

FLOOD INSURANCE STUDY

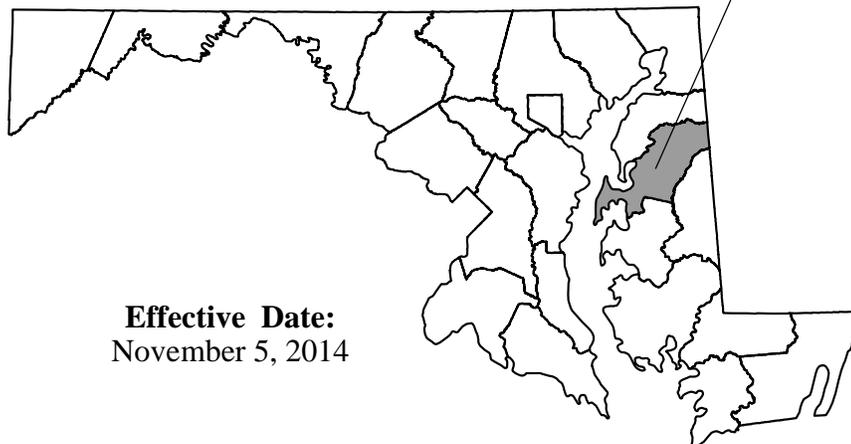


QUEEN ANNE'S COUNTY, MARYLAND AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
*BARCLAY, TOWN OF	240125
CENTREVILLE, TOWN OF	240056
CHURCH HILL, TOWN OF	240057
QUEEN ANNE'S COUNTY (UNINCORPORATED AREAS)	240054
QUEEN ANNE, TOWN OF	240059
QUEENSTOWN, TOWN OF	240120
*SUDLERSVILLE, TOWN OF	240060

Queen Anne's
County

*No Special Flood Hazard Areas Identified



Effective Date:
November 5, 2014



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
24035CV000A

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) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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

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

<u>Old Zone(s)</u>	<u>New Zone</u>
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Initial Countywide FIS Effective Date: November 5, 2014

Revised Countywide FIS Date:

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**FLOOD INSURANCE STUDY
QUEEN ANNE’S COUNTY, MARYLAND AND INCORPORATED AREAS**

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FIS’s / Flood Insurance Rate Maps (FIRMs) in the geographic area of Queen Anne’s County, Maryland, including the Towns of Barclay, Centreville, Church Hill, Queen Anne, Queenstown, and Sudlersville, and the unincorporated areas of Queen Anne’s County (referred to collectively herein as Queen Anne’s County) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS 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 Queen Anne’s County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used 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.

Please note that the Town of Millington is geographically located in Queen Anne’s and Kent Counties. Flood hazard information for the entire Town of Millington is included in the Kent County FIS, and therefore not included in this countywide revision.

Please note that the Town of Queen Anne is geographically located in Queen Anne’s and Talbot Counties. The Town of Queen Anne is included in its entirety in this FIS report.

Please note that the Town of Templeville is geographically located in Caroline and Queen Anne’s Counties. Flood hazard information for the entire Town of Templeville is included in the Caroline County FIS, and therefore not included in this countywide revision.

Please note that on the effective date of this study, the Towns of Barclay and Sudlersville have no special flood hazard areas identified. This does not preclude future determinations of Special Flood Hazard Areas (SFHA) that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

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) shall be able to explain them.

1.2 Authority and Acknowledgments

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

This FIS was prepared to include the unincorporated areas of, and incorporated communities within, Queen Anne's County in a countywide format FIS. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Centreville, Town of	The hydrologic and hydraulic analyses for this study were performed by the State of Maryland Water Resources Administration (the Study Contractor) for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-0274. This study was completed in June 1984.
Queen Anne, Town of	The hydrologic and hydraulic analyses for this study were performed by the State of Maryland Water Resources Administration for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-0274. This study was completed in February 1984.
Queen Anne's County (Unincorporated Areas)	The hydrologic, hydraulic, and wave height analyses for this study were performed by the State of Maryland, Water Resources Administration for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C0274. This study was completed in December 1982.
Queenstown, Town of	The hydrologic and hydraulic analyses for this study were performed by the State of Maryland, Water Resources Administration for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-02 74. This study was completed in January 1983.

There are no previous FISs or FIRMs for the Towns of Barclay and Sudlersville, and no previous FIS for the Town of Church Hill; therefore the previous authority and acknowledgement information for these communities are not included in this FIS.

For this countywide FIS, new hydrologic and hydraulic analyses were performed for portions of Chester River, Cox Creek, Mill Stream Branch, and Tuckahoe Creek. New approximate floodplains were also mapped for Queen Anne’s County and its incorporated areas. The criteria for these floodplains can be found in Section 2.0 of this Flood Insurance Study.

The Digital Flood Insurance Rate Map (DFIRM) production for this study was performed by AMEC Environment & Infrastructure, Inc. for FEMA, under Contract No. HSFE03-07-D-0030; Task Order No. HSFE03-08-J-0010.

Base map information shown on this FIRM was provided in digital format. Streamline files and road centerlines were supplied by Queen Anne’s County Department of Land Use, Growth Management and Environment. Political boundaries were obtained from the Maryland State Highway Administration and Queen Anne’s County. Adjustments were made to specific base map features to align them to 2007 National Agriculture Imagery Program (NAIP) ortho imagery mosaic. 2003-2006 LiDAR data derived from the National Oceanic and Atmospheric Administration (NOAA) were utilized to delineate floodplain boundaries.

The coordinate system used for the production of this FIRM was Universal Transverse Mercator (UTM), Zone 18 North. Horizontal datum was North American Datum of 1983 (NAD 83), GRS 80 spheroid. Differences in the datum, spheroid, projection or UTM 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

An initial Consultation and Coordination Officer's (CCO) meeting is held typically with representatives of Federal Emergency Management Agency (FEMA), the community, and the study contractor to explain the nature and purpose of a FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the pre-countywide initial and final CCO meetings held for the communities within Queen Anne’s County are shown in Table 1, “Initial and Final CCO Dates.”

TABLE 1 – INITIAL AND FINAL CCO DATES

<u>Community Name</u>	<u>Initial CCO Date</u>	<u>Final CCO Date</u>
Centreville, Town of	August 3, 1979	October 15, 1984
Queen Anne, Town of	August 3, 1979	October 15, 1984
Queen Anne’s County (Unincorporated Areas)	August 3, 1979	September 22, 1983
Queenstown, Town of	August 3, 1979	September 22, 1983

For this countywide study, Queen Anne’s County and the Towns of Barclay, Centreville, Church Hill, Queen Anne, Queenstown, and Sudlersville were notified in September 2009 that the FIS would be updated and converted to countywide format.

An initial CCO meeting was held on January 26, 2011 in Town of Centreville, MD, and was attended by representatives of FEMA, RAMPP, Queen Anne’s County, Town of Centreville, AMEC, Maryland Emergency Management Agency; and Maryland Department of Environment (MDE). A Flood Risk Review meeting was also held on September 6, 2012 for the coastal study and was attended by representatives of FEMA, RAMPP, Queen Anne’s County, Town of Centreville, AMEC; and MDE.

A final CCO meeting was held on January 16, 2013 and was attended by representatives of FEMA, the Maryland State NFIP Office, Queen Anne’s County, the Towns of Centreville, Church Hill, and Queenstown, and the study contractor. At these meetings the findings of the study and the potential impact of the study results on the communities were discussed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Queen Anne’s County, Maryland, including the Towns of Barclay, Centreville, Church Hill, Queen Anne, Queenstown, and Sudlersville, and the unincorporated areas of Queen Anne’s County.

All or portions of the flooding sources listed in Table 2 “Flooding Sources Studied by Detailed Methods” were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRMs (Exhibit 2).

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Chesapeake Bay	Queenstown Creek
Chester River	Three Bridges
Cox Creek	Tuckahoe Creek
Eastern Bay	Wye East River
Gravel Run	Wye River
Little Queenstown Creek	Yellow Bank Stream
Mill Stream Branch	

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction.

For this countywide FIS, updated or new analyses were included for the flooding sources shown in Table 3, "Scope of Study."

TABLE 3 - SCOPE OF STUDY

<u>Stream Name</u>	<u>Limits of Revised or New Detailed Study</u>
	<u>Detailed Study Streams</u>
Chester River	From approximately 3.39 miles downstream of US Route 301 to 0.48 mile upstream of Sassafras Street
Cox Creek	From approximately 1.05 miles upstream of Benton Road to just upstream of Grollman Road
Mill Stream Branch	From approximately 0.32 mile downstream of Centerville Road to 0.71 mile upstream of Centerville road
Tuckahoe Creek	From approximately 10.81 miles upstream of Main Street to 2.53 miles upstream of Crouse Mill Road

The tidal portions of the Chesapeake Bay, Chester River, Eastern Bay, Gravel Run, Little Queenstown Creek, Mill Stream Branch, Queenstown Creek, Three Bridges, Tuckahoe Creek, Wye River, Wye East River, and Yellow Bank Stream were studied by detailed methods.

All or portions of the following streams listed in Table 4 "Flooding Sources Studied by Approximate Methods" were studied by approximate methods.

TABLE 4 –FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Andover Branch	Tributary 1 to Long Marsh Ditch
Beaverdam Ditch	Tributary 1 To Reed Creek
Blockston Branch	Tributary 1 To Southeast Creek
Community Lake	Tributary 1 to Tuckahoe Creek
German Branch	Tributary 1 To Wye East River
Mason Branch	Tributary 1 To Wye River
Norwich Creek	Tributary 1A to Tributary 1 to Community Lake
Reed Creek	Tributary 1A to Tributary 1 To Wye River
Sewall Branch	Tributary 1B to Tributary 1 To Wye River
Southeast Creek	Tributary 2 to German Branch
Taylor's Branch	Tributary 2 to Long Marsh Ditch
Tributary 1 to Andover Branch	Tributary 2 to Tuckahoe Creek
Tributary 1 to Community Lake	Unicorn Branch
Tributary 1 to German Branch	

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by FEMA and Queen Anne's County.

Portions of the approximate study areas were found to be inundated by tidal flooding from the Chesapeake Bay. For these areas the detailed tidal surge elevation is shown.

2.2 Community Description

Queen Anne's County is located on the Eastern Shore of Maryland and is bordered to the north by the Chester River and Kent County, to the east by the State of Delaware and Caroline County, to the south by Talbot County and Eastern Bay and to the west by the Chesapeake Bay (Reference 1). The population for Queen Anne's County as determined by the 2000 Census was 40,563, and the 2010 Census was 47,798, an increase of 17.8% (Reference 2). Centreville is the county seat of Queen Anne's County and home of vegetable and seafood canning factories as well as multiple commercial establishments. Local rural industries include agriculture, fishing and service trades.

The vision for the future of Queen Anne's County has remained constant with emphasis on maintaining and enhancing a "predominately rural county with small towns connected by creeks and county roads through fields and forest - a great place to live; a county that encourages agriculture, seafood and maritime industries, tourism and outdoor sports, small business and high tech enterprise - a good place to work; a county that is a faithful steward of its natural and cultural heritage - a good neighbor for the Bay and other Eastern Shore counties; a county in which development by some does not impair the quality of life enjoyed by all - a good community that protects the expectations and opportunities of all its citizens." (Reference 3).

The continental climate of Queen Anne's County is moderated by effects from the Chesapeake Bay and Atlantic Ocean. The highest temperature recorded in Sudlersville was 105 degrees Fahrenheit (°F.) and occurred in July 1911. The lowest temperature of -12 degrees °F. was recorded in February 1918. The maximum rainfall record of 6.6 inches occurred in Stevensville on August 12, 1928 (Reference 1). The average annual rainfall is 43.4 inches. The yearly snowfall is 18.3 inches. The average summer temperature is 74.5°F, and the average winter temperature is 36.7° F. The duration of the freeze-free period is 188 days (Reference 4).

The underlying unconsolidated sediments slope gently toward the southeast at approximately 10 to 95 feet per mile. These unconsolidated deposits were the result of the deposition of sediment from meltwater of the continental glaciers and the terracing effect of several sea level oscillations. Beneath the coastal plain sediments lie older Paleozoic crystalline rocks at an average depth of 2,500 feet. Abundant groundwater is available throughout Queen Anne's County, with the water table depth generally less than 25 feet.

Major drainage basins in the county provide drainage directly into the Chesapeake Bay. The northwestern portion of the county drains into the Chester River which flows west to the Chesapeake Bay. The eastern portion of the county drains into Tuckahoe Creek, a major tributary of the Choptank River. The southwestern portion of the county drains into the Wye River and Eastern Bay.

The highest elevation in Queen Anne's County is 87 feet, which is located near the Town of Starr, in the northeastern part of the county (Reference 5).

Flood plain development in Queen Anne's County is primarily single family residential homes. Some marinas, restaurants and seafood processing plants are present on Kent Narrows and other local wharfs scattered throughout the county.

The Town of Barclay is a small crossroads community in agricultural northern Queen Anne's County at the intersection of Maryland Routes 313 and 302. The town is comprised mostly of single family houses sheltering approximately 150 people. It has several family-owned businesses, the largest of which is Delmarva Sash and Door Co., Inc., which was founded in October 1942 and employs approximately 125 people. Other businesses include a retail tire outlet, a lawn and garden equipment repair shop, a burial vault company, an automotive body shop, and a grocery/deli store (Reference 6). The population for the Town of Barclay as determined by the 2010 Census was 143 (Reference 2).

The Town of Centreville is located on the Eastern Shore of Maryland and is bordered by the unincorporated areas of Queen Anne's County (Reference 1). The population for the Town of Centreville as determined by the 2010 Census was 4,285 (Reference 2), which is an increase of 117.5% over the 2000 Census population of 1,970. Centreville, which is the county seat, is a designated "growth sub-area" in accordance with the County's Comprehensive Plan and also meets the criteria for accommodating additional growth under the Maryland Economic Development, Resource Protection and Planning Act of 1992 and Maryland "Smart Growth" legislation. The Town has recently upgraded its wastewater plant and is in the process of considering additional upgrades to the wastewater plant as well as the water system. These factors all indicate that growth management planning for Centreville and the surrounding area should be based on population projections that are consistent with the Town's designated and accepted role as a growth center with reasonable expectations that adequate development infrastructure will ultimately be in place (Reference 7).

Flood plain development in the Town of Centreville is primarily single family residential homes and commercial structures.

Runoff from the Town of Centreville flows into the Corsica River which in turn flows into the Chester River.

The highest elevation in the Town of Centreville is 63 feet (Reference 2).

The Town of Church Hill is a quaint little town dating back to colonial days. Nestled in beautiful farming countryside, it has been a quiet, friendly place

throughout the years. Probably, it was named for the historic St. Luke's Episcopal Church (c. 1732), which sits atop a hill overlooking the center of town (Reference 6). The population for the Town of Church Hill as determined by the 2010 Census was 745 (Reference 2).

The Town of Queen Anne is located on the Eastern Shore of Maryland and is bordered to the east by Tuckahoe Creek, to the north by the unincorporated areas of Queen Anne's County, and to the south and west by Talbot County (Reference 1). The population for the Town of Queen Anne as determined by the 2010 Census was 222 (Reference 2).

The highest elevation in the Town of Queen Anne is 40 feet (Reference 2).

The Town of Queen Anne drains into Tuckahoe Creek which flows into the Choptank River.

Flood plain development in the Town of Queen Anne consists of industrial and commercial structures as well as single family residential homes.

The Town of Queenstown is located on the Eastern Shore of Maryland and is bordered to the north and west by Queenstown Creek and Little Queenstown Creek to the east and south by the unincorporated areas of Queen Anne's County (Reference 1). The population for the Town of Queenstown as determined by the 2010 Census was 664 (Reference 2).

The Town of Queenstown drains into the Queenstown Creek and Little Queenstown Creek which flows west to the Chester River.

The highest elevation in the Town of Queenstown is 20 feet (Reference 2).

Flood plain development in the Town of Queenstown is primarily single family residential homes.

The Town of Sudlersville, through the years, has been, and is, a farming community. In the 19th century, its crops consisted mainly of corn, tan bark (mulch) and tobacco. Tobacco was a source of money for the early settlers. Farmers were given certificates for their tobacco crop and those certificates were used as money. Today, the crops are mainly corn and soy beans (Reference 8). The population for the Town of Sudlersville as determined by the 2010 Census was 497 (Reference 2).

2.3 Principal Flood Problems

The low lying, relatively undisturbed topography, high seasonal water tables, poor drainage and high runoff characteristics of the soils combine to provide a high flooding potential. When heavy rainfall and a high river discharge combine with storm tides, low lying areas adjacent to rivers and estuaries become inundated with saltwater. Major floods in the Queen Anne's County area have

occurred in 1933, 1954, 1955, 1960, 1972, 1999, 2003, 2008 and 2011. Few detailed records of historical flood damage are available.

In August 1933, the "Great Storm of 1933" lashed the Eastern Shore of Maryland. Many trees and limbs were downed as a result of high winds. Flooding occurred, but no specific reports were available (Reference 9).

In late October 1954, Hurricane Hazel caused extensive damage to Queen Anne's County. Damage estimates were placed at approximately \$500,000. One hundred people were evacuated from Kent Narrows as a result of high storm tides. The storm tides in the Towns of Centreville and Queenstown were reported as the highest in history.

The storm tide flooded the office of Valiants Fertilizer in Centreville. Two 18,000-gallon, empty oil tanks were overturned at the Thocar Oil Company by the high tide. Many boats were washed ashore by the high winds and tide (Reference 10).

During August 1955, Hurricane Connie struck Queen Anne's County. Advance warning made it possible for residents to prepare their property against high water, drastically reducing property damages in comparison with Hurricane Hazel (Reference 10).

In mid-September 1960, Hurricane Donna brought heavy rainfall which was responsible for extensive road washouts and flooding in the Towns of Centreville, Queen Anne, and Queenstown. The major road closings in the vicinity were: Route 213 just south of Church Hill, Route 305 at Tanyard Branch, Route 544 near Crumpton at Red Lion Branch, Route 213 over Mill Stream Branch in the Town of Centreville and Route 213 over Island Creek, north of Centreville, when a 31-foot crack in the concrete bridge occurred (Reference 10).

Tropical Storm Agnes lashed the Chesapeake Bay region in late June 1972. The northern part of Queen Anne's County and the Towns of Centreville, Queen Anne, and Queenstown were the areas most affected by the storm. High water in the vicinity of Centreville, Queen Anne, and Queenstown closed roads on: Route 213 north of Church Hill, Route 19 between Church Hill and Route 301, Route 300 between Church Hill and Sudlersville and the Route 313 Bridge at the Town of Millington (Reference 10).

The high levels of freshwater and high coliform concentrations in the Bay forced state officials to place a ban on the harvesting of shellfish. This caused a severe economic hardship for Queen Anne's County watermen (Reference 10).

On August 3-5, 1967, locally heavy thunderstorms passed through Queen Anne's County and the Town of Queen Anne, resulting in moderate flooding. The greatest amount of rain recorded from those storms was 9.15 inches in 6 hours at nearby Goldsboro (Reference 11). Water was reportedly one foot deep in the main office of K.M.C. Foods in the Town of Queen Anne (Reference 12).

Alternate Route 404 at the Town of Queen Anne was completely washed away leaving a gap 12 feet deep and 75 feet wide (Reference 10).

Hurricane Floyd battered the Maryland Eastern Shore on September 16, 1999 and brought with it torrential rains and damaging winds. The hurricane caused widespread flash flooding as storm totals averaged around ten inches, most of which fell in a twelve hour period from the early morning through the afternoon on the 16th. The torrential downpours associated with Hurricane Floyd exceeded the 1-percent annual chance flood return period for most of the Eastern Shore. Hundreds of roads and bridges were closed. Hardest hit were homes in Sandfield just outside of Millington (Queen Anne's County). The only railroad service into Queen Anne's County was suspended after flooding along the Charles River crippled the railroad's trestles. There were voluntary evacuations in low-lying areas and also in some mobile home parks. Many roads were also closed on Miller's Island. Queen Anne's County was one of the harder hit counties on the Eastern Shore by Floyd. Water rescues started at 10 a.m. EDT and continued all day. About 75 persons were evacuated to shelters. Fifty-five roads were closed during the height of the storm including major roadways such as U.S. Route 50 and Maryland State Routes 213, 291, 300, 304 and 313. Two 29-year-old men were injured when their pickup truck fell into a 30 foot by 30 foot hole on MD 304 near Centreville. Thirty-four roads were closed by either heavy flooding or minor to moderate damage. Twenty bridges or culverts were washed out or had substantial damage. All roads that were not badly damaged were reopened Saturday afternoon the 18th. All county roads were reopened by the 21st although eight bridges and three state roads were still closed. The number of bridge closings was down to six on October 2nd. In addition, fallen trees blocked about 70 roads throughout the county. Most of the damage occurred in the northern half of the county. The worst flood related property damage occurred on the Queen Anne's side of Millington along the Chester River. Forty homes were damaged, 15 of them in Sandtown had six foot high water marks on the first floor. Ten homes and several businesses along the Tuckahoe Creek in Queen Anne were badly flooded. Some persons were still displaced on October 9th. Other townships that also were hit hard by flooding were Centreville, Church Hall and Sudlersville (The downtown area became an island.) Another effect of Floyd was a boom in the mosquito population throughout the Middle Atlantic States (Reference 13).

On September 18, 2003, Tropical Storm Isabel caused a record breaking tide and storm surge up the Chesapeake Bay, heavy rain and strong power outage producing winds. In Queen Anne's County, public and private damage was estimated at 37 million dollars. Thirty-seven homes were destroyed, 151 suffered major damage and 192 suffered minor damage. Most of the damage was caused by the tidal flooding, although four homes were damaged by fallen trees. The heavy rain did not coincide with the tidal flooding and occurred mainly from the afternoon of the 18th into the early morning of the 19th. There were no reports of stream related flooding due to the heavy rain. Because the heaviest rain with tropical systems often falls west of its storm track, the region was spared heavier rain. On the other hand, the strongest winds are often on the right side of the storm track. Winds gusted up to 58 mph in the bay and caused numerous trees,

tree limbs and power lines to be knocked down. Storm totals included 2.14 inches in Stevensville (Queen Anne's County) (Reference 13).

On October 7-8, 2005, the combination of a very slow moving cold front and copious moisture from the remnants of Tropical Storm Tammy produced very heavy rain across the Maryland Eastern Shore. This heavy rain helped propel the state of Maryland to its second wettest October on record since 1895. The monthly statewide average precipitation total of 7.97 inches was 4.59 inches wetter than normal and only 1976 (8.05 inches) was wetter. The slow movement and stalling coupled with an unstable air mass and tropical moisture associated with Tammy helped enhance the torrential downpours. The flooding would have been even worse if not for the unseasonably dry weather that preceded this event from the middle of August (Reference 13).

On September 1, 2006, the combination of the remnants of Tropical Storm Ernesto and a large high pressure system over eastern Canada produced heavy rain and strong winds along the Maryland Eastern Shore. Rain moved into the area during the morning of the 1st and did not exit until around noon EDT on the 2nd. The heaviest rain took a long time to move north. In addition to the heavy rain, persistent east to northeast winds caused tree damage as the heavy rain loosened the root support and weighed down limbs. Strong winds started during the late morning on the 1st, peaked during the evening of the 1st and around midnight EDT on the 2nd and subsided before sunrise on the 2nd. Delmarva Power reported about 21,350 of its customers lost power on the 1st and 2nd. Actual storm totals included 2.50 inches in Stevensville (Queen Anne's County). The low pressure system that was Ernesto moved slowly north. Of greater importance, was a strong high pressure system (greater than 1032 millibars) that remained over southeastern Canada and maintained the pressure gradient (difference) between it and the remnant low of Ernesto (Reference 13).

On September 6, 2008, Tropical Storm Hanna brought heavy rain, strong winds and some tidal flooding to the Eastern Shore during the day and into the evening of the 6th. Rain moved into the region during the morning, fell heavy at times from the late morning into the afternoon and ended during the evening. The eastbound lanes of the William Preston Lane Junior Memorial Bridge (Queen Anne's County) were closed during the morning of the 6th. It was reopened during the afternoon, but driving restrictions remained in place in both directions into the evening. The persistent strong winds knocked down several weak trees and limbs. This caused scattered power outages and a few road closures. Peak wind gusts included 49 mph in Stevensville (Queen Anne's County). Precipitation totals included 1.80 inches in Church Hill (Queen Anne's County) (Reference 13).

Coastal flooding occurred on January 25, 2010 in Queen Anne's County. The strong south winds up Chesapeake Bay also caused tidal flooding during the afternoon of the 25th in Queen Anne's County. The afternoon high tide caused flooding in the Kent Narrows area of Queen Anne's County. Flooding occurred along Maryland State Route 18 and Wharf Road in Chester. At high tide both directions of Maryland State Route 18 near Dundee Avenue was closed. The

same roadway was also closed near Love Point. The strong southerly flow and rain ended after its cold front moved through the Eastern Shore during the early afternoon (Reference 13).

During August 27 through August 28, 2011, Hurricane Irene produced heavy flooding rain, tropical storm force wind gusts and caused one wind related death across the Eastern Shore. Preliminary damage estimates were around three million dollars and approximately 85,000 homes and businesses lost power. Tropical storm force wind gusts overspread the Eastern Shore during the afternoon and early evening of the 27th and persisted into the afternoon of the 28th. Peak wind gusts averaged 50 to 60 mph. Event precipitation totals averaged 6 to 12 inches and caused widespread field and roadway flooding. Because the flash flooding and flooding blended into one, all flooding related county entries were combined into one under flood events. On August 25, Maryland Governor Martin O'Malley declared a state of emergency in preparation for Irene. In Queen Anne's County, in Queenstown, an 88-year-old woman was killed when a tree fell on a chimney, sending bricks through the glass roof of a sun room where she had taken refuge since it had emergency power. Some tomato, corn, and cantaloupe crops were destroyed (Reference 13).

Hurricane Sandy, unofficially known as Superstorm Sandy, made landfall near Brigantine, New Jersey on October 29, 2012. It brought heavy rainfall and high speed of wind to Queen Anne's County, forcing officials to close Chesapeake Bay Bridge over the Chesapeake Bay and the Millard E. Tydings Memorial Bridge and Thomas J. Hatem Memorial Bridge over the Susquehanna River in the midday hours. The county was declared a Disaster Area in November of 2012 but no severe damage was reported.

2.4 Flood Protection Measures

The State of Maryland, Department of Natural Resources has established rules and regulations governing construction on nontidal waters and flood plains. It restricts development in, obstructions to, and encroachment on the 1-percent annual chance flood plain.

Queen Anne's County has two ordinances which pertain to flood protection. Section 14:3-33 of the Environmental Protection Regulations states that a watercourse with floodplain, a minimum one-hundred-foot flood protection setback shall be maintained from the edge of the banks of the watercourse, except where the setback may extend beyond the floodplain; for a watercourse without a floodplain, a minimum fifty-foot flood protection setback shall be maintained from the top of the bank. Section 18:1-64 of the Zoning and Subdivision Regulations states that no development activities are permitted on tidal or nontidal wetlands, or within 25 feet of a nontidal wetland, or within 100 feet of a tidal wetland or body of water unless approved by the USACE or the Maryland Department of Natural Resources (DNR) or the Maryland Department of the Environment (MDE). Wetlands of state concern as identified by DNR or MDE must have a one-hundred-foot buffer (Reference 14).

No flood protection structures have been constructed in the county; however, some small ponds may provide limited flood protection. Ditching along roadways is a continuous project which helps improve runoff conditions (Reference 15).

Section 5-503 of the Environment Article of the State of Maryland code states that wherever private activity changes in any manner, "the course, current, and cross section of any stream or body of water", within state waters, a permit is required. State waters are defined to include the flood plain of free flowing waters determined by the Department of Natural Resources on the basis of the 1-percent annual chance flood. Regulations of the Department of Health and Mental Hygiene require that proper drainage and flood considerations be incorporated into land development activities. Activities of the Department of Planning relate primarily to overseeing land-use activities statewide and offering advice and assistance so that land-use changes which create a potentially serious flooding situation are avoided.

In managing construction sites, care should be taken to avoid depositing excess sediment downstream of the embankment, adjacent to a stream or floodplain. Obstruction of stream channels and navigable rivers by sediment deposits reduces hydraulic capacity and increases flooding.

Standards for erosion and sediment control during construction activities and management of stormwater runoff quality and quantity are found in regulations administered by the Maryland Department of the Environment (MDE) under Title 26, subtitle 17, Chapter 1 of the Code of Maryland Regulations (COMAR). New regulations were published in the Maryland Register, Volume 39, Issue 2, on January 27, 2012. Changes include establishing a maximum 20-acre grading area for most construction sites in order to limit large earth disturbances that are more likely to cause sediment pollution; improving stabilization requirements to assist in reducing erosion and sediment generation and help establish grass in non-work areas; and requiring each county and municipality to submit a draft erosion and sediment control ordinance to MDE for review and final adoption within one year of the regulations' adopted date. These standards provide for local soil and shore erosion control programs which are related to flood management (Reference 16).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail 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 which 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-, 2-, 1-, and 0.2-percent annual chance 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

which equals or exceeds the 1-percent annual chance flood in any 50-year period is approximately 40 percent (4 in 10), and, 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 county.

All streams studied by detailed methods received updated hydrologic and hydraulic data as part of this revision. The new hydrologic analysis calculated revised 10-, 2-, 1- and 0.2-percent annual chance flows. For this FIS update, flows were also established for streams studied using approximate methods. Updated coastal flood hazard analyses were performed by U.S. Army Corps of Engineers and Risk Assessment, Mapping, and Planning Partners (RAMPP) and are described in Section 3.3, "Coastal Analysis."

The Maryland Department of Environment contracted Dr. Glenn Moglen of the Department of Civil and Environmental Engineering at the University of Maryland to perform the updated hydrologic calculations for this FIS (Reference 17).

The current regional regression equations being used by the Maryland State Highway Administration were developed by Jonathan Dillow, a hydrologist for the USGS. Dillow defined regression equations for five hydrologic fixed regions: Appalachian Plateau and Allegheny Ridges, Blue Ridge and Great Valley, Piedmont, Western Coastal Plain and Eastern Coastal Plain (Reference 18).

Dr. Moglen developed a new set of regression equations, called the fixed region regression equations, for the State of Maryland. The fixed region method used in his study is based on the predefined regions of Dillow since these regions are based on physiographic regions. Queen Anne's County is located within the Eastern Coastal Plain region.

The fixed region regression equations for the Eastern Coastal Plain Region are based on 28 stations in Maryland and Delaware with drainage area (DA) ranging from 0.91 to 113.70 square miles, percent A soils (S_A) ranging from 0.0 to 78.8 percent, and land slope (LSLOPE) ranging from 0.00250 to 0.0160 ft/ft. All variables are statistically significant at the 5-percent level of significance except LSOPE for flood discharges less than the 5-year event but LSLOPE is included in the regression equations for consistency. Equations applicable to this report, along with their standard error of estimate in percent, and equivalent years of record are listed in Table 5, "Eastern Coastal Plain Fixed Regional Regression Equations" (Reference 19).

TABLE 5 – EASTERN COASTAL PLAIN FIXED REGIONAL REGRESSION EQUATIONS

Eastern Coastal Plain	Standard Error (percent)	Equivalent Years of Record
$Q_{10} = 924.3 \text{ DA}^{0.844} (S_A + 1)^{-0.196} \text{ LSLOPE}^{0.445}$	36.7	9.7
$Q_{50} = 2941.5 \text{ DA}^{0.824} (S_A + 1)^{-0.222} \text{ LSLOPE}^{0.531}$	41.6	15
$Q_{100} = 4432.9 \text{ DA}^{0.812} (S_A + 1)^{-0.230} \text{ LSLOPE}^{0.557}$	44.2	17
$Q_{500} = 10587 \text{ DA}^{0.783} (S_A + 1)^{-0.247} \text{ LSLOPE}^{0.610}$	51.6	19

All calculations using the fixed region regression equations were performed with GISHydro2000. GISHydro is a computer program used to assemble and evaluate hydrologic models for watershed analysis. Originally developed in the mid-1980s, the program combines a database of terrain, land use, and soils data with specialized GIS tools for assembling data and extracting model parameters. The primary purpose of the GISHydro program is to assist engineers in performing watershed analyses in the State of Maryland. In the fall of 1997, a collaborative project between the Department of Civil and Environmental Engineering at the University of Maryland and the Maryland State Highway Administration updated and enhanced GISHydro into GISHydro2000. GISHydro2000 runs on ArcView 3, software no longer supported by its developer ESRI. The move of GISHydro to the ArcGIS platform is ongoing and will result in the GISHydroNXT application.

It should also be emphasized that these regression equations, although not developed by the USGS, provide better standard error performance than the current USGS regression equations for Maryland. These equations were endorsed for use in Maryland by the Maryland Hydrology Panel as documented in their report which can be obtained from the Maryland State Highway Administration (Reference 19).

A summary of the peak discharge-drainage area relationships for the selected recurrence intervals for the streams studied by detailed methods is shown in Table 6, "Summary of Discharges."

TABLE 6 - SUMMARY OF DISCHARGES

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (sq. miles)</u>	PEAK DISCHARGES (cubic feet per second)			
		<u>10-Percent- Annual- Chance</u>	<u>2-Percent- Annual- Chance</u>	<u>1-Percent- Annual- Chance</u>	<u>0.2-Percent- Annual- Chance</u>
CHESTER RIVER					
Approximately 145 feet downstream of confluence of Unicorn Branch	118.44	5,430	10,302	12,904	20,666
Approximately 977 feet upstream of Unicorn Branch	97.58	4,614	8,795	11,045	17,796
Approximately 1,345 feet downstream of Blue Star Memorial Highway Route 301SB	86.60	4,089	7,788	9,784	15,789
Approximately 855 feet upstream of Railroad	84.47	4,096	7,825	9,841	15,918
COX CREEK					
Downstream Study Limits	*	1,557	*	2,471	*
Proposed Crossing (Section 6)	*	1,179	*	1,876	*
Benton Road (Section 41.3)	*	933	*	1,497	*
Ackerman Bridge (Section 49.3)	*	705	*	1,137	*
Stream Junction (Section 64)	*	380	*	613	*
MILL STREAM BRANCH					
Approximately 158 feet downstream of Route 213 Bridge	11.74	873	1,751	2,261	3,899
TUCKAHOE CREEK					
Main Street Bridge Alternate SR 404	99.57	4,279	7,750	9,607	15,199
Approximately 450 feet downstream of Queen Anne Highway SR 404	99.46	4,273	7,739	9,592	15,174

*Data not available

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table 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.

During periods of peak flow, flood elevations in the vicinity of bridges and culverts are often increased by ice jams, debris blockage, and other obstructions to flow. The hydraulic analyses for this study, however, are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, and dams and other flood control structures operate properly and do not fail.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. 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).

This FIS is a restudy of all flood hazards identified on the effective FIRM.

Streams studied by detailed methods on the effective FIRM were to be restudied in detail while approximate effective streams were to be improved through enhanced approximate studies. For all of the studies with the exception of Cox Creek, AMEC used the stream crossing inventory collected by the Maryland Department of the Environment (MDE) and the topographic data developed from LiDAR data for Queen Anne's County to perform the hydraulic analyses. For detailed studies, AMEC also extracted channel data from the effective hydraulic models and incorporated it where appropriate. The hydraulic analyses were used to establish flood elevations and regulatory floodways for the subject flooding sources.

Detailed hydraulic models include water-surface profile development for the 10-percent (10-year), 2-percent (50-year), 1-percent (100-year) and 0.2-percent (500-year) annual chance floods and floodway. Enhanced approximate models include only the 1-percent annual chance flood and do not include flood profile or floodway development.

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USACE's HEC-RAS (Version 4.0) step-backwater computer program (Reference 20).

The 2003 and 2006 LiDAR points provided by NOAA were used to develop Digital Elevation Model (DEM) that served as the terrain basis for detailed and approximate riverine model data extractions. HEC-RAS (version 4.0) models were created using AMEC-developed automated tools. For each stream a geodatabase containing the stream centerline, bank stations, flow path locations, and cross sections is created and the data is imported into a HEC-RAS model. There is a single model for each defined reach.

The stream centerlines provided by the county were ortho-rectified and aligned with the contours where orthophotos were inconclusive. Cross-sections were placed within ArcGIS at hydraulically significant locations.

The DEM was used to import the cross section data into HEC-RAS model. For streams studied in detail the channel data was extracted from effective HEC-2 or WSP-2 models and incorporated into the updated hydraulic models, where appropriate. All hydraulic structures were computed using MDE inventory information, aeriels and topography to obtain elevation data and structural geometry. For this study, the computed water-surface elevations were converted from the National Geodetic Vertical Datum of 1929 (NGDV 29) to the North American Vertical Datum of 1988 (NAVD 88).

Stream crossings inventoried by MDE were incorporated in HEC-RAS models for detailed and enhanced approximate studies. Since the provided bridge data were not vertically referenced, structures were coded relative to road surface extracted from the terrain data. Inaccessible structures were modeled using data from effective HEC-2 models; otherwise, assumptions were made for structure geometry based on the available data and engineering judgment. The internal Manning’s ‘n’ values for stream crossings were adjusted based on the MDE inventory photos.

Channel and overbank roughness factors (Manning’s “n” Values) were assigned to each cross section using HEC-RAS Reference Manual Table 3-1 (Reference 20). The aerial photographs and pictures taken by MDE during structure inventory were used to estimate the roughness coefficients. Table 7, "Manning's "n" Values," shows the channel and overbank “n” values for the streams studied by detailed methods.

TABLE 7 – MANNING’S “n” VALUES

<u>Stream</u>	<u>Channel "n"</u>	<u>Overbank "n"</u>
Chester River	0.045	0.05 - 0.1
Mill Stream Branch	0.03 - 0.05	0.012 - 0.1
Tuckahoe Creek	0.032	0.05 - 0.1

Floodways were developed for streams studied by detailed methods. Initially, Encroachment Method 4 was used to obtain equal conveyance reduction on each overbank, if possible. The results were imported into Method 1 and adjusted accordingly to maintain allowable surcharges throughout the study reach.

AMEC developed enhanced approximate floodplain models using their Automated Floodplain Generator (AFG) proprietary software along with ArcGIS v.9.3. Stream crossing information was included in these approximate models. Despite enhancements to the typical approximate analysis, these models should not be utilized to support the mapping of Base Flood Elevations.

All qualifying benchmarks within a given jurisdiction that are catalogued 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.

Benchmarks catalogued 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 (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation (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 benchmarks, 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 benchmarks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at 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 the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

3.3 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 7, “Summary of Coastal 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.

An analysis was performed to establish the frequency peak elevation relationships for coastal flooding in Queen Anne’s 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, Chesapeake Bay including its tributaries, and the Delaware Bay. This study replaces outdated coastal storm surge stillwater elevations for all FIS Reports in the study area, including Queen Anne’s County, MD, and serves as the basis for updated FIRMs. Study efforts were initiated in 2008 and concluded in 2012.

This 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 21). 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 22). The resulting model system is typically referred to as SWAN+ADCIRC (Reference 22). 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 assessed by quantitative comparison of model output to wind, wave, water level and high water mark observations.

The tidal surge affects the entire coastline of Chesapeake Bay and Eastern Bay including Crab Alley Bay, Prospect Bay, Wye River, and Wye East River and approximately 41 miles along Chester River from its mouth to Crumpton, MD in

Queen Anne’s County. The coastline of the Chesapeake Bay and Eastern Bay is more prone to damaging wave action during high wind events due to the significant fetch over which winds can operate. From the Chester River mouth further upstream, the fetch considerably shortens to be within the river channel.

The storm-surge elevations for the 10-, 2-, 1-, and 0.2-percent annual chance floods were determined for The Chesapeake Bay and the Chester River and are shown in Table 8, “Summary of Coastal Stillwater Elevations.” The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects.

TABLE 8 - SUMMARY OF COASTAL STILLWATER ELEVATIONS

<u>FLOODING SOURCE AND LOCATION</u>	<u>ELEVATION (feet NAVD)*</u>			
	<u>10-Percent- Annual-Chance</u>	<u>2-Percent- Annual-Chance</u>	<u>1-Percent- Annual-Chance</u>	<u>0.2-Percent- Annual-Chance</u>
CHESTER RIVER				
From Crumpton to Kingstown	3.0-4.7	5.3-5.6	6.0-6.6	7.0-8.5
From Kigstown to the mouth of the Corsica River	4.2-4.7	4.9-5.6	5.1-6.0	6.2-7.1
From the mouth of the Corsica River to Kent Narrows	3.8-4.2	4.4-4.9	4.6-5.1	5.5-6.2
CHESAPEAKE BAY				
From Kent Narrows to William Preston Lane, Jr. Memorial Bridge	3.7-3.9	4.2-4.5	4.4-4.7	5.4-5.7
From William Preston Lane, Jr. Memorial Bridge to the mouth of the Eastern Bay	3.5-3.7	4.0-4.2	4.3-4.4	5.1-5.4
CRAB ALLEY				
Entire shoreline	3.7-3.9	4.2-4.4	4.4-4.6	5.6-6.0
EASTERN BAY				
From the mouth to the mouth of Crab Alley Bay	3.5-3.9	4.1-4.2	4.4-4.6	5.6-6.0
From the mouth of Prospect Bay to Bennett Point	3.7-3.8	4.2-4.3	4.4-4.5	5.4-5.8
PROSPECT BAY				
Entire shoreline	3.8-3.9	4.3-4.5	4.5-4.8	5.5-6.4

*North American Vertical Datum of 1988

TABLE 8 - SUMMARY OF COASTAL STILLWATER ELEVATIONS- continued

<u>FLOODING SOURCE AND LOCATION</u>	<u>ELEVATION (feet NAVD)*</u>			
	<u>10-Percent- Annual-Chance</u>	<u>2-Percent- Annual-Chance</u>	<u>1-Percent- Annual-Chance</u>	<u>0.2-Percent- Annual-Chance</u>
WYE RIVER				
From the mouth to the confluence with Wye East River	3.6-3.8	4.2-4.5	4.4-4.8	5.4-6.1
WYE EAST RIVER				
From the mouth	3.8-4.0	4.5-4.6	4.8-4.9	6.1-6.5

*North American Vertical Datum of 1988

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (NAS) (Reference 23). This method is based on three major concepts. First, depth-limited waves in shallow water reach maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in the 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. This added energy is related to fetch length and depth.

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 coastally influenced riverine and inland bay areas of Queen Anne's 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.

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%

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.

Bluff erosion was taken into account along the Chesapeake Bay coastline and areas along the Eastern Bay where the fetch lengths are larger than 5 miles. A standard of 175 ft² eroded area has been applied to erodible bluffs after calibration to historical data. 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 (Reference 24). 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 Queen Anne's 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 25). 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% wave runup level be computed for the coastal feature being evaluated (cliff, coastal bluff, dune, or structure) (Reference 24). The 2% 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 0.43 feet along Chester River near Crumpton, MD where the fetch is short to 8.02 feet at the western shore of Eastern Bay where the fetch is longer. The corresponding wave elevation at the shoreline varies from 5.20 feet NAVD 88 at the coastline of Chester, MD to 7.56 feet NAVD 88 along Chester River.

Figure 1, “Transect Location Map,” illustrates the location of each transect. Along each transect, wave envelopes were computed considering the combined effects of changes in ground elevation, vegetation and physical features. 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. The transect descriptions for the county are presented in Table 9, “Transect Data,” which describes the location of each transect. In addition, Table 9 provides the 1-percent annual chance stillwater with wave setup and the maximum wave crest elevations for each transect along coastline. In Table 9, “Transect Data,” the flood hazard zone and base flood elevations for each transect flooding source is provided, along with the 10-, 2-, 1-, and 0.2-percent annual chance stillwater elevations for the respective flooding source.

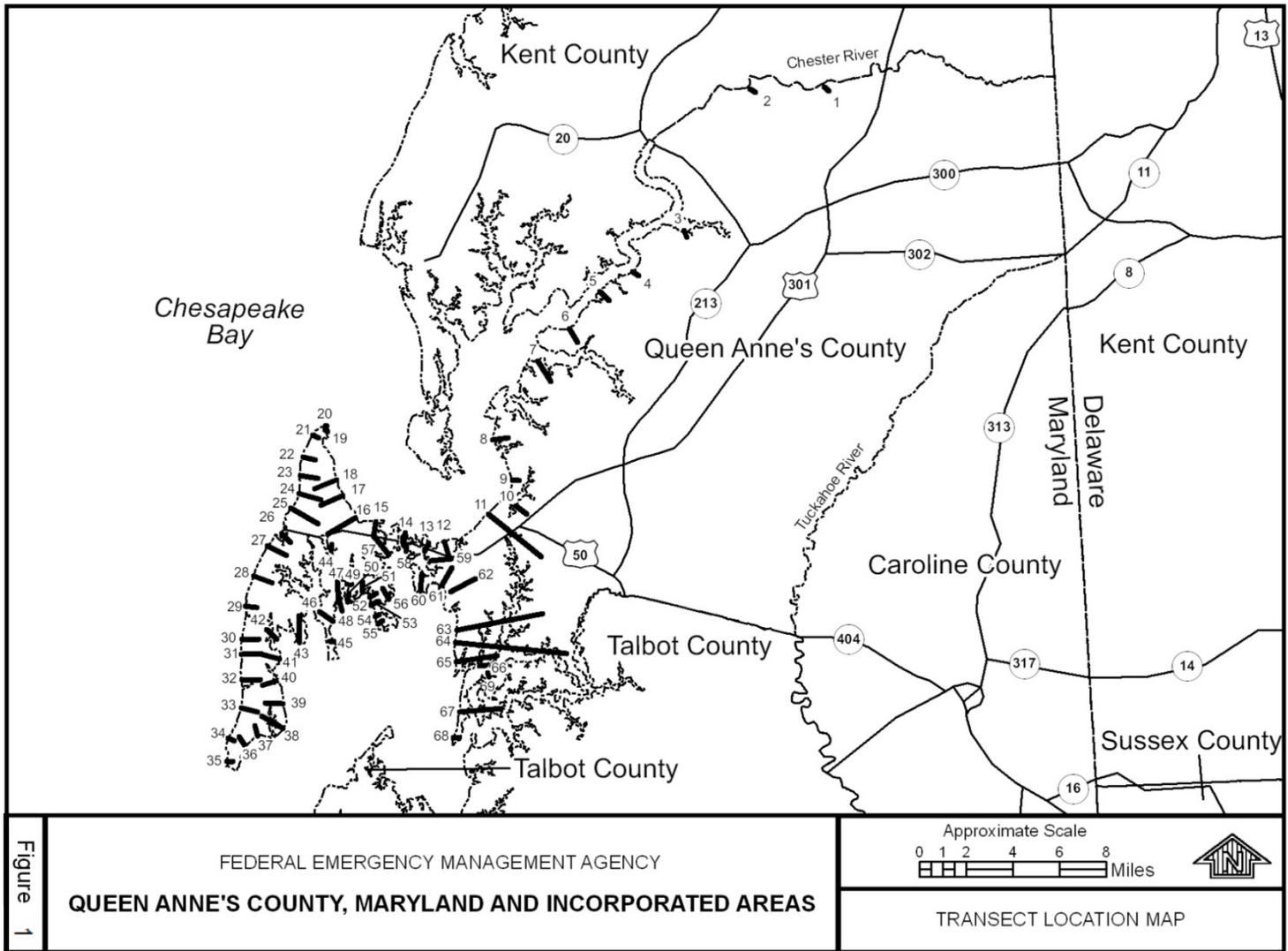


TABLE 9 - TRANSECT DATA

<u>Flood Source</u>	<u>Transect</u>	<u>Starting Wave Conditions for the 1% Annual Chance</u>			<u>Starting Stillwater Elevations (ft NAVD88)</u> Range of Stillwater Elevations* <u>(ft NAVD88)</u>			
		<u>Coordinates</u>	<u>Significant Wave Height</u> <u>H_s (ft)</u>	<u>Peak Wave Period</u> <u>T_p (sec)</u>	<u>10% Annual Chance</u>	<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.2% Annual Chance</u>
Chester River	1	N 39.240002 W 75.93	0.5	2.5	3.0	5.3	6.4	8.4
Chester River	2	N 39.2388 W 75.986099	0.8	2.1	4.7	6.0	6.6	7.9
Southeast Creek	3	N 39.155201 W 76.035004	1.1	2.2	4.5	5.5	5.9	7.1
Chester River	4	N 39.130901 W 76.073502	1.7	2.4	4.4	5.3	5.6	6.5
Chester River	5	N 39.119202 W 76.098297	1.3	2.4	4.3	5.1	5.4	6.4
Chester River	6	N 39.097401 W 76.144501	2.1	2.7	4.3	5.0	5.3	6.3
Chester River	7	N 39.0783 W 76.144501	2.6	3.0	4.2	4.9	5.2	6.1
Chester River	8	N 39.031601 W 76.177803	3.3	3.6	4.1	4.7	4.9	5.8
Chester River	9	N 39.0079 W 76.162804	2.3	3.0	4.0	4.6	4.8	5.8
Queenstown Creek	10	N 38.993198 W 76.159798	1.2	2.4	4.0	4.6	4.8	5.7

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

TABLE 9 - TRANSECT DATA- continued

<u>Flood Source</u>	<u>Transect</u>	<u>Starting Wave Conditions for the 1% Annual Chance</u>			<u>Starting Stillwater Elevations (ft NAVD88)</u> Range of Stillwater Elevations* (ft NAVD88)			
		<u>Coordinates</u>	Significant Wave Height <u>H_s (ft)</u>	Peak Wave Period <u>T_p (sec)</u>	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Chester River	11	N 38.987999 W 76.180702	2.0	2.7	4.0	4.6 4.6-4.7	4.8 4.8-5.0	5.7 5.7-6.6
Chester River	12	N 38.971699 W 76.213402	1.6	2.3	3.9	4.5	4.7	5.6
Chester River	13	N 38.970798 W 76.225601	1.5	2.3	3.9 3.8-3.9	4.5 4.3-4.5	4.6 4.5-4.7	5.6 5.5-6.2
Chester River	14	N 38.976601 W 76.243103	1.5	2.5	3.8 3.8-3.9	4.4 4.3-4.4	4.6 4.5-4.6	5.5 5.5-5.9
Chester River	15	N 38.983101 W 76.265404	2.0	2.7	3.9 3.8-3.9	4.4	4.6	5.5
Chester River	16	N 38.9855 W 76.280403	1.6	2.6	3.8	4.4	4.6 4.6-4.7	5.5 5.5-6.8
Chester River	17	N 38.9981 W 76.2901	2.4	3.2	3.9	4.4	4.6 4.6-4.7	5.7 5.7-6.8
Chester River	18	N 39.0075 W 76.294899	2.9	3.5	3.9	4.4	4.6 4.6-4.7	5.7 5.7-6.8
Chester River	19	N 39.0354 W 76.302002	3.5	3.9	3.9	4.5 4.4-4.5	4.7	5.7
Chesapeake Bay	20	N 39.0392 W 76.303497	3.3	3.9	3.9	4.4	4.6	5.6
Chesapeake Bay	21	N 39.033501 W 76.313202	2.5	3.8	3.9	4.4	4.5	5.6
Chesapeake Bay	22	N 39.0205 W 76.320297	2.5	3.4	3.8 3.8-3.9	4.4	4.5	5.6

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

TABLE 9 - TRANSECT DATA- continued

<u>Flood Source</u>	<u>Transect</u>	<u>Starting Wave Conditions for the 1% Annual Chance</u>			<u>Starting Stillwater Elevations (ft NAVD88)</u> Range of Stillwater Elevations* <u>(ft NAVD88)</u>			
		<u>Coordinates</u>	Significant Wave Height <u>H_s (ft)</u>	Peak Wave Period <u>T_p (sec)</u>	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Chesapeake Bay	23	N 39.009602 W 76.322601	2.5	3.4	3.8	4.3	4.5	5.5
Chesapeake Bay	24	N 38.999001 W 76.323097	2.1	2.9	3.8	4.3	4.5	5.5
Chesapeake Bay	25	N 38.990501 W 76.329399	2.1	2.8	3.8	4.3 4.3-4.5	4.4 4.4-4.8	5.5 5.5-6.9
Chesapeake Bay	26	N 38.975399 W 76.335999	2.1	3.2	3.7 3.7-3.8	4.2	4.4	5.4
Chesapeake Bay	27	N 38.9683 W 76.346397	2.4	3.0	3.7	4.2	4.4	5.4 5.4-6.5
Chesapeake Bay	28	N 38.9506 W 76.356697	2.8	3.9	3.7	4.2 4.2-4.4	4.3	5.4 5.4-6.8
Chesapeake Bay	29	N 38.932899 W 76.362602	3.1	4.3	3.6	4.1	4.4	5.4
Chesapeake Bay	30	N 38.9133 W 76.364998	3.1	4.1	3.6	4.1	4.3	5.4
Chesapeake Bay	31	N 38.904499 W 76.365303	2.9	4.0	3.6	4.1	4.3	5.4 5.3-5.4
Chesapeake Bay	32	N 38.889702 W 76.364998	3.2	4.4	3.6	4.1	4.3	5.3
Chesapeake Bay	33	N 38.873001 W 76.365097	2.8	3.7	3.6 3.5-3.6	4.1	4.3	5.3
Chesapeake Bay	34	N 38.855 W 76.374397	3.1	4.1	3.5	4.1	4.3	5.1

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

TABLE 9 - TRANSECT DATA- continued

<u>Flood Source</u>	<u>Transect</u>	<u>Starting Wave Conditions for the 1% Annual Chance</u>			<u>Starting Stillwater Elevations (ft NAVD88)</u> Range of Stillwater Elevations* <u>(ft NAVD88)</u>			
		<u>Coordinates</u>	<u>Significant Wave Height H_s (ft)</u>	<u>Peak Wave Period T_p (sec)</u>	<u>10% Annual Chance</u>	<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.2% Annual Chance</u>
Chesapeake Bay	35	N 38.841499 W 76.375397	3.8	4.9	3.5	4.0	4.3	5.2
Eastern Bay	36	N 38.851299 W 76.362198	4.7	4.1	3.5 3.5-3.6	4.1	4.3	5.5
Eastern Bay	37	N 38.856499 W 76.352303	4.4	4.2	3.6	4.1	4.3	5.5 5.5-5.6
Eastern Bay	38	N 38.861099 W 76.333603	4.1	3.9	3.6 3.6-3.7	4.1 4.1-4.2	4.3 4.3-4.4	5.3 5.3-5.6
Eastern Bay	39	N 38.875801 W 76.333702	4.7	4.0	3.6 3.6-3.7	4.1 4.1-4.2	4.3 4.3-4.4	5.5 5.5-5.6
Eastern Bay	40	N 38.8894 W 76.337502	4.5	4.1	3.6	4.1 4.1-4.2	4.4	5.6
Eastern Bay	41	N 38.902 W 76.3367	4.2	4.2	3.7	4.2	4.4	5.8 5.8-5.9
Shipping Creek	42	N 38.9137 W 76.338997	3.5	4.1	3.7	4.2 4.2-4.3	4.5	6.0 6.0-6.1
Eastern Bay	43	N 38.911598 W 76.321899	4.2	4.2	3.7 3.7-3.8	4.2 4.2-4.3	4.4 4.4-4.5	5.8 5.8-6.1
Cox Creek	44	N 38.965801 W 76.2985	0.5	2.0	3.8	4.4	4.6	6.7
Crab Alley Bay	45	N 38.9128 W 76.295998	4.3	4.1	3.7	4.2	4.4	5.7

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

TABLE 9 - TRANSECT DATA- continued

<u>Flood Source</u>	<u>Transect</u>	<u>Starting Wave Conditions for the 1% Annual Chance</u>			<u>Starting Stillwater Elevations (ft NAVD88)</u> Range of Stillwater Elevations* (ft NAVD88)			
		<u>Coordinates</u>	<u>Significant Wave Height</u> <u>H_s (ft)</u>	<u>Peak Wave Period</u> <u>T_p (sec)</u>	<u>10% Annual Chance</u>	<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.2% Annual Chance</u>
Crab Alley Bay	46	N 38.924198 W 76.296799	4.6	4.0	3.7 3.7-3.8	4.3	4.5	5.9 5.9-6.2
Crab Alley Bay	47	N 38.935101 W 76.292603	1.9	3.8	3.8	4.3	4.5 4.5-4.6	6.1 6.1-6.2
Crab Alley Bay	48	N 38.930599 W 76.289703	4.0	4.2	3.8	4.3	4.5	5.9 5.9-6.1
Crab Alley Creek	49	N 38.9464 W 76.2855	0.7	2.1	3.9	4.4	4.6	6.3
Crab Alley Bay	50	N 38.935699 W 76.286102	3.4	4.0	3.8	4.3	4.5	6.0 6.0-6.1
Crab Alley Bay	51	N 38.941502 W 76.2743	3.2	3.9	3.9	4.4	4.6	6.1 6.1-6.2
Crab Alley Bay	52	N 38.938599 W 76.269501	3.3	3.8	3.8	4.4	4.5 4.5-4.6	6.0 6.0-6.1
Crab Alley Bay	53	N 38.9338 W 76.267998	3.7	3.8	3.8	4.3	4.5	5.9
Crab Alley Bay	54	N 38.9272 W 76.264999	3.6	4.0	3.8	4.3	4.5	5.8
Crab Alley Bay	55	N 38.922798 W 76.262901	3.7	4.3	3.8	4.3	4.5	5.8 5.8-5.9
Prospect Bay	56	N 38.937599 W 76.2547	3.5	3.8	3.8	4.4	4.6	6.0
Prospect Bay	57	N 38.963699 W 76.255402	3.0	4.1	3.9 3.8-3.9	4.4	4.7 4.6-4.7	6.3

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

TABLE 9 - TRANSECT DATA- continued

<u>Flood Source</u>	<u>Transect</u>	<u>Starting Wave Conditions for the 1% Annual Chance</u>			<u>Starting Stillwater Elevations (ft NAVD88)</u> Range of Stillwater Elevations* (ft NAVD88)			
		<u>Coordinates</u>	<u>Significant Wave Height</u> <u>H_s (ft)</u>	<u>Peak Wave Period</u> <u>T_p (sec)</u>	<u>10% Annual Chance</u>	<u>2% Annual Chance</u>	<u>1% Annual Chance</u>	<u>0.2% Annual Chance</u>
Prospect Bay	58	N 38.966099 W 76.242302	2.8	3.2	3.9	4.5 4.4-4.5	4.7	6.3 6.1-6.3
Marshy Creek	59	N 38.9603 W 76.223701	1.7	2.4	3.9	4.5	4.8 4.7-4.8	6.3
Prospect Bay	60	N 38.942699 W 76.231201	4.4	4.6	3.8 3.8-3.9	4.4	4.6 4.6-4.7	6.0 6.0-6.2
Prospect Bay	61	N 38.9459 W 76.2155	3.3	4.3	3.8 3.8-3.9	4.4 4.4-4.5	4.6 4.6-4.7	6.1 6.1-6.3
Cabin Creek	62	N 38.942299 W 76.208397	3.3	4.3	3.8	4.4	4.7	6.0
Eastern Bay	63	N 38.9198 W 76.203499	3.6	4.5	3.8 3.8-3.9	4.3 4.3-4.5	4.5 4.5-4.8	5.8 5.8-6.2
Eastern Bay	64	N 38.912498 W 76.204803	3.7	4.6	3.8 3.5-3.9	4.3 4.0-4.5	4.5 4.2-4.8	5.7 5.6-6.2
Eastern Bay	65	N 38.901199 W 76.203697	3.8	4.6	3.7 3.6-3.8	4.3 4.1-4.4	4.5 4.3-4.7	5.6 5.6-6.0
Greenwood Creek	66	N 38.899101 W 76.186096	0.6	2.4	3.8	4.4	4.6	5.8
Eastern Bay	67	N 38.871601 W 76.200996	3.2	3.5	3.7	4.2 4.2-4.3	4.4 4.4-4.5	5.5 5.5-5.7
Eastern Bay	68	N 38.8568 W 76.205704	3.9	3.9	3.6 3.6-3.7	4.2	4.4	5.4 5.4-5.5
Wye River	69	N 38.892399 W 76.179199	2.4	2.8	3.8	4.4	4.6	5.9

*For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

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 26). The 3-foot wave has been determined to be the minimum size wave capable of causing major damage to conventional wood frame or 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 23.

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).

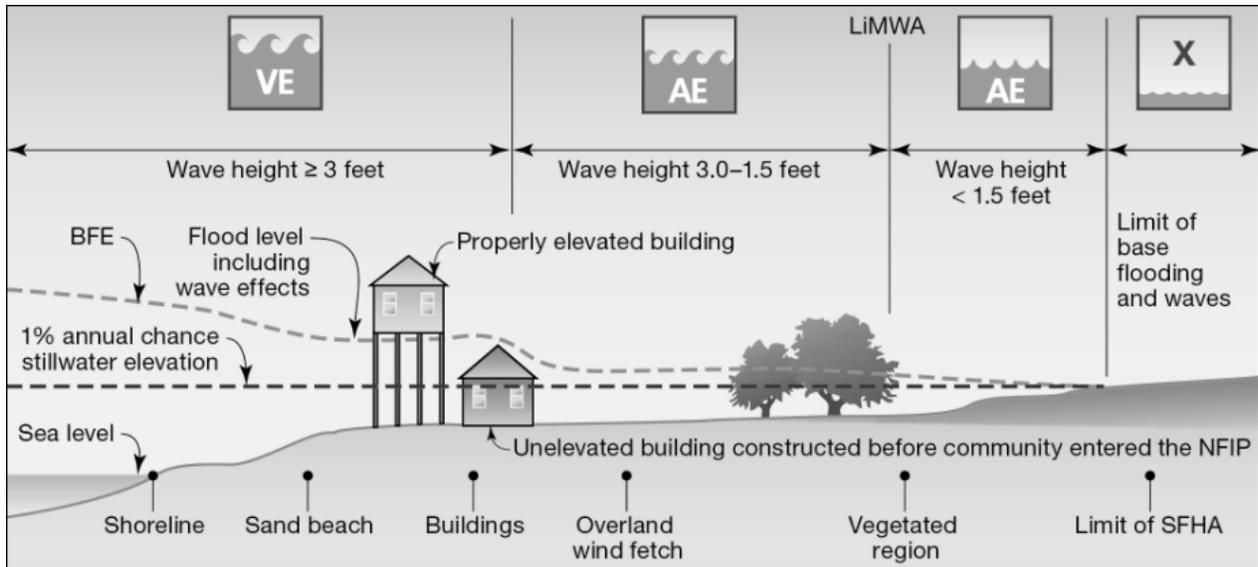


FIGURE 2 TRANSECT SCHEMATIC

3.4 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (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 now referenced to NAVD 88. In order to perform this conversion, effective NGVD 29 elevation values were adjusted downward by 0.78 foot. 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 BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD29 should apply the stated conversion factor to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

$$\text{NAVD88} + 0.78 = \text{NGVD29}$$

For additional information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website (listed below) 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. To assist in this endeavor, each FIS report provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1-percent and 0.2-percent annual chance floodplains; and a 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, and Floodway Data tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1-percent annual chance and 0.2-percent annual chance boundaries have been determined at each cross section. The delineations are based on the best available topographic information.

Pre-countywide Analysis

For the streams studied in detail, the 1-percent and 0.2-percent annual chance floodplains have been delineated using the flood elevations determined at each cross section.

Queen Anne's County (Unincorporated Areas)

The boundaries between cross sections were interpolated using topographic maps at a scale of 1:7200 with a contour interval of 2 feet (Reference 27). For the wave height analysis, the 1- and 0.2-percent annual chance boundaries were delineated using the 1:7200 topographic maps of the study area.

For the areas studied by approximate methods, the boundary of the 1-percent annual chance flood was delineated using SCS (now NRCS) soil survey maps and

the existing Flood Hazard Boundary Map for the unincorporated areas of Queen Anne's County (References 28 and 29).

On the FIRM, special flood hazard areas inundated by the 1-percent annual chance flood which have additional hazards due to significant wave action have been designated as Zone VE. The 1-percent annual chance flood boundary corresponds to the boundary of the areas of special flood hazards (Zone AE), and the 0.2-percent annual chance flood boundary corresponds to the boundary of areas of moderate flood hazards (Zone X).

The A and V Zones were divided into whole-foot elevation zones based on the average wave crest elevation in that zone. Where the map scale did not permit delineating zones at 1 foot intervals, larger increments were used.

Town of Centreville

For each stream studied in detail, the 1- and 0.2-percent annual chance flood plain boundaries have been delineated using the flood elevations interpolated using topographic maps at a scale of 1:7200 with a contour interval of 2 feet (Reference 27).

Town of Queen Anne

For each stream studied in detail, the 1- and 0.2-percent annual floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using a topographic map at a scale of 1:24000 with a contour interval of 20 feet (Reference 27).

Town of Queenstown

For each flooding source studied in detail, the boundaries of the 1- and 0.2-percent annual chance floods have been delineated using topographic maps at a scale of 1:7200 with a contour interval of 2 feet (Reference 27).

This Countywide Analyses

Floodplain boundaries were delineated using 2003-2006 LiDAR data derived from NOAA. The 1-percent and 0.2-percent annual chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AO, 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-percent 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.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases 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 FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 10).

No floodways have been computed for Cox Creek.

As shown on the FIRM (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 1-percent annual chance flood are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths for the Chester River and Tuckahoe Creek extend beyond the Queen Anne's County 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 10, "Floodway Data." In order 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.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by 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.

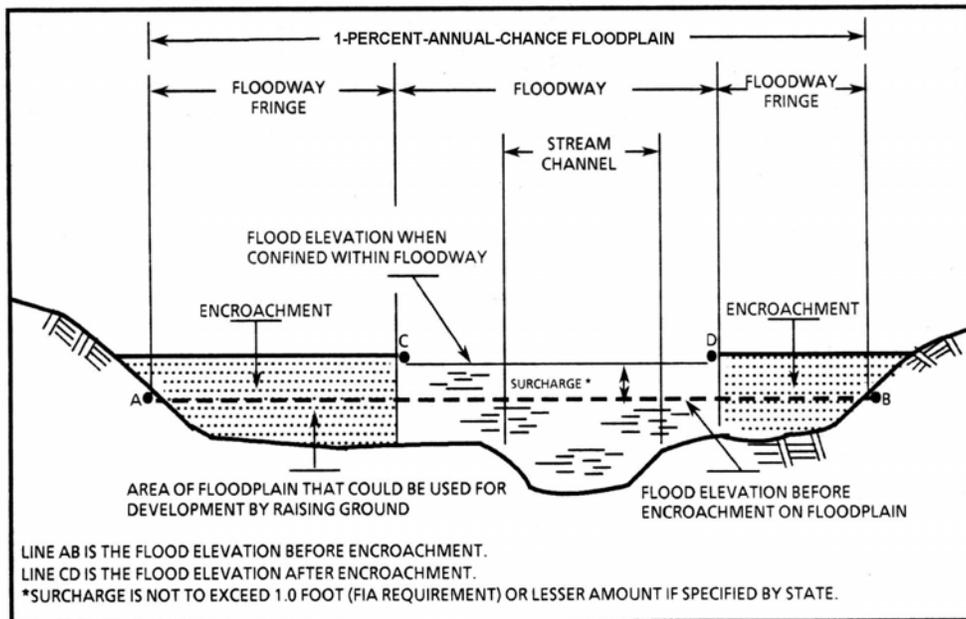


FIGURE 3: FLOODWAY SCHEMATIC

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE ¹	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Chester River								
A	953	693 / 76 ²	5,287	2.4	6.6	6.6	6.9	0.3
B	3,425	683 / 281 ²	6,312	2.0	7.3	7.3	7.6	0.3
C	5,424	1,196 / 123 ²	8,413	1.5	7.6	7.6	8.0	0.4
D	7,138	775 / 119 ²	7,099	1.8	8.1	8.1	8.5	0.4
E	8,774	745 / 163 ²	6,182	1.8	8.4	8.4	8.9	0.5
F	10,663	200 / 100 ²	2,214	4.5	9.4	9.4	9.8	0.4
G	11,113	168 / 68 ²	2,202	4.5	9.8	9.8	10.2	0.4
H	13,066	197 / 130 ²	2,484	4.0	11.0	11.0	11.4	0.4
I	14,569	424 / 314 ²	4,785	2.1	11.7	11.7	12.2	0.5
J	16,155	883 / 575 ²	10,963	0.9	12.0	12.0	12.6	0.6
K*	17,448	1,267 / 1158 ²	13,750	0.7	12.2	12.2	12.7	0.5
L*	18,313	890 / 812 ²	8,323	1.2	12.2	12.2	12.8	0.6
M*	19,147	361 / 239 ²	3,250	3.0	12.3	12.3	12.9	0.6
N*	19,786	720 / 180 ²	7,219	1.4	12.4	12.4	13.4	1.0
O*	19,938	895 / 298 ²	9,594	1.0	12.5	12.5	13.4	0.9

¹ Feet above Tidal Limit

² Width / Width within Queen Anne's County

* Data Not Included on FIRM – Information for the town of Millington show in its entirety on the FIRM for Kent County MD and Incorporated Areas

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

**QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS**

FLOODWAY DATA

CHESTER RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mill Stream Branch								
A	28 ¹	266	838	3.1	6.0	6.0	6.8	0.8
B	193 ¹	278	905	2.5	6.2	6.2	7.0	0.8
C	891 ¹	156	785	2.9	7.3	7.3	7.8	0.5
D	1,452 ¹	287	1,904	1.2	7.9	7.9	8.5	0.6
E	2,267 ¹	420	2,227	1.0	8.1	8.1	8.7	0.6
F	2,908 ¹	382	1,354	1.7	8.5	8.5	9.1	0.6
G	3,731 ¹	246	957	2.4	9.5	9.5	10.1	0.6
Tuckahoe Creek								
A	300 ²	490/116 ³	4,333	2.2	8.4	8.4	9.1	0.7
B	832 ²	745 / 79 ³	5,611	1.7	8.5	8.5	9.2	0.7
C	1,111 ²	530/132 ³	4,215	2.3	8.6	8.6	9.3	0.7
D	1,549 ²	385/149 ³	3,555	2.7	8.9	8.9	9.6	0.7
E	1,912 ²	420/131 ³	3,740	2.6	9.2	9.2	9.7	0.5

¹ Feet above Centreville Road Bridge State Route 213

² Feet above Main Street Bridge Alternate State Route 404

³ Width / Width within Queen Anne's County

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

**QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS**

FLOODWAY DATA

MILL STREAM BRANCH – TUCKAHOE CREEK

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The 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 base flood elevations or 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 base flood elevations 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 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 base flood elevations 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 base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to 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 base flood elevations or 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 rate zones as described in Section 5.0. In the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations 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-percent and 0.2-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The countywide FIRM presents flooding information for the entire geographic area of Queen Anne's County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each incorporated community with identified flood hazard areas and the unincorporated areas of the county. Historical map dates relating to pre-countywide maps prepared for each community are presented in Table 11, "Community Map History."

7.0 OTHER STUDIES

FISs have been prepared for the Towns of Centreville, Queen Anne, and Queenstown, (References 30, 31, and 32). The Flood Insurance Study for the Unincorporated Areas of Queen Anne's County, Maryland was prepared on March 28, 1984 (Reference 33). All of these reports have been superseded by the countywide study.

FISs have also been prepared for the neighboring counties of Caroline, Kent, and Talbot Counties, Maryland, and Kent County, Delaware (References 34, 35, 36, and 37).

Countywide studies are currently being prepared by FEMA for Caroline, Kent, and Talbot Counties, Maryland (Reference 38).

This study is authoritative for purposes of the Flood Insurance Program and the data presented here either supersede or are compatible with previous determinations.

8.0 LOCATION OF DATA

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

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Barclay, Town of ¹				
Centreville, Town of	July 26, 1974	May 21, 1976	September 27, 1985	
Church Hill, Town of	August 16, 1974	December 19, 1975	June 3, 1986	
Queen Anne, Town of	August 9, 1974	July 9, 1976	September 27, 1985	
Queen Anne's County (Unincorporated Areas)	December 13, 1974	March 24, 1978	September 28, 1984	July 3, 1986 June 16, 1992
Queenstown, Town of	January 20, 1974	June 18, 1976	September 28, 1984	
Sudlersville, Town of ¹				

¹This community did not have a FIRM prior to the first countywide FIRM for Queen Anne's County

TABLE 11

**FEDERAL EMERGENCY MANAGEMENT AGENCY
QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS**

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

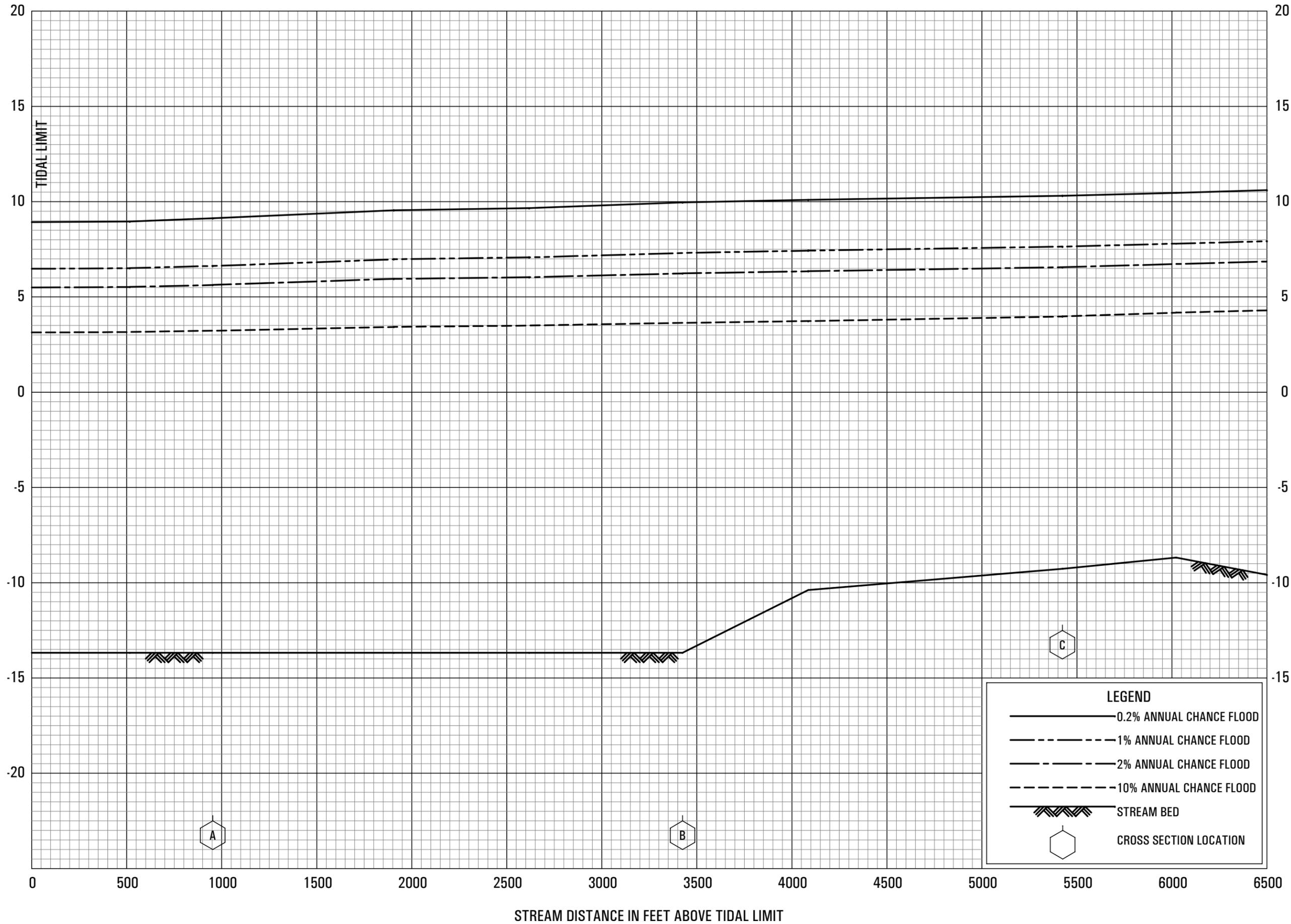
1. Maryland Department of Economic and Community Development, Queen Anne's County Community Economic Inventory, 1977, 1980.
2. U.S. Department of Commerce, Census Bureau, State & County QuickFacts. <http://quickfacts.census.gov/>
3. Comprehensive Plan, Queen Anne's County, Maryland, 2010. <http://www.qac.org/default.aspx?pageid=1402&template=3&PageLevel=2&toplevel=34&cid=73>
4. Maryland Department of Business & Economic Development, Queen Anne's County Brief Economic Facts, Baltimore, Maryland, 2009. <http://www.choosemaryland.org/factsstats/Documents/briefeconomicfacts/QueenAnnesBEF.pdf>
5. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Interval 20 feet: Chestertown 1973 ; Church Hill 1973; Sudlersville 1973; Millington 1973; Love Point 1954; Langford Creek 1954; Centreville 1973; Price 1973; Goldsboro Md, Del, 1944; Kent Island 1973; Queenstown 1973; Wye Mills 1973; Ridgely 1973; Clairborne 1974; St. Michaels 1942.
6. Maryland Municipal League, The Association of Cities and Towns, 1212 West Street, Annapolis, MD 21401. <http://www.mdmunicipal.org/cities/citiesweb.cfm>
7. Centreville Community Plan, Queen Anne's County, Department of Land Use, Growth Management and Environment, Centreville, Maryland, 2009. http://www.mdp.state.md.us/PDF/OurWork/CompPlans/QueenAnnes/Centreville/09_CMP_Centreville.pdf
8. Stahl, Laura, Clerk/Treasurer, Town of Sudlersville, Article for the Maryland Municipal Clerks Association Newsletter, Sudlersville, Maryland, November 13, 2007. <http://www.sudlersville.org/other%20files/Article%20on%20Sudlersville%20for%20MMCA%20Newsletter%2011-13-07.pdf>
9. The Cambridge Record, Cambridge, Maryland, August 24, 1933; August 25, 1933.
10. Queen Anne's Record-Observer, Centreville, Maryland, October 21, 1954; August 18, 1955; September 15, 1960; June 28, 1972.
11. U.S. Geological Survey, Water Resources Division, Floods of August 1967 in Maryland and Delaware, Towson, Maryland, 1969.

12. Robert Gibson, private citizen, Personal Communication.
13. National Climatic Data Center, National Environmental Satellite, Data, and Information Services (NESDIS), NOAA Satellite and Information Service, U.S. Department of Commerce, Storm Events for Maryland, Asheville, NC. <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>
14. Queen Anne's County General Code, Board of County Commissioners of Queen Anne's County, Maryland <http://www.ecode360.com/QU1770?#QU1770>
15. Ned Garber, Queen Anne's County Assistant Planner, Personal Communication.
16. Maryland Department of the Environment, Soil Erosion and Sediment Control Regulations, Baltimore, Maryland, Last accessed: August 1, 2012. http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SoilErosionandSedimentControl/Pages/Programs/WaterPrograms/SedimentandStormwater/erosionsedimentcontrol/esc_standards.aspx
17. University of Maryland, Department of Civil and Environmental Engineering, Procedure Used to Calculate Peak Flow Hydrology in Maryland, Glen E. Moglen, November 27, 2006.
18. Dillow, J.J.A., 1996. Technique for estimating magnitude and frequency of peak flows in Maryland: U.S. Geological Survey Water-Resources Investigations Report, 95 - 4154, 55p.
19. Maryland State Highway Administration and Maryland Department of the Environment, Application of Hydrologic Methods in Maryland, Third Edition, Baltimore, MD, Revised September 2010.
20. U.S. Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System HEC-RAS, User's Manual, Version 4.0.0, Davis California, March 2008.
21. Luettich, R. A. and J.J Westerink. A (Parallel). (February 6, 2008). Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC). Version 45.12. University of North Carolina at Chapel Hill, Institute of Marine Sciences. Morehead City, NC
22. U.S. Army Corps of Engineers. (2012) ERDC/CHL TR11-X. FEMA Region 3 Storm Surge Study Coastal Storm Surge Analysis: Modeling System Validation Submission No.2. US Army Corps of Engineers
23. National Academy of Sciences. (NAS) (1977). Methodology for Calculating Wave Action Effects Associated with Storm Surges.

24. Federal Emergency Management Agency, (2007a). Atlantic Ocean and Gulf of Mexico Update Coastal Guidelines Update. Washington, DC.
25. Federal Emergency Management Agency (2007b). Wave Height Analysis for Flood Insurance Studies (WHAFIS), Version 4.0. Washington, DC, August
26. U.S. Army Corps of Engineers, Galveston District, (June 1975). Guidelines for Identifying Coastal High Hazard Zones. Galveston, Texas.
27. State of Maryland, Department of Natural Resources, Flood Management Division, Topographic Maps, developed from aerial photography, Scale 1:7200, Contour Interval 2 feet: 1981.
28. U.S. Department of Agriculture, Soil Conservation Service, Soil Survey, Queen Anne's County, Maryland, 1966.
29. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Queen Anne's County, Unincorporated Areas, Maryland, September 1978.
30. Federal Emergency Management Agency, Flood Insurance Study, Town of Queenstown, Queen Anne's County, Maryland, March 28,
31. Federal Emergency Management Agency, Flood Insurance Study, Town of Centreville, Queen Anne's County, Maryland, September 27,
32. Federal Emergency Management Agency, Flood Insurance Study, Town of Queen Anne, Queen Anne's and Talbot Counties, Maryland, September 27, 1985.
33. Federal Emergency Management Agency, Flood Insurance Study, Queen Anne's County, Maryland, Unincorporated Areas, March 28, 1984.
34. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Caroline County, Unincorporated Areas, Maryland, October 1980; September 7, 1998.
35. Federal Emergency Management Agency, Flood Insurance Study, Kent County, Unincorporated Areas, Maryland, December 4, 1985.
36. Federal Emergency Management Agency, Flood Insurance Study, Talbot County, Unincorporated Areas, Maryland, November 15, 1984.
37. Federal Emergency Management Agency, Flood Insurance Study, Kent County, Delaware and Incorporated Areas, Washington, D.C., May 5, 2003.
38. Federal Emergency Management Agency, Flood Insurance Study, Talbot

County, Maryland and Incorporated Areas, Washington, D.C., Revised
Preliminary Issuance, January 30, 2012.

ELEVATION IN FEET (NAVD 88)

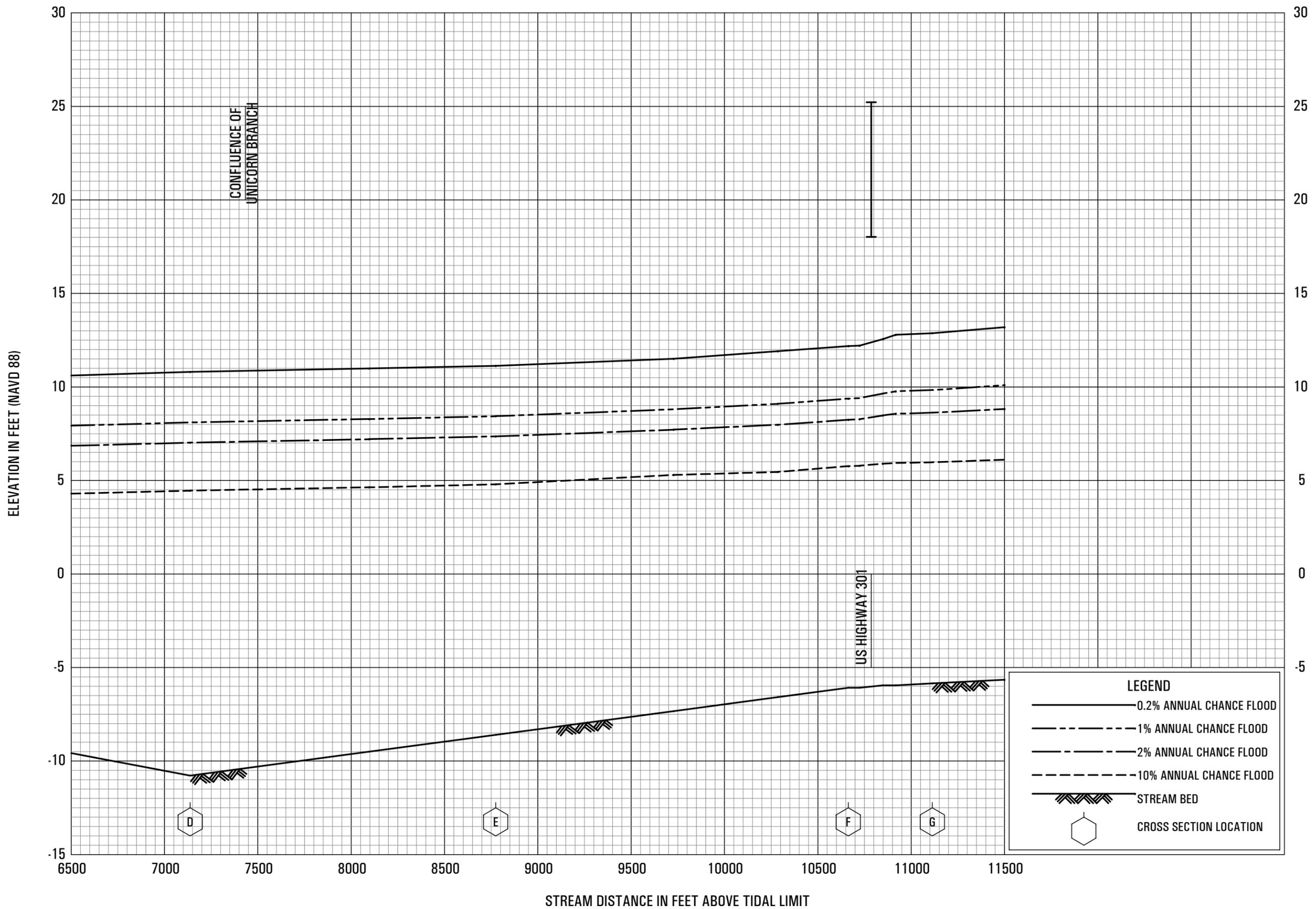


FLOOD PROFILES

CHESTER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS

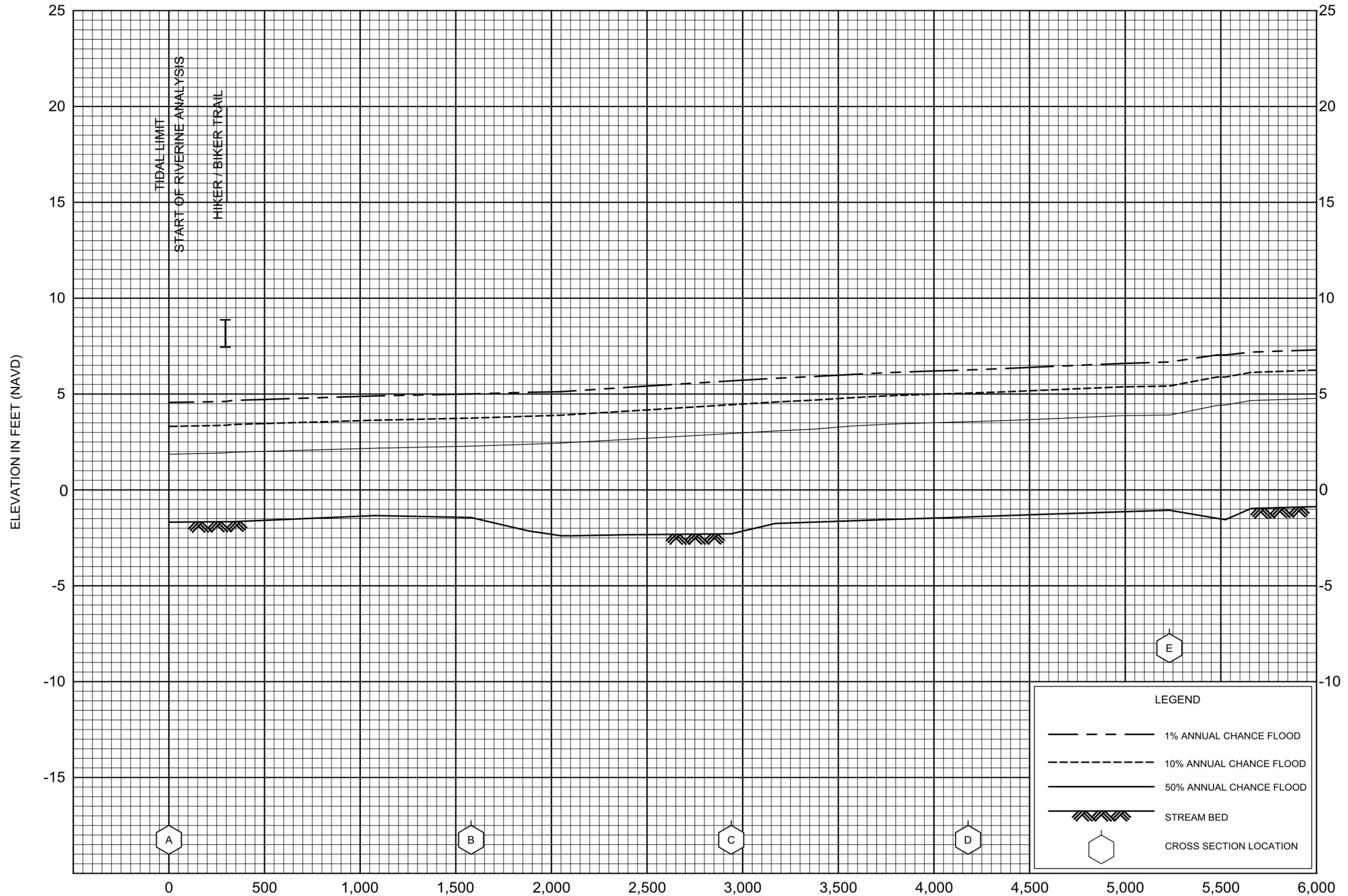


FLOOD PROFILES

CHESTER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

**QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS**



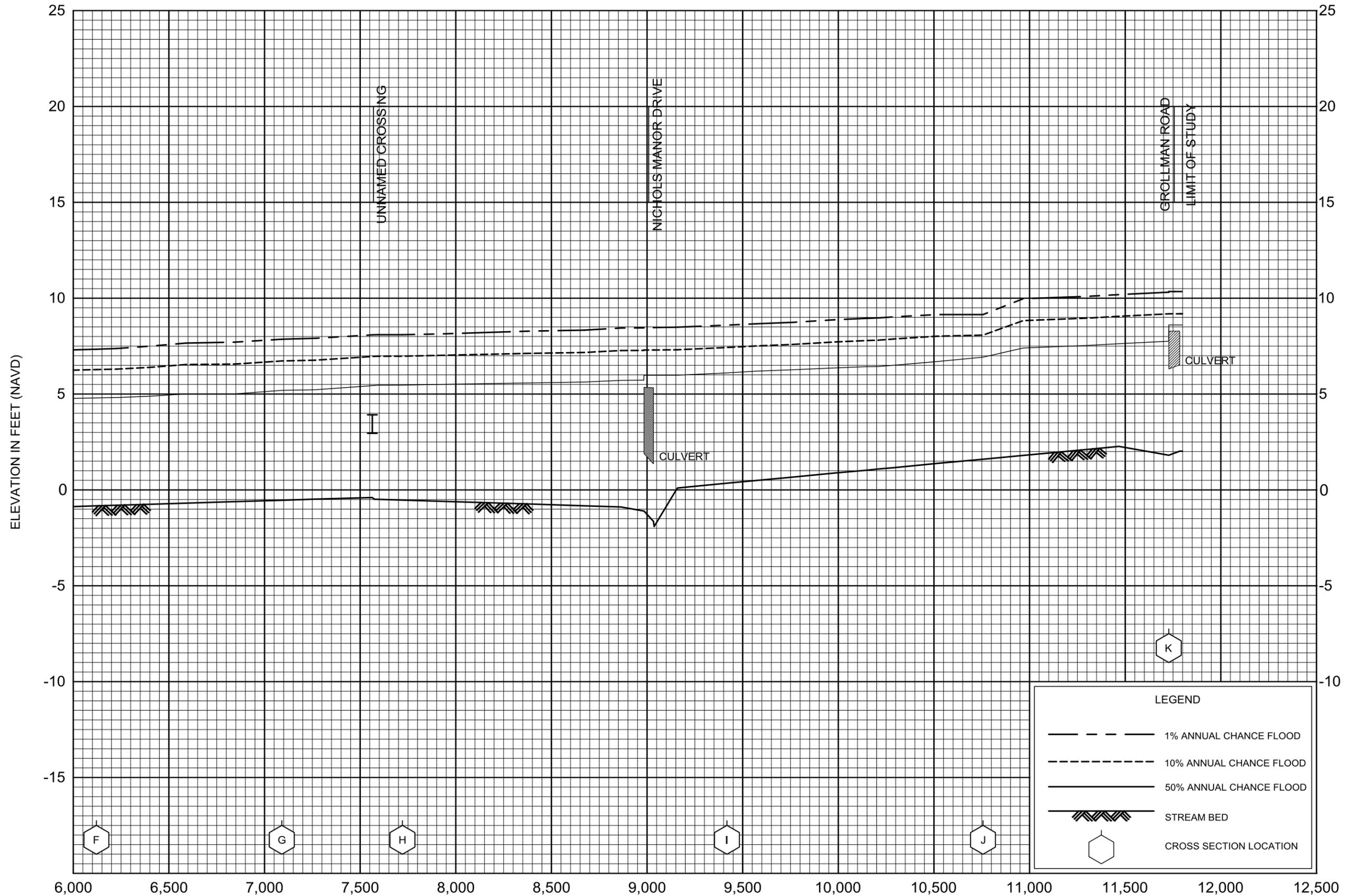
* APPROXIMATELY 0.68 MILES ABOVE
US ROUTE 50 BLUE STAR MEMORIAL HIGHWAY

STREAM DISTANCE IN FEET AT START OF RIVERINE ANALYSIS*

FLOOD PROFILES

COX CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS



* APPROXIMATELY 0.68 MILES ABOVE
US ROUTE 50 BLUE STAR MEMORIAL HIGHWAY

STREAM DISTANCE IN FEET AT START OF RIVERINE ANALYSIS*

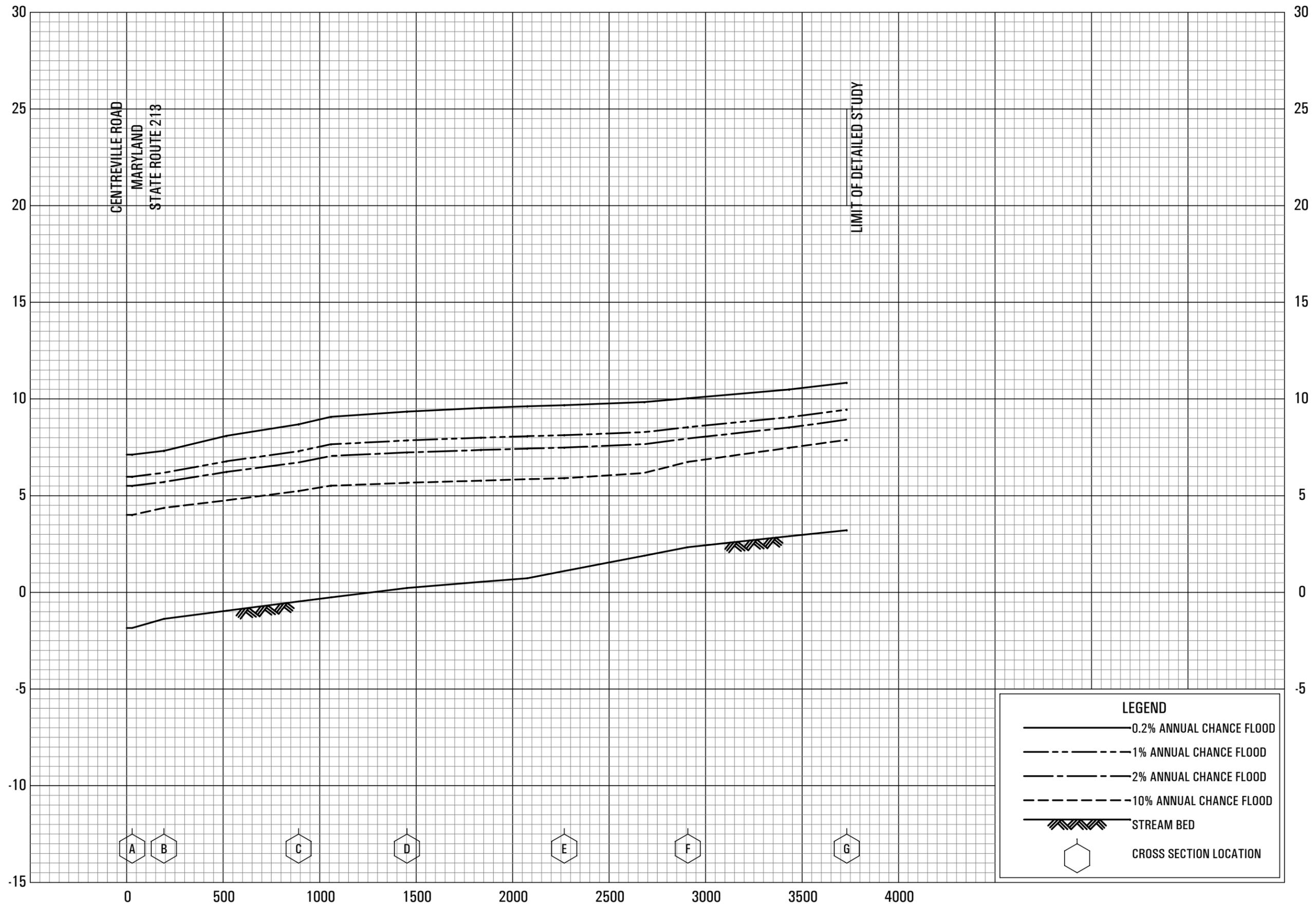
FLOOD PROFILES

COX CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS

ELEVATION IN FEET (NAVD 88)



FLOOD PROFILES

MILL STREAM BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY
QUEEN ANNE'S COUNTY, MD
AND INCORPORATED AREAS

