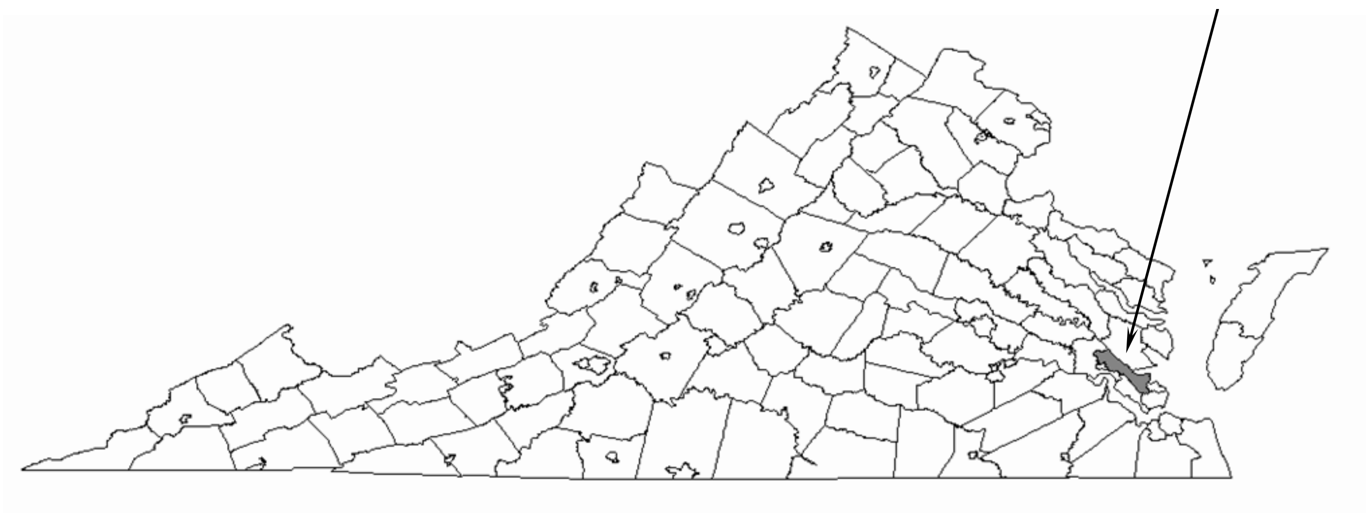
FLOOD INSURANCE STUDY

YORK COUNTY, VIRGINIA
(ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER
YORK COUNTY (UNINCORPORATED AREAS)	510182



REVISED:
JANUARY 16, 2015

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
51199CV000B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) report may not contain all data available within the repository. It is advisable to contact the community 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 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 Report Effective Date: June 16, 2009

Revised FIS Report Dates: January 16, 2015

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FLOOD INSURANCE STUDY
YORK COUNTY, VIRGINIA (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of the unincorporated areas of York County, Virginia (referred to collectively herein as York County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Act of 1973. There are no incorporated communities within York County. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain development. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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

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.

For the original December 16, 1988, FIS, 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 Interagency Agreement No. EMW-84-E-1506, Project Order No. 1, Amendment No. 20. That work was completed in October 1986.

For the June 16, 2009, countywide study, the FIS was prepared by the USACE for FEMA, under Interagency Agreement No. HSFE03-05-X-0005, Project Order No. P403558Y/ P403560Y. This work was completed in January 2007. This FIS was revised to show updated community description information, historical flood information, FEMA contact information, and bibliography and references. The hydrologic and hydraulic analyses have not been revised or updated. The revised FIS also includes information regarding survey bench marks and vertical datums. The previous FIRM was converted to a digital format, utilizing geographic information system (GIS) vector data as the base map. The floodplain boundaries were also revised to reflect updated topographic data (Reference 1).

For this January 16, 2015, countywide revision, detailed coastal flood hazard analyses were performed for several flooding sources. The study replaces outdated coastal storm surge stillwater elevations for all FISs in the study area, including York County, and serves as the basis for updated FIRMs. Study efforts were initiated in 2008 and concluded in 2012. The FEMA Region III office initiated a study in 2008 to update the coastal storm surge elevations within the states of Virginia, Maryland, and Delaware, and the District of Columbia including the Atlantic Ocean, Chesapeake Bay including its tributaries, and the Delaware Bay.

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 topographic data for the coastal floodplain mapping was prepared Dewberry, for the U.S. Geological Survey (USGS) and FEMA, under Contracts G10PC00013 and G11PD00089.

Base map information was provided in by the Commonwealth of Virginia through the Virginia Base Mapping Program (VBMP). The orthophotos were flown in 2009 at scales of 1:100 and 1:200 (Reference 2).

The projection used in the preparation of this map was Virginia State Plane South zone. The horizontal datum was North American Datum of 1983 (NAD83), HARN. Differences in 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 this FIRM.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO) meeting is to discuss the scope of the FIS. A final CCO meeting is held to review the results of the study.

For June 16, 2009, countywide revision, an initial CCO meeting was held on June 12, 1979, with representatives of FEMA, York County, the Virginia State Water Control Board, and an architect/engineering firm. At this meeting, the nature and purpose of the study and the scope and limits of the work were explained, and flood information currently available concerning the county was obtained. On February 2, 1984, an intermediate CCO meeting was held to review the scope of work with the USACE. A final CCO meeting was held on January 28, 1988, attended by representatives of FEMA, York County, the Virginia State Water Control Board, and the USACE.

For the June 16, 2009, countywide revision, an initial CCO meeting was held on March 15, 2005, with representatives of FEMA, York County, the Virginia Department of Conservation and Recreation, and the USACE (the study contractor). A final CCO meeting was held on April 3, 2008, and attended by representatives of FEMA, York County, the Virginia Department of Conservation and Recreation, and the USACE.

For this January 16, 2015, countywide revision, a RiskMAP coordination meeting was held on May 4, 2011, with representatives from FEMA, York County, the Virginia Department of Conservation and Recreation, and the USACE. The final CCO meeting was held May 16, 2013, with representatives of FEMA, York County, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers all areas of York County, Virginia.

Tidal flooding, including its wave action from Back Creek, Brick Kiln Creek, the Chesapeake Bay, Chisman Creek, and York River and their adjoining estuaries were studied by detailed methods. All areas within the county which are affected by tidal flooding were included in the detailed study. 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.

All streams in the county not affected by tidal flooding were studied by approximate methods. Generally, these studies were extended up the streams to where the drainage area is less than one square mile. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The following flooding sources were studies by approximate methods: Baptist Run, Barlows Pond, Beaverdam Creek, Big Bethel Reservoir, Carter Creek, City of Newport News Reservoir, Great Run, Harwoods Mill Reservoir, King Creek, Poquoson River, Skimino Creek, and Waller Mill Reservoir. The scope and methods of the study were proposed to, and agreed upon by, FEMA and York County.

This countywide revision incorporates the determinations of Letters of Map Revisions (LOMRs) issued by FEMA. Table 1, "Letters of Map Change", incorporated into this countywide study:

TABLE 1 – LETTERS OF MAP CHANGE

LOMC	Case Number	Effective Date	Project Identifier
LOMR	09-03-0030P	March 16, 2010	Big Bethel Reservior

2.2 Community Description

York County is located on Virginia's Coastal Plain, on a peninsula bordered by the York and James Rivers and the Chesapeake Bay. It is bordered by the Cities of Poquoson, Hampton, and Newport News to the east and south; by the City of Williamsburg and the unincorporated areas of James City County to the west; and the unincorporated areas of Gloucester County to the north. The county has approximately 108 square miles of land area, is rectangular in shape, approximately 27 miles in length, and 6 miles in width (Reference 3). The population of York County was 35,463 in 1980, 42,422 in 1990, 56,297 in 2000, and 66,134 in 2010 (Reference 4).

York County, first called Charles River County, was one of Virginia's original shires formed in 1634. York County has played a major role in the development of this nation. It was at Yorktown on October 19, 1781, that Lord Cornwallis surrendered his British Army to the Allied French and American forces bringing a close to the Revolutionary War. Yorktown and York County also played roles in the War of 1812 and the Civil War. In 1917-18, during World War I, the York River was the base for the Atlantic Fleet of the U.S. Navy. During World War II, several important military installations were enlarged or added, and further expansion has taken place since. These installations now include the U.S. Coast Guard Training Center, the Naval Weapons Station, Cheatham Annex, and Camp Peary (Reference 3).

York County is located in the Coastal Plain province and is underlain primarily by sand, gravel, clay, and marl strata. The county is characterized by a series of distinct level flats, called scarps, and rolling plains progressing from the low-lying areas along the Chesapeake Bay to the uplands in the northwestern portion of the county, reaching elevations of approximately 100 feet above sea level.

The area enjoys a temperate climate with moderate seasonal changes. The climate is characterized by moderately warm summers with temperatures averaging approximately 78 degrees Fahrenheit (°F) during July, the warmest month. The winters are cool with temperatures averaging approximately 40°F in January, the coolest month. The annual precipitation over the area averages approximately 44 inches. There is some variation in the monthly averages; however, this rainfall is distributed evenly throughout the year. Snowfall averages six inches each year, generally occurring in light falls which normally melt within 24 hours (Reference 5).

Being strategically located within the Hampton/Newport News metropolitan area, approximately midway between Richmond and Norfolk, the economy of York County is significantly influenced by the economies and development of all peninsula jurisdictions. Today, the economy of the county is primarily oriented toward the retail, service, and tourism industries. Tourism is very important to York County with the attractions at Jamestown, Williamsburg, and Yorktown.

The floodplains of York County are concentrated in the eastern portion of the county among the numerous peninsula-like landforms created by the tidal waters of the Chesapeake Bay, the York River, and their estuaries. Residential development has concentrated on many of these peninsulas because of the desirability of waterfront locations. York County has become increasingly attractive as a residential location for persons employed in Newport News, Hampton, or Williamsburg. With the county's many miles of shoreline, there will be pressure for future development in the floodplain.

2.3 Principal Flood Problems

The coastal areas of York County are vulnerable to tidal flooding from major storms such as hurricanes and northeasters. Both types of storms produce winds which push large volumes of water against the shore.

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 November, nearly 80 percent occur in the months of August, September, and October with approximately 40 percent occurring in September. From analysis of records from 1944 to 1999 for hurricanes passing within approximately 100 miles, there is approximately a 40 percent chance that York County will be affected by a hurricane (Reference 6). The most severe hurricanes on record to strike the study area occurred in August 1933, September 2003 (Hurricane Isabel), August 2011 (Hurricane Irene), and October 2012 (Hurricane Sandy). Another notable hurricane which caused significant flooding in York County occurred in September 1936.

Another type of storm which could cause severe damage to the county is the northeaster. This is also a cyclonic type of storm and originates with little or no warning along the middle and northern Atlantic coast. These storms occur 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 northeaster was the worst ever recorded in the county.

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 northeasters. Flooding from hurricanes rarely lasts more than one tidal cycle, while flooding from northeasters 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 county from the Chesapeake Bay normally fluctuate twice daily with a mean tide range of approximately 2.4 feet (Reference 7). The range of fluctuation may vary slightly in most of the connecting bays and inlets.

All development in the floodplain is subject to water damage. Some areas, depending on exposure, are subject to high velocity wave action which can cause structural damage and severe erosion along beaches. 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. Portions of the eastern and northern shorelines of York County are vulnerable to wave damage due to the vast exposure afforded by the Chesapeake Bay.

York County has experienced major storms since the early settlement of the area. Historical accounts of severe storms in the 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 23, 1933, hurricane was one of the most destructive for this area as well as for the remainder of the Chesapeake Bay region. The hurricane entered the mainland near Cape Hatteras, North Carolina on August 22, passed slightly west of Norfolk, and continued in a northern direction accompanied by extreme winds and tides. At Norfolk, gusts of wind reached measured velocities of 88 miles per hour (mph), although the maximum sustained velocity was only 56 mph. The storm surge in the Chesapeake Bay and tidal estuaries was the highest on record. At Gloucester Point, the elevation of flooding reached 7.75 feet, referenced to the North American Vertical Datum of 1988 (NAVD). In addition to damage from tidal flooding, much damage was caused to roofs, communication lines, and other structures by the high wind. Damage of this nature is characteristic of that caused by hurricanes (Reference 8).

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. At Gloucester Point, the elevation of flooding reached 5.35 feet, NAVD. Damage was severe, and by occurring during the Depression period, became a double hardship on the populace (Reference 8).

On October 15, 1954, Hurricane Hazel entered the mainland south of Wilmington, North Carolina. The storm moved rapidly northward, passing approximately 60 miles inland through Virginia in the early afternoon, causing high winds and moderately high tides. Hurricane force winds with gusts of 80 to 100 mph were experienced near the path of the storm center and eastward to the coast. The hurricane surge was not as high as the August 1933 storm although the tidal surge was superimposed on the normal high tide (Reference 8).

On March 6-8, 1962, a northeaster caused disastrous flooding and high waves all along the Atlantic Seaboard from New York to Florida. This storm was unusual even for a northeaster since it was caused by a low pressure cell which moved from south to north and then reversed its course, moving again to the south and bringing with it huge volumes of water and high waves. This storm caused severe tidal flooding in York County. Great destruction was caused by high waves and breakers superimposed on high tides. The waves and breakers undermined and collapsed buildings, eroded beaches and roads, interrupted communications, and damaged power lines.

Damaging high water occurred on five successive high tides over a period of two days, and disrupted all normal activities for several days in the area (Reference 9). At Gloucester Point, the elevation of flooding reached 4.75 feet, NAVD.

In November 1985, high winds and tides combined to play havoc with the Chesapeake Bay and York River shoreline in the worst storm in decades. The storm was a product of a low pressure system that swept up the Atlantic Seaboard. Northeast winds in excess of 65 mph pushed tides above normal and battered piers, bulkheads, boats, boathouses, and other waterfront structures along the exposed areas. In Yorktown, along Water Street, most of the sidewalk was destroyed and sections of the road undermined. Yorktown Beach lost at least 500 tons of sand reducing the width and length of the beach. County officials said damage to the beach was some of the worst in 25 years (Reference 10).

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 (Reference 11). Historical maximum water level records were exceeded at several locations within the Chesapeake Bay. 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 (Reference 12).

2.4 Flood Protection Measures

There are no existing flood control structures that would provide protection during major floods in the study area. There are a number of measures that have afforded some protection against flooding, including bulkheads and seawalls, jetties, sand dunes, 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 100-year 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" (Reference 13). These requirements will no doubt be beneficial in reducing future flood damages in the county.

3.0 ENGINEERING METHODS

For the flooding sources studied by detail methods in the county, 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 one year are considered. For example, the risk of having a flood which equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (four in ten); for any 90-year period, the risk increases to approximately 60 percent (six in ten). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Coastal Analysis

Coastal analysis, 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 2, "Summary of Stillwater Elevations" table 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.

For this countywide revision, the storm-surge elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were determined for the Chesapeake Bay and are shown in Table 2, "Summary of Stillwater Elevations." The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects.

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

	ELEVATION (feet NAVD[1])			
FLOODING SOURCE AND LOCATION	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CHESAPEAKE BAY				
At Tue Point	4.6	5.8	6.5	7.6
At York Point	4.6	5.9	6.4	7.7
POQUOSON RIVER				
At Hodges Cove	4.8	6.4	7.0	8.5
At State Route 658, extended	5.1	6.7	7.4	8.9
YORK RIVER				
At Point of Rocks	4.8	6.0	6.5	7.9
At Ferry Point	5.1	6.2	6.6	8.2

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS - continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BIG BETHEL RESERVOIR				
Upper Pool	*	*	18.3	*
Lower Pool	*	*	15.4	*

[1]North American Vertical Datum of 1988

*Data Not Available

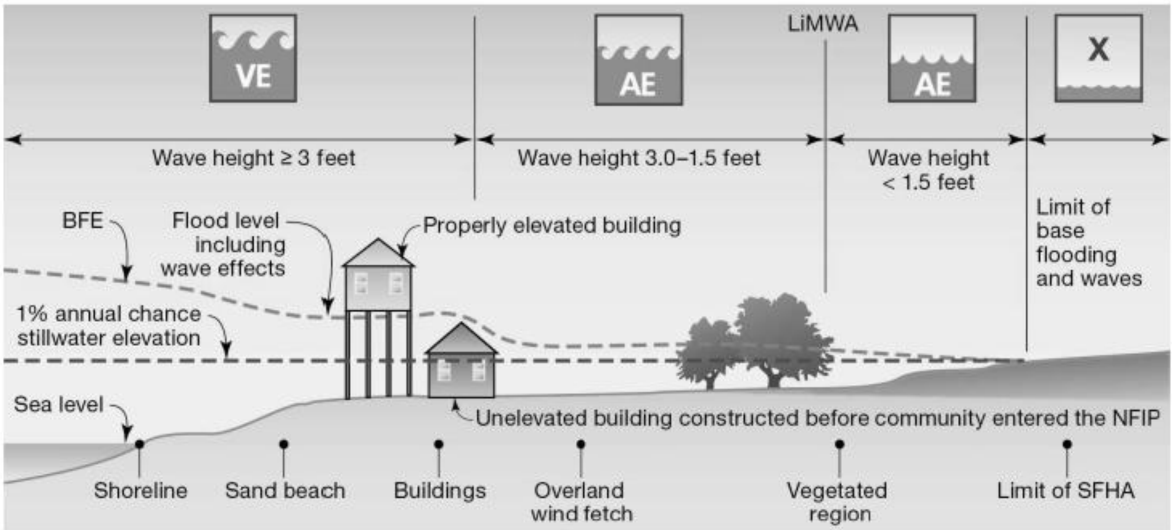
The tidal surge in the Chesapeake Bay affects the entire 230 miles on York County coastline. The coastlines of the Poquoson and York Rivers, are more prone to damaging wave action during high wind events due to the significant fetch over which winds can operate. The widths of several embayments, including Back Creek, Boathouse Creek, Cabin Creek, Chisman Creek, Kings Creek, Lambs Creek, Patricks Creek, Queens Creek, West Branch, and Wormley Creek narrow considerably. In these areas, the fetch over which winds can operate for wave generation is significantly less.

Development along the coastline of York County is sporadic, beginning along the Chesapeake Bay and the western shoreline of the York River, with much of the area occupied by military reservations, industrial and educational facilities. Extensive residential development exists along the Poquoson River and its' estuaries. Undeveloped areas extend along the western shoreline of the York River consisting of military reservations and parkland. Much of the Chesapeake Bay shoreline remains undeveloped. The entire Chesapeake Bay coastline is comprised of a small dune whose elevation varies from four feet to more than nine feet NAVD. Behind the dune, the ground slopes down to largely developed marshland areas.

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 (Reference 14). 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 1, "Transect Schematic".

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 15). 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 still water depth, and the wave crest is 70 percent of the total wave height above the still water 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. And the third major concept is that the wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water.

Figure 1, “Transect Schematic”, is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave crest elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in the county may not include all the situations illustrated in Figure 1.



<u>FIGURE 1 - TRANSECT SCHEMATIC</u>

After analyzing wave heights along each transect, wave crest elevations were interpolated between transects. Various source data were used in the interpolation, including the topographic work maps, notes and photographs taken during field inspections, and engineering judgment. Controlling features affecting the wave crest elevations were identified and considered in relation to their positions at a particular transect and their variation between transects. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo any major changes. The results of this analysis are summarized in Table 2, “Summary of Stillwater Elevations”.

An analysis was performed to establish the frequency peak elevation relationships for coastal flooding in York County. The FEMA, Region III office, initiated a study in 2008 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. The study replaces outdated coastal storm surge stillwater elevations for all FISs in the study area, including York County, VA, and serves as the basis for updated FIRM. Study efforts were initiated in 2008 and concluded in 2012.

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).

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 (Reference 16). ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating Waves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge (Reference 17). The resulting model system is typically referred to as SWAN+ADCIRC (Reference 17). 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 coastal analysis and mapping for York County was conducted for FEMA by Risk Assessment, Mapping, and Planning Partners (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.

Wave heights were computed across transects that were located along coastal and inland bay areas of York County, as illustrated on the FIRMs. The transects were 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, as illustrated in Figure 2, “Transect Location Map.”

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 due is defined as the point where the ground profile changes from relatively steep to relatively mild.

Dune erosion was taken into account along the Chesapeake Bay. A review of the geology and shoreline type in York County 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 (Reference 18). 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.

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

YORK COUNTY, VIRGINIA (ALL JURISDICTIONS)

TRANSECT LOCATION MAP

Wave height calculations used in this study follow the methodologies described in the FEMA guidance for coastal mapping (Reference 18). 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 York County 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 (Reference 19). 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-annual-chance wave runup level be computed for the coastal feature being evaluated (cliff, coastal bluff, dune, or structure) (Reference 18). The 2-percent-annual-chance runup level is the highest 2-percent-annual-chance 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 4.5 to 5.1 feet along the Chesapeake Bay and portions of the Poquoson River, from 4.6 to 4.8 feet along the York River, where the fetch is long to a range of 2.5 to 4.3 feet along portions of the Poquoson River, and 4.3 to 4.5 feet along the York River where the fetch is short. The corresponding wave elevation at the shoreline varies from 9.5 to 10.6 feet NAVD along the Chesapeake Bay and portions of the Poquoson River, from 4.6 to 4.8 NAVD feet along the York River. The dune along the Chesapeake Bay coast serves to reduce wave height transmitted inland, but the large areas of low-lying marshes which are inundated by the tidal surge allow regeneration of the waves as they proceed inland. In general, the relatively shallow depth of water in the marshes along with the energy dissipating effects of vegetation allows only minor regeneration of the waves.

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 undergo major changes. The transect data table, Table 3, "Transect Data," provides the Atlantic Ocean, the Chesapeake Bay, and Back Bay 10-, 2-, 1- and 0.2-percent-annual-chance stillwater elevations and the starting wave conditions for each transect.

TABLE 3 - TRANSECT DATA

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD88)			
		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
York River	1	N 37.36668 W -76.66099	3.7	3.5	5.1	6.2	6.6	8.2
York River	2	N 37.35346 W -76.65755	3.9	3.6	5.1	6.3	6.7	8.3
York River	3	N 37.34626 W -76.65441	3.9	3.6	5.1	6.3	6.7	8.3
York River	4	N 37.34143 W -76.64790	4.1	3.7	5.1	6.3	6.7	8.2
York River	5	N 37.33129 W -76.64220	4.0	3.8	5.1	6.2	6.7	8.2
York River	6	N 37.32360 W -76.63469	4.1	3.9	5.1	6.2	6.7	8.2
York River	7	N 37.31192 W -76.62537	4.1	3.9	5.1	6.2	6.7	8.2
York River	8	N 37.29932 W -76.61278	3.8	3.8	5.0	6.2	6.7	8.2
York River	9	N 37.29326 W -76.60538	4.0	3.8	5.0	6.2	6.7	8.1
York River	10	N 37.28757 W -76.59571	4.1	3.8	5.0	6.2	6.7	8.1
York River	11	N 37.27274 W -76.57937	4.2	3.7	5.0	6.2	6.7	8.1
York River	12	N 37.27038 W -76.56648	4.1	3.7	4.9	6.2	6.7	8.0
York River	13	N 37.26474 W -76.55147	4.0	3.6	4.9	6.1	6.6	7.9

TABLE 3 – TRANSECT DATA - (continued)

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD88)			
		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
York River	14	N 37.25350 W -76.53938	4.1	3.6	4.9	6.1	6.6	8.0
York River	15	N 37.24334 W -76.52619	4.3	3.8	4.9	6.1	6.6	7.9
York River	16	N 37.23712 W -76.50649	5.6	4.9	4.8	6.0	6.6	7.9
York River	17	N 37.22962 W -76.49721	6.2	4.8	4.8	6.0	6.5	7.9
York River	18	N 37.22375 W -76.48737	5.9	4.8	4.8	6.0	6.5	7.9
York River	19	N 37.21989 W -76.47942	5.3	4.6	4.8	6.0	6.5	7.9
York River	20	N 37.21667 W -76.47372	5.0	4.8	4.8	6.0	6.5	7.9
York River	21	N 37.21383 W -76.46960	4.9	4.8	4.7	6.0	6.5	7.9
York River	22	N 37.21671 W -76.46469	4.9	4.9	4.7	6.0	6.5	7.8
York River	23	N 37.21809 W -76.45612	4.8	6.4	4.7	6.0	6.5	7.8
York River	24	N 37.21872 W -76.44729	5.1	4.6	4.7	5.9	6.5	7.8
York River	25	N 37.21890 W -76.43866	5.0	4.6	4.7	5.9	6.4	7.7
York River	26	N 37.22009 W -76.43162	5.1	4.6	4.7	5.9	6.4	7.7
York River	27	N 37.22167 W -76.42630	5.2	4.7	4.6	5.9	6.4	7.7

TABLE 3 – TRANSECT DATA - (continued)

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (feet NAVD88)			
		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
Chesapeake Bay	28	N 37.21809 W -76.42094	3.8	4.2	4.7	5.8	6.5	7.8
Chesapeake Bay	29	N 37.22195 W -76.39241	8.3	5.8	4.6	5.8	6.5	7.6
Chesapeake Bay	30	N 37.20850 W -76.41771	3.8	3.9	4.6	5.9	6.4	7.8
Chesapeake Bay	31	N 37.20672 W -76.40214	4.9	5.5	4.6	5.9	6.4	7.7
Chesapeake Bay	32	N 37.20323 W -76.39923	4.8	6.5	4.6	5.9	6.4	7.6
Chesapeake Bay	33	N 37.19029 W -731939	7.0	6.7	4.6	5.8	6.3	7.6
Chesapeake Bay	34	N 37.18101 W -76.39141	5.3	6.3	4.6	5.9	6.4	7.7
Chesapeake Bay	35	N 37.16922 W -76.40965	3.9	4.4	4.8	6.4	7.0	8.5
Chesapeake Bay	36	N 37.16152 W -76.41266	4.0	4.3	5.0	6.5	7.1	8.6
Chesapeake Bay	37	N 37.15418 W -76.43026	1.5	2.6	5.1	6.7	7.4	8.9
Chesapeake Bay	38	N 37.15187 W -76.42645	2.4	2.8	5.1	6.7	7.4	8.9
Chesapeake Bay	39	N 37.13978 W -76.43072	1.8	2.6	5.1	6.8	7.5	9.1
Chesapeake Bay	40	N 37.13460 W -76.43053	1.7	2.5	5.1	6.8	7.5	9.2
Chesapeake Bay	41	N 37.14865 W -76.41549	3.3	3.5	5.0	6.6	7.3	8.8

Qualifying bench marks (elevation reference marks) within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and 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 movement (e.g., concrete monument below frost line)

- Stability D: Mark of questionable or unknown 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 at (301) 713-3242, (Internet address: 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 FIRMs. Interested individuals may contact FEMA to access this data.

3.2 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the NAVD 88, many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. In order to perform this conversion, effective NGVD elevation values were adjusted downward by 1.046 feet. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities. The conversion equation for all of York County is as follows:

NGVD = NAVD +1.046 ft.

For more information on NAVD 88, see 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 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
(301) 713-3242 http://www.ngs.noaa.gov/

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 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 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 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 flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. In the previous FIS, for flooding sources studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries were delineated using topographic maps at a scale of 1:4,800 with a contour interval of 2 feet (Reference 14).

In this revised FIS, flooding sources studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries, were delineated using 1 foot contours developed from orthophotography flown in March 2005 (Reference 2). The 1- and 0.2- percent-annual-chance floodplain boundaries are shown on the Flood Insurance Rate Map (Exhibit 1). In cases where the 1- and 0.2- percent-annual-chance flood boundaries were close together, only the 1- percent-annual-chance floodplain boundary has been shown.

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 1).

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

Zone AE

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

Zone X (Future Base Flood)

Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use 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.

The current FIRMs present flooding information for the entire geographic area of York County. Historical data relating to the previous maps prepared for the community is presented in Table 4, “Community Map History”.

7.0 OTHER STUDIES

FISs have been prepared for the Cities of Norfolk and Virginia Beach, Virginia (References 20 and 21).

FISs are being updated for the Cities of Portsmouth and Suffolk, Virginia (References 22 and 23).

Being part of the same regional analysis, the results of this study are all in or will be in agreement with the adjacent cities. Information pertaining to revised and unrevised flood hazards for each jurisdiction within York County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS reports, and FIRMs for all of the incorporated and unincorporated jurisdictions within York County, and should be considered authoritative for the purposes of the NFIP

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, FEMA Region III, One Independence Mall, Sixth Floor, 615 Chestnut Street, Philadelphia, Pennsylvania 19106-4404.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
York County (Unincorporated Areas)	November 29, 1974	July 2, 1982	December 16, 1988	

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

YORK COUNTY, VIRGINIA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

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