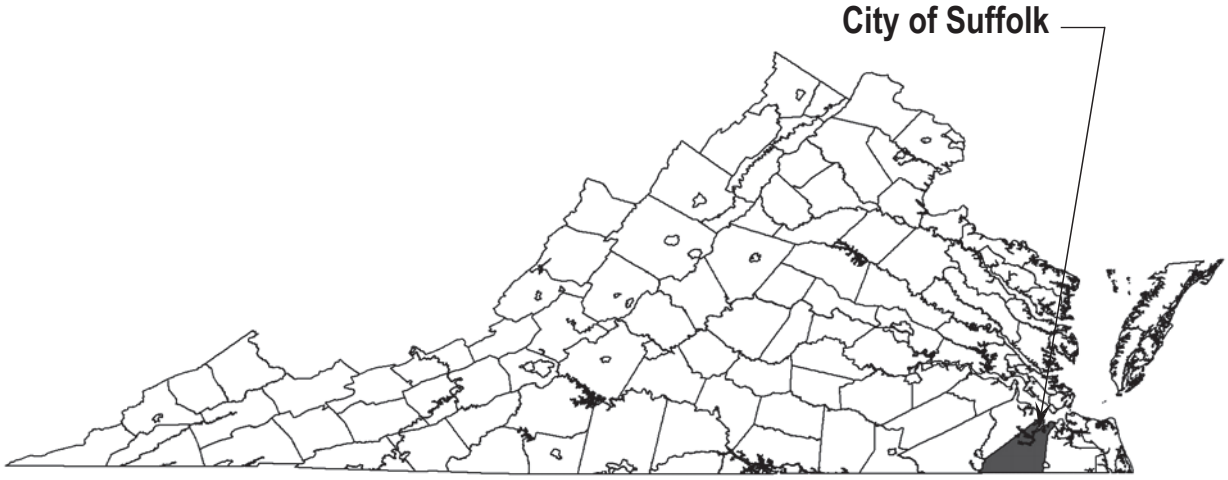
FLOOD INSURANCE STUDY



CITY OF SUFFOLK, VIRGINIA INDEPENDENT CITY



Revised: August 3, 2015

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER

510156V000C

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) 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.

Part or all of this FIS report may be revised and republished at any time. In addition, part of this FIS report may be revised by the Letter of Map Revision (LOMR) process, which does not involve republication or redistribution of the FIS report. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS report components.

Initial FIS Effective Date:	November 16, 1990
Revised FIS Dates:	September 4, 2002 – to add Base Flood Elevations, floodway and roads and road names; to change Special Flood Hazard Areas and zone designations and to update map format. November 16, 2011 – to add Base Flood Elevations; to add Special Flood Hazard Areas; to change Special Flood Hazard Areas; to update map format; to add roads and road names; to incorporate previously issued Letters of Map Revision; and to reflect updated topographic information. August 3, 2015 – to change Base Flood Elevations, to change Special Flood Hazard Areas, to update the effects of wave action, to incorporate Primary Frontal Dune analysis, to reflect revised shoreline, and to reflect the effects of coastal erosion.

TABLE OF CONTENTS

Page

1.0 INTRODUCTION **1**
- 1.1 Purpose of Study 1
- 1.2 Authority and Acknowledgements 1
- 1.3 Coordination 3

2.0 AREA STUDIED 4
- 2.1 Scope of Study 4
- 2.2 Community Description 5
- 2.3 Principal Flood Problems 6
- 2.4 Flood Protection Measures 9

3.0 ENGINEERING METHODS 10
- 3.1 Hydrologic Analyses 10
- 3.2 Hydraulic Analyses 12
- 3.3 Coastal Analyses 15
- 3.4 Vertical Datum 23

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS 24
- 4.1 Floodplain Boundaries 24
- 4.2 Floodways 26

5.0 INSURANCE APPLICATION 30

6.0 FLOOD INSURANCE RATE MAP 31

7.0 OTHER STUDIES 31

8.0 LOCATION OF DATA 32

9.0 BIBLIOGRAPHY AND REFERENCES 32

TABLE OF CONTENTS - CONTINUED

Page

FIGURES

Figure 1 – Transect Location Map……22
Figure 2 – Typical Transect Schematic…… 25
Figure 3 – Floodway Schematic…… 27

TABLES

Table 1 – Blackwater River Gaging Stations …… 11
Table 2 – Summary of Discharges ……..……... 11
Table 3 – Summary of Coastal Stillwater Elevations……...……. 16
Table 4 – Transect Descriptions…… 18-21
Table 5 – Floodway Data…….. 28-29

EXHIBITS

Exhibit 1 – Flood Profiles
Blackwater River Panels 01P – 04P
Shingle Creek Panels 05P – 06P

Exhibit 2 – Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
CITY OF SUFFOLK, INDEPENDENT CITY, VIRGINIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS report and/or Flood Insurance Rate Map (FIRM) for the City of Suffolk, Independent City, Virginia, 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. This information will also be used by the City of Suffolk to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the 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

1.2 Authority and Acknowledgements

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The original FIS was published on November 16, 1990. The hydrologic and hydraulic analyses were prepared by the Norfolk District of the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA), under the Inter-Agency Agreement No. EMW-84-E-1506, Project Order No. 1, Amendment No. 20. The work was completed in October 1987.

A revised FIS was published on September 4, 2002. The hydrologic and hydraulic analyses were prepared by the Norfolk District of the USACE for FEMA. This work was completed in March 2000. The digital base mapping for the City of Suffolk was derived from U.S. Geological Survey (USGS) 1:24,000 scale Digital Line Graph (DLG) files. The digital base mapping was photogrammetrically compiled from aerial photography dated 1988 and 1990. Additional information may have been derived from other sources.

A revised FIS was published on November 16, 2011. That FIS was prepared by the Norfolk District of the USACE for FEMA, under Interagency Agreement No. HSFE03-04-X-0011, Project Order No. P394342Y. That work was completed in January 2010. The November 16, 2011, FIS revised the 2002 study showing updated community description information, historical flood information, and bibliography and references. The hydrologic and hydraulic analyses were not revised or updated; however, due to minor conflicts, tidal stillwater elevations were revised to agree with adjacent communities. In addition, effective flood elevations were converted and referenced to the North American Vertical Datum of 1988 (NAVD 88). The November 16, 2011, FIS also includes information regarding survey bench marks, vertical datums, and datum conversion factors. The November 16, 2011, FIRM was converted to a digital format, utilizing updated aerial photography (Commonwealth of Virginia, 2007) as the base map; floodplain boundaries were also revised to reflect updated topographic data (City of Suffolk, 1999).

For the November 16, 2011, FIS, base map information was provided in digital format by the Commonwealth of Virginia, Virginia Geographic Information Network. The majority of the orthophotography was compiled at a scale of 1" = 200'. The western border of Suffolk was compiled at a scale of 1" = 100'. The orthophotography was flown in 2007 as part of the Virginia Base Mapping Program (VBMP) (Commonwealth of Virginia, 2007). The projection used in the preparation of the FIRM was Universal Transverse Mercator Zone 18. The horizontal datum was the North American Datum of 1983, Geodetic Reference System 80 Spheroid.

For this August 3, 2015, revision, the FEMA Region III office initiated a study to update the coastal storm surge elevations within the States of Virginia, Maryland, and Delaware, and the District of Columbia including the Atlantic Ocean, the Chesapeake Bay (including its tributaries), and the Delaware Bay. This effort is one of the most extensive coastal storm surge analyses to date, encompassing coastal floodplains in three states and including the largest estuary in the world. The study replaces outdated coastal storm surge stillwater elevations for all FISs in the study area, and serves as the basis for new coastal hazard analysis and ultimately updated FIRM. Study efforts were initiated in 2008 and concluded in 2011.

For this August 3, 2015, revision, the coastal analysis and mapping for the City of Suffolk was conducted for FEMA by RAMPP under Contract No. HSFEHQ-09-D-0369, Task Order HSFE03-09-0002. The coastal analysis involved transect layout, field reconnaissance, erosion analysis, and overland wave modeling including wave setup, wave height analysis and wave runup.

The storm surge study was conducted for FEMA by the USACE and its project partners under Project HSFE03-06-X-0023, "NFIP Coastal Storm Surge Model for Region III" and Project HSFE03-09-X-1108, "Phase II Coastal Storm Surge Model for FEMA Region III". The work was performed by the Coastal Processes Branch

(HF-C) of the Flood and Storm Protection Division (HF), U.S. Army Engineer Research and Development Center – Coastal & Hydraulics Laboratory (ERDC-CHL).

For this August 3, 2015, revision, the coastal boundaries were mapped using a Digital Elevation Model (DEM) derived from Light Detection and Ranging (LiDAR) data collected in April-May 2010 by Terrapoint for the USGS. The coastal mapping was completed in September 2013. The coastal flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land cover data, and topographic data.

For this August 3, 2015, revision, base map information was produced in digital format by the Commonwealth of Virginia through the VBMP. The orthophotos were flown in 2009 at scales of 1:100 and 1:200.

The coordinate system used for the production of this FIRM is the Virginia State Plane South zone. The horizontal datum was NAD 83, HARN. Differences in the datum, spheroid, projection, or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

Coordination with local officials and Federal, State, and regional agencies produced information pertaining to floodplain regulations, community maps, flood history, and other hydrologic data.

The purpose of the initial Consultation Coordination Officer (CCO) meeting is to discuss the scope of the FIS. A final CCO meeting is held to review the results of the study. Contacts with various state and federal agencies are made during the study in order to minimize possible hydrologic and hydraulic conflicts. A search for basic data is made at all levels of government.

For the November 16, 1990, FIS, an initial CCO meeting was held on February 2, 1984, and a final CCO meeting was held on December 21, 1989. Both of these meetings were attended by representatives of the city, the study contractor, and FEMA.

For the September 4, 2002, revision, the City of Suffolk was notified by FEMA in a letter dated July 26, 2001, that its FIS would be revised using the analyses prepared by the USACE, Norfolk District.

For the November 16, 2011, revision, an initial CCO meeting was held on January 13, 2005, with representatives of FEMA, the city, the Virginia Department of Conservation and Recreation, and the USACE (study contractor). A final CCO

meeting was held on November 2, 2010.

For this August 3, 2015, revision, the FEMA Region III office initiated a coastal storm surge study in 2008 for the Atlantic Ocean, the Chesapeake Bay and its tributaries, and the Delaware Bay. Therefore, no initial CCO meeting for the coastal storm surge study was held. A final CCO meeting was held on February 4, 2014, with representatives from FEMA, the Virginia Department of Conservation and Recreation, the USACE, the mapping partners, and the City of Suffolk.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the incorporated area of the City of Suffolk, Independent City, Virginia.

For the November 16, 1990, FIS, Shingle Creek was studied by detailed methods, from its confluence with the Nansemond River to a point approximately 650 feet upstream of White Marsh Road (VA Route 642). Tidal flooding from Hampton Roads, which affects the James River and the Nansemond River and their adjoining estuaries, was also studied by detailed methods. The effects of wave action were considered in the tidal analyses. The areas studied by detailed methods were selected with priority given to all known flood hazard areas of projected development and proposed construction through October 1992.

All or portions of the following flooding sources were studied by approximate methods: Adams Swamp, Blackwater Swamp, Cedar Lake, Chapel Swamp, Chuckatuck Creek, Cohoon Creek, Council Swamp, Crumps Mill Pond, Cypress Swamp, Dragon Swamp, Eley Swamp, Great Dismal Swamp, Jones Swamp, Kingsdale Swamp, Lake Burnt Mills, Lake Cohoon, Lake Kilby, Lake Meade, Lake Prince, March Swamp, Mill Swamp, Moss Swamp, Norfleet Pond, Pine Swamp, Pitchkettle Creek, Quaker Swamp, Shingle Creek, Sleepy Swamp, Somerton Creek, Speights Run, Spivey Swamp, and the Western Branch Reservoir.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Suffolk.

For the September 4, 2002, FIS, the Blackwater River was restudied by detailed methods for its entire length within the City of Suffolk.

The November 16, 2011, FIS incorporated the determination of a Letter of Map Revision (LOMR) issued by FEMA resulting in a map change. The LOMR was issued under Case Number 08-03-0311P, on March 24, 2008, for Davis Ditch Shingle Creek Tributary.

Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2). The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

For this August 3, 2015, revision, updated coastal storm surge elevations within the city were analyzed and mapped.

2.2 Community Description

The City of Suffolk is located in southeastern Virginia. It is bordered by the Counties of Isle of Wight and Southampton to the west, the State of North Carolina to the south, the Cities of Chesapeake and Portsmouth to the east and the James and Nansemond Rivers to the north. The Town of Suffolk, named after Governor William Gooch's home in Suffolk County, England, was established in 1742. Burned by the British in 1779 and damaged by other fires throughout the next century, Suffolk survived to become a city in 1910. In 1974, the Cities of Suffolk and Nansemond (incorporated as a city in 1973) merged to become the new City of Suffolk, the largest city (in land area) in Virginia and the fifth largest in the United States. The city has a land area of approximately 430 square miles, which includes a portion of the Great Dismal Swamp National Wildlife Refuge in the eastern part of the community (Commonwealth of Virginia, 1970 and City of Suffolk, 2009).

The population for the city was estimated at 85,181 in 2012; the population was 84,585 in 2010; the population was estimated at 82,302 in 2008; and the population was 63,677 in 2000 (U.S. Census Bureau, 2013). The principal occupations of its residents are computer modeling and simulation and education. Other industries include product assembly and testing, production machinery and equipment, communications equipment, food processing, engineering, research and management services, technical support centers, maritime-related office operations, and wholesale, packaging, and distribution. Suffolk is privileged to host a network of military and civilian research and development such as the U.S. Joint Forces Command, the Virginia Modeling Analysis and Simulation Center, Lake View Technology Center and Bridgeway Technology Centers. In addition, many city residents commute daily to government and industrial jobs in the Newport News-Portsmouth-Norfolk areas (City of Suffolk, 2009).

The City of Suffolk enjoys a temperate climate, with moderate seasonal changes, characterized by warm summers and cool winters. Temperatures average approximately 78 degrees Fahrenheit (F) in July, the warmest month, and 42 degrees F in January, the coolest month. Annual precipitation over the area averages approximately 50 inches, but light, absorbent soil facilitates infiltration (Commonwealth of Virginia, 1970). There is some variation in the monthly averages; however, this rainfall is distributed uniformly throughout the year. Snowfall is infrequent, generally occurring in light amounts and usually melting in a short period of time.

The city is located in the Coastal Plain province and is underlain predominantly by sand, gravel, marl, and clay strata. Elevations within the city range from sea level to approximately 85 feet.

The floodplains of the City of Suffolk consist of scattered residential structures, marinas, croplands, and forests. With the city's many miles of streams and shoreline, pressure for future development within the floodplains is expected to continue.

2.3 Principal Flood Problems

Flood problems in the City of Suffolk result from abnormally high storm tides. Minor flooding, up to elevations of 4 to 5 feet, is associated with periods of moderately high, sustained winds from the northeast, north, and northwest, which may be experienced several times within any one year. The main sources of concern are the large and infrequent floods, which are associated with major storm events that push the waters of the Atlantic Ocean westward through the Chesapeake Bay. The type of storm which affects the area most severely is the hurricane, with its high winds and heavy rainfall, which produces large waves and tidal flooding. The term 'hurricane' is applied to an intense cyclonic storm originating in tropical or subtropical latitudes in the Atlantic Ocean just north of the Equator. While hurricanes may affect the area from May through December, most hurricane activity is likely from June through November, with maximum activity occurring in early to mid-September. From analysis of records from 1944 to 1999 for hurricanes passing within approximately 100 miles, there is approximately a 40-percent chance that Suffolk will be affected by a hurricane (U.S. Department of Commerce, 2014). The most severe hurricanes on record to strike the study area occurred in August 1933 and in September 2003 (Hurricane Isabel).

Another type of storm which could cause severe damage to the study area is the nor'easter. This is a cyclonic type of storm that develops with little or no warning along the middle and northern Atlantic Coast. This storm occurs most frequently in the winter months but may occur at any time. Accompanying winds are not of hurricane force but are persistent, causing above-normal tides for long periods of time. The March 1962 nor'easter was the worst ever recorded in the city.

The amount and extent of damage caused by any tidal flood will depend upon the topography of the area flooded, rate of rise of floodwaters, the depth and duration of flooding, the exposure to wave action, and the extent to which structures have been placed in the floodplain. The depth of flooding during these storms depends upon the velocity, direction, and duration of the wind; the size and depth of the body of water over which the wind is acting; and the astronomical tide. The duration of flooding depends upon the duration of the tide-producing forces. Floods caused by hurricanes are usually of much shorter duration than those caused by nor'easters. Flooding from hurricanes rarely lasts more than one tidal cycle, while flooding from nor'easters may last several days, during which the most

severe flooding takes place at the time of the peak astronomical tide.

The timing or coincidence of the maximum storm surge with the normal high tide is an important factor in the consideration of flooding from tidal sources. Tidal waters in the study area normally fluctuate twice daily. The mean tide range for the Nansemond River is approximately 3.8 feet (U.S. Department of Commerce, 2006). The range is somewhat less in most of the connecting bays and inlets.

The city also contains numerous estuaries of the Nansemond River that are subject to tidal flooding in their lower reaches, but fluvial flooding on the upper reaches. Flooding on the upper reaches of these streams and on tributaries of the Blackwater River and other streams in Suffolk may be caused by heavy rains occurring any time of the year. Flooding may also occur as a result of intense rainfall produced by local summer thunderstorms or tropical disturbances such as hurricanes, which move into the area from the Gulf or Atlantic coasts. Flood heights on these streams can rise from normal to extreme flood peaks in a relatively short period of time. The amount and extent of damage caused by fluvial flooding depends upon the size of the area flooded, the height of flooding, the velocity of flow, the rate of rise, and the duration of flooding. The rate of rise and duration of flooding depend largely on the time required for floodwaters to concentrate at a particular point, and on the duration and intensity of flood producing rainfall. Stream velocities during floods depend largely on the size and shape of the cross sections, roughness conditions of the stream that tend to retard flow, and the bed slope, all of which vary on different streams and at different locations on the same stream. During all major floods, high-velocity flood flows and hazardous conditions would exist in the main stream channel.

All development in the floodplain is subject to water damage. Some areas, depending upon exposure, are subject to high velocity wave action which may cause structural damage and severe erosion along the shoreline. Waves are generated by the action of wind on the surface of the water. Wave heights at any location are dependent upon the velocity, direction, and duration of the wind, and the length, width, and depth of water over which the wind is acting. The northern portion of the city along the James and Nansemond Rivers and Chuckatuck Creek is vulnerable to wave damage because of the vast exposure afforded by Hampton Roads.

The City of Suffolk has experienced major storms since the early settlement of the area. Historical accounts of severe storms in the Hampton Roads area date back several hundred years. The following paragraphs discuss some of the larger known storms which have occurred in recent history. This information is based on newspaper accounts, historical records, field investigations, and routine data collection programs normally conducted by the USACE.

The August 1933 hurricane was one of the most severe storms ever to occur in the middle Atlantic region. This tropical hurricane passed inland near Cape Hatteras on August 22, passed slightly west of Norfolk, and continued toward the north

accompanied by extreme high wind and tide and caused the most extensive flooding. The maximum storm surge produced was the greatest of record and occurred about 3 hours before, but persisted through the peak of the astronomical tide. The water level reached an approximate elevation of 7 feet, in Suffolk (USACE, 1962).

Excerpts from A Pictorial Record of Tidewater's Worst Storm, August 22 and 23, 1933 (Pilot and Norfolk Landmark, 1933):

"Untold property damage and an almost complete paralysis of transportation, communication and business was the toll of the tropical hurricane that swept Tidewater, Virginia, Tuesday night and Wednesday morning, August 22nd and 23rd, 1933."

"The storm, the worst in this section, raged for hours, leveling or damaging hundreds of homes, uprooting thousands of trees driving before it tide water of unprecedented depths."

"Homes and retail stores in the cities were turned into veritable islands – beach resorts were lashed and whipped in many cases to complete destruction."

The eye of the September 18, 1936, hurricane passed approximately 20 miles east of Cape Henry. High tides and gale force winds caused much damage throughout the lower Chesapeake Bay area as the storm moved off to the northeast. In Portsmouth, the elevation of flooding was approximately 0.5 foot less than the storm of August 1933 (USACE, 1973).

On March 6-8, 1962, a nor'easter caused disastrous flooding and high waves all along the Atlantic Seaboard from New York to Florida. This storm was unusual even for a nor'easter since it was caused by a low pressure cell which moved from south to north past Hampton Roads and then reversed its course, moving again to the south bringing with it huge volumes of water and high waves which battered the mid-Atlantic coastline for several days (USACE, 1973).

Excerpts from The Virginian-Pilot, March 8, 1962 (The Virginian Pilot, 1962):

"Storm Pounds Coast Into Ruins, Thousands Escape Worst in Thirty Years"

"The worst storm to hit the Virginia-North Carolina coast in almost 30 years continued to lash low-lying coastal areas Wednesday, killing at least two men, destroying or damaging hundreds of homes and sending thousands of persons fleeing to higher ground."

"Storm damages was estimated to run into many millions of dollars."

On September 16, 1999, Hurricane Floyd crossed into North Carolina and Virginia. Although it weakened when it came over land, the slow-moving storm caused

inland flooding to a large part of the eastern U.S. Water-surface elevations increased dramatically during the days following the storm. The floods from Hurricane Floyd caused an estimated $35 million in initial damage to over 200 businesses in the City of Franklin, Isle of Wight County, and Southampton County. In addition, the floodwaters caused by Hurricane Floyd are estimated to have caused more than $13.1 million in lost revenue to Franklin area businesses in the year following the disaster. In addition to the flooding there was significant revenue lost because of crop failure (FEMA, 2000).

Southeastern Virginia rainfall amounts during Hurricane Floyd were as high as 18.13 inches in Yorktown, Virginia. The Town of Smithfield in Isle of Wight County experienced 12.5 inches of rainfall (National Weather Service, 1999). There were five reported deaths in Virginia from the record storm. The Franklin stream gage on the Blackwater River measured a record stream flow of 25,000 cubic feet per second (cfs) after Hurricane Floyd. The stream gage on the Nottoway River at Sebrell measured a stream flow of 35,700 cfs.

The most recent tidal stage of major proportions occurred during Hurricane Isabel, making landfall on September 18, 2003, along the Outer Banks of North Carolina and tracking northward through Virginia and up to Pennsylvania. At landfall, maximum sustained winds were estimated at 104 mph. Isabel weakened to a tropical storm by the time it moved into Virginia and lost tropical characteristics as it moved into Pennsylvania. The storm caused high winds, storm surge flooding, and extensive property damage throughout the Chesapeake Bay region. Within Virginia, ninety-nine communities were directly affected by Isabel. There were thirty-three deaths, over a billion dollars in property damage, and over a million electrical customers without power for many days (Commonwealth of Virginia, 2003). Historical maximum water level records were exceeded at several locations within the Chesapeake Bay region. In general, maximum water levels in the lower Chesapeake Bay resembled those of the August 1933 hurricane, with storm surge occurring around the time of the predicted high tide. Some communities along the Chesapeake Bay and its tributaries also experienced severe damage from wave action (U.S. Department of Commerce, 2004).

In August 2011, Hurricane Irene hit the eastern coast of the United States and caused substantial damage. In September 2011, President Barack Obama made a Major Disaster Declaration for numerous jurisdictions, including the City of Suffolk. The disaster declaration allowed assistance for emergency work and the repair or replacement of disaster-damaged facilities, and allowed residents affected by the storm to apply for federal aid.

2.4 Flood Protection Measures

There are no existing flood control structures that would provide protection during major floods in the city. There are a number of measures that have afforded some protection against flooding, including bulkheads and seawalls and non-structural measures for floodplain management such as zoning codes. The "Uniform

Statewide Building Code" which went into effect in September 1973 states, "where a structure is located in a 1- percent-annual-chance floodplain, the lowest floor of all future construction or substantial improvement to an existing structure … must be built at or above that level, except for non-residential structures which may be floodproofed to that level" (Commonwealth of Virginia, 1973). These requirements will no doubt be beneficial in reducing future flood damages in the city.

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 are 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 Analyses.

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Flood probability estimates can be based on statistical analyses of streamflow records available for the watershed under study. However, for the November 16, 1990, FIS, Shingle Creek lacked this data and required analysis of rainfall and runoff characteristics of the watershed in order to develop flood frequency estimates. These analyses involved the application of rainfall-runoff amounts to a synthetic graph (unit hydrograph) using the USACE's HEC-1 computer program (USACE 1981, revised 1985).

For the September 4, 2002, revision, the discharge values were based on records maintained by the USGS, in cooperation with the Virginia Department of Environmental Quality, of river stages and discharges on the Blackwater River. Flood flow frequencies for the Blackwater River were based on statistical analyses of stage-discharge records for the gaging stations shown in Table 1, "Blackwater River Gaging Stations."

Table 1 – Blackwater River Gaging Stations

Gaging Station	Record	Historic Flood
02047500 Blackwater River near Dendron	Oct. 1941 – Sept. 1999	Sept. 1999
02048000 Blackwater River at Zuni	Oct. 1942 – Sept. 1988, and Sept. 1999	Sept. 1999
02049500 Blackwater River near Franklin	Oct. 1941 – Sept. 1999	Sept. 1999

Data from the gaging stations listed in Table 1 were used for defining the discharge-frequency relationships for the Blackwater River. The discharges for the 10-, 2-, 1-, and 0.2- percent-annual-chance floods were developed by application of procedures outlined in Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (U.S. Department of the Interior, 1981). The August 1940 flood was included in the statistical record for the period of analysis. Missing flow data for the period 1989 to 1998 at the Zuni gage were reconstituted utilizing gage data from the upstream and downstream gages and incorporated into the analysis. No other adjustments were made to the statistics.

A summary of drainage area-peak discharge relationships are shown in Table 2, "Summary of Discharges."

Table 2 – Summary of Discharges

Flooding Source and Location	Drainage Area (Mi²)	Exceedance Probability Discharge (cfs) 10% Annual Chance	2% Annual Chance	1 % Annual Chance	0.2% Annual Chance
Blackwater River					
At confluence with the Nottoway River	739.00	8,210	15,200	19,100	31,400
At the downstream corporate limits of the City of Franklin	713.00	8,110	14,900	18,800	31,000
Shingle Creek					
At Wilroy Road	24.50	965	1,380	1,520	1,930
Downstream of Norfolk Southern Railway	22.50	955	1,330	1,465	1,860
Upstream of Norfolk Southern Railway	22.50	1,230	1,870	2,110	2,890
At White Marsh Road	3.30	1,040	1,520	1,735	2,410

Tide records for the City of Suffolk are inadequate to establish a tide-frequency relationship. However, adjacent frontages on the Hampton Roads estuary make it appropriate to adopt flood elevations defined in nearby Norfolk Harbor to the James and Nansemond Rivers and Chuckatuck Creek. An accurate record of tide heights has been maintained at Sewells Point (National Oceanic and Atmospheric Administration gage), and at Fort Norfolk (USACE gage) since 1928, and at the U.S. Naval Shipyard in Portsmouth, Virginia, since 1935. After adjustment for the gradual rise in local sea level, those recorded data were analyzed in accordance with standard procedures to define the tidal frequency-elevation relationship (U.S. Department of the Interior, 1981). A Pearson Type III distribution was determined to give the best data fit, but the 90-percent band for that relationship excluded the three highest floods recorded in Norfolk Harbor (August 22, 1933; September 18, 1936; and March 7, 1962). A graphical adjustment was therefore applied to the computed results for suitable agreement with recorded elevations of extreme floods. This adjusted curve was judged to be applicable to this study.

For the November 16, 2011, revision and this August 3, 2015, revision, no new detailed hydrologic analyses were conducted.

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 elevations rounded to the tenth and may not exactly reflect the elevations shown on the Flood Profiles or 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 report in conjunction with the data shown on the FIRM.

Cross sections for the backwater analyses of the Blackwater River were obtained from field surveys and topographic maps. Cross sections were located at close intervals to bridges in order to compute the backwater effects of these structures. Elevation data and structural geometry for structures were obtained from field surveys and as-built drawings. Field checks were made for the existence of new structures and modifications to existing structures in the study area.

Cross sections for the backwater analyses of Shingle Creek were obtained by field surveys and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of the selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was

computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals for the Blackwater River and Shingle Creek were computed using USACE HEC-2 step-backwater computer program (USACE, 1990 and 1982). Starting water-surface elevations for Shingle Creek were calculated using slope/area method. However, in the lower reach of Shingle Creek, tidal flood elevations are higher than fluvial flood elevations and are shown on the Flood Profiles and the FIRM. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment, field observations of the stream and floodplain areas. For the Blackwater River, roughness factors were also based on model calibration to high-water marks. The following tabulation shows the channel and overbank "n" values for the streams studied by detailed methods:

Stream	Channel "n"	Overbank "n"
Blackwater River	0.065 - 0.080	0.180 - 0.200
Shingle Creek	0.030 - 0.050	0.050 - 0.100

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of the shorelines.

Special consideration was given to the vulnerability of the City of Suffolk to wave attack. The inclusion of wave height, which is the distance from the trough to the crest of the wave, increases the water-surface elevation. The height of a wave is dependent upon wind speed and its duration, depth of water, and length of fetch. The wave crest elevation is the sum of the stillwater elevation and the portion of the wave height above the stillwater elevation.

These concepts and equations were used to compare wave heights and wave crest elevations associated with the 1-percent-annual-chance storm surge. Accurate topographic, land-use, and land-cover data are required for the wave height analysis. Maps of the shoreline areas at a scale of 1:600 with contour intervals of 5 and 10 feet were used for the topographic data (Benatec Associates, 1986). The land-use and land-cover data were obtained from notes and photographs taken during field inspections.

From the 1990 FIS, for the stream studied by approximate methods, the 1-percent-annual-chance floodplain boundaries were determined from slope/area computations and U.S. Department of Housing and Urban Development's Flood Hazard Boundary Maps (U.S. Department of Housing and Urban Development, 1978).

For the November 16, 2011, revision and this August 3, 2015, revision, no new detailed hydraulic analyses were conducted.

Qualifying bench marks within a given jurisdiction are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS). First or Second Order Vertical bench marks that have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)

- Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment)

- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)

- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS bench marks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current elevation, description, and/or location information for bench marks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS by telephone at (301) 713-3242, or visit their Web site, http://www.ngs.noaa.gov.

It is important to note that 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 this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 Coastal Analyses

Coastal analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along the shoreline. Users of the FIRM should be aware that coastal flood elevations are provided in Table 3, 'Summary of Coastal Stillwater Elevations' in this report. If the elevation on the FIRM is higher than the elevation shown in this table, a wave height, wave runup, and/or wave setup component likely exists, in which case, the higher elevation should be used for construction and/or floodplain management purposes.

Development is moderate along the entire shoreline within City of Suffolk ranging from coastal marshland and agricultural areas to a number of shorefront residential developments. The coastline elevations vary from sea level sloping landward gently to elevations approaching 25 feet.

A coastal flooding analysis was performed to establish the frequency peak elevation relationships in the City of Suffolk. The end-to-end storm surge modeling system includes the Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC) for simulation of 2-dimensional hydrodynamics (Luettich et. al, 2008). ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating Waves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge (USACE, 2012). The resulting model system is typically referred to as SWAN+ADCIRC (USACE, 2012). A seamless modeling grid was developed to support the storm surge modeling efforts. The modeling system validation consisted of a comprehensive tidal calibration followed by a validation using carefully reconstructed wind and pressure fields from three major flood events for the Region III domain: Hurricane Isabel, Hurricane Ernesto, and Extratropical Storm Ida. Model skill was accessed by quantitative comparison of model output to wind, wave, water level, and high water mark observations.

The tidal surge for those estuarine areas affected by the Chesapeake Bay affect the entire shoreline within the City of Suffolk. Open coastline areas, from Chuckatuck Creek to the northeastern corporate limits, along Hampton Roads, are more prone to damaging wave action during high wind events due to the significant fetch over which winds can operate. Behind the coastline, those areas still prone to coastal flooding gently rise in elevation and narrow considerably as they converge with upland agricultural and residential areas. In these areas, the fetch over which winds can operate for wave generation are significantly less.

The Stillwater elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods determined for the Chesapeake Bay/Hampton Roads are shown in Table 3, "Summary of Coastal Stillwater Elevations." The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects.

Table 3 - Summary of Coastal Stillwater Elevations

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88*) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
HAMPTON ROADS AND TRIBUTARIES				
Nanticoke Chuckatuck Creek at Kings Point	6.0	7.8	8.5	9.9
Hampton Roads at Pike Point	5.8	7.5	8.2	9.6
Nansemond River at Trotman Wharf	6.8	8.7	9.5	11.4
Nansemond River at Newmans Point	6.2	8.1	8.9	10.6
Nansemond River at Pig Point	5.7	7.4	8.0	9.7
Hampton Roads at Hoffler Creek	5.7	7.3	7.9	9.7

*North American Vertical Datum of 1988

The methodology for analyzing the effects of wave heights associated with the coastal surge flooding is described in the National Academy of Sciences (NAS) report (NAS, 1977). This method is based on three major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth, and the wave crest is 70-percent of the total wave height above the stillwater level. The second major concept is that the wave height may be diminished by the dissipation of energy due to the presence of obstructions such as sand dunes, dikes, seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures described in the aforementioned NAS 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. The added energy is related to fetch length and water depth.

Wave heights were computed across transects that were located along coastal areas of the City of Suffolk, as illustrated on the FIRM. Transects are located with consideration given to existing transect locations and to the physical and cultural characteristics of the land so that they would closely represent conditions in the locality.

Each transect was taken perpendicular to the shoreline and extended inland to a point where coastal flooding ceased. 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 a 1-percent-annual-chance event 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 Zone VE (area with velocity wave action) was computed at each transect. Along the open coast, the Zone VE designation applies to all areas seaward of the landward toe of the primary frontal dune system. The primary frontal dune is defined as the point where the ground profile changes from relatively steep to relatively mild.

Due to the low marshy nature, dune erosion was not taken into account along the Chesapeake Bay coastline. A review of the geology and shoreline type in the City of Suffolk was made to determine the applicability of standard erosion methods, and FEMA's standard erosion methodology for coastal areas having primary frontal dunes, referred to as the "540 rule," was used (FEMA, 2007a). This methodology first evaluates the dune's cross-sectional profile to determine whether the dune has a reservoir of material that is greater or less than 540 square feet. If the reservoir is greater than 540 square feet, the "retreat" erosion method is employed and approximately 540 square feet of the dune is eroded using a standardized eroded profile, as specified in FEMA guidelines. If the reservoir is less than 540 square feet, the "remove" erosion method is employed where the dune is removed for subsequent analysis, again using a standard eroded profile. The storm surge study provided the return period stillwater elevations required for erosion analyses. Each cross-shore transect was analyzed for erosion, when applicable.

Wave height calculations used in this study follow the methodologies described in the FEMA guidance for coastal mapping (FEMA, 2007a). Wave setup results in an increased water level at the shoreline due to the breaking of waves and transfer of momentum to the water column during hurricanes and severe storms. For the City of Suffolk study, wave setup was determined directly from the coupled wave and storm surge model The total stillwater elevation (SWEL) with wave setup was then used for simulations of inland wave propagation conducted using FEMA's Wave Height Analysis for Flood Insurance Studies (WHAFIS) model Version 4.0 (FEMA, 2007b). WHAFIS is a one-dimensional model that was applied to each transect in the study area. The model uses the specified SWEL, the computed wave setup, and the starting wave conditions as input. Simulations of wave transformations were then conducted with WHAFIS taking into account the storm-induced erosion and overland features of each transect. Output from the model includes the combined SWEL and wave height along each cross-shore transect allowing for the establishment of base flood elevations (BFEs) and flood zones from the shoreline to points inland within the study area.

Wave runup is defined as the maximum vertical extent of wave uprush on a beach or structure. FEMA's 2007 Guidelines and Specifications require the 2-percent wave runup level be computed for the coastal feature being evaluated (cliff, coastal bluff, dune, or structure) (FEMA, 2007a). The 2-percent runup level is the highest 2-percent of wave runup affecting the shoreline during the 1-percent-annual-chance flood event. Each transect defined within the Region III study area was evaluated for the applicability of wave runup, and if necessary, the appropriate runup methodology was selected and applied to each transect. Runup elevations were then compared to WHAFIS results to determine the dominant process affecting BFEs and associated flood hazard levels. Based on wave runup rates, wave overtopping was computed following the FEMA 2007 Guidelines and Specifications.

Computed controlling wave heights at the shoreline range from 1.2 feet to 6.1 feet. The corresponding wave elevation at the shoreline varies from 1.2 feet to 12.8 feet. Vertical reinforced coastlines serve to reduce wave height z.

Between transects, elevations were interpolated using topographic maps, land-use and land cover data, and engineering judgment to determine the aerial extent of flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergoes major changes. Table 4, "Transect Descriptions", provides the 10-, 2-, 1- and 0.2-percent-annual-chance stillwater elevations and the starting wave conditions for each transect. Figure 1, 'Transect Location Map', provides an illustration of the transect locations for the county.

Table 4 – Transect Descriptions

Flooding Source	Transect Number	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD 88)			
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Chuckatuck Creek	1	N 36.904578 W 76.517524	2.2	2.7	6.0	7.9	8.6	10.0
Chuckatuck Creek	2	N 36.910975 W 76.506808	2.4	2.9	5.9	7.7	8.4	9.9
Chuckatuck Creek	3	N 36.913143 W 76.498531	2.5	2.9	5.9	7.7	8.3	9.8
Chuckatuck Creek	4	N 36.917174 W 76.492152	3.3	5.0	5.8	7.6	8.3	9.8
Hampton Roads	5	N 36.921444 W 76.491943	4.9	5.2	5.8	7.5	8.2	9.6
Hampton Roads	6	N 36.918063 W 76.483883	6.1	5.2	5.8	7.5	8.1	9.6
Hampton Roads	7	N 36.912911 W 76.480504	6.2	5.3	5.8	7.5	8.1	9.8
Nansemond River	8	N 36.903488 W 76.482004	5.7	5.3	5.9	7.6	8.3	9.9

Table 4 – Transect Descriptions - continued								
		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD 88)			
Flooding Source	Transect Number	Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Nansemond River	9	N 36.896125 W 76.483744	5.4	5.1	5.9	7.7	8.4	10.0
Nansemond River	10	N 36.893348 W 76.490851	4.4	5.3	6.0	7.8	8.5	10.1
Nansemond River	11	N 36.8907301 W 76.500247	3.1	3.1	6.0	7.9	8.6	10.3
Nansemond River	12	N 36.888247 W 76.511237	2.6	4.6	6.6	8.0	8.7	10.3
Nansemond River	13	N 36.879842 W 76.509202	3.2	3.1	6.7	8.0	8.7	10.4
Nansemond River	14	N 36.871730 W 76.520278	2.8	3.1	6.7	8.0	8.6	10.6
Nansemond River	15	N 36.861204 W 76.528876	2.9	3.2	6.3	8.1	8.8	10.7
Nansemond River	16	N 36.849843 W 76.537926	2.7	3.2	6.8	8.4	9.0	10.9
Nansemond River	17	N 36.843296 W 76.546854	2.6	3.1	6.8	8.5	9.3	11.0
Nansemond River	18	N 36.839453 W 76.560197	2.1	2.7	6.6	8.6	9.4	11.1
Nansemond River	19	N 36.827707 W 76.566335	2.6	2.9	6.6	8.6	9.5	11.3
Nansemond River	20	N 36.814387 W 76.553364	2.1	2.8	6.8	8.7	9.5	11.4
Nansemond River	21	N 36.836627 W 76.548909	2.2	3.1	6.5	8.6	9.3	11.2
Nansemond River	22	N 36.834163 W 76.541164	2.7	3.1	6.5	8.5	9.3	11.1

Table 4 – Transect Descriptions - continued								
		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD 88)			
Flooding Source	Transect Number	Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Nansemond River	23	N 36.835241 W 76.534031	2.3	3.0	6.4	8.5	9.3	11.2
Nansemond River	24	N 36.841370 W 76.530953	2.9	3.2	6.4	8.4	9.2	11.0
Nansemond River	25	N 36.842116 W 76.520822	2.8	3.2	6.4	8.4	9.1	10.9
Nansemond River	26	N 36.846834 W 76.512153	2.6	3.0	6.3	8.3	9.0	10.9
Nansemond River	27	N 36.856448 W 76.518810	2.9	3.2	6.3	8.2	9.0	10.8
Nansemond River	28	N 36.857269 W 76.509814	2.8	3.2	6.2	8.2	8.9	10.7
Nansemond River	29	N 36.863450 W 76.506447	2.9	3.2	6.2	8.1	8.9	10.6
Nansemond River	30	N 36.867589 W 76.500782	3.1	3.1	6.1	8.0	8.8	10.5
Nansemond River	31	N 36.871888 W 76.491123	3.0	3.1	6.1	8.0	8.7	10.4
Nansemond River	32	N 36.877957 W 76.494515	2.9	3.4	6.1	8.0	8.7	10.4
Nansemond River	33	N 36.881122 W 76.488883	4.2	5.2	6.0	7.9	8.6	10.3
Nansemond River	34	N 36.879315 W 76.480311	4.2	4.7	6.0	7.8	8.6	10.3
Nansemond River	35	N 36.882595 W 74.71923	5.5	5.1	5.9	7.7	8.4	10.2
Nansemond River	36	N 36.883423 W 74.61867	5.6	5.8	5.9	7.7	8.4	10.2
Nansemond River	37	N 36.885627 W 76.454207	4.9	4.8	5.9	7.6	8.3	10.2

Table 4 – Transect Descriptions - continued								
		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD 88)			
Flooding Source	Transect Number	Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Nansemond River	38	N 36.893904 W 76.452975	5.7	4.8	5.8	7.6	8.2	9.9
Hampton Roads	39	N 36.904276 W 76.446043	6.3	5.2	5.7	7.4	8.0	9.7
Hampton Roads	40	N 36.904948 W 76.432607	7.0	5.2	5.7	7.3	8.0	9.7
Hampton Roads	41	N 36.901302 W 76.420646	7.1	5.3	5.7	7.3	8.0	9.7
Hampton Roads	42	N 36.898645 W 76.410682	6.7	5.3	5.7	7.3	7.9	9.7

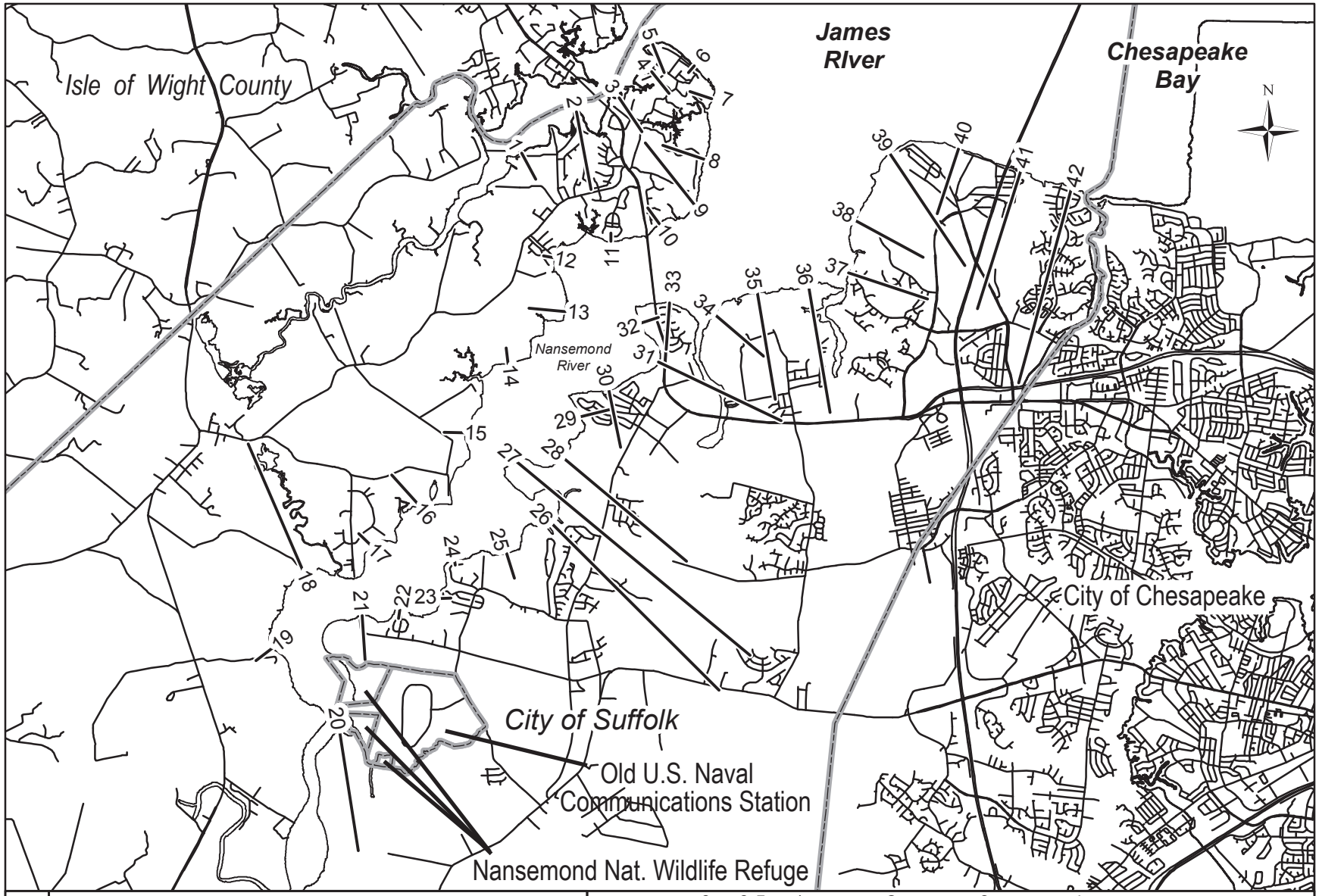


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VIRGINIA
INDEPENDENT CITY

TRANSECT LOCATION MAP

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 in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the NAVD 88, many FIS reports and FIRMs are being prepared using the NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to the NAVD 88. It is important to note that adjacent communities may be referenced to the NGVD 29. This may result in differences in BFEs across the corporate limits between the communities. The vertical datum conversion factor of (-) 1.05 was used to convert elevations from NGVD 29 to NAVD 88 for the following flooding sources and tributaries: Hampton Roads, Chuckatuck Creek, Bennett Creek, Nansemond River up to its confluence with Cedar Creek, and Cedar Creek. The conversion factor of (-) 1.35 feet was applied to the southern portion of the city including the Nansemond River and tributaries, south of its confluence with Cedar Creek, and other flooding sources, such as the Blackwater River.

General Conversion Equations:

Northern Portion of City
Hampton Roads area and between the mouth of Nansemond River and Cedar Creek:
NGVD 29 = NAVD 88 +1.05 feet.

Southern Portion of City
Nansemond River south of Cedar Creek and remainder of City:
NGVD 29 = NAVD 88 + 1.35 feet.

For more information on the NAVD 88, see FEMA publication entitled, Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the National Geodetic Survey online (http://www.ngs.noaa.gov) or at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. Therefore, each FIS provides floodplain data, which may include a combination of the 10-percent-annual-chance, 2-percent-annual-chance, 1-percent-annual-chance, and 0.2-percent-annual-chance flood elevations, delineations of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains, and the 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including the Summary of Stillwater Elevations table, Transect Descriptions table, and the Transect Data table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local 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 (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, 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 the boundaries were interpolated using the methods discussed in Section 3.2.

For the tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and topographic maps. The 1-percent-annual-chance floodplain was divided into whole-foot elevation zones based on the average wave crest envelope in that zone. Where the map scale did not permit these zones to be delineated at 1-foot intervals, larger increments were used.

In the November 16, 1990, FIS, the boundaries were interpolated between cross sections, using topographic maps at a scale of 1” = 600 with a contour interval of 5 and 10 feet (Benatec Associates, 1986).

For the September 2002, FIS the boundaries were interpolated between cross sections, using topographic maps at a scale of 1” = 600 and 1” = 1000 feet with contour intervals of 5 and 10 feet (Air Survey Corporation, 1987). For tidal areas without wave action, the 1- and 0.2-percent-annual-chance boundaries were delineated using the topographic maps referenced above.

For the November 16, 2011, revision, the effective flood elevations and the streams studied by approximate methods were delineated using Geographic Information System, analyses and updated digital elevation data able to support a topographic

map contour interval of 2 feet (City of Suffolk, 2009). The approximate 1-percent-annual-chance floodplain boundary for the Great Dismal Swamp was digitized from the 2002 FIRM for the City of Suffolk.

For this August 3, 2015, revision, areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (USACE, 1975). The 3-foot wave has been determined the minimum size wave capable of causing major damage to conventional wood frame of brick veneer structures. The one exception to the 3-foot wave criteria is where a primary frontal dune exists. The limit the coastal high hazard area then becomes the landward toe of the primary frontal dune or where a 3-foot or greater breaking wave exists, whichever is most landward. The coastal high hazard zone is depicted on the FIRMs as Zone VE, where the delineated flood hazard includes wave heights equal to or greater than three feet. Zone AE is depicted on the FIRMs where the delineated flood hazard includes wave heights less than three feet. A depiction of how the Zones VE and AE are mapped is shown in Figure 2, 'Typical Transect Schematic'.

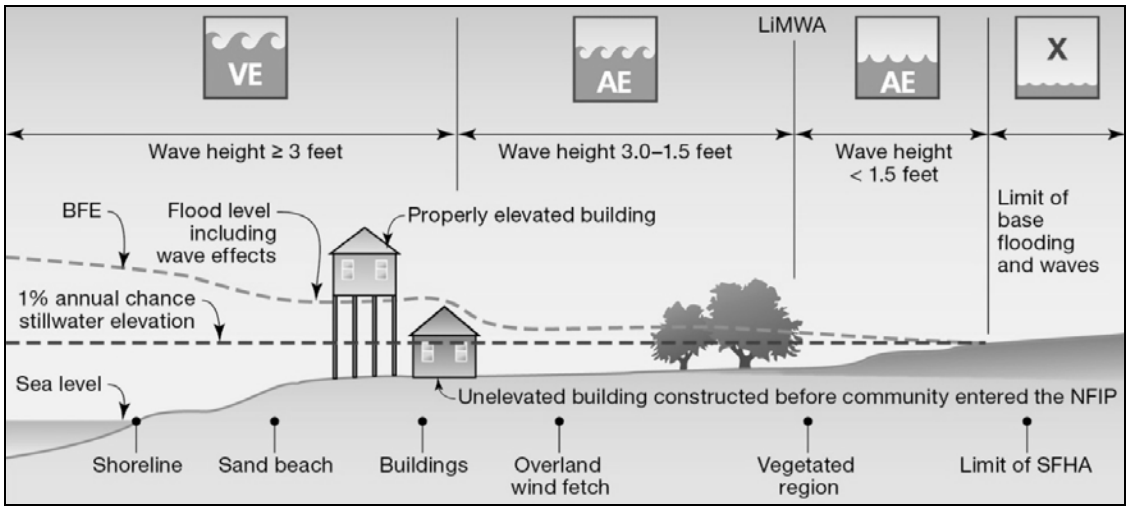


Figure 2 – Typical Transect Schematic

Post-storm field visits and laboratory tests have confirmed that wave heights as small as 1.5 feet can cause significant damage to structures when constructed without consideration to the coastal hazards. Additional flood hazards associated with coastal waves include floating debris, high velocity flow, erosion, and scour which can cause damage to Zone AE-type construction in these coastal areas. To help community officials and property owners recognize this increased potential for damage due to wave action in the AE zone, FEMA issued guidance in December 2008 on identifying and mapping the 1.5-foot wave height line, referred to as the Limit of Moderate Wave Action (LiMWA). While FEMA does not impose floodplain management requirements based on the LiMWA, the LiMWA is provided to help communicate the higher risk that exists in that area. Consequently, it is important to be aware of the area between this inland limit and the Zone VE boundary as it still poses a high risk, though not as high of a risk as Zone VE (see Figure 2, Typical Transect Schematic).

The 1- and 0.2-percent-annual-chance floodplain boundaries (100-year and 500-year, respectively) are shown on the FIRM (Exhibit 1). On this map, the 1-percent- annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones AE 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.

In the original FIS, FIRM panels were shown at a scale of 1:7,200. For this August 3, 2015, revision, the revised FIRM panels are shown at a scale of 1:6,000 using aerial photographs as the base map (Commonwealth of Virginia, 2007).

For the streams studied by approximate methods only the 1-percent-annual-chance floodplain boundary is shown.

4.2 Floodways

Encroachment of floodplains, such as structures and fill, reduces the flood carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or can be used as a basis for additional floodway studies.

The floodways presented in the FIS were computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 5, “Floodway Data”. The computed floodways are shown on the revised FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

The floodway for the Blackwater River extends beyond the corporate limits.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 5, "Floodway Data." To reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

Near the mouth of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 5 for certain downstream cross sections of Shingle Creek and Blackwater River are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

The area between the floodway and the 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3, 'Floodway Schematic'.

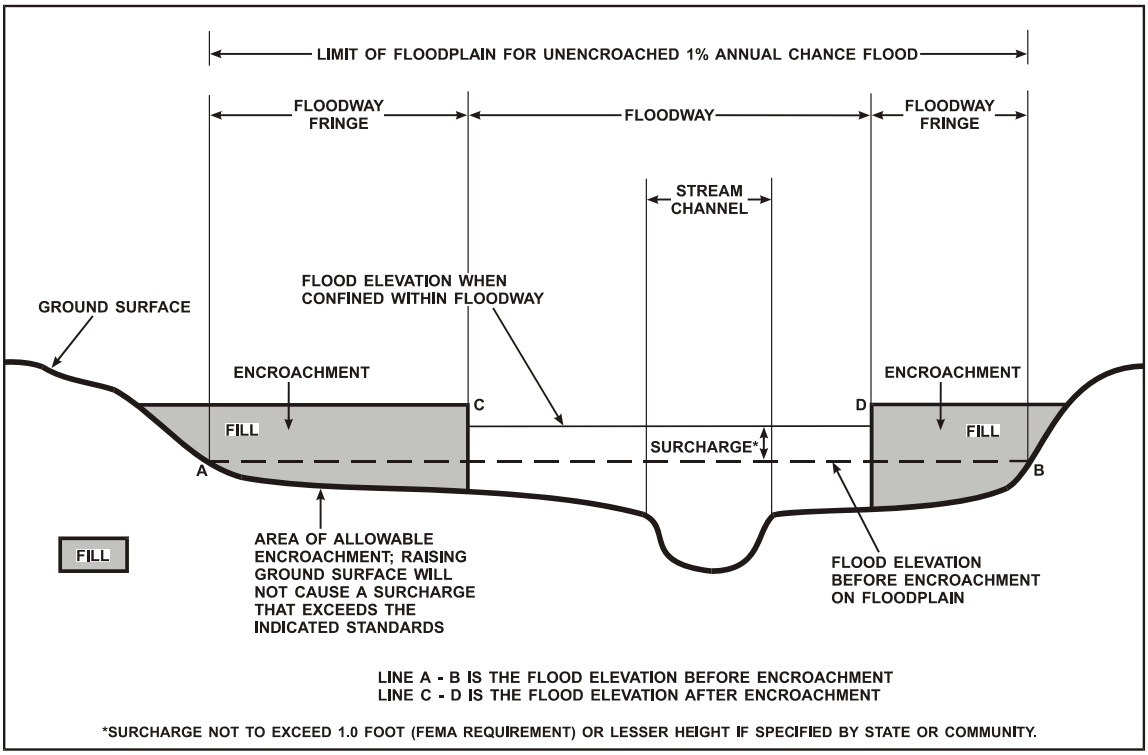


Figure 3 - Floodway Schematic

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Blackwater River								
A	10,512	1,220 / 1,600	10,912	1.8	13.3	4.6[3]	5.1	0.5
B	17,427	128 / 1,845	16,334	1.2	13.6	7.5[3]	8.0	0.5
C	29,042	696 / 900	12,315	1.6	13.6	10.6[3]	11.3	0.7
D	34,797	92 / 650	9,920	1.9	13.6	12.2[3]	13.0	0.8
E	38,547	1,001 / 1,200	17,328	1.1	13.6	13.1[3]	13.9	0.8
F	45,097	367 / 1,400	22,577	0.8	13.6	13.6[3]	14.4	0.8
G	46,415	106 / 1,400	18,753	1.0	13.8	13.8	14.6	0.8
H	48,895	593 / 1,700	23,178	0.8	14.1	14.1	15.0	0.9

[1] Feet above confluence with the Chowan River
[2] Floodway width within City of Suffolk / Total floodway width
[3] Elevation computed without consideration of tidal effects from the Nottoway River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

(INDEPENDENT CITY)

FLOODWAY DATA

BLACKWATER RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Shingle Creek								
A	6,940	182	1,310	1.2	*	*	*	*
B	7,700	115	995	1.5	*	*	*	*
C	8,750	185	1,810	0.8	*	*	*	*
D	9,500	135	1,265	1.2	*	*	*	*
E	10,600	195	1,710	0.9	*	*	*	*
F	11,200	175	1,375	1.1	9.9	9.9	10.6	0.7
G	11,500	75	635	2.3	10.4	10.4	10.8	0.4
H	12,240	150	1,150	1.3	10.7	10.7	11.3	0.6
I	12,500	301	2,560	0.8	17.0	17.0	18.0	1.0
J	13,250	229	2,560	0.8	17.0	17.0	18.0	1.0
K	14,330	202	1,895	1.1	17.2	17.2	18.1	0.9
L	15,050	211	1,860	1.1	17.4	17.4	18.3	0.9
M	16,200	233	1,685	1.1	17.7	17.7	18.5	0.8
N	17,100	125	985	1.9	18.2	18.2	18.9	0.7
O	17,650	125	1,030	1.7	21.2	21.2	21.6	0.4
P	18,200	140	1,010	1.8	21.4	21.4	22.0	0.6
Q	18,700	125	580	3.0	21.5	21.5	22.5	1.0
R	19,100	125	920	1.9	25.0	25.0	25.2	0.2
S	19,500	125	945	1.8	25.2	25.2	25.6	0.4

[1] Feet above confluence with the Nansemond River

* Superseded by coastal analyses / tidal effects from the Nansemond River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

(INDEPENDENT CITY)

FLOODWAY DATA

SHINGLE CREEK

5.0 INSURANCE APPLICATION

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 base flood elevations (BFEs) or base flood depths are shown within this zone.

Zone AE:

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

Zone AH:

Zone AH is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO:

Zone AO is the flood insurance risk zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot base flood depths derived from the detailed hydraulic analyses are shown within this zone.

Zone AR:

Zone AR is the flood insurance risk zone that corresponds to an area of special flood hazard formerly protected from the 1-percent-annual-chance flood event by a flood-control system that was subsequently decertified. Zone AR indicates that the former flood-control system is being restored to provide protection from the 1-percent-annual-chance or greater flood event.

Zone A99:

Zone A99 is the flood insurance risk zone that corresponds to areas of the 1-percent-annual-chance floodplain that will be protected by a Federal flood

protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone V:

Zone V is the flood insurance risk zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE:

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

Zone X:

Zone X is the flood insurance risk 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, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or base flood depths are shown within this zone.

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 risk zones as described in Section 5.0. In the 1-percent-annual-chance floodplains that were studied by detailed methods, the FIRM shows selected whole-foot BFEs or average depths. Insurance agents use the 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.

7.0 OTHER STUDIES

FISs have been prepared for the adjacent Cities of Chesapeake and Portsmouth and the Counties of Isle of Wight and Southampton (FEMA, 2014, 2009, 2002, and 2002). The FISs for the City of Portsmouth and Isle of Wight County are currently being revised to reflect the coastal storm surge analysis for the Atlantic Ocean, the Chesapeake Bay

(including its tributaries), and the Delaware Bay. This FIS is in agreement with those studies.

A FIS has been prepared for Gates County, North Carolina (FEMA, 2009). Information for the Blackwater River was obtained from the Southampton County, Virginia FIS (FEMA, 2002). The Great Dismal Swamp was studied by approximate methods.

A Floodplain Information Report for Portsmouth, Virginia, was prepared by the USACE in February 1973 (USACE, 1973).

An Emergency Action Plan, dated March 23, 2009, was prepared for the City of Portsmouth with regards to four dams within the City of Suffolk: Speights Run Reservoir, Lake Cohoon, Lake Kilby, and Lake Meade dams. The results from this action plan were not used in the delineation of floodplain boundaries (Wilson, 2009).

This FIS report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for 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 the Flood Insurance and Mitigation Division, Federal Emergency Management Agency, One Independence Mall, 6th floor, 615 Chestnut Street, Philadelphia, PA, 19106.

9.0 BIBLIOGRAPHY AND REFERENCES

Benatec Associates of Columbus, Ohio, Topographic maps prepared by photographic methods from USGS 7.5-Minute Series Topographic Maps, Scale 1" = 600', Contour Intervals 5 and 10 feet: City of Suffolk, Virginia 1986. The following USGS 7.5-Minute Series Topographic Maps, Scale 1:24000, Contour Intervals 5 and 10 Feet, were used: Benns Church, Virginia, 1965, Photorevised 1980; Newport News South, Virginia, 1964, Photorevised 1980; Windsor, Virginia, 1965, Photorevised 1980; Chuckatuck, Virginia, 1965, Photorevised 1979; Bowers Hill, Virginia, 1965, Photorevised 1979; Franklin, Virginia, 1967, Photorevised 1980; Holland, Virginia, 1967, Photorevised 1979; Buckhorn, Virginia, 1954, Photorevised 1979; Suffolk, Virginia, 1977; Lake Drummond NW, Virginia, 1954; Riverdale, Virginia – North Carolina, 1967; Gates, North Carolina – Virginia, 1967, Photorevised 1981; Corapeake, Virginia-North Carolina, 1977; Lake Drummond, Virginia-North Carolina, 1977.

City of Suffolk, Internet address: http://www.suffolk.va.us/community/history.html, "All about Suffolk", Historical Overview, 2009.

City of Suffolk, Internet address: http://www.suffolk.va.us/community/employment.html, "All about Suffolk", Employment, 2009.

City of Suffolk, Virginia, 2 ft. Topographic Contours, completed by Michael Baker, Jr., Inc., Virginia Beach, Virginia, Scale: 1 inch = 200 feet, March 1999.

Commonwealth of Virginia, An Assessment: Virginia's Response to Hurricane Isabel, Richmond, Virginia, December 2003.

Commonwealth of Virginia, Division of State Planning and Community Affairs, Data Summary – Nansemond County and Suffolk City, Richmond, Virginia, April 1970.

Commonwealth of Virginia, Virginia Geographic Information Network, VBMP Orthophotography – 2006 / 2007, Richmond, Virginia, Scales: 1 inch = 200 feet and 1 inch = 100 feet, 2007.

Commonwealth of Virginia, Virginia Uniform Statewide Building Code, Article 8, Part C, Section 872.6, September 1973.

Federal Emergency Management Agency, Flood Insurance Study, City of Chesapeake, Independent City, Virginia, Washington, D.C., December 16, 2014.

Federal Emergency Management Agency, Flood Insurance Study, Isle of Wight County, Virginia and Incorporated Areas, Washington, D.C., September 4, 2002.

Federal Emergency Management Agency, Flood Insurance Study, City of Portsmouth, Independent City, Virginia, Washington, D.C., 2009.

Federal Emergency Management Agency, Flood Insurance Study, Southampton County, Virginia and Incorporated Areas, Washington, D.C., September 4, 2002.

Federal Emergency Management Agency, "Information on Federally Declared Disasters, Hurricane Floyd", Washington, D.C., May 8, 2000.

Federal Emergency Management Agency, State of North Carolina - Cooperating Technical State, Flood Insurance Study, Gates County, North Carolina and Incorporated Areas, Washington, D.C., July 20, 2009.

Federal Emergency Management Agency, User's Manual for Wave Height Analysis, Washington, D.C., February 1981.

National Academy of Sciences, "Methodology for Calculating Wave Action Effects Associated with Storm Surges", Washington, D.C., 1977.

National Weather Service, "Preliminary Post Storm Report…Hurricane Floyd", Wakefield, Virginia, September 20, 1999.

Pilot and Norfolk Landmark, A Pictorial Record of Tidewater's Worst Storm, Norfolk, August 22 and 23, 1933, Norfolk, Virginia, 1933.

The Virginian-Pilot, Norfolk, Virginia, March 1962.

Topographic Maps – Cities of Franklin and Suffolk, Virginia, Counties of Isle of Wight and Southampton, Virginia, Scale 1" = 600'; Scale 1" = 1000', prepared by Air Survey Corporation, Reston, Virginia, 1987. Maps developed by photographic methods from U.S. Department of Interior, Geological Survey, 7.5 Minute Series (Topographic) Maps, Scale 1:24,000, Contour Intervals 5 and 10 Feet; Riverdale, Virginia, 1967, Photorevised 1986; Franklin, Virginia, 1967, Photorevised 1980 and 1986

U.S. Army Corps of Engineers, Galveston District, General Guidelines for Identifying Coastal High Hazard Zones, Galveston, Texas, 1975.

U.S. Army Corps of Engineers, House Document 354, 87th Congress, 2nd Session, Norfolk, Virginia - Interim Hurricane Survey, 1962.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Users Manual, Davis, California, September 1981, revised January 1985.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, September 1982.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, User's Manual, Davis, California, September 1990.

U.S. Army Corps of Engineers, Norfolk District, Flood Plain Information Report, Coastal Flooding, Portsmouth, Virginia, Norfolk, Virginia, February 1973.

U.S. Census Bureau, Internet address: http://factfinder.census.gov, American Fact Finder, 2009.

U.S. Census Bureau, Internet address: http://quickfacts.census.gov/qfd/states/51/51800.html, State & County QuickFacts: Suffolk City, Virginia, last revised June 27, 2013.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research, Atlantic Oceanographic and Meteorological Research Laboratory, Hurricane Research Division, Internet address: www.aoml.noaa.gov/hrd/, Hurricane Research Division, Weather Info, Hurricane Frequently Asked Questions (FAQs).

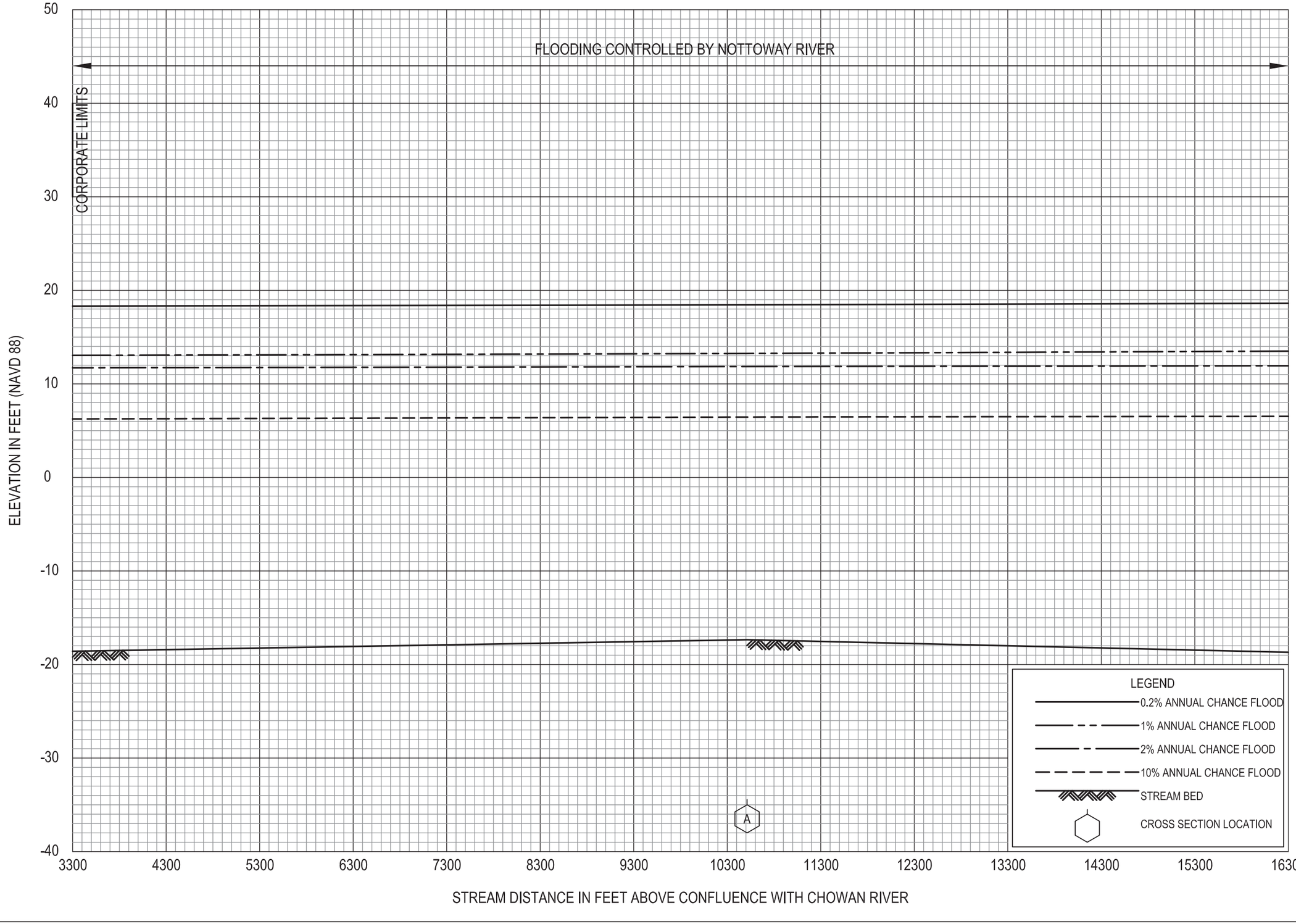
U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Center, Center for Operational Oceanographic Products and Services, Internet address: www.tidesandcurrents.noaa.gov, Products, Predictions, Published Tide Tables, 2006.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Report NOS CO-OPS 040, Effects of Hurricane Isabel on Water Levels Data Report, Silver Spring, Maryland, April 2004.

U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Suffolk, Independent City, Virginia, March 24, 1978.

U.S. Department of the Interior, Geological Survey, Office of Water Data Collection, Interagency Advisory Committee on Water Data, "Guidelines for Determining Flood Flow Frequency", Bulletin 17B, Reston, Virginia, September 1981.

Wiley Wilson, City of Portsmouth, Emergency Action Plan (EAP), Speights Run Reservoir Dam: Inv. No. 80010, Lake Cohoon Dam: Inv. No. 80001, Lake Kilby Dam: Inv. 80002, Lake Meade Dam: Inv. No. 80013, Lynchburg, Virginia, March 23, 2009.



FLOOD PROFILES

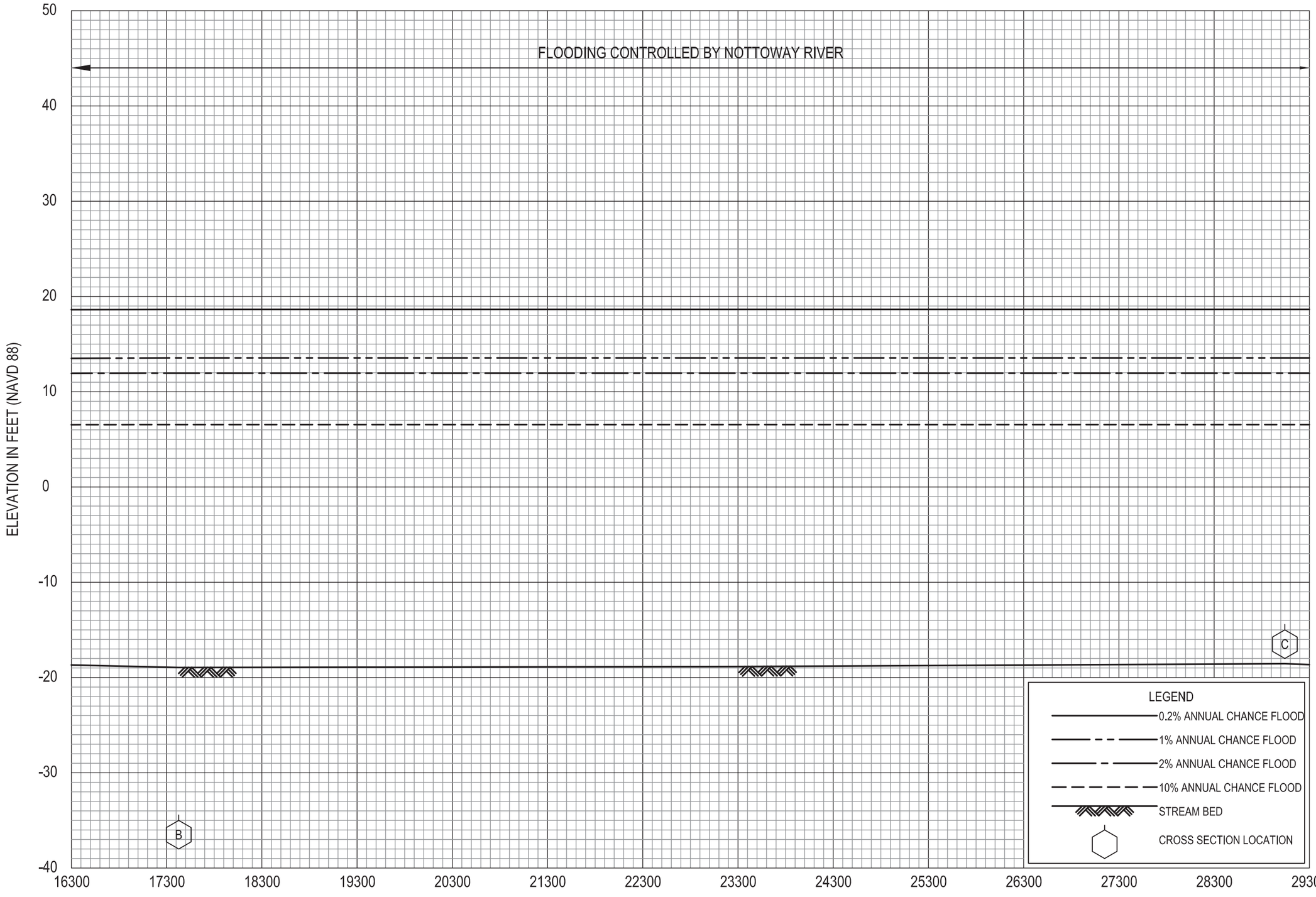
BLACKWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

INDEPENDENT CITY

01P



FLOOD PROFILES

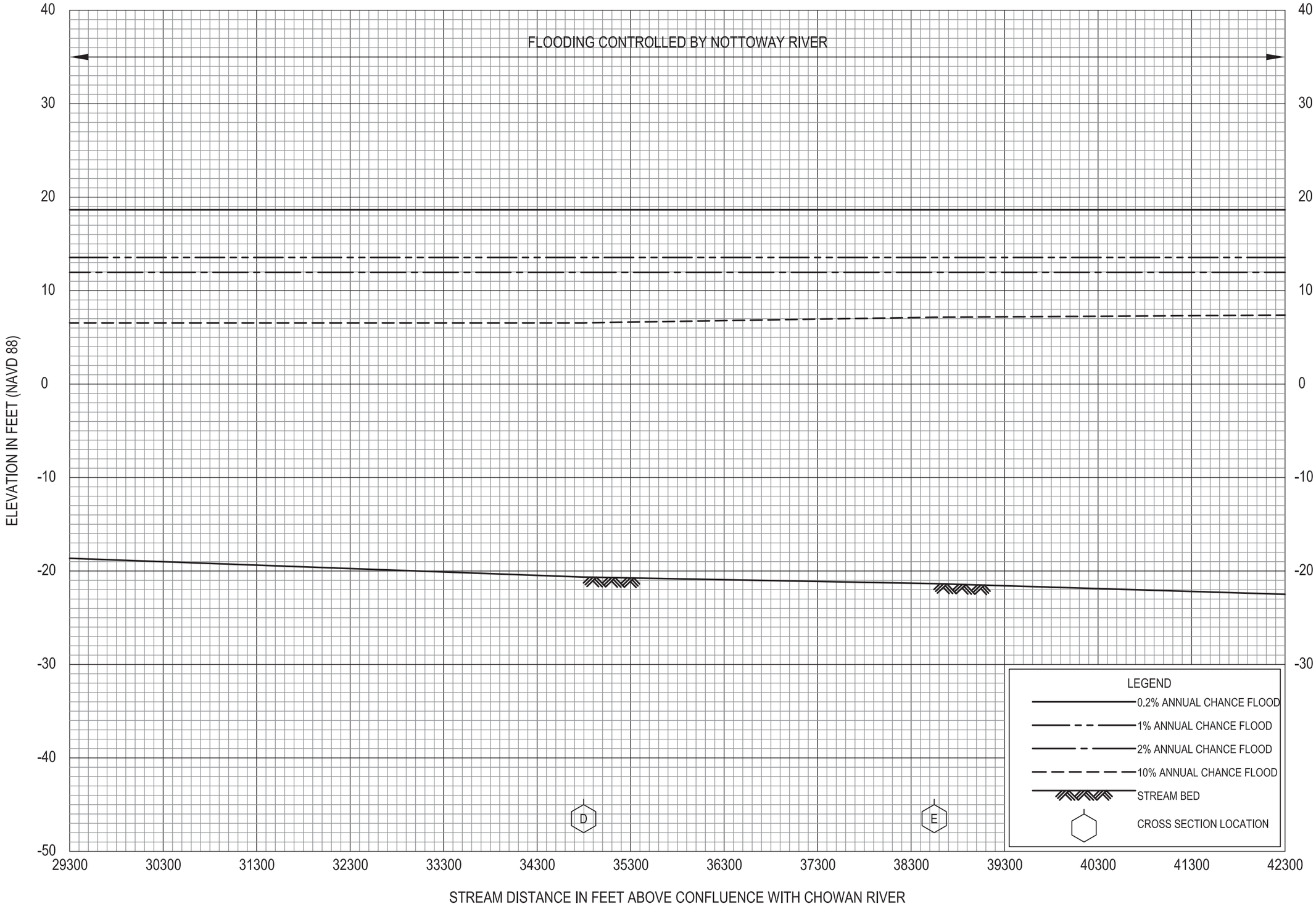
BLACKWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

INDEPENDENT CITY

02P



FLOOD PROFILES

BLACKWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

INDEPENDENT CITY

03P

FLOODING CONTROLLED BY NOTTOWAY RIVER

S. QUAY RD / VA ROUTE 189

US ROUTE 58

CORPORATE LIMITS

ELEVATION IN FEET (NAVD 88)

50
40
30
20
10
0
-10
-20
-30
-40

42300 43300 44300 45300 46300 47300 48300 49300 50300 51300 52300 53300 54300 55300

STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH CHOWAN RIVER

F G H

LEGEND

- 0.2% ANNUAL CHANCE FLOOD
- 1% ANNUAL CHANCE FLOOD
- 2% ANNUAL CHANCE FLOOD
- 10% ANNUAL CHANCE FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

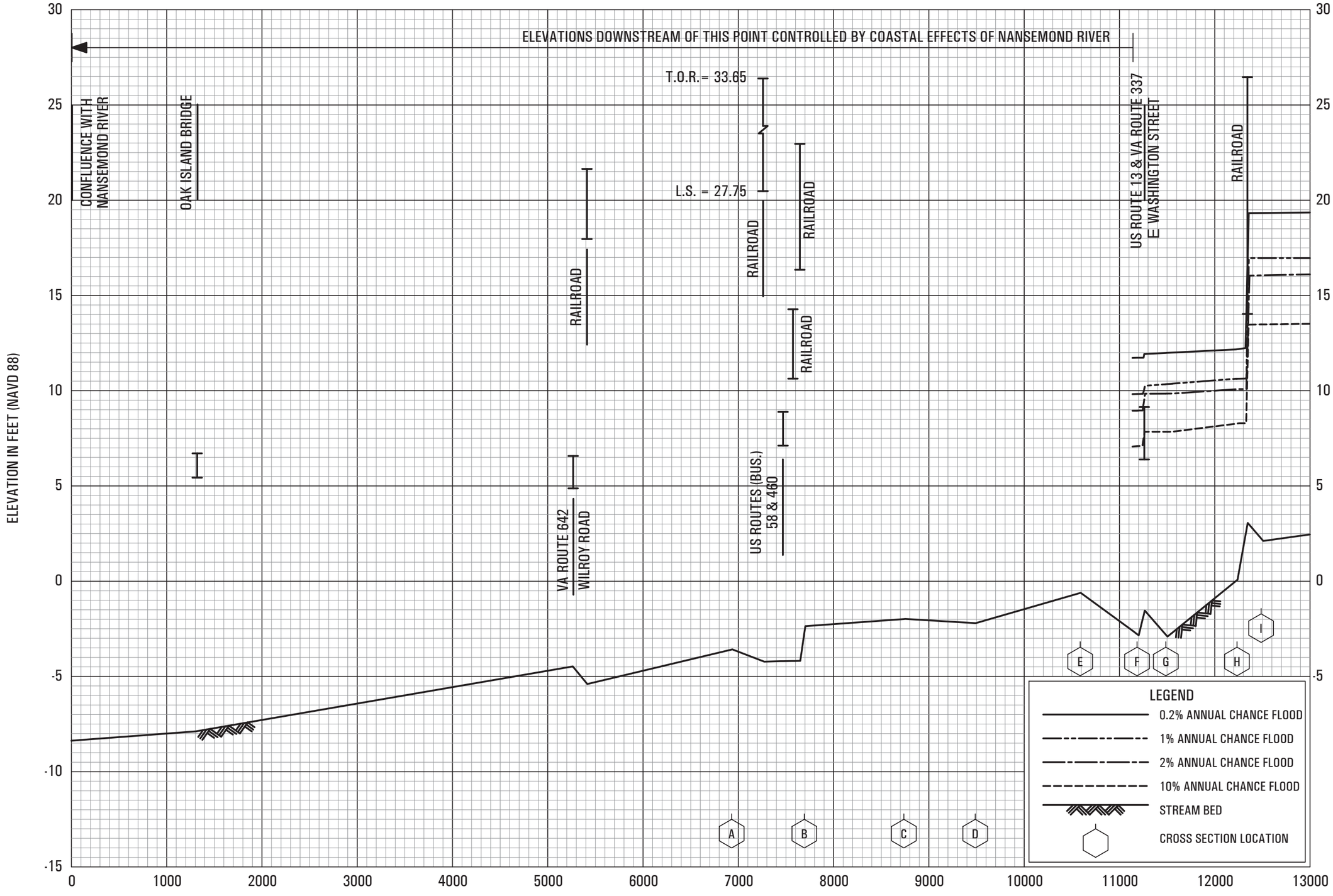
BLACKWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

INDEPENDENT CITY

04P



FLOOD PROFILES

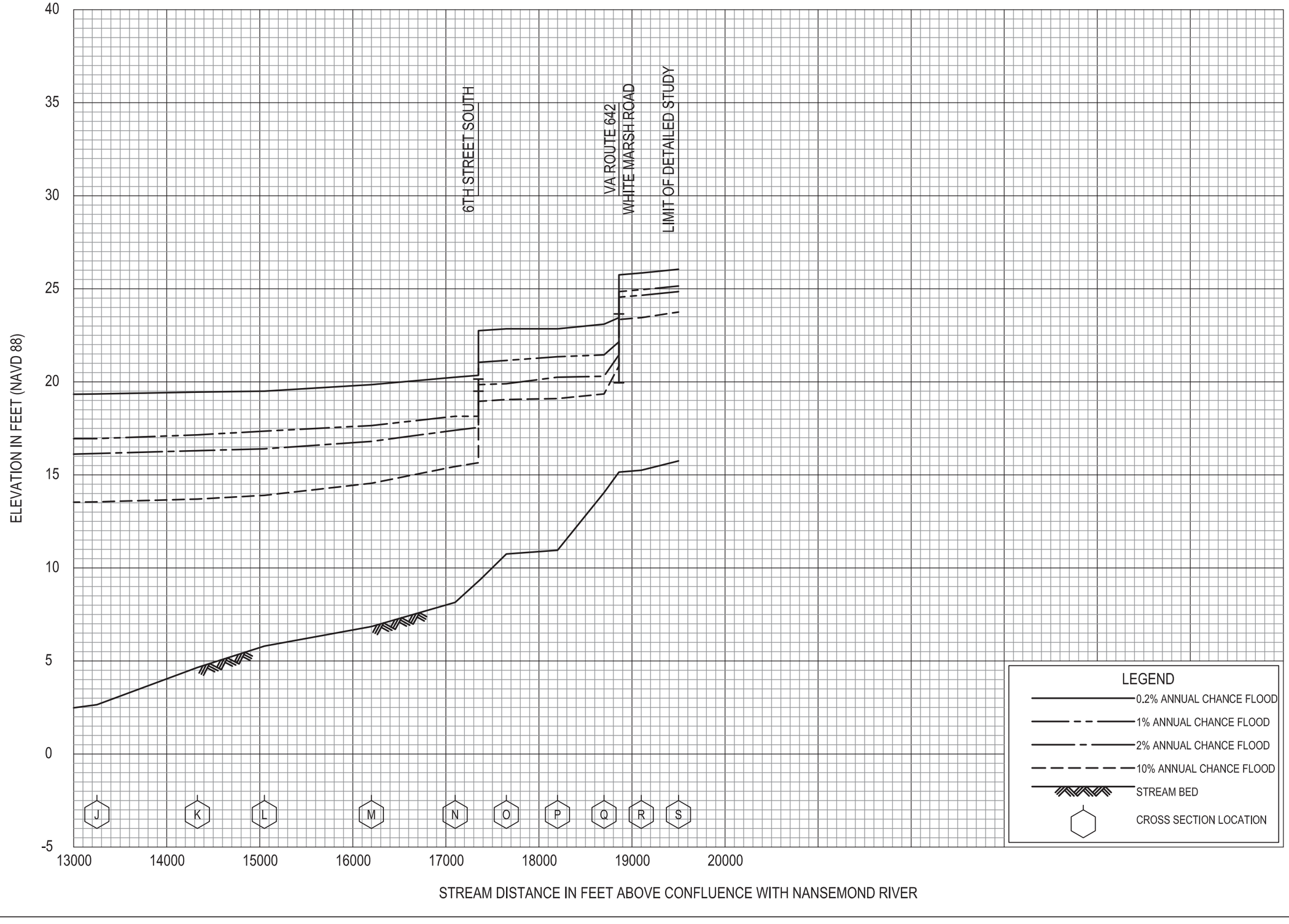
SHINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

INDEPENDENT CITY

05P



FLOOD PROFILES

SHINGLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SUFFOLK, VA

INDEPENDENT CITY

06P