Chestnut Creek Local Flood Analysis

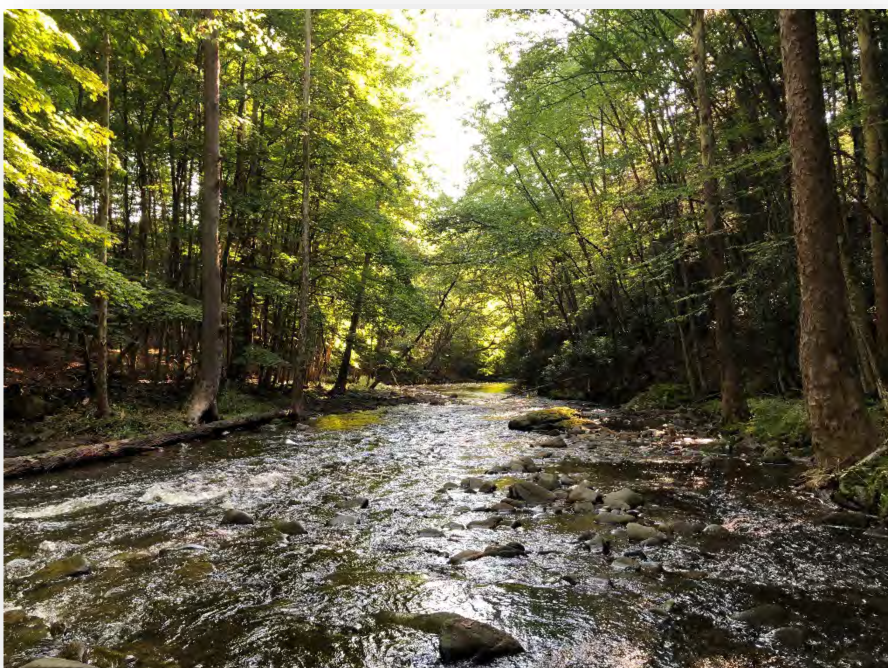
Hamlet of Grahamsville, New York

Prepared for:

Rondout Neversink Stream Program
Sullivan County Soil & Water Conservation District
P.O. Box 256
Grahamsville, NY 12740

SLR #141.14282.00009

December 2022



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CONTENTS

FIGURES

TABLES

ACRONYMS

AOP	Aquatic Organism Passage
BFE	Base Flood Elevation
BRIC	Building Resilient Infrastructure and Communities
CAP	Community Assistance Program
CAV	Community Assistance Visit
CFA	Consolidated Funding Application
CFS	Cubic Feet per Second
CRRA	Community Risk and Resiliency Act
CSC	Climate Smart Communities
CWC	Catskill Watershed Corporation
EFC	Environmental Facilities Corporation
EWP	Emergency Watershed Protection
FAC	Flood Advisory Committee
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPMS	Floodplain Management Services Program
GIGP	Green Innovation Grant Program
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
LFA	Local Flood Analysis
LFHMIP	Local Flood Hazard Mitigation Implementation Program
LiDAR	Light Detection and Ranging
LOMA	Letter of Map Amendment
LOMA-F	Letter of Map Revision
NBI BIN	National Bridge Inventory Bridge Identification Number
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
NYCDEP	New York City Department of Environmental Protection
NYCFFBO	New York City Funded Flood Buy-Out Program
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation

PDM	Pre-Disaster Mitigation
RFC	Repetitive Flood Claims
RNSP	Rondout Neversink Stream Program
SCSWCD	Sullivan County Soil & Water Conservation District
SFHA	Special Flood Hazard Area
SLR	SLR Engineering, Landscape Architecture, and Land Surveying, P.C.
SMIP-FHM	Stream Management Implementation Program Flood Hazard Mitigation Grants
SMP	Smooth metal pipe
SMP	Stormwater Management Practices
SRL	Severe Repetitive Loss
STA	Station
USACE	United States Army Corps of Engineers
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WI/PWL	Waterbody Inventory/Priority Waterbodies List

EXECUTIVE SUMMARY

Sullivan County Soil & Water Conservation District has retained SLR Engineering, Landscape Architecture, and Land Surveying, P.C. to complete a Local Flood Analysis for the hamlet of Grahamsville in the town of Neversink, New York. A Local Flood Analysis is an engineering feasibility study that seeks to develop a range of hazard mitigation alternatives. Its primary purpose is to identify flood hazard and mitigation options for the community to implement. In the long term, these mitigation options are designed to reduce flooding and facilitate recovery from flood events. The flood analysis focuses on flooding along the Chestnut Creek within the project area.

The Catskill Mountains are subject to severe storm events that are often unevenly distributed across watersheds. As a result, local flash floods can occur in one basin while an adjacent basin receives little rainfall. In addition to local flash floods, larger storm events can cause widespread flooding. Floods can take place any time of the year but are commonly divided into those occurring in winter and spring and those occurring in summer and fall. Floods that take place in summer and fall are typically due to extreme rainfall events caused by hurricanes and tropical storms. Floods in winter and spring are associated with rain on snow events and spring snowmelt.

A project kickoff meeting was convened at the beginning of the Local Flood Analysis process. Attendees were provided with an overview of the project, the Local Flood Analysis process, and hydraulic modeling techniques. Attendees were asked to describe and identify locations of flooding and flood damages during past flood events, including during catastrophic storm events such as Tropical Storm Irene. Information was collected on flood damages and potential flood mitigation alternatives. This information was used throughout the Local Flood Analysis process to verify flood damages, pinpoint problem areas, and develop flood mitigation alternatives.

Public remarks indicated that the hamlet of Grahamsville has not witnessed an extreme flood event along the Chestnut Creek in recent memory. The United States Geological Survey (USGS) operates two stream flow gauges in Grahamsville to monitor discharge on the Chestnut Creek. Analysis of peak stream flow data collected at a USGS gauge on Chestnut Creek confirms that this community has not experienced major storms and flood events in recent years. In the available period of record (1938 to current), annual peak flows recorded at the gauge have exceeded the 25-year peak discharge two times – once in 1955 and again in 1975. More recently, flows have marginally exceeded the estimated 10-year peak discharge.

Hydraulic assessment was used to estimate the historical and predicted water surface elevations to identify flood-prone areas where flooding is known to have caused damage to infrastructure and properties. Hydraulic modeling suggested that most of the bridges spanning Chestnut Creek are inadequately sized and contribute to flooding. Findings and recommended replacement structures at the assessed crossings are summarized in Table ES-1. Recommendations are prioritized based on factors, including the severity of flooding caused by the structure and its existing structural condition. When these culverts are scheduled for replacement, it is recommended that a full hydraulic assessment be conducted to ensure that the new structures meet applicable New York State Department of Transportation hydraulic design standards and New York State Department of Environmental Conservation stream crossing guidelines.

Table ES-1 Recommended Prioritization for Chestnut Creek Stream Crossing Projects

Priority	Feature Carried	NYSDOT Poor Status	Detour Available?	Current Hydraulic Capacity	Contributes to Flooding of Infrastructure?	Suggested Action to Prioritize
HIGH	Davis Lane	Yes	Yes (0.5 mi – Fairground Road)	25-Year	Yes	Bridge structural soundness
	Route 42	No	Yes (multiple)	25-Year	Yes	Upstream flood reduction
	River Road	No	No	25-Year	Yes	Post-flood passage
MEDIUM	Hilltop Road	No	No	< 10-Year	Yes	Hydraulic adequacy and post-flood passage
	Clark Road	No	No	> 100-Year	Yes	Upstream flood reduction and post-flood passage
	Slater Road	N/A	Possibly	> 100-Year	No	Culvert structural soundness and AOP
LOW	NYS Route 55	No	Yes (10.5 mi)	> 100-Year	No	Inspection and maintenance
	Fairground Road	No	Yes (0.5 mi – Davis Lane)	> 100-Year	No	Inspection and maintenance
	Kelly Road	No	No	> 100-Year	No	Inspection and maintenance and post-flood passage
	Reynolds Road	N/A	N/A	N/A	No	Inspection and monitoring

AOP = Aquatic Organism Passage

1. INTRODUCTION

1.1 PROJECT BACKGROUND AND OVERVIEW

SLR Engineering, Landscape Architecture, and Land Surveying, P.C. (SLR) has been retained to conduct a Local Flood Analysis (LFA) in the hamlet of Grahamsville, town of Neversink, New York. The study included the analysis and prioritization of ten road crossings over Chestnut Creek. The LFA study area encompasses 4.1 miles of Chestnut Creek from the mouth of the Rondout Reservoir to approximately 250 feet upstream of Slater Road. The LFA has been undertaken with funding provided by the New York City Department of Environmental Protection (NYCDEP), administered through the Rondout Neversink Stream Program (RNSP) operating under the Sullivan County Soil & Water Conservation District (SCSWCD).

The Catskill Mountains are subject to large storm events that are often unevenly distributed across watersheds. As a result, local flash floods can occur in one basin while an adjacent basin receives little rainfall. In addition to local flash floods, larger storm events can cause widespread flooding and have devastated rural communities in this region.

The LFA is a program specific to the New York City water supply watersheds that was initiated following Tropical Storm Irene to help communities identify long-term, cost-effective projects to mitigate flood hazards and protect water quality.

Project recommendations generated through an approved LFA may be eligible for Flood Hazard Mitigation funding available through the Stream Management Implementation Program (SMIP) administered by SCSWCD, the Catskill Watershed Corporation's (CWC) Local Flood Hazard Mitigation Implementation Program (LFHMIP), or NYCDEP's voluntary New York City Funded Buy-Out Program (NYCFFBO). A more detailed list of potential funding sources is included in Section 5 of this LFA report.

1.2 TERMINOLOGY

In this report, all references to right bank and left bank refer to "river right" and "river left," meaning the orientation assumes that the reader is standing in the river, looking downstream. Stream stationing (STA) is used in the narrative and on maps as an address to identify specific points along the watercourse. Stationing along Chestnut Creek is measured in feet and begins at STA 00+00 where Chestnut Creek empties into the Rondout Reservoir and continues upstream to STA 337+15. As an example, Chestnut Creek passes underneath River Road at STA 67+74, or 6,774 feet upstream from the Rondout Reservoir mouth.

The Federal Emergency Management Agency (FEMA) is an agency of the United States Department of Homeland Security. To provide a common standard, FEMA's National Flood Insurance Program (NFIP) has adopted a baseline probability called the base flood. The base flood has a 1 percent (one in 100) chance of occurring in any given year, and the base flood elevation (BFE) is the level floodwaters are expected to reach in this event. For the purpose of this report, the 1 percent annual chance flood is also referred to as the 100-year flood. Other recurrence probabilities used in this report include the 2-year flood event (50 percent annual chance flood), the 10-year flood event (10 percent annual chance flood), the 25-year flood event (4 percent annual chance flood), the 50-year flood event (2 percent annual chance flood), and the 500-year flood event (0.2 percent annual chance flood).

The Special Flood Hazard Area (SFHA) is the area inundated by flooding during the 100-year flood event. Within the project area, FEMA has developed Flood Insurance Rate Mapping (FIRM), which indicates the location of the SFHA along Chestnut Creek and some of its tributaries.

It should be noted that over the time period of a standard 30-year property mortgage a property located within the SFHA will have a 26 percent chance of experiencing a 100-year flood event. Structures falling within the SFHA may be at an even greater risk of flooding if a house is low enough that it may be subject to flooding during the 25-year or 10-year flood events. In this case, during the period of a 30-year mortgage, the chance of being hit by a 25-year flood event is 71 percent, and the chance of being hit by a 10-year flood event is 96 percent, which is a near certainty.

Lastly, the tributary that drains from the north into Chestnut Creek near STA 92+81 does not appear to be identified in any historical United States Geological Survey (USGS) topographic quadrangles for Neversink, nor in the National Hydrography Dataset for the region. The watercourse is locally referred to as “Bullet Brook” by community members and will therefore be referred to as such in this report.

1.3 STUDY AREA

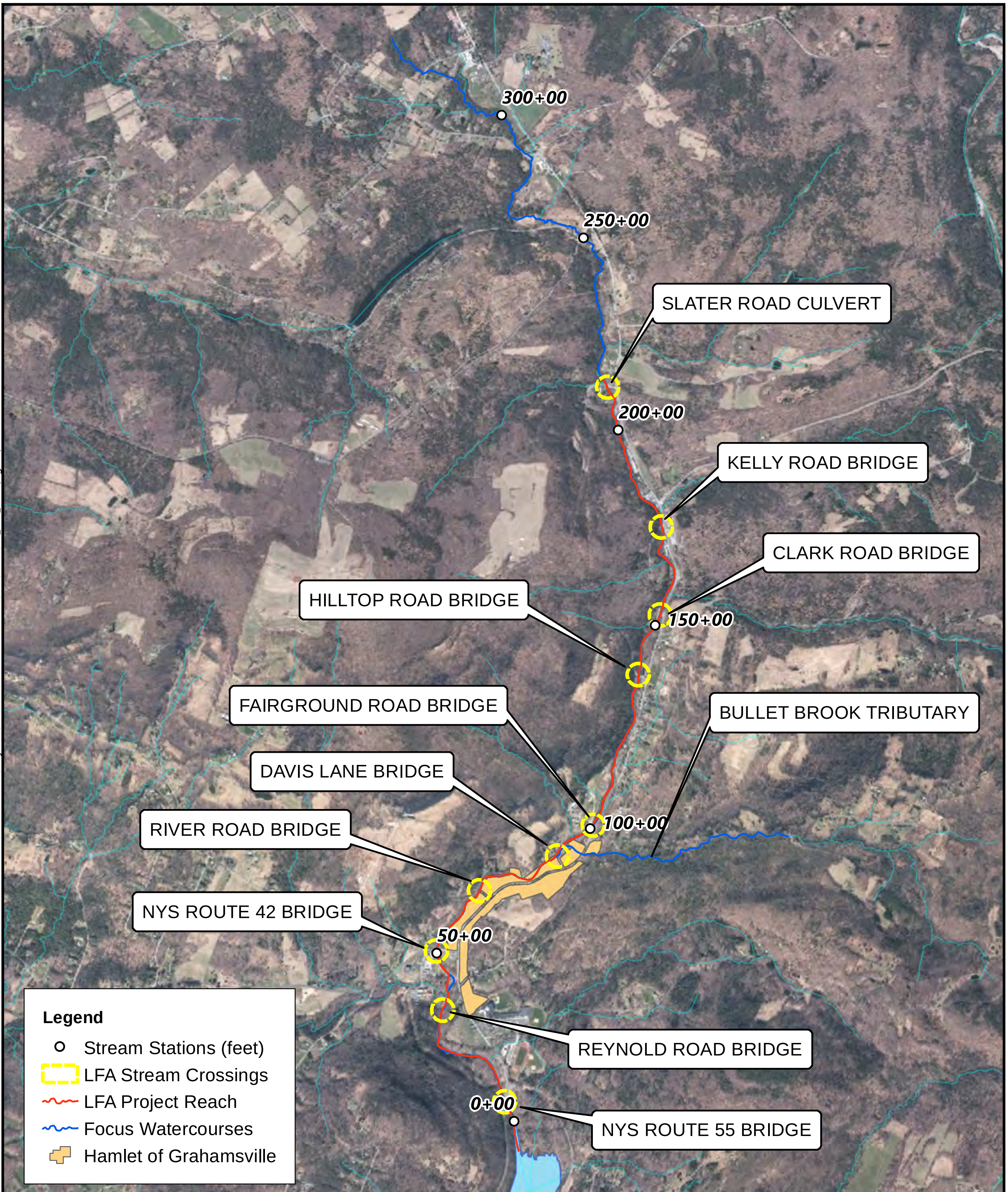
The hamlet of Grahamsville is a small rural community located on the southeastern flank of the town of Neversink in Sullivan County, New York. The hamlet is estimated to have a population of 450, which accounts for 13 percent of the total population for the town of Neversink as of the 2020 U.S. census. The center of the hamlet is located at the intersection of northbound NY Route 42 with NY Route 55, where residential and commercial buildings along the westbound portion of Route 55 form the hamlet’s main populous center.

The subject LFA focuses on flooding mitigation and infrastructure improvements within the hamlet of Grahamsville although flooding hazards may exist elsewhere in the town. The analysis focused on inundation of public and private infrastructure associated with high flows coming from Chestnut Creek. More specifically, the study focused on the Chestnut Creek reach that extends the mouth of the Rondout Reservoir upstream to 250 feet above the Slater Road bridge. A total of ten public road crossings spanning Chestnut Creek were evaluated. Although present, private bridges over Chestnut Creek were not studied. The stream crossings within the LFA study reach that were investigated are listed from downstream to upstream:

- NY Route 55 (BIN 1027070)
- Reynolds Road (decommissioned)
- NY Route 42 (BIN 1025010)
- River Road (BIN 3357080)
- Davis Lane (BIN 3357040)
- Fairground Road (BIN 5524660)
- Hilltop Road (BIN 3357180)
- Clark Road (BIN 3357090)
- Kelly Road (BIN 3229170)
- Slater Road

Figure 1-1 illustrates the extent of the LFA project area and the structures of interest.

In addition to culvert and bridge evaluations, SLR was requested to perform supplementary investigations at specific sites that were selected according to their impact on flooding and water quality impairment. A field visit and visual assessment of the Bullet Brook tributary and Chestnut Creek confluence was undertaken to document sources of flooding and investigate potential mitigation actions. At the Neversink town hall building, SLR was asked to provide input on the proposed town hall parking lot and driveway expansion. Findings and final recommendations to these supplemental tasks are described in greater detail in Section 4.2 of this report.



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CHESTNUT CREEK LFA OVERVIEW MAP

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

0 1,000 2,000
Feet

SCALE 1 " = 3,000 '

DATE 8/18/2022

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FIG. 1-1

1.4 COMMUNITY INVOLVEMENT

The LFA was undertaken in close consultation with the Grahamsville Flood Advisory Committee (FAC), which was assembled for this purpose. The FAC is comprised of individuals with technical and nontechnical backgrounds and is meant to represent various interests and stakeholders at town and county levels as well as the SCSWCD, CWC, and NYCDEP. The FAC met regularly over the course of the LFA process to review results and provide input on flood mitigation alternatives. FAC members include representatives from the following organizations and backgrounds:

- Officials from the hamlet and town
  - Elected officials and board members
  - Highway Department representatives
- Residents of the hamlet and town
- Rondout Neversink Stream Program
- NYCDEP
- CWC
- SLR

The LFA process included a community and stakeholder outreach that was conducted by RNSP to gain additional information on critical flood-prone areas. Letter mailings were distributed near the start of the study and served to inform the public about the LFA process, gather input about past flood events, and gather flood damage records within the project area. A public meeting was held at the end of the LFA process to share key findings, summarize final recommendations, and make the community aware of the LFA technical report.

Table 1-1 summarizes FAC and public meetings that took place during the LFA process.

Table 1-1 LFA Meeting Schedule

Date	Type of Meeting	Topic
September 22, 2020	Virtual FAC #1	Introduction to and overview of LFA process; present initial findings and gathering feedback from FAC members
November 10, 2022	Final Public Meeting	Present additional findings and final recommendations to stakeholders. Distribute draft LFA report for comments.

2. DATA COLLECTION

Data were gathered from various sources related to the hydrology and hydraulics of Chestnut Creek and its tributaries, Chestnut Creek watershed characteristics, recent and historical flooding in the affected communities, and factors that may contribute to flood hazards.

2.1 INITIAL DATA COLLECTION

The Chestnut Creek Stream Management Plan

The Stream Management Program (SMP), in partnership with SCSWCD, undertook a stream corridor assessment of Chestnut Creek in 2004. This evaluation identifies and assesses stream and basin geomorphic characteristics, land cover and hydrology, stream crossings, and floodplain modifications and encroachments. This report indicates that, overall, Chestnut Creek is in good condition, excepting localized issues such as problematic erosion and roads impinging on the stream corridor. The report also identifies heavily disturbed sections of Chestnut Creek that have resulted from historical dredging and straightening of the stream corridor.

The various products of the Chestnut Creek Management Plan can be accessed via the link below:
https://catskillstreams.org/chestnut-creek-stream-management-plan/

Sullivan County Multi-Jurisdictional Hazard Mitigation Plan

The purpose of Hazard Mitigation Plans (HMP) is to identify policies and actions that will reduce risk in order to limit losses of property and life. Flood hazard mitigation, in particular, seeks to implement long- and short-term strategies that will successfully limit loss of life, personal injury, and property damage that can occur due to flooding (URS, 2009). Flood mitigation strategies are most successful when private property owners; businesses; and local, state, and federal governments work together to identify hazards and develop strategies for mitigation (Tetra Tech, 2009).

In 2004, Sullivan County completed a multijurisdictional natural HMP and has made three updates to the document since. By participating in the plan, jurisdictions within the county comply with the Federal Disaster Mitigation Act of 2000. Compliance with this act allows jurisdictions to apply for federal aid for technical assistance and post-disaster mitigation project funding. The most recent update to the HMP was October 2012, and a version of this document is currently posted on the Sullivan County website. This new report has been finalized and accepted by FEMA. It has been adopted via resolution by Sullivan County and is in process for adoption by the towns. Both plans are available on the Sullivan County website.

2005 Plan:
https://sullivanny.us/sites/default/files/departments/DPEM/Resources/PreDisasterMitigationPlan.pdf

2012 Plan Update:
https://sullivanny.us/sites/default/files/departments/DPEM/hazardmitigation/2012/Hazard_Mitigation_Plan_Oct_30_2012_Rev_ID_298155.pdf

Appendix B of the 2012 HMP identifies flooding as a moderately high hazard in Sullivan County. Hazards were ranked based on probability of occurrence and impact on the community. Flooding received the highest rating, which means that flooding is frequent and likely to occur within 25 years. The HMP listed flooding as Sullivan County's most prevalent hazard event and is estimated at $10,400,000 in damages annually. Between 1978 and 2002, the Town of Neversink averaged $1,351.60 of repetitive annual property losses (FEMA, NFIP, 2002).

During the public information gathering process, it was mentioned that Sullivan County would be updating the HMP soon. At the time of this report, the updated version of the report that is meant to supersede the 2012 plan has not been released. New details on the status of the new HMP may be found by visiting Sullivan County's website at the links below:

- https://www.sullivanny.us/Departments/Emergencymanagementhomelandsecurity
- https://sullivan.mitigateny.org/

Water Quality Reports

In order to fulfill requirements of the Federal Clean Water Act, the New York State Department of Environmental Conservation (NYSDEC) must provide periodic assessments of the quality of the water resources in the state regarding their ability to support specific uses. These assessments reflect monitoring and water quality information drawn from a number of programs and sources both within and outside the department. This information has been compiled by the NYSDEC Division of Water and merged into an inventory database of all waterbodies in New York State. The database is used to record current water quality information, characterize known and/or suspected water quality problems and issues, and track progress toward their resolution.

Chestnut Creek and its tributaries are classified by NYSDEC as A(T) streams. Class A indicates that the waterbody is used as a source of drinking water. The additional standard of T (trout) indicates that the watercourse may support a trout population; special NYSDEC requirements apply to these waters that support and sustain valuable and sensitive fisheries resources.

According to the River Waterbody Inventory/Priority Waterbodies List (WI/PWL), which provides water quality assessment data for various waterbodies in the state, Chestnut Creek and its tributaries are characterized as having no water quality impacts with no apparent sources of pollution. However, the reports note impacts from failing and/or inadequate onsite septic systems as being of concern. These WI/PWL factsheets can be accessed via the *DECinfo Locator*, an online interactive mapper found at the link below:

https://www.dec.ny.gov/chemical/36730.html

Local Flood Damage Prevention Codes

The Town of Neversink has adopted a local Flood Damage Prevention Law in January 2011. The present code is authorized by the New York State Constitution and consistent with the federal guidelines, which are requirements for participation in the NFIP. The Town Code Enforcement Officer is empowered as the Local Administrator and is responsible for administering, implementing, and enforcing the local Flood Damage Prevention Law.

This law can be found on file with the Neversink Town Clerk or accessed online here:

https://ecode360.com/8360199

The stated purposes of this local law are as follows:

1. Regulate uses that are dangerous to health, safety, and property due to water or erosion hazards or that result in damaging increases in erosion or in flood heights or velocities.
2. Require that uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction.
3. Control the alteration of natural floodplains, stream channels, and natural protective barriers that are involved in the accommodation of floodwaters.
4. Control filling, grading, dredging, and other development that may increase erosion or flood damages.
5. Regulate the construction of flood barriers that will unnaturally divert floodwaters or that may increase flood hazards to other lands.
6. Qualify for and maintain participation in the NFIP.

The stated objectives of the local law are as follows:

1. To protect human life and health
2. To minimize the expenditure of public money for costly flood control projects
3. To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public
4. To minimize prolonged business interruptions
5. To minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; and streets and bridges located in areas of special flood hazard
6. To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas
7. To provide that developers are notified that property is in an area of special flood hazard
8. To ensure that those who occupy the areas of special flood hazard assume responsibility for their actions

New York State Community Risk and Resiliency Act

The New York State Community Risk and Resiliency Act (CRRA) was adopted in 2014 for the purpose of ensuring that projects receiving state funding or requiring permits include consideration of the effects of climate risk and extreme weather events.

To meet its obligation to develop guidance for the implementation of the CRRA, NYSDEC has proposed a new document, *State Flood Risk Management Guidance*, which is intended to inform state agencies as they develop program-specific guidance to require that applicants demonstrate consideration of sea level rise, storm surge, and flooding as permitted by program-authorizing statutes and operating regulations. The guidance incorporates possible future conditions, including the greater risks of coastal flooding presented by sea level rise and enhanced storm surge and of inland flooding expected to result from increasingly frequent extreme precipitation events.

NYSDEC is also proposing a new guidance document entitled *Guidance for Smart Growth Public Infrastructure Assessment*. This new document is intended to guide state agencies as they assess mitigation of sea level rise, storm surge, and flooding in design of public infrastructure projects as required by CRRA.

In response to CRRA, NYSDOT has provided updates to its guidelines and manuals relating to the design of bridges and culverts, including a revision of Chapter 8 of the *Highway Design Manual* and a revised *Bridge Manual*. For new and replacement bridges and culverts, current peak flows are to be increased to account for future projected peak flows, which range from 10 to 20 percent. Bridges are required to pass the 50-year flow with a minimum of 2 feet of freeboard and must pass the 100-year flow without causing a rise in water surface elevations. Culverts must pass the 50-year flow and meet allowable headwater limits.

NYSDEC Stream Crossing Guidelines and Standards

NYSDEC has developed stream crossing guidelines and standards aimed at protecting and restoring stream continuity. They provide minimum criteria to avoid fragmentation of streams. The objective is to maintain natural conditions that do not restrict the movement of fish and wildlife through the stream system.

These are summarized below and are available in more detail at:
https://www.dec.ny.gov/permits/49060.html
and:
https://www.dec.ny.gov/permits/49066.html

- Provide a minimum opening width of 1.25 times the width of the stream channel bed in the vicinity of the culvert.
- Use open-bottom culverts or closed-bottom culverts that have the bottom slabs placed below the streambed elevation, which allows for installation of natural streambed material through the length of the culvert.

- Match the channel slope through the culvert to the natural channel slope upstream and downstream of the culvert.
- The culvert should not be skewed relative to the direction of flow of the stream.
- Install new or replacement structures so that no inlet or outlet drop would restrict aquatic organism passage.

United States Geological Survey Stream Gauging Network

The USGS operates over 1,000 stream flow gauges throughout the country, two of which are stationed along Chestnut Creek in the hamlet of Grahamsville. The stream gauge known as the 'Chestnut Creek at Grahamsville NY' (gauge 01365500) is situated approximately 600 feet downstream from where Red Brook meets Chestnut Creek. This station has been in operation since 1938, with a gap in flow records from 1987 to October 1998. A second gauge 'Chestnut Creek at [Rondout Reservoir] Mouth at Grahamsville NY' (gauge 0136550) has been collecting daily water temperature readings and daily discharge amounts since September 2018. Data recorded at this gauge are completely regulated by flows from the Neversink Reservoir diversion tunnel.

These gauges record daily stream flow, including flood flows that are essential to understanding long-term runoff trends. Gauge data can be utilized to determine flood magnitudes and frequencies. Additionally, real-time data is available to monitor water levels and provide flood alerts. Stream flow data and water levels are available at https://waterdata.usgs.gov/nwis.

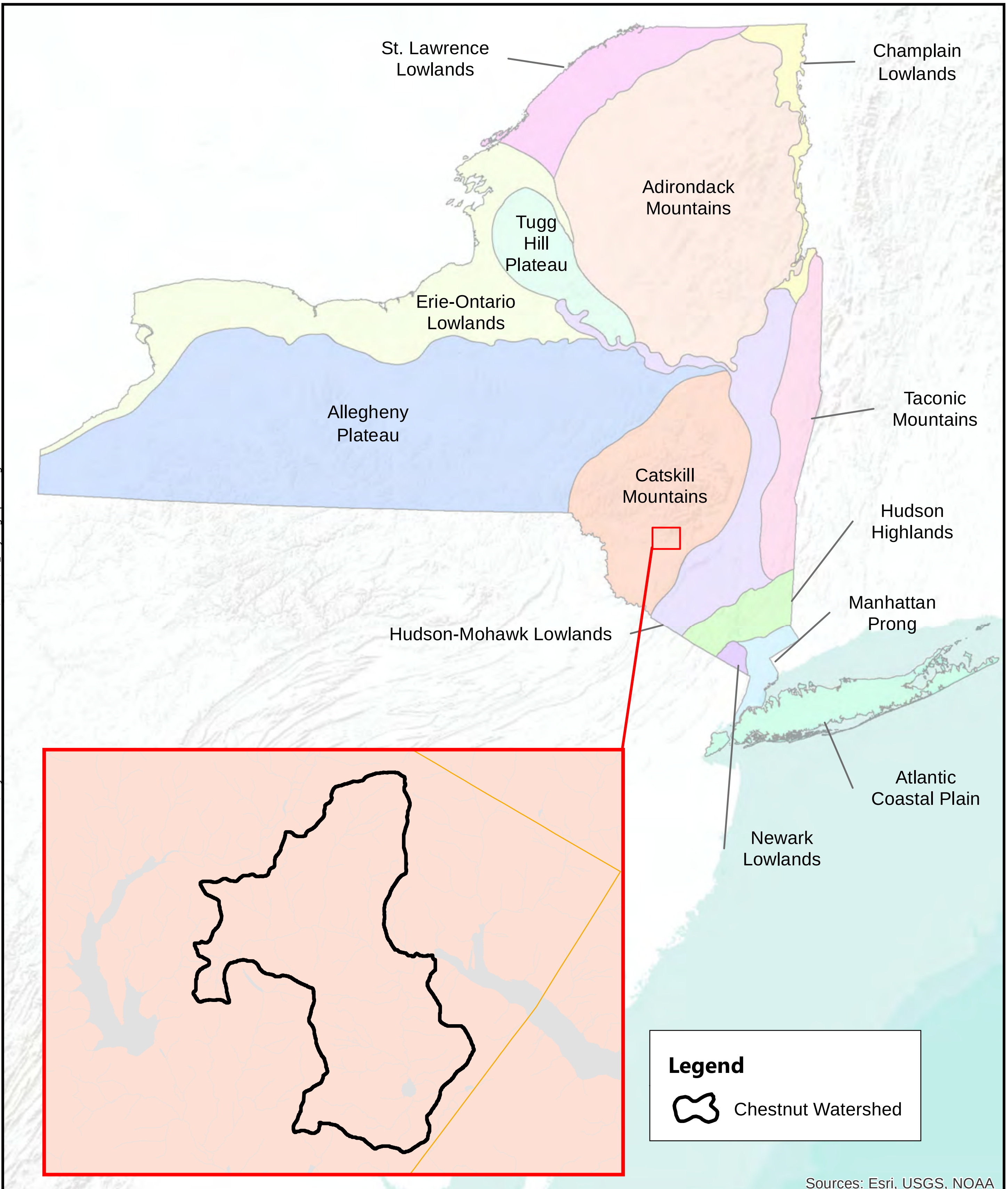
2.2 CHESTNUT CREEK WATERSHED

Chestnut Creek is located in Sullivan County, in southern New York State. The watershed falls within the physiographic region of New York State known as the Catskill Mountains as seen in Figure 2-1. The watershed flows generally from west to east, draining predominantly within the town of Neversink and a small portion of the town of Fallsburg to the south before joining with the Rondout Reservoir. The entirety of the hamlet of Grahamsville drains into Chestnut Creek. The watershed is triangular in shape, widening in size from north to south. When measured at its confluence with the Rondout Reservoir, the Chestnut Creek watershed is 21.5 square miles in size. Figure 2-2 is a watershed map. Watershed relief is depicted in Figure 2-3.

The bedrock geology of Chestnut Creek is dominated by fine sandstone and shale. Over 50 percent of bedrock within the Chestnut Creek watershed is mapped as the Lower Walton Formation. This is found at lower elevations, which encompasses the east central and southeast portions of the watershed. The Lower Walton Formation is Upper Devonian Period in age and mainly comprises of shale, with smaller amounts of sandstone and conglomerate. Forty-five percent of bedrock in the Chestnut Creek watershed is mapped as the Upper Walton Formation. This is found at the high points of the watershed, which encompasses the western and northeast portions. The lithology of the Upper Walton Formation is very similar to the Lower Walton Formation. The remainder of the bedrock within the Chestnut Creek watershed is mapped as the Slide Mountain Formation and is found in the northeast corner of the watershed. It is Upper Devonian Period in age and consists of conglomerate, sandstone, and shale.

These formations are a part of the "Catskill Delta," and the geologic history of these formations is very similar in nature. During the Upper Devonian Period, the Catskill Mountains and much of New York State was covered by a sea. Over the course of millions of years, the sea was in a cycle of expansion and contraction. As the sea advanced eastward, the water deepened in eastern New York, and sediments that formed shale were deposited in the deeper waters. After the sea ceased to expand, deposition began filling the edge of the sea and laid down shallower water sediments. Some of the siltstones and sandstones seen today were deposited by turbidity currents, which are caused by churned-up sediment in suspension that flow down slope along the sea bottom after a river channel empties into the sea. Most of the rocks within the Chestnut Creek watershed were deposited in a nonmarine environment, specifically onto a delta, a wetland type area that forms where a river empties into a slow-moving body of water.

The surficial geology of the Chestnut Creek watershed is a mixture of glacial legacy sediment and exposed bedrock. During the Pleistocene Epoch, New York State was undergoing a period of glaciation. The Catskill Mountains were covered by mountain glaciers, and the retreat and advance of these glaciers eroded the landscape as well as leaving glacial deposits made of sediment sourced from the eroded land. Sixty-three percent of the surficial geology is mapped as glacial till and found all throughout the watershed. Twenty-nine percent of the watershed is mapped as exposed or near exposed (within 3 feet of the surface) bedrock. The remaining 8 percent of the watershed is mapped as kame deposits. Kame deposits consist mainly of sand and gravel deposited by sediment-laden streams that flowed off the ice front.



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NEW YORK STATE PHYSIOGRAPHIC REGIONS

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NY

N

0 140,000 280,000
Feet

SCALE 1 " = 300,000 '

DATE 8/18/2022

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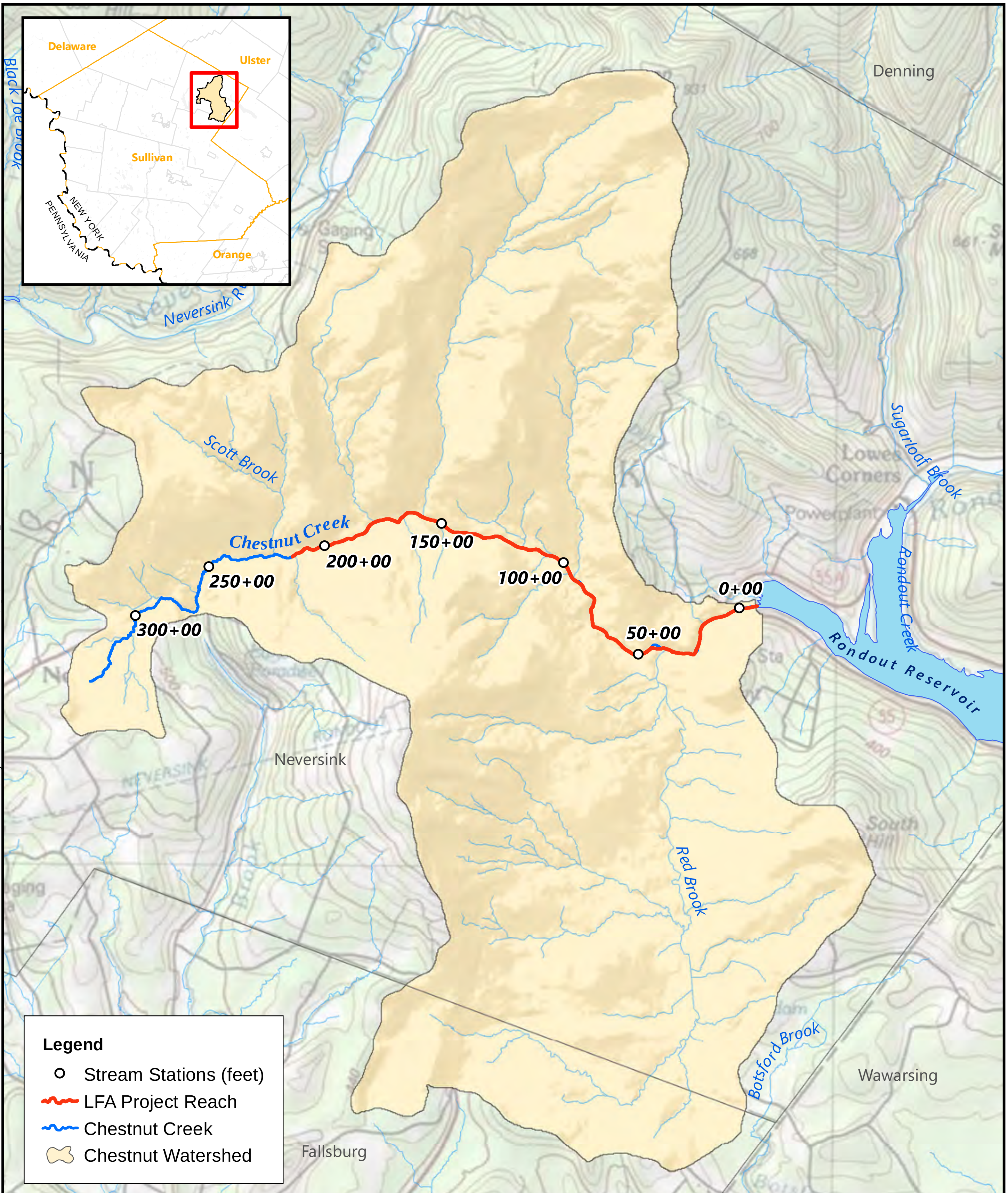
FIG. 2-1



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CHESTNUT CREEK WATERSHED

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

0 2,000 4,000 Feet

SCALE 1 " = 5,000 '

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FIG. 2-2

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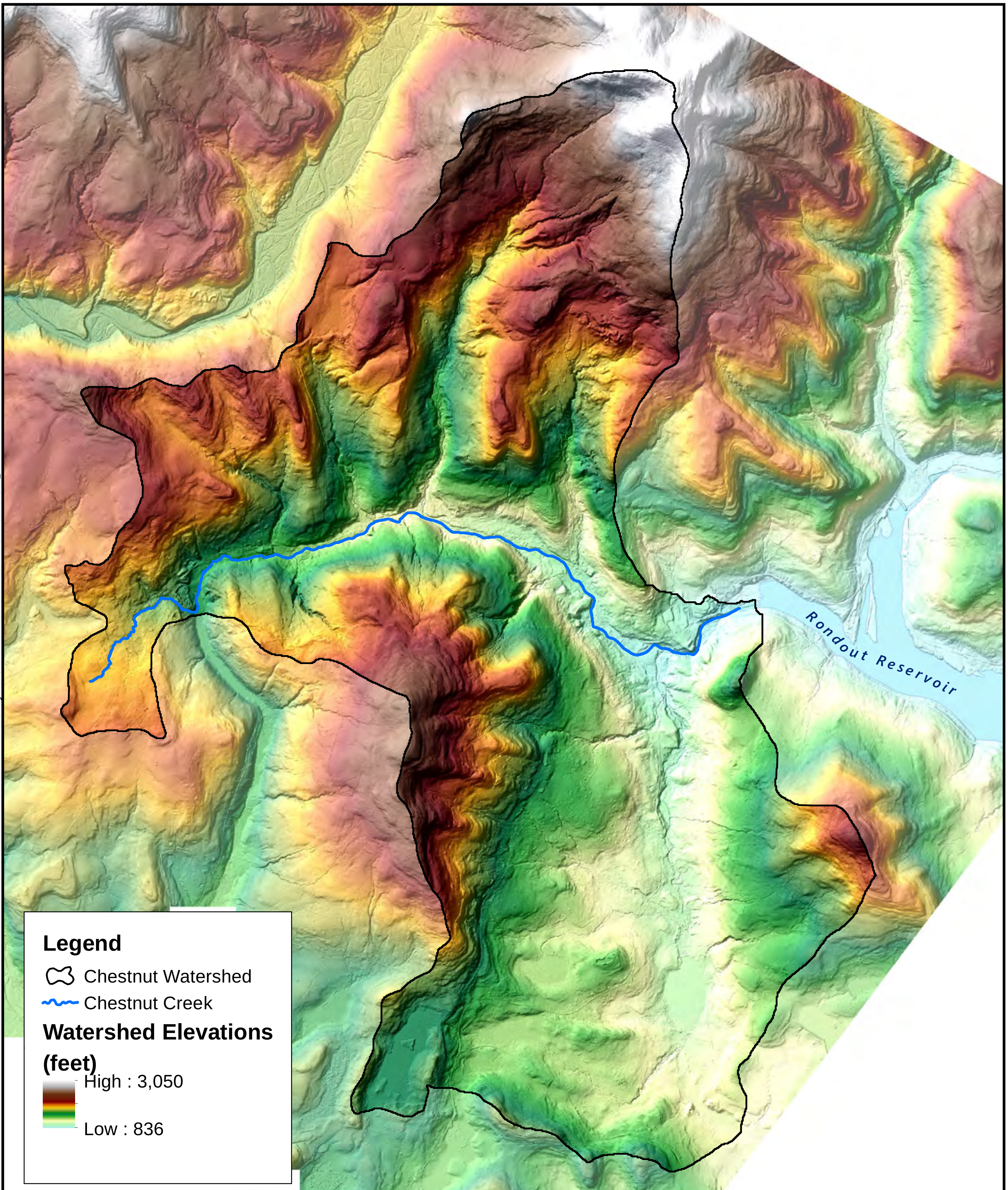

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CHESTNUT CREEK WATERSHED RELIEF MAP

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

SCALE	1 " = 5,000 '
DATE	7/6/2022
PROJ. NO.	4282.0009

FIG. 2-3

During a rainfall event, the proportion of rainfall that runs off directly into rivers and streams or that infiltrates into the ground is greatly influenced by the composition of soils within a watershed. Soils are assigned a hydrologic soil group identifier, which is a measure of the infiltration capacity of the soil. These are ranked A through D. A hydrologic soil group A soil is often very sandy, with a high infiltration capacity and a low tendency for runoff except in the most intense rainfall events; a D-ranked soil often has a high silt or clay content or is very shallow to bedrock and does not absorb much stormwater, which instead is prone to runoff even in small storms. A classification of B/D indicates that when dry the soil exhibits the properties of a B soil, but when saturated, it has the qualities of a D soil. Over 82 percent of the mapped soils in the Chestnut Creek watershed are classified as hydrologic soil group C or D, indicating a low capacity for infiltration and a high tendency for runoff (Figure 2-4).

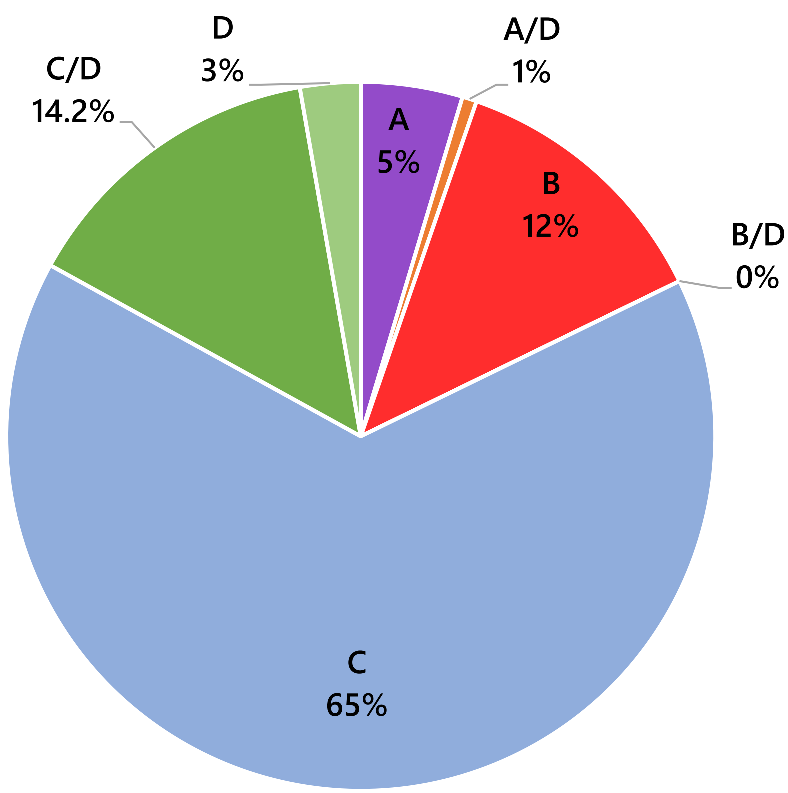


Figure 2-4: Hydrologic Grouping of Soils within the Chestnut Creek Watershed

Forested land makes up 85 percent of the Chestnut Creek watershed. Developed land makes up 6 percent. Agricultural land makes up 6 percent. Wetlands make up 2 percent of the watershed. The remaining 1 percent of land cover consists of grassland and shrubland, open water, and barren land (Figure 2-5).

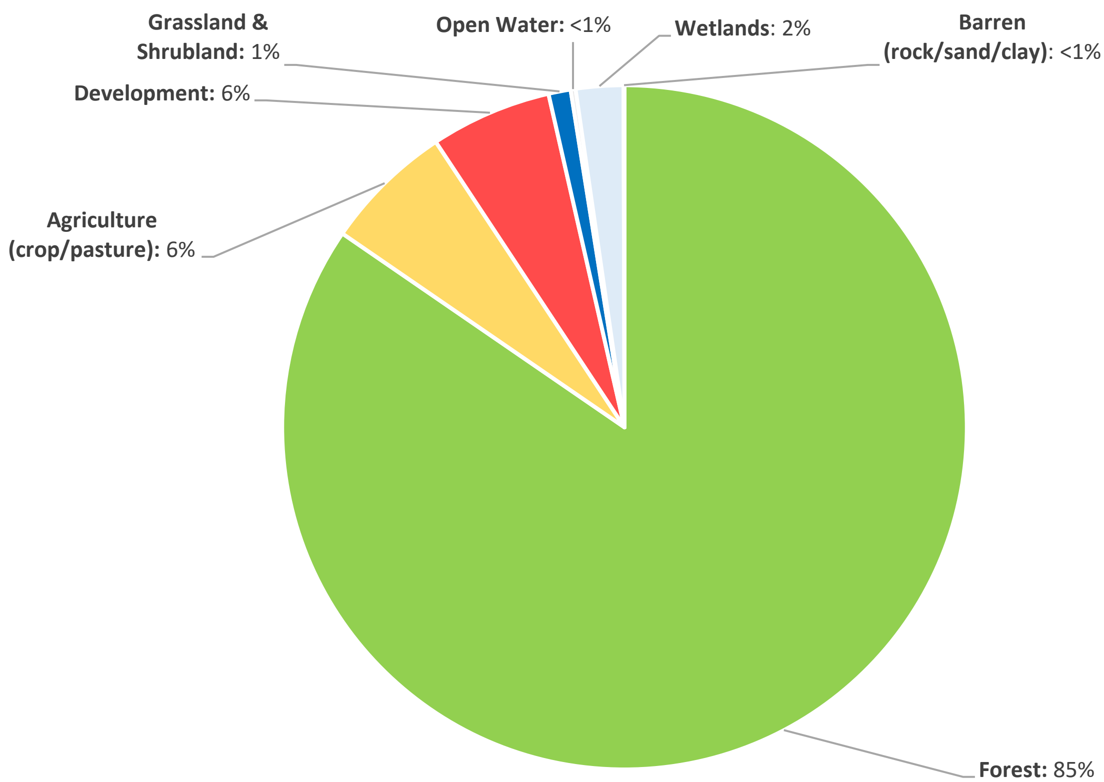


Figure 2-5: Land Cover within the Chestnut Creek Watershed

Wetland cover was also examined using information available from the U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI). The NWI indicates that there are 2,489 acres of wetlands in the Chestnut Creek watershed, or approximately 18 percent of the watershed. This amount is larger than the estimated wetland amount determined from landcover. The wetland type found in the Chestnut Creek watershed includes freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, lake, and riverine. Wetlands play an important role in flood mitigation by storing water and attenuating peak flows. It is estimated that since colonial times approximately 50 to 60 percent of the wetlands in the state of New York have been lost through draining, filling, and other types of alteration.

2.3 CHESTNUT CREEK WATERCOURSE

The main stem of Chestnut Creek originates in the southern flank of the town of Neversink and flows generally eastward before emptying into the Rondout Reservoir. Chestnut Creek is approximately 7 miles in length where it meets the reservoir. Named tributaries to Chestnut Creek include Red Brook (STA 36+60) and Scott Brook (STA 220+80).

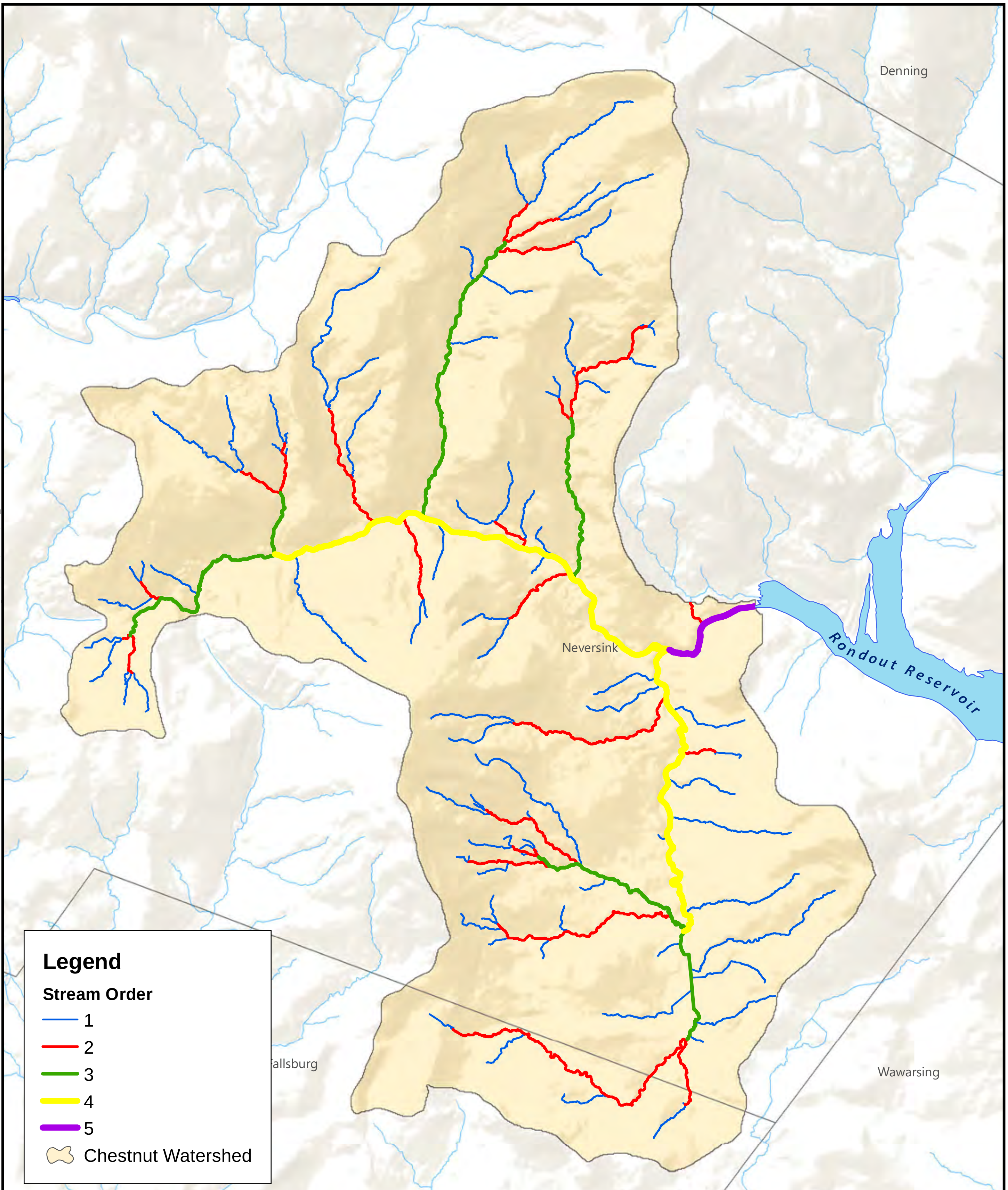
Stream order provides a measure of the relative size of streams by assigning a numeric order to each stream in a stream network. The smallest tributaries are designated as first-order streams, and the designation increases as tributaries join.

The main stem of Chestnut Creek can be characterized as a fifth-order stream at its confluence with Rondout Reservoir and is a fourth-order stream for around half of its length. Figure 2-6 is a map depicting stream order in the Chestnut Creek watershed.

Characteristics of each order of stream (total length, average slope, and percentage of overall stream network) are summarized in Table 2-1 for Chestnut Creek. First- and second-order streams account for most of the overall stream length within the Chestnut Creek watershed (76 percent). First- and second-order streams are steeper in slope than higher-order streams.

Table 2-1 Stream Order Characteristics in Chestnut Creek Watershed

Stream Order	Total Length (Miles)	Percentage Of Overall Network Length (%)	Average Slope (%)
1st	34.8	9.8	53
2nd	15.2	7.1	23
3rd	8.1	2.9	12
4th	6.2	1.9	10
5th	1.0	0.8	2
Total	**65.4**	**100**	



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SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

CHESTNUT CREEK WATERSHED STREAM ORDER

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

0 2,000 4,000
Feet

SCALE 1 " = 5,000 '

DATE 8/18/2022

4282.0009
PROJ. NO.

FIG. 2-4

2.4 HYDROLOGY

Hydrologic studies are conducted to understand historical, current, and potential future river flow rates, which are a critical input for hydraulic modeling software such as *Hydrologic Engineering Center – River Analysis System* (HEC-RAS). These often include statistical techniques to estimate the probability of a certain flow rate occurring within a certain period of time based on data from the past; these data are collected and maintained by USGS at thousands of stream gauging stations around the country. For the streams without gauges, USGS has developed region-specific regression equations that estimate flows based on watershed characteristics, such as drainage area and annual precipitation, as well as various techniques to account for the presence of nearby stream gauges or to improve analyses of gauges with limited records. These are based on the same watershed characteristics as gauged streams in that region so are certainly informative although not as accurate or reliable as a gauge due to the intricacies of each unique basin.

For the purposes of this study, we are primarily concerned with the more severe flood flows although hydrologic analyses may be conducted for the purposes of estimating low flows, high flows, or anywhere in between. The commonly termed "100-Year Flood" refers to the flow rate that is predicted to have a 1 percent, or 1 in 100, chance of occurring in any year. A "25-Year Flood" has a 1 in 25 chance of occurring (4 percent) every year. It is important to note that referring to a specific discharge as an "X-Year Flood" is a common and convenient way to express a statistical probability but can be misleading because it has no bearing whatsoever on when or how often such a flow actually occurs.

A simplified diagram of the hydrologic cycle is presented in Figure 2-7.

Along with the location, duration, and intensity of a storm, the flooding that may result from a rainfall event can vary widely depending on the unique hydrology of each basin. Characteristics of local topography, soils, vegetation cover and type, bedrock geology, land use and cover, river hydraulics and floodplain storage, ponding, wetland, and reservoir storage, combined with antecedent conditions in the watershed such as snowpack or soil saturation, can impact the timing, duration, and severity of flooding.

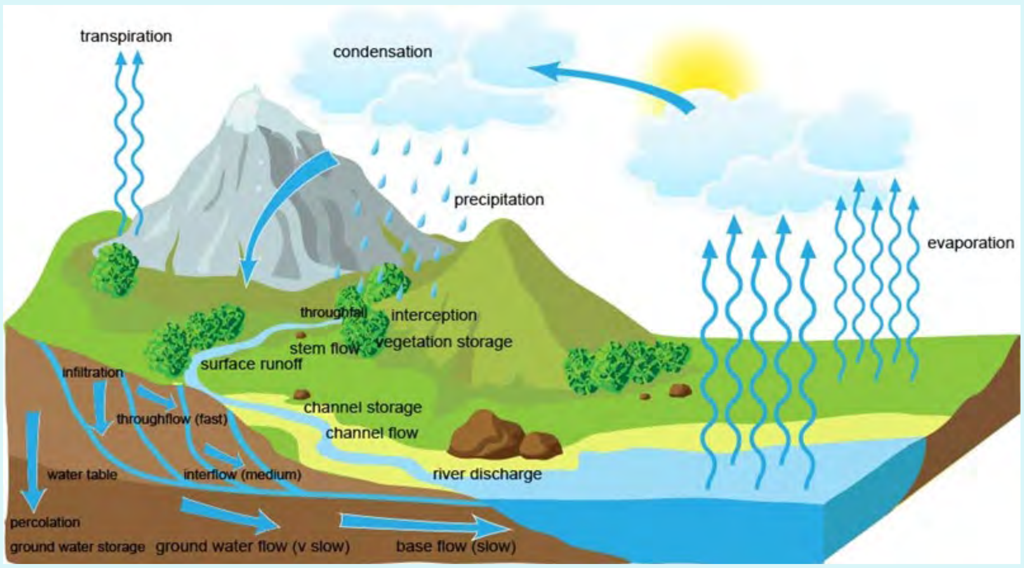

Figure 2-7: Diagram of Simplified Hydrologic Cycle

Flood hydrology for Chestnut Creek was originally conducted for the effective Flood Insurance Studies (FIS) for Sullivan County, New York (36105CV001B, Revised August 17, 2015). However, the 2015 FIS report states that the hydrologic analysis was completed in 2013 and may not represent recent flood events. Peak discharge records are outdated and do not account for the last 9 years of peak-flow data recorded at the Chestnut Creek USGS gauge (USGS 0136500). A log-Pearson Type III probability distribution was conducted to update peak-flow recurrence intervals at gauge 01365500. These flows were then transferred upstream to the project sites using the area transfer methodologies developed for New York State detailed in the USGS *Scientific Investigations Report* (SIR) 2006-5112. Discharge estimates for the 2-, 10-, 25-, 50-, 100-, and 500-year storm events were recomputed for the locations along the focus watercourse that fall within the flood study limits.

For the streams without gauges, USGS has developed region-specific regression equations that estimate flows based on watershed characteristics, such as drainage area and annual precipitation, as well as various techniques to account for the presence of nearby stream gauges or to improve analyses of gauges with limited records. These are based on the same watershed characteristics as gauged streams in that region so are certainly informative although not as accurate or reliable as a gauge due to the intricacies of each unique basin.

Updated flow amounts for Chestnut Creek are presented in Table 2-2. Flood recurrence information updated with USGS gauge peak-flow data was used for this study because they represent the most current and reliable hydrologic analysis within the study watershed. Peak-flood discharge amounts from the effective FIS, and those derived using regional regression equations, are included in the table for comparative purposes.

Table 2-2 Updated Hydrology for Chestnut Creek Calculated at Change Point Locations Identified in the Sullivan County FIS (36105CV001B) Hydraulic Model

Location	Drainage Area (mi^2)	Peak-Flood Discharge (cfs): Updated Flows *(FEMA Flows)* *(Regional Regression Flows)*					
		2-Year	10-Year	25-Year	50-Year	100-Year	500-Year
At the confluence with Rondout Reservoir	21.6	1,262 *(1,270)* *(1,080)*	2,777 *(2,940)* *(2,520)*	3,742 *(4,190)* *(3,520)*	4,556 *(5,320)* *(4,390)*	5,454 *(6,610)* *(5,360)*	7,906 *(10,400)* *(8,140)*
At Davis Lane	11.6	784 *(809)* *(782)*	1,847 *(1,930)* *(1,850)*	2,559 *(2,700)* *(2,570)*	3,181 *(3,370)* *(3,200)*	3,872 *(4,120)* *(3,900)*	5,810 *(6,260)* *(5,870)*
Approximately 250 feet upstream of Slater Road	2.7	240 *(261)* *(204)*	548 *(628)* *(492)*	740 *(849)* *(689)*	896 *(1,010)* *(859)*	1,065 *(1,200)* *(1,050)*	1,507 *(1,670)* *(1,580)*

cfs = cubic feet per second

2.5 HYDRAULICS

To develop hydraulic modeling to assess flood mitigation alternatives, effective FEMA HEC-RAS hydraulic models were sought for the Chestnut Creek watershed. Models were obtained from NYCDEP.

Effective FEMA modeling of Chestnut Creek was completed in 2013 as part of the Sullivan County, New York, FIS (36105CV001B). The Chestnut Creek HEC-RAS model extends from the Rondout Reservoir confluence to approximately 250 feet upstream of Slater Road and was used in its entirety to conduct hydraulic analyses for this study.

The HEC-RAS computer software program was developed by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center and is the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one- and two-dimensional, steady- and unsteady-state flow conditions. The system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions. Water surface profiles are computed from one cross section to the next by solving the one-dimensional energy equation with an iterative procedure called the Standard Step Method. Energy losses are evaluated by friction (Manning's Equation) and the contraction/expansion of flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence.

Model geometry was based on a combination of surveyed channel cross sections included in effective FEMA modeling, field measurements by SLR, and Light Detection and Ranging (LiDAR)-derived topographic mapping from the NYS Geographic Information System (GIS) Clearinghouse. Roughness coefficients were applied to the model domain based on field observations and aerial orthophotography.

2.6 INFRASTRUCTURE

A total of ten public road crossings, nine bridges, and one culvert span Chestnut Creek within the LFA study reach and, in certain cases, may contribute to flooding in these locations. These structures and summary details are listed below in Table 2-3. NYSDEC stream crossing guidelines, described in more detail below, state that bridges and culverts spanning watercourses should provide a minimum opening width of 1.25 times the channel width of the waterway in the vicinity of the crossing. It should be noted that in Table 2-3 the measured span of several crossings is less than the watercourse's bankfull width, indicating that the crossing is likely hydraulically undersized. According to the NYSDEC dam inventory database, there are two registered dams within the Chestnut Creek watershed. Table 2-4 lists the information and location of these structures, which are located along tributaries of Chestnut Creek. There are no NYSDEC registered dams located along the Chestnut Creek mainstem, although the Chestnut Creek SMP reported the presence of a 1-foot-high man-made check dam located 140 feet below the Route 42 bridge near STA 48+85.

Table 2-3 Summary Data for Assessed Bridge and Culvert Crossings of Chestnut Creek

Roadway	River Station (feet)	Structure (Year Built)	NBI BIN* (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
New York State Route 55	0+50	Steel stringer/multi-beam or girder bridge (2010)	1027070 (NYC Dept. Water Supply)	1	73	50
Reynolds Road	35+00	Bridge abutment remnants (unknown)	Not Listed (Unknown)	1	20	48
New York State Route 42	50+73	Prestressed concrete box beam bridge (N/A)	1025010 (NYSDOT)	1	64	47
River Road	67+74	Steel stringer/multi-beam or girder bridge (1996)	3357080 (Sullivan County)	1	43	53
Davis Lane	90+00	Steel stringer/multi-beam or girder bridge (1993)	3357040 (Sullivan County)	2	57	53

Roadway	River Station (feet)	Structure (Year Built)	NBI BIN* (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
Fairground Road	101+00	Steel stringer/multi-beam or girder bridge (1976)	3357180 (Town of Neversink)	1	37	53
Hilltop Road	137+85	Timber stringer/multi-beam or girder bridge (1967)	3357180 (Sullivan County)	1	22	47
Clark Road	152+75	Steel stringer/multi-beam or girder bridge (1995)	3357090 (Sullivan County)	1	30	46
Kelly Road	175+21	Timber stringer/multi-beam or girder bridge (1979)	3229170 (Sullivan County)	1	29	35
Slater Road	211+23	Corrugated metal arch culvert (unknown)	Not Listed (Town of Neversink)	1	14	27

*NBI BIN = National Bridge Inventory Bridge Identification Number

Table 2-4 List of NYSDEC Registered Dams Inside the Chestnut Creek Watershed

Feature Name	State ID (Federal ID)	Watercourse	Hazard Code Classification	Dam Height (feet)	Dam Length (feet)
Craig Weiss Dam	162-5120 (NY 14761)	Tributary to Scott Brook	Class “A” – low hazard	12	270
Beaver Dam	162-0806 (NY 12748)	Red Brook	Class “A” – low hazard	N/A	275

In 2014, the CRRA was signed into law to build New York’s resilience to rising sea levels and extreme flooding. The Climate Leadership and Community Protection Act made modifications to the CRRA, expanding the scope of climate hazards and projects for consideration. These modifications became effective January 1, 2020. NYSDEC has provided guidelines for requirements under CRRA, which are summarized in a publication entitled *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act*.

Based on guidance provided in the New York State Department of Transportation (NYSDOT) *Highway Design Manual* (NYSDOT, 2021) and *Bridge Design Manual* (NYSDOT, 2019), the design criteria for bridges and culverts are listed below. Culverts are classified as any stream crossings with a span of less than 20 feet (measured parallel to the roadway) while bridges have a span of 20 feet or greater.

- Culverts will be designed to pass the predicted 50-year storm event.
- Bridges will be designed to pass the 50-year storm event with 2 feet of freeboard below the bridge low chord and the 100-year storm event without touching the low chord.
- Hydrologic analysis will include an evaluation of future predicted flows.
- Headwater at culverts will be limited to an elevation that:
    - Would not result in damage to upland property,
    - Would not increase the water surface elevation allowed by floodplain regulations, and
    - Would result in a headwater depth-to-culvert height ratio of not greater than 1.0 for culverts with a height greater than 5 feet and not greater than 1.5 for culverts with a height of 5 feet or less.

NYSDEC stream crossing guidelines require, if possible, that the following best management guidelines will be incorporated:

- Provide a minimum opening width of 1.25 times the width of the stream channel bed. This width is measured bank to bank at the ordinary high-water level in the vicinity of the crossing or at an undisturbed reference reach.
- Use open-bottom or embedded, closed-bottom structures, which allows for installation of natural streambed material throughout the length of the structure.
- Match the channel slope through the bridge or culvert to the natural channel slope.
- Install bridges or culverts perpendicularly to the direction of flow of the stream.
- Install new or replacement structures so that no inlet or outlet drop would restrict aquatic organism passage.

2.7 CRITICAL INFASTRUCTURE AND ANCHOR BUSINESSES

An important component of the LFA information-gathering stage is the identification of critical facilities and anchor businesses. Critical facilities are defined as follows: public facilities such as a firehouse (Figure 2-8), school, town hall, drinking water supply treatment or distribution facility, or wastewater treatment plant or collection facility, which if destroyed or damaged would impair the health and/or safety of the community.

The known critical facilities in Grahamsville, along the Chestnut Creek LFA reach are listed in Table 2-5.

Figure 2-8: Grahamsville Volunteer Fire Department, a critical facility

Table 2-5 Critical Municipal Facilities in the Project Area

Facility	River Station (feet)	Address	Located in SFHA?
Sewage Treatment Plant	40+00	7870 NY-42, Grahamsville, NY 12740	No
NYCDEP Police Station	50+00	7892 NY-42, Grahamsville, NY 12740	No
NYCDEP Grahamsville Building	50+00	7870 NY-42, Grahamsville, NY 12740	No
Grahamsville Volunteer Fire Department	57+45	205 Main Street, Grahamsville, NY 12740	Partially
Unites States Postal Service Building	58+75	215 Main Street, Grahamsville, NY 12740	No
Neversink Town Clerk Building	65+00	273 Main Street, Grahamsville, NY 12740	Partially
Grahamsville First Aid Squad	97+77	499 Main Street, Grahamsville, NY 12740	Partially
Neversink Highway Department and Town Transfer Station	175+00	7941 State Route 55, Grahamsville, NY 12740	No

Anchor businesses are defined as follows: private gas stations, grocery stores, lumber yards, hardware stores, and medical doctor’s office or pharmacy, which if destroyed or damaged would impair the health and/or safety of the community.

There are no known anchor businesses along the Chestnut Creek project corridor.

3. IDENTIFICATION OF FLOOD HAZARDS

3.1 FLOODING HISTORY

According to the FIS report for Sullivan County (36105CV001B), flooding in Sullivan County can occur any time of the year but usually occurs during late winter-early spring months when precipitation events combine with snow. Late summer flooding is also a possibility due to thunderstorms and tropical storms/hurricanes. According to the Sullivan County Hazard Mitigation Plan, 11 Presidential Disaster Declarations related to flooding events were issued and 47 records of extensive flood events were reported for Sullivan County. Table 3-1 is a summary of flood events that impacted Sullivan County and Chestnut Creek. The flood history is summarized from the FEMA FIS for Sullivan County, the Sullivan County Multi-Jurisdictional Hazard Mitigation Plan, National Oceanic and Atmospheric Administration (NOAA) historical records, and other resources.

Table 3-1 Sullivan County Flood History

DATE	FLOOD EVENT	NOTES
August 1955	Hurricane Diane	Hurricane Diane produced excessive rainfall over Pennsylvania, New York, New Jersey, and New England on August 18 and August 19. Accompanied by the rainfall of an antecedent hurricane of August 11-15, rainfall amounts in Sullivan County ranged from 5 to 7 inches. Eight states were declared federal disaster areas.
October 1955	Unnamed Storm	A slow-moving coastal storm produced heavy rainfall across southern New York and caused flooding in Sullivan County.
July – August 1969	Unnamed Storm	An intense storm that traveled across New York State dropped a range of 3 to 10 inches of rain on Sullivan County. The highest rainfall amounts were in eastern Sullivan County, and flooding ensued. Flood damage occurred to homes, stores, highways, streets, and bridges. Estimated damages sustained in New York State is $1,380,000.
January 1996	Blizzard of 1996	The combination of snowmelt and rain created flooding conditions in Sullivan County. Forty-eight inches of snow was melted by an unseasonably warm 3 inches of rain on January 12. Widespread flooding ensued. Multiple lives were lost, thousands of homes and businesses were destroyed, and hundreds of roads were closed. More than $6 million in individual and public assistance went to Sullivan County. Multiple counties in New York State were declared federal disaster areas.
December 1996	Flood	Major stream and roadway flooding occurred in northern Sullivan County. One and one half to 3.5 inches of rainfall was recorded across the region. Soils were already saturated before the storm, and once the rainfall came, flooding occurred quickly. Major stream and roadway flooding developed in northern Sullivan County. Ten thousand dollars in property damage was sustained in Sullivan County.

DATE	FLOOD EVENT	NOTES
September 1999	Remnants of Hurricane Floyd	The remnants of Hurricane Floyd traveled up the east coast on September 16 and during the early hours of September 17. Minor flooding and road washouts occurred in Sullivan County. Drought conditions were present in Sullivan County at the time of the storm, so flooding was minor.
July 2000	Unnamed Storm	Prolonged heavy rainfall affected the Rondout Creek basin, and road flooding was reported in Neversink.
December 2000	Flash Flood	Heavy rainfall combined with snowmelt created flooding. Roads were washed out in Sullivan County. Jeffersonville was evacuated, and a State of Emergency was declared in the towns of Rockland, Liberty, and Callicoon. One million dollars in property damage occurred. Two to 5 inches of rain fell across the region.
September 2003	Flash Flood	Five-hundred thousand dollars in damage occurred. Many roads were undermined or closed due to flooding. Stewart Road in the town of Callicoon was washed out with a 10-foot hole in the road.
July 2004	Unnamed Storm	Thunderstorms with heavy rain caused flash flooding. Numerous roads were washed out. Northeastern Sullivan County sustained $50,000 in damages.
September 2004	Remnants of Hurricane Ivan	Remnants of Hurricane Ivan dropped 3 to 6 inches of rain and caused flash flooding across Sullivan County. Three hundred homes and dozens of businesses were damaged, and 1,200 people were evacuated county-wide. Eighteen million dollars in damages were sustained.
April 2005	Unnamed Storm	A slow-moving storm from the Ohio Valley brought 2 to 4 inches of rain to Sullivan County. All towns were affected, and all streams and creeks flooded. Buildings, roads, and bridges were damaged as a result. Sullivan County sustained 10 million dollars in damage.
June 2006	Unnamed Storm	Heavy rain fell over the Delaware River basin from June 24 to June 28. Twelve to 15 inches of rain was recorded. Flash floods occurred on June 28 and 29. Near-record flood crests occurred along stream and rivers throughout the Delaware River basin. More than 1,500 homes were flooded along with bridges and roads. According to the Sullivan County Multi-Jurisdictional Hazard Mitigation Plan, the flash flooding was described as the worst ever in Sullivan County. One person was killed when their home was flooded.
July 2008	Flash Flood	Heavy rain from thunderstorms caused significant flash flooding. A State of Emergency was declared in the town of Colchester. Serious damage occurred to bridges and roads. $15 million in damages were sustained in the town of Rockland.

DATE	FLOOD EVENT	NOTES
August and September 2011	Tropical Storm Irene and Tropical Storm Lee	Hurricane Irene formed from a tropical wave on August 21, 2011, in the tropical Atlantic Ocean. It moved northwestward before becoming a hurricane. Irene struck Puerto Rico as a tropical storm. Hurricane Irene steadily strengthened to reach peak winds of 120 miles per hour on August 24. Irene then gradually weakened and made landfall on the Outer Banks of North Carolina with winds of 85 miles per hour on August 27. It slowly weakened over land and reemerged into the Atlantic on the following day. On August 28, Irene was downgraded to a tropical storm and made two additional landfalls, one in New Jersey and another in New York. Irene produced heavy damage over much of New York, totaling $296 million. The storm is ranked as one of the costliest in the history of New York, after Hurricane Agnes in 1972. Much of the damage occurred due to flooding, both from heavy rainfall in inland areas and storm surge in New York City and on Long Island. Tropical storm force winds left at least three million residents without electricity in New York and Connecticut. Ten fatalities are directly attributed to the hurricane. Sullivan County experienced widespread flooding and major damage. At least four bridges were severely damaged, and multiple roads were water damaged. Power outages ensued, and clean water supplies were disrupted. Multiple lives were lost.
October 29, 2012	Hurricane Sandy	Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season as well as the second-costliest hurricane in United States history. It was classified as the eighteenth named storm, tenth hurricane, and second major hurricane of the year. Hurricane Sandy made landfall in the United States about 8:00 p.m. EDT October 29, striking near Atlantic City, New Jersey, with winds of 80 miles per hour. A full moon made high tides 20 percent higher than normal and amplified Sandy's storm surge. Hurricane Sandy affected 24 states, including the entire eastern seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin, with particularly severe damage in New Jersey and New York. Its storm surge hit New York City on October 29, flooding streets, tunnels, and subway lines and cutting power in and around the city. Damage in the United States is estimated at over $100 billion (2013 USD). Sullivan County was moderately impacted by Hurricane Sandy. A range of 4 to 8 inches of rain fell on the county.
August 2018	Unnamed Storm	Heavy rainfall fell across northern Sullivan County as a result of deep tropical-like air interacting with areas of weak low pressure. Flash flooding was observed in Grahamsville, specifically on a road near Main Street and River Road.

DATE	FLOOD EVENT	NOTES
August through September 2021	Tropical Storm Henri and Tropical Storm Ida	Tropical Storm Henri was the first tropical cyclone to make landfall in Rhode Island since Hurricane Bob in 1991. It proceeded to move northwestward, weakening down to a tropical depression while greatly slowing down. On August 23, Henri degenerated into a remnant low over New England before dissipating the next day over the Atlantic. Despite its relatively weak intensity, the storm brought very heavy rainfall over the Northeastern United States and New England, causing widespread flooding in many areas, including Ulster County. Hurricane Ida made landfall near Port Fourchon, Louisiana, and moved through the Northeastern United States as a Tropical Storm on September 1–2, 2021, dropping large amounts of rainfall across the region before moving out into the Atlantic. Widespread flooding shut down much of the New York City Subway system as well as large portions of the New Jersey Transit, Long Island Railroad, and Metro-North Railroad commuter rail systems and Amtrak intercity services. Extensive and historic flooding occurred in Lower New York. Heavy rainfall associated with Hurricane Ida led to flash flooding in small streams and urban areas within Sullivan County.

The USGS operates two stream flow gauges along Chestnut Creek in Grahamsville. USGS gauge 01365500 is the upstream most gauge located 600 feet downstream from Red Brook. The gauge has been in operation from October 1938 to March 1987, decommissioned for 11 years until October 1998, and has been recording flow data measurements continuously since. A second USGS gauge (01365550) is located approximately 1,000 feet upstream of Rondout Reservoir and approximately 1,900 feet downstream from the Neversink Reservoir diversion channel. This gauge has only been operational since 2018 to the current year. Daily flow records at this gauge are stated to be regulated by the Neversink Reservoir (station 01435900).

Annual peak-flow data on Chestnut Creek provide a useful view into past flood events. A hydrograph with annual peak flows measured at gauge 01365500 for the 2020 water year is illustrated in Figure 3-1. The hydrographs were updated with the recent flood event that took place in December 2020. Published and updated flood recurrence information was superimposed on the hydrographs. The FEMA FIS 10-, 25-, 50-, and 100-year peak discharges are denoted by solid lines while the updated gauge analysis peak flows are denoted by dashed lines. The events that resulted in the largest magnitude flows on Chestnut Creek include a storm in October 1955, which exceeded a 50-year event, and an event in January 1975, which was close to a 50-year flood event. The August 2011 Tropical Storm Irene event, which caused widespread flooding across the Catskill region, reached a peak of 2,600 cubic feet per second (cfs) on Chestnut Creek, or almost a 10-year flood event. Within the past two decades, the largest recorded storm was the April 2005 flood that was above a 10-year storm event.

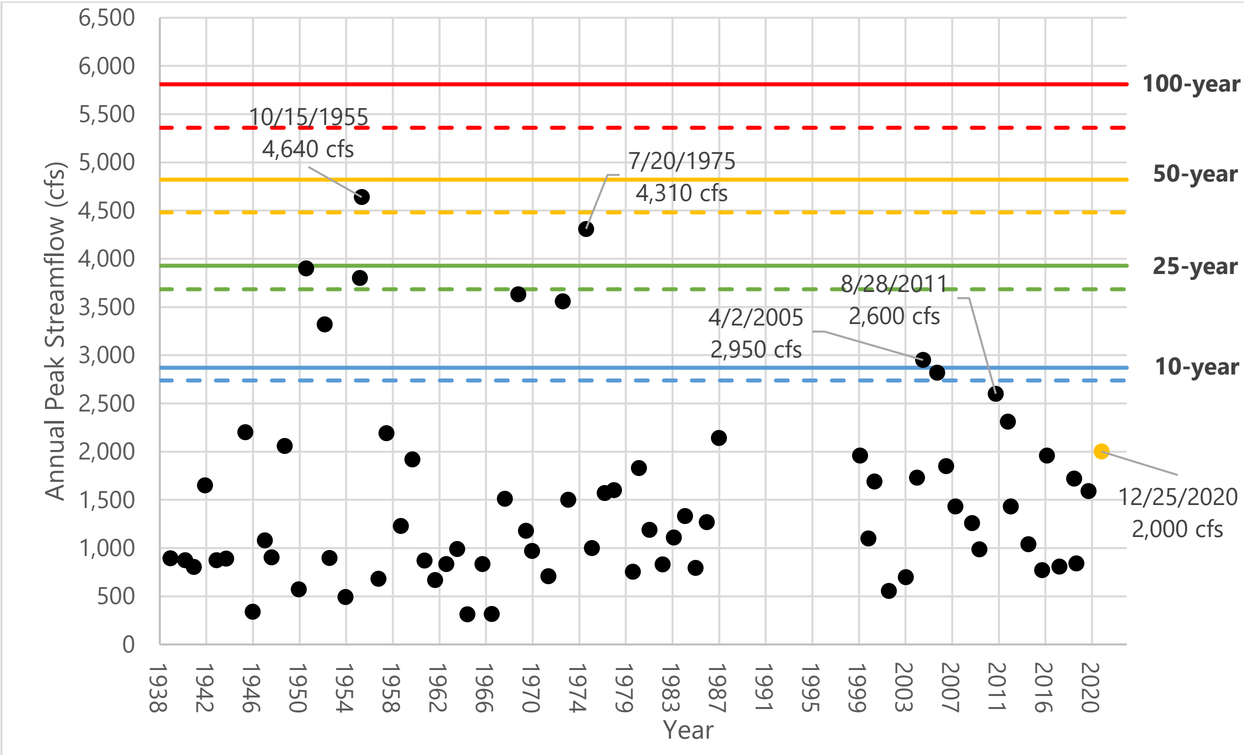

Figure 3-1: Hydrograph of annual peak flows as recorded by USGS Gauge 01365500 on Chestnut Creek in Grahamsville, New York (1938 – 1987; 1998 – Current)

3.2 FEMA MAPPING

Over the period of a standard 30-year mortgage, a property located within the SFHA will have a 26 percent chance of experiencing a 100-year flood event. Structures falling within the SFHA may be at an even greater risk of flooding because if a house is low enough it may be subject to flooding during the 25-year or 10-year flood events. During the period of a 30-year mortgage, the chance of being hit by a 25-year flood event is 71 percent, and the chance of being hit by a 10-year flood event is 96 percent, which is a near certainty.

As part of the NFIP, FEMA produces FIRMs that demarcate the regulatory floodplain boundaries. As part of an FIS, the extents of the 100-year and 500-year floods are computed or estimated as well as the regulatory floodway if one is established. The area inundated during the 100-year flood event is also known as the SFHA. In addition to establishing flood insurance rates for the NFIP, the SFHA and other regulatory flood zones are used to enforce local flood damage prevention codes related to development in floodplains.

The current FIS for Sullivan County (36105CV001B) has an initial effective date of February 18, 2011, with revisions to some areas of the county effective August 17, 2015. The flood hazard areas delineated by FEMA are mapped for each focus watercourse. For the 2015 FIS revision, detailed hydrologic and hydraulic analyses were conducted for the section of Chestnut Creek within the hamlet of Grahamsville. Figures 3-2 through 3-6 depict flood hazard mapping along the Chestnut Creek corridor. Each map displays the Special Flood Hazard Layers delineated by FEMA for each focus watercourse in this report, including the 1.0 percent annual chance flood hazard layer (100-year flood), 0.2 percent annual chance flood hazard layer (500-year flood), and the floodway hazard layer.

The figures provide an overview of what FEMA data is available on each focus watercourse. Residents are encouraged to consult the most recent products available from the FEMA Flood Map Service Center (https://msc.fema.gov/portal/home) for a more complete understanding of the flood hazards that currently exist.

As part of their detailed studies in the Sullivan County FIS, FEMA developed a series of hydraulic models for focus watercourses using the HEC-RAS computer software. These models are available for professional use and are a valuable component of the LFA. A key element of the HEC-RAS analysis is the determination of the area flooded during the 100-year frequency event, referred to as the SFHA. A detailed HEC-RAS model was created for the LFA study reach of Chestnut Creek.

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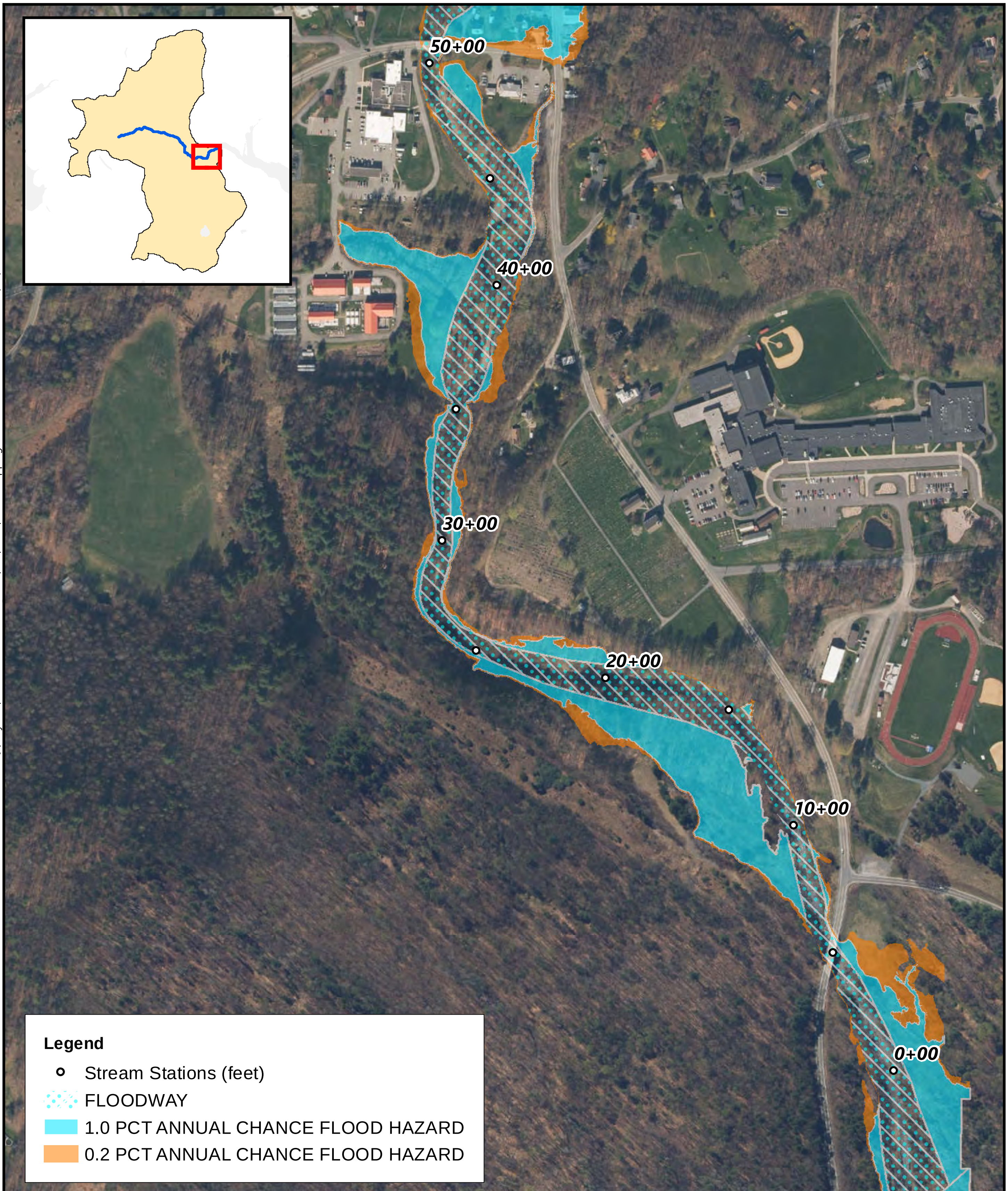

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CHESTNUT CREEK FEMA MAPPING

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

0 500
Feet

SCALE 1 " = 500 '

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FIG. 3-#

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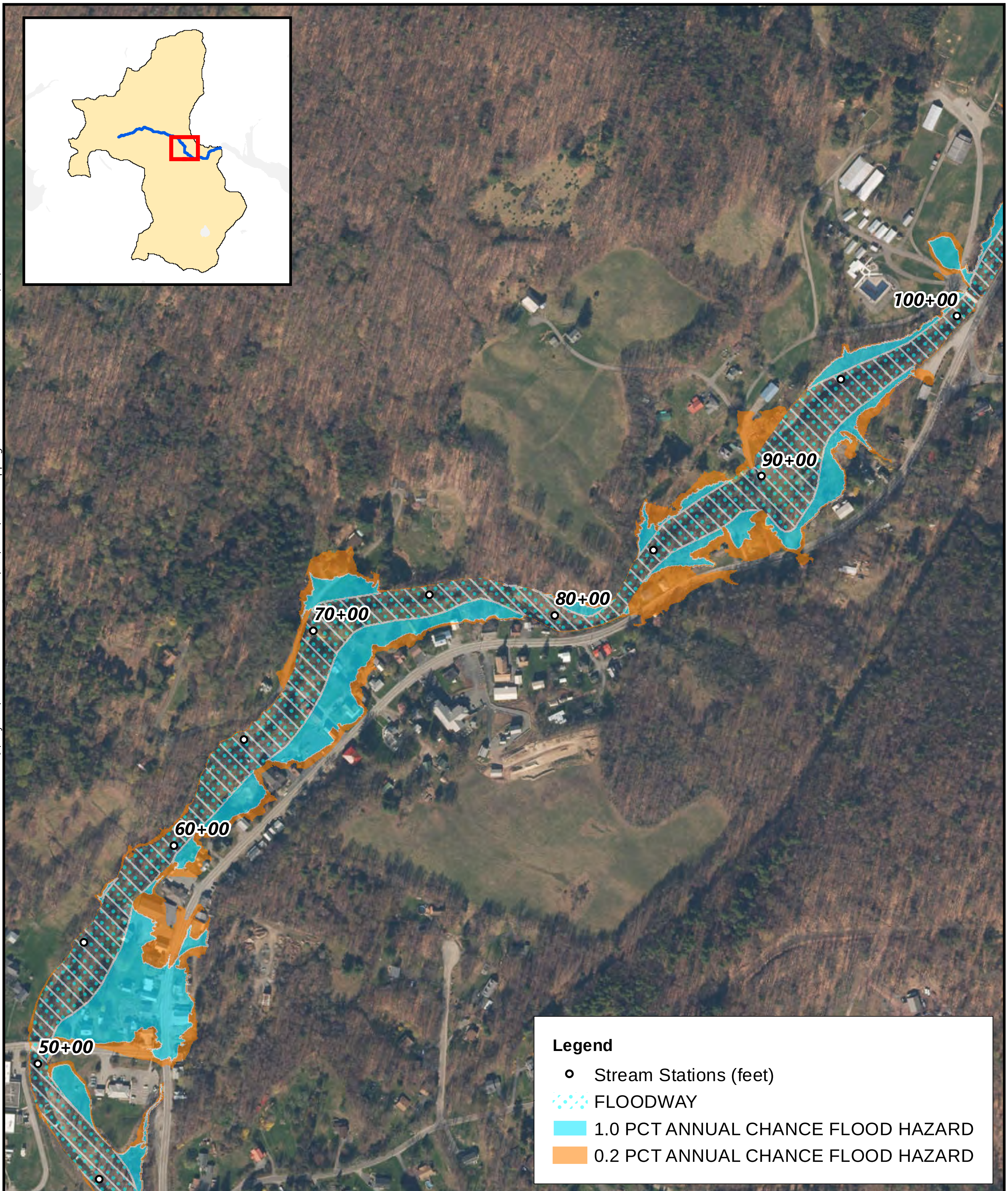

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CHESTNUT CREEK FEMA MAPPING

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

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SCALE 1 " = 500 '

DATE 8/16/2022

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FIG. 3-#

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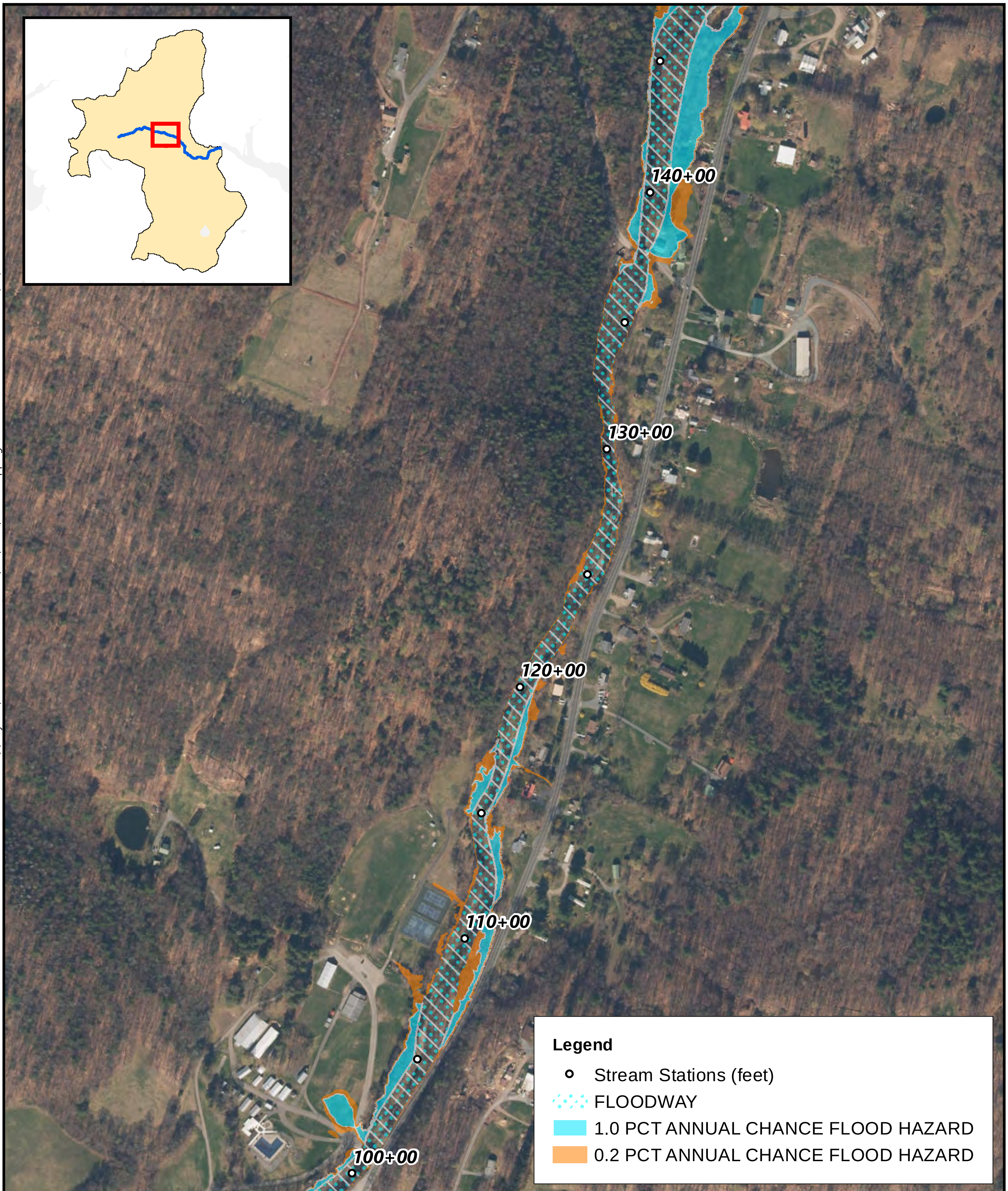

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CHESTNUT CREEK FEMA MAPPING

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

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Feet

SCALE 1 " = 500 '

DATE 8/16/2022

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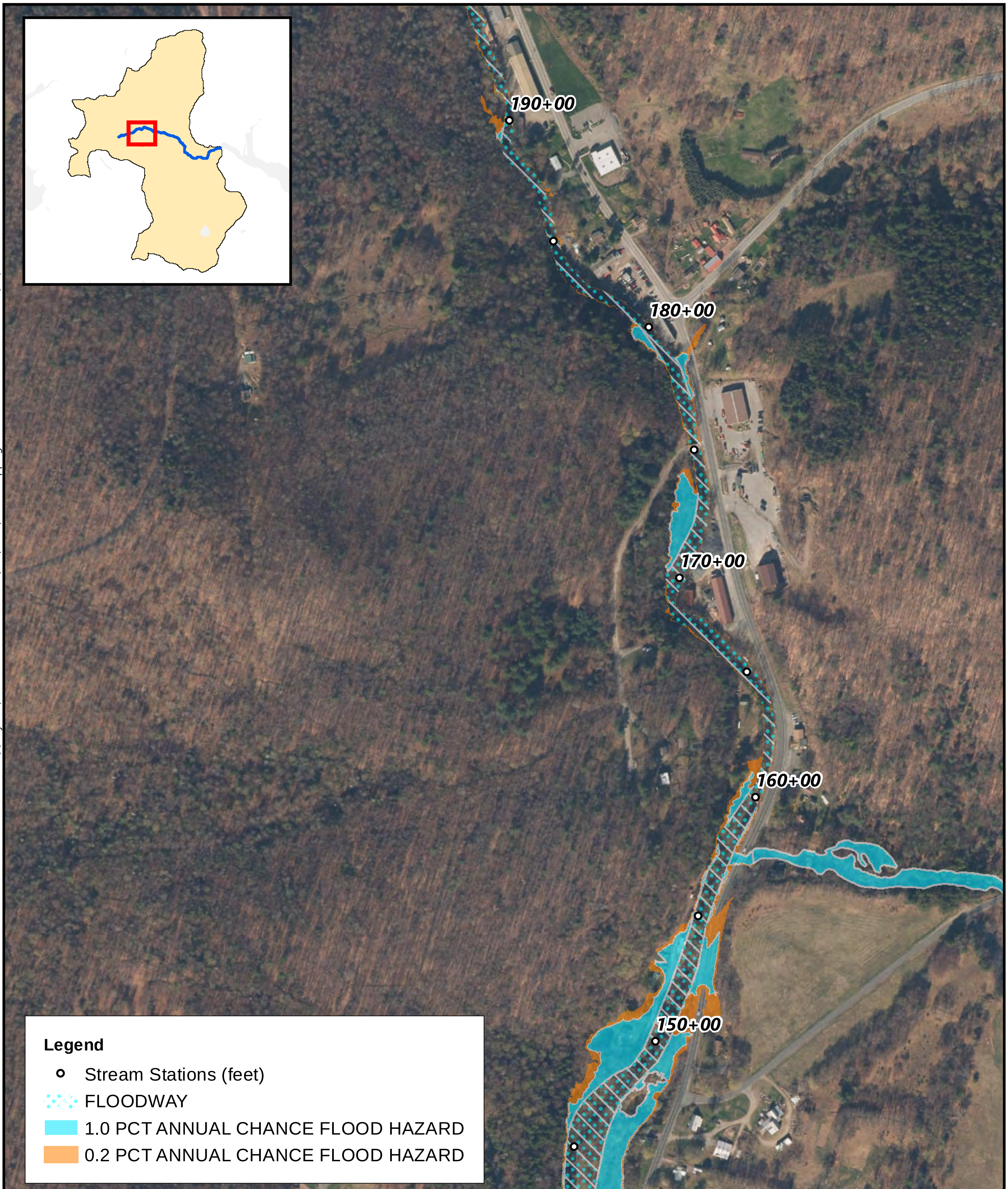
FIG. 3-#



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CHESTNUT CREEK FEMA MAPPING

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

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SCALE 1 " = 500 '

DATE 8/16/2022

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PROJ. NO.

FIG. 3-#

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CHESTNUT CREEK FEMA MAPPING

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

0 260
Feet

SCALE 1 " = 250 '

DATE 8/16/2022

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PROJ. NO.

FIG. 3-#

4. FLOOD ANALYSIS AND RECOMMENDATIONS

Multiple flood mitigation approaches to reduce water surface elevations, including bridge and culvert replacements and floodplain bench alternatives, were evaluated in the project area. These are listed below and described in more detail in the sections that follow. Alternatives target minimal alterations of roadways and alignments unless necessary. Complete hydraulic assessments are recommended prior to any upgrades to ensure that replacement structures meet NYSDOT standards and NYSDEC guidelines for new culverts in terms of hydraulic opening, permissible headwater depths, and aquatic organism passage. Meeting these criteria frequently requires a substantial capital investment, so upgrades must be prioritized to maintain a robust transportation network and efficiently improve flood resiliency. Unscheduled upgrades, such as replacement of a failed culvert following a flood, are often ad hoc, intended to quickly reopen roads in the aftermath of a storm. In these cases, the replacement structure is frequently the same size or just slightly larger than the one that failed, and the crossing is likely to be damaged again in future floods. Flood resiliency may be improved if undersized culverts have been identified and replacement structures adequately sized, even if only approximately, before damage occurs. Regular culvert inspections and an up-to-date asset inventory may help to prioritize culverts for scheduled replacement and prepare for appropriate repairs in case of flooding damage.

In addition to the flood mitigation approaches listed above, which seek to reduce or eliminate flood damages by reducing water surface elevations, flood protection measures for individual properties were explored. These scenarios were evaluated case by case and seek to reduce flood-related damages by either relocating, floodproofing, or elevating homes and businesses located in flood-prone areas.

4.1 BRIDGE AND CULVERT ASSESSMENT

Ten public stream crossings are located within the Chestnut Creek LFA study corridor. Nine of these crossings are structures that span equal to or greater than 20 feet and therefore are categorized as bridges in this study. The most upstream crossing along the focus watercourse measures less than 20 feet wide and is therefore referred to as a culvert. A hydraulic assessment was conducted at each of the crossings to identify their existing hydraulic capacity and evaluate their impact on flooding. A series of flood mitigation scenarios was explored in the hydraulic model and ultimately the most viable projects which created the most significant flood damage reductions are reported. An overview map of the LFA study and key components is shown in Figure 4-1.

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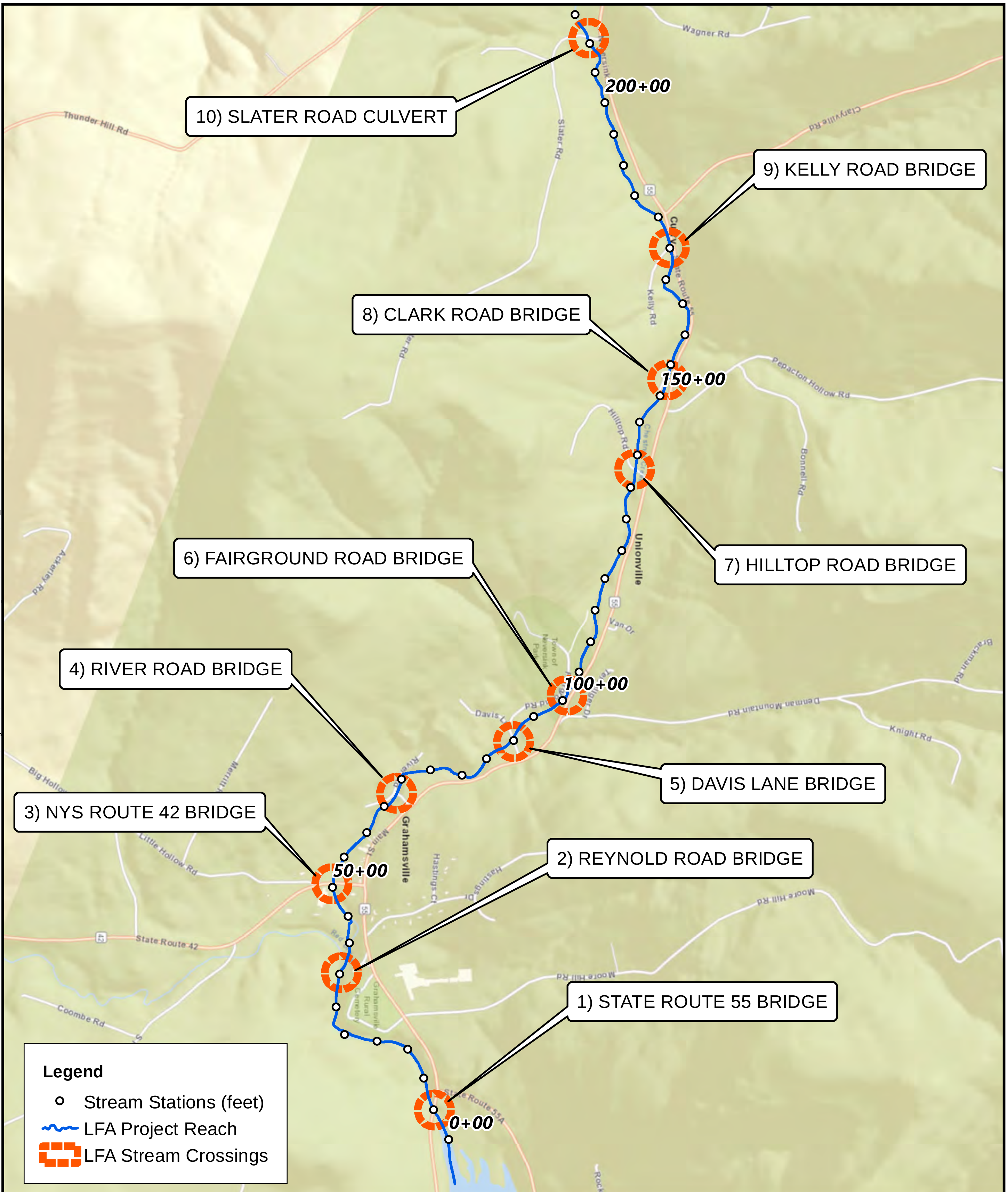

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CHESTNUT CREEK STREAM CROSSINGS

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

SCALE	1 " = 2,000 '
DATE	8/18/2022
PROJ. NO.	4282.0009
	FIG. 4-1

4.1.1 NEW YORK STATE ROUTE 55

The NYS Route 55 bridge (BIN 1027070) crosses over Chestnut Creek at STA 0+50 near the downstream limits of the LFA project reach. The structure is an open deck steel girder bridge built in 2010 that is owned by the NYC Department of Water Supply, Gas and Electricity (Figure 4-2). The structure spans 73 feet wide and has a vertical opening of approximately 24 feet. There were no problems reported by the public at this crossing at the time of this analysis. The NYSDOT bridge inspection report for the State Route 55 bridge, dated April 2020, did not identify any problems with the structure.

Figure 4-2: Downstream outlet opening of the State Route 55 bridge

According to the hydraulic model, the State Route 55 bridge can convey all modeled peak storm events without obstructing flow or ever overtopping. The bridge is shown to be adequately sized to pass all modeled flows with sufficient freeboard and is not indicated to increase water surface elevations upstream. The sound structural integrity and hydraulic competency of this bridge makes any immediate action at this crossing a low priority. Instead, continued routine inspections and maintenance are recommended.

4.1.2 REYNOLDS ROAD BRIDGE

Reynolds Road crossed over Chestnut Creek at STA 35+00, or 255 feet below the confluence with Red Brook tributary, before being partially removed in the 1980s (CCSMP, 2010). The abutments of the former bridge remained in place and were included in the 2015 FEMA FIS hydraulic model. The structure is not listed in the NYSDOT bridge database, and no additional details are available besides what is depicted in the hydraulic model. The left and right abutments measure approximately 20 feet wide, 12 feet high, and are spaced 48 feet apart. The bridge abutment remnants are shown to be moderately constrictive to flows and increase upstream water surface elevations by 1.0 and 3.0 feet in the 10- and 100-year storm events, respectively. However, the rise in upstream water surface elevations does not appear to worsen flooding at any upstream infrastructure.

The presence of the bridge abutments was confirmed during a site visit conducted in summer 2022. Observations made during the site visit did not indicate any negative impacts to the morphology of Chestnut Creek because of the abutments. Moreover, the USGS gauge 01365500 is housed on the downstream face of the right abutment, and stream flow recordings at the gauge are likely calibrated to the channel shape with the structures in place.

The former roadway has been properly closed off with guiderails and signage and does not appear to pose a threat to public safety. Due to reasons listed above, immediate action at this crossing is deemed low priority. It is recommended that continued inspections of this reach be conducted and noted in future stream management plans to monitor the condition of the abutments and their influence on the stream channel.

4.1.3 NEW YORK STATE ROUTE 42

New York State Route 42 is a north-south state highway that branches off Main Street (State Route 55) in downtown Grahamsville. The structure carrying NYS Route 42 over Chestnut Creek at STA 50+73 is a single-span concrete box beam bridge built in 1998 (Figure 4-3). The bridge measures approximately 64 feet wide and has a vertical opening of roughly 9.5 feet. According to the NYSDOT bridge inspection report from April 2020, the structure was determined to be in overall good condition with no listed action items.

Figure 4-3: Looking upstream at the outlet of the NYS Route 42 bridge over Chestnut Creek

The hydraulic model indicates that the existing bridge can pass all modeled peak discharges with enough freeboard except for the 500-year storm event. However, the road is oriented at a slant, connecting the lower floodplain to the left (north) of Chestnut Creek to a ridge to the south – an approximately 7-foot-elevation differential. The left flank of the bridge is shown overtopping with shallow flow beginning in the 100-year storm event, although inundation of homes and businesses on the upstream left overbank is shown to commence at the 10-year storm event. A low point along Main Street (State Route 55) to the west of the intersection with State Route 42 is suggested to flood with 1.8 feet of water during the 50-year storm event and with over 2.5 feet in the 100-year storm. Buildings on the upstream left bank inundate with 0.5 to 4.0 feet of water during the 10-year and 100-year storms.

According to the hydraulic model, upstream flooding is likely due to the reduction in flood flow conveyance caused by the narrow bridge opening and the roadway embankment to the left (north). The section of the approach that is within 200 feet of the left bridge abutment appears to be fill material on the Chestnut Creek floodplain placed at about 3 feet above the elevation of Chestnut Creek's natural 100-year floodplain. This inconsequentially decreases floodplain flood relief and contributes to the impoundment of water at upstream buildings on the left overbank. One flood mitigation alternative that was considered included upsizing the State Route 42 bridge and floodplain reclamation by constructing a floodplain bench along the left bank of the replacement bridge. The proposed floodplain bench would measure approximately 500 feet long, between 70 to 80 feet wide, excavated at 5.5 feet below existing ground at its deepest, and meant to be activated during a 10-year storm. The State Route 42 bridge would need to be expanded to its left by 72 feet to accommodate the new floodplain bench. Figure 4-4A illustrates a concept map of the floodplain bench creation and the State Route 42 bridge replacement.

The scenario described above would reduce flooding of Main Street and building across all flood storm events, most notably in the lower-frequency but higher-magnitude floods. In the 50-year event, reductions in upstream water surface elevations would range from 1.2 to 3.0 feet below existing conditions. Water surface elevations would be lowered between 1.3 to 2.7 feet in the proposed conditions 100-year storm event. The resulting reductions in water surface elevations is suggested to remove about half a dozen homes from the current inundation extents of the 50- and 100-year storm events. Flood depth mapping for the 10-year storm event is depicted in Figure 4-4 (existing conditions) and Figure 4-5 (proposed conditions). Mapping for the 50-year storm is illustrated in Figure 4-6 (existing conditions) and Figure 4-7 (proposed conditions). Lastly, the 100-year storm is illustrated in Figure 4-8 (existing conditions) and Figure 4-9 (proposed conditions).

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NY ROUTE 42 - CONCEPT MAP
CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N
0 200
Feet

SCALE 1 " = 200 '
DATE 8/31/2022
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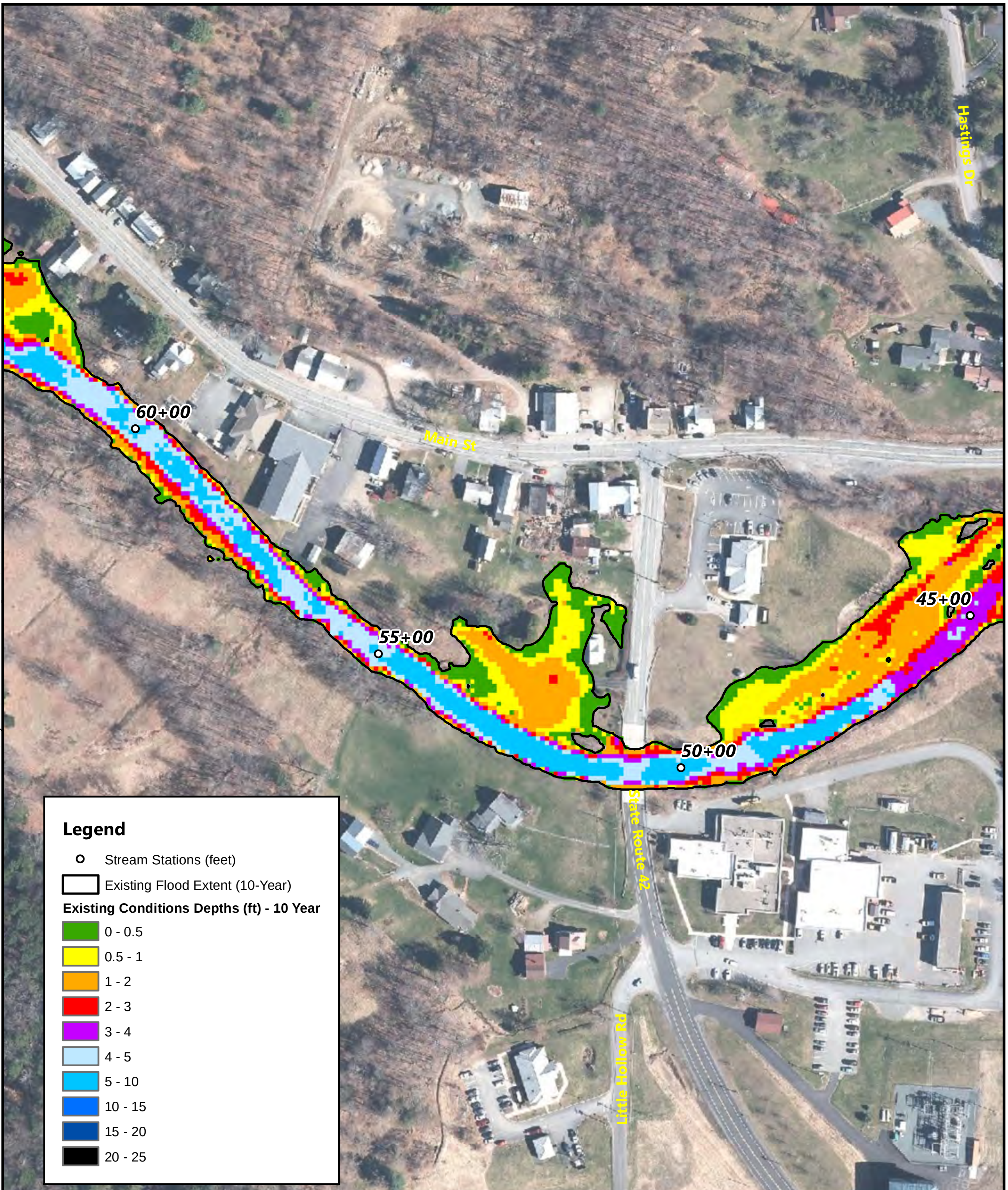
FIG. 4-4A



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NY STATE ROUTE 42 - EXISTING CONDITIONS 10-YEAR

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

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Feet

SCALE 1 " = 200 '

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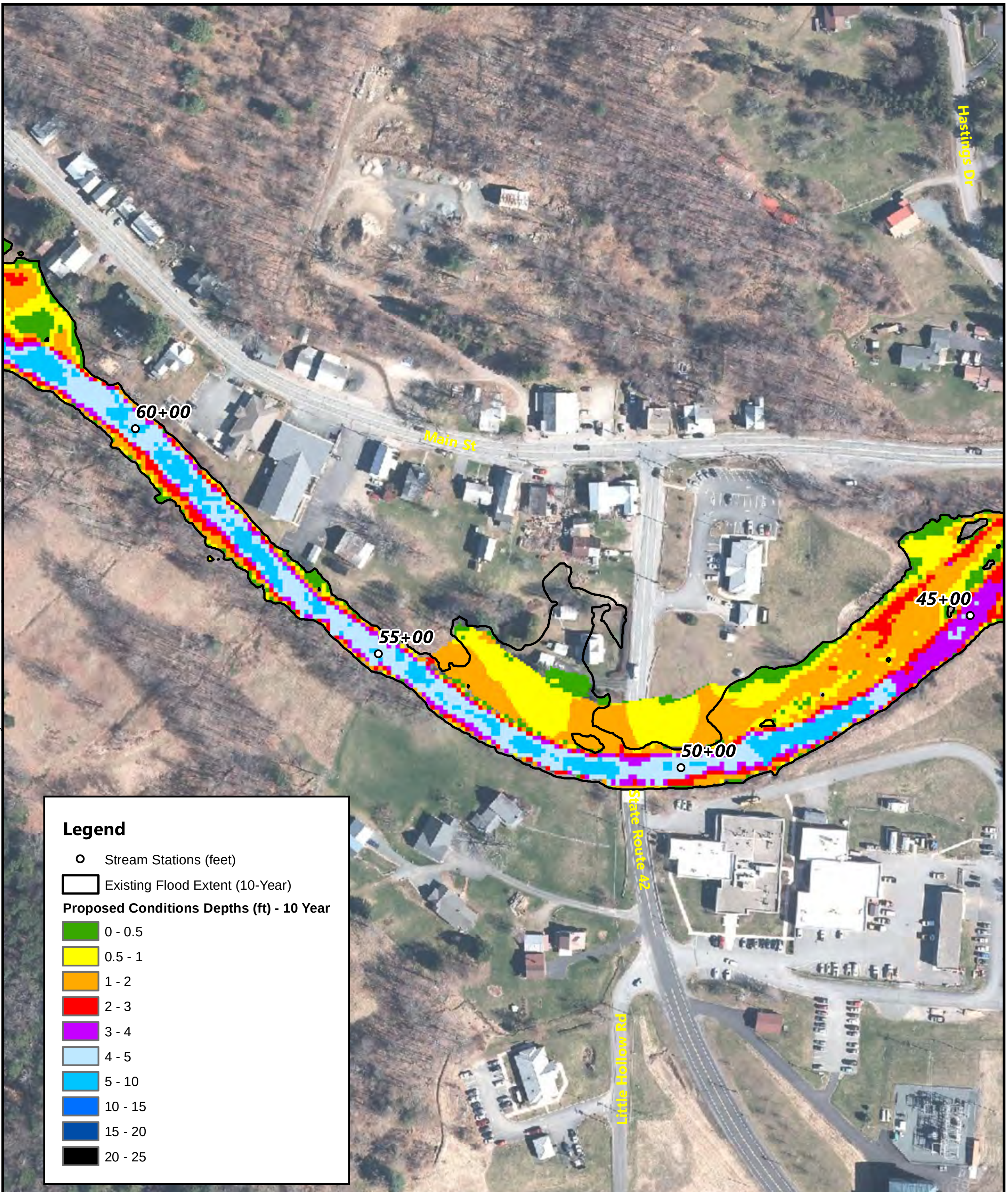
FIG. 4-4



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NY STATE ROUTE 42 - PROPOSED CONDITIONS 10-YEAR

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

0 200 Feet

SCALE 1 " = 200 '

DATE 8/31/2022

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FIG. 4-5

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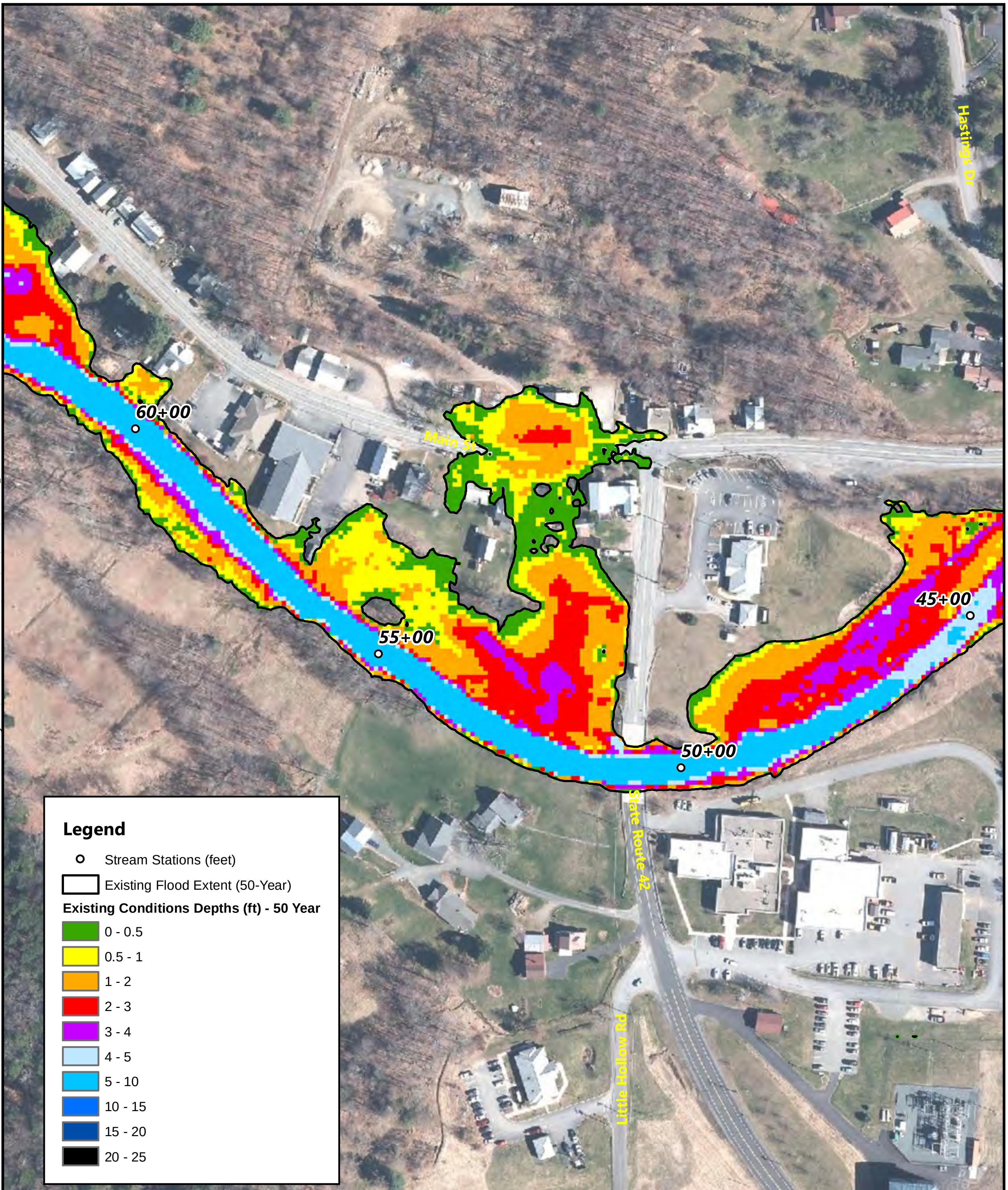

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NY STATE ROUTE 42 - EXISTING CONDITIONS 50-YEAR
CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

SCALE 1 " = 200 '
DATE 8/31/2022
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FIG. 4-6

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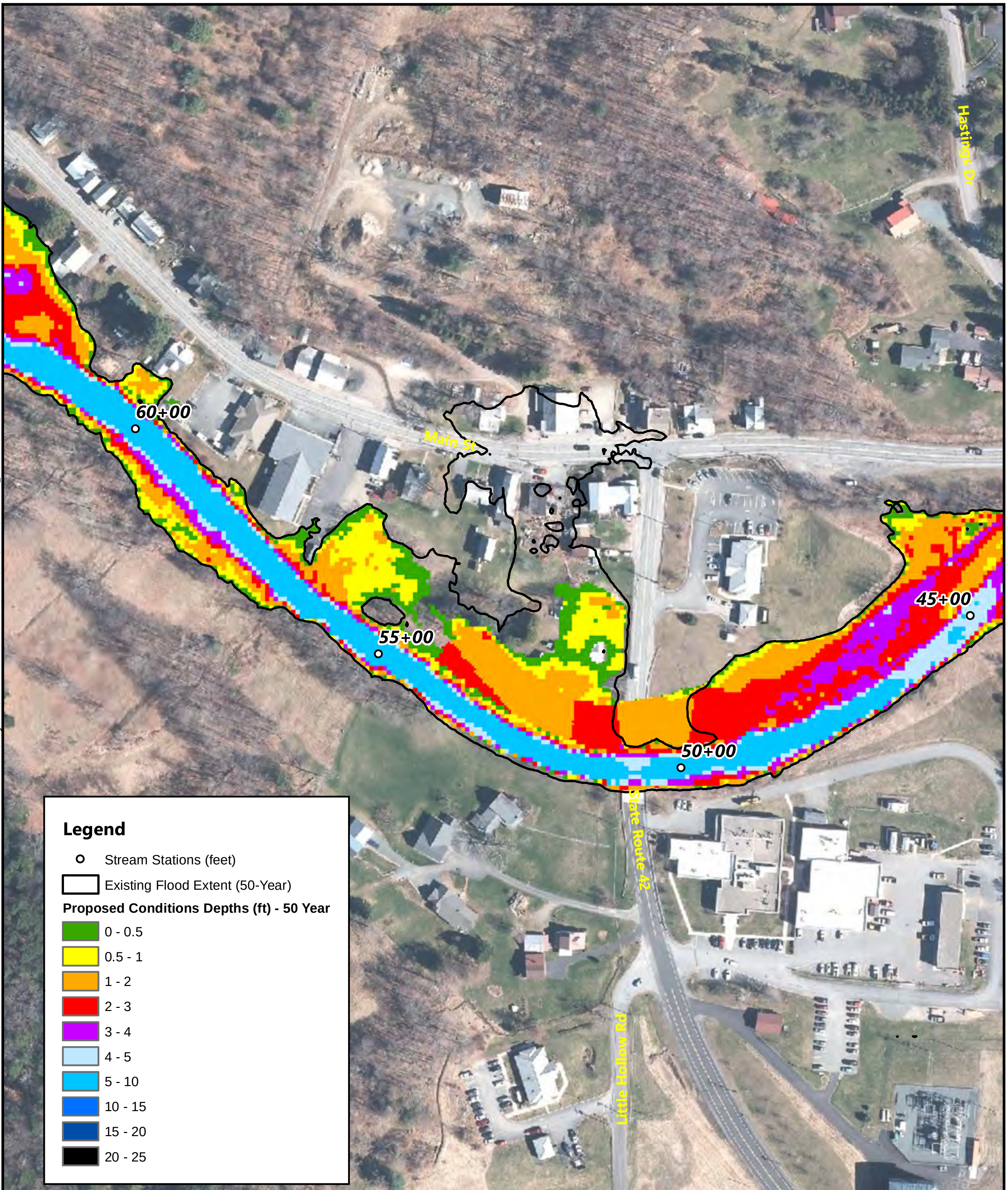

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NY STATE ROUTE 42 - PROPOSED CONDITIONS 50-YEAR

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

SCALE 1 " = 200 '
DATE 8/31/2022
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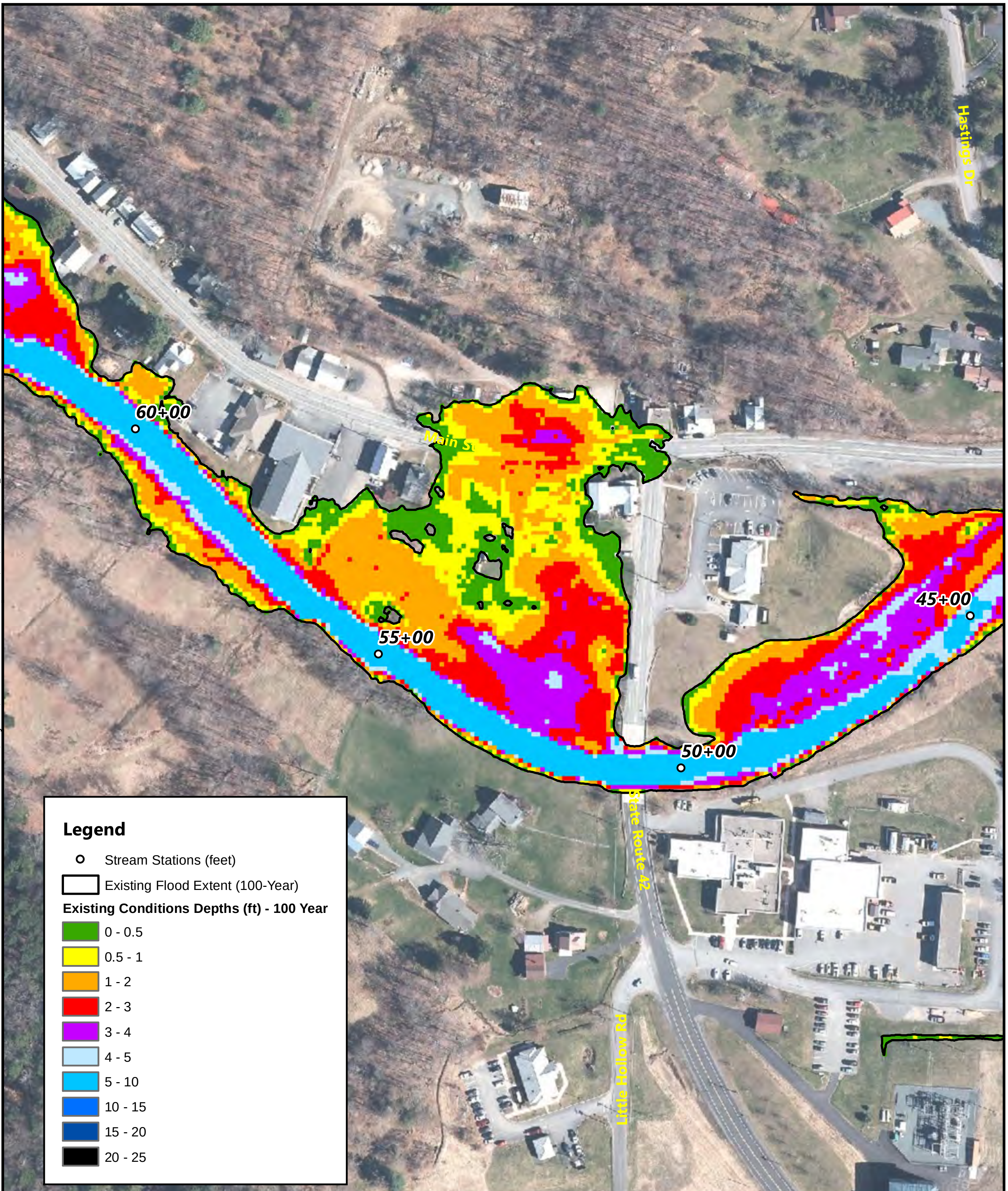
PROJ. NO.

FIG. 4-7



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NY STATE ROUTE 42 - EXISTING CONDITIONS 100-YEAR

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

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Feet

SCALE	1 " = 200 '
DATE	8/31/2022
PROJ. NO.	4282.0009

FIG. 4-8

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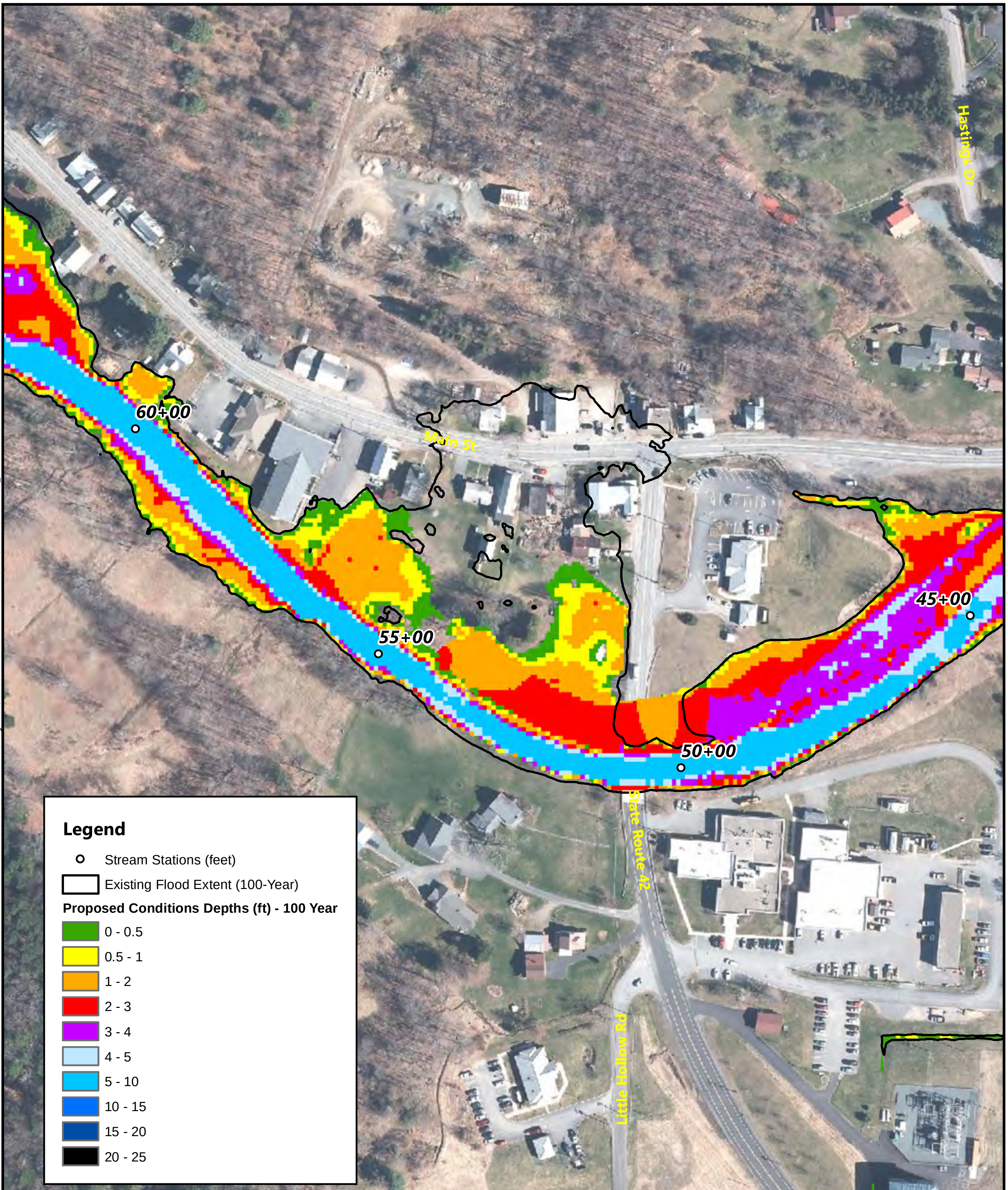

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NY STATE ROUTE 42 - PROPOSED CONDITIONS 100-YEAR
CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

SCALE 1 " = 200 '
DATE 8/31/2022
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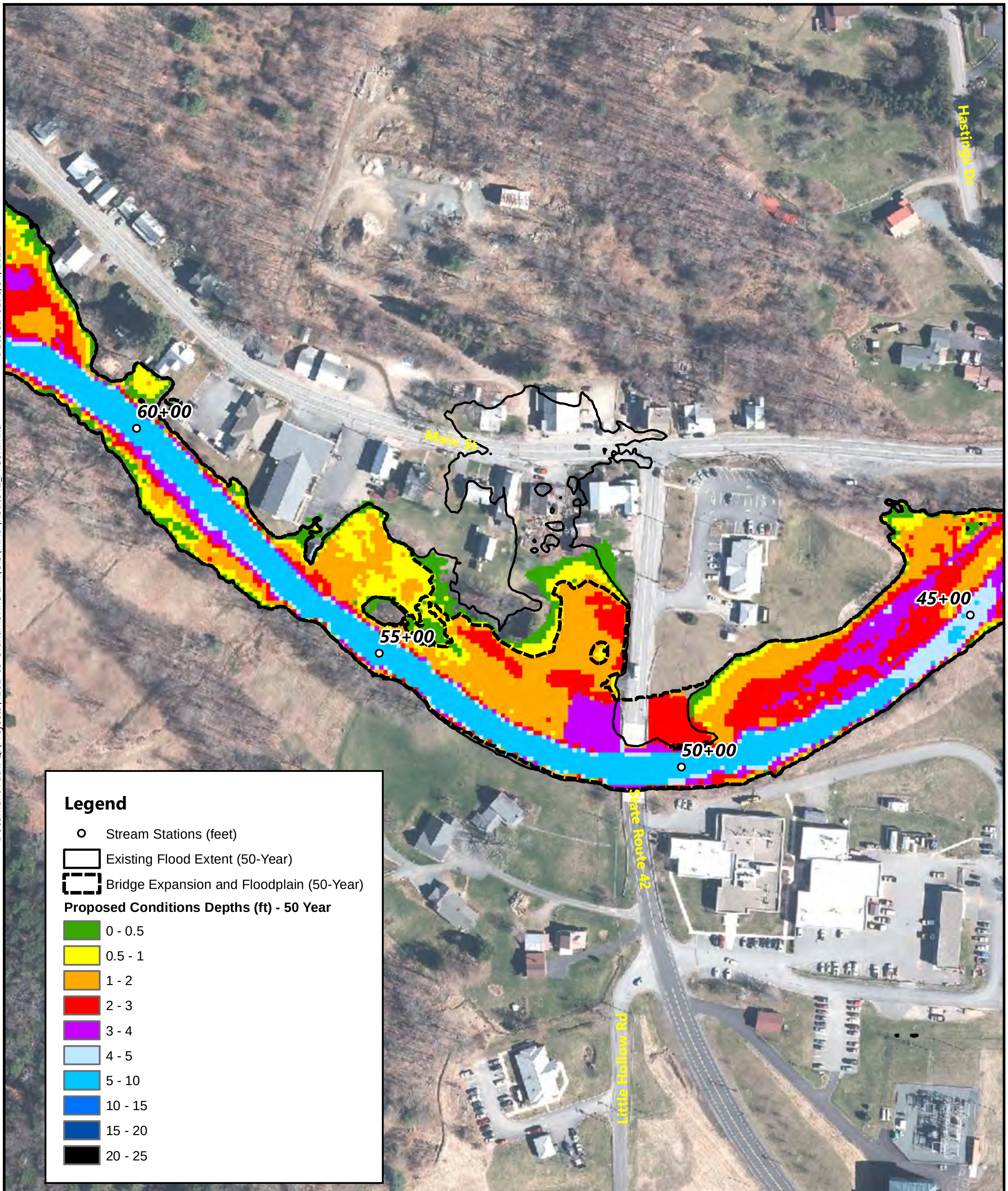
FIG. 4-9

Alternatively, the implementation of relief culverts as opposed to increasing the span of the State Route 42 bridge was explored. This proposed alternative would require that the adjoining upstream and downstream sections of the left overbank be excavated down to allow for the installation of floodplain relief culverts. Two separate configurations were modeled as follows:

1) Five 48-inch-diameter high-density polyethylene, smooth interior culverts at 7 feet on center
2) An 18-foot-span by 4-foot-rise four-sided concrete box culvert

According to the hydraulic model, both relief culvert scenarios would result in comparable reductions in upstream water surface elevations. Over 0.5 feet in water surface elevation reductions can be expected in a 10-year storm event when compared to existing conditions, and approximately 1.4 feet in reductions were observed for the 100-year event.

Relief culverts would result in moderate flood alleviation although not to the same extent as the floodplain bench and bridge replacement scenario described previously. Inserting flood relief culverts would still pull water off Main Street in the 50- and 100-year storm events and reduce flooding at buildings on the left overbank but to a lesser degree. Figure 4-10 illustrates flood depth mapping for the concrete box relief culvert during the 50-year event, with the existing and proposed floodplain bench and bridge expansion inundation extents superimposed. Figure 4-11 depicts the same conditions for the 100-year storm event. When due for replacement, a rigorous hydrologic and hydraulic study is recommended for the State Route 42 crossing. If relief culverts are favorable, it is recommended that a single-span structure be considered instead of multiple structures since this would reduce the likelihood of debris blockage at the inlet and consequently lower flood conveyance. Individual floodproofing measures and voluntary relocations are recommended at homes that are still expected to experience flooding. Recommendations for individual homes and landowners are described in Section 4.2.



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NY ROUTE 42 - PROPOSED RELIEF CULVERTS (50-YR)

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

SCALE 1 " = 200 '

DATE 8/31/2022

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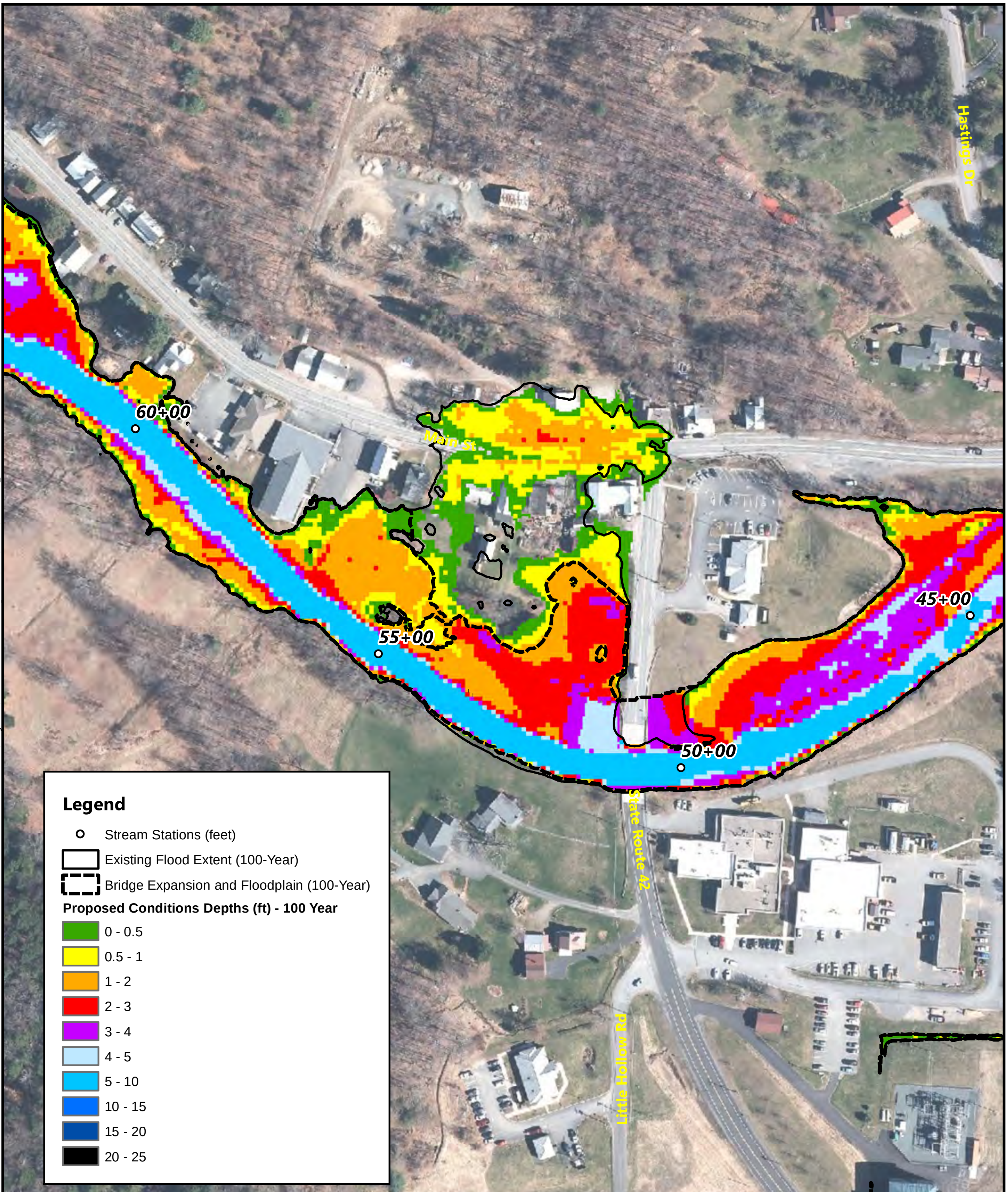
FIG. 4-10



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NY STATE ROUTE 42 - PROPOSED CONDITIONS 100-YEAR

CHESTNUT CREEK LOCAL FLOOD ANALYSIS
HAMLET OF GRAHAMSVILLE
SULLIVAN COUNTY, NEW YORK

N

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Feet

SCALE 1 " = 200 '

DATE 8/31/2022

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FIG. 4-11

4.1.4 RIVER ROAD BRIDGE

The River Road bridge (BIN 3357080) over Chestnut Creek at STA 67+74 is a single-span steel girder bridge approximately 43 feet wide with a 6.5-foot-high opening (Figure 4-12). According to the bridge inspection report dated June 2008, the bridge was built in 1996 and exhibits minor structural wear at its deck and slight erosion along the bank protection measures abutting the structure. River Road branches off State Route 55 and runs southwest across the Chestnut Creek valley floor. The left (northeast) approach is at grade with the natural floodplain for most of its length and ramps slightly upward as it approaches the left bridge abutment. River Road is a dead-end access road to about half a dozen homes located southeast of the creek along River Road and Gilette Road.

Figure 4-12: Looking upstream at the inlet of the River Road bridge over Chestnut Creek

The existing capacity of the bridge, according to the hydraulic model, is suggested to be less than the 10-year storm event under unobstructed conditions. The structure is projected to get flanked to its left (north) with about 0.5 feet of water during said event and with as much as 3.5 feet of water in the 100-year storm. The bridge structure is shown to be a moderate constriction and increases upstream water surface elevations by 1.0 feet and 0.93 feet in the 10-year and 100-year storm events, respectively, increasing flooding at a single home upstream. The influence of the River Road bridge extends 400 feet upstream from the bridge face and terminates near STA 70+00.

Replacing the structure to span 1.25 times bankfull or 66 feet, reconstructing the adjoining section of stream, and creating a 150-foot-long by 3-foot-deep floodplain bench would reduce upstream water surface elevations by 0.5 feet in the 10-year storm and by 1.6 feet in the 100-year storm. Moreover, removing any outbuildings on the left overbank within 150 feet of the edge of stream in the hydraulic model resulted in an additional 0.5-foot flood reduction in the 100-year storm. However, this would not eliminate overtopping of the low-lying approach to the left, which is shown to still flood during a 10-year storm.

Attempting to eliminate floodwater from running over the northern approach road is difficult because the road is built on the Chestnut Creek floodplain, which is naturally subjected to inundation during significant storm events. Raising the roadway to be above a targeted flood elevation is possible; however, adding fill to the floodplain can have negative consequences to upstream homeowners by increasing water surface elevations. In this case, approximately 185 feet of approach roadway would need to be elevated by 0.5 to 1.6 feet, which would amount to a considerable quantity of fill to be placed on the floodplain. If enough stakeholder interest exists, this can be explored further to arrive at an optimal bridge replacement and road elevation combination that will not produce a rise. Otherwise, other engineered measures can be enacted to protect the roadway from future flood-related damages, including armoring of the roadway shoulders and interplanting with native plants to create a riparian buffer. Guidance for riparian buffer reestablishment is provided in Section 4.4 of this report.

A detailed hydrologic and hydraulic study is recommended when the River Road bridge is due for replacement. In addition, it is recommended that proper road closure signage be implemented in the event of an overtopping flood. According to the analysis performed in Section 4.3, the River Road bridge approach is likely to start inundating when the Chestnut Creek gauge nears 2,000 cfs. Additional recommendations for stream gauge monitoring and how to sign up for flood warning alerts is provided in Section 4.3 of this report.

4.1.5 DAVIS LANE BRIDGE

The structure carrying Davis Lane over Chestnut Creek at STA 90+00 is a county-owned bridge (BIN 3357040) built in 1993. The steel girder bridge spans 57 feet wide, approximately 6.5 feet high, and has a center pier underneath (Figure 4-13). According to the NYSDOT bridge inspection report dated March 2020, the road crossing exhibits structural deficiencies and received an overall inspection score of ‘poor.’ At about 20 feet downstream of the bridge face, there is a grouted angular rock weir structure that has been installed to protect a utility sewer main that runs under Chestnut Creek. The hard weir structure limits the downstream vertical adjustment of the natural stream bottom and might be contributing to sediment transport instabilities and the development of a lateral sediment bar upstream of the bridge. In the event of an overtopping flood on Davis Lane, a 0.5-mile detour via Fairground Road is available to residents that live southwest across Chestnut Creek.

Figure 4-13: Looking downstream at the Davis Lane bridge inlet over Chestnut Creek. A prominent lateral sediment bar is located immediately upstream of the bridge.

The Davis Lane bridge low chord is shown to be positioned above the adjacent ground and roadway to the left (northeast) by over 1.5 feet. Consequently, the structure can only pass the 10-year modeled storm event; otherwise, the bridge is flanked to its left during larger-magnitude storms. The 25-year storm inundates the approach road with 2 feet of water and with as much as 4 feet of water in the 100-year storm event. The bridge structure is shown to be a moderate constriction and raises upstream water surface elevations anywhere from 0.4 feet to 1.2 feet in the 10-year and 100-year storm events, respectively. Increases in upstream flooding from the bridge and its embankment is expected to extend over 900 feet upstream of the bridge, stopping near STA 99+00. Although development is sparse in the upstream locality, the current bridge does contribute to flooding at a home located upstream near STA 91+50 on the left bank.

The hydraulic model indicates that replacing the bridge with a 66-foot-wide, or 1.25 times the bankfull width, single-span structure with no piers would reduce upstream water surface elevations by 0.5 feet in the 10-year and by 0.3 feet in the 100-year. The resultant decreases in water surface elevations would produce moderate flood extent reductions upstream on the left overbank of Chestnut Creek. However, the left approach road would still see flooding in the 25-year event although with about a foot less of water. Floodwater is always likely to inundate the approach road unless it is raised to be above the estimated water surface elevation of a specific flood event. For example, elevating 200 linear feet of the road to the left by 1.5 to 3.0 feet at some spots would keep water off the roadway in the 100-year event. In conjunction with increasing the span of the Davis Lane bridge, the structure would convey the modeled 100-year storm without overtopping of the bridge deck or roadway. Fill on top of the existing roadway would need to be offset by compensatory storage elsewhere, and the implications of potentially raising upstream water surface elevations needs to be considered. If stakeholders are interested in keeping the road passable during floods, a thorough compensatory volume analysis would need to be conducted to ensure a ‘no-rise’ condition.

When the Davis Lane bridge is due for replacement, a rigorous hydraulic and hydrologic study is recommended to adequately size a new bridge. Due to the presence of a detour in the case of a flood event, modifying the northeast approach is not necessary and instead can be engineered to reduce scouring damage from overtopping events. This may include installing rock armor protection at the shoulders interplanted with native vegetation. Replacement of the Davis Lane bridge should be a higher priority for the town because of the ‘poor’ bridge inspection rating that it received from NYSDOT. It is also recommended that the structural integrity of the bridge be reevaluated by a professional structural engineer who can estimate the urgency for replacement or if other options are available. In addition, it is recommended that proper road closure signage be implemented in the event of a flood. According to the analysis performed in Section 4.3, the Davis Lane bridge approach is likely to be inundated when the Chestnut Creek gauge nears 3,660 cfs, nearly a 20-year flood event. Additional recommendations for stream gauge monitoring and how to sign up for flood warning alerts is provided in Section 4.3 of the report.

4.1.6 FAIRGROUND ROAD BRIDGE

The Fairground Road covered bridge (BIN 5524660) passes over Chestnut Creek at STA 101+00 (Figure 4-14). The road connects State Route 55 on the north to the Grahamsville Fairgrounds and a few homes located across Chestnut Creek to the south. The town-owned structure is a steel girder open-bottom bridge built in 1976 that spans 36.5 feet wide and is approximately 9.0 feet high. As of the NYDOT inspection dated March 2020, this structure received an overall rating of ‘good,’ with no action items listed. However, the report describes multiple sightings of spalling and undermining near the abutment interfaces with the wingwalls. In the event that the bridge becomes unsafe for vehicular passage, a 0.5-mile detour is available via Davis Lane for emergency ingress and egress.

Figure 4-14: Looking upstream at the Fairground Road covered bridge outlet over Chestnut Creek

The hydraulic model indicates that the Fairground Road bridge can convey all modeled peak discharges except for the 500-year storm event. Water is shown to reach the low chord of the structure in the 50-year and 100-year events and is estimated to inundate the southern flank with approximately 1.5 feet of water. The bridge is shown to create a backwater starting at the 50-year storm event by increasing upstream water surface elevations by 3.0 feet and by 3.6 feet in the 100-year. Although the structure is shown as a constriction, its influence fully diminishes at approximately 530 feet upstream near STA 106+75 and does not contribute to flooding of any upstream homes or infrastructure.

Due to the general condition of the Fairground Road bridge and its sufficient hydraulic adequacy, replacement should be a low priority. No further recommendations aside from routine inspections and maintenance are recommended. When due for replacement, a rigorous hydraulic and hydrologic study should be conducted for the replacement bridge to reduce stress on the low chord of the bridge during the less frequent but larger-magnitude flood events such as the 50-year and 100-year storms.

4.1.7 HILLTOP ROAD BRIDGE

Hilltop Road branches off State Route 55 and is carried over Chestnut Creek near STA 137+85 by a single-span timber multi-girder bridge on concrete abutments (BIN 3357180). The 1967 open-deck structure measures 22 feet wide by approximately 8 feet high and is owned by Sullivan County. Hilltop Road appears to be the only point of access to a subdivision of homes to the south, with no apparent detours available. According to the NYSDOT bridge inspection report from spring 2019, the structure received a NYS inspection General Recommendation rating of 4 or "*Moderate deterioration of primaries, secondaries, and substructures has occurred, but bridge load capacity is not substantially reduced. Considerable reconditioning of secondary members, substructures, and other components may be needed. Primary* *members do not yet need extensive reconditioning. There may be some minor substructure undermining.*" However, the structure was not flagged as being in 'poor' status.

Figure 4-15: Looking downstream at the Hilltop Road bridge inlet over Chestnut Creek

Hydraulic modeling suggests that the existing capacity of the Hilltop Road bridge is less than the modeled 10-year storm. During this event, water is shown to flank the structure to its left (north), inundating the approach road with approximately over 0.5 feet of water. Flood depths over the roadway increase with each subsequent flood event; as much as 1.6 feet of water is predicted in the 100-year storm event. The bridge is shown in the hydraulic model to be severely constrictive to flows and increases upstream water surface elevations between 3.4 feet and 2.9 feet in the 10-year and 100-year storm events, respectively. The backwater from the bridge stretches approximately 127 feet upstream of the bridge face, terminating near STA 139+22. This is likely to impact flooding at a residential building that is located upstream of the bridge on the left (north) overbank. This building is barely mapped outside the inundation extent of the 10-year storm. The southwestern portion of the building is mapped partially within the flood extents of the 100-year storm.

Replacing the existing bridge with an open-bottom bridge that spans 58 feet wide and with a comparable vertical opening was investigated in the model. The resulting water surface elevation reductions from the replacement bridge would be only marginally lower than existing conditions. The hydraulic model indicates that increasing the span alone would not improve the hydraulic capacity of the bridge unless further stream channel modifications were enacted. Reconstructing the adjoining river reach to at least bankfull dimensions (47 feet), approximately 45 feet upstream and downstream of the existing bridge, was shown to improve conveyance of the replacement bridge. Modifying the channel shape and increasing the span of the bridge to 58 feet would pass all modeled storm events except for the 500-year storm. The model indicates 1.4 feet of freeboard below the low chord of the proposed bridge in the 50-year storm and 0.9 feet of freeboard in the 100-year storm.

A rigorous hydraulic and hydrologic study is recommended for the Hilltop Road bridge when due for replacement. In the event of a severe flood event, inundation of the approach roadway or damage to the Hilltop Road bridge would interrupt emergency access or public evacuation to community members residing south of Chestnut Creek; replacement of the Hilltop Road bridge should be given a higher priority for the town because of the lack of detours. It is also recommended that the structural integrity of the bridge be reevaluated by a professional structural engineer who can estimate the urgency for replacement or if other options are available. In addition, it is recommended that proper road closure signage be implemented in the event of a flood. According to the analysis conducted in Section 4.3, the Hilltop Road bridge approach is likely to be inundated when the Chestnut Creek gauge nears 2,611 cfs or less than a 10-year flood event. Additional recommendations for stream gauge monitoring and how to sign up for flood warning alerts is provided in Section 4.3 of the report.

4.1.8 CLARK ROAD BRIDGE

The structure carrying Clark Road over Chestnut Creek at STA 152+75 is a single-span, open-bottom steel girder bridge built in 1995 (Figure 4-16). The county-owned bridge (BIN 3357090) measures 30 feet wide and has a vertical opening of approximately 7 feet. As of the August 2020 bridge inspection report, this bridge is listed as being in overall good condition without mention of any significant wear or structural deficiencies requiring further investigation. Clark Road is a dead-end road branching off NYS Route 55 that serves about four homes to the south and is the only route available for residents and emergency responders across the creek.

Figure 4-16: Looking upstream at the Clark Road bridge

In the hydraulic model, the Clark Road bridge is shown to pass all modeled storm events except for the 500-year storm. The structure is shown as a moderate constriction to flows during larger-magnitude flood events, increasing upstream water surface elevations as much as 2.4 feet in the 50-year event and 3.2 feet in the 100-year event. The impact of the bridge is shown to propagate upstream for about 400 feet before fully diminishing. The hydraulic model indicates that the undersized Clark Road bridge contributes to flooding of a residence on the right overbank and floods a portion of NYS Route 55 to the left (north) in the 50-year and 100-year storm events.

According to the hydraulic model, replacing the Clark Road bridge with a structure that spans 46 feet, or the estimated bankfull width, and raising the low chord of the bridge by 2 feet would drastically improve flow conveyance at this crossing. A reduction in upstream water surface elevations between 1.7 feet and 2.4 feet can be expected in the 50-year and 100-year storm events, respectively. The resulting reductions in water surface elevations are shown to pull water off Route 55 in the 50-year storm event and lower flooding at the upstream home on the right overbank. In the 100-year storm, reduced flooding along Route 55 and the house is expected to be between 1.8 feet and 1.4 feet, respectively, lower than existing conditions.

When due for replacement, a detailed hydraulic and hydrologic study is recommended to properly size a replacement crossing that will reduce the upstream influence of the current bridge. Priority should be given to maintaining passage during or following major flood events by continuing routine bridge inspections and maintenance to ensure that the structural integrity of the bridge is enough to withstand high flows. Because Clark Road is a dead-end road with moderate hydraulic deficiencies, bridge replacement prioritization should be comparatively high. Crossing replacement prioritization recommendations are further discussed in Section 4.2.

4.1.9 KELLY ROAD BRIDGE

Kelly Road branches off to the south of NYS Route 55 and crosses over Chestnut Creek at STA 175+21 (BIN 3229170). The structure carrying Kelly Road is a single-span timber steel girder bridge that measures approximately 29 feet wide and has an open bottom that is about 12 feet high at its deepest point (Figure 4-17). This bridge is the sole means of access to the subdivision of homes located to the south of Chestnut Creek. An informal detour may be available for emergency access or evacuation via a privately owned driveway bridge that crosses the creek at STA 163+35. According to the NYSDOT bridge inspection report dated April 2020, the 1979 structure was identified to be in overall good condition and shows no issues requiring immediate action.

Figure 4-17: Looking downstream at Kelly Road bridge inlet over Chestnut Creek

According to the hydraulic model, the Kelly Road bridge can pass all modeled peak storm events without overtopping. The structure is also indicated to have a negligible backwater influence under unobstructed flow conditions. Due to the structural condition of the Kelly Road bridge and its hydraulic adequacy, no further recommendations are made other than routine inspection and maintenance. When due for replacement, a detailed hydraulic and hydrologic analysis is recommended to mitigate the likelihood of damage to the bridge during unprecedented high-magnitude flow events. Crossing replacement prioritization recommendations are further discussed in Section 4.2.

4.1.10 SLATER ROAD CULVERT

Slater Road crosses over Chestnut Creek at STA 211+23 and is the upstream most crossing within the LFA study reach. The roadway is carried by a corrugated metal arch culvert with a 14-foot span and 9.8-foot rise abutted with stacked stoned wingwalls (Figure 4-18). Reports from town officials indicate that the stacked stone wingwalls at the inlet have begun deterioration and pose a threat to the overall performance of the culvert in the event of a collapsing failure. During field site visits, inlet and outlet drops were observed at this crossing, including a 2-foot-deep scour pool at the downstream end. These features are indicative of stream channel instabilities resulting from an undersized stream crossing and present passage problems for aquatic organisms. Based on aerial imagery, the crossing serves roughly seven to eight homes to the south of Chestnut Creek, and an informal seasonal detour may be available via Thunder Hill Road in the event of a roadway washout.

Figure 4-18: Looking downstream at Slater Road culvert over Chestnut Creek. The stacked stone wall and culvert inlet drop are also illustrated.

In the hydraulic model, Slater Road is shown passing all modeled storm events without overtopping the roadway except in the 500-year storm event. During a 500-year storm, the hydraulic model indicates that the approach road to the left (north) and a portion of NYS Route 55 would be underwater. The existing Slater Road culvert is shown to be constrictive during the 100-year and 500-year storm events, raising upstream water surface elevations by 2.4 feet and 5.8 feet, respectively. Flow impedance created by the culvert during a 500-year storm is suggested to cause flooding at a home located upstream on the left (north) overbank.

When due for replacement, a detailed hydraulic and hydrologic analysis should be conducted to properly size a replacement culvert under Slater Road. It is recommended that preference be given to a four-sided or open-bottom box replacement structure as opposed to replacing the Slater Road culvert with an in-kind conduit. Replacing the existing culvert in the hydraulic model with a 15-foot-wide by 9.8-foot-high concrete box backfilled with native streambed material would lower upstream water surface elevations by 1.3 feet in the 100-year event and 1.5 feet in the 500-year storm event. The resulting reductions produce minimal changes to the current inundation extents; however, a replacement structure with a natural stream bottom would provide improved aquatic organism connectivity at this crossing. Due to the hydraulic adequacy of the Slater Road culvert replacement, it is deemed a medium priority for replacement. Routine inspections and maintenance are recommended until due for replacement. The current structure exhibits signs of structural deterioration that should be inspected by a professional that can dictate if immediate corrective action is necessary.

4.1.11 PROJECT IMPLEMENTATION PRIORITIZATION FOR STREAM CROSSINGS

Recommendations for the prioritization of projects at the Chestnut Creek crossings is provided in Table 4-1 below. Final rankings were determined based on the findings previously described for each crossing and the probability of impact on the community during and after a flood. The information provided herein is meant to be a starting point for the town to begin addressing flooding threats identified in this study and potential mitigation strategies to investigate. Prioritization criteria should continue to be reviewed and revised based on the current knowledge of high-risk areas, funding availability, and the goal and objectives of the town.

Table 4-1 Recommended Prioritization for Chestnut Creek Stream Crossing Projects

Priority	Feature Carried	NYSDOT Poor Status	Detour Available?	Current Hydraulic Capacity	Contributes to Flooding of Infrastructure?	Suggested Action to Prioritize
HIGH	Davis Lane	Yes	Yes (0.5 mi – Fairground Road)	25-Year	Yes	Bridge structural soundness
	Route 42	No	Yes (multiple)	25-Year	Yes	Upstream flood reduction
	River Road	No	No	25-Year	Yes	Post-flood passage
MEDIUM	Hilltop Road	No	No	< 10-Year	Yes	Hydraulic adequacy and post-flood passage
	Clark Road	No	No	> 100-Year	Yes	Upstream flood reduction and post-flood passage
	Slater Road	N/A	Possibly	> 100-Year	No	Culvert structural soundness and AOP
LOW	NYS Route 55	No	Yes (10.5 mi)	> 100-Year	No	Inspection and maintenance
	Fairground Road	No	Yes (0.5 mi – Davis Lane)	> 100-Year	No	Inspection and maintenance
	Kelly Road	No	No	> 100-Year	No	Inspection and maintenance and post-flood passage
	Reynolds Road	N/A	N/A	N/A	No	Inspection and monitoring

AOP = Aquatic Organism Passage

4.2 RECOMMENDATIONS FOR SITE SPECIFIC FLOOD-PRONE LOCATIONS

During the public data-gathering process of the study, there were critical sites within the town and hamlet project areas where flooding is known to cause extensive damage to homes and buildings. These specific sites were evaluated more closely on a case-by-case basis, and target recommendations were developed for each problem area. Alternative mitigation actions were assessed with hydraulic modeling wherever possible to evaluate efficacy. The narrative below describes findings and recommendations at these selected sites where replacement of a bridge or culvert alone would not resolve a specific issue.

4.2.1 BULLET BROOK TRIBURATY AT CHESTNUT CREEK CONFLUENCE

Bullet Brook meets Chestnut Creek near STA 92+81 and has a drainage area of 1.64 square miles. Reports of flooding and erosion near the confluence with Chestnut Creek were mentioned during the public outreach portion of the study. A field visit was conducted in summer 2022 to document current site conditions and any potential sources of channel instability. Figure 4-19 illustrates a series of photographs taken while walking the confluence area.

Figure 4-19: (Top Left) Bullet Brook tributary near confluence looking upstream. (Top Right) Looking downstream at eroding bank on Chestnut Creek. (Bottom Left) Large sediment buildup upstream of confluence area. (Bottom Right) Mid-channel sediment bar downstream of confluence area.

Erosion near the confluence of Bullet Brook with Chestnut Creek appears to be a result of large sediment buildup and multiple flow paths along this stretch of stream. From a visual standpoint, Bullet Brook does not seem to be a major sediment source that is responsible for the large buildup in material. Rather, the aggradation that appears is likely being caused by an overwidened stream channel that lacks the necessary sediment transport capabilities. The problem is possibly connected to the aggradation issues occurring near Davis Lane (STA 90+00) as previously discussed in Section 4.1.5. This idea was also noted in the 2004 Chestnut Creek Stream Management Plan: "the reinforced sewer downstream of the Davis Lane bridge has resulted in an extremely flat channel gradient in the vicinity of the bridge upstream, which has undoubtedly contributed to the ongoing aggradation problems [upstream]."

When the Davis Lane bridge is due for replacement, the sewer line downstream should also be relocated. An engineered reconstruction of the channel upstream and downstream of the Davis Lane is also suggested to reestablish a natural stream gradient between STA 90+00 to STA 93+00. Channel restoration would include excavation of a properly sized, multistage channel and floodplain; installation of grade control structures and/or scour protection measures along the restored channel to prevent channel incision and protect upstream infrastructure, and installation of native plantings.

4.2.2 TOWN OF NEVERSINK TOWN HALL PARKING LOT EXPANSION

The Town of Neversink recently acquired land parcel 27.4-11, which is located immediately southeast of the Town of Neversink Town Clerk office near STA 65+00. The town plans to demolish the abandoned dwelling on the property and is proposing to create additional parking space atop of where the existing house foundation is set and is also looking to expand the width of their existing driveway. Expansion of the driveway would require filling an existing wedge of space that is deepest adjacent to the existing structure and tapers off as it approaches Chestnut Creek. Figure 4-20 illustrates the approximate parking area and driveway expansion that was described to SLR during a site visit meeting with town representatives.

Figure 4-20: Town of Neversink Clerk Office building proposed parking lot and driveway expansion. Layout of the proposed development areas is conceptualized and may differ from the town's final design.

The proposed parking lot development area is positioned on the edge of the FEMA-mapped 100-year floodplain extent. Removing the building and adding a parking lot should not raise floodwater surface elevations so long as the fill material placed does not encroach on the 100-year floodplain. Adding the 50-foot-wide by 100-foot-long parking lot as depicted above did not result in water surface elevations for any of the modeled peak flow events.

A 12-foot lateral driveway expansion was assumed and inserted to the hydraulic model. The reduction in floodwater conveyance resulted in a 0.9-foot and a 0.3-foot increase in upstream water surface elevations for the 50-year and 100-year storms, respectively. Adding fill in the floodplain would marginally worsen flooding in the vicinity of the Town Clerk building. To eliminate the rise, the town would need to offset the fill with an equal or greater amount of compensatory storage on the floodplain. This can be accomplished by creating a floodplain bench along the river-left bank of Chestnut Creek that is sized to the 2-year flood and measures approximately 100 feet long and 40 feet wide maximum. This floodplain bench alternative would counteract the effects of the floodplain fill and would reduce water surface elevations by an additional foot.

It is important to consider that creating impervious area might require the need for a runoff reduction technique that complies with NYSDEC stormwater management practices (SMPs) for development sites. Accepted techniques include vegetated open swales, a rain garden, or a combination of both; whatever is necessary to treat the added runoff. A separate stormwater analysis would be required to determine the sizing criteria for these systems. This system, in conjunction with floodplain bench creation, can provide additional compensatory volume storage benefits. Further analysis is recommended to optimize the design of both systems and make the most of the excavation efforts.

4.2.3 RECOMMENDATIONS FOR OTHER FLOOD-PRONE HOMES AND BUILDINGS

Within the project areas, several homes are mapped within, near, or bordering the SFHA. Other properties may not be included in these delineated floodplains but incur flood damages from unmapped tributaries. Although there were few reports of flooding within hamlet areas, it is recommended that property owners who have experienced flooding damage in the past seek appropriate flood mitigation strategies whether through buyouts, relocation, or individual floodproofing measures. A comprehensive description of potential sources of funding for flood mitigation and damage reduction projects is included in this report. Residents may consult the current effective FEMA FIRM to determine the location of their home relative to the SFHA, which is the area inundated by flooding during the 100-year flood event.

The effective FIRM products for Sullivan County at the time of this report were acquired from the FEMA Flood Map Service Center, which can be accessed at the link below:
https://msc.fema.gov/portal/advanceSearch#searchresultsanchor

Residents may also search for their home address directly by visiting https://msc.fema.gov/portal/home.

- It is recommended that the town works to floodproof or relocate the most flood-vulnerable properties where there is owner interest and programmatic funding available through flood buyout and relocation programs. The two flow charts below provide decision-making guidance for nonresidential (Figure 4-21) and residential (Figure 4-22) properties.

- It is recommended that the town identify priority areas and structures that are prone to the most frequent and deepest flooding. These areas should be considered the highest priority for individual flood protection measures.

Some of the homes in the SFHA are rarely flooded. Residents and businesses may benefit from minor individual property improvements. Providing landowners with information regarding individual property protection is recommended.

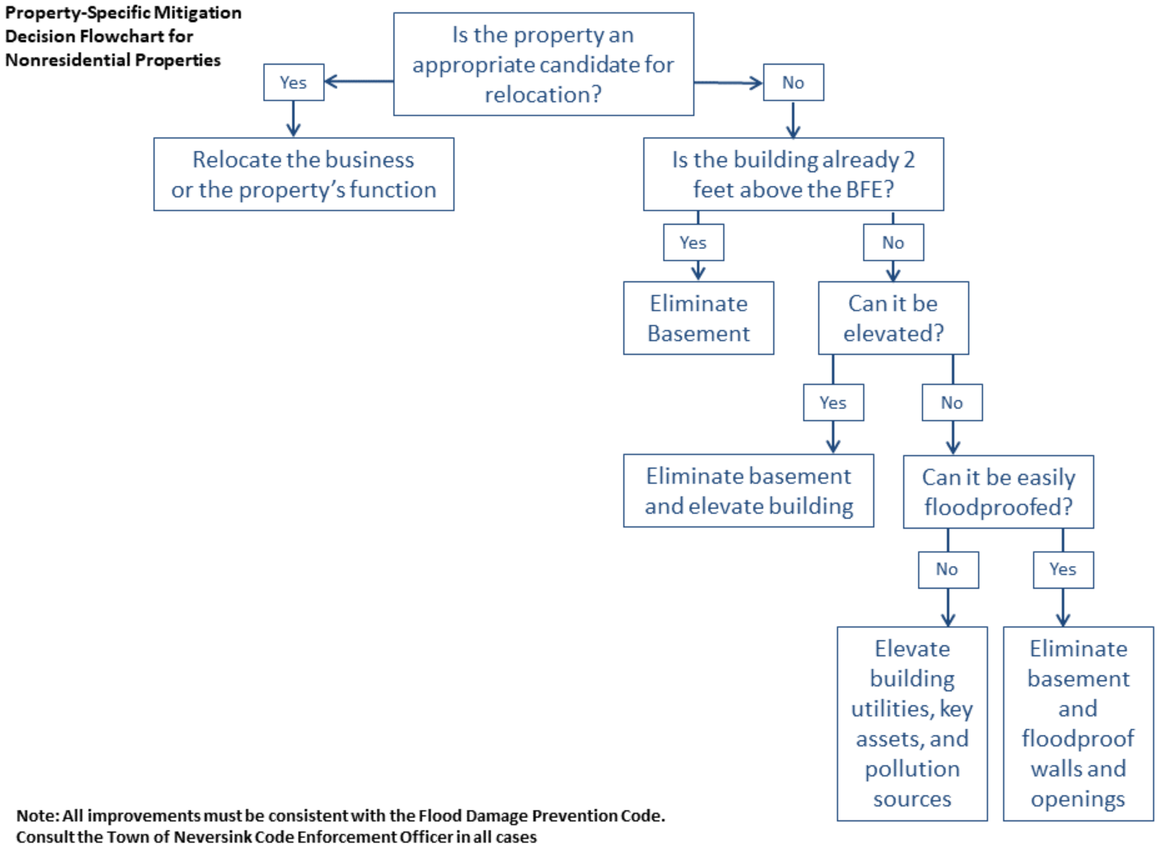

Figure 4-21: Property-specific mitigation for nonresidential properties

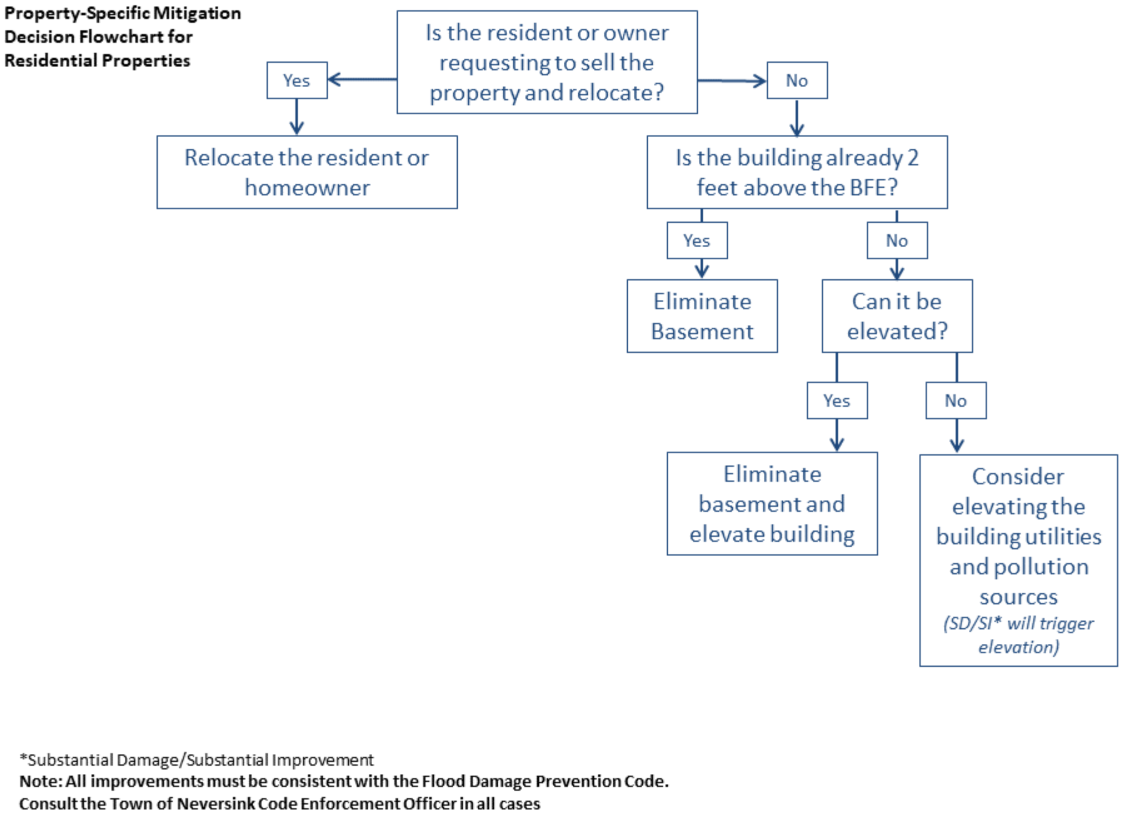

Figure 4-22: Property-specific mitigation for residential properties

In areas that are vulnerable to flooding, improvements of individual properties and structures may be appropriate. All practices to protect property within a floodplain must comply with local flood law and obtain the approval of the town floodplain administrator or code enforcement officer. Potential measures for property protection include the following:

<u>Elevation of the structure</u> – Home elevation entails the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located 2 feet or more above the level of the 100-year flood event. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first-floor level or suspended from basement joists or similar mechanism at an elevation no less than 2 feet above the BFE.

<u>Dry floodproofing of the structure to keep floodwaters from entering</u> – Dry floodproofing refers to the act of making areas below the flood level watertight. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents would be either permanently closed or covered with removable shields. Flood protection should extend only 2 to 3 feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water.

Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded – Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Furniture and electrical appliances should be moved away or elevated above the 100-year flood elevation. Wet floodproofing should only be considered as a last resort.

Performing other home improvements to mitigate damage from flooding – The following measures can be undertaken to protect home utilities and belongings:

- Relocate valuable belongings above the 100-year flood elevation to reduce the amount of damage caused during a flood event.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the BFE.
- Anchor fuel tanks to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer or septic backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- Elevate the electrical box or relocate it to a higher floor and elevate electric outlets to at least 12 inches above the high-water mark.

Encouraging property owners to purchase flood insurance under the NFIP and to make claims when damage occurs – While having flood insurance will not prevent flood damage, it will help a family or business put things back in order following a flood event. Property owners should be encouraged to submit claims under the NFIP whenever flooding damage occurs, which will increase the eligibility of the property for projects under the various mitigation grant programs.

Construction of property improvements such as barriers, floodwalls, and earthen berms – Such structural projects can be used to prevent shallow flooding. There may be properties within the town where implementation of such measures will serve to protect structures. Such barriers must not be permitted unless designed by a qualified engineer and shown to comply with NFIP and local floodplain laws. These improvements are not eligible for funding under CWC or Stream Management Program – Flood Hazard Mitigation (SMP-FHM) grant programs.

Anchoring of Fuel Tanks – It is recommended that sources of man-made pollution be reduced or eliminated through the relocation or securing of fuel oil and tanks.

Water Quality – In addition to helping communities identify and mitigate flood hazards, the LFA program mandate included water quality in the NYC water supply watershed. In order to protect water quality during flood events, the following are recommended:

- Effort should be made to identify additional parcels that could benefit from securing or relocating fuel tanks to eliminate a potential source of man-made pollution and apply for funding through CWC (https://cwconline.org/fhmi-program-flood-analysis-relocation-assistance-fuel-tank-anchoring/)

- Equipment that has the potential to be washed away in a flood (e.g., generators, snowmobiles, ATVs, construction equipment, etc.) should be securely anchored, housed in a shed/garage, or stored outside the 100-year flood boundary.

4.3 EVACUATION PLAN AND FLOOD WARNING ALERTS

The USGS stream gauge on Chestnut Creek should be used by town officials, emergency responders, and community residents as an alert system to predict flooding. Real-time gauge information can be accessed at https://waterdata.usgs.gov/ny/nwis/uv?site_no=01365500

Table 4-2 provides suggested flood alert levels corresponding to stream discharge levels along Chestnut Creek.

Table 4-2 Flood Danger Levels along Chestnut Creek

Discharge at USGS Gauge(cfs)	Corresponding Danger Level
2,500	**Condition Yellow:** Flood levels approaching 10-year event
4,000	**Condition Orange:** Flood levels approaching 50-year event
5,000	**Condition Red:** Flood levels approaching 100-year event

A bridge and roadway overtopping threshold analysis of critically undersized crossings was performed to establish a relationship between flood discharge and road closure. This analysis essentially used the hydraulic model to obtain the flow discharge amount that caused bridge or roadway overtopping at a crossing. Flood-frequency curves at each crossing were created to extrapolate the corresponding return interval of the overtopping flood discharge. These return intervals thresholds were then plotted over the flood-frequency curve from the Chestnut Creek USGS stream gauge analysis to determine the corresponding stream flow reading at the gauge. The results of the analysis are summarized in Table 4-3, and Figure 4-23 illustrates the flood-frequency curve.

Table 4-3 Chestnut Creek Stream Crossing Overtopping Thresholds and Estimated Corresponding Flow at USGS Gauge (01365500)

Crossing	Threshold Flow at Crossing (cfs)	Corresponding Flow Reading at Gauge (cfs)
River Road	1,333	2,000
Hilltop Road	1,439	2,611
Davis Lane	2,730	3,660
NYS Route 42	2,455	3,976
Fairground Road	3,359	5,600

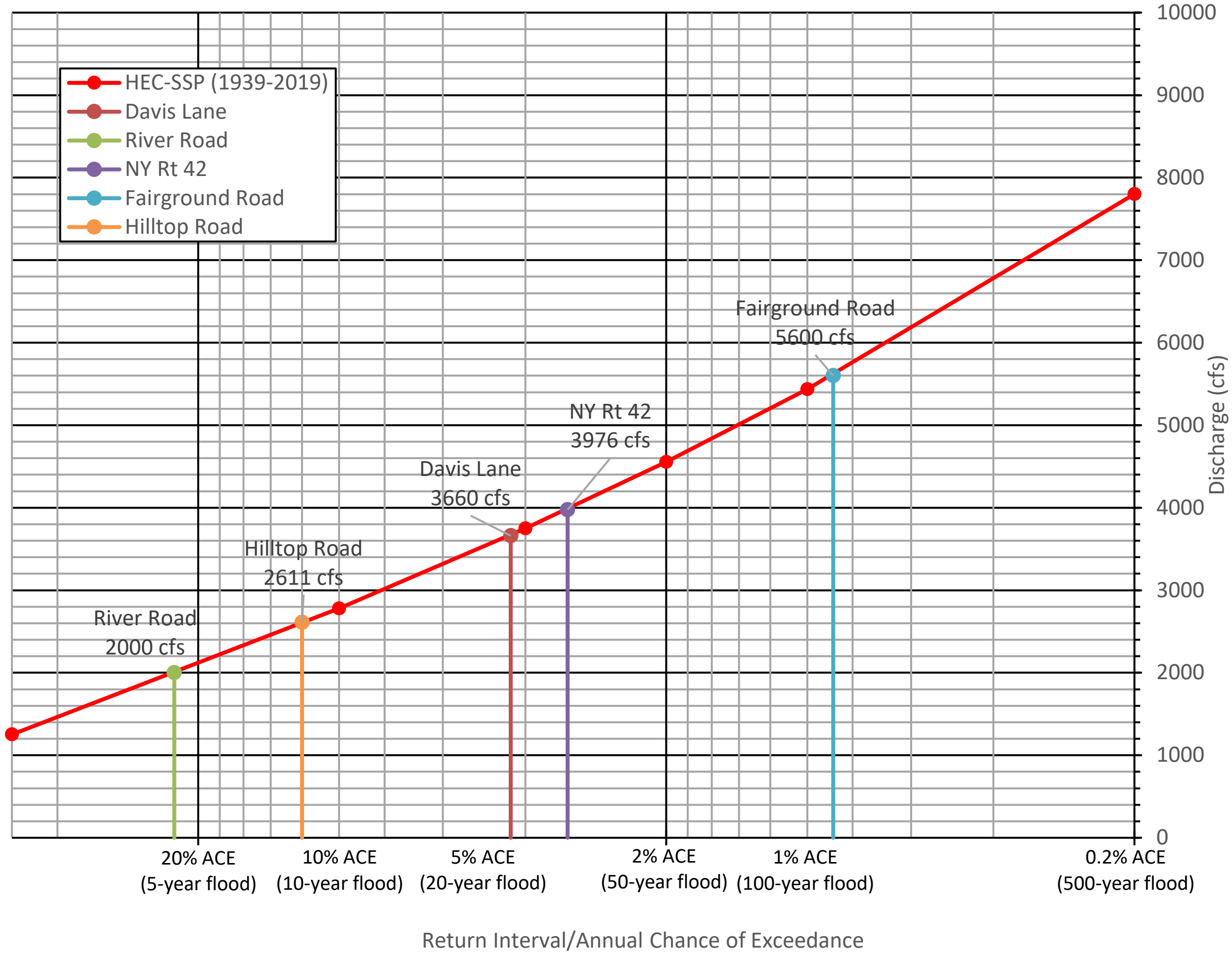

Figure 4-23: Flood-Frequency Curve created from USGS Stream Gauge Analysis on Chestnut Creek. Community members can expect flooding at the specified crossings when the flow reading at the USGS gauge approaches the indicated discharge amounts.

Grahamsville residents can sign up to receive an email or text message alerts when a user-defined water level, stream flow, or other parameter is equaled or exceeded at a gauge. For more information or to set up alerts, visit https://maps.waterdata.usgs.gov/mapper/wateralert/.

4.4 RIPARIAN BUFFERS & WATERSHED HEALTH

The Natural Resources Conservation Service (NRCS) (2016) defines a riparian buffer as, "a corridor of trees and/or shrubs planted adjacent to a river, stream, wetland or water body." The definition continues to note that the width of the buffer and the distance of the buffer from the waterbody are essential characteristics determining the functioning of the buffer.

The benefits provided by riparian buffers to their adjacent waterbodies have been well documented. These benefits can include those to the physical stability of the stream as well as those to habitat and water quality.

The physical benefit of a riparian buffer to a stream has been shown to include increased stability, reduced stream bank erosion, and reduced channel migration. Scientific studies have found that intertwining roots within a stream bank can increase stream bank strength, increase resistance to erosion caused by high flows, and provide greater channel stability (Sweeney and Newbold, 2014). One study found that following major floods bank erosion was 30 times more prevalent along stream bends without forests than those with forests (Beeson and Doyle, 1996). Other studies have also shown that forested stream reaches exhibit slower channel migration and thus provide more stability than deforested channels (Hession et al., 2003; Allmendinger et al., 2005). The NRCS (2016) notes that stabilized stream banks also help maintain the geometry of the stream, including characteristics such as the meander length and profile.

The dimensions of the riparian buffer have been shown to play an important role in the functioning of the buffer. Burckhardt and Todd (1998) found that streamside forests with widths of around 10 meters (approximately 33 feet) provide some protection from channel migration. Similarly, Zaimes et al. (2006) found bank erosion was lowered significantly by the presence of a streamside forest approximately 33 feet wide along reaches within an agricultural landscape. Sweeney and Newbold (2014) found that the influence of vegetation appears to be greatest when the roots extend to the toe of banks (Thorne, 1990; Anderson et al., 2004). Otherwise, the stream bank is susceptible to erosion from the stream as it flows. According to the NRCS Practice Standard for Riparian Forest Buffers, the minimum width should be at least 35 feet from the top of the bank.

In terms of the vegetation making up the riparian buffer, the NRCS recommends utilizing native species, if available, that are as follows:

- Adapted to the soil and climate of the planting site
- Water-loving or water-tolerant species and tolerant of extended periods of flooding (depending on the width of the planting and distance from the stream banks)
- Moderate to aggressive root and crown spread to occupy the site quickly and provide adequate litter fall
- Resistant to pests and herbicides (if adjacent to farmland)

The benefits of riparian buffers to habitat include providing food and cover for wildlife and shade that helps to lower water temperatures. Buffers can also increase habitat diversity in several ways. The addition of large woody debris to a stream provides habitat to a range of species, and a reduction in sedimentation helps prevent silt from covering large rocks or stones and from filling pools in the streambed, both of which serve as habitat. In terms of improvements to water quality, buffers have been shown to protect water resources from pollutants in surface runoff such as sediment and nutrients. Vegetated riparian buffers serve to slow water velocity, thus allowing sediment to settle out of the runoff water. The nitrogen and phosphorus attached to the sediment settle out of the surface runoff as well. To a lesser extent, dissolved nitrogen and phosphorus and other pollutants can be sequestered, degraded, and processed within the riparian buffer.

An additional consideration to mitigate flood damages is to maintain the overall health of the watershed. Land development activities change the surface of the land in the watershed by adding impervious surfaces, filling small wetlands and rerouting streams. These activities change the path of water and ultimately influence where water goes during heavy storms. The following recommendations are provided to reduce damages and maintain flood resiliency in the Chestnut Creek watershed below:

Recommendations for Protecting Forests and Open Space

- Develop a watershed-wide Forest Protection Plan that encourages tree planting, directs development away from forested areas, reduces paved surfaces, and limits clearcutting or tree clearing in sensitive riparian areas.
- Encourage conservation easements that protect forested land from being developed.
- Enhance or restore the health, condition, and function of forest fragments in developed areas, improving conditions for tree growth to ensure long-term sustainability.
- Plant trees and shrubs in buffers along streams wherever feasible, focusing on reaches that are prone to erosion and flooding.
- Develop specific guidelines to limit impervious surfaces.
- Initiatives can be developed for subbasins with less than 10 percent impervious cover to keep this percent low.
- Policies can be developed for subbasins with impervious cover that approaches 10 percent to keep these areas below the threshold.
- Impervious surfaces can be reduced or replaced where possible in subbasins that are 10 percent or more impervious cover, and green infrastructure practices can be employed to mitigate impacts.
- In large subbasins, apply these recommendations to the smaller basins drained by local streams and wetlands.

Recommendations for Floodplains

- Adopt or enhance a Floodplain Management Plan for the entire watershed (consistent for all municipalities in the watershed) that may include floodplain ordinances, overlay zones, and guidelines for managing specific sites that are prone to flooding.
- Maintain unimpeded connection between a stream or river and its floodplain to improve floodwater retention and accommodation during floods.
- Use green infrastructure and best management practices within floodplains to improve existing conditions where structures are already present and reduce the extent of impervious surfaces within floodplains.

Recommendations for Streams and Wetlands

- Develop and implement a watershed-wide Aquatic Buffer Ordinance or Water Resources Protection Plan that includes specific guidelines for the size and vegetative composition of buffers along all stream, lake, and wetland edges.

- Develop an inventory of "target" riparian areas for restoration to protect water quality, reduce flood damages, and provide habitat.
- Maintain natural stream channels and banks; avoid deepening or straightening channels.
- If there is uncertainty regarding whether a wetland is present in a particular location, have the site evaluated by a professional wetland delineator. Contact the County Soil and Water Districts for assistance.
- Avoid dumping trash and other debris (including organic debris and yard waste) in wetlands and streams.

4.5 GENERAL RECOMMENDATIONS

Flooding of and damage to bridges, culverts, and roadways during flood events have been reported at numerous locations along the Chestnut Creek LFA project reach. Most flood-related fatalities occur in vehicles, often when drivers attempt to cross flooded roadways. It is impossible to tell if a flooded roadway is safe just by looking at it. It is recommended that risks associated with the flooding of bridges and roadways be reduced by temporarily closing flood-prone roads during high-flow events. This requires effective signage, road closure barriers, and consideration of alternative routes. Because it is impossible to prepare for every contingency and closing roads and establishing detours in a flash flood event is not always possible, it is critical that residents be advised of the extreme dangers of attempting to cross flooded roadways and reminded not to do so when flooding occurs or is forecasted. Informed and prepared residents are the foundation of life safety preservation in floods.

In the event of future flooding, it is highly recommended that the Town of Neversink collect and maintain clear, detailed records of all damages and associated repair costs, including materials and labor. These should be distinguished by site so that problem areas can be identified and addressed and not lost amongst the overall total. Where possible, once waters recede and it is safe to do so, high water marks and other evidence of flooding extents should be photographed and carefully documented and their elevations measured from a permanent reference. These data may be extremely valuable when seeking funding for flood mitigation assistance.

Public welfare depends on awareness and proper enforcement of the town's local Flood Prevention Law. It is recommended that town government staff seek training regarding the content and implementation of this law, especially the Town Code Enforcement Officer. As the Local Administrator, this individual is responsible for administering, implementing, and enforcing the local Flood Damage Prevention Code. This will allow town officials to successfully disseminate important information regarding the law to the public and to implement the law accurately to meet its stated purposes.

It is recommended that the Town of Neversink maintain its status in the NFIP and regularly participate in a Community Assistance Visit (CAV). The CAV is a major component of the NFIP's Community Assistance Program (CAP). The CAV is a visit to a community by a FEMA staff member or staff of NYSDEC on behalf of FEMA that serves the dual purpose of providing technical assistance to the community and assuring that the community is adequately enforcing its floodplain management regulations. Generally, a CAV consists of a tour of the floodplain, an inspection of community permit files, and meetings with elected officials. If any administrative problems or potential violations are identified during a CAV, the community will be notified and given the opportunity to correct those administrative procedures and remedy the violations to the maximum extent possible within established deadlines. FEMA or NYSDEC will work with the community to help it bring its program into compliance with NFIP requirements. In extreme cases where the community does not take action to bring itself into compliance, FEMA may initiate an enforcement action against the community. For Neversink to be eligible for funding under the CWC LFHMIP or the Stream Management Program LFA, the town needs to participate in a CAV at least every 5 years.

FEMA Elevation Certificates are an important administrative tool of the NFIP and are necessary to provide elevation information to ensure compliance with community floodplain management ordinances. Elevation certificates are also useful to landowners to determine proper flood insurance premium rates and support the request of a Letter of Map Amendment or Revision (LOMA or LOMR-F). As part of the agreement for making flood insurance available to a community, the NFIP requires the Town of Neversink to obtain the elevation of the lowest floor (including basement) of all new and substantially improved buildings. Clear records should be maintained of any such information and filed within the floodplain administrative offices so that they are readily accessible. FEMA encourages communities to use the Elevation Certificate document developed by FEMA, which can be accessed at https://www.fema.gov/glossary/elevation-certificate since it can also be used by property owners to obtain flood insurance. CWC provides flood risk assessment for individual property owners and may be able to assist with the preparation of an elevation certificate for those interested.

5. PROJECT FUNDING SOURCES

5.1 FUNDING SOURCES

Funding for culvert replacements and other infrastructure upgrades is often scarce in a small community. In a 2017 survey of county, city, town, and village officials in NYS conducted by Aldag et al. of Cornell University, 80 percent of responders reported that infrastructure needs contribute to local fiscal stress, and 86 percent said that fiscal stress affects local infrastructure budgeting. The consequence is that local governments that are fiscally stressed are likely to have substantial needs for infrastructure investment but must defer addressing them (NYS Comptroller, 2017). Because of this, external funding is often necessary, and a concerted effort is required to secure these grants, although small local governments may not have staff available to dedicate to these endeavors.

Several funding sources may be available for the implementation of recommendations made in this report (listed in Table 5-1). These and other potential funding sources are discussed in further detail below. Note that these may evolve over time as grants expire or are introduced.

Table 5-1 Potential Funding Source for Flood Mitigation Alternatives

Recommendation	Potential Eligibility		
	Federal	State	Other
Replacement of assessed bridges and culverts with an appropriately sized structure		Bridge NY, NYSDOT	Sullivan County, CWC, SMIP-FHM
Replacement of undersized culverts	FEMA	Bridge NY, NYSDOT	Sullivan County, CWC, SMIP-FHM
Debris removal following floods	USACE, EWP		CWC
Floodplain enhancements	FEMA		SMIP-FHM
Install floodproofing at critical facilities and anchor businesses	FEMA		CWC
Floodproof or relocate the most flood-vulnerable properties where there is owner interest	FEMA		CWC, NYCFFBO
Anchor fuel tanks			CWC
Feasibility study to assess individual flood mitigation alternatives for individual properties			CWC
Riparian buffer restoration projects			RNSP

CWC = Catskill Watershed Corporation
EWP = Emergency Watershed Protection Program
FEMA = Federal Emergency Management Agency
FHM = Flood Hazard Mitigation
NYCFFBO = New York City Funded Flood Buy-Out Program
NYSDOT = New York State Department of Transportation
SMIP = Stream Management Implementation Program
RNSP = Rondout Neversink Stream Program
USACE = United States Army Corps of Engineers

Stream Management Implementation Program Flood Hazard Mitigation Grants (SMIP-FHM)

FHM is a funding category in the SMIP for LFA communities and those participating in the NY Community Reconstruction Program. Municipalities may apply to implement one or more recommendations contained in their LFA and approved by the municipal board. All projects must have modeled offsite flood reduction benefits. Eligible projects include the following:

- Design/construction of floodplain restoration and reconnection
- Design/construction of naturally stable stream channel dimensions and sediment transport processes
- Design/construction of public infrastructure to reduce water velocity, flow path, and/or elevation
- Correction of hydraulic constrictions

Ineligible projects include construction of floodwalls, berms, or levees; stream dredging; routine annual maintenance; or replacement of privately owned bridges, culverts, or roads. Municipalities must apply to the SMP in their respective counties. Contact information for Sullivan County, New York, is as follows:

Rondout Neversink Stream Program
Sullivan County Soil & Water Conservation District
P.O. Box 256
Grahamsville, NY 12740
Phone: (845) 292-6552

New York City Funded Flood Buy-Out Program

The New York City Funded Flood Buy-Out Program (NYCFFBO) is a voluntary program intended to assist property owners who were not eligible for, or chose not to participate in, the FEMA flood buyout program. It is intended to operate between flood events, not as an immediate response to one. Categories of eligible properties include the following:

Hydraulic Study Properties

1. Properties identified in community LFAs
2. Anchor businesses, critical community facilities, and LFA-identified properties applying to the CWC for relocation assistance

Special Case Properties

3. Properties needed for a stream project
4. Erosion hazard properties
5. Inundation hazard properties

Risk assessments and authorization or supporting resolutions are required by the Town of Neversink for these purchases. Municipalities may choose to own and manage the properties after they are purchased and cleared of structures. Conservation easements must be given to NYSDEC, and there are limits to what may be placed on these parcels. Allowed structures are public restrooms served by public sewers or by septic systems whose leach field is located outside the 100-year floodplain or open-sided structures such as gazebos and pavilions.

The NYCFFBO is governed by the Water Supply Permit and the Property Evaluation and Selection Process document (Process document). Communities work through outreach and assessment leads appointed by the municipality to inform potential applicants about the program and evaluate the eligibility of properties based on the program criteria established in the Process document.

Local Flood Hazard Mitigation Implementation Program
The CWC funds LFA-recommended projects to prevent and mitigate flood damage in the West of Hudson watershed, specifically to remedy situations where an imminent and substantial danger to persons or properties exists or to improve community-scale flood resilience while providing a water quality benefit.

Municipalities and individual property owners may apply directly to the CWC. Municipalities may apply for grants for projects identified in an LFA or New York Rising planning process.

Eligible LFA-derived projects could include the following:

- Alterations of public infrastructure that are expected to reduce/minimize flood damage
- Private property protection measures such as elevation or floodproofing of a structure
- Elimination of sources of man-made pollution such as the relocation or securing of fuel oil/propane tanks
- Stream-related construction (Ineligible projects include construction of floodwalls, berms, or levees; stream dredging; or annual maintenance.)
- Relocation assistance for a residence or business recommended by an LFA to a location within the same town or village

Property owners may apply for the following assistance:

- Funds for relocation assistance of an anchor business. Anchor businesses must be located in a floodplain in a watershed hamlet where an LFA has been conducted, although their relocation does NOT have to be recommended in the LFA. These include gas stations, grocery stores, lumber yards and hardware stores, medical offices, or pharmacies, which if damaged or destroyed would immediately impair the health and/or safety of a community.
- Funds for relocation of critical community facilities, such as a firehouse, school, town hall, public drinking water treatment or distribution facility, or wastewater treatment plant or collection system, which if destroyed or damaged would impair the health and/or safety of a community. Facilities must have been substantially damaged by flooding. They do NOT have to be recommended by an LFA but MUST be located in an LFA community.
- Funds for assistance to relocate homes and/or businesses within the same town where the NYCFFBO covers the purchase of a former property (does NOT have to be in an LFA community)
- Stream debris removal after a serious flood event (does NOT have to be recommended in an LFA)

Sustainable Community Planning Program

This CWC program is for municipalities that have prepared LFAs. It is intended to fund revisions of local zoning codes or zoning maps or to upgrade comprehensive plans in order to identify areas within those municipalities that can serve as new locations for residences and/or businesses to be moved after purchase under the voluntary NYCFFBO. Grants of up to $20,000 are available through this program, part of the CWC's Local Technical Assistance Program. The CWC program rules can be accessed by clicking the 'Flood Hazard Mitigation Program Rules' link found here: http://cwconline.org/fhmi-program-overview

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's NRCS can help communities address watershed impairments that pose imminent threats to lives and property. Most EWP work is for the protection of threatened infrastructure from continued stream erosion. NRCS may pay up to 75 percent of the construction costs of emergency measures. The remaining costs must come from local sources and can be made in cash or in-kind services. EWP projects must reduce threats to lives and property; be economically, environmentally, and socially defensible; be designed and implemented according to sound technical standards; and conserve natural resources. More information about the EWP program can be found here:
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

FEMA Building Resilient Infrastructure and Communities (BRIC) Program

Building Resilient Infrastructure and Communities (BRIC) will support states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. The BRIC program guiding principles are supporting communities through capability- and capacity-building, encouraging and enabling innovation, promoting partnerships, enabling large projects, maintaining flexibility, and providing consistency.
https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities.

FEMA Pre-Disaster Mitigation (PDM) Program

The PDM program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through PDM planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities. The PDM program is subject to the availability of appropriation funding as well as any program-specific directive or restriction made with respect to such funds.
https://www.fema.gov/pre-disaster-mitigation-grant-program

FEMA Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.

The HMGP is one of the FEMA programs with the greatest potential fit to potential projects in this LFA. However, it is available only in the months subsequent to a federal disaster declaration in the State of New York. Because the state administers the HMGP directly, application cycles will need to be closely monitored after disasters are declared in New York.
https://www.fema.gov/hazard-mitigation-grant-program

FEMA Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the NFIP. FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs and made the following significant changes to the FMA program:

- The definitions of repetitive loss and SRL properties have been modified.
- Cost-share requirements have changed to allow more federal funds for properties with RFC and SRL properties.
- There is no longer a limit on in-kind contributions for the nonfederal cost share.

One limitation of the FMA program is that it is used to provide mitigation for *structures* that are insured or located in SFHAs. Therefore, the individual property mitigation options described in this LFA are best suited for FMA funds. Like PDM, FMA programs are subject to the availability of appropriation funding as well as any program-specific directive or restriction made with respect to such funds.
http://www.fema.gov/flood-mitigation-assistance-grant-program

NYS Department of State

The Department of State may be able to fund some of the projects described in this report. In order to be eligible, a project should link water quality improvement to economic benefits.

U.S. Army Corps of Engineers (USACE)
The USACE provides 100 percent funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the USACE for mitigation are listed below.

- Section 205 – Small Flood Damage Reduction Projects: This section of the 1948 Flood Control Act authorizes the USACE to study, design, and construct small flood control projects in partnership with nonfederal government agencies. Feasibility studies are 100 percent federally funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65 percent with a 35 percent nonfederal match. In certain cases, the nonfederal share for construction could be as high as 50 percent. The maximum federal expenditure for any project is $7 million.

- Section 14 – Emergency Stream Bank and Shoreline Protection: This section of the 1946 Flood Control Act authorizes the USACE to construct emergency shoreline and stream bank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and nonprofit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- Section 208 – Clearing and Snagging Projects: This section of the 1954 Flood Control Act authorizes the USACE to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- Section 206 – Floodplain Management Services: This section of the 1960 Flood Control Act, as amended, authorizes the USACE to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of flood-prone structures. When funding is available, this work is 100 percent federally funded.

In addition, the USACE provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. USACE assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the USACE can loan or issue supplies and equipment once local sources are exhausted during emergencies.

Other Potential Sources of Funding

New York State Grants
As part of New York's efforts to improve the business climate and expand economic growth, the NYS Consolidated Funding Application (CFA) was created. The CFA allows applicants to access multiple state funding sources through one application, making the process quicker, easier, and more productive.
https://apps.cio.ny.gov/apps/cfa/

All New York State grants are announced on the NYS Grants Gateway. The Grants Gateway is designed to allow grant applicants to browse all NYS agency anticipated and available grant opportunities, providing a one-stop location that streamlines the way grants are administered by the State of New York.
https://grantsmanagement.ny.gov/

Climate Smart Communities (CSC)

Climate Smart Communities (CSC) is a New York State program that helps local governments take action to reduce greenhouse gas emissions and adapt to a changing climate. The program offers free technical assistance, grants, and rebates for electric vehicles. Registered communities have made a commitment to act by passing the CSC pledge. Certified communities are the foremost leaders in the state; they have gone beyond the CSC pledge by completing and documenting a suite of actions that mitigate and adapt to climate change at the local level.
https://climatesmart.ny.gov/

Environmental Facilities Corporation
The Environmental Facilities Corporation (EFC) helps local governments and eligible organizations undertake water infrastructure projects. EFC provides grants and financing to help ensure projects are affordable while safeguarding essential water resources. EFC administers state and federal grants as well as interest-free and low-cost financing to help minimize the tax burden for communities.
https://efc.ny.gov

The EFC’s Green Innovation Grant Program (GIGP) supports projects across New York State that utilize unique Environmental Protection Agency (EPA)-designated green stormwater infrastructure design and creates cutting-edge green technologies. Competitive grants are awarded annually to projects that improve water quality and mitigate the effects of climate change through the implementation of one or more of the following green practices: Green Stormwater Infrastructure, Energy Efficiency, and Water Efficiency.
https://efc.ny.gov/gigp

Bridge NY Program
The Bridge NY program, administered by NYSDOT, is open to all municipal owners of bridges and culverts. Projects are awarded through a competitive process and support all phases of project development. Projects selected for funding are evaluated based on the resiliency of the structure, including such factors as hydraulic vulnerability and structural resiliency; the significance and importance of the bridge, including traffic volumes, detour considerations, number and types of businesses served, and impacts on commerce; and the current bridge and culvert structural conditions.
https://www.dot.ny.gov/BRIDGENY.

Private Foundations

Private entities such as foundations are potential funding sources in many communities. The Town of Neversink and FAC members will need to identify the foundations that are potentially appropriate for some of the actions proposed in this report.

In addition to the funding sources listed above, other resources are available for technical assistance, planning, and information. While the following sources do not provide direct funding, they offer other services that may be useful for proposed flood mitigation projects.

Land Trust and Conservation Groups

These groups play an important role in the protection of watersheds, including forests, open space, aquatic ecosystems, and water resources.

As the recommendations of this LFA are implemented, the Town of Neversink will need to work closely with potential funders to ensure that the best combinations of funds are secured for the proposed alternatives and for the property-specific mitigation such as floodproofing, elevations, and relocations. It will be advantageous for the town to identify combinations of funding sources in order to reduce its own requirement to provide matching funds.

5.2 HOMES AND PROPERTIES

For repetitive loss homes in the LFA area where the town supports buyouts, FEMA has developed precalculated benefits for acquisition and elevation of buildings. The following is excerpted from a FEMA memorandum regarding Hazard Mitigation Assistance (HMA) precalculated benefits (FEMA, 2013):

> FEMA's Risk Reduction Division analyzed over 11,000 structures acquired or elevated and found that the average benefits for each project type are $323,000 and $205,000, respectively. Therefore, FEMA has determined that the acquisition or elevation of a structure located in the 100-year floodplain as delineated on the FIRM or based on best available data that costs less than or equal to the amount of benefits listed above is considered cost effective. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criterion. This methodology is available for all HMA grant programs.

Homeowners in the SFHA floodplain may qualify if relocation or elevation costs are projected to be less than these average benefit values. Homeowners would require support for any acquisitions in the form of a resolution by the Town of Neversink that identifies the property as an inundation or erosion hazard.

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