FLOOD INSURANCE STUDY

NOTICE
This preliminary FIS report includes only revised Flood Profiles and Floodway Data tables. See "Notice to Flood Insurance Users" page for additional details.

ULSTER COUNTY, NEW YORK
(ALL JURISDICTIONS)

VOLUME 1 OF 4

COMMUNITY NAME	COMMUNITY NUMBER
DENNING, TOWN OF	361439
ELLENVILLE, VILLAGE OF	360975
ESOPUS, TOWN OF	360855
GARDINER, TOWN OF	360856
HARDENBURG, TOWN OF	361578
HURLEY, TOWN OF	360857
KINGSTON, CITY OF	360858
KINGSTON, TOWN OF	361218
LLOYD, TOWN OF	361012
MARBLETOWN, TOWN OF	361219
MARLBOROUGH, TOWN OF	361220
NEW PALTZ, TOWN OF	360859
NEW PALTZ, VILLAGE OF	361544
OLIVE, TOWN OF	360860
PLATTEKILL,TOWN OF[1]	361221
ROCHESTER, TOWN OF	360861
ROSENDALE, TOWN OF	360862
SAUGERTIES, TOWN OF	360863
SAUGERTIES, VILLAGE OF	361504
SHANDAKEN, TOWN OF	360864
SHAWANGUNK, TOWN OF	360865
ULSTER, TOWN OF	360866
WAWARSING, TOWN OF	360867
WOODSTOCK, TOWN OF	360868

PRELIMINARY
May 24, 2013

REVISED:

[1] No Special Flood Hazard Areas Identified

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
36111CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at anytime. 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 and cross sections). In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Initial FIS Effective Date: September 25, 2009 (partial countywide)

Revised FIS Dates:

This preliminary FIS report does not include unrevised Floodway Data Tables or unrevised Flood Profiles. These Floodway Data Tables and Flood Profiles will appear in the final FIS report.

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FLOOD INSURANCE STUDY
ULSTER COUNTY, NEW YORK (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) in the geographic area of Ulster County, New York, including the Towns of Denning, Esopus, Gardiner, Hardenburg, Hurley, Kingston, Lloyd, Marbletown, Marlborough, New Paltz, Olive, Plattekill, Rochester, Rosendale, Saugerties, Shanadaken, Shawangunk, Ulster, Wawarsing, and Woodstock; the Villages of Ellenville, New Paltz, and Saugerties; and the City of Kingston (hereinafter referred to collectively as Ulster County).

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Ulster County – Outside the New York City Watershed to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in Title 44 of the Code of Federal Regulations, Section 60.3 (44 CFR 60.3).

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the floodplain, as set forth in 44 CFR 60.3(d). In such cases, however, it shall be understood that the State (or other jurisdictional agency) shall be able to explain these requirements and criteria.

Please note that on the effective date of this study, the Town of Plattekill has no identified Special Flood Hazard Areas (SFHA). This does not preclude future determinations of SFHAs 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.

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 study was prepared to include all jurisdictions within Ulster County into a countywide FIS. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is provided below:

Ellenville, Village of: The hydrologic analyses for this study were prepared by the U.S. Army Corps of Engineers (USACE). The hydraulic analyses were prepared by the Gannet Fleming Corddry and Carpenter, Inc., for the USACE. That work was completed in April 1981.

Esopus, Town of: The hydrologic and hydraulic analyses for this study were prepared by the New York State Department of Environmental Conservation (NYSDEC) and Dewberry & Davis for the Federal Emergency Management Agency (FEMA), under contract No. H-4624. That work was completed in March 1983.

Gardiner, Town of: For the original March 30, 1982, FIS report and September 30, 1982, FIRM, the hydrologic and hydraulic analyses were prepared by Urbitran Associates, Inc., for FEMA, under Contract No. H-4825. That work was completed in November 1980.

For the FIS dated July 16, 1997, revised hydrologic and hydraulic analyses for the Mara Kill were prepared by Kozma Associates Consulting Engineers, P.C., for FEMA, under Contract No. EMW-94-C-4379. That work was completed in July 1995.

Planimetric base map information was derived from U.S. Geological Survey (USGS) 1:000,000 scale Digital Line Graphs. Additional information may have been derived from other sources. The Digital Flood Insurance Rate Map (DFIRM) was produced in Universal Transverse Mercator (UTM) coordinates referenced to the North American Datum of 1927 and the Clarke 1866 Spheroid.

Hurley, Town of: The hydrologic and hydraulic analyses for the original study was performed by Dewberry & Davis for FEMA based on the data used to prepare the FIS for the City of Kingston and the Town of Ulster. That work was completed in June 1984.

The hydrologic and hydraulic analyses for the August 18, 1992 FIS were prepared by Kozma Associates Consulting Engineers, P.C. for FEMA, under Contract No. EMW-87-C-2449. That work was completed in October 1990.

Kingston, City of: The hydrologic and hydraulic analyses for this FIS were prepared by the NYSDEC and Dewberry & Davis for FEMA, under Contract No. H-4624. That work was competed in May 1984.

Kingston, Town of: The hydrologic and hydraulic analyses for the April 5, 1988, FIS represent a revision of the original analyses prepared for FEMA. The hydrologic and hydraulic analyses for the April 5, 1988 study were prepared using the USACE Flood Plain Technical Services report on Saw Kill. The hydrologic analysis for that study was prepared by USACE. The hydraulic analysis for that study was prepared by Leonard Jackson Associates under subcontract to USACE. That work was completed in March 1985.

Lloyd, Town of: For the revision of the January 18, 1985, FIS report and the July 18, 1985, FIRM, the hydrologic and hydraulic analyses for the Hudson River were performed by Harris-Toups Associates during the preparation of the FIS for the Town of Poughkeepsie, New York. The Poughkeepsie study was completed in August 1977.

For the July 5, 2000, revision the hydrologic and hydraulic analyses for Black Creek and Twaalfskill Creek were prepared by Leonard Jackson Associates for FEMA, under Contract No. EMW-C-4692. This work was completed in February 1998.

Planimetric base map information was derived by scanning and vectorizing the previously published FIRM for the Town of Lloyd, New York. Additional information may have been derived from other sources. The DFIRM was produced using UTM coordinates referenced to the North American Datum of 1927 and the Clarke 1866 spheroid.

Marbletown, Town of: The hydrologic and hydraulic analyses for this study were prepared by Kozma Associates Consulting Engineers, P.C., for FEMA under Inter-Agency Agreement No. EMW-86-C-2244. This work was completed in December 1989.

Marlborough, Town of: The hydrologic and hydraulic analyses for this study were performed by Harris-Toups Associates during the preparation of the FIS for the Town of Poughkeepsie, New York. The Poughkeepsie study was completed in August 1977.

New Paltz, Town of: The hydrologic and hydraulic analyses for this study represent a revision of the original analyses by NYSDEC for FEMA under Contract No. H-4547. The original work was completed in May 1980. An updated version prepared by Dewberry & Davis under agreement with FEMA was completed in July 1983. The hydrologic and hydraulic analyses for the Wallkill River were again revised by Dewberry & Davis; the second revision was completed in December 1984.

New Paltz, Village of: The hydrologic and hydraulic analyses for this study represent a revision of the original analyses by NYSDEC for FEMA, under Contract No. H-4547. The original work was completed in May 1980. An updated version prepared by Dewberry & Davis under agreement with FEMA was completed in July 1983. The hydrologic and hydraulic analyses for the Wallkill River were again revised by Dewberry & Davis; the second revision was completed in December 1984.

Olive, Town of: The hydrologic and hydraulic analyses for this study were performed by the New York District of USACE, during the Report on Technical Services for Esopus Creek. The report was completed in November 1982.

Rochester, Town of:	The hydrologic analyses for the original study were performed by USACE and hydraulic analyses were performed by Gannett Fleming Corddry and Carpenter for FEMA. The work for the original study was completed in April 1981. For the updated study, additional hydrologic and hydraulic analyses for Rondout Creek, and hydrologic and hydraulic analyses for the other streams studied by detailed methods, were prepared by Edwards and Kelcey Engineers, Inc., for FEMA, under Contract No. EMW-85-C-1887. This work was completed in March 1989.
Rosendale, Town of:	The hydrologic and hydraulic analyses for the original study were prepared by NYSDEC and Dewberry & Davis for FEMA, under Contract No. H-4624. This work was completed in March 1983. The hydrologic and hydraulic analyses for the Wallkill River were revised by Dewberry & Davis. The revised work was completed in December 1984.
Saugerties, Town of:	The hydrologic and hydraulic analyses for the original study were prepared by Dewberry & Davis for FEMA during the preparation of FISs for the City of Kingston and the Town of Ulster. The work for the original study was completed in June 1984. In the first revision, the hydraulic and hydrologic analyses were performed by the Buffalo District of USACE for FEMA under Inter-Agency Agreement No. EMW-88-E-2768, Project Order Nos. 1A and 1B. The work for the first revision was completed in June 1989. In the next revision, the hydraulic analyses were prepared by Dewberry & Davis. The work for the second revision as completed in July 1991.
Saugerties, Village of:	The hydrologic and hydraulic analyses in the February 5, 1985, study represent a revision of the analyses done by the original contractor for FEMA. The updated version was prepared by Dewberry & Davis for FEMA during the course of preparing the FISs for the City of Kingston and the Town of Ulster. This work was completed in June 1984.
Shandaken, Town of:	The hydrologic and hydraulic analyses for this study were performed by the New York District of USACE during the Report on Technical Services for Esopus Creek. The report was completed in November 1982.
Shawangunk, Town of:	The hydrologic and hydraulic analyses for the original study were prepared by Urbitran Associates, Inc. for FEMA, under Contract No. H-4825. This work was completed in November 1980.

Ulster, Town of:	The hydrologic and hydraulic analyses for the original study were prepared by NYSDEC and Dewberry & Davis for FEMA, under Contract No. H-4624. This work was completed in May 1984.
Wawarsing, Town of:	The hydrologic for the original study were performed by USACE. The hydraulic analyses were prepared by Gannett Fleming and Carpenter, Inc., for USACE. The work was completed in April 1981.
Woodstock, Town of:	The hydrologic for the original study were performed by Leonard Jackson Associates for FEMA, under Contract No. EMW-88-C-2600. The work was completed in September 1989.

No FIS reports were previously prepared for the Towns of Denning, Hardenburgh and Plattekill in Ulster County.

For the September 25, 2009, FIS, NYSDEC and FEMA entered into a Cooperative Technical Partners Agreement to collaboratively produce this countywide FIS. Revised hydrologic and hydraulic analyses for all approximate studies and for detailed studies on the Saw Kill, Twaalfskill Brook, and Rondout Creek were prepared by Gomez and Sullivan Engineers, P.C. and PAR Government Services for NYSDEC. This work was completed in September 2007.

For this revision, the hydrologic and hydraulic analyses was revised for Alton Creek, Alton Creek Tributary, Beaver Kill, Birch Creek, Broadstreet Hollow, Bush Kill, Bushnellsville Creek, Cross Mountain Hollow, Dry Brook, East Branch Neversink River, Esopus Creek Reach 2, Fox Hollow, Little Beaver Kill, Maltby Hollow Brook, Mink Hollow, Muddy Brook, Rondout Creek Reach 2, Stony Clove Creek, Sundown Creek, Wagner Creek, Warner Creek, Woodland Creek, and Woodland Creek Tributary.

This work was performed for FEMA by Risk Assessment, Mapping, and Planning Partners (RAMPP), a joint venture of Dewberry & Davis LLC, URS Group Inc., and ESP Associates. This work was completed in April 2013.

The digital base map information shown on the FIRMs for the September 25, 2009 partial countywide was provided by NYSDEC. This information was derived from the New York State Office of Cyber Security and Critical Infrastructure Coordination from aerial photography dated April 2004.

The digital base map information shown on the FIRMs under this revision was provided by NYSDEC. This information was derived from the New York State Office of Cyber Security and Critical Infrastructure Coordination from aerial photography dated April 2009.

The projection used for the preparation of the DFIRMs was UTM Zone 18. The horizontal datum was the North American Datum of 1983, GRS1980 spheroid. Differences in 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 the FIRMs.

1.3 Coordination

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

The dates of the initial and final CCO meetings held for prior FISs for the incorporated communities within Ulster County, are shown in Table 1.

TABLE 1 - INITIAL AND FINAL CCO MEETING DATES

Community Name	Initial CCO Meeting	Final CCO Meeting
Ellenville, Village of	June 12, 1980	August 9, 1982
Esopus, Town of	May 25, 1977	August 10, 1983
Gardiner, Town of	June 1978	November 12, 1981
Hurley, Town of	May 1986	*
Kingston, City of	May 25, 1977	April 18, 1983
Kingston, Town of	September 18, 1986	April 20, 1987
Lloyd, Town of	*	August 29, 1984
Marbletown, Town of	October 11, 1990	January 24, 1991
Marlborough, Town of	*	July 16, 1984
New Paltz, Town of	May 26, 1977	May 5, 1981
New Paltz, Village of	May 26, 1977	May 5, 1981
Olive, Town of	*	November 18, 1983
Rochester, Town of	September 25, 1984	March 8, 1990
Rosendale, Town of	May 26, 1977	August 10, 1983
Saugerties, Town of	*	*
Saugerties, Village of	*	*
Shandaken, Town of	*	February 8, 1984
Shawangunk, Town of	June 1978	November 6, 1981
Ulster, Town of	May 25, 1977	April 18, 1983
Wawarsing, Town of	June 12, 1980	September 2, 1982
Woodstock, Town of	May 1987	October 18, 1990

*Data Not Available

Initial CCO meetings for the September 25, 2009, FIS were held in 2004, with representatives of the NYSDEC and local officials and the Town of Plattekill.

Initial CCO meetings for this countywide FIS were held on November 15, 2011, with representatives of the NYSDEC, FEMA, RAMPP, and local officials. Flood Risk Review Meetings were held on March 20, 2013.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic areas of Ulster County, New York.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction. All 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 FIRM (Exhibit 2).

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS

Alton Creek	Preymaker Brook
Alton Creek Tributary	Rochester Creek
Beaver Kill	Rondout Creek Reach 1
Birch Creek	Rondout Creek Reach 2
Black Creek	Sandburg Creek
Broadstreet Hillow	Saw Kill
Bush Kill	Shawangunk Kill
Bushnellsville Creek	Shawangunk River
Cross Mountain Hollow	Stony Clove Creek
Dry Brook	Stony Creek
Dwaar Kill East	Sundown Creek
Dwaar Kill West	Tannery Brook
East Branch Neversink River	Tributary 1 to Mill Brook
Englishmans Creek	Tributary 1 to Rochester Creek
Esopus Creek Reach 1	Tributary 2A
Esopus Creek Reach 2	Tributary No. 18 to Esopus Creek
Fox Hollow	Twaalfskill Brook
Hudson River	Twaalfskill Creek
Kate Yaeger Kill	Verkeerder Kill
Little Beaver Kill	Wallkill River
Maltby Hollow Brook	Wagner Creek
Mara Kill	Warner Creek
Mill Brook	Woodland Creek
Mink Hollow	Woodland Creek Tributary
Muddy Brook	

As part of this countywide FIS, updated analyses were included for the flooding sources shown in Table 3, "Scope of Revision."

TABLE 3 - SCOPE OF REVISION

Stream	Limits of Revised or New Detailed Study
Alton Creek	From its confluence with Birch Creek to approximately 2 miles upstream of Bonnieview Avenue
Alton Creek Tributary	From its confluence with Alton Creek to approximately 520 feet upstream of State Highway 28
Beaver Kill	From its confluence with Esopus Creek Reach 2 to approximately 0.6 miles upstream of Sickler Road
Birch Creek	From its confluence with Esopus Creek Reach 2 to approximately 0.3 miles upstream of Academy Street

TABLE 3 - SCOPE OF REVISION (CONT'D)

Broadstreet Hollow	From its confluence with Esopus Creek Reach 2 to approximately 0.7 miles upstream of Broadstreet Hollow Road
Bush Kill	From its confluence with Ashokan Reservoir to approximately 495 feet upstream of Watson Hollow Road
Bushnellsville Creek	From its confluence with Esopus Creek Reach 2 to approximately 250 feet upstream of State Route 42
Cross Mountain Hollow	From its confluence with Woodland Creek to approximately 500 feet upstream of Morning Dove Road
Dry Brook	From its confluence with Bush Kill to approximately 2.2 miles upstream of Hillside Drive
East Branch Neversink River	From its confluence with Neversink River Reach 2 to approximately 0.2 miles upstream of Denning Road
Esopus Creek Reach 2	From its confluence with the Ashokan Reservoir to approximately 125 feet upstream of Maben Hollow Road
Fox Hollow	From its confluence with Esopus Creek Reach 2 to approximately 0.2 miles upstream of Fox Hollow Road
Little Beaver Kill	From its confluence with Esopus Creek Reach 2 to approximately 0.5 miles upstream of State Route 28
Maltby Hollow Brook	From its confluence with Bush Kill to approximately 0.3 miles upstream of Shultis Lane
Mink Hollow	From its confluence with Beaver Kill to approximately 1.2 miles upstream of Van Hoogland Road
Muddy Brook	From its confluence with Woodland Creek to approximately 310 feet upstream of Woodland Valley Road
Rondout Creek Reach 2	From its confluence with the Rondout Reservoir to approximately 0.3 miles upstream of Slater Road
Stony Clove Creek	From its confluence with Esopus Creek Reach 2 to approximately 0.3 miles of Grubman Road
Sundown Creek	From its confluence with Rondout Creek Reach 2 to approximately 0.7 feet upstream of William Way
Wagner Creek	From its confluence with Beaver Kill to approximately 130 feet upstream of Cross Patch Road

TABLE 3 - SCOPE OF REVISION (CONT'D)

Warner Creek	From its confluence with Stony Clove Creek to approximately 1.4 miles upstream of Silver Hollow Road
Woodland Creek	From its confluence with Esopus Creek Reach 2 to approximately 500 feet upstream of Tonisgah Road
Woodland Creek Tributary	From its confluence with Woodland Creek to approximately 700 feet upstream of Woodland Valley Road

The areas studied by detailed methods were selected with priority given to all flood hazard areas and areas of projected development and proposed construction. 3

In addition, several streams are studied by limited detailed and approximate methods. Section 3.2 provides a comprehensive definition of limited detailed and approximate flood hazard designations.

2.2 County Description

Ulster County is located in southeastern New York, approximately 75 miles north of the New York City metropolitan area. It is bordered on the north by Delaware and Greene Counties, on the south by Orange County, on the east by Dutchess and Columbia Counties, and on the west by Sullivan County. Ulster County has the Hudson River as its eastern county line.

The largest city in Ulster County is the county seat, Kingston, with a population of 23,893. The total 2010 Census population of Ulster County is 182,493 (Reference 30).

The climate in southeast New York is humid continental, characterized by short, mild summers and long, cold winters. The varied terrain induces numerous microclimates with variations in temperature, wind channeling, vertical currents, relative humidity, and precipitation. The mean temperature is 25.2 degrees Fahrenheit (°F) in January and 70.8 °F in July. The annual precipitation is typically between 40 and 50 inches. The average annual snowfall is approximately 62 inches.

The Hudson River flows in a southerly direction along the eastern border of Ulster County. The Hudson River originates near Mt. Marcy in Essex County in northeast New York and flows south for 315 miles to Upper New York Bay, in the southeast corner of New York State. The drainage area of the Hudson River at the northern portion of Ulster County (near the Esopus Creek confluence) is approximately 10,500 square miles.

Other major streams in Ulster County are Rondout Creek, the Wallkill River, Saw Kill, and Esopus Creek. Rondout Creek originates in the New York State Catskill Mountains adjacent to Peekamoose Mountain. The creek flows southwest to southeast for 25 miles to Napanock and the foothills of the Shawangunk Mountains. The valley has steeply wooded slopes and an average width of 700 to 1,500 feet. Beyond this point, the creek then turns northeast and meanders along the base of the Shawangunk Mountains to High Falls then through a narrow, steep banked valley to Rosendale, where it crosses the mountains at Lefevre Falls and flows to its confluence with the Wallkill River. The creek continues to Kingston where it joins the Hudson River.

The Wallkill River originates at the outlet of Lake Mohawk at Sparta, New Jersey. The river generally flows northwest through northern New Jersey into southeast New York

State. In Ulster County, the Wallkill River flows through the Towns of Shawangunk, Gardiner, New Paltz, Rosendale, and Esopus before emptying into Rondout Creek.

Esopus Creek originates at the outlet of Winnisook Lake in the Catskill Mountains. The stream flows north to Big Indian, New York, where it joins Birch Creek and turns to the east. Esopus Creek then flows approximately 4.2 miles to Allaben, New York, which is the location of the Shandaken Tunnel discharge chamber. After receiving discharges from the tunnel at Allaben, the creek flows southeast for 11.8 miles where it enters the Ashokan Reservoir (drainage area – 256 square miles; storage capacity – 130.5 billion gallons). The creek continues southeast and then turns to the northeast where it flows through the Towns of Marbletown, Hurley, Ulster, and Saugerties, eventually discharging into the Hudson River. The main channel of Esopus Creek is lined with trees and consists of wooded areas interspersed with areas of short grasses and brush or cropland.

The Ashokan Reservoir is located on Esopus Creek. The reservoir, completed in 1915, was designed to provide drinking water for New York City. It also acts as a detention basin, thus significantly reducing the potential for flooding downstream, and serves as an important recreation facility for the surrounding communities.

2.3 Principal Flood Problems

Flooding can occur in Ulster County during any season of the year, but is most likely to occur in the late winter-early spring months when severe or long-duration precipitation events combine with melting snow. Late summer flooding is also a possibility due to thunderstorms and tropical storms/hurricanes carrying abundant amounts of rain as they travel up the eastern seaboard.

Portions of Esopus Creek are silty, which may cause a reduction in capacity during flooding. During the winter, the reduction in flow capacity may cause ice to form in the channel, blocking the flow of water (ice jam) and creating severe flooding. Ice jams have been reported in some locations on Esopus Creek.

Some of the major storms of record in Ulster County occurred December 29-31, 1948; October 14-18, 1955; August 17-19, 1955; and March 21-22, 1980. Discharges for major floods occurring in the study area were obtained from the USGS gaging station on Esopus Creek. The USGS gage (No. 01362500) on Esopus Creek is located at Coldbrook, New York, above the Ashokan Reservoir and has a drainage area of 192 square miles. The Kingston Flood Control Project on Esopus Creek is located at Kingston, New York, below the Ashokan Reservoir and has a drainage area of 319 square miles..

A significant ice jam occurred on Esopus Creek in February 1976. The area subject to the most damage in the City of Kingston consisted of a portion of Esopus Creek approximately 7,000 feet in length, from Old Route 28 to approximately 3,500 feet downstream of State Route 199. Along this portion of the stream are two trailer parks and several residential and commercial structures. Although the flood level caused by the ice jam was lower than the flows of the storms in 1951 and 1955, damage to structures was extensive.

Floods in Rondout Reservoir Watershed can occur anytime during the year. Flooding that occurs in the summer and fall seasons is caused mainly by heavy rainfall produced by hurricanes and tropical storms. Flooding occurring in winter and spring mainly results from snowmelt caused by rising temperatures and/or mixing of rain with snow. The largest storm on record in Rondout Creek occurred during Hurricane Irene in August

2011. The measured peak discharge at the Rondout Creek gage during Hurricane Irene was 7,970 cubic feet per second (cfs). The flooding that occurred as a result of Hurricane Irene had a recurrence interval between a 25-year and 50-year storm at the Rondout Creek gage.

In the Neversink Watershed, storm events in the latter part of summer and early fall of 2011 resulted in record peaks within the watershed. The second highest flood peak, approximately 21,300 cfs, was recorded at USGS Gage 01435000, on the Neversink River near Claryville, New York. Additionally, record peaks were observed on the East Branch of the Neversink River at USGS Gage 0143400680 near Denning, and USGS Gage 01434017 near Claryville, as well as on the West Branch Gage at Claryville. High-water marks were collected as part of FEMA's rapid response riverine high-water mark collection for Hurricane Irene (Reference 36). Where available, these high-water marks were used in calibration of streams studied by detailed and limited detail models.

2.4 Flood Protection Measures

Several communities within Ulster County have constructed flood-control structures to mitigate flooding. The following paragraphs describe some of the more significant measures.

Kingston Flood Control Project – (Esopus Creek)

This improvement to the right bank of Esopus Creek is located between State Route 28 / Interstate Route 587 and Washington Avenue and was constructed in 1978. The levee design flow is 37,400 cfs, which at the time represented the 100-year flood and is 10-percent greater than the largest known flood, with a discharge of 34,000 cfs. Current hydrology has put the 100-year discharge at 45,452 cfs. Documentation provided by the NYSDEC indicates the Kingston Levee does not meet the freeboard requirements of 44 CFR 65.10 of the NFIP Regulations. Accordingly, the levee has been mapped as not providing protection against the 1-percent-annual-chance flood.

Ellenville Flood Control Project - (Sandburg Creek)

As a result of the extensive damage inflicted on the Village of Ellenville during the 1955 flooding, a local flood protection project for North Ellenville, Beer Kill, and Fantine Kill was initiated by USACE. This project, as authorized by the 1962 Flood Control Act, provides local works for the protection of Ellenville from the overflow of Beer Kill and Fantine Kill. Flooding in this area is the result of the closeness with which the streams discharge into Sandburg Creek, thereby causing their waters to sweep over the low-lying ground that separates the mouths of these streams. The improvement is designed to protect part of North Ellenville against a recurrence of a flood greater than the flood of 1955. Total protective works along Beer Kill and Fantine Kill extend approximately 16,130 feet, with 7,440 feet on the right bank of Beer Kill, 3,860 feet on the left bank of Beer Kill, 280 feet of flume near Main Street, and 275 feet of channel improvement. The protective works along Fantine Kill include 380 feet of channel improvement, a new channel 1,200 feet in length, and levees of 1,400 feet in length on the left bank and 1,300 feet in length on the right bank. Protective works consist of levees, walls, concrete flume, channel improvement, interior drainage and diversion ditches, ponding areas, the raising or replacement of bridges, abutments and approaches to the bridges, the removal of a dam, and the relocation of utility facilities and other structures. This flood-control project is not mapped as providing protection against the 1-percent-annual-chance flood.

Rosendale Flood Control Project – (Rondout Creek)

The Rosendale flood-control project consists of channel improvements, walls, levees, interior structures, ponding areas, a pumping station, road raising, and removal of buildings. The channel excavation consisted of deepening and widening for 11,300 feet, starting 1,000 feet upstream of the New York State thruway bridge and terminating 450 feet upstream of the James Street Bridge. The existing channel was widened and deepened through the gorge at Lefevre Falls for a distance of approximately 500 feet. This flood-control project is not mapped as providing protection against the 1-percent-annual-chance flood.

Ashokan Reservoir – (Esopus Creek)

The Ashokan Reservoir, although not specifically designed for flood control, has historically provided some storage during floods. The reservoir is located on Esopus Creek 1.6 miles south of Ashokan and 9.1 miles northwest of the City of Kingston in Ulster County. The reservoir drains 256 square miles of land and has had water levels recorded daily since 1913. The Ashokan Reservoir is formed by the masonry Olive Bridge Dam across Esopus Creek and a series of earthen embankments between hills. The reservoir is divided into two basins separated by a weir containing a gate house. The initial filling of the reservoir began on September 9, 1913. Usable capacity of the west basin is 47,180 million gallons between a minimum operating level of 495.5 feet and the crest of the spillway to the east basin at an elevation of 590.0 feet. Dead storage below the minimum operating level is 2,237 million gallons. The east basin operates at a minimum level of 500.0 feet to the spillway crest elevation at 587.1 feet. Usable capacity of the east basin is 80,678 million gallons, with no dead storage. The reservoir impounds water for diversion into Catskill Aqueduct for the New York City water supply system.

Rondout Reservoir – (Rondout Creek)

The reservoir is located at the release chamber at Merriman Dam on Rondout Creek, 1.1 miles upstream from Brandy Brook, and 1.3 miles northwest of Lackawack in Ulster County. The reservoir drains 94.4 square miles of land and the water levels have been recorded since 1851. Rondout Reservoir is formed by an earthfill rockfaced dam. The reservoir was initially filled to capacity (crest of spillway) on March 28, 1955, approximately 4 years after its storage began on May 10, 1951. The minimum operating level elevation of 720.0 feet and crest of spillway elevation of 840 feet will yield a usable storage capacity of 50,048 million gallons. The dead storage below the minimum operating level is approximately 2,387 million gallons. The reservoir impounds water from the following sources: Rondout Creek; the Cannonsville Reservoir diverted through the West Delaware Tunnel; the Pepacton Reservoir diverted through the East Delaware Tunnel; and the Neversink Reservoir diverted through the Neversink-Grahamsville Tunnel. Water is also diverted from Rondout Reservoir for the New York City water supply through the West Tunnel of the Delaware Aqueduct.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed or limited detailed methods in the county.

Precountywide Analyses

In the Town of Hurley, discharges for Esopus Creek were previously developed by the USACE—New York District and NYSDEC, using a USACE HEC-1 model of the entire Esopus Creek basin. One of the key assumptions in this USACE HEC-1 model was that the Ashokan Reservoir would be full or nearly full during the occurrence of a major storm. When this assumption is input into the USACE HEC-1 model, very large discharges for respective recurrence intervals in the lower Esopus Creek basin were created. When considering worst case flooding and determining a Standard Project Storm or a Probable Maximum Flood (PMF), the assumption is that the reservoir is full approximately 2 to 3 months out of the year; however, in developing a statistical analysis of past flooding, this assumption cannot be made because the reservoir has not been full during any of the large historic floods.

A more appropriate method for determining the discharge-frequency relationship for the reservoir outflow is to perform a log-Pearson Type III analysis of the outflows from the Ashokan Reservoir. This leaves out any assumptions concerning the initial water-surface elevation (WSEL) in the reservoir and models what has actually occurred in the past for the lower Esopus Creek basin. Therefore, a log-Pearson Type III analysis was performed using the last 42 years of peak recorded outflows from the Ashokan Reservoir. Using these revised peak discharges (determined from the log-Pearson Type III analysis), hydrographs for the 10-, 50-, 100-, and 500-year floods were then estimated using the previously determined hydrographs (from the original USACE HEC-1 model) as a guide. These hydrographs were then routed using the USACE HEC-1 models (1981 version) through the study area.

For streams studied by detailed methods in the FIS for the Town of Hurley, dated August 18, 1992, the peak discharges of the 100-year recurrence interval were determined using the procedures and regression equations outlined in gaged streams. For the southeastern region of New York State, the following equation was used:

$$Q = K(DA)^{X}S^{Y}(P\text{-}20)^{Z}$$

Where Q is the stream discharge: DA is the drainage area; S is the main channel slope; and K, x, y, and z are functions of the frequency. The value used for (K) was 0.138, for (x) 1.06, for (y) 0.447, and for (z) 1.57.

In the Towns of Olive and Shandaken, the NYSDEC developed a model of the Esopus Creek basin using the USACE HEC-1 computer program. The model was modified by the USACE—New York District to reflect the flood of March 21-22, 1980, at the Coldbrook gaging station. Hypothetical storms with recurrence intervals of 10, 50, 100, and 500 years were then developed using Technical Memorandum HYDRO-35 and Technical Paper 40. By computing the 10-, 50-, and 100-year floods on the model and adjusting the constant loss rate of rainfall to a reasonable value, peak discharges were produced at Coldbrook in close agreement with the peak discharge-frequency relations based on a 49-year record of flood peaks observed at Coldbrook. However, no agreement between the hypothetical 500-year flood and the peak discharge versus frequency curve based on observed flood peaks was possible.

Peak discharges were required at Coldbrook and four points upstream to the Town of Shandaken for the 10-, 50-, 100-, and 500-year hypothetical floods and the flood of March 21-22, 1980. The procedure used to define these discharges is as follows. Peak discharges at Coldbrook for the 10-, 50-, 100-year flood were computed by the USACE HEC-1 computer model using the hypothetical storms. The 500-year peak discharge at Coldbrook was taken from the peak discharge-frequency curve based on observed floods. These discharges were plotted, and the curve was adjusted for partial duration and then used as the peak discharge-frequency relation for Coldbrook.

For the four points upstream of Coldbrook, the 10-, 50- and 100-year peak discharges computed by the USACE HEC-1 model from the hypothetical storms were plotted, and curves were drawn. The curves were extended to a 500-year recurrence interval by making them parallel to the curve for Coldbrook. They were also adjusted for partial duration.

In the Town of Wawarsing hydrologic analyses were made to determine the peak discharges for the 10-, 50-, 100-, and 500-year floods and the June 1972 and March 1980 floods at various points of interest along Rondout Creek and Sandburg Creek. The hydrologic analyses were based on a study done by Water Resources Engineers, Inc. Modifications were made to the basic model as necessary to provide information at the required locations. The revised model was then calibrated to updated discharge-frequency relationships for the hypothetical events and to observed data for the June 1972 and March 1980 storms.

Updated discharge-frequency relationships were developed according to current Water Resources Council guidelines by using a USACE computer program for four USGS gages. The gages included USGS gage No. 01365000 on Rondout Creek near Lowes Corners (1937-1979), USGS gage No. 01365500 on Chestnut Creek at Grahamsville (1939-1979), USGS gage No. 01366650 on Sandburg Creek at Ellenville (1957-1977), and USGS gage No. 01367500 on Rondout Creek at Rosendale (1910, 1915-1918, and 1927-1980).

Data for the gages were obtained from the USGS in the form of annual peak discharges. The calibration of the model was accomplished by the utilization of the USACE HEC-1 computer program.

In the Town of Woodstock, two regional analysis methods were used to compute peak discharges for the FIS dated September 27, 1991. A USGS analysis, "Techniques for Estimating Magnitude and Frequency of Floods on Rural Unregulated Streams in New

York," utilized gage data throughout New York State to formulate regression equations for use on ungaged streams. The Stankowski Method utilized the parameters of drainage area, channel slope, and impervious area in regression equations. Peak discharges were also computed using an SCS method.

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Rondout Creek

In the previous effective studies, the hydrologic analysis for Rondout Creek was performed in two parts. These parts consisted of the portions above and below the confluence of the Wallkill River with Rondout Creek.

Above the confluence of the Wallkill River, the previous effective study for Rondout Creek was performed using a log-Pearson Type III analysis based on USGS gage No. 01367500 on Rondout Creek at Rosendale, New York using the period of record from 1927 to 1981. The previous study also performed a log-Pearson Type III analysis using only the 38 years of regulated record (1944 to 1981) to reflect the operation of the Rondout Reservoir, located approximately 35 stream miles upstream of the Rosendale gage. The results of the regulated-only analysis were almost identical to the analysis of the entire record. Therefore, the effects of regulation or diversion were deemed negligible at the gage site.

As described in the previous study for the Town of Rosendale:

> "The hydrologic analysis below the confluence of the Wallkill River is complicated by the fact that the Wallkill River basin is approximately twice as large as the Rondout Creek basin at the confluence of the two streams, but the discharges of the Wallkill River are lower due to the geologic conditions in the basin (Reference 1). Therefore, a drainage area-discharge transfer using the Rosendale gage would not be reliable, and a different method of analysis was required. The methodology in a regional frequency study by the COE was selected for this application (Reference 2). Basin characteristics for each stream were averaged using information from USGS gages Nos. 01367500 on Rondout Creek at Rosendale and 01371500 on the Wallkill River at Gardiner, New York. Discharges for Rondout Creek were then developed and modified to closely relate to the August 1955 and October 1955 floods, which are the floods of record for Rondout Creek and the Wallkill River."

The previous study for the Town of Rosendale also mentions that the discharges on the Wallkill River are influenced by topographic constrictions in the Perrine's Bridge area and large amounts of available storage upstream of Perrine's Bridge. As described in that report:

> "Discharges for the Wallkill River were developed using the HEC-1 Modified Puls storage routing model. The flood of October 1955 at the USGS gage in Gardiner, New York, was assigned a recurrence interval of 100 years in the USGS Report No. 78-322 (Reference 3). Discharge ratios used in deriving the discharges for the different frequencies in the HEC-1 analysis were taken from the information provided in the above mentioned report. Surveyed cross-section data and USGS topographic maps were used to determine the storage-elevation

> relationships for the Wallkill River. A rating curve of elevation-discharge was developed from the COE HEC-2 model. The October 1955 hydrograph, discharge ratios, storage-elevation relationships, and the elevation-discharge rating curve were incorporated into the HEC-1 model. The derived discharges were then used in the HEC-2 model, and the model was adjusted to match the observed elevations of the October 1955 flood."

For the present study, the hydrological analysis of Rondout Creek is divided into two parts—upstream and downstream of the confluence with the Wallkill River—as it was in the previous study.

<u>Rondout Creek upstream of the confluence with the Wallkill River:</u>

A Log-Normal Graphical Analysis was conducted for USGS Gage 1367500, located at Rosendale on Rondout Creek. This analysis was performed graphically because the record includes the possible effects of regulation by the Rondout Reservoir. The graphical analysis was performed for the period of record after 1943, when the Rondout Reservoir became operational. The contributing area at the Rosendale gage is 383 square miles, and the regulated period of record consists of 61 years (1944 to 2004).
In addition, two log-Pearson Type III analyses were conducted for the regulated period (1944 to 2004), and for the entire period of record (1927 to 2004). The results of these two new analyses are similar, indicating that the effects of regulation appear to be negligible, as the previous FIS concluded.

The effective discharges are more conservative than the newly computed discharges and the regulated results vary by less than 15 percent. Therefore, the effective discharges are nominated for new Hydraulic Studies at the Rosendale USGS gage location. Additional nominations were transferred from the Rosendale gage location using a discharge-area relationship derived from the 1991 USGS regression equations, or by interpolation based on relative drainage areas.

<u>Rondout Creek downstream of the confluence of the Wallkill River:</u>

There is no USGS gage record at or below the confluence of the Wallkill River with Rondout Creek. To obtain a relationship for the combined contribution of the drainage areas (1,173 square miles), a timing analysis was conducted using 15-minute interval hydrographs for two USGS gages. The gage at Rosendale on Rondout Creek (383 square miles of drainage area at Rosendale) is near the confluence. However, the gage at Gardiner on the Wallkill River (695 square miles of drainage area at Gardiner) is roughly 15 miles upstream of the confluence, and has a difference of approximately 91 square miles of contributing drainage area (695 vs. 786 square miles). The results of the gage analysis at Gardiner were transferred downstream using the discharge-area relationship derived from the USGS Regression Equation for NYS Region 4.

Peak flows for Rondout Creek below the confluence with the Wallkill River were estimated by combining hydrographs from the two streams. An estimate of the lag time between the arrivals of the two hydrographs at the confluence is required to combine the two hydrographs. Ranges of lag times were estimated from general channel and flood conditions. These estimates were applied to 15-minute interval hydrographs from the Rosendale and Gardiner gages for a November 2005 event. The 15-minute interval hydrograph for Gardiner was transferred downstream, taking into consideration the additional 91 square miles of contributing area. Various lag times were assumed and graphically combined with the 15-minute interval hydrograph for Rosendale. This resulted in the combined peak discharges equal to a fraction (between 0.91 and 0.99) times the sum of the peak discharges of each hydrograph. These relationships were applied to the updated gage analyses for Rosendale and Gardiner to estimate the 10-, 2-, 1-, and 0.2-percent-annual-chance discharges.

The previous effective discharges compare well with the newly estimated discharges for the confluence of the Wallkill River with Rondout Creek, and the previous effective discharges are the more conservative estimates. Therefore, the previous effective discharges are nominated for the reach of Rondout Creek below the confluence with the Wallkill River. The results of the analysis were transferred downstream using the discharge area relationship derived from the USGS regression equations New York State Region 4 (Reference 4).

The nominated discharges for Rondout Creek are presented in Table 4, "Summary of Discharges."

<u>Esopus Creek</u>

This countywide FIS includes a Limited Detailed Study on Esopus Creek of approximately 7.3 miles, proceeding immediately downstream from the Ashokan Reservoir. This reach was mapped previously as an approximate study; therefore, discharges were not reported. In the previous FIS, a detailed study was carried out for locations farther downstream on Esopus Creek, and flow nominations were reported at several locations, including the Mount Marion gage site (USGS 01364500), the City of Kingston, and the downstream corporate limits of the Town of Hurley. Peak flow nominations were also reported for the 100-year return period at the downstream corporate limit of the Town of Marbletown. These effective flows were determined using a HEC-1 analysis, which was a revision of an earlier HEC-1 analysis used in the original FEMA FIS. The original modeling was based on the assumption that the Ashokan Reservoir would be at spillway crest at the time of the flooding event. However, subsequent observations of reservoir levels during actual flooding events suggested that the full-reservoir scenario was less likely than first assumed. Therefore, the HEC-1 model was updated in the previous FIS to anticipate some storage capacity in the reservoir. Printouts of the revised HEC-1 model for Esopus Creek were obtained from NYSDEC and compared to the effective discharges obtained from the previous FIS reports.

This FIS compares the previous effective flows, based on the revised HEC-1 model, to an analysis of three gage records. The comparison is based on records for the Mount Marion gage on Esopus Creek (USGS 01364500), the Coldbrook gage (USGS 01362500), which provides a record of inflow to the Ashokan Reservoir, and the spill and release records for the Ashokan Reservoir (NYCDEP). The analysis provides an estimate of probable reservoir storage, based on inflow and outflow from the reservoir, recorded for several of the larger events. The drainage area at Coldbrook is 192 square miles, the drainage area for the Ashokan Reservoir is 256 square miles, and the drainage area at Mount Marion is 419 square miles. For the larger events that are available at all three locations, the available storage capacity of the Ashokan Reservoir appears to be a key factor in the resulting discharge below the reservoir.

The Mount Marion gage record provides historic flows for the years of 1908 to1915 and 1971 to 2004. It does not include the years between 1915 and 1971. The Coldbrook gage record was used to estimate the historical inflows to the Ashokan Reservoir for the years of 1932 to 2004. The probability-peak discharge analyses for both the Mount Marion gage and the Ashokan Reservoir spill and release data used graphical plotting techniques in consideration of the influence of regulation from the Ashokan Reservoir. The updated analysis for the Mount Marion gage indicates peak flows considerably lower than the HEC-1 analysis used in the FIS study. These results again suggest that the contribution of the regulation at the Ashokan Reservoir is significant. This supports the assumptions and revisions of the HEC-1 model, as presented in the 1992 Saugerties FIS, that attempted to take into account the available storage capacity of the Ashokan Reservoir.

To determine the validity of the 1992 Saugerties FIS, an analysis of 18 large flood events was conducted. This analysis compared the gage records for Coldbrook (estimate of the inflows to the reservoir) and the spill and release records for the Ashokan Reservoir (estimate of outflows of the reservoir) to determine the effect of reservoir storage on flood events. This storage effect analysis was then used to determine the reservoir outflow discharges for the 10-, 2-, 1-, and 0.2-percent annual-chance events for the corresponding inflows at the Coldbrook USGS gage. The resulting values are consistent with the modeled outflows of the Ashokan Reservoir obtained from the revised HEC-1 model printouts.

Printouts of the revised HEC-1 model output for Esopus Creek were obtained from the NYSDEC. The modeled flows were extracted from those printouts and used to develop discharge nominations for the Limited Detailed Study on Esopus Creek. The modeled outflows for the Ashokan Reservoir are nominated at the upstream end of the Limited Detail Study. The effective discharge, from the Town of Marbletown FIS, is nominated for the downstream end of the Limited Detail Study at Hurley Mountain Road.

A portion of Esopus Creek upstream of the confluence with the East Ashokan Reservoir Spillway is not affected by reservoir outflows. Peak flows for this upstream section were nominated using the USGS regression equations for New York State.

The nominated discharges for Esopus Creek are presented in Table 4, “Summary of Discharges.”

Twaalfskill Brook

Twaalfskill Brook in the City of Kingston was formerly mapped as an approximate study, and no discharges were reported.

In the present study, Twaalfskill Brook is studied by detailed methods. Discharges were determined using the 1991 USGS regression equations for New York State. This method is applicable since the stream is unregulated, and urbanization is minor (less than 15 percent of the contributing drainage area is classified as impervious).

The nominated discharges for Twaalfskill Brook are presented in Table 4, “Summary of Discharges.”

Saw Kill

Previous studies of Saw Kill are mentioned in the FIS reports for the Towns of Kingston (1988) and Woodstock (1991). Saw Kill also passes through the Town of Ulster (1984), where it has a confluence with Esopus Creek, but no mention is made of it and no nominations are given in the Town of Ulster FIS. The Woodstock FIS indicates that two older methods, based on regional regression analyses, were used to nominate peak flows within the community – the Stankowski Method and the 1979 USGS Regression Equations for New York. However, it was not stated which method was used to make specific peak flow nominations along the Saw Kill. Nominations were given for only the 1-percent-annual-chance event. The Kingston FIS lists nominations based on a USACE HEC-1 study of the Saw Kill basin in the Towns of Kingston, Ulster, and Woodstock.

The present study compares previous nominations from the Kingston FIS (which were obtained using the USACE HEC-1 model) to peak flows estimated using the 1991 USGS Regression Equations for New York State. At a location with approximately 35 square miles of drainage area, regression equation peak flows were within 13 percent of the previously nominated values. The 95 percent confidence interval for Region 4 of the regression equations is 56.6 percent. Since the regression equation estimates are within the recommended confidence limits, and considering the greater level of detail used in the USACE HEC-1 analysis, the previous peak flows were nominated for Saw Kill.

Unfortunately, the peak flows in the previous study as reported in the Kingston FIS were shown for only two locations and for only the 100-year return period. Records of a HEC-2 run from the previous study for the Saw Kill 100-year event were used to determine in detail the locations and discharge values used for the 1-percent-annual-chance event in the present study. These locations and discharges were duplicated in the updated hydraulic modeling for the present study. Also, discharges for the 10-, 2-, and 0.2-percent-annual-chance discharges were taken from archived engineering notes listing the 100-year discharges and locations consistent with those in the HEC-2 model run, along with the discharges for the 10-, 50-, and 500-year return periods. These notes were presumed to document discharges and locations from the HEC-1 study.

This Revision

Hydrologic computations and analyses consist of determining the discharges for the 10-percent, 4-percent, 2-percent, 1-percent, and 0.2-percent-annual-chance flood events for streams studied using detailed methods, and 1-percent-annual-chance flood events for limited detail and approximate study streams within the watersheds. The hydraulic methods used for this analysis include steady flow analysis using HEC-RAS version 4.1. RAMPP will determine peak flood discharges for the 1-percent-annual-chance flood event that uses the effective New York State USGS regression equations (area only) and gage analysis, if applicable.

For drainage areas where a regression analysis is not appropriate, the latest hydrologic analyses guidance found in the NY State Department of Transportation (NYDOT) Highway Drainage Manual will be used. Per the NYDOT guidance, for areas up to 200 acres, the Rational Method with higher runoff coefficients for steeper slopes will be used, while TR-55 will be used for drainage areas up to 640 acres. Small lakes on detailed study reaches that were not constructed as flood-controls structures and that do not have sufficient storage to affect the 100-year WSEL will use the appropriate and most recent full versions of the USGS regression equations to determine a 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood event. A rainfall/runoff model will not be completed for these reaches.

For detailed study reaches on lakes with significant storage, an inflow hydrograph based on a hydrograph created by the USGS's National Streamflow Statistics program for New York State will be used. An inflow hydrograph will be hydraulically routed (using a program like HEC-HMS 3.3) through the lake and the outlet structures (principal, emergency spillways) to determine 10-, 4-, 2- ,1-, and 0.2-percent-annual-chance WSELs.

For the approximate and limited detail hydrologic analyses, full parameter regression equations from USGS's Magnitude and Frequency of Floods in New York, SIR 2006-5112, were used to compute the 1-percent-annual-chance flood discharges. The New York USGS's StreamStats web application (Reference 5) of the regression equations was used to compute desired flood discharges.

For watersheds with specific modeling approaches, details are shown below:

Esopus Watershed:

Flood flow frequencies for all the study streams were developed using a calibrated rainfall-runoff model of Esopus Creek watershed. The model was developed following the criteria outlined in Appendix C of the FEMA Guidelines and Specificatons. The Rainfall-Runoff model was developed using the HEC-HMS 3.5 computer model (Reference 42). Hydrologic losses were based on the Natural Resource Conservation Service's (NRCS) Curve Number method; rainfall-runoff transformations were based on NRCS (unit hydrograph) procedures; and reach routing was based on the Muskingum-Cunge method. Reservoir routing for the Ashokan Reservoir was based on the curves developed by NYCDEP for a Dam Break study (Reference 43). The model calibration and verification were performed by simulating historic flood events. Calibration was performed for Hurricane Irene, which occurred in August 2011, and verifications were performed for Tropical Storm Lee, which occurred in September 2011 and another storm that occurred in October 2005.

Hypothetical rainfall data (frequency storm) are used to develop peak flow hydrographs for the five return intervals scoped for the project. The frequencies considered for this study are 10-Year (10 percent), 25-year (4 percent), 50-Year (2 percent), 100-Year (1percent) and 500-Year (0.2 percent). The hypothetical rainfall used in this study was based on National Oceanic and Atmospheric Administration Atlas 14 data and was obtained from the Northeast Regional Climate Center – Cornell University. The duration chosen for the frequency storm is 24-hour and the type of distribution chosen is SCS Type-2.

Neversink Watershed:

The peak discharge computation procedure is presented in the USGS Scientific Investigations Report (SIR) 2006-5112, *Magnitude and Frequency of Floods in New York*. The methodology outlines the following steps, which were performed to determine peak discharge rates. Step 1 was the only step performed for ungaged streams. Gage weighting was performed for ungaged flow breakpoint locations within the drainage area

influence of the USGS gage on gaged streams. Gage selection and influence criteria is further discussed in section 2.2.3 of the SIR report..
SIR 2006-5112 sub-divided New York into six hydrologic regions by considering regional differences in physiographic and geologic conditions. These delineations were evaluated using statistical tests to compare regression residuals among the six regions. In regions where the mean residuals did not differ statistically, other factors such as topography, geology, climate, and hydrologic judgment were used.

The Neversink Watershed is in hydrologic region 3. The regional regression equations used for peak discharge computations, presented in SIR 2006-5112, are listed below.

$$Q_{10} = 0.103\,(A)^{0.963}\,(LAG+1)^{-0.228}\,(RUNF)^{0.658}\,(MXSNO)^{1.794}$$

$$Q_{25} = 0.117\,(A)^{0.957}\,(LAG+1)^{-0.239}\,(RUNF)^{0.524}\,(MXSNO)^{2.016}$$

$$Q_{50} = 0.119\,(A)^{0.953}\,(LAG+1)^{-0.244}\,(RUNF)^{0.430}\,(MXSNO)^{2.195}$$

$$Q_{100} = 0.115\,(A)^{0.951}\,(LAG+1)^{-0.249}\,(RUNF)^{0.341}\,(MXSNO)^{2.375}$$

$$Q_{500} = 0.105\,(A)^{0.948}\,(LAG+1)^{-0.258}\,(RUNF)^{0.147}\,(MXSNO)^{2.759}$$

Where,

Q is flow, in cubic feet per second

A is drainage area, in square miles

LAG is basin lag factor calculated as $L / [(SL\_UP + 1)(SL\_LO + 1)]^{0.5}$

RUNF is mean annual runoff, in inches

MXSNO is seasonal maximum snow depth, 50^{th} percentile, in inches.

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 4, "Summary of Discharges.

TABLE 4 - SUMMARY OF DISCHARGES

Flooding Source	Location	Drainage Area square miles	Peak Discharges (cubic feet per second) 10-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent-Annual Chance
Alton Creek	Above Alton Creek Tributary	1.08	248	531	698	1,274
	Above confluence with Birch Creek	2.43	563	1,220	1,615	2,989
Alton Creek Tributary	Above confluence with Alton Creek	0.54	140	300	394	718
Beaver Kill	Above confluence with Mink Hollow	1.45	234	448	583	1,002
	Above confluence with Wagner Creek	13.59	2,601	5,232	6,942	12,666
	Confluence of Beaver Kill and Hoyt Hollow	20.58	3,683	7,583	10,109	18,446
	Above confluence with Esopus Creek	25.06	4,613	9,583	12,764	23,147
Birch Creek	Birch Creek at intersection of Birch Creek Rd and Lower Birch Creek Rd	3.05	602	1,348	1,797	3,365
	Above confluence withAlton Creek	4.96	936	2,060	2,738	5,094
	Above confluence with Giggle Hollow	7.96	1,564	3,433	4,570	8,484
	Above confluence with Rochester Hollow	10.24	1,838	4,033	5,390	10,016
	Above confluence with Esopus Creek	12.86	2,253	4,937	6,569	12,348
Broad Street Hollow	Above confluence with Esopus Creek	7.29	1,772	3,628	4,810	8,598
Bush Kill	Above confluence with Kanape Brook	1.11	215	503	695	1,319
	Above confluence with Mine Hollow	5.16	464	1,110	1,557	3,058
	Above confluence with South Hollow	6.3	647	1,537	2,150	4,193
	Above confluence with Maltby Hollow Brook	10.09	1,255	3,046	4,271	8,319
	Above confluence with Dry Brook	17.51	2,485	6,058	8,484	16,492
	Above oulet into Ashokan Reservoir	19.66	2,835	6,938	9,725	18,904
Bushnellsville Creek	2000 ft Upstream of Gossoo Rd	8.59	1,823	3,787	4,944	8,930
	Above confluence with Esopus Creek	11.12	2,200	4,654	6,114	11,213

TABLE 4 - SUMMARY OF DISCHARGES (CONT'D)

Flooding Source	Location	Drainage Area square miles	Peak Discharges (cubic feet per second) 10-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent-Annual Chance
Cross Mountain Hollow	Above confluence with Woodland Creek	2.5	537	1,260	1,740	3,301
Dry Brook	Near upstream end of Dry Brook Rd	1.36	244	600	843	1,647
	Above confluence with Bush Kill	2.01	336	832	1,174	2,310
Esopus Creek Reach 2	Above confluence with Elk Bush Kill	11.8	2,711	5,390	6,943	12,199
	Above confluence with McKinley Hollow	16.14	3,539	7,051	9,104	16,133
	Above confluence with Hatchery Hollow	20.66	4,393	8,919	11,611	20,869
	Above confluence with Lost Clove	26.66	5,439	11,397	15,007	27,333
	Above confluence with Birch Creek	29.95	5,886	12,406	16,312	30,206
	Above confluence with Bushnellsville Creek	47.57	8,716	18,444	24,287	45,372
	Above confluence with Peck Hollow	63.71	11,390	24,274	31,925	60,210
	Above confluence with Broad Street Hollow	69.95	12,600	26,827	35,214	66,342
	Above confluence with Woodland Creek	83.98	15,173	31,970	42,159	79,494
	Above confluence with Stony Clove Creek	105.3	18,209	38,121	51,036	97,916
	Above confluence with Beaver Kill	144.23	24,183	50,173	68,362	134,869
	Above confluence with Little Beaver Kill	173.1	28,476	59,272	80,683	158,630
	Above Ashokan Reservoir	193.64	30,440	63,747	86,781	169,597
Fox Hollow	At Herdmand Rd	2.36	691	1,401	1,814	3,216
Little Beaver Kill	At Yankeetown Pond Outlet	4.04	735	955	1,279	2,261
	At 6000 ft downstream of Coldbrook Rd	7.43	740	1,416	1,940	3,806
	At Woodstock-Olive corporate boundary	13.38	1,455	3,185	4,351	8,361
	Above confluence with Esopus Creek	16.73	1,839	4,038	5,520	10,553

TABLE 4 - SUMMARY OF DISCHARGES (CONT'D)

Flooding Source	Location	Drainage Area square miles	Peak Discharges (cubic feet per second) 10-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent-Annual Chance
Maltby Hollow Brook	Above confluence with Unnamed Tributary	3.3	553	1,321	1,837	3,531
	Above confluence with Bush Kill	6.85	1,192	2,919	4,067	7,864
Mink Hollow	Above confluence with Unnamed Tributary	3.11	1,006	2,069	2,746	4,876
	Above confluence with Beaver Kill	9.46	2,605	5,314	7,058	12,583
Muddy Brook	Above confluence with Woodland Creek	1.42	312	729	1,006	1,926
Rondout Creek Reach 2	At county line	33.4	5,030	8,020	9,470	13,300
	Downstream of confluence of Sundown Creek	33.1	5,000	7,980	9,420	13,300
	At Bridge	26.3	4,260	6,840	8,100	11,400
	Downstream of confluence of High Falls Brook	24.4	4,260	6,840	8,100	1,140
	Upstream of confluence of High Falls Brook	22.3	4,260	6,840	8,100	11,400
Stony Clove Creek	Above confluence with Warner Creek	17.51	4,772	10,569	14,324	26,694
	Above confluence with Ox Clove	27.06	5,807	12,979	17,606	32,650
	Above confluence with Esopus Creek	32.44	6,966	15,463	20,895	38,759
Sundown Creek	At confluence with Rondout Creek	6.77	1,320	2,320	2,840	4,320
	Downstream of confluence of Unnamed Tributary 1	5.8	1,150	2,020	2,840	3,770
	Upstream of confluence of Unnamed Tributary 1	5	995	1,750	2,150	3,270
	Downstream of confluence of Unnamed Tributary 2	4.66	934	1,650	2,020	3,080
	Upstream of confluence of Unnamed Tributary 2	3.1	633	1,120	1,370	2,090
	Downstream of confluence of Unnamed Tributary 3	3.05	623	1,100	1,350	2,050
	Upstream of confluence of Unnamed Tributary 3	1.73	375	665	816	1,250
	Downstream of confluence of Unnamed Tributary 4	1.34	297	528	649	994
	Upstream of confluence of Unnamed Tributary 4	0.76	176	313	385	591

TABLE 4 - SUMMARY OF DISCHARGES (CONT'D)

Flooding Source	Location	Drainage Area square miles	Peak Discharges (cubic feet per second) 10-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent-Annual Chance
Wagner Creek	Above confluence with Beaver Kill	3.87	532	1,230	1,702	3,249
Warner Creek	Above confluence with Stony Clove Creek	9.04	1,448	3,162	4,281	7,915
Woodland Creek	Above confluence with Mount Hollow	9.63	1,930	4,442	6,103	11,485
	Above confluence with Woodland Creek Tributary 1	12.9	2,555	5,920	8,143	15,398
	Above confluence with Panther Kill	15.14	2,938	6,868	9,501	18,113
	Above confluence with Muddy Brook	18.76	3,698	8,598	11,934	22,655
	Above confluence with Esopus Creek	20.58	3,991	9,352	13,011	24,747
Woodland Creek Tributary 1	Above confluence with Woodland Creek	0.37	113	257	353	668

For the Hudson River, stillwater elevations were taken from the prior FISs. Stage-frequency relationships for the Hudson River were developed by the USACE at Catskill, Spuyten Duyvil, and the mouth of Wappinger Creek. The USACE basic data covers recurrence periods from 1 year to 200 years and has been extrapolated to a 500-year frequency on log-probability paper. Tidal stages for points between the mouth of Wappinger Creek and Catskill were obtained by interpolation. Some stillwater elevations were taken from the FIS for the Town of Catskil.

Rondout Reservoir 100- and 500-year WSELs are based on a HEC-1 model of the PMF completed for the Rondout Reservoir, by GZA GeoEnvironmental of New York, Buffalo, New York, (2005), Final Hydrology Study Report for the Merriman Dam and Rondout Reservoir, Contract CAT-146, Capital Project No.WM-30, Detailed Study/Investigation for the Reconstruction of the Dams in the Catskill & Delaware Watersheds. Prepared for the New York DEP, Bureau of Environmental Engineering Watershed Facilities Design, Corona, New York. This model was converted to HEC-HMS. Rainfall data for 100- and 500-year frequency based storms in the converted model are based on the values for the centroid of the Rondout Watersheds from: Extreme Precipitation in New York & New England.

Elevations for floods of the selected recurrence intervals are shown in Table 5, "Summary of Stillwater Elevations."

TABLE 5 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (FEET NAVD 88)				
	10-Yr.	25r.	50-Yr.	100-Yr.	500-Yr.
ASHOKAN RESERVOIR					
West Basin (Ashokan Reservoir)	592.6	593.9	595.1	596.5	600.7
East Basin (Ashokan Reservoir)	588.8	589.7	590.5	591.4	594.4
HUDSON RIVER					
At Newburgh, New York	5.5	*	6.6	7.2	8.7
At Poughkeepsie, New York	5.9	*	7.1	7.9	9.7
In the Vicinity of Hyde Park	5.8	*	7.2	7.9	9.7
At Kingston Point	6.0	*	7.5	8.9	10.4
In the Vicinity of Tivoli	6.1	*	7.8	8.5	10.6
At upstream Town of Saugerties corporate limits	6.2	*	7.9	8.5	10.8
KENOZIA LAKE					
Generic Junction	693.9	694.7	695.4	696.4	699.1
LITTLE BEAVER KILL					
Little Beaver Kill at Yankeetown Pond Outlet	843.5	843.5	844.2	844.9	846.6
PEEKAMOOSE LAKE					
Entire shoreline	*	*	*	1453.9	*
RONDOUT POND					
Entire shoreline	*	*	*	1944.8	*
RONDOUT RESERVOIR					
Entire shoreline	*	*	*	844.2	846.3

*****Data Not Available

3.2 Hydraulics Analyses

Analyses of the hydraulic characteristics of flooding from the stream 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 this FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Cross-section elevations were extracted from a Digital Elevation Model (DEM). The DEM was generated by combining overbank elevation data from an aerial Light Detection and Ranging (LiDAR) survey with data from a traditional field survey of the stream channel and the immediate overbank areas. For detailed studies, cross sections were field surveyed at close intervals just upstream and downstream of bridges, culverts, dams, and other hydraulic obstructions, at natural control sections along the stream length, and at significant changes in ground relief, land use, or land cover. Detailed structural geometry for bridges and culverts was also obtained from NYDOT as-built drawings where they were available.

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

Precountywide Analyses

In the Town of Hurley, WSELs of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program. For this August 18, 1992, FIS, the computer model was calibrated using historic floodwater profiles. Flood profiles were drawn showing computed WSELs for floods of the selected recurrence intervals. Starting WSELs for Esopus Creek were taken from the FIS for the Town of Ulster. Starting WSELs for the remaining streams studied in detail were calculated using the slope-area method.

The approximate analyses for the Ashokan Reservoir, First Lake, and Kenozia Lake were taken from the USGS publication, Determination of Approximate 100-Year Flood Boundaries for Streams in New York State.

In the Towns of Olive and Shandaken, WSELs of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program Flood profiles were drawn showing computed WSELs for floods of the selected recurrence intervals. Starting WSELs for Esopus Creek were calculated by the slope/area method.

In the Town of Wawarsing, the WSELs of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program. The hydraulic model was adjusted using available high-water marks of the March 1980 flood. The USGS gaging station rating table for Sandburg Creek was also used when adjusting the hydraulic model for Sandburg Creek. Starting WSELs for the streams studied by detailed methods were determined using the slope/area method.

In the Town of Woodstock, the WSELs of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program. The starting WSEL for Saw Kill was determined by coincident peak. The starting WSEL for Beaver Kill and West Branch Tannery Brook were determined by critical depth. The starting WSEL for East Branch Tannery Brook was determined by the slope/area method.

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WSELs for floods of the selected recurrence intervals for detailed, limited detail, and approximate studies were computed using the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) river modeling software program (Version 3.1.3). The HEC-RAS model for each flooding source is based on cross-section geometry generated using manual and semi-automated methods derived from GIS techniques and data.

In accordance with FEMA's Guidelines and Specifications, starting WSELs for the hydraulic models were determined using normal depth. For reaches where the hydraulic analysis indicated supercritical flow conditions, critical depth was assumed for the flood elevations.

Rondout Creek

This detailed restudy begins at the confluence with the Hudson River in the City of Kingston/Town of Esopus, and extends upstream approximately 12.5 miles to the Lawrenceville Road Bridge in the Town of Rosendale.

Twaalfskill Brook

Prior to this countywide analysis, Twaalfskill Brook was studied by approximate methods. For this new detailed study, the reach begins at the confluence with Rondout Creek and extends upstream approximately one half mile to the Brook Street crossing in the City of Kingston

Saw Kill

Prior to this countywide analysis, Saw Kill Creek was studied by approximate methods in the Town of Ulster, and detailed methods in the Towns of Kingston and Woodstock. This detailed study/restudy for Saw Kill begins at the confluence with Esopus Creek in the Town of Ulster, extends upstream approximately 8.46 miles, and ends approximately 2,020 feet above the dam at Kingston Reservoir #2. This FIS only covers the 3.48-mile portion of the stream between its confluence with Esopus Creek and the Town of Kingston/Town of Woodstock corporate limits.

Esopus Creek (Limited Detailed)

Prior to this countywide analysis, this reach of Esopus Creek was studied by approximate methods. This new limited detailed (enhanced approximate) study begins approximately 350 feet downstream of the County Route 5 (Hurley Mountain Road) bridge (Town of Marbletown) and extends upstream approximately 7.5 miles into the Town of Olive to a location approximately 350 feet upstream of the covered bridge on the State University of New York New Paltz – Ashokan Field Campus.

Roughness factors (Manning’s “n”) used in the hydraulic model were chosen by engineering judgment and are based on field observations and semi-automated methods supported by GIS-based techniques. Table 6 provides a summary of the Manning’s “n” values used in the hydraulic computations for the channel and overbank areas.

This Revision

Hydraulic analyses were completed for flooding sources identified in the *Technical Proposal for Task Order HSFE02-11-J-0001* (subsequently changed to Task Order HSFE02-11-J-0001, upon signing), dated August 31, 2010, prepared by RAMPP. The analyses consisted of determining WSELs for the 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood events and floodways for detailed study streams, and 1-percent-annual-chance flood events for limited detail and approximate study methods within the watershed. The hydraulic methods used for this analysis include steady flow analysis using HEC-RAS version 4.1. The most recent versions of the USGS regression equations were used to determine the peak discharges for small lakes on limited detailed study reaches.

Regulatory floodway widths were determined using the equal-conveyance reduction approach on both overbanks. All floodways were confirmed to be outside of the current boundaries of NYSDEC’s polygon shapefile defining freshwater wetlands. The encroachments on the 1-percent-annual-chance flood event were applied such that a positive surcharge less than or equal to 1.0 foot for all cross sections. RAMPP computed 50- and 1-percent-annual-chance peak discharges for approximate and limited detail study streams and 50-, 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance peak discharges for detailed study streams. These peak discharges were used for the hydraulic analyses of study streams.

Normal depth, which was computed using ground profile slope, was used as the downstream boundary condition for all streams tying into the backwater of a main-stem. For cases where a stream was divided into multiple reaches to accommodate different levels of study detail, the WSEL transition was made continuous by using Known WSEL as the downstream boundary conditions for the upstream reach. Known WSEL was also used for streams determined to have coincident peak with the main stem at their confluence. Coincident peaks were used for confluencing streams where the ratio of the two drainage areas is between 0.6 and 1.4, the shapes of the drainage areas are similar, and there is a high likelihood of a single storm covering both areas.

Applicable situations for split flow analyses were assessed for detailed and limited detail study reaches only. A split flow was modeled for significant flow separation and mixing between two limited detail study streams: West Branch Neversink River and West Branch Neversink River Tributary 3. The land use in this area is primarily forest. The situation is being captured using split flow junctions at the upstream and downstream ends, with lateral weirs to allow flow exchange where flow is overtopping from one stream to the other. There is a diversion structure into West Branch Neversink River Tributary 3, upstream of the scope of West Branch Neversink River, but there is significant overtopping of the diversion structure and it is not affecting the flow balance. Because this diversion is upstream of the study limit of the limited detailed study stream, no survey was available. To test the sensitivity of the model to the opening width, flow through the opening was tested with an assumed opening of 2-foot diameter and 0.2-foot diameter, both as a circular culvert. The opening only conveyed 19 cfs for the 1-percent-annual-chance event for the 2-foot diameter opening and 0.06 cfs for the 0.2-foot diameter opening.

The flows at the downstream junction do not have coincident peaks, so the main stem flow is used as the primary flow. The split flows into West Branch Neversink River Tributary 3 are higher than the calculated peak flows, except where cross sections for West Branch Neversink River Tributary 3 would not contain the flow for either case.

Calibration is the final phase of the modeling process that serves as verification that the model adequately represents the physical system. For floodplain studies, this is often accomplished by comparing the WSELs of a recent significant flood event with the results of a model simulation under the same conditions. Additionally, measured flow rates and flow depths at USGS streamgage locations can be compared to the various flow profiles of a model simulation. For the current study, the significant flood event used as the benchmark for comparison to model outputs was Hurricane Irene. The flooding in the Esopus Watershed caused by Hurricane Irene was severe enough to wash out bridges and shift channel centerlines in some locations. The stage and discharge of this event was recorded at several locations by several USGS streamgages in the watershed. High-water marks were also collected at several locations. All streamgages and high-water marks were considered in the calibration of the study reaches. However, some study reaches did not have any calibration data available.

Roughness factors (Manning's "n") used in the hydraulic model were chosen by engineering judgment and were based on field observations of the streams and floodplain areas Table 6 provides a summary of the Manning's "n" values used in the hydraulic computations for the channel and overbank areas

TABLE 6 - MANNING'S "N" VALUES

Flooding Source	Channel "n" Values	Overbank "n" Values
Alton Creek	0.065 - 0.070	0.013 - 0.100
Alton Creek Tributary	0.050 - 0.065	0.016 - 0.120
Beaver Kill	0.048 - 0.059	0.016 - 0.110
Birch Creek	0.040 - 0.059	0.013 - 0.100
Black Creek	0.044 - 0.055	0.060 - 0.070
Broadstreet Hollow	0.044 - 0.055	0.016 - 0.100
Bush Kill	0.050 - 0.080	0.016 - 0.100
Bushnellsville Creek	0.050-0.085	0.016-0.100
Cross Mountain Hollow	0.058-0.067	0.016-0.100
Dry Brook	0.055-0.060	0.016-0.100
Englishmans Creek	0.030 – 0.040	0.080
East Branch Neversink River	0.032-0.045	0.030-0150
Esopus Creek Reach 1	0.030-0.045	0.020-0.080
Esopus Creek Reach 2	0.030-0.063	0.016-0.120
Esopus Creek (LD)	0.035 – 0.065	0.060 – 0.200
Fox Hollow	0.045-0.065	0.016-0.100
Dwaar Kill	0.030 – 0.040	0.060 – 0.080
Kate Yaeger Kill	0.030 – 0.040	0.040 – 0.100
Little Beaver Kill	0.048-0.065	0.016-0.100
Maltby Hollow Brook	0.060-0.080	0.016-0.100
Mink Hollow	0.050	0.016-0.100
Muddy Brook	0.068-0.073	0.016-0.100
Preymaker Brook	0.030 – 0.040	0.080
Rondout Creek Reach 1	0.029 – 0.100	0.050 – 0.198
Rondout Creek Reach 2	0.055-0.062	0.020-0150
Sandburg Creek	0.038-0.042	0.045-0.060
Saw Kill	0.034 – 0.064	0.049 – 0.180
Shawangunk Kill	0.030 – 0.040	0.060 – 0.080
Stony Clove Creek	0.048-0.080	0.016-0.100
Stony Creek	0.030-0.040	0.080
Sundown Creek	0.055-0.062	0.020-0.150
Twaalfskill Brook	0.030 – 0.070	0.030 – 0.178
Tannery Brook	0.035	0.060 – 0.120
Vernooy Kill	0.040-0.045	0.050-0.083
Wagner Creek	0.040-0.068	0.016-0.100
Wallkill River	0.015 – 0.065	0.060 – 0.080
Warner Creek	0.058-0.083	0.016-0.120
West Branch Tannery Brook	0.035	0.060-0.120
Woodland Creek	0.054-0.059	0.016-0.100
Woodland Creek Tributary	0.065	0.016-0.100

As discussed previously, certain flooding sources were studied using limited detailed and approximate methods. These methods are discussed below.

<u>Limited Detail "Enhanced approximate floodplains":</u> This category is assigned to areas where "unnumbered" A Zones are shown on the effective maps, and communities have requested new/upgraded studies, but the level of projected development does not warrant a detailed study. It is also applied to lakes that do not have level gage data, and will be included in a hydraulic model. The level of effort includes collection of orthophotos, LiDAR, and limited survey of structures, nomination of flow rates, and the development of HEC-RAS hydraulic models.

For the purposes of this document "limited survey" refers to the survey of man-made hydraulic obstructions, such as dams, bridges and culverts, and to the survey of the outlet channels of lakes with natural outlet controls. The purpose of collecting limited survey data is to enhance the accuracy of the hydraulic model, thus allowing the development and publication of "Advisory Base Flood Elevations (ABFEs)." Engineering drawing plans and Department of Transportation (DOT) hydraulic studies may be substituted for limited survey, where appropriate and available.

For the Esopus Creek Limited Detail study, two bridges were surveyed and modeled in the study reach. The structures were located at the downstream and upstream segments of the study reach. In addition to the two man-made structures surveyed, a survey of the Esopus Creek channel was performed to further enhance the accuracy of the hydraulic model. The 1-percent-annual-chance ABFEs for selected modeled cross sections of Esopus Creek are provided in Table 7, "Limited Detailed Flood Hazard Data." These cross sections will also be shown on the FIRM. Because the BFEs are "advisory," the published values need not be used to enforce floodplain management ordinances as outlined in 44 CFR 60.3(c)(10), but should be used as BFE data according to 44 CFR 60.3(b)(4). Development in Special Flood Hazard Areas that are designated Zone A, but which have ABFEs, should comply with the elevation standards, but may not require analysis of WSEL increases, unless required by the local community.

***Approximate* (A) "A Zones":** This category is assigned where "unnumbered" A Zones are shown on the effective maps, but the anticipated level of development does not warrant the collection of field survey; or where communities have requested an approximate study where there was currently no study at all. The desktop analysis approach to be applied to approximate studies is defined in Appendix C, Section 4.3 of FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners*. The level of effort includes orthophoto collection, LiDAR and stream breakline collection, use of engineering drawing plans and DOT studies (where appropriate and available), nomination of flow rates, and the development of HEC-RAS hydraulic models.

TABLE 7 - LIMITED DETAILED (ENHANCED A-ZONES) FLOOD HAZARD DATA

Cross Section Number & Stream Distance from Confluence with Esopus Creek Reach 2	Flood Discharge (cfs)	1% Annual Chance Advisory Base Flood Elevation (Feet NAVD 88)	FIRM Panel Number
BIRCH CREEK			
1 (24,855ft)	2,738	1,717.2	40
2 (34,765 ft)	1,797	2,103.5	40
DRY BROOK			
1 (5,507 ft)	9,633	1,595.3	200
2 (6,578 ft)	9,174	1,611.3	200
3 (10,436 ft)	6,507	1,656.8	200
4 (15,5758 ft)	5,777	1,732.4	200
5 (18,716 ft)	5,261	1,771.1	200
6 (19,200 ft)	5,047	1,778.6	200
7 (23,261 ft)	3,574	1,856.6	200
8 (25,711 ft)	3,350	1,903.2	200
9 (27,944 ft)	3,042	1,945.5	200
10 (30,940 ft)	2,451	2,008.6	200
11 (33,530 ft)	2,108	2,079.1	200
12 (34,071 ft)	1,773	2,093.5	200
13 (35,980 ft)	1,395	2,167.6	200
14 (36,926 ft)	1,338	2,196	200
15 (38,272 ft)	744	2,252.8	200
16 (28,832 ft)	668	2,287.9	200
17 (40,923 ft)	498	2,430.5	200
18 (14,407 ft)	437	2,451.3	200
19 (42,411 ft)	234	2,577.3	200
20 (43,524 ft)	209	2,811.8	200
21 (44,482 ft)	126	2,902.1	200

TABLE 7 - LIMITED DETAILED (ENHANCED A-ZONES) FLOOD HAZARD DATA (CONT'D)

Cross Section Number & Stream Distance from Limit of Study	Flood Discharge (cfs)	1% Annual Chance Advisory Base Flood Elevation (Feet NAVD 88)	FIRM Panel Number
EAST BRANCH NEVERSINK RIVER			
1 (1,345 ft)	8,400	1,762.3	370
2 (2,845 ft)	8,330	1,776.1	370
3 (3,345 ft)	8,280	1,780.1	370
4 (4,468 ft)	8,070	1,796.1	370
5 (6,386 ft)	8,050	1,809.3	370/375
6 (6,945 ft)	7,930	1,817	375
7 (12,407 ft)	7,747	1,874.7	370/375
8 (12,917 ft)	7,747	1,881.2	370/375
9 (13,864 ft)	7,553	1,890.5	375
10 (15,375 ft)	7,159	1,897.2	375
11 (16,376 ft)	7,035	1,908.2	400
12 (20,390 ft)	6,632	1,956.3	400
13 (22,396 ft)	6,252	1,978.3	400
14 (24,392 ft)	6,101	2,008.4	400
15 (24,892 ft)	5,873	2,015.4	400
16 (27,921 ft)	5,790	2,054	400
HATCHERY HOLLOW			
1 (2,605 ft)	4,506	1,368	205
LITTLE BEAVER KILL			
1 (7,895 ft)	5,520	767.3	265
2 (18,667 ft)	4,351	804.9	265
3 (25,553 ft)	1,940	817.9	265
4 (34,114 ft)	1,279	825.6	270

TABLE 7 - LIMITED DETAILED (ENHANCED A-ZONES) FLOOD HAZARD DATA (CONT'D)

Cross Section Number & Stream Distance from Confluence with Dry Brook	Flood Discharge (cfs)	1% Annual Chance Advisory Base Flood Elevation (Feet NAVD 88)	FIRM Panel Number
MCKINELEY HOLLOW			
1 (1,402 ft)	2,532	1,453	205
RIDER HOLLOW			
1 (2,607 ft)	2109	1,647.1	200
2 (4,003 ft)	2,066	1,672.7	200
3 (6,483 ft)	1,641	1,728	200
4 (9,053 ft)	1,449	1,795.1	200
5 (10,593 ft)	1,169	1,839.2	200
6 (12,879 ft)	1,056	1,913.6	200
7 (13,040 ft)	889	1,919.2	200
8 (15,189ft)	672	1,997	200
9 (15,744 ft)	639	2,018.3	200
10 (16,781 ft)	566	2,062.9	200
11 (18,371 ft)	412	2,139	200
12 (20,134 ft)	352	2,252.8	200
WEST BRANCH NEVERSINK RIVER			
1 (15 ft)	8,680	1,895.8	375
2 (1,118 ft)	7,650	1,905	375
3 (3,147 ft)	7,290	1,918.8	375
4 (6,518 ft)	7,290	1,958.9	375
5(6,647 ft)	7,290	1,962.6	375
6 (7,651 ft)	7,000	1,974.8	375
7 (11,566 ft)	4,240	2,022.3	400
WEST BRANCH NEVERSINK RIVER TRIBUTARY 4			
1 (4,788 ft)	5	1,960.5	375

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988

(NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. 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 (BFEs) across the corporate limits between the communities.

As noted above, the elevations shown in the FIS report and on the FIRM for Ulster County are referenced to NAVD 88. For this revision ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor to NGVD 29 is +0.614. The conversion between the datums may be expressed as an equation:

$$\text{NGVD 29} = \text{NAVD 88} + 0.614 \text{ foot}$$

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 NGVD 29 should apply the stated conversion factor(s) 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.

For more information on NAVD 88, see the FEMA publication entitled Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20 / June 1992, or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration in Rockville, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

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 county. Interested individuals may contact FEMA to access these data.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance flood elevations and delineations of the 1- and 0.2-percent-annual-chance floodplain boundaries and 1-percent-annual-chance floodways to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Tables, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report, as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using a DEM prepared from LiDAR data provided by the NYSDEC.

LiDAR data for the West of Hudson River Watersheds, including the Rondout Watershed, was acquired by the New York City Department of Environmental Protection (NYCDEP). The LiDAR acquisition was completed in 2009 with a 1-meter resolution. Breaklines were developed for the inside low channel, bottom of bank, stream centerline, and bridges as part of the terrain model development. The terrain model was projected to "NAD_1983_StatePlane_New_York_East_FIPS_3101_Feet". All topographic data was referenced to the vertical datum of NAVD88.

The 1- 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 and AE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations, but cannot be shown because of limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

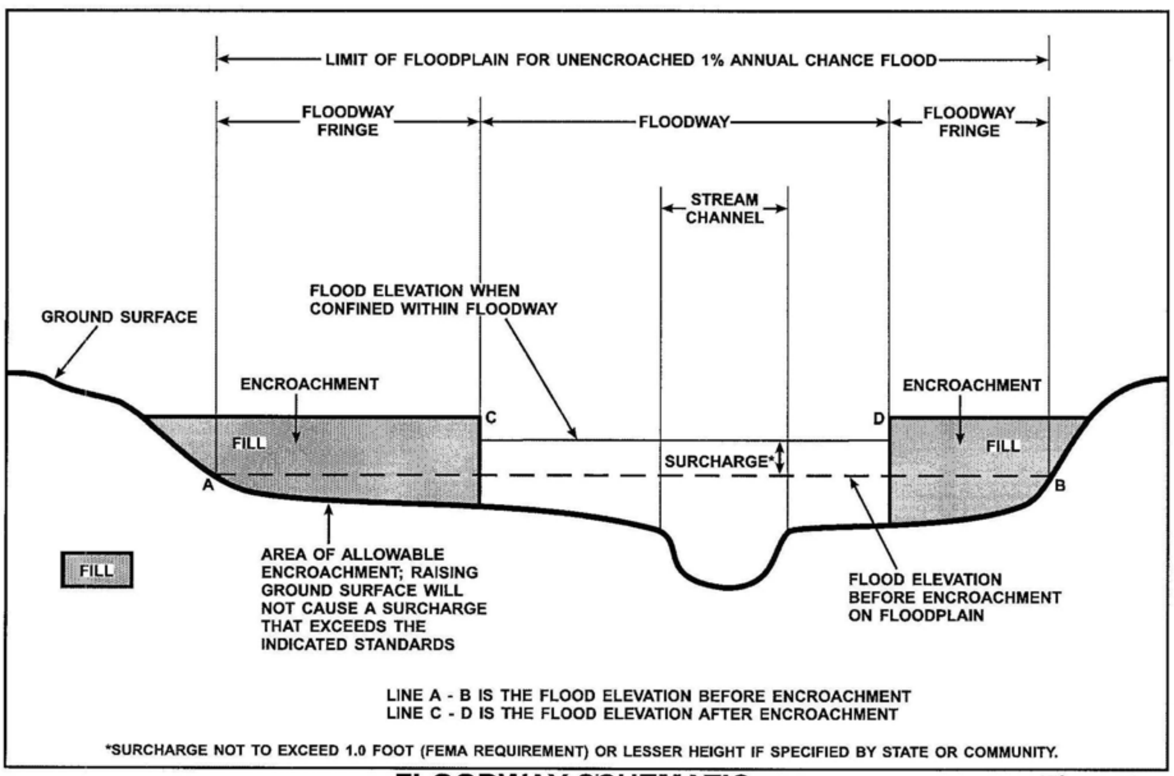
Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development 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. FEMA's minimum standards limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or used as a basis for additional floodway studies.

The floodways presented in this FIS report and on the FIRM were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections (Table 8). The computed floodway is shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

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 8, “Floodway Data.” To reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, “Without Floodway” elevations presented in Table 8 for certain downstream cross sections of Englishmans Creek and Preymaker Brook are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

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



FLOODWAY SCHEMATIC Figure 1

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
Alton Creek								
A	378	26	129	12.5	1,484.8	1,484.8	1,484.8	0.0
B	953	50	238	6.8	1,514.4	1,514.4	1,514.4	0.0
C	1,485	60	196	8.2	1,529.6	1,529.6	1,529.6	0.0
D	2,033	30	135	12.0	1,550.5	1,550.5	1,550.6	0.1
E	3,088	33	146	11.0	1,594.4	1,594.4	1,594.4	0.0
F	4,032	41	184	8.8	1,624.7	1,624.7	1,624.7	0.0
G	4,830	16	63	11.2	1,668.1	1,668.1	1,668.2	0.1
H	5,984	25	73	9.6	1,758.5	1,758.5	1,758.5	0.0
I	7,240	32	103	6.8	1,816.0	1,816.0	1,816.3	0.3
J	8,591	18	73	9.6	1,879.3	1,879.3	1,879.8	0.5
K	10,336	21	68	10.3	2,070.7	2,070.7	2,070.7	0.0
L	11,966	23	71	9.9	2,217.0	2,217.0	2,217.0	0.0
M	13,186	14	60	11.7	2,379.9	2,379.9	2,380.0	0.1
N	14.585	47	89	7.9	2.586.2	2.586.2	2.586.2	0.0

[1] Feet above confluence with Birch Creek

TABLE 8	FEDERAL EMERGENCY MANAGEMENT AGENCY **ULSTER COUNTY, NY** **(ALL JURISDICTIONS)**	**FLOODWAY DATA** **ALTON CREEK**

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
Alton Creek Tributary								
A	471	13	39	10.0	1,667.8	1,667.8	1,668.1	0.3
B	921	18	44	8.9	1,695.0	1,695.0	1,695.0	0.0
C	1,657	32	55	7.2	1,755.5	1,755.5	1,755.5	0.0
D	2,657	56	79	5.0	1,828.6	1,828.6	1,829.4	0.8
E	3,490	18	44	8.9	1,900.3	1,900.3	1,900.3	0.0
F	4,095	19	46	8.6	1,962.3	1,962.3	1,962.3	0.0
G	4,872	14	41	9.6	2,044.3	2,044.3	2,044.3	0.0
H	5,662	30	55	7.1	2,107.9	2,107.9	2,108.7	0.8
I	6,757	24	49	8.1	2,229.8	2,229.8	2,229.8	0.0
J	7,695	41	58	6.8	2,350.1	2,350.1	2,350.7	0.6
K	8,327	13	44	8.9	2,443.0	2,443.0	2,443.7	0.7
L	8,773	60	85	4.6	2,501.7	2,501.7	2,501.7	0.0

[1] Feet above confluence with Alton Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

ALTON CREEK TRIBUTARY

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
Beaver Kill								
A	548	240	2.387	5.4	706.2	706.2	706.6	0.4
B	2.020	177	981	13.0	723.7	723.7	724.1	0.4
C	3.728	126	1.179	10.8	752.6	752.6	753.2	0.6
D	5.238	132	1.089	11.7	778.0	778.0	778.9	0.9
E	6.491	61	738	17.3	811.6	811.6	812.1	0.5
F	8.206	100	825	15.5	848.4	848.4	849.0	0.6
G	9.743	105	801	15.9	883.8	883.8	883.8	0.0
H	11.032	114	1.442	8.9	914.9	914.9	915.3	0.4
I	12.811	563	1.919	7.0	933.2	933.2	933.7	0.5
J	14.168	78	689	14.7	950.5	950.5	950.8	0.3
K	15.928	130	1.200	8.4	979.7	979.7	980.4	0.7
L	17.061	79	711	14.2	995.3	995.3	995.6	0.3
M	18.428	90	795	12.7	1.018.1	1.018.1	1.018.6	0.5
N	20.169	283	2.007	5.0	1.040.6	1.040.6	1.041.5	0.9
O	21.615	847	6.850	1.5	1.047.5	1.047.5	1.047.8	0.3
P	25.887	1.041	3.449	2.0	1.048.9	1.048.9	1.049.2	0.3
Q	27.709	1.031	1.770	3.9	1.053.9	1.053.9	1.054.3	0.4
R	29,609	372	1,637	4.2	1,068.2	1,068.2	1,068.4	0.2
S	30,846	99	442	1.3	1,075.1	1,075.1	1,075.1	0.0
T	32,261	149	451	1.3	1,077.2	1,077.2	1,077.5	0.3
U	33,519	71	203	2.9	1,082.9	1,082.9	1,083.0	0.1
V	34,002	92	248	2.4	1,085.0	1,085.0	1,085.2	0.2
W	34,248	70	183	3.2	1,086.3	1,086.3	1,086.5	0.2

[1] Feet above confluence with Esopus Creek Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

BEAVER KILL

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
Birch Creek								
A	860	253	1026	6.4	1,219.4	1,219.4	1,219.9	0.5
B	2,026	52	458	14.3	1,240.1	1,240.1	1,240.1	0.0
C	3,008	139	991	6.6	1,256.9	1,256.9	1,257.9	1.0
D	3,832	53	427	15.4	1,267.1	1,267.1	1,267.8	0.7
E	4,969	97	587	9.2	1,287.4	1,287.4	1,287.6	0.2
F	6,006	87	490	11.0	1,304.5	1,304.5	1,304.7	0.2
G	7,002	103	535	10.1	1,321.6	1,321.6	1,321.6	0.0
H	8,166	81	456	11.8	1,343.6	1,343.6	1,343.6	0.0
I	9,144	59	431	12.5	1,363.3	1,363.3	1,363.3	0.0
J	10,084	137	642	8.4	1,382.5	1,382.5	1,382.5	0.0
K	11,404	29	276	16.6	1,409.5	1,409.5	1,410.2	0.7
L	12,530	120	528	8.7	1,427.6	1,427.6	1,428.5	0.9
M	13,239	65	377	12.1	1,444.0	1,444.0	1,444.0	0.0
N	14,172	127	738	6.2	1,461.0	1,461.0	1,461.7	0.7
O	15,312	39	219	12.5	1,488.5	1,488.5	1,488.5	0.0
P	16,313	85	305	9.0	1,518.0	1,518.0	1,,518.0	0.0
Q	17,496	50	248	11.1	1,550.0	1,550.0	1,550.4	0.4

[1] Feet above confluence with Esopus Creek Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

BIRCH CREEK

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
Broad Street Hollow								
A	255	93	424	11.4	967.9	967.9	968.1	0.2
B	1,402	93	431	11.2	990.5	990.5	990.9	0.4
C	2,971	117	574	8.4	1,028.9	1,028.9	1,028.9	0.0
D	3,838	84	699	6.9	1,058.2	1,058.2	1,059.0	0.8
E	4,935	70	462	10.4	1,093.1	1,093.1	1,093.1	0.0
F	5,916	80	522	9.2	1,116.4	1,116.4	1,117.3	0.9
G	7,215	71	372	12.9	1,148.0	1,148.0	1,148.0	0.0
H	8,348	142	476	10.1	1,177.3	1,177.3	1,177.3	0.0

[1] Feet above confluence with Esopus Creek Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

BROAD STREET HOLLOW

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
Bush Kill								
A	862	688	2,070	4.7	606.4	606.4	606.6	0.2
B	1,895	403	1,779	5.5	622.3	622.3	622.4	0.1
C	4,564	139	739	11.5	653.2	653.2	653.4	0.2
D	6,523	73	592	14.3	684.4	684.4	684.8	0.4
E	8,523	133	663	6.4	715.5	715.5	716.1	0.6
F	9,650	137	482	8.9	731.7	731.7	732.0	0.3
G	11,679	88	409	10.4	769.3	769.3	769.4	0.1
H	13,972	180	779	5.5	813.9	813.9	814.8	0.9
I	15,129	130	560	7.6	833.4	833.4	833.9	0.5
J	16,738	99	408	10.5	865.0	865.0	865.0	0.0
K	18,356	43	148	10.5	909.1	909.1	909.1	0.0
L	20,190	51	228	6.8	958.6	958.6	958.9	0.3
M	21,863	52	167	9.3	1,008.1	1,008.1	1,008.1	0.0
N	23,780	43	159	9.8	1,086.5	1,086.5	1,086.7	0.2
O	25,160	36	82	8.5	1,165.0	1,165.0	1,165.0	0.0

[1] Feet above confluence with the Ashokan Reservoir

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

BUSH KILL

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
Bushnellsville Creek								
A	443	75	478	12.8	1,072.5	1,072.5	1,072.7	0.2
B	1,695	80	525	11.7	1,097.7	1,097.7	1,097.7	0.0
C	2,755	142	659	9.3	1,123.7	1,123.7	1,123.7	0.0
D	4,173	53	416	14.7	1,157.3	1,157.3	1,157.5	0.2
E	5,403	40	381	16.1	1,185.6	1,185.6	1,185.6	0.0
F	6,470	49	403	15.2	1,211.3	1,211.3	1,211.4	0.1
G	7,438	122	664	9.2	1,239.8	1,239.8	1,239.8	0.0
H	8,489	43	354	14.0	1,267.0	1,267.0	1,267.7	0.7
I	11,372	115	486	10.2	1,353.8	1,353.8	1,353.8	0.0
J	12,494	84	489	10.1	1,382.5	1,382.5	1,383.1	0.6
K	14,087	71	431	11.5	1,426.6	1,426.6	1,426.7	0.1

[1] Feet above confluence with Esopus Creek Reach 2
[2] Elevation computed without consideration of backwater effects from Weasel Brook

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

BUSHNELLSVILLE CREEK

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
Cross Mountain Hollow								
A	72	43	164	10.6	1,181.5	1,181.5	1,181.7	0.2
B	309	53	191	9.1	1,190.3	1,190.3	1,190.7	0.4
C	550	39	212	8.2	1,201.8	1,201.8	1,202.8	1.0

[1] Feet above confluence with Woodland Creek
[2] Elevation computed without consideration of backwater effects from Weasel Brook

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

CROSS MOUNTAIN HOLLOW

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
Dry Brook								
A	266	77	153	7.7	628.1[2]	622.5	622.5	0.0
B	1,966	31	128	9.1	663.6	663.6	664.1	0.5
C	2,873	72	144	8.2	686.6	686.6	686.7	0.1
D	4,225	29	112	10.5	733.6	733.6	733.6	0.0
E	5,186	40	120	9.8	770.9	770.9	770.9	0.0
F	6,389	45	124	9.5	833.6	833.6	833.6	0.0
G	7,448	27	106	11.1	897.5	897.5	897.5	0.0
H	8,542	48	142	8.3	961.5	961.5	962.2	0.7
I	9,935	15	69	12.3	1,039.1	1,039.1	1,039.6	0.5
J	10,977	24	81	10.4	1,113.9	1,113.9	1,114.0	0.1
K	12,012	14	68	12.4	1,193.1	1,193.1	1,193.3	0.2
L	13,119	25	82	10.2	1,288.3	1,288.3	1,288.3	0.0
M	14,326	20	77	11.0	1,414.3	1,414.3	1,414.4	0.1
N	15,616	54	113	7.5	1,599.5	1,599.5	1,599.5	0.0
O	16,822	18	78	10.8	1,907.6	1,907.6	1,907.7	0.1
P	17,197	14	68	12.4	2,045.3	2,045.3	2,045.8	0.5

[1] Feet above confluence with Bush Kill
[2] Flooding controlled by Bush Kill

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

DRY BROOK

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
East Branch Neversink River								
A	5,316	225	1,055	9.3	1,661.5	1,661.5	1,661.9	0.4
B	6,300	190	1,080	8.8	1,672.0	1,672.0	1,672.7	0.7
C	7,697	123	790	12.0	1,686.0	1,686.0	1,686.1	0.1
D	8,660	297	1,665	5.7	1,697.6	1,697.6	1,698.6	1.0
E	9,757	117	853	11.1	1,707.0	1,707.0	1,707.5	0.5
F	11,917	227	1,156	7.8	1,729.4	1,729.4	1,730.0	0.6
G	12,849	240	1,033	8.3	1,737.7	1,737.7	1,738.4	0.7
H	13,422	88	925	9.1	1,744.5	1,744.5	1,745.1	0.6
I	14,081	155	875	9.6	1,749.0	1,749.0	1,749.9	0.9

[1] Feet above confluence with Neversink River Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

EAST BRANCH NEVERSINK RIVER

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
Esopus Creek Reach 2								
A	780	605	6,132	14.2	598.9	598.9	598.9	0.0
B	2,788	701	11,103	7.8	616.6	616.6	616.6	0.0
C	5,092	422	4,622	18.8	623.5	623.5	623.5	0.0
D	6,855	320	5,407	16.1	632.2	632.2	632.8	0.6
E	8,533	214	3,743	23.2	637.4	637.4	637.6	0.2
F	10,238	279	5,237	15.4	648.3	648.3	648.4	0.1
G	12,261	332	3,788	18.1	653.1	653.1	653.1	0.0
H	13,816	1,326	12,718	5.4	661.8	661.8	661.8	0.0
I	16,399	452	4,594	14.9	671.5	671.5	671.6	0.1
J	17,818	253	4,672	14.6	679.5	679.5	679.6	0.1
K	19,327	664	9,598	7.1	686.1	686.1	686.4	0.3
L	20,660	776	6,285	11.2	687.0	687.0	687.2	0.2
M	24,680	1,379	7,819	6.5	699.9	699.9	700.1	0.2
N	27,168	503	4,173	12.2	712.7	712.7	712.7	0.0
O	28,817	581	5,727	8.9	722.2	722.2	722.2	0.0
P	31,493	860	6,293	8.1	734.6	734.6	734.8	0.2
Q	33,364	1,183	7,936	6.4	745.4	745.4	745.4	0.0
R	35,278	1,044	8,021	6.4	756.4	756.4	756.4	0.0
S	38,249	1,262	7,020	7.3	773.4	773.4	773.5	0.1
T	39,710	853	5,428	9.4	782.1	782.1	782.6	0.5
U	42,283	796	5,291	9.7	799.7	799.7	799.7	0.0
V	46,064	337	2,871	14.7	827.4	827.4	828.1	0.7
W	47,531	459	3,704	11.4	842.8	842.8	843.2	0.4
X	50,195	229	2,167	16.3	864.5	864.5	864.5	0.0
Y	52,190	589	3,824	9.2	882.8	882.8	882.8	0.0
Z	54,419	229	2,177	16.2	898.9	898.9	898.9	0.0
AA	57,266	541	3,274	10.8	915.7	915.7	916.2	0.5
AB	60,144	707	3,093	8.0	935.4	935.4	935.5	0.1

[1] Feet above confluence with the Ashokan Reservoir

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

ESOPUS CREEK REACH 2

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
Esopus Creek Reach 2 (cont'd)								
AC	63,592	694	3,093	11.4	956.8	956.8	956.8	0.0
AD	65,769	546	2,729	11.7	972.0	972.0	972.0	0.0
AE	67,540	397	2,449	14.2	988.0	988.0	988.2	0.2
AF	69,503	419	2,960	10.8	1,003.3	1,003.3	1,003.4	0.1
AG	71,883	869	4,664	6.8	1,021.8	1,021.8	1,021.8	0.0
AH	73,719	508	3,636	8.3	1,037.6	1,037.6	1,037.6	0.0
AI	76,755	585	3,580	8.4	1,060.7	1,060.7	1,061.0	0.3
AJ	79,148	209	1,644	14.8	1,084.6	1,084.6	1,084.6	0.0
AK	81,253	107	1,255	19.4	1,100.6	1,100.6	1,100.6	0.0
AL	82,849	373	2,765	8.1	1,111.7	1,111.7	1,112.6	0.9
AM	85,450	385	2,999	8.8	1,136.5	1,136.5	1,137.3	0.8
AN	87,135	150	1,462	16.6	1,147.8	1,147.8	1,147.8	0.0
AO	89,190	399	2,786	8.7	1,166.4	1,166.4	1,166.4	0.0
AP	92,006	458	2,932	8.3	1,192.7	1,192.7	1,192.7	0.0
AQ	95,008	767	2,949	8.2	1,213.1	1,213.1	1,213.1	0.0
AR	98,638	248	1,401	10.7	1,245.6	1,245.6	1,245.9	0.3
AS	101,050	724	2,328	6.5	1,273.2	1,273.2	1,273.2	0.0
AT	103,324	596	1,964	7.6	1,295.9	1,295.9	1,296.4	0.5
AU	106,170	247	1,312	8.9	1,334.8	1,334.8	1,335.1	0.3
AV	107,584	528	1,561	7.4	1,350.1	1,350.1	1,350.1	0.0
AW	109,320	615	2,060	5.6	1,371.6	1,371.6	1,372.2	0.6
AX	111,374	748	2,305	5.1	1,399.6	1,39,9.6	1,399.6	0.0
AY	112,398	293	1,431	8.1	1,412.4	1,412.4	1,413.2	0.8
AZ	114,060	365	1,362	6.7	1,432.8	1,432.8	1,432.8	0.0
BA	115,717	303	1,244	7.3	1,456.4	1,456.4	1,456.5	0.1
BB	117,132	406	1,312	6.9	1,474.9	1,474.9	1,475.1	0.2
BC	117,792	161	634	11.0	1,484.0	1,484.0	1,484.1	0.1
BD	120,421	159	609	11.4	1,526.6	1,526.6	1,526.6	0.0

[1] Feet above confluence with the Ashokan Reservoir

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

ESOPUS CREEK REACH 2

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
Fox Hollow								
A	297	57	254	11.3	1,023.3	1,023.3	1,023.9	0.6
B	1,122	52	428	6.7	1,057.0	1,057.0	1,057.8	0.8
C	2,246	26	187	15.3	1,112.1	1,112.1	1,112.3	0.2
D	3,075	63	279	10.3	1,167.5	1,167.5	1,168.1	0.6
E	4,086	37	242	11.9	1,213.9	1,213.9	1,214.1	0.2
F	4,658	58	403	7.1	1,232.8	1,232.8	1,233.3	0.5
G	5,700	40	174	10.4	1,254.0	1,254.0	1,254.7	0.7
H	6,820	22	131	13.8	1,296.3	1,296.3	1,296.4	0.1
I	7,839	55	298	6.1	1,332.5	1,332.5	1,333.3	0.8
J	8,862	41	160	11.4	1,376.3	1,376.3	1,376.4	0.1
K	9,632	35	189	9.6	1,418.9	1,418.9	1,419.2	0.3
L	9,974	25	183	9.9	1,439.8	1,439.8	1,440.1	0.3
M	10,533	53	180	10.1	1,469.4	1,469.4	1,469.7	0.3

[1] Feet above confluence with Esopus Creek Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

FOX HOLLOW

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
Little Beaver Kill								
A	498	118	495	11.2	652.5	651.8[2]	651.8	0.0
B	908	72	554	10.0	658.7	658.7	658.7	0.0
C	1,761	61	431	12.8	670.4	670.4	670.7	0.3
D	2,474	118	575	9.6	684.7	684.7	685.3	0.6
E	3,069	87	488	11.3	695.7	695.7	696.0	0.3

[1] Feet above confluence with Esopus Creek Reach 2
[2] Elevation computed without consideration of backwater effects from Esopus Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

LITTLE BEAVER KILL

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
Maltby Hollow Brook								
A	277	79	344	11.8	707.4	707.4	707.6	0.2
B	1,306	65	326	12.5	734.9	734.9	735.0	0.1
C	2,343	113	392	10.4	764.2	764.2	764.2	0.0
D	3,373	56	357	11.4	792.7	792.7	793.0	0.3
E	4,147	106	515	7.9	811.9	811.9	812.6	0.7
F	5,675	73	373	10.9	861.1	861.1	861.6	0.5
G	8,203	90	423	9.6	931.2	931.2	931.5	0.3
H	9,344	35	159	11.6	969.3	969.3	969.3	0.0
I	9,956	61	219	8.4	994.1	994.1	994.6	0.5
J	10,818	39	166	11.1	1,031.5	1,031.5	1,032.0	0.5

[1] Feet above confluence with Bush Kill

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

MALTBY HOLLOW BROOK

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
Mink Hollow								
A	837	184	914	7.7	1,080.7	1,080.7	1,081.0	0.3
B	2,170	108	552	12.8	1,101.9	1,101.9	1,102.0	0.1
C	3,862	77	505	14.0	1,137.2	1,137.2	1,137.2	0.0
D	5,266	111	945	7.5	1,168.8	1,168.8	1,169.6	0.8
E	6,440	109	652	10.8	1,189.5	1,189.5	1,189.9	0.4
F	8,197	133	594	11.9	1,224.8	1,224.8	1,224.9	0.1
G	9,879	167	560	12.6	1,268.8	1,268.8	1,268.8	0.1
H	11,272	89	612	11.5	1,302.8	1,302.8	1,303.1	0.3
I	12,883	78	601	11.8	1,339.9	1,339.9	1,339.9	0.0
J	14,475	139	718	9.8	1,382.6	1,382.6	1,382.7	0.1
K	16,106	105	309	8.9	1,420.2	1,420.2	1,420.4	0.2
L	18,521	50	255	10.8	1,504.6	1,504.6	1,504.6	0.0

[1] Feet above confluence with Beaver Kill

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

MINK HOLLOW

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
Muddy Brook								
A	150	41	116	8.7	908.2	908.2	909.1	0.9
B	326	31	100	10.1	920.3	920.3	920.3	0.0
C	563	24	91	11.0	931.6	931.6	931.8	0.2
Preymaker Brook								
A	840[2]	35	113	9.5	164.2	164.2	164.2	0.0
B	2,075[2]	38	129	8.3	188.7	188.7	189.3	0.6
C	3,630[2]	42	189	5.7	230.7	230.7	231.0	0.3
D	5,300[2]	50	139	7.7	247.1	247.1	247.4	0.3
E	6,400[2]	44	276	3.9	253.5	253.5	254.5	1.0
F	7,660[2]	42	66	7.2	255.4	255.4	255.4	0.0
G	9,980[2]	18	50	9.5	300.1	300.1	300.1	0.0
H	12,890[2]	74	216	2.2	403.0	403.0	403.3	0.3
I	14,985[2]	200	648	0.7	420.3	420.3	421.0	0.8
J	16,740[2]	160	396	1.2	420.4	420.4	421.4	1.0

[1] Feet above confluence with Woodland Creek

[2] Feet above confluence with Englishmans Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

MUDDY BROOK – PREYMAKER BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Rondout Creek Reach 2								
A	23,648	213	1,255	7.6	972.0	972.0	972.0	0.0
B	25,673	440	1,588	5.1	991.6	991.6	992.3	0.7
C	28,843	272	1,330	6.1	1,027.3	1,027.3	1,028.0	0.7
D	30,914	390	1,636	5.0	1,051.6	1,051.6	1,052.5	0.9
E	32,259	100	813	10.0	1,066.5	1,066.5	1,066.6	0.1
F	34,544	185	1,179	6.9	1,096.4	1,096.4	1,096.9	0.5
G	35,949	329	1,246	6.5	1,114.4	1,114.4	1,115.4	1.0

[1] Feet above the confluence with the Rondout Reservoir

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

RONDOUT CREEK REACH 2

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
Stony Clove Creek								
A	288	221	1,628	12.8	816.0	816.0	816.4	0.4
B	2,183	206	2,025	10.3	842.1	842.1	842.1	0.0
C	3,697	179	1,581	13.2	863.5	863.5	864.4	0.9
D	5,189	214	1,871	11.2	884.7	884.7	885.3	0.6
E	6,829	91	1,258	16.6	907.6	907.6	908.4	0.8
F	8,341	130	1,646	12.7	937.0	937.0	937.0	0.0
G	9,875	126	1,552	13.5	968.5	968.5	968.6	0.1
H	11,861	217	2,254	7.8	985.5	985.5	986.4	0.9
I	13,009	306	1,820	9.7	1,003.4	1,003.4	1,003.4	0.0
J	14,252	103	1,805	9.8	1,033.3	1,033.3	1,033.7	0.4
K	15,985	165	1,167	12.3	1,078.7	1,078.7	1,078.9	0.2
L	17,237	208	1,258	11.4	1,096.9	1,096.9	1,096.9	0.0
M	18,652	168	1,616	8.9	1,117.9	1,117.9	1,118.6	0.7
N	20,668	107	950	15.1	1,146.0	1,146.0	1,146.4	0.4
O	21,860	214	1,278	11.2	1,162.8	1,162.8	1,162.9	0.1

[1] Feet above confluence with Woodland Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

STONY CLOVE CREEK

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
Sundown Creek								
A	50	150	406	7.0	982.6	982.6	982.8	0.2
B	181	135	349	8.2	985.7	985.7	985.7	0.0
C	837	38	238	11.9	1,003.2	1,003.2	1,003.4	0.2
D	1,690	38	220	12.9	1,024.7	1,024.7	1,024.8	0.1
E	2,533	43	227	12.5	1,053.3	1,053.3	1,053.3	0.0
F	3,643	49	279	10.2	1,086.6	1,086.6	1,087.1	0.5
G	4,469	29	162	13.3	1,120.7	1,120.7	1,120.7	0.0
H	5,885	82	343	6.3	1,193.6	1,193.6	1,194.0	0.4
I	7,023	32	170	12.7	1,229.8	1,229.8	1,230.0	0.2
J	7,734	40	203	10.6	1,250.5	1,250.5	1,250.8	0.3
K	8,702	48	189	11.4	1,284.1	1,284.1	1,284.1	0.0
L	9,888	24	80	10.2	1,329.6	1,329.6	1,329.6	0.0
M	10,956	39	105	7.8	1,454.0	1,454.0	1,454.0	0.0
N	11,611	56	115	7.1	1,479.8	1,479.8	1,480.4	0.6
O	12,500	29	96	8.5	1,511.8	1,511.8	1,511.8	0.0
P	13,701	26	49	7.8	1,562.5	1,562.5	1,562.5	0.0
Q	14,226	16	43	9.1	1,591.4	1,591.4	1,591.6	0.2
R	14,784	18	43	8.9	1,619.0	1,619.0	1,619.0	0.0

[1] Feet above confluence with Rondout Creek Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

SUNDOWN CREEK

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
VernooyKill								
A	816[1]	66	504	10.7	268.0	257.6	258.6	1.0
B	2.320[1]	124	758	7.1	268.0	266.1	266.7	0.6
C	4.248[1]	74	465	11.6	279.6	279.6	280.0	0.4
D	4.520[1]	78	436	12.4	283.8	283.8	283.8	0.0
Wagner Creek								
A	511[2]	106	368	4.6	1,055.4	1,055.4	1,056.0	0.6
B	1,404[2]	39	152	11.2	1,068.8	1,068.8	1,068.8	0.0
C	2,542[2]	38	157	10.9	1,095.4	1,095.4	1,095.5	0.1
D	3,374[2]	55	211	8.1	1,121.3	1,121.3	1,121.7	0.4
E	4,401[2]	47	172	9.9	1,149.3	1,149.3	1,149.3	0.0
F	5,572[2]	82	215	7.9	1,184.5	1,184.5	1,184.6	0.1
G	6,783[2]	69	187	9.1	1,217.9	1,217.9	1,217.9	0.0
H	7,978[2]	73	205	8.3	1,262.4	1,262.4	1,262.4	0.0

[1] Feet above confluence with Rondout Creek
[2] Feet above confluence with Beaver Kill

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

VERNOOY KILL – WAGNER CREEK

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
Warner Creek								
A	476	62	329	13.0	1,073.4	1,073.4	1,073.4	0.0
B	1,886	63	482	8.9	1,106.2	1,106.2	1,106.8	0.6
C	3,198	263	1,103	3.9	1,126.4	1,126.4	1,126.4	0.0
D	4,198	166	740	5.8	1,136.1	1,136.1	1,136.5	0.4
E	5,385	99	488	8.8	1,153.9	1,153.9	1,154.3	0.4
F	6,961	111	441	9.7	1,172.2	1,172.2	1,172.3	0.1
G	9,071	112	459	9.3	1,200.4	1,200.4	1,200.4	0.0
H	10,861	68	358	12.0	1,228.5	1,228.5	1,228.8	0.3

[1] Feet above confluence with Stony Clove Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

WARNER CREEK

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
Woodland Creek								
A	188	101	1,269	10.3	863.8	863.8	863.8	0.0
B	1,481	103	850	15.3	882.7	882.7	883.2	0.5
C	2,572	113	1,363	9.6	904.9	904.9	905.5	0.6
D	4,137	151	1,284	7.4	923.9	923.9	924.2	0.3
E	5,205	97	747	12.7	939.3	939.3	939.8	0.5
F	6,512	185	1,190	8.0	957.9	957.9	958.8	0.9
G	7,929	301	1,857	5.1	979.3	979.3	980.1	0.8
H	9,382	139	1,036	9.2	1,005.3	1,005.3	1,005.5	0.2
I	10,815	116	898	10.6	1,033.0	1,033.0	1,033.8	0.8
J	12,214	69	584	16.3	1,058.7	1,058.7	1,058.7	0.0
K	14,140	152	740	11.0	1,104.9	1,104.9	1,105.5	0.6
L	15,866	81	737	11.1	1,139.4	1,139.4	1,140.2	0.8
M	17,346	179	1,096	7.4	1,166.8	1,166.8	1,166.9	0.1
N	18,223	81	550	14.8	1,184.4	1,184.4	1,184.4	0.0

[1] Feet above confluence with Esopus Creek Reach 2

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY (ALL JURISDICTIONS)

FLOODWAY DATA

WOODLAND CREEK

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
Woodland Creek Tributary								
A	126	23	45	7.8	1,105.1	1,105.1	1,105.1	0.0
B	655	25	46	7.8	1,152.2	1,152.2	1,152.2	0.0

[1] Feet above confluence with Woodland Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

FLOODWAY DATA

WOODLAND CREEK TRIBUTARY

5.0 INSURANCE APPLICATIONS

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

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

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

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

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

6.0 FLOOD INSURANCE RATE MAP

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

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

The current FIRM presents flooding information for the geographic areas of Ulster County that lie outside the New York City Watershed area. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community. Historical data relating to the maps prepared for each community are presented in Table 9, "Community Map History."

7.0 OTHER STUDIES

FIS reports and FIRMs have been published for the following communities in Ulster County that lie outside the New York City Watershed: the City of Kingston; the Villages of Ellenville, Saugerties, and New Paltz; and the Towns of Esopus, Gardiner, Kingston, Lloyd, Marbletown, Marlborough, New Paltz, Plattekill, Rochester, Rosendale, Saugerties, Shawangunk, and Ulster.

Because it is based on more up-to-date analyses, this FIS supersedes previously printed FISs for the listed communities in Ulster County that lie outside the New York City Watershed. This FIS also supersedes the Flood Boundary and Floodway Maps for Ulster County that were printed as part of previous FISs. The information from the superseded Flood Boundary and Floodway Maps has been added to the revised FIRM accompanying this FIS.

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

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Ellenville, Village of	May 24, 1974	June 18, 1976	July 5, 1983	
Esopus, Town of	May 31, 1974	January 9, 1976	July 5, 1984	
Gardiner, Town of	May 31, 1974	July 30, 1976	September 30, 1982	July 16, 1997
Kingston, City of	May 17, 1974	November 28, 1975 January 18, 1980	May 1, 1985	
Kingston, Town of	October 20, 1974	May 14, 1976	August 27, 1982	April 5, 1988
Lloyd, Town of	September 6, 1974	July 9, 1976	September 17, 1982	July 18, 1985 July 5, 2000
Marbletown, Town of	September 20, 1974	July 9, 1976	October 22, 1982	August 5, 1991
Marlborough, Town of	December 6, 1974		December 5, 1984	
New Paltz, Town of	May 17, 1974	January 2, 1976 August 6, 1976	September 30, 1982	November 1, 1985
New Paltz, Village of	January 24, 1975		April 15, 1982	October 15, 1985
Plattekill, Town of [1, 2]	N/A	N/A	N/A	N/A
Rochester, Town of	June 21, 1974	July 8, 1977	March 16, 1983	February 6, 1991
Rosendale, Town of	May 31, 1974	July 2, 1976	November 1, 1985	
Saugerties, Town of	May 31, 1974	May 21, 1976	August 19, 1985	February 15, 1991 September 30, 1992
Saugerties, Village of	November 15, 1974	June 18, 1976	September 10, 1982	August 5, 1985
Shawangunk, Town of	June 21, 1974	May 14, 1976	September 30, 1982	
Ulster, Town of	May 3, 1974	May 28, 1976	May 1, 1985	

[1] No Special Flood Hazard Areas Identified [2] This community did not have a FIRM prior to the first countywide FIRM for Ulster County

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ULSTER COUNTY, NY
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Flood Insurance and Mitigation Division, Federal Emergency Management Agency, 26 Federal Plaza, Rm. 1337, New York, NY 10278-0002.

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