture Condition was set according to rainfall data for the previous two weeks and greatly affected the computed total runoff volume. Initial Abstraction was used to adjust the rising limb slope of the computed runoff hydrograph. For normal to wet conditions, an I_a of 0.2 was used. The Manning's n values were adjusted based on field observation and are consistent with values determined during calibration of the hydraulic models.

Three storm events were selected for HEC-HMS model calibration. Calibration rainfall and runoff hydrographs are presented for each event by Figures 4.8, 4.9, and 4.10. The runoff hydrographs shown represent calibration results, which were adopted for inclusion in the final HEC-HMS models. Hydrographs calibrated to match the individual storms at either the Alligator Creek or Thomas Creek gage locations are not shown.

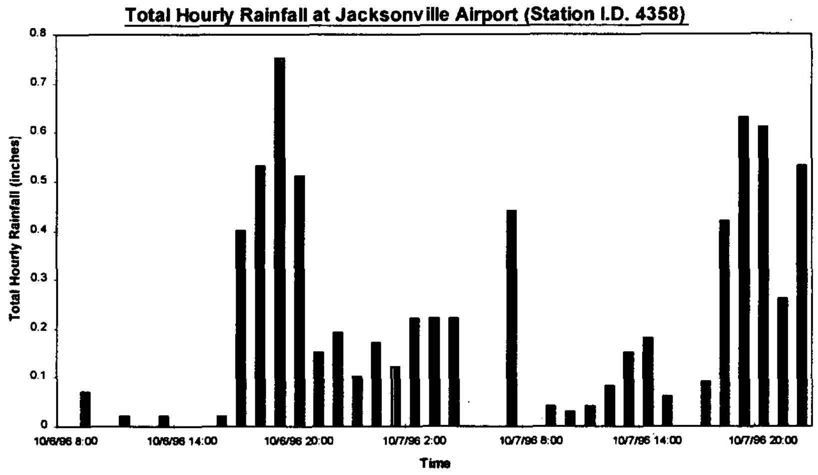
The first calibration event occurred in October 1996. For this event the Jacksonville rain gage measured a total rainfall depth of 7.27 inches in 39 hours with 7.16 inches occurring within a 30 hour interval. Corresponding peak flow measurements at the Alligator Creek and Thomas Creek gages were 931 cfs and 4,220 cfs, respectively. The Alligator Creek peak discharge ranked number 1 during the 17 year period of record whereas the Thomas Creek discharge ranked number 2 during the 33 year period of record. HEC-HMS calculated peak discharges at Alligator Creek and Thomas Creek were 1,230 cfs and 3,387 cfs, respectively. The model over-predicted the peak discharge at the Alligator Creek gage by 33 percent and under-predicted the peak discharge at Thomas Creek gage by 20 percent. For both events, calculated runoff volumes compared very well with the observed data.

The second calibration event occurred during April/May 1996. For this event the Jacksonville rain gage measured a total rainfall depth of 2.24 inches in 23 hours with 1.7 inches occurring within a 4 hour interval. Corresponding peak flow measurements at the Alligator Creek and Thomas Creek gages were 280 cfs and 466 cfs, respectively.

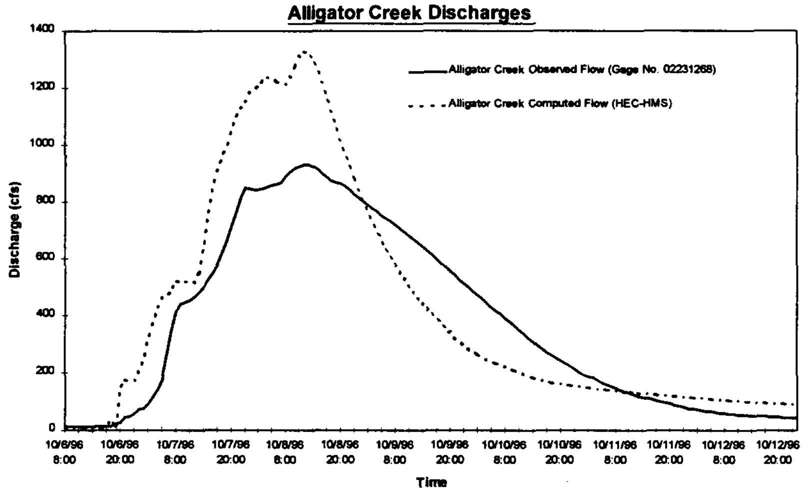
HEC-HMS calculated discharges at Alligator Creek and Thomas Creek were 286 cfs and 800 cfs, respectively. The model nearly matched observed peak discharge at the Alligator Creek gage but over-predicted the observed peak discharge at Thomas Creek gage by 72 percent. However, the calculated runoff volumes were comparable with the observed data at both gage locations.

The third and final calibration event occurred in October 1992. The Jacksonville rain gage measured a total rainfall depth of 8.11 inches in 36 hours with a 24 hour maximum rainfall depth of 7.83 inches for this storm event. The measured peak flows were approximately 479 cfs and 5,350 cfs at the Alligator Creek and Thomas Creek gages, respectively. The Alligator Creek peak discharge ranked number 3 during the 17 year period of record whereas the Thomas Creek discharge ranked number 1 during the 33 year period of record. Unfortunately, hourly measurements for the Thomas Creek gage were not available for this event, although instantaneous peak and daily values were. HEC-HMS model results compared well with the available observed data for Thomas Creek, under-predicting the observed flow by 10 percent and computing a similar runoff volume. However, computed peak flow and runoff volume for Alligator Creek were approximately 3 times greater than the observed values.

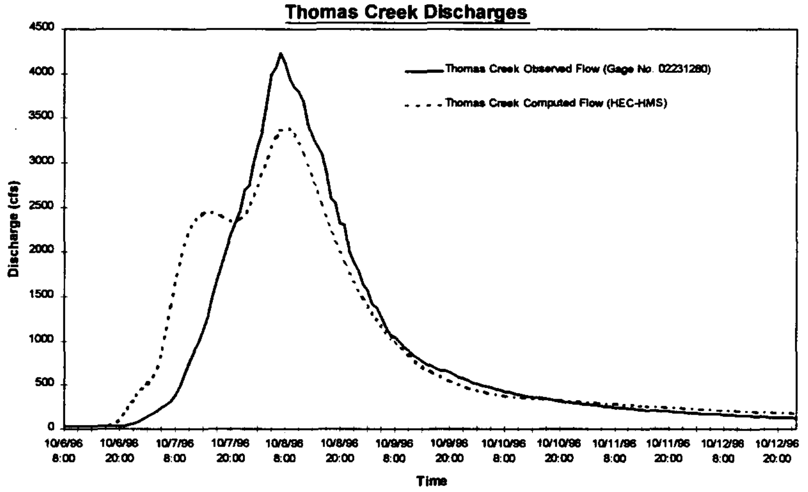
Rainfall variation and the high storage characteristics of the calibration basins may account for many of the differences between the observed and computed calibration hydrographs. With reliance on only the Jacksonville International Airport rain gage measurements for calibration data, spatial rainfall variation can not be discerned. Also, the calibration basin's small size and high storage capabilities suggest that actual runoff values for equivalent storms can vary appreciably with Antecedent Moisture Condition (AMC) and the depth of water already impounded within depressional areas.



Total Hourly Rainfall at Jacksonville Airport (Station I.D. 4358)

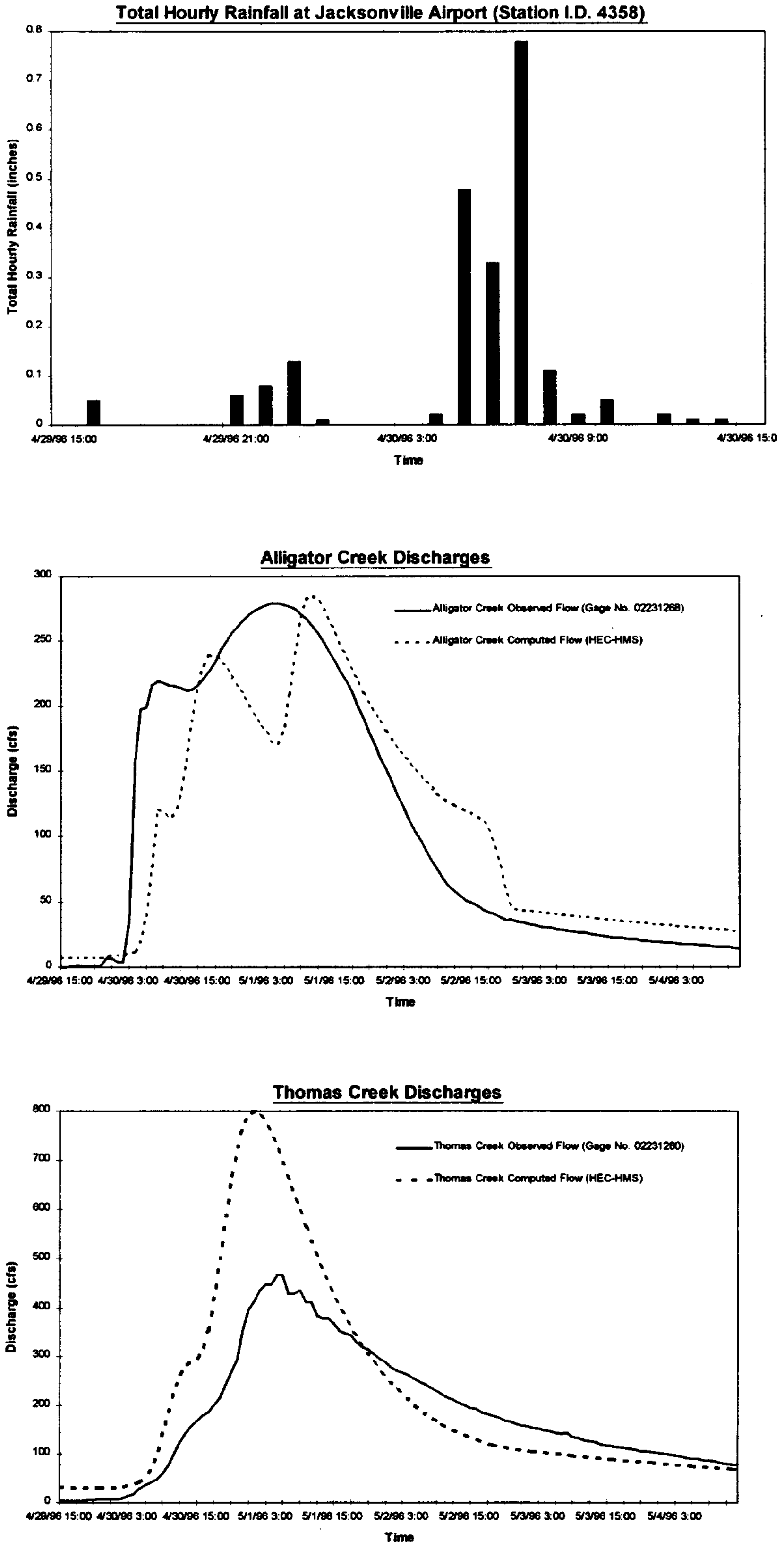


Alligator Creek Discharges



Thomas Creek Discharges

Figure 4.8: October 1996 Calibration Rainfall and Discharges



Total Hourly Rainfall at Jacksonville Airport (Station I.D. 4358)

Alligator Creek Discharges

Thomas Creek Discharges

Figure 4.9: April 1996 Calibration Rainfall and Discharges

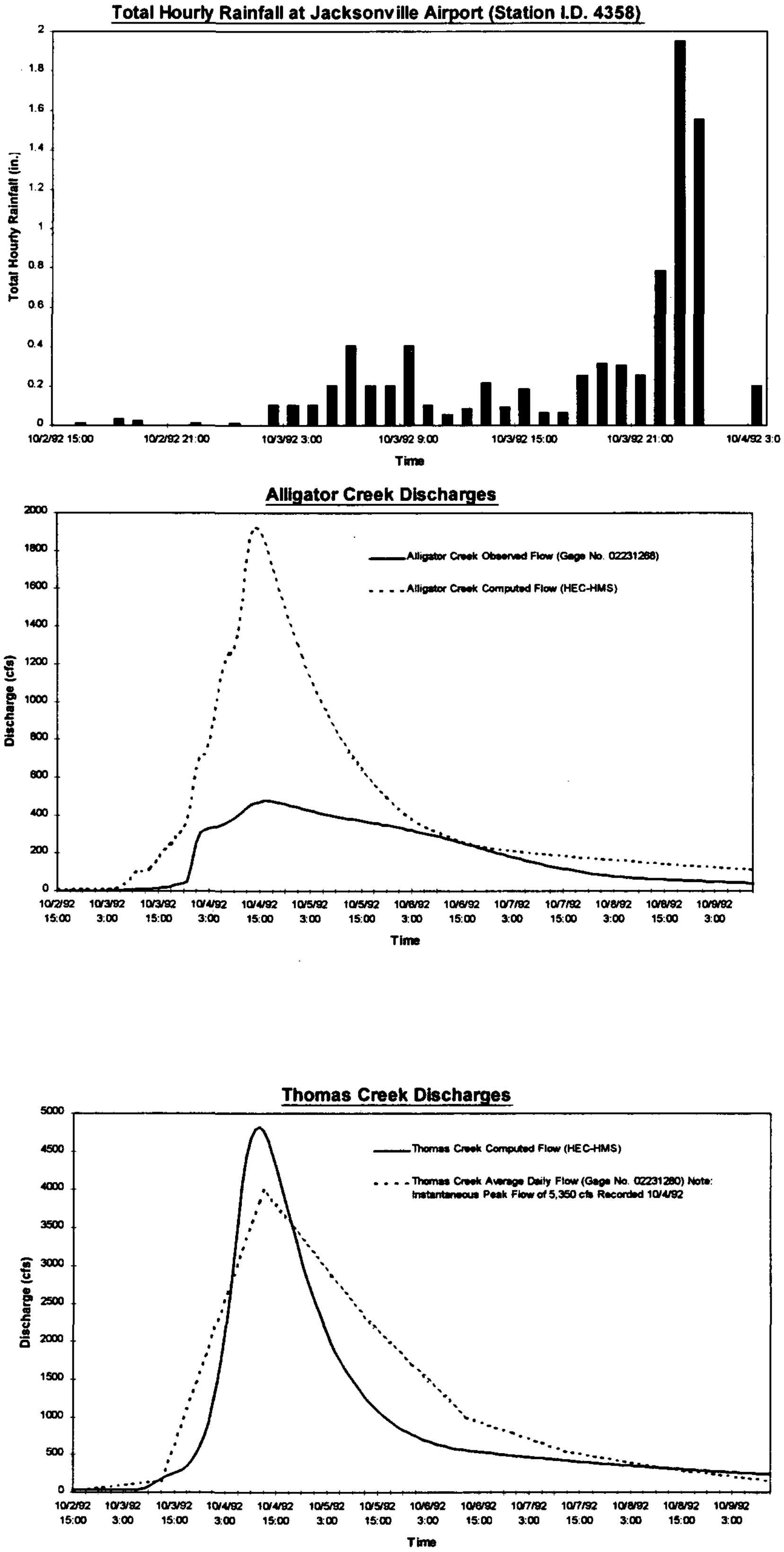


Figure 4.10: October 1992 Calibration Rainfall and Discharges

HYDRAULIC MODELING

UNET model calibration was performed using the USGS Alligator Creek gage. The October, 1996 event and the peak stage and discharge record from 1982 through 1996 were used in the calibration. Figure 4.11 shows the gage peak stages and discharges and the UNET model computed stages and discharges for the 1996 event. Calibration was achieved by adjusting the channel and overbank Manning's n values until the computed results matched the observed data. Also, potential backwater effects from downstream structures were investigated and were not significant. Using a channel Manning's n of 0.045 and a floodplain Manning's n of 0.25 for Upper Alligator Creek provided a reasonable fit to the observed data. At the flood of record (October 8, 1996), the UNET model is 0.25 feet higher than the observed stage, but tends to be lower than most of the remaining data. The data for the period between 1994 and 1996 is plotted with a different symbol than the earlier data because there is a 2-year gap in the gage record. The reason for the gap is unknown. Compared to the more recent data, UNET tends to predict stages up to one foot above the gage data except for the October 12, 1994 event (419 cfs at 12.81 ft-NGVD) where UNET is 0.5 foot low. Given the range of scatter in the gage data, the calibrated Manning's n values produce reasonable results.

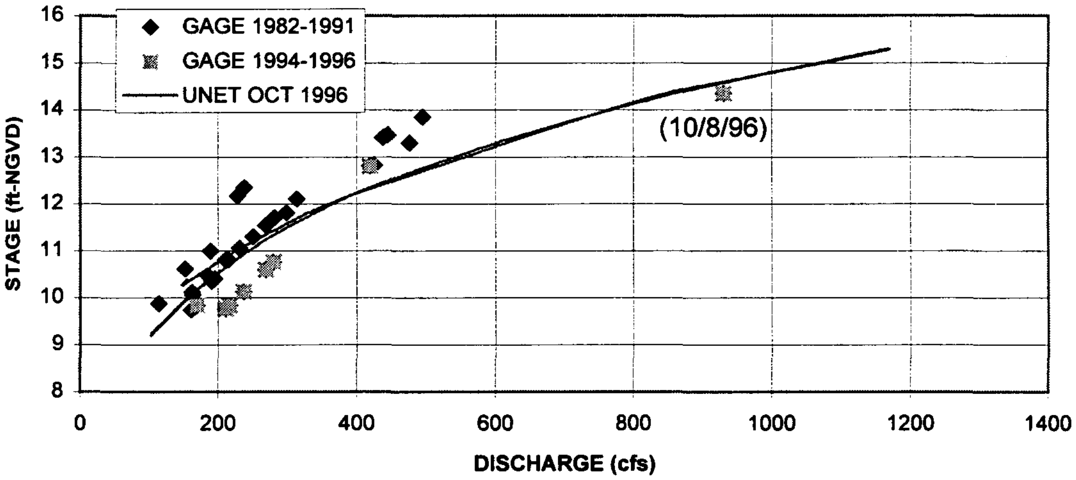


Figure 4.11 Alligator Creek Observed Peaks versus UNET Results

Figure 4.12 shows the observed, HEC-HMS and UNET hydrographs at the Alligator Creek gage for the October, 1996 event. HEC-HMS produces the highest flow and steepest hydrograph rising and falling limbs. When the UNET model is run for this event and more extreme conditions, the predicted water surfaces at the upstream ends of several reaches indicate widespread inundation. Although this is an expected outcome, it also indicates that storage would occur at these locations and the storage needs to be incorporated into the UNET model. Based on the topography of the areas upstream of the surveyed cross sections, several additional cross sections were added to the UNET

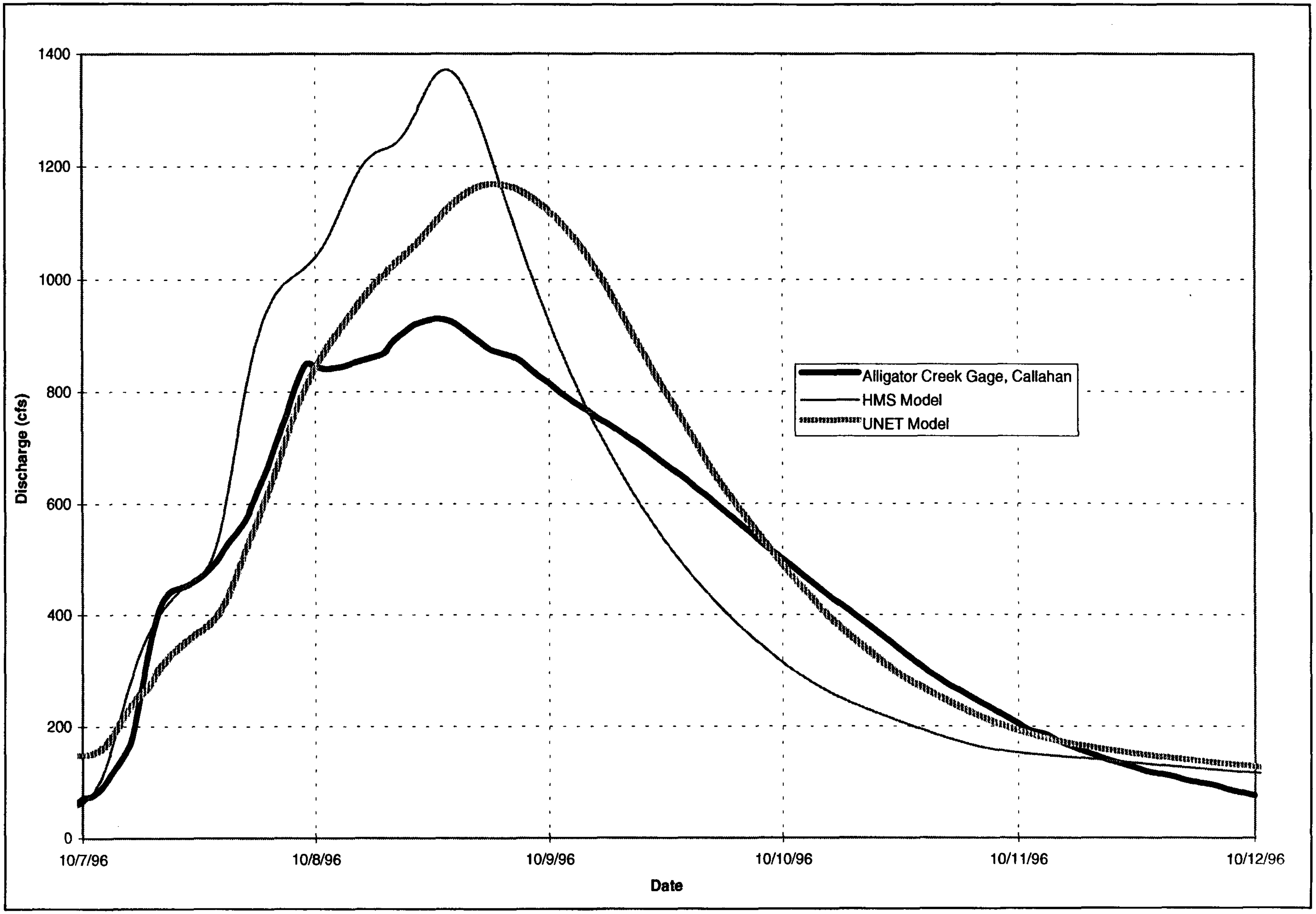


Figure 4.12 Observed, HEC-HMS and UNET Calibration Hydrographs for Alligator Creek

model. UNET used the HEC-HMS sub-basin hydrographs as input and routes the flow through the channel network based on the channel geometry and roughness characteristics. Figure 4.12 shows the UNET hydrograph at the Alligator Creek gage with the added cross sections included at the upstream end of Reach 3. If these additional cross sections were not included in the UNET model, the UNET and HEC-HMS hydrographs would be nearly identical. Additional cross sections were included at the upstream ends of Alligator Creek (Reach 3), Cushing Creek and Thomas Creek Tributary (Reach 1), Thomas Creek (Reach 9) and Boggy Creek (Reach 12) to account for storage.

Table 4.8 shows the Manning's n's for the UNET model. Based on the similarity of channels and floodplains in the upper reaches, the UNET model included the calibrated Manning's n's of 0.045 and 0.25 for the majority of the reaches. Because Reach 10 of Alligator Creek is channelized, the channel Manning's n was reduced to 0.040 although the floodplain Manning's n remained at 0.25. The Nassau River is much larger than the upstream channels, has less channel vegetation and has a floodplain which transitions to tidal marsh. Therefore, upstream of the confluence with Thomas Creek the channel and floodplain Manning's n values for Nassau River were reduced to 0.035 and 0.15 and downstream of the Thomas Creek confluence they were further reduced to 0.030 and 0.10, respectively.

Table 4.8 Manning's n Values.

	UNET		HEC-RAS	
Reach	Channel n	Floodplain n	Channel n	Floodplain n
Upper Alligator Creek	0.045	0.25	0.041	0.225
Little Mills Creek	0.045	0.25	0.041	0.225
Alligator Creek (channelized)	0.040	0.25	0.036	0.225
Cushing Creek	0.045	0.25	0.041	0.225
Cushing Creek tributary	0.045	0.25	0.041	0.225
Thomas Creek (Reach 11)	0.045	0.25	0.038	0.213
Thomas Creek (Reach 9)	0.045	0.25	0.041	0.225
Thomas Creek tributary	0.045	0.25	0.041	0.225
Boggy Creek	0.045	0.25	0.041	0.225
Nassau River U/S of Thomas	0.035	0.15	0.030	0.128
Nassau River D/S of Thomas	0.030	0.10	0.027	0.090

4.2.3 Synthetic Storm Simulation

The HEC-HMS model was run for the 10-, 25-, and 100-year 24-hour events using the rainfall distributions and depths discussed in Section 3.2.2. Model curve numbers were based on the normal Antecedent Moisture Condition 2 (AMC-2) only for the 25-year event. Because of an increased chance for a smaller event to occur during drier conditions, curve numbers were adjusted according to AMC-1 for the 10-year event. This resulted in decreased discharges for the 10-year event, which are more consistent with previous estimates. AMC-3 was used for the 100-year event to simulate very wet conditions.

The UNET model was run for the 10-, 25-, and 100-year 24-hour runoff events using the HEC-HMS results as input. The UNET model is considered accurate within the limitations of calibration data, although the complexity of the model limits it's utility for floodplain management purposes. Therefore, maximum discharge and water surface profiles were output from the UNET model to develop a HEC-RAS model which yield similar results. The HEC-RAS model incorporates the same geometry (channel and structure) as the UNET model and uses the peak discharges from the UNET model. Because the maximum discharge occurs simultaneously everywhere in the HEC-RAS model (steady state) and maximum discharge at a cross section in UNET generally occurs prior to the peak conditions downstream, water surfaces are higher in the HEC-RAS model. Manning's n values were reduced in the HEC-RAS model to generally match the UNET maximum water surface profile. A 10 percent reduction in Manning's n (both channel and floodplain) was used throughout the HEC-RAS model except for Reaches 12 and 11 where Manning's n was reduced by 15 percent and in Reach 13 where Manning's n was reduced by 20 percent. These reduced Manning's n values resulted in water surface profiles generally within 0.5 foot of the UNET results and typically within 0.2 ft. Water surface profiles plots are shown in Figures 4.13 –4.22.

The 10-, 25-, and 100-year flood boundaries are included in Plate 4. These flood boundaries and the profiles (Figures 4.13 – 4.22) are based on the HEC-RAS results. Table 4.9 is a summary of the discharges and water surfaces from the HEC-RAS model. Although the profiles and flood delineation indicate limited flood potential in the lower reaches, especially Nassau River, this study only included flooding from upland runoff. Although the potential for flooding due to a hurricane storm surge was not investigated, flooding from this source is likely to be greater than from upland runoff, at least for areas east of I-95.

River/Creek Name and Comments	River Mile above Nassau River mouth	Distance above mouth (ft)	10 Year Flood Discharge (cfs)	10 Year Flood Water Surface Elevation (ft, NGVD)	25 Year Flood Discharge (cfs)	25 Year Flood Water Surface Elevation (ft, NGVD)	100 Year Flood Discharge (cfs)	100 Year Flood Water Surface Elevation (ft, NGVD)
Nassau River								
Confluence with Alligator and Boggy Creeks	31.961	168763	4616	4.63	7898	5.90	12990	7.46
Upstream of confluence with Thomas Creek	24.356	128604	5495	3.64	9278	4.30	15362	5.53
Downstream of confluence with Thomas Creek	24.356	128604	8867	3.62	15210	4.26	25141	5.48
Upstream face of Interstate 95	22.871	120764	9028	3.51	15419	3.99	25558	4.97
Upstream face of Railroad Crossing	19.918	105168	9596	3.40	15992	3.71	26548	4.40
Upstream face of U. S. Highway 17	18.856	99562	9596	3.37	15992	3.64	26548	4.25
Upstream face of Highway A-1-A	0.827	4367	21697	3.19	32981	3.20	48674	3.20
Mouth of Nassau River	0.000	0	22211	3.19	33721	3.19	49666	3.19
Boggy Creek								
Upstream end of reach	39.913	41984	1693	5.50	3321	7.33	5678	9.38
Upstream face of S. R. 200	39.657	40364	1693	5.46	3321	7.22	5678	9.17
Confluence with Nassau River and Alligator Creek	31.961	0	1865	4.66	3502	5.94	6074	7.50
Thomas Creek								
Upstream end of reach	43.625	101745	2591	11.48	4640	14.21	7469	16.67
Upstream face of U. S. Highway 1	43.538	101285	2591	11.36	4640	14.12	7469	16.58
Upstream face of S. R. 115	41.435	90177	2830	10.62	5054	13.10	8224	15.62
Upstream of confluence with Funks Creek	40.389	84654	2830	8.86	5054	10.99	8224	13.18
Downstream of confluence with Funks Creek	40.389	84654	2917	8.89	5209	11.03	8439	13.23
Confluence with Nassau River	24.356	0	3118	3.63	5461	4.26	8897	5.48
Alligator Creek								
Upstream end of reach	44.901	68332	989	18.15	1520	19.32	1866	20.26
Upstream face of Seaboard Railroad	44.483	66124	989	17.28	1520	18.54	1866	19.61
Upstream face of U. S. Highway 1	44.231	64791	989	14.53	1520	16.05	1866	17.17
Upstream of confluence with Little Mills Creek	43.450	60665	989	10.31	1520	12.16	1866	14.00
Downstream of confluence with Little Mills Creek	43.450	60665	1423	10.42	2418	12.23	3234	14.04
Upstream face of Seaboard Coastline Railroad	43.170	59187	1478	9.94	2547	11.81	3509	13.70
Upstream face of S. R. 200	42.978	58173	1478	9.19	2547	10.80	3509	12.56
Upstream of confluence with Cushing Creek	42.725	56836	1478	8.79	2547	10.35	3509	12.23
Downstream of confluence with Cushing Creek	42.725	56836	2546	8.77	4009	10.34	5845	12.21
Confluence with Boggy Creek and Nassau River	31.961	0	2803	4.65	4367	5.94	6854	7.51
Cushing Creek								
Upstream face of Seaboard Railroad	45.770	16085	891	15.08	1223	15.99	1802	17.42
Upstream face of U. S. Highway 1	45.089	12488	941	13.79	1314	14.88	1981	16.50
Upstream of confluence with Cushing Creek Tributary	43.931	6368	1015	11.41	1441	12.82	2233	14.73
Downstream of confluence with Cushing Creek Tributary	43.931	6368	1071	11.30	1529	12.75	2396	14.70
Upstream face of S. R. 115	43.737	5344	1071	10.81	1529	12.26	2396	14.51
Upstream face of Stratton Road	43.184	2426	1071	9.42	1529	10.81	2396	13.33
Confluence with Alligator Creek	42.725	0	1089	8.77	1561	10.33	2440	12.21
Funks Creek								
Upstream face of Seaboard Railroad	44.126	19730	35	15.43	72	16.21	143	17.88
Upstream face of U. S. Highway 1	43.364	15708	116	15.27	187	15.88	338	16.94
Upstream face of S. R. 115	41.507	5902	275	13.02	416	13.89	653	15.04
Confluence with Thomas Creek	40.389	0	379	8.90	505	11.04	718	13.24
Cushing Creek Tributary								
Upstream end of reach	44.726	4197	171	13.05	280	13.76	370	15.49
Upstream face of U. S. Highway 1	44.247	1670	265	11.57	410	13.14	509	15.24
Confluence with Cushing Creek	43.931	0	297	11.42	456	12.83	566	14.75
Little Mills Creek								
Downstream face of Seaboard Railroad	44.245	4198	659	15.60	1146	16.78	1660	18.07
Upstream face of U. S. Highway 1	43.768	1682	659	12.89	1146	14.66	1660	16.98
Confluence with Alligator Creek	43.450	0	659	10.31	1146	12.18	1660	14.03

Table 4.9 Summary of HEC-RAS Discharges and Water Surface Elevations

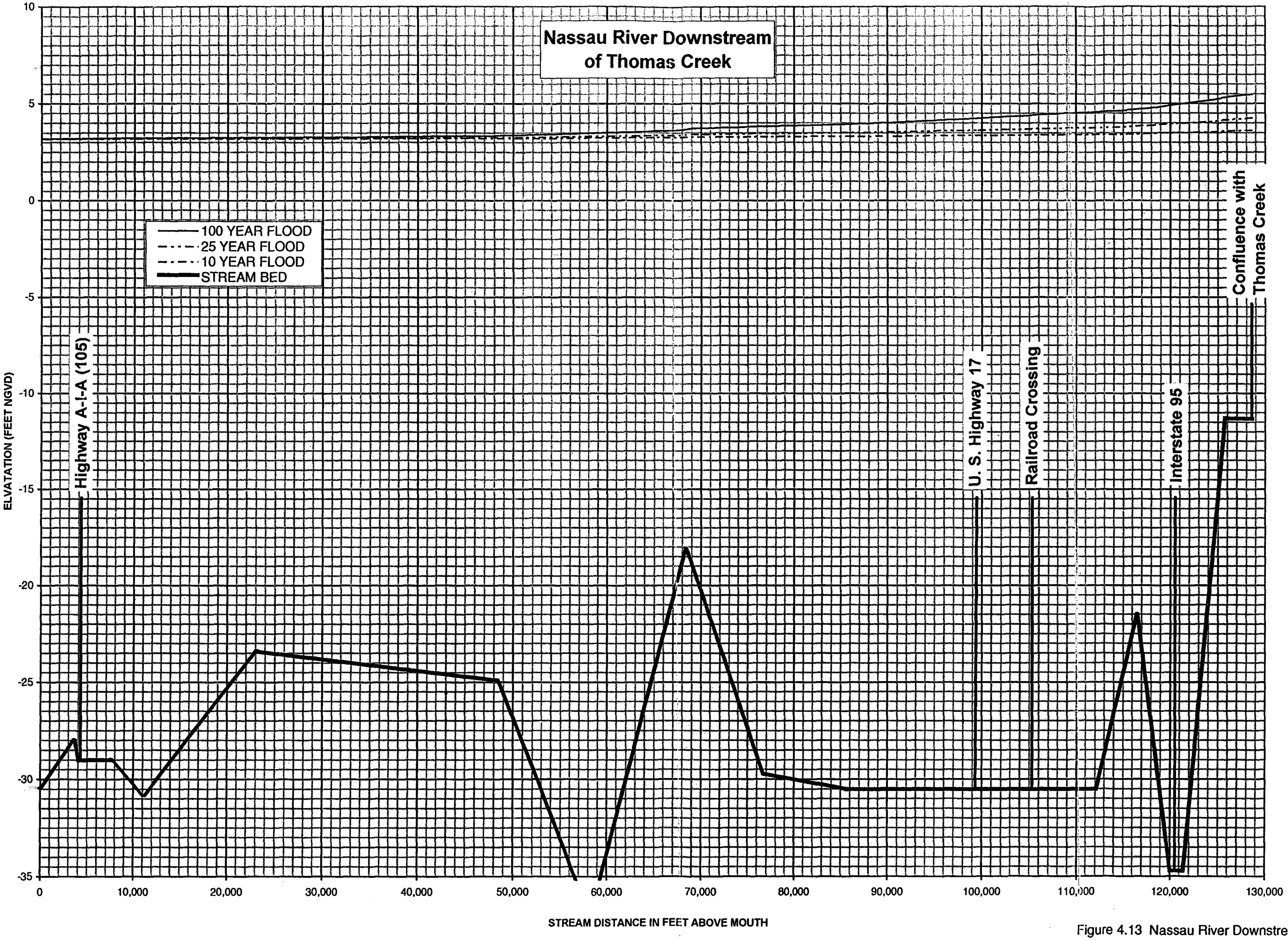


Figure 4.13 Nassau River Downstream of Thomas Creek

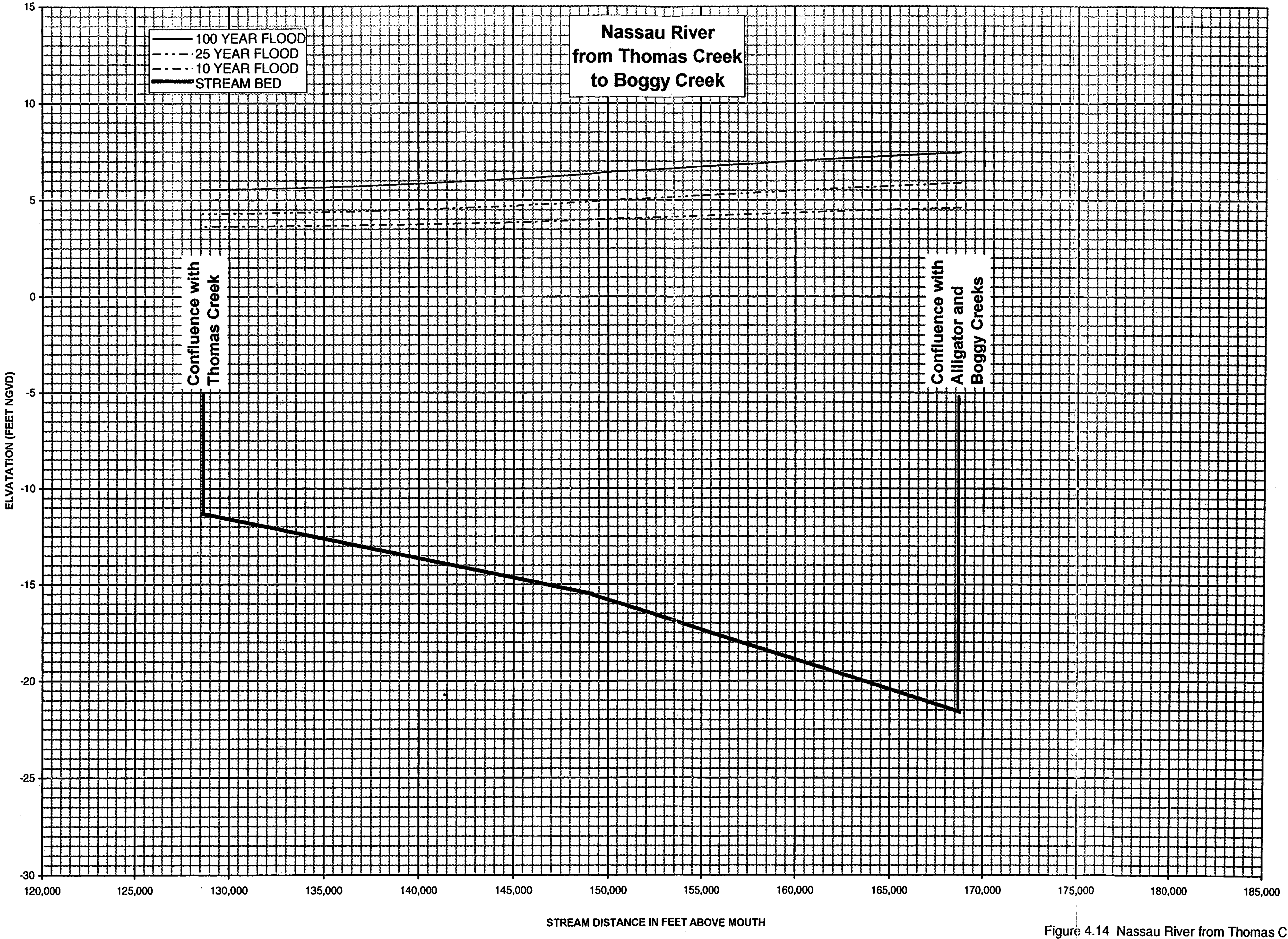


Figure 4.14 Nassau River from Thomas Creek to Boggy Creek

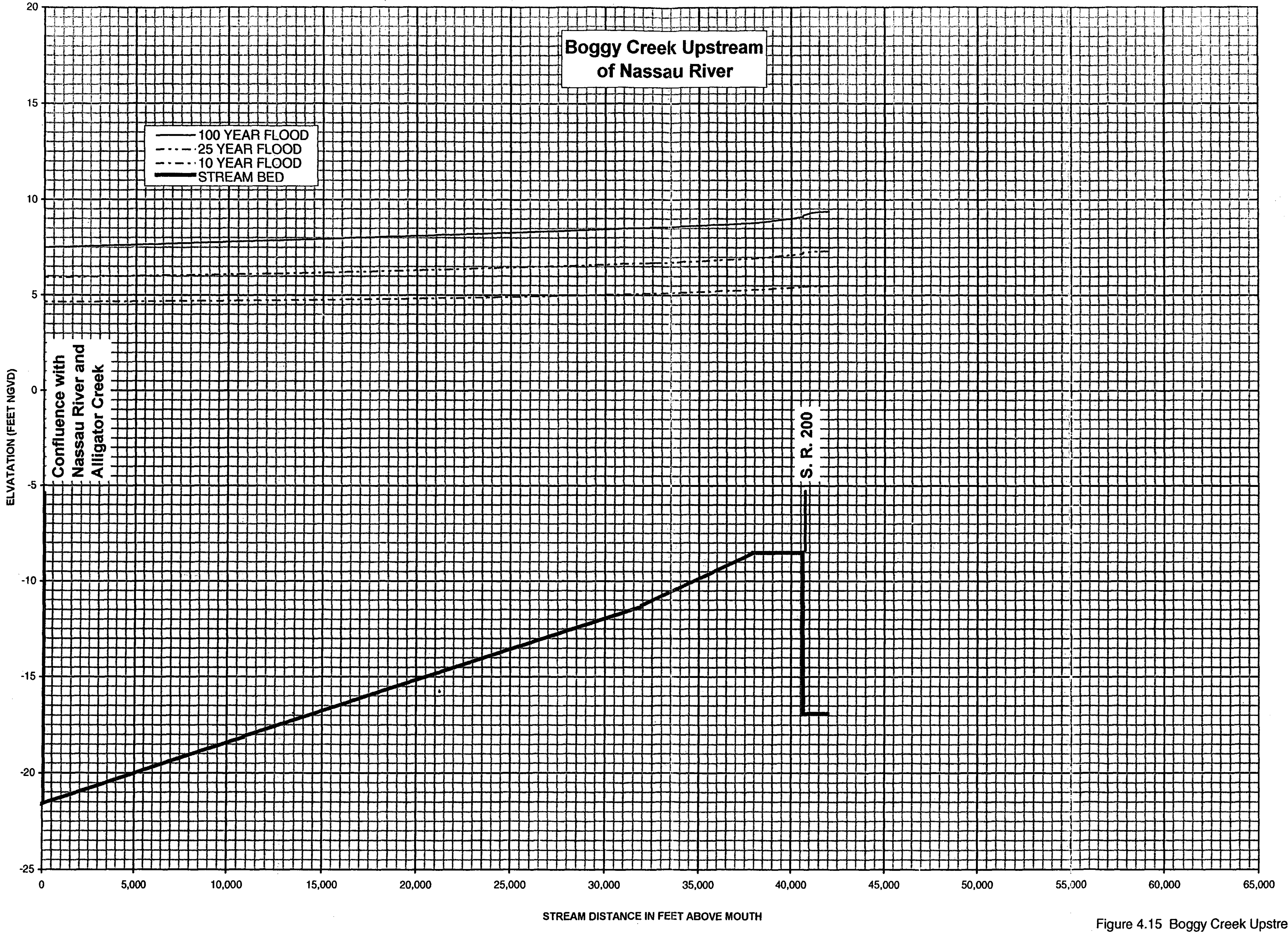


Figure 4.15 Boggy Creek Upstream of Nassau River

5.0 SUMMARY AND CONCLUSIONS

The Nassau River Basin HEC-HMS was developed using limited basin and calibration data for a predominately flat and poorly drained watershed that is not well represented by "textbook" hydrologic parameters. The model was calibrated based on the behavior of only 11 percent of the basin's total area using observed rainfall from a single source no less than 8 to 10 miles removed from the calibration basin areas. In addition, the runoff response of the tidal marsh and coastal plain topographies of the eastern portion of the Nassau River Basin cannot be expected to behave similar to the forested upland and wetland topographies found in the calibration basin areas.

As a consequence of these data limitations, the hydrologic model component can be refined with additional data. Significant improvements would involve additional recording rainfall gages within the basin, and additional stage/discharge gages located upstream of normal tidal influence on Lofton Creek and Boggy Creeks. Additionally, improvements can be realized through determination of actual drainage condition corresponding with dual hydrologic group (B/D and A/D) soils, and additional survey cross-sections across wetland storage areas.

For this study, the UNET model is considered generally more accurate than HEC-RAS in predicting peak water surface elevations and discharges throughout the modeled channels because UNET does not require maximum flow conditions occurring simultaneously throughout the model. The HEC-RAS model is less complex and better suited for floodplain management purposes than UNET and was calibrated to the UNET results. Given the uncertainties inherent in both the hydrologic and hydraulic modeling with limited calibration data, the accuracy of the flood profiles is approximately 1 foot. The areas where the model is most approximate are in the bridge and culvert geometry because no as-built surveys were available. In some cases, design plans were available, although it is uncertain that the plans are related to the model datum (NGVD). Another area where the model can be improved is extending the survey cross sections upstream of developed areas to accurately account for storage. Storage was incorporated into the upstream ends of several reaches based on the USGS quadrangle maps.

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