HAMLET OF PINE HILL LOCAL FLOOD ANALYSIS

Town of Shandaken, New York

Prepared for:

Town of Shandaken
P.O. Box 134
Shandaken, NY 12480
SLR #142.14615.00030

November 2022

Local Flood Analysis – Hamlet of Pine Hill

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P.O. Box 134
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CONTENTS

FIGURES

TABLES

ACRONYMS

AWSMP	Ashokan Watershed Stream Management Program
BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BRIC	Building Resilient Infrastructure and Communities
CFS	Cubic Feet per Second
CRRA	Community Risk and Resiliency Act
CRS	Community Rating System
CSC	Climate Smart Communities
CWC	Catskill Watershed Corporation
DEM	Digital Elevation Model
EFC	Environmental Facilities Corporation
EWP	Emergency Watershed Protection
FEMA	Federal Emergency Management Agency
FFE	Finished Floor Elevations
LFHMIP	Local Flood Hazard Mitigation Implementation Program
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
LiDAR	Light Detection and Ranging
LOMA	Letter of Map Amendment
LOMR-F	Letter of Map Revision
MPH	Miles per hour
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
SAFARI	Shandaken Area Flood Assessment and Remediation Initiative
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
SRL	Severe Repetitive Loss
USACE	United States Army Corps of Engineers
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

EXECUTIVE SUMMARY

SLR Engineering, Landscape Architecture, and Land Surveying, P.C. (SLR) was retained to conduct a Local Flood Analysis (LFA) in Pine Hill. The analysis was undertaken with funding provided by the New York City Department of Environmental Protection (NYCDEP). The Local Flood Analysis Program is specific to the New York City water supply watersheds and was initiated following Tropical Storm Irene to help communities identify long-term, cost-effective projects to mitigate flood hazards. Flood mitigation recommendations provided in this analysis may be eligible for project implementation funding from a range of funding sources.

The flood analysis was undertaken in consultation with the Shandaken Area Flood Assessment and Remediation Initiative (SAFARI), which is comprised of individuals with technical and nontechnical backgrounds and represents various interests and stakeholders. The SAFARI committee met regularly over the course of the flood analysis process to review results and provide input on flood mitigation alternatives. The process included three public meetings.

This LFA provides an analysis of riverine flooding and provides recommendations for mitigation and infrastructure improvements within the study boundaries. Analysis was conducted along portions of Birch Creek, Alton Creek, Woodchuck Hollow, and unnamed tributaries to these watercourses. Multiple flood mitigation approaches to reduce water surface elevations, including bridge and culvert replacements and floodplain bench alternatives, were evaluated in the project areas. Recommendations are provided, which are intended to serve as a blueprint for short- and long-term flood mitigation in Pine Hill.

The Birch Creek watershed falls within the physiographic region of New York State (NYS) known as the Catskill Mountains. The entire Pine Hill LFA project area drains into Birch Creek. When measured at its confluence with Esopus Creek, the Birch Creek watershed is 12.7 square miles in size. Pine Hill and the Birch Creek watershed are located high in the Esopus Creek watershed, characterized by relatively steep slopes and deep valleys that transition to gentler slopes and wider valleys further downstream. The fast-moving water picks up sediment that is then deposited further downstream as the water slows in the flatter regions. The watercourses in Pine Hill are therefore expected to see a trend of erosion over time.

Pine Hill sustained damages during flood events in July 1973, April 1987, and January 1996. The hamlet was largely spared from flood damages during Tropical Storm Irene, in August 2011, although severe flooding and flood-related damages occurred in surrounding communities and throughout the Catskill Region. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) indicate that homes and businesses in the hamlet are vulnerable to flooding.

Fifteen stream crossings were assessed in this study. Each was assessed for its capacity to pass flood flows without overtopping the road and the impact of backwater flooding caused by insufficient capacity. A prioritization is provided for the replacement of the crossings. Three crossings of Bonnie View Avenue, the county bridge, the intersection with Station Road, and between Mill and Station Roads, were all noted as high priority for replacement due to structural and hydraulic capacity concerns. The other 12 crossings were sorted into medium priority, low priority, or no replacement recommended at this time. The high-and medium-priority crossings are further analyzed. In most cases, the crossing is only part of the cause of flooding, and the replacement project should include work on the channels and floodplains for a more robust solution.

Six distinct project areas are identified. Channel adjustments, floodplain creation or lowering, and crossing replacement are recommended where appropriate. The eight high- and medium-priority crossings are discussed with recommendations of crossing spans, channel widths, and floodplain changes. The six project areas are as follows:

Project 1 is at the intersection of Bonnie View Avenue and Station Road. The proposed changes include removing unused, undersized crossings over Alton Creek, including an abandoned private driveway, two platforms, and Station Road. The Bonnie View Avenue crossing should be resized. Additionally, it is recommended to widen the entrenched channel and lower the floodplain for better connectivity. The roadway may also be raised to reduce flooding along Bonnie View Avenue during flood events.

Project 2 is located where Bonnie View Avenue crosses Alton Creek between Station Road and Mill Street. The project includes widening the channel, a new bridge with increased span, enhancing the floodplain downstream of the crossing, and raising the roadway.

Project 3 is the historical Mill Street crossing over Alton Creek. The crossing is undersized, and the channel upstream is entrenched. It is recommended to widen the channel and increase the span of the crossing to reduce flooding.

Project 4 is the Main Street crossing over Alton Creek. The entrenched channel upstream of the crossing causes flooding and erosion of the banks. It is recommended to widen the channel and connect to enhanced floodplains where possible. The span of the crossing should also be increased.

Project 5 is the historical Academy Street crossing over Birch Creek. It is recommended to widen the channel upstream of the crossing and increase the span of the crossing. The new crossing should have an open bottom to support aquatic organism passage.

Project 6 runs along Birch Creek and includes the Main Street bridge. It is recommended to widen the channel and enhance floodplain connectivity in this section. The span of the bridge should also be increased to cross the channel and floodplain.

Two additional crossings are recommended along Bonnie View Avenue: the county bridge and the access to the water treatment facility.

A Benefit-Cost Analysis was used to evaluate the cost effectiveness of the proposed projects. To facilitate the analysis, a survey of first finished floor elevations (FFE) of structures in the FEMA 100-year flood zone was carried out. Although the recommended projects received low numerical scores, it is noted that scores would increase if additional information were to be made available for each crossing, including historic damages, cleanup costs, past emergency response, and economic loss information. It was also noted that the numerical score may not adequately capture all potential benefits of a proposed project because factors such as human safety and water quality are not fully considered. Brief narratives are included in the Benefit-Cost Analysis section of this report describing each recommended project and its benefits. The narratives should be considered in combination with the numerical scores when weighing the projects for potential funding.

A range of federal, state, and local funding may be available for the implementation of recommendations made in this report. These potential funding sources are discussed in further detail in this report. The Pine Hill Historic District is a national historic district encompassing 125 buildings and other features. It developed between about 1800 and 1962 and includes notable examples of architecture. The Pine Hill Historic District was listed on the National Register of Historic Places in 2012. Rehabilitation of historic residential buildings may qualify for a New York State tax incentive.

As the flood mitigation recommendations provided in this LFA are implemented, the Town of Shandaken will need to work closely with potential funders to ensure that the best combinations of funds are secured. It will be advantageous for the town to identify combinations of funding sources to reduce its own requirement to provide matching funds.

1. INTRODUCTION

1.1 PROJECT BACKGROUND AND OVERVIEW

SLR has been retained by the Town of Shandaken to conduct an LFA in the hamlet of Pine Hill, town of Shandaken, New York. 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.

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.

Project recommendations generated through an approved LFA may be eligible for Flood Hazard Mitigation (FHM) funding available through the Stream Management Implementation Program (SMIP) administered by the Ashokan Watershed Stream Management Program (AWSMP), the Catskill Watershed Corporation's (CWC) Local Flood Hazard Mitigation Implementation Program (LFHMIP), or NYCDEP's voluntary New York City Founded Buy-Out Program (NYCFFBO). Given the high cost of the projects recommended in this LFA, state and federal funding will likely be required for design and implementation. A more detailed list of potential funding sources is included in Section 6 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 is used in the narrative and on maps as an address to identify specific points along the watercourse. Stationing along Birch Creek is measured in feet and begins at stream station 00+00 where Birch Creek empties into Esopus Creek and continues upstream to stream station 405+04. For Alton Creek, stationing begins at stream station 00+00 at the confluence of Birch Creek and continues upstream to stream station 117+82. As an example, Birch Creek passes underneath Route 296 at stream station 151+82. Stream stationing was also created for focus tributaries starting at stream station 0+00 at the confluence with the main watercourse and continuing upstream to the tributary headwaters.

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) represents 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).

It should be noted that **over the time period of a standard 30-year property mortgage, a property located within the Special Flood Hazard Area (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 at an elevation that 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.

The SFHA represents the area expected to be inundated by flooding during the 100-year flood event. Within the project area, FEMA has developed a FIRM, which indicates the location of the SFHA along Birch Creek, Alton Creek, and their tributaries.

It is important to clarify that the Pine Hill boundaries in this LFA study are not the same as the designated hamlet boundary. Although portions of the hamlet are incorporated in the study area, the study boundaries were outlined based on population density and prior knowledge of flooding.

This study uses the name Alton Creek for the creek that flows along Bonnie View Avenue and has a confluence with Birch Creek southwest of Elm Street in Pine Hill. Some sources have different names for parts or all of the creek such as Cathedral Glen Creek. Refer to the map in Figure 1-2 for further clarification of the watercourse.

The active channel width is the width of a watercourse during a normal high flow event such as after a steady rain. This is the space the channel needs to pass a regularly occurring flow level. If a channel is significantly narrower than the active channel width, the watercourse is constricted. This can lead to damaged banks as the velocity increases or flooding, if the water level rises above the banks. If the channel is significantly wider than the active channel width, the flow may be too shallow for aquatic organisms and may cause aggradation, the accumulation of sediment in the channel.

A **constriction** in the channel, such as culvert or reduced width, can create **backwater flooding** during a flood event. The constriction can act like a dam when the high flow exceeds the channel capacity. Water then backs up behind the constriction and the water level rises. The increased water surface level may lead to overtopping of the crossing or flooding of nearby roads and properties. Removing the constriction, by increasing the channel width or upsizing a culvert or bridge, increases the conveyance capacity and thereby reduces the flood levels.

Floodplains along a watercourse are critical to reducing damage due to flooding. A river in flood stage must convey large amounts of water, and the water has to go somewhere. **A floodplain will hold and convey water during high water events, reducing the water surface elevation and flow velocity**. Development and placement of fill in the natural floodplain of a river can severely hinder a river's ability to convey flood flows without overtopping its banks and/or causing heavy flood damages such as erosion. Additionally, if the floodplain is too high or disconnected from the river by a berm, it is less effective and only used in extreme events.

Pine Hill and the LFA area are high in the Esopus Creek watershed. **This headwater region is characterized by relatively steep slopes and deep valleys that transition to gentler slopes and wider valleys further**

downstream. The fast-moving water picks up sediment that is then deposited further downstream as the water slows in the flatter regions. Areas like Pine Hill are therefore expected to see a trend of erosion over time.

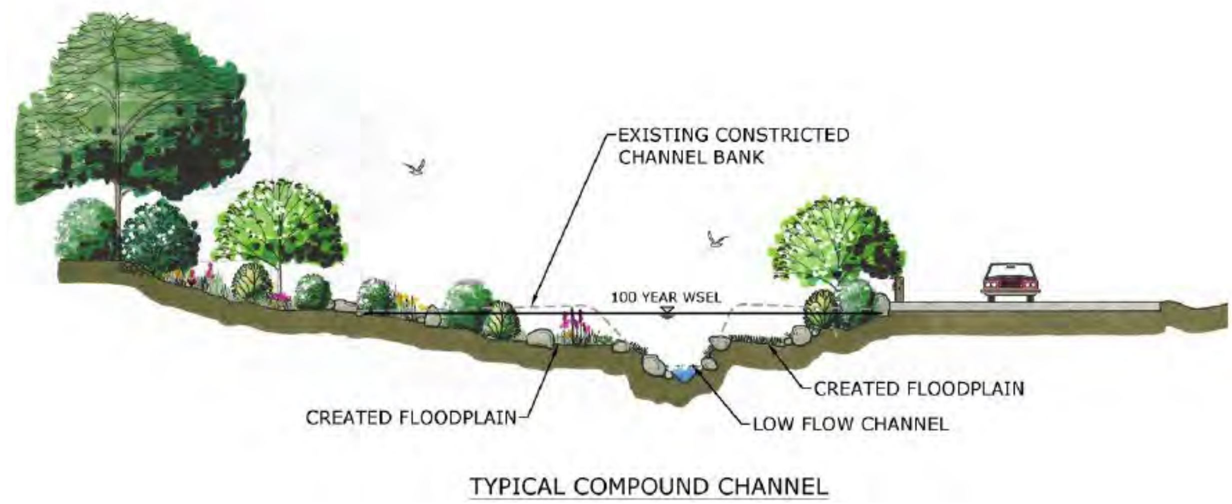
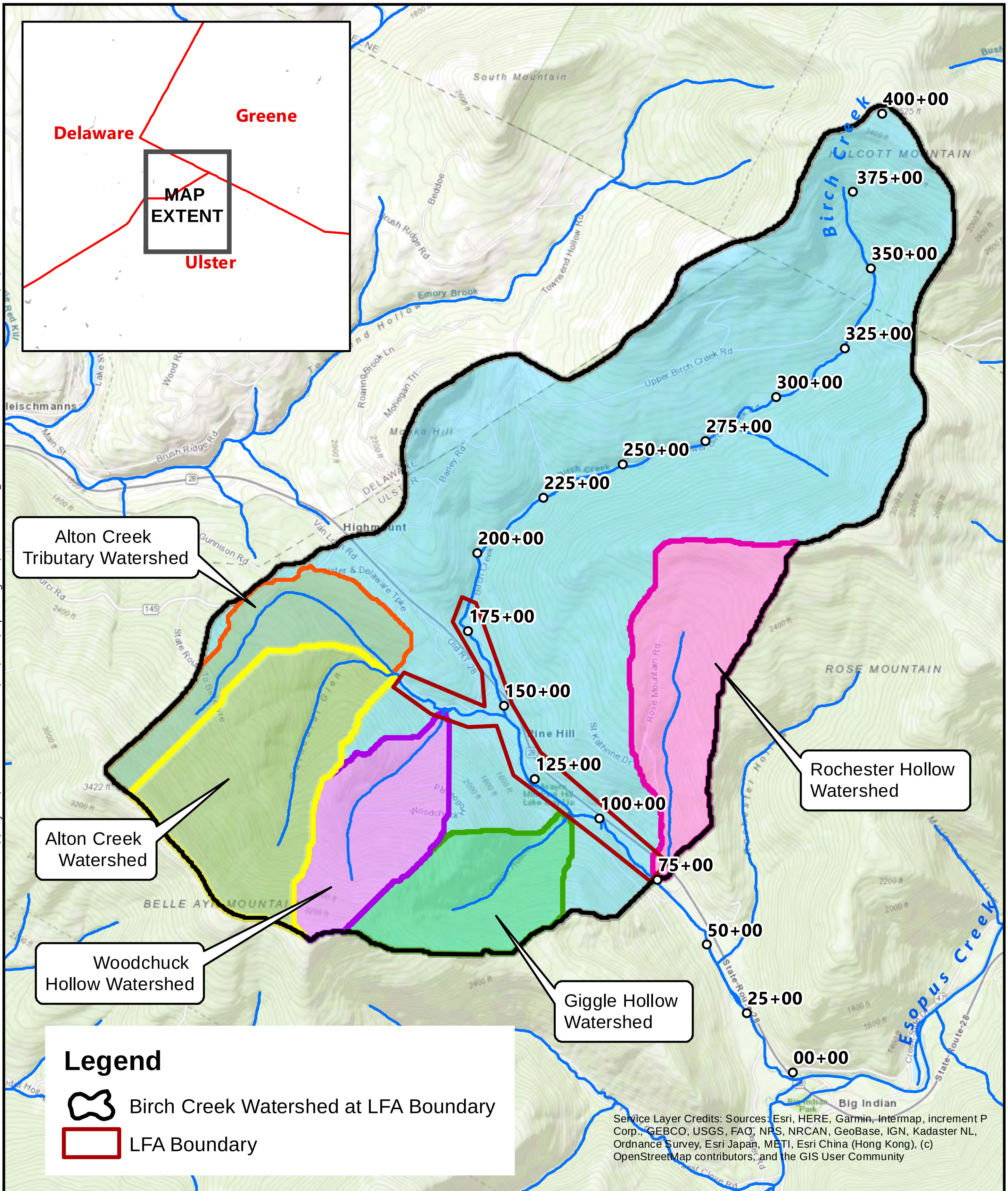


Figure 1-1: Cross Section of River Channel with Floodplains

1.3 STUDY AREA

The LFA bounds within the hamlet of Pine Hill are located in northwestern Ulster County within the northwestern section of the town of Shandaken. The Pine Hill study area is located within the Birch Creek watershed. Figure 1-2 illustrates an overview map of the LFA project area and contributing watersheds.

The Pine Hill LFA focuses on riverine flood mitigation and infrastructure improvements within the LFA study boundaries, although flooding hazards may exist elsewhere in the town. A total of 15 road stream crossings across the focus watercourses have been assessed as summarized in Table 2-6.



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PINE HILL LFA WATERSHEDS

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

0 1,500 3,000
Feet

SCALE 1 " = 3,750 '

DATE 11/17/2022

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FIG. 1-2

1.4 COMMUNITY INVOLVEMENT

The LFA was undertaken in close consultation with SAFARI, the town flood committee assembled in 2010 to address flood mitigation. SAFARI is comprised of individuals with technical and nontechnical backgrounds and is meant to represent various interests and stakeholders at town and county levels. SAFARI met regularly over the course of the LFA process to review results and provide input on flood mitigation alternatives. SAFARI members include representatives from the following organizations and backgrounds:

- Town of Shandaken members:
  - Elected and appointed officials
  - Highway Department representatives
- Ashokan Watershed Stream Management Program:
  - Ulster County Soil & Water Conservation District
  - Cornell Cooperative Extension of Ulster County
  - New York City Department of Environmental Protection
- Ulster County:
  - Department of Planning
  - Department of Public Works
  - Department of Emergency Services
  - Department of Environment
- Catskill Watershed Corporation
- SLR Engineering, Landscape Architecture, and Land Surveying, P.C.

The LFA process included three public meetings, all held at the Pine Hill Community Center. The first public meeting took place near the start of the study and served to inform the public about the LFA process, gather input about past flood events, and record reported flood damages within the project areas. A second public meeting was held at the midpoint of the LFA process to share key findings. A third public meeting was held at the end of the LFA process to summarize final recommendations and make the community aware of the LFA technical report.

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

Table 1-1 LFA Meeting Schedule

Date	Type of Meeting	Topic
April 4, 2022	SAFARI #1	Introduction to and overview of the LFA process; gathering of flood information from SAFARI members
May 10, 2022	SAFARI #2	Present preliminary findings and collect additional details on high risk areas
May 23, 2022	Public Meeting #1	Introduction to and overview of the LFA process to Pine Hill residents; gathering additional flood information and areas of concern
July 12, 2022	SAFARI #3	Present new preliminary findings and gather feedback from the SAFARI on recommendations
August 10, 2022	Public Meeting #2	Update of the LFA process and introduction of preliminary findings to Pine Hill residents; gather feedback
August 15, 2022	SAFARI #4	Review of public meeting, present findings, and gather feedback from the SAFARI on recommendations
October 11, 2022	SAFARI #5	Review of Pine Hill Draft Report and final recommendations; gather comments
November 15, 2022	SAFARI #6	Review of revised Pine Hill Draft Report; gather final comments; discuss presentation for final public meeting
November 30, 2022	Public Meeting #3	Presentation of the Pine Hill LFA final report and findings

2. DATA COLLECTION

Data were gathered from various sources related to the hydrology and hydraulics of Birch Creek and its tributaries, Birch 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 initial data collection for this study included existing reports and adopted plans in the watershed.

2.1.1 STREAM MANAGEMENT PLAN

A detailed description of the Esopus Creek watershed is contained in the 2007 Upper Esopus Creek Stream Management Plan prepared by Cornell Cooperative Extension of Ulster County and NYCDEP, with assistance from the U.S. Army Corps of Engineers (USACE) Research Development Center. The AWSMP assessed Birch Creek in 2011 and documented key stream features. The assessment included the sections of Birch Creek, Alton Creek, and Giggle Hollow Brook within the study boundary. In the future, these sections will be reassessed, and the AWSMP will publish a stream management plan for Birch Creek.

2.1.2 ULSTER COUNTY MULTIJURISDICTIONAL NATURAL HAZARD MITIGATION PLAN

In 2007, Ulster County completed a multijurisdictional natural Hazard Mitigation Plan (HMP), which was approved by FEMA in 2009. An updated HMP, dated September 2017, was approved by FEMA and the New York State Department of Homeland Security and Emergency Services. 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 postdisaster mitigation project funding.

The HMP identifies flooding as a significant natural hazard in Ulster County. The Town of Shandaken is noted as being especially vulnerable as the majority of development is located in the valley of Esopus Creek and its tributaries, which were identified as High Risk Areas. High Risk Areas are defined as having a 1 percent chance of being flooded in any given year.

2.1.3 ULSTER COUNTY COMPREHENSIVE EMERGENCY MANAGEMENT PLAN

The Ulster County Comprehensive Emergency Management Plan, adopted by the Ulster County Legislature in June 2014, includes recommendations for reducing flood exposure. These recommendations are summarized as follows:

- Update the Multi-Jurisdictional Hazard Mitigation plan and encouraging 100 percent participation by the municipalities of the county.

- Protect vulnerable populations by reducing their exposure to flooding through acquisitions, elevations, or relocation programs and, where proven effective, decreasing flood elevations by stream management techniques and resolving man-made hydraulic constrictions.
- Implement local land use controls and infrastructure investment policies that discourage inappropriate land use and development in floodprone areas.
- Utilize Light Detection and Ranging (LIDAR), new hydraulic modeling, and other technologies to develop more accurate floodplain delineation, leading to greater accuracy in predicting expected flood levels, associated damages, and prioritization in the use of funding.
- Encourage continued cooperation with NYCDEP.
- Maximize hazard mitigation funding to create a more resilient transportation and public works infrastructure.
- Utilize a science-based approach to stream management. Factors such as climate change must be considered in siting and potentially relocating critical infrastructure such as water and sewer facilities.

2.1.4 TOWN OF SHANDAKEN FLOOD MITIGATION PLAN

Based on its flood history, the Town of Shandaken decided to develop a flood mitigation plan to more specifically address its needs and aid in reducing vulnerability to floods. The plan, first published in 2013 and updated in 2019, identifies hazards as well as resources, information, and strategies to reduce risk from flood hazards. Additionally, the plan helps guide and coordinate mitigation activities.

2.1.5 LOCAL FLOOD DAMAGE PREVENTION CODES

The Town of Shandaken has adopted a local code for flood damage prevention. The present code was adopted on October 10, 2016, to be consistent with the federal guidelines in order to participate in the NFIP.

The stated purposes of this local law are to do the following:

- 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.
- Require that uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction.
- Control the alteration of natural floodplains, stream channels, and natural protective barriers that are involved in the accommodation of floodwaters.
- Control filling, grading, dredging, and other development that may increase erosion or flood damages.
- Regulate the construction of flood barriers that will unnaturally divert floodwaters or that may increase flood hazards to other lands.
- Qualify for and maintain participation in the NFIP.

The stated objectives of the local law are as follows:

- Protect human life and health.
- Minimize the expenditure of public money for costly flood control projects.
- Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public.
- Minimize prolonged business interruptions.
- Minimize damage to public facilities and utilities such as water and gas mains; electric, telephone, and sewer lines; streets; and bridges located in areas of special flood hazard.
- 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.
- Provide that developers are notified that property is in an area of special flood hazard.
- Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.

The Office of the Building Inspector/Zoning and Code Enforcement is empowered as the local administrator for administering and implementing the local Flood Damage Prevention code. It is the duty of the local administrator to grant or deny floodplain development permits in accordance with the code. The local administrator must conduct a permit application review prior to approval and must review the subdivision or new development to determine if the proposed site is reasonably safe from flooding. It is also their responsibility to determine if proposed development in an area of special flood hazard may result in physical damage to other property.

The local law identifies a series of Construction Standards for development in the floodplain, broken down into General Standards, Standards for All Structures, Residential Structures, Non-Residential Structures, and Manufactured Homes and Recreational Vehicles. The General Standards section is broken down into standards for subdivision proposals and encroachments. All new subdivision proposals and other development proposed in an SFHA must be consistent with the need to minimize flood damage, minimize flood damage to utilities, and provide adequate drainage. When encroaching on zones A1-A30 and AE along streams without a regulatory floodway, development must not increase the BFE by more than 1 foot. Along streams with a regulatory floodway, development must not create any increase in the BFE.

Standards for all structures include provisions for anchoring, construction materials and methods, and utilities. New structures must be anchored so as to prevent flotation, collapse, or lateral movement during the base flood. Construction materials must be resistant to flood damage, and construction methods must minimize flood damage. Enclosed areas below the lowest floor in zones A1-A30, AE, AH, and, in some cases, zone A must be designed to allow for the entry and exit of floodwaters. Utility equipment such as electrical, HVAC, and plumbing connections must be elevated to or above the base flood height. Water supply and sanitary sewage systems must be designed to minimize or eliminate the infiltration of floodwaters.

The elevation of residential and nonresidential structures is required in areas of special flood hazard. In zones A1-A30, AE, AH, and, in some cases, zone A, new residential construction and substantial improvements must have their lowest floor (including basement) elevated at or above an elevation that is 2 feet above the BFE. In cases where BFE data is not known for zone A, new residential construction and substantial improvements must have their lowest floor elevated at or above 3 feet above the highest adjacent grade.

For nonresidential structures in zones A1-A30, AE, AH, and, in some cases, zone A, developers have the option of either elevating the structures or improvements to or above an elevation that is 2 feet above the BFE or floodproofing the structure so that it is watertight below an elevation that is 2 feet above the BFE. In cases where BFE data is not known for zone A, new construction and substantial improvements must have their lowest floor elevated at or above 3 feet above the highest adjacent grade.

Recreational vehicles are only allowed in zones A1-A30, AE, and AH if they are on site fewer than 180 consecutive days and are licensed and ready for highway use or meet the construction standards for manufactured homes. Manufactured homes in the A1-A30, AE, and AH zones must be placed on a permanent foundation with the lowest floor elevated at least 2 feet above the BFE. The home should be anchored to the foundation to resist flotation, collapse, or lateral movement. In zone A where no BFE data are available, such structures must be placed on reinforced piers or similar elements that are at least 3 feet above grade.

2.1.6 COMMUNITY RATING SYSTEM

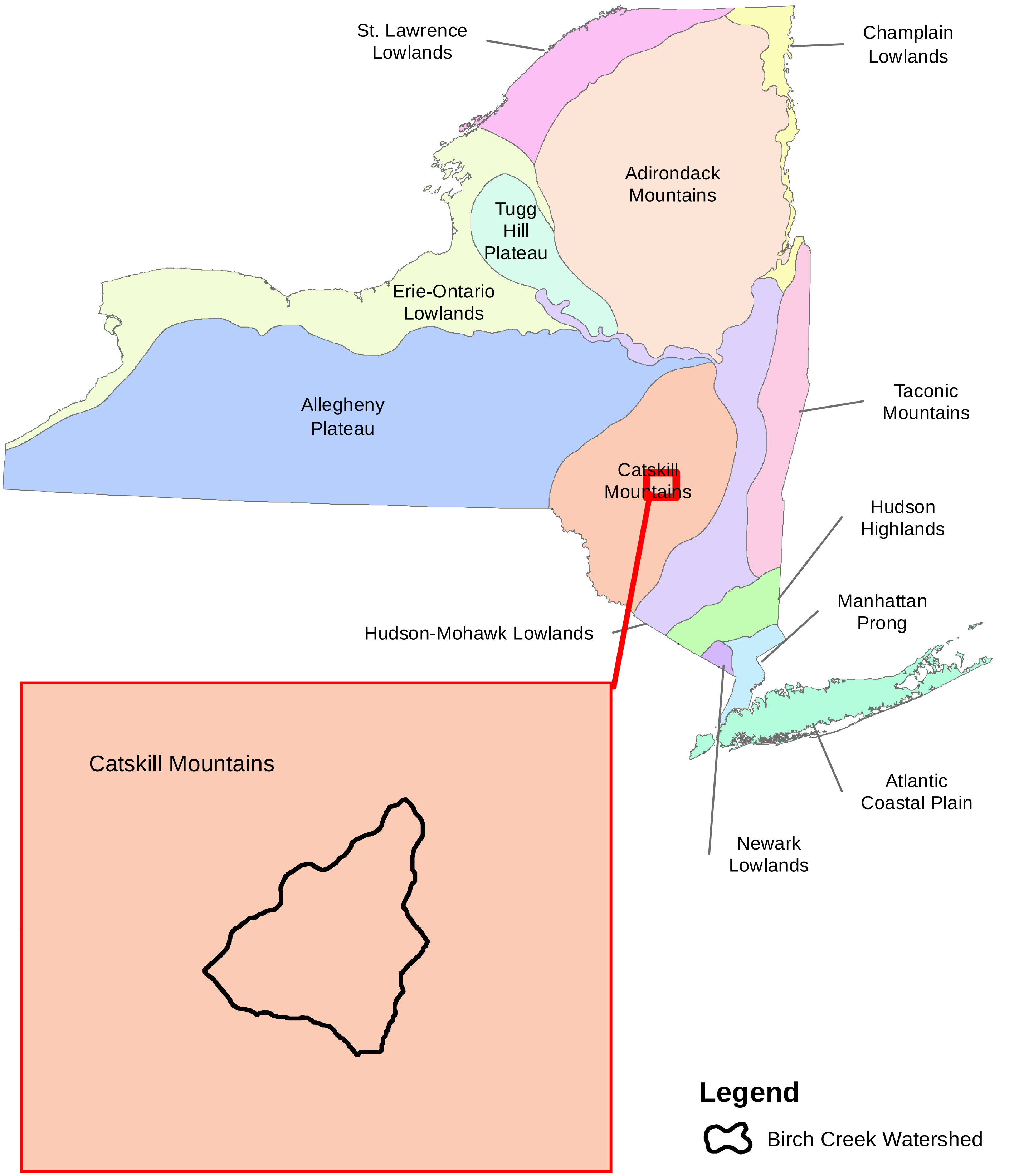
The Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. Over 1,500 communities participate nationwide. In CRS communities, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community's efforts that address the three goals of the program:

- Reduce and avoid flood damage to insurable property
- Strengthen and support the insurance aspects of the National Flood Insurance Program
- Foster comprehensive floodplain management

In June 2021, the Town of Shandaken met the standards for entry into the NFIP's CRS. The town met the criteria for a CRS Class 8 rating, which qualifies the community for a 10 percent discount on the cost of flood insurance premiums for NFIP policies issued or renewed in SFHAs on or after October 1, 2021. The CRS rating will be renewed annually if there are no NFIP noncompliance actions.

2.2 BIRCH CREEK WATERSHED

Birch Creek is located in Ulster County in southeast central 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 in a generally southward direction, draining a portion of northeastern Ulster County before joining with Esopus Creek. The entirety of the hamlet of Pine Hill and a northeast portion of the town of Shandaken drain into Birch Creek. The watershed is triangular in shape, widening in size from north to south. When measured at its confluence with Esopus Creek, the Birch Creek watershed is 12.7 square miles in size. Figure 2-1 is a map of the NYS physiographic regions, and Figure 2-2 is a relief map of the Birch Creek watershed.



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NYS PHYSIOGRAPHIC REGIONS

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 7,500 15,000
Feet

SCALE 1 " = 15,000 '

DATE 9/30/2022

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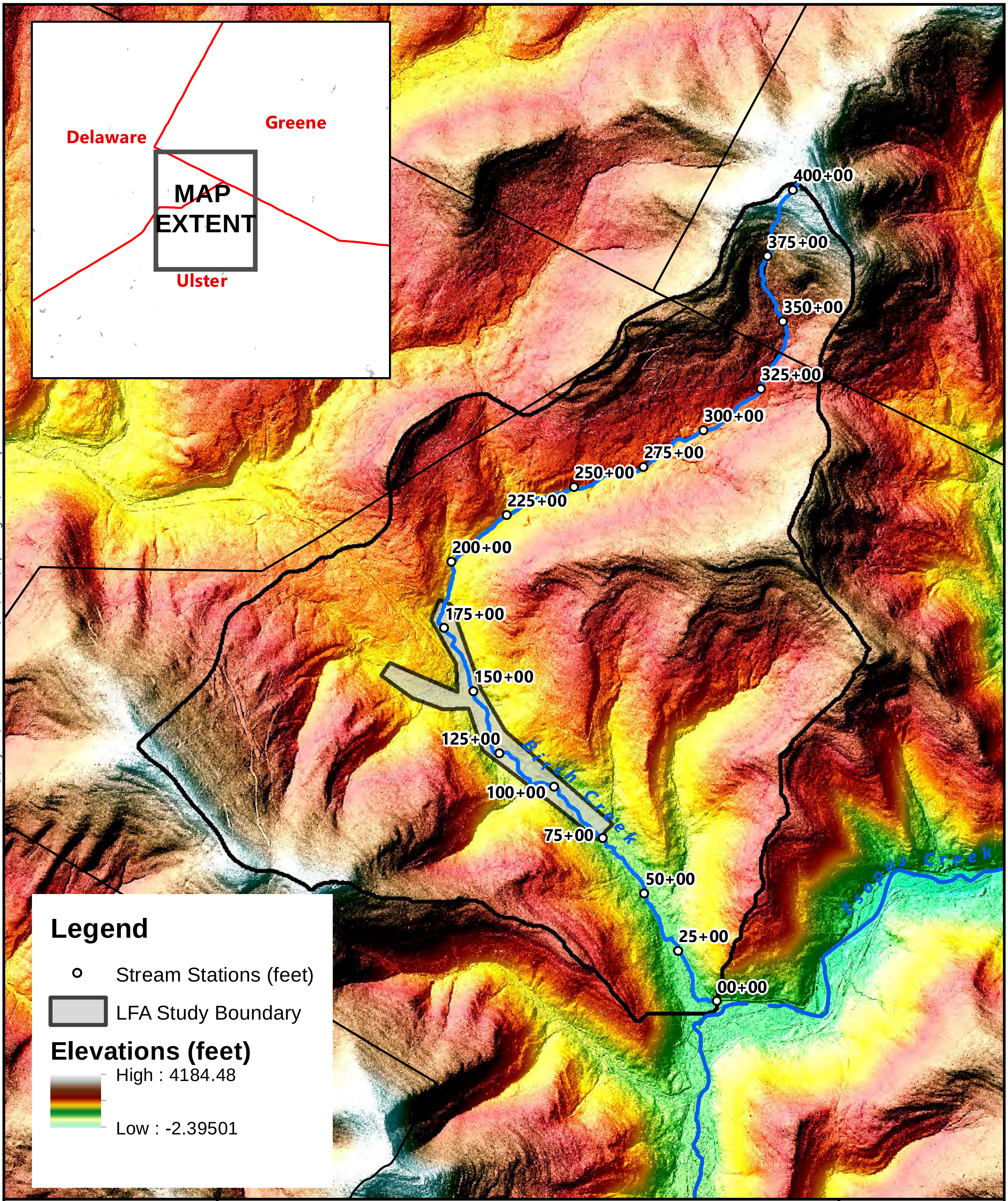
FIG. 2-1



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RELIEF MAP

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

0 2,500 5,000
Feet

SCALE 1 " = 6,000 '
DATE 10/25/2022
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FIG. 2-2

The geology of the bedrock underlying the Birch Creek watershed mostly consists of the Upper and Lower Walton formations. The Upper and Lower Walton formations are both Upper Devonian Period in age and have similar lithologies. They consist of conglomerate, sandstone, and shale. The Lower Walton formation is mapped in the lower elevations within the watershed and underlies most of the Birch Creek watercourse. This area covers the central portions of the watershed. The Upper Walton formation is found in higher elevations of the watershed and makes up the outer margins. A small section of the eastern border of the watershed is mapped as the Slide Mountain formation, bedrock that is also dated from the Upper Devonian Period and contains conglomerate, sandstone, and shale.

These formations are a part of the “Catskill Delta,” and the geologic history of these formations are very similar in nature. During the Upper Devonian Period, the Catskill Mountains and much of New York State was covered by a sea. Over 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 Birch 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 Birch 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. Bedrock is mapped on the northeast and southern borders of the watershed while the glacial till is found in the central and northwest portions of the watershed. Alluvium underlies the lower half of the Birch Creek watercourse. A small area of kame deposits is mapped in the south-central area. Kame deposits consist mainly of sand and gravel deposited by sediment-laden streams that flowed off the ice front.

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 91 percent of the mapped soils in the Birch Creek watershed are classified as hydrologic soil group C or D, indicating a low capacity for infiltration and a high tendency for runoff (Figure 2-3).

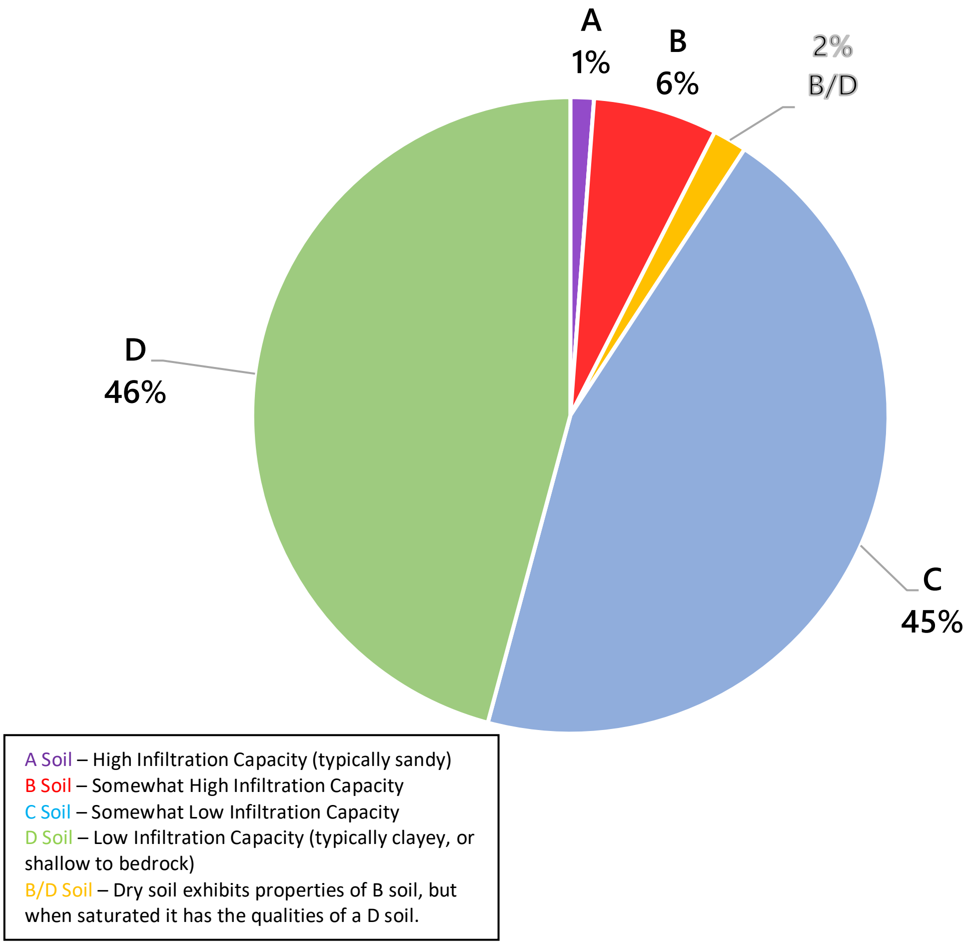


Figure 2-3: Hydrologic Grouping of Soils within the Birch Creek Watershed

Forested land makes up 93 percent of the Birch Creek watershed. Developed land makes up 6 percent. The remaining 1 percent of land cover consists of agricultural land, grassland and shrubland, open water, wetlands, and barren land (Figure 2-4). A portion of Belleayre Mountain Ski Center is located in the northeast corner of the watershed. The ski center artificially makes snow and utilizes several ponds in the watershed to produce the snow.

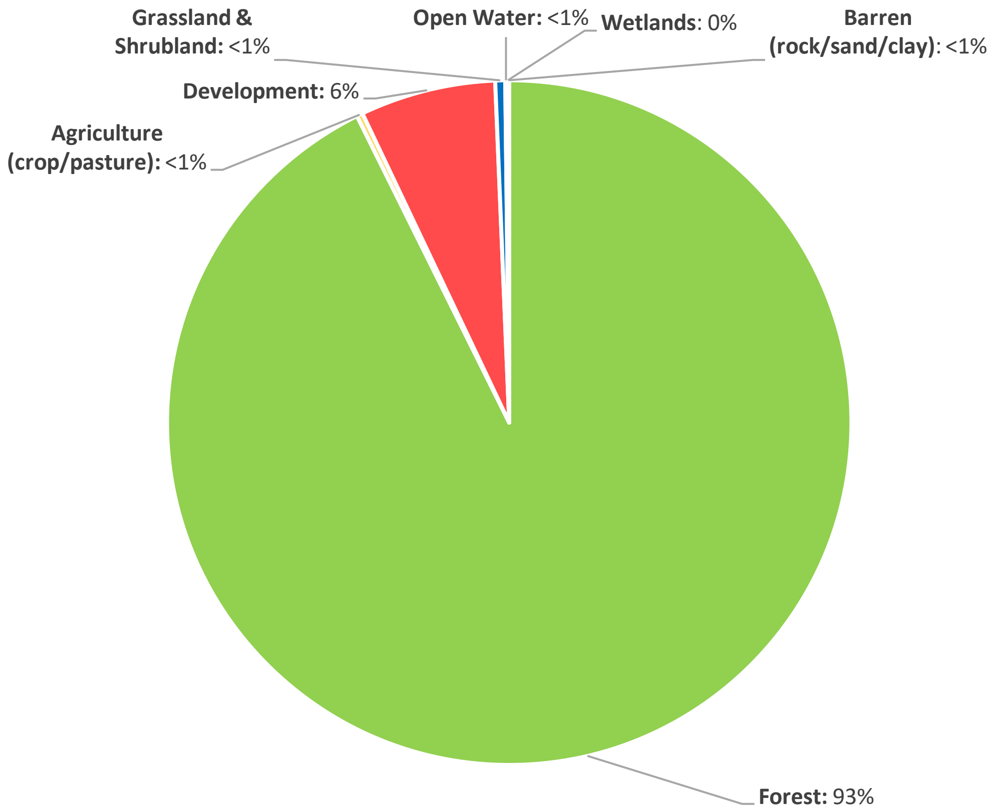


Figure 2-4: Land Cover within the Birch Creek Watershed

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 294 acres of wetlands in the Birch Creek watershed, or approximately 3 percent of the watershed. The wetland type found in the Birch Creek watershed includes freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, 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 BIRCH CREEK WATERCOURSE

The main stem of Birch Creek originates on the upper slope of Halcott Mountain and flows generally southwestward through northeastern town of Shandaken before flowing in a southeast direction through the hamlet of Pine Hill. Birch Creek empties into Esopus Creek within the hamlet of Big Indian, approximately 2 miles downstream of the Pine Hill hamlet boundary. Birch Creek is approximately 11 miles in length where it meets Esopus Creek. Named tributaries to Birch Creek include Alton Creek, Woodchuck Hollow, Giggle Hollow, and Rochester Hollow.

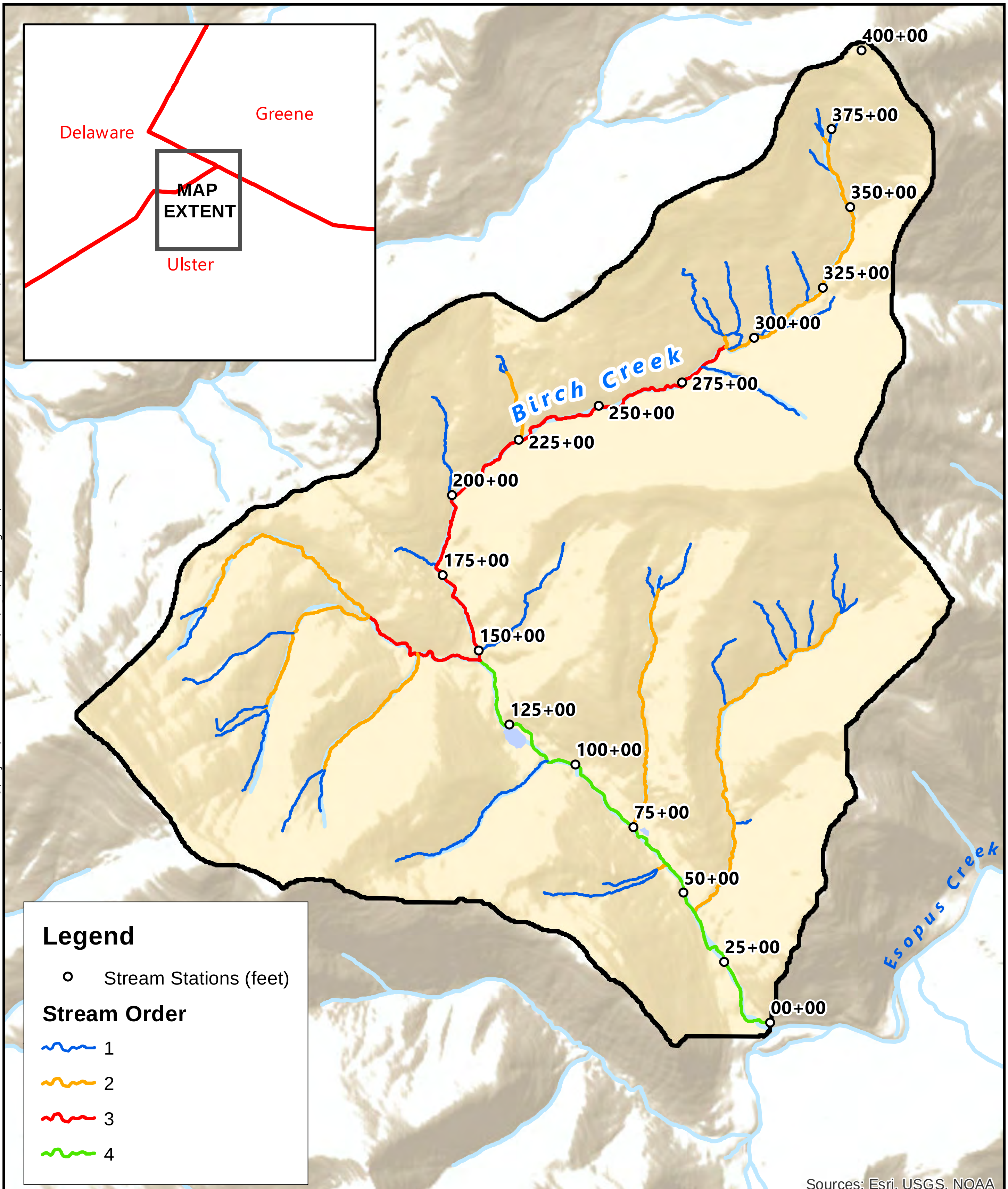
Stream order provides a measure of the relative size of streams by assigning a numeric order to each stream in a stream network. The smallest tributaries are designated as first-order streams, and the designation increases as tributaries join.

The main stem of Birch Creek can be characterized as a fourth-order stream at its confluence with Esopus Creek and is a fourth-order stream for around half of its length. Figure 2-5 is a map depicting stream order in the Birch 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 Birch Creek. First- and second-order streams account for most of the overall stream length within the Birch Creek watershed (77 percent). The first- and second-order streams in the Birch Creek watershed are steeper in slope than third- and fourth-order streams.

Table 2-1 Stream Order Characteristics in Birch Creek Watershed

STREAM ORDER	TOTAL LENGTH (MILES)	PERCENTAGE OF OVERALL NETWORK LENGTH (%)	AVERAGE SLOPE (%)
1st	13.2	46	14.3
2nd	8.8	31	10.7
3rd	3.6	13	2.9
4th	2.8	10	2.8
Total	**28.4**	**100**	



SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

STREAM ORDER

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

0 2,000 4,000
Feet

SCALE 1 " = 5,000 '

DATE 8/5/2022

142.14615.00030
PROJ. NO.

FIG. 2-5

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) and HY-8. 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 the United States Geological Survey (USGS) at thousands of stream gauging stations around the country. For the streams without gauges, the 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 2-6.

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.

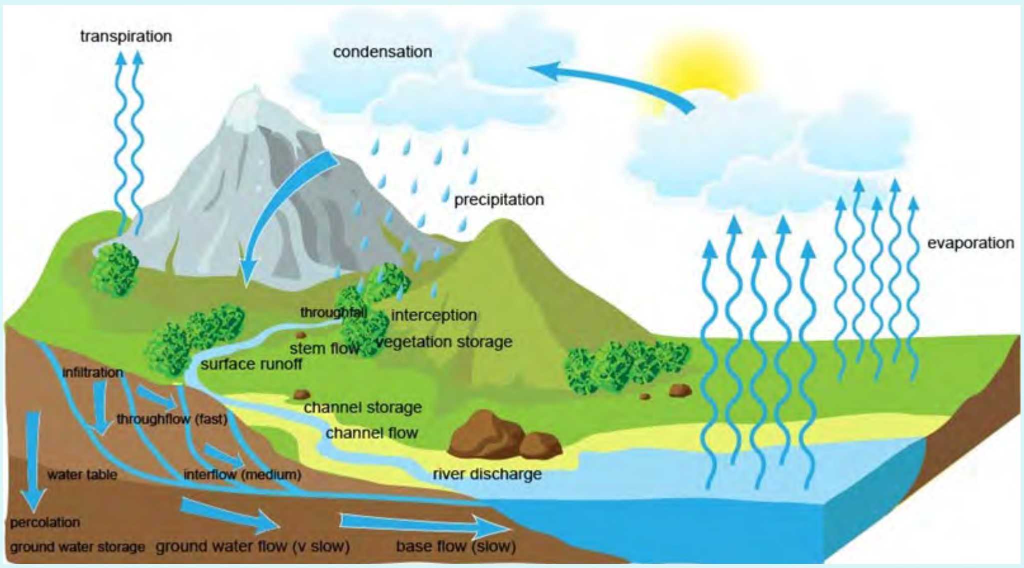


Figure 2-6: Diagram of Simplified Hydrologic Cycle

For the streams without gauges, such as Woodchuck Hollow, the 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.

Flood hydrology for Birch Creek and Alton Creek was originally conducted for the effective Flood Insurance Studies (FIS) for Ulster County, New York (36111CV001B), and was used in the hydraulic analysis for the Pine Hill LFA study. FEMA conducted an in-depth hydrologic analysis of the Ashokan Reservoir watershed, which includes upper Esopus Creek and its tributaries (FEMA, 2012). The study was conducted following extensive flooding in 2011 caused by Tropical Storms Irene and Lee. The purpose was to develop current hydrologic analyses for use in other FEMA flood hazard products.

Flow amounts for Birch Creek and Alton Creek are presented in Tables 2-2 and 2-3, respectively. Woodchuck Hollow is not included in the FIS report, so regional regression equations for peak flow, as calculated by USGS *StreamStats*, were used (Table 2-4). Climate change is expected to increase precipitation and the intensity of storms in the Catskill Region. To include this impact, the future peak flows are also considered (Table 2-5). The future peak flows follow the New York Department of Transportation (NYDOT)-recommended 20 percent increase in current peak flow.

Table 2-2 Hydrology for Birch Creek

Location	Drainage Area (mi^2)	Peak Flood Discharge (cfs) – (FEMA Flows)			
		10-Year	50-Year	100-Year	500-Year
Intersection of Birch Creek Road and Lower Birch Creek Road	3.05	608	1,348	1,797	3,365
Above confluence with Alton Creek	4.96	936	2,060	2,738	5,094
Above confluence with Giggle Hollow	7.96	1,564	3,433	4,570	8,484

cfs = cubic feet per second

Table 2-3 Hydrology for Alton Creek

Location	Drainage Area (mi^2)	Peak Flood Discharge (cfs) – (FEMA Flows)			
		10-Year	50-Year	100-Year	500-Year
Above Alton Creek Tributary	1.08	248	531	698	1,274
Above confluence with Birch Creek	2.43	563	1,220	1,615	2,989

Table 2-4 Hydrology for Woodchuck Hollow

Location	Drainage Area (mi^2)	Peak Flood Discharge (cfs) – (Regional Regression)			
		10-Year	50-Year	100-Year	500-Year
At Station Road culvert	0.57	148	267	330	511

Table 2-5 Future Peak Flows

Watercourse	Location	Current Peak Flood Discharge (cfs)		Future Peak Flood Discharge (cfs)	
		50-Year	100-Year	50-Year	100-Year
Alton Creek	Above Alton Creek Tributary	531	698	638	837
	Above confluence with Birch Creek	1,220	1,615	1,464	1,938
Birch Creek	Intersection of Birch Creek Road and Lower Birch Creek Road	1,348	1,797	1,618	2,156
	Above confluence with Alton Creek	2,060	2,738	2,472	3,286
	Above confluence with Giggle Hollow	3,433	4,570	4,120	5,484
Woodchuck Hollow	At Station Road culvert	267	330	320	396

2.5 HYDRAULICS

To develop hydraulic modeling to assess flood mitigation alternatives, effective FEMA HEC-RAS hydraulic models were sought for areas of the Alton and Birch Creek watersheds. Models were obtained from NYCDEP.

Effective FEMA modeling was completed in 2013 as part of the Ulster County, New York, FIS (36111CV001B). The Birch Creek HEC-RAS model extends from approximately 0.2 miles upstream of Academy Street to the confluence with Esopus Creek. The Alton Creek model extends from the headwaters to the confluence with Birch Creek, a distance of about 2.2 miles.

Hydraulic analyses for the above-listed watercourses were conducted using the HEC-RAS computer software. This program was developed by the 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 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.

Sites outside of the HEC-RAS model area were modeled with the Federal Highway Administration's (FHWA) *HY-8 Culvert Hydraulics Analysis Program* (Version 7.60; FHWA, 2019). This software uses several input parameters to perform hydraulic calculations for structures but with limited contextual data relative to the surrounding stream. For this reason, these models are relatively simple and useful for approximate sizing of culverts but are not substitutes for complete hydraulic analyses of proposed culvert upgrades, especially if projects are expected to impact flow dynamics beyond their immediate vicinity.

For HY-8 models, culvert geometry, including dimensions of the hydraulic opening, barrel material, slope, and inlet configuration as well as roadway embankment characteristics and stream channel profile and cross sections were measured in the field. Culvert capacity and potential roadway overtopping were then assessed.

2.6 INFRASTRUCTURE AND CRITICAL FACILITIES

Several bridge and culvert crossings of Birch Creek, Alton Creek, and its tributaries are contained within LFA study areas and, in certain cases, may contribute to flooding in these locations. These structures and summary details are listed below in Table 2-6. Note that Route 28 crosses Birch Creek in the LFA area. The crossing is large enough that it is not considered to impact the hydraulics of the creek and is therefore not further included in this study.

Table 2-6 Summary Data for Assessed Bridge and Culvert Crossings of Birch Creek, Alton Creek, and its Tributaries

Watercourse	Roadway	River Station (feet)	Structure (Year Built)	NBI BIN[1] (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
Birch Creek	Birch Creek Road	209+20	Metal Box Culvert 1991	2264390 (Town of Shandaken)	1	19	24
	Academy Street[2]	161+20	Retrofitted Stone Arch Culvert	Not Listed (Town of Shandaken)	1	13	29
	Elm Street	151+40	Twin Concrete Box Culvert (1958)	2346960 (Town of Shandaken)	2	12 each	29
	Main Street	134+60	Bridge (1990)	2269010 (Town of Shandaken)	1	35	36
	Former Lake Street	127+60	Twin-Arch Culvert	Not listed (NYS)	2	10 each	36
	Belleayre Day Use Area Access	110+30	Covered Bridge (1992)	2224640 (NYS)	1	55	36
Alton Creek	Bonnie View Avenue (to Water Treatment Plant)	41+30	Metal Pipe Culvert	Not Listed (Unknown)	1	6	16
	Bonnie View Avenue (county bridge)	37+10	Bridge (1999)	3346760 (Ulster County)	1	24	19
	Private Driveway	32+20	Open-Bottom Box Culvert	Not Listed (Private)	1	13	19
	Bonnie View Avenue (at Station Road)	28+50	Open-Bottom Box Culvert	Not Listed (Town of Shandaken)	1	16	19
	Bonnie View Avenue (Between Station Road and Mill Street)	24+30	Open-Bottom Box Culvert	Not Listed (Town of Shandaken)	1	16	19

	Mill Street[2]	15+75	Stone Arch Culvert (1897)	Not Listed (Town of Shandaken)	1	12	22
	Main Street	9+10	Bridge (1988)	2267650 (Town of Shandaken)	1	20	22
	Elm Street[2]	5+50	Stone Arch Culvert (1897)	Not Listed (Town of Shandaken)	1	10	22
Woodchuck Hollow	Station Road	8+80	Metal Pipe Culvert	Not Listed (Town of Shandaken)	1	7	12

[1]NBI BIN = National Bridge Inventory Bridge Identification Number
[2] Historic bridge

In 2014, the Community Risk and Resiliency Act (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. New York State Department of Environmental Conservation (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 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

- 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 bankfull width of the waterway in the vicinity of the crossing.
- Use open-bottom or embedded, closed-bottom structures, which allows for installation of natural streambed material through 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.

There are critical facilities in the LFA project area. The facilities are essential for administration of the town. Critical facilities are listed in Table 2-7. FEMA requires that critical facilities must be outside of the 500-year floodplain or protected from the 500-year flood event. The water treatment plant in Pine Hill lies within the 50-year floodplain and therefore requires floodproofing.

Table 2-7 Critical Facilities in the LFA Project Area

Facility	Address	Floodway? (Y/N)	SFHA? (Y/N)
Pine Hill Fire Station	265 Main Street	N	N
Pine Hill Community Center	287 Main Street	N	N
Wastewater treatment plant	8811 NY-28	N	Y

2.7 POTENTIAL IMPACTS ON WATER QUALITY DUE TO FLOODING

In addition to helping communities identify and mitigate flood hazards, the LFA program mandate includes protecting water quality in the New York City water supply watershed. Flooding is known to cause impaired water quality. Reduction of flooding reduces water quality impairment by reducing the area of land and buildings exposed to floodwaters and by reducing the depth and velocity of floodwaters that mobilize pollutants.

When flooding occurs in the Pine Hill LFA project area, roads and parking lots are inundated by floodwaters, causing oils, gasoline, and other pollutants to be mobilized. When flooding is severe, vehicles can become inundated; yards, buildings, and storage areas can be flooded; and tanks and fuel drums can be washed into Birch Creek and its tributaries, severely impacting water quality. Septic systems are also vulnerable to flooding, and potentially to scour, especially when located within the floodway. Large tanks at 258 Main Street lie in the SFHA. Their use and contents are unknown.

3. IDENTIFICATION OF FLOOD HAZARDS

3.1 FLOODING HISTORY

According to the FIS report for Ulster County (36111CV001B), flooding in Ulster County 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. Ulster County has an active history of hurricanes and tropical storms. According to the Ulster County HMP and National Oceanic and Atmospheric Administration (NOAA) historical records, ten hurricanes or tropical storms have been recorded in Ulster County since 1863. Table 3-1 is a summary of flood events that impacted Ulster County. The flood history is summarized from the FEMA FIS for Ulster County, the Ulster County Multi-Jurisdictional Hazard Mitigation Plan, NOAA historical records, the Town of Shandaken Hazard Mitigation Plan, and historic local newspaper articles.

Table 3-1 Ulster County Flood History

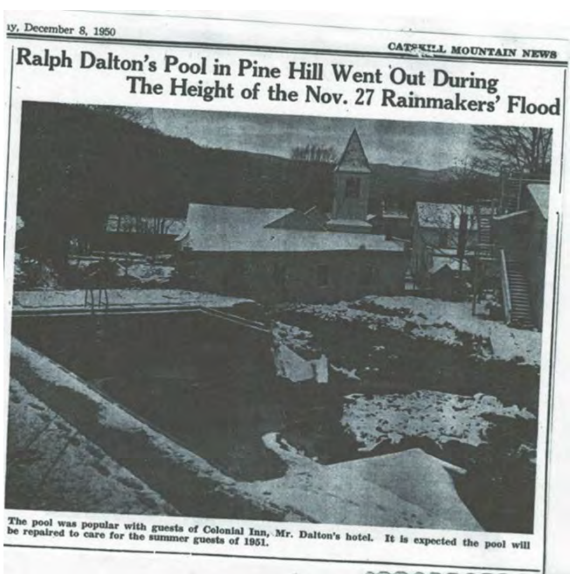
DATE	FLOOD EVENT	NOTES
December 1948	Unnamed Storm	This storm was the result of a low-pressure area moving toward the middle Atlantic coast from the west. The Rondout Creek watershed at Rosendale received approximately 7.2 inches of rainfall.
November 1950	Rainmaker Flood	A storm named the "Rainmaker Flood" caused major flooding in Pine Hill as well as in Phoenicia, Margaretville, Shandaken, Arkville, and Fleischmanns. A total of 4.63 inches of rain fell on the Phoenicia area. Old Mill dam, located above the hamlet of Pine Hill, caved in and sent waves of water down Main Street. Upper Main Street bridge was severely damaged and eventually washed out later in the night. Several residents were stranded in their houses. Multiple businesses and homes were damaged, including the pool at the Colonial Inn. Two dams were washed out on Esopus Creek as well as many roads. Figure 3-1 depicts photos of the hamlet of Pine Hill in the aftermath of the storm.
April 1951	Unnamed Storm	An unnamed storm dropped heavy rains onto Ulster County. That, combined with snowmelt, caused flooding along Esopus Creek. Widespread damage occurred, although most it was at and below Phoenicia.
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 reached a maximum of 9.05 inches at Mohonk Lake, New York.

DATE	FLOOD EVENT	NOTES
October 1955	Unnamed Storm	A cold front moved into eastern Pennsylvania and southern New York on the morning of October 13 and slowly drifted northward on October 14 and 15. At the same time, an extra-tropical cyclone progressed from the Carolinas to New York and brought high winds that were accompanied by heavy rainfall extending through October 17. The maximum recorded rainfall during the storm was 17.80 inches at West Shokan, New York. Major flooding occurred on Schoharie Creek. Ulster County damages totaled $8,393,000. In addition to the destruction of stretches of Route 28, Route 42, and secondary roads, there were five major bridges and seven secondary spans that were washed out during this storm in the town of Shandaken. In Pine Hill, serious damage was caused to a home when a bank behind the house gave away and slid through the kitchen doors across the first floor. Other Pine Hill residents experienced damage to their homes, with many basements flooded and lawns washed out.
July 1969	Unnamed Storm	An unnamed storm caused flooding in Pine Hill and Big Indian. The dam wall at Friendship Manor Lake was breached, sending walls of water downstream to Big Indian.
July 1973	Unnamed Storm	An unnamed storm dropped around 4 inches of rain on the town of Shandaken, causing flooding in the area. Part of Birch Creek Road, Rose Hill Road, and Barley Road in Pine Hill were washed away by high waters. Woodchuck Hollow Road was completely washed out for about a mile. Multiple highways were eroded in the towns of Shandaken, Hardenburgh, Middletown, and several other communities in the Catskill Mountains. Ulster County was declared a disaster area. Figure 3-2 depicts a photo of the Birch Creek Road washout.
March 1980	Unnamed Storm	This storm brought heavy rains in a relatively short period of time and produced a storm of record for the upper Esopus Creek basin. Tannersville recorded 9.4 inches of rainfall, and Coldbrook recorded 6.3 inches of rainfall. Flood damage in the town of Shandaken was estimated at $6 million.
April 1987	Unnamed Storm	Multiple storms dropped large amounts of rainfall onto eastern New York along with eastern Pennsylvania and New Jersey over the course of a few days between March 31 and April 4-7. Around 9 inches of rain fell in the Catskill Mountains. These storms, combined with snowmelt, caused catastrophic flooding over a widespread area. Peak discharge estimates of a number of streams within the area reached or exceeded the 25-year recurrence interval. A New York State Thruway bridge collapsed into Schoharie Creek, killing 10 motorists. Many people were evacuated from their homes. Multiple counties, including Ulster County, were declared disaster areas. Around $65 million in damage occurred. The hamlet of Pine Hill was affected as well, and many homes were flooded in the area. Figure 3-3 and Figure 3-4 are photos within Pine Hill associated with the April 1987 event.
November 1995	Unnamed Storm	Three to 4 inches of rain fell in eastern New York State, which resulted in flooding throughout the area. A state of emergency was declared in the hamlet of Phoenicia. Ulster County ensued $100,000 in damages.

DATE	FLOOD EVENT	NOTES
January 19-21, 1996	Unnamed Storm	Around 4.5 inches of rain fell on at least 45 inches of melting snow in the Catskill Mountain region during January 18 and 19, creating major flooding in the area. The Ashokan Reservoir on Esopus Creek stored 5.1 inches of runoff, which helped mitigate flooding downstream. For the Esopus Creek at Coldbrook, discharges had a recurrence interval of almost 50 years. In Pine Hill, the lower Main Street bridge near Lake Street sustained damage (Figure 3-5).
January 27-28, 1996	Unnamed Storm	One to 2 inches of rain fell across eastern New York State, with some areas in Catskill receiving 3 inches of rain. Soils were already saturated, which caused a number of smaller streams to flood in Ulster County. In the town of Shandaken, many roads were washed out. and the town declared a state of emergency. Ulster County experienced $100,000 in damages.
June 1998	Unnamed Storm	Heavy rain, in some places totaling up to 10 inches, fell over the Catskills and eastern Mohawk Valley over a period of 3 days. Numerous creeks and smaller streams flooded within Ulster County. Ulster County experienced $45,000 in damages.
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. Ulster County was impacted with high winds, heavy rains, and some flooding. A frontal zone helped concentrate the heaviest rain just to the west of the Hudson Valley in the eastern Catskills. Almost 80,000 people lost power in the Mid-Hudson Valley region. Albany, Dutchess, Greene, and Rensselaer counties were declared major disaster areas.
May to June 2004	Unnamed Storm	Slow-moving thunderstorms produced large amounts of rainfall in Ulster County. In Pine Hill, Birch Creek flooded, topping the Academy Street bridge and closing Main Street. Part of Birch Creek Road washed out. Numerous culverts were washed out, and roads were closed due to flooding. The town of Shandaken had $500,000 in damages.
September 2004	Remnants of Hurricane Ivan	Remnants of Hurricane Ivan impacted Ulster County with high winds, heavy rain, and some flooding. Some streams overflowed onto Route 40 in Phoenicia.
April 2005	Unnamed Storm	Heavy rain fell on the Rondout and Esopus Creek basins, causing extensive flooding in the area. Rainfall amounts ranged from 2 inches to almost 6 inches. The peak at Rondout Creek at Rosendale had a recurrence interval of 50 years while the peak at Bushnellsville Creek at Shandaken had a recurrence interval of greater than 100 years. In the town of Shandaken, Bushnellsville Creek overflowed its bank and flooded Route 40. Ulster County had over $275,000 in damages.

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 west-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 (mph) on August 24. Irene then gradually weakened and made landfall on the Outer Banks of North Carolina with winds of 85 mph on August 27. It slowly weakened over land and re-emerged 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 3 million residents without electricity in New York and Connecticut. Ten fatalities are directly attributed to the hurricane. Between 4 and 11 inches of rain fell on the Catskill Region. Tropical Storm Irene is the largest storm on record for both Esopus Creek and Rondout Creek. A peak discharge of 75,800 cfs was recorded on Esopus Creek at the Coldbrook stream gauge. High-water marks were collected as part of FEMA's rapid response riverine high-water mark collection for Tropical Storm Irene and were used in calibration of streams studied by detailed and limited detailed models. The town of Shandaken was hit hard, but the hamlet of Pine Hill did was not affected as much. Birch Creek did not surpass the FEMA 10-year peak discharge.
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 18th named storm, 10th hurricane, and 2nd 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 mph. 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). Ulster County was heavily impacted by Superstorm Sandy. Widespread flash flooding was observed around Rondout Creek, Wallkill River, and Lower and Upper Esopus Creek. Homes, businesses, and infrastructure were destroyed.

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 west-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 on 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.



y, December 8, 1950 CATSKILL MOUNTAIN NEWS

Ralph Dalton's Pool in Pine Hill Went Out During The Height of the Nov. 27 Rainmakers' Flood

The pool was popular with guests of Colonial Inn, Mr. Dalton's hotel. It is expected the pool will be repaired to care for the summer guests of 1951.

Figure 3-1: Photos depicting flooding damage in Pine Hill due to the Rainmaker flood event in November 1950. Photo Sources: Catskill Mountain News

ONE HALF of the Birch creek road washed out by the Birch Creek stream in Pine Hill, town of Shandaken.

(RAY DUNN Photo)

Figure 3-2: A photo depicting flood damage within the hamlet of Pine Hill on Birch Creek Road during the July 1973 event. Photo Source: Catskill Mountain News


Catskill Mou

— Photos by Brian Sweeney

WATER MAIN-There was no traffic through Main Street, Pine Hill over the weekend as the normally small Birch Creek could not hold the heavy rains and spilled across the hamlet's main thoroughfare.

Figure 3-3: A photo depicting flooding across Main Street (left) and flood damage within the hamlet of Pine Hill on Upper Main Street bridge during the April 1987 event (below). Photo Source: Catskill Mountain News (left) and Daily Freeman (below)

Figure 3-4: A photo depicting flood damage within the hamlet of Pine Hill during the April 1987 event. Photo Source: Aaron Bennett, NYCDEP


January 31, 1996

News

Photo by Phil Harrington

IT CARRIED A LOCOMOTIVE in December, but this little bridge on Pine Hill's Main Street was damaged by raging water January 19.

Figure 3-5: A photo depicting flood damage within the hamlet of Pine Hill on lower Main Street bridge during the January 1996 event. Photo Source: Catskill Mountain News

The USGS operates a stream flow gauge along each of the project focus watercourses. [USGS gauge 013621955] on Birch Creek is located 0.1 mile upstream from the Lasher Road bridge, 10 feet west of State Highway 28, and has been in operation since October 1998. Daily flow records are stated to be influenced by seasonal diversion for snowmaking by Belleayre Mountain Ski Center in Pine Hill. There is occasional regulation by Pine Hill Lake located 1.7 miles upstream, and low flows may be affected by Pine Hill Wastewater Treatment Plant located around 1.1 miles upstream.

Annual peak-flow data on Birch Creek provide a useful view into past flood events. Hydrographs with annual peak flows measured at the stream flow gauge for the 2020 water year are illustrated in Figure 3-6 for Birch Creek. The hydrographs were updated with the flood event that took place in December 2020. Published and updated flood recurrence information was superimposed on the hydrographs. The FEMA FIS 10-year peak discharge is denoted by solid lines while the updated gauge analysis peak flows are denoted by the green line. The events that resulted in the largest magnitude flows on Birch Creek include the August 2011 Tropical Storm Irene and the unnamed storm that took place in April 2009. Neither of these flows surpassed FEMA FIS 10-year peak discharge.

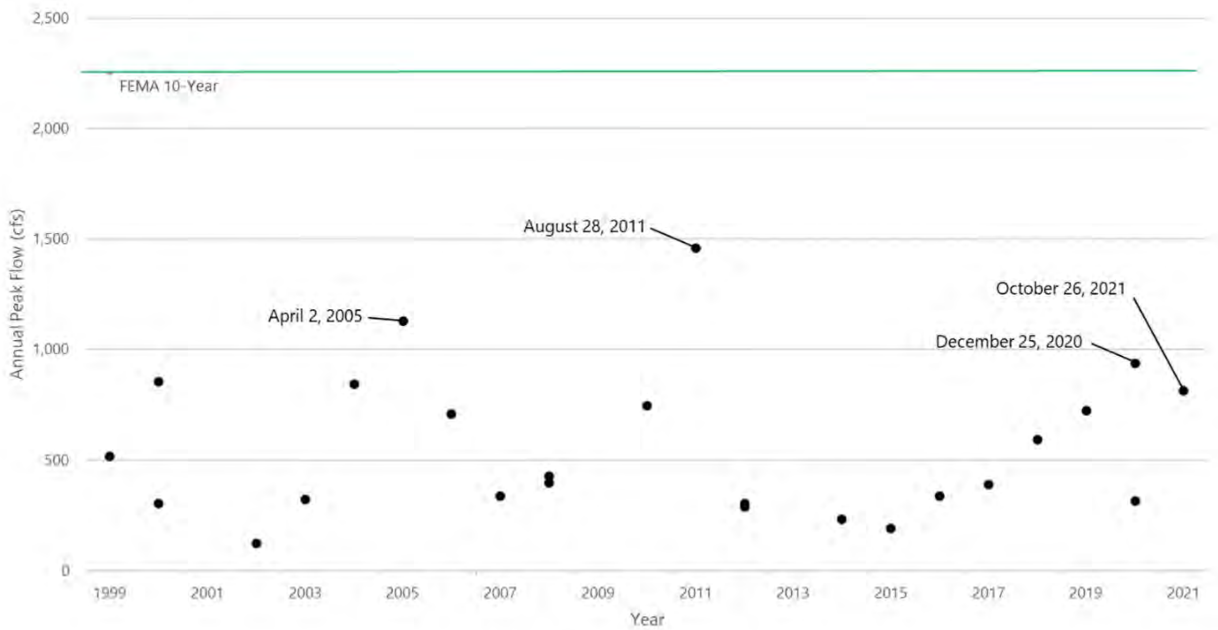


Figure 3-6: Hydrograph of Annual Peak Flow on Birch Creek at Pine Hill, New York 1999 - 2021

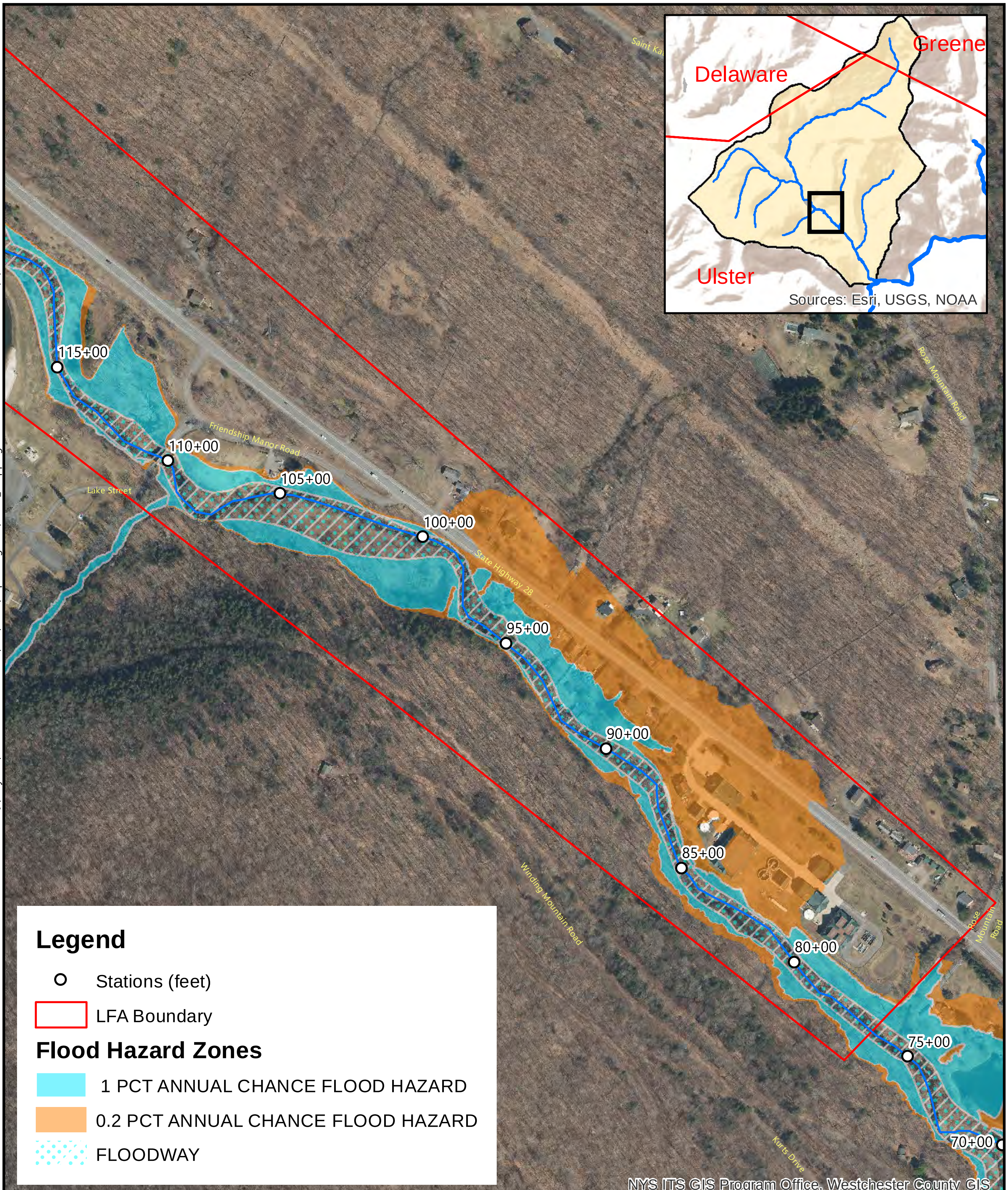
3.2 FEMA MAPPING

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.

> 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.

The FIS for Ulster County has been effective since September 2009 and revised as of November 2016. The flood hazard areas delineated by FEMA are mapped for each focus watercourse. Figures 3-7 through 3-10 depict flood hazard mapping along the Birch Creek. Figures 3-11 through 3-13 depict mapping along Alton Creek. 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.



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BIRCH CREEK FEMA MAPPING 1

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

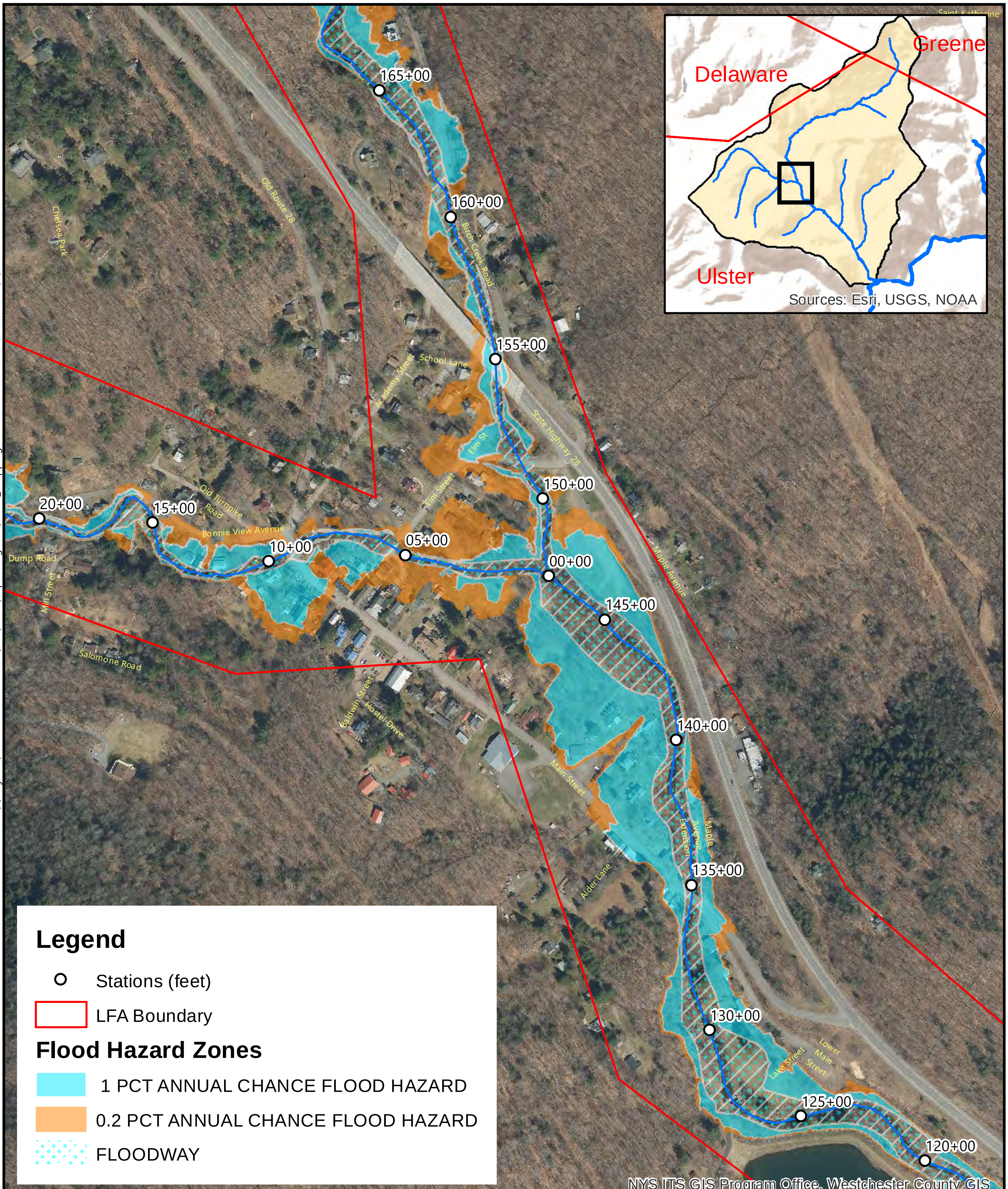
0 500
Feet

SCALE 1 " = 600 '

DATE 11/3/2022

142.4615.00030
PROJ. NO.

FIG. 3-7



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BIRCH CREEK FEMA MAPPING 2

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

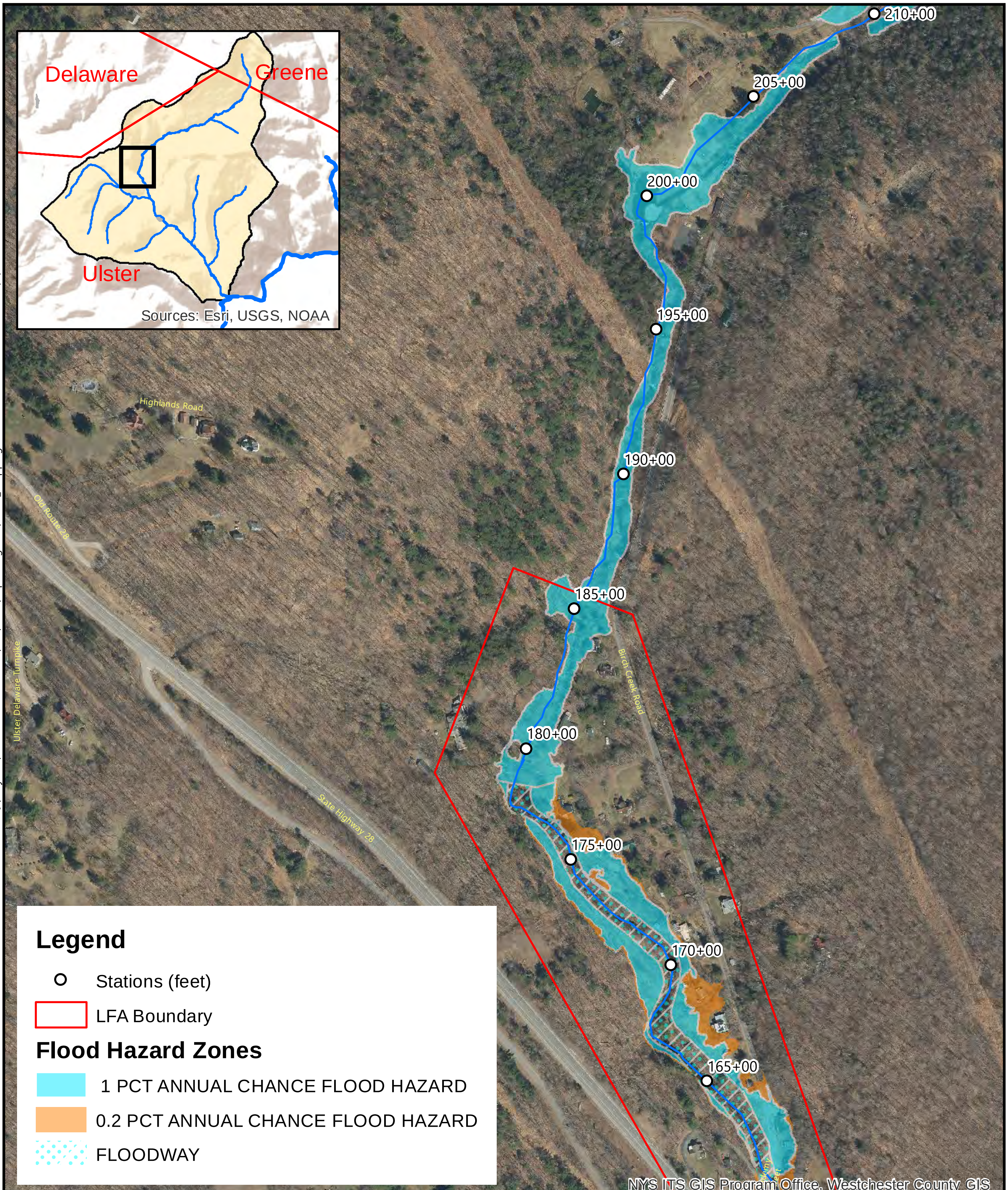
0 500
Feet

SCALE 1 " = 600 '

DATE 11/3/2022

142.4615.00030
PROJ. NO.

FIG. 3-8



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BIRCH CREEK FEMA MAPPING 3

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 500
Feet

SCALE 1 " = 600 '

DATE 11/3/2022

142.4615.00030
PROJ. NO.

FIG. 3-9

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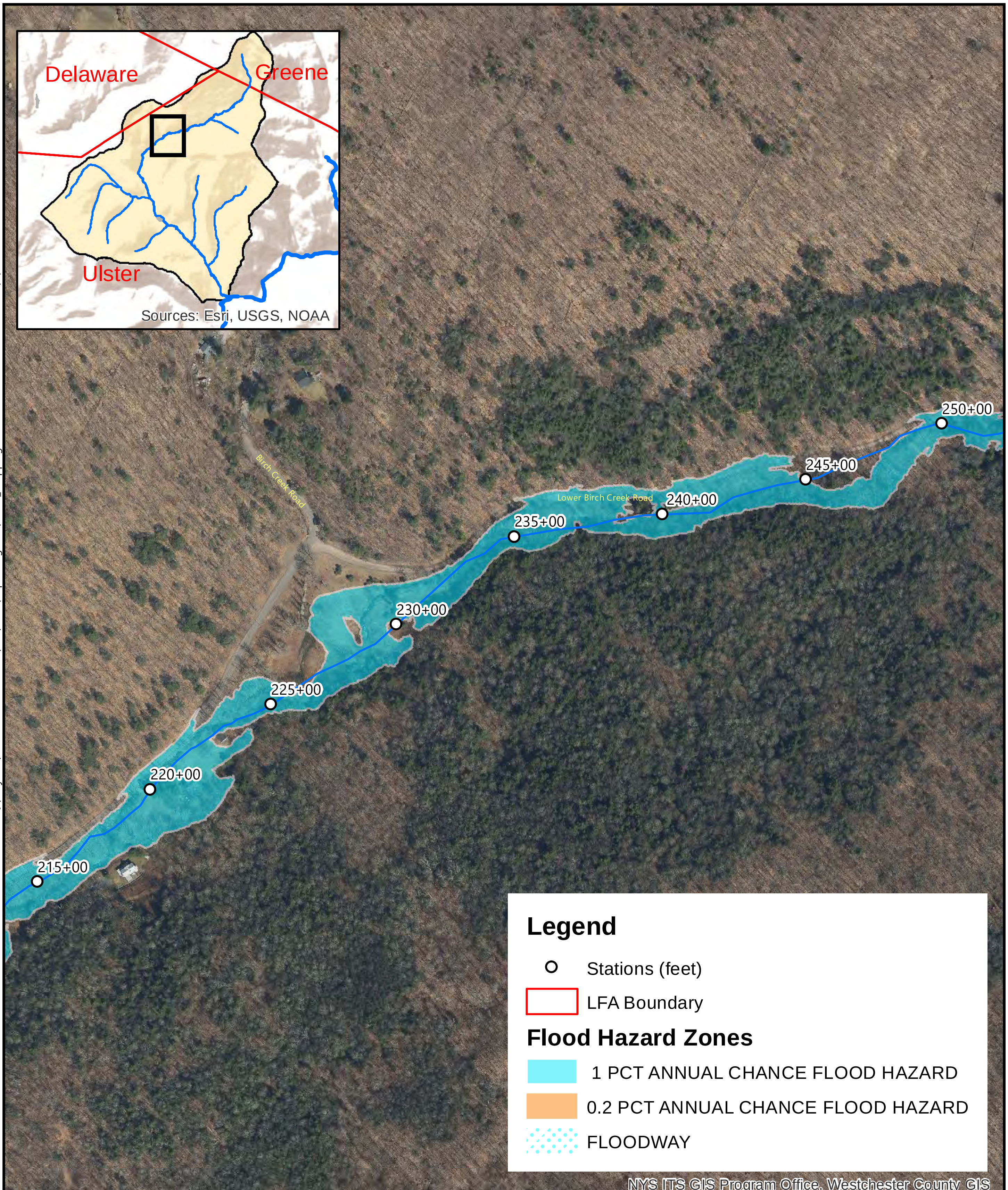

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BIRCH CREEK FEMA MAPPING 4

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 500
Feet

SCALE 1 " = 600 '

DATE 11/3/2022

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FIG. 3-10

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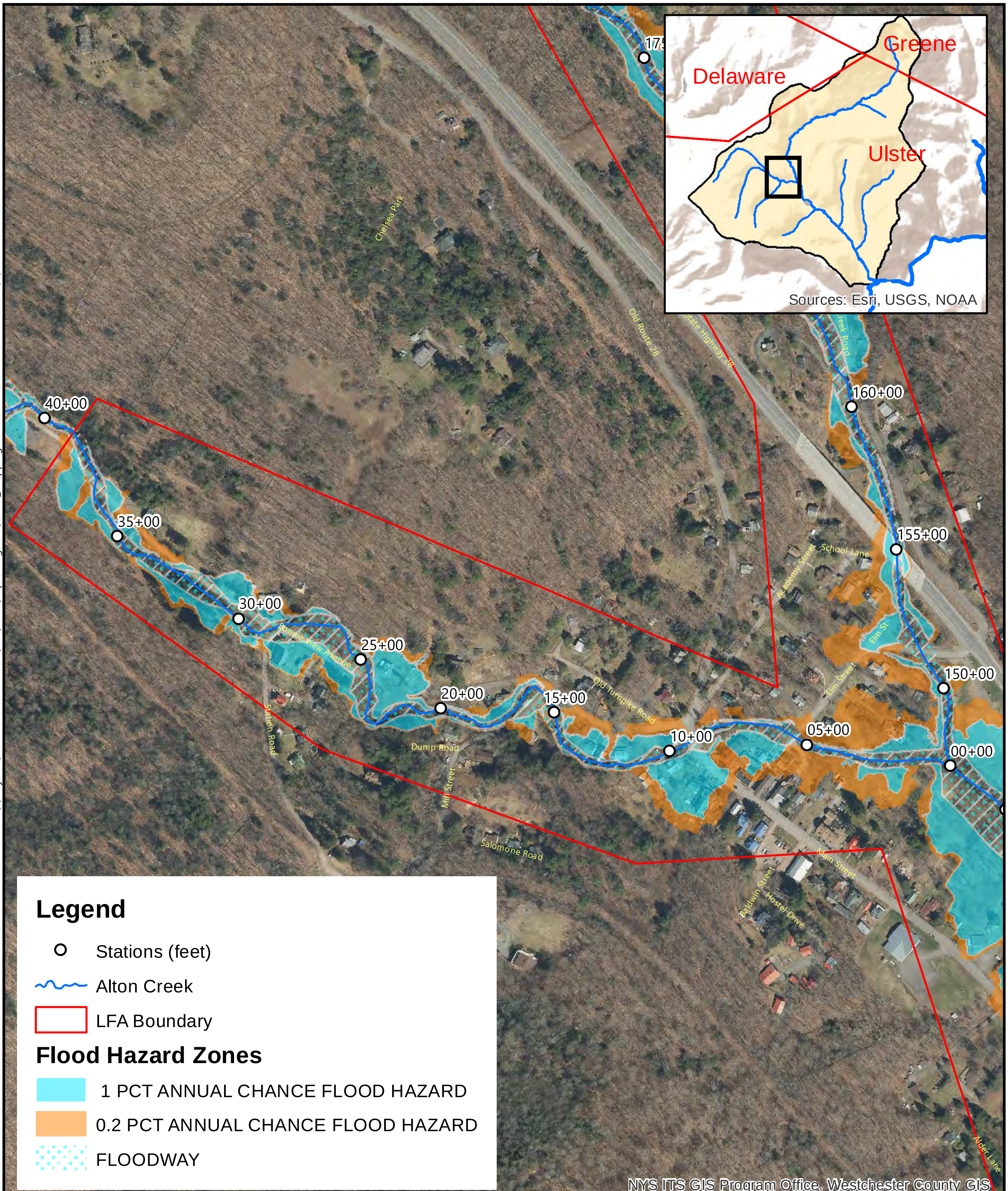

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ALTON CREEK FEMA MAPPING 1

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

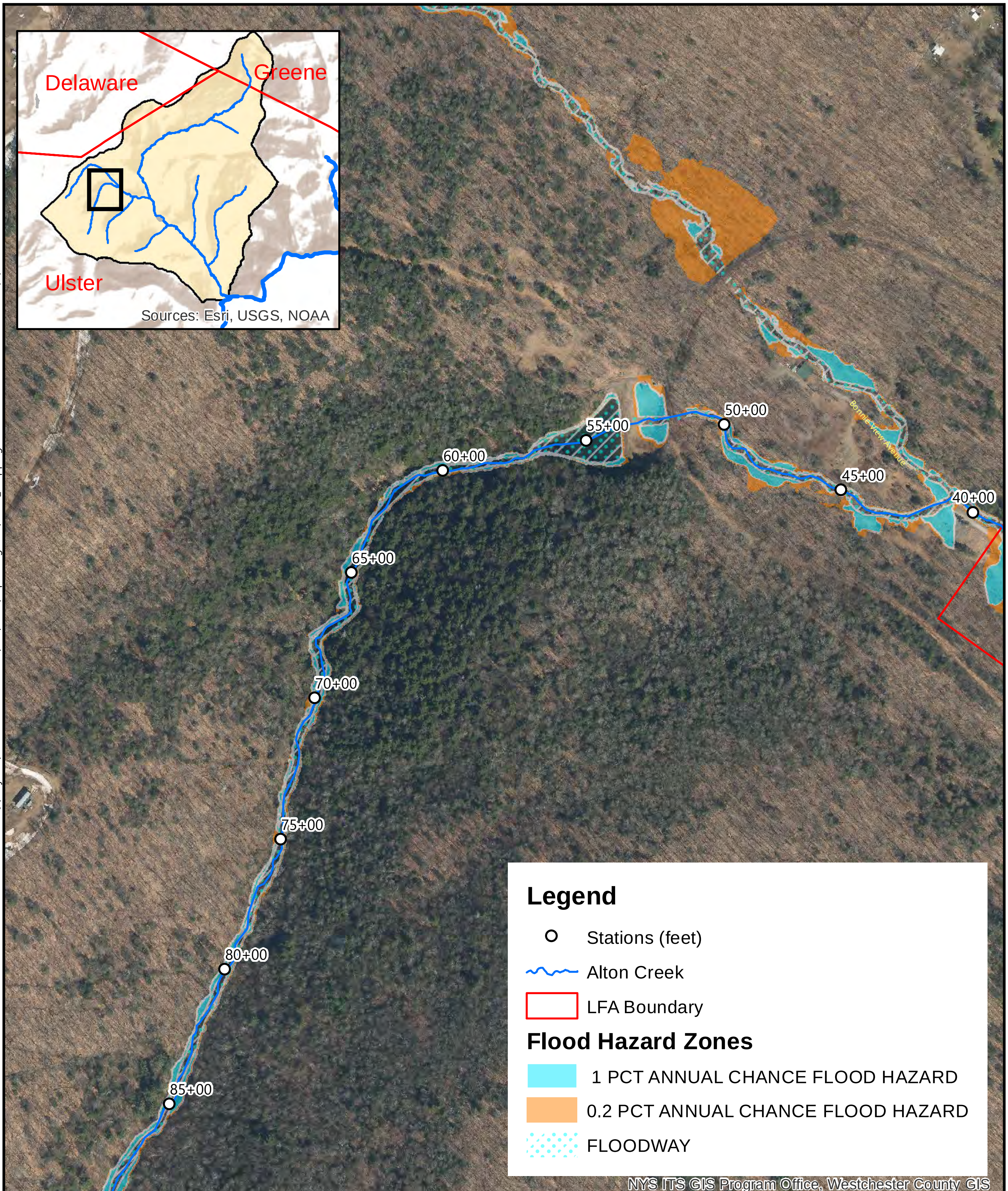
0 500 Feet

SCALE 1 " = 600 '

DATE 11/3/2022

142.4615.00030
PROJ. NO.

FIG. 3-11



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ALTON CREEK FEMA MAPPING 2

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 500
Feet

SCALE 1 " = 600 '

DATE 11/3/2022

142.4615.00030
PROJ. NO.

FIG. 3-12

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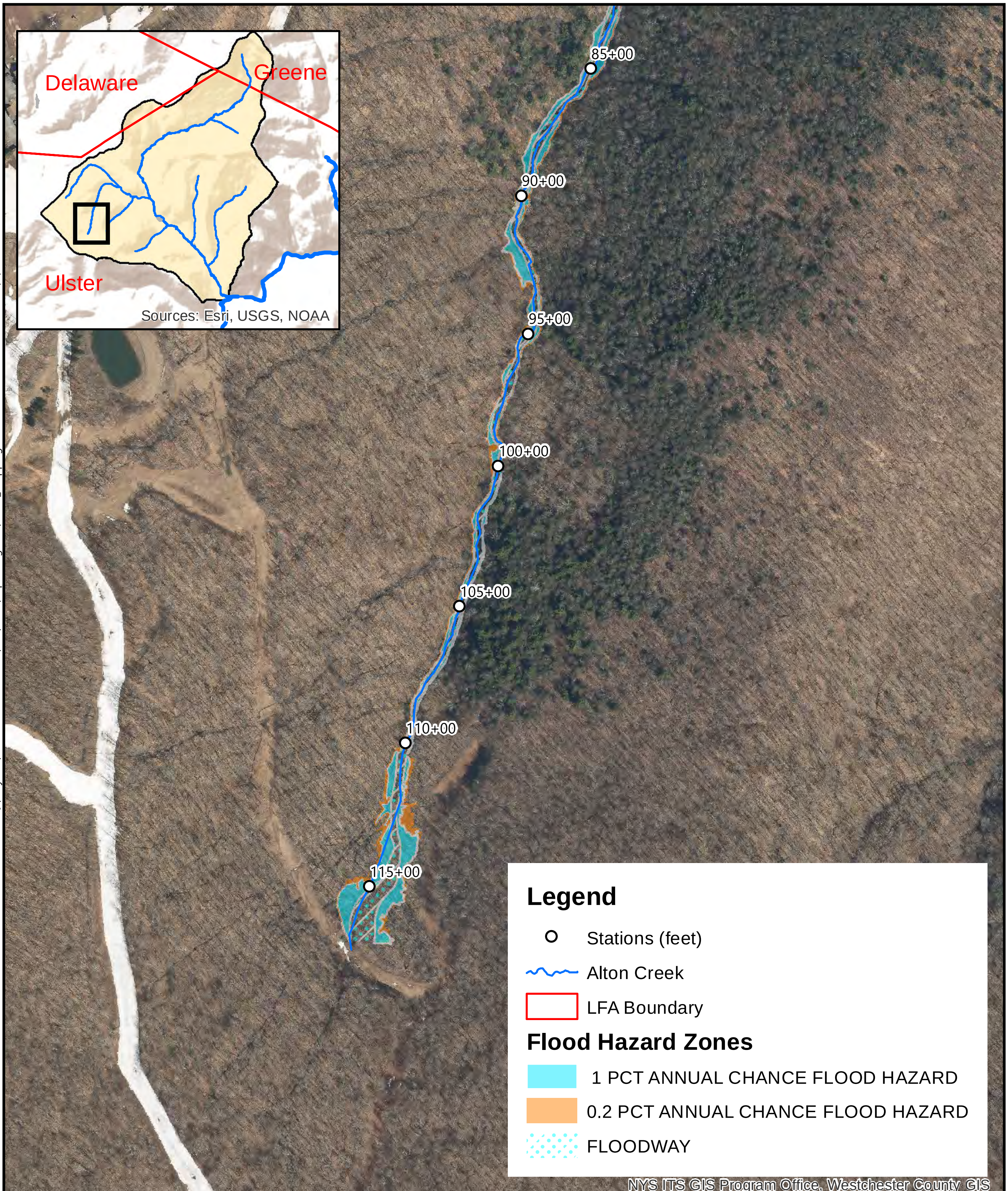

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NEW PALTZ, NY 12561
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ALTON CREEK FEMA MAPPING 3

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 500
Feet

SCALE 1 " = 600 '
DATE 11/3/2022
142.4615.00030
PROJ. NO.

FIG. 3-13

4. FLOOD ANALYSIS AND RECOMMENDATIONS

Multiple flood mitigation approaches to reduce water surface elevations were evaluated in the project areas, including bridge and culvert replacements and floodplain bench alternatives. 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

Fifteen crossings in the LFA area were assessed in this study. Each was assessed for its capacity to pass flood flows without overtopping the road and the impact of backwater flooding caused by insufficient capacity. These assessments, in addition to input from SAFARI committee members, lead to a prioritization for replacement of the crossings. Three crossings of Bonnie View Avenue, the county bridge, the intersection with Station Road, and between Mill and Station Roads, were all noted by SAFARI as high priority for replacement due to their contribution to flooding along Bonnie View Avenue and the bordering properties as well as structural concerns. Six crossings are categorized as medium priority. They have a higher risk of flooding properties and critical roadways. Four crossings, with lower impact on flooding are categorized as low priority. Two crossings are not recommended for replacement due to flood concerns at this time. A summary of the prioritizations is given in Table 4-1, listed by watercourse. Figure 4-1 is an overview map of the priority crossings. The high- and medium-priority crossings are further analyzed to include proposed changes. In addition to replacing the bridge or culvert, some crossings also require channel adjustments and floodplain enhancements to reduce the impact of flooding. These components are combined to make six project areas, which extend from the crossing to include the upstream and/or downstream reaches. Figure 4-2 is an overview map of the project areas and proposed changes.

Table 4-1 Prioritization of Crossing Replacement

Watercourse	Roadway	River Station (feet)	Replacement Priority	PROJECT AREA
Birch Creek	Birch Creek Road	209+20	Low	N/A
	Academy Street	161+20	Medium	5
	Elm Street	151+40	Low	N/A
	Main Street	134+60	Medium	6
	Former Lake Street	127+60	Low	N/A
	Belleayre Day Use Area Access	110+30	None	N/A
Alton Creek	Bonnie View Avenue (to Water Treatment Plant)	41+30	Medium	N/A
	Bonnie View Avenue (County Bridge)	37+10	High	N/A
	Private Driveway	32+20	Medium	1
	Bonnie View Avenue (at Station Road)	28+50	High	1
	Bonnie View Avenue (Between Station Road and Mill Street)	24+30	High	2
	Mill Street	15+75	Medium	3
	Main Street	9+10	Medium	4
	Elm Street	5+50	Low	N/A
Woodchuck Hollow	Station Road	8+80	None	N/A

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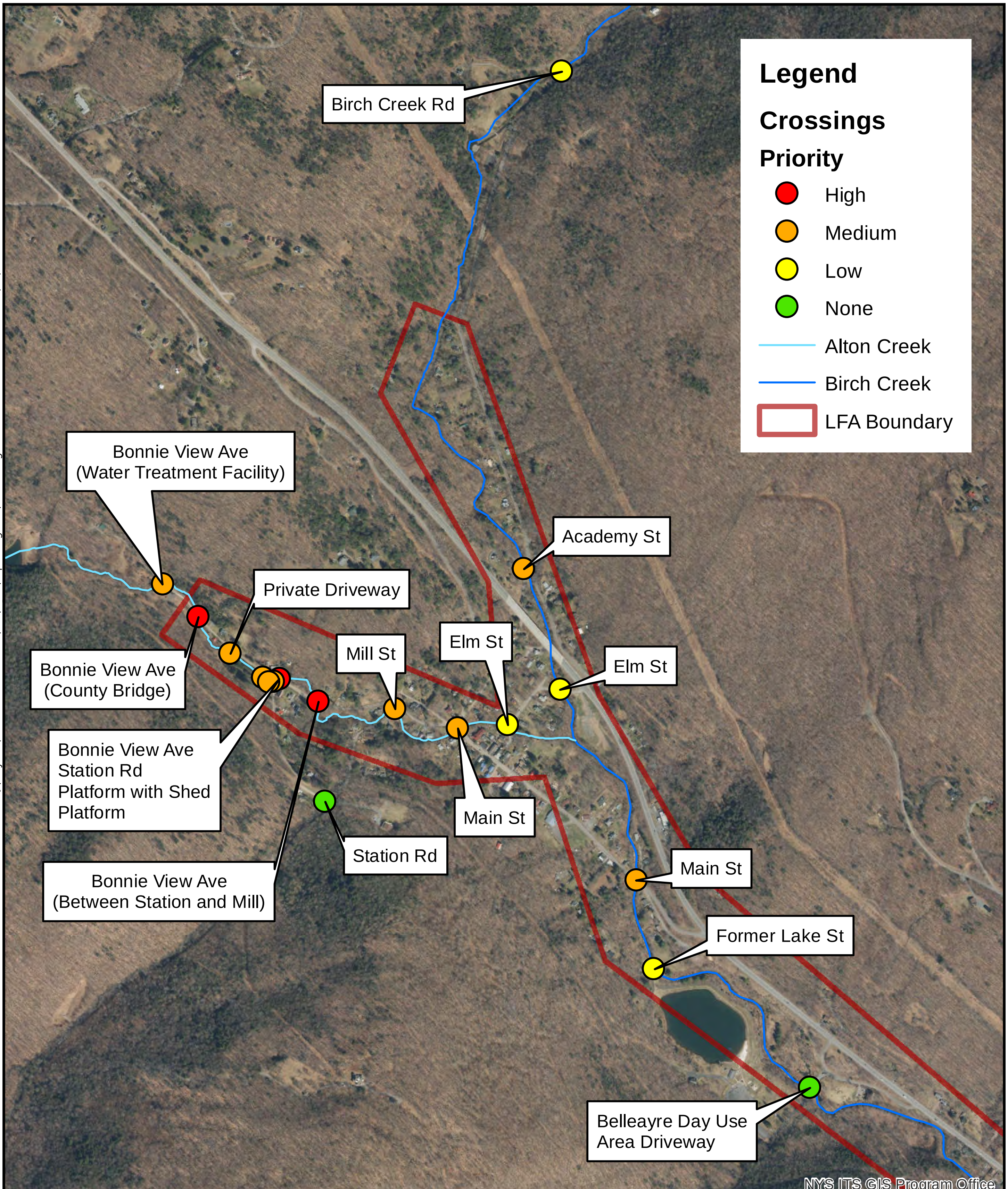

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SUMMARY OF CROSSINGS

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

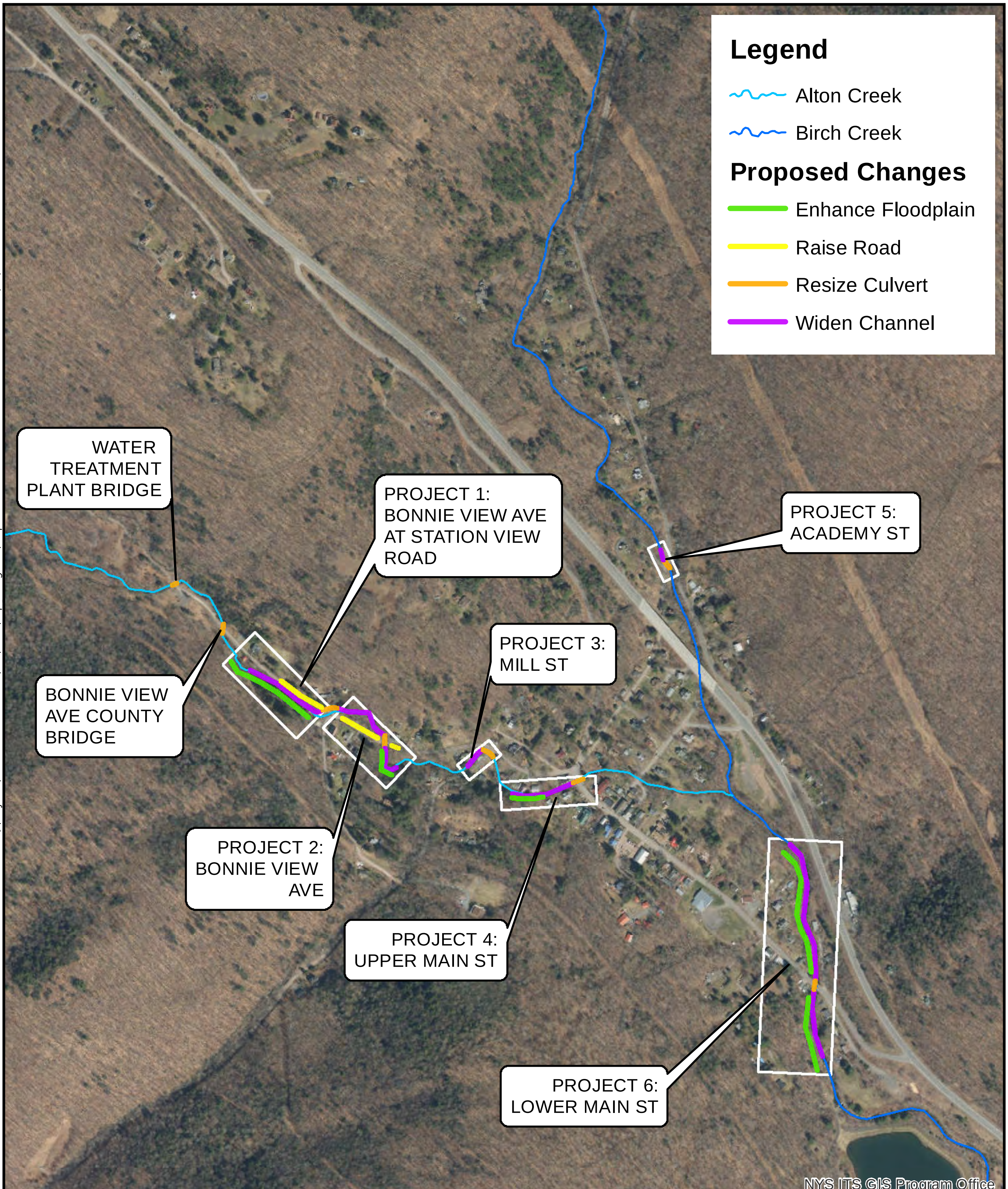
N
0 500
Feet

SCALE 1 " = 1,016 '

DATE 11/22/2022

142.14615.00030
PROJ. NO.

FIG. 4-1



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PROJECT AREAS & PROPOSED CHANGES

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 500
Feet

SCALE 1 " = 750 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.

FIG. 4-2

4.2 ANALYSIS AND MITIGATION

The high- and medium-priority crossings are further analyzed for both current and future peak flows. In most cases, the crossing is only part of the cause of flooding, and the replacement project should include work on the channels and floodplains for a more robust solution.

In the Pine Hill LFA area, some of the projected flood levels are exacerbated by undersized channel size and insufficient floodplains. Alton Creek is entrenched for most of its path through the hamlet. Vertical stone walls restrict the water to a channel that is narrower than the active channel width. Sections of Birch Creek are also entrenched and disconnected from the floodplain. Widening the channel and creating or lowering floodplains will reduce the water surface level, flow velocity, and shear stress along the banks.

Channel adjustments, floodplain creation or lowering, and crossing replacement are the key tools used in the mitigation recommendations below. The nine high- and medium-priority crossings are discussed below with recommendations of crossing spans, channel widths, and floodplain changes. The additional six crossings, with low or no priority for replacement, are also described.

4.2.1 BONNIE VIEW AVENUE COUNTY BRIDGE

Bonnie View Avenue crosses Alton Creek four times. The crossing at river station 37+10, upstream of the intersection with Station Road, is a county-owned bridge (BIN 3346760) called Crystal Spring bridge. Alton Creek makes a sharp turn at the inlet to cross under the road, then a more gradual turn at the outlet. The bridge is due for replacement due to rusting steel superstructure; however, the equipment needed for repair cannot access it due to the weight limit on another crossing along Bonnie View Avenue (see Project Area 2). Only the superstructure is planned for replacement at this time, so the existing bridge dimensions are appropriate to model the renovated structure as well. The existing bridge passes a 10-year flow without overtopping. There are no residences upstream of this crossing. The crossing is part of the only route to the critical water treatment facility, which must remain accessible. Due to the flood risk, in addition to the structural deficiencies, this bridge is a high priority for replacement.

The hydraulic constriction is not addressed in the current renovation plans. A full hydrologic and hydraulic study is needed to properly size a replacement structure. Based on the HEC-RAS model used in this study, a span of 40 feet is needed to pass the 100-year flood event and 50-year future flood event.

Figure 4-4 is a concept map of proposed changes to the Bonnie View Avenue county bridge and crossing to the water treatment facility (Section 4.2.4). Figure 4-5 is a map of the 50-year flows under existing conditions. Figure 4-6 is a map of the 50-year flows under proposed conditions. Figure 4-7 is a map of the 100-year flows under existing conditions. Figure 4-8 is a map of the 100-year flows under proposed conditions.

Figure 4-3: Outlet of county bridge over Alton Creek

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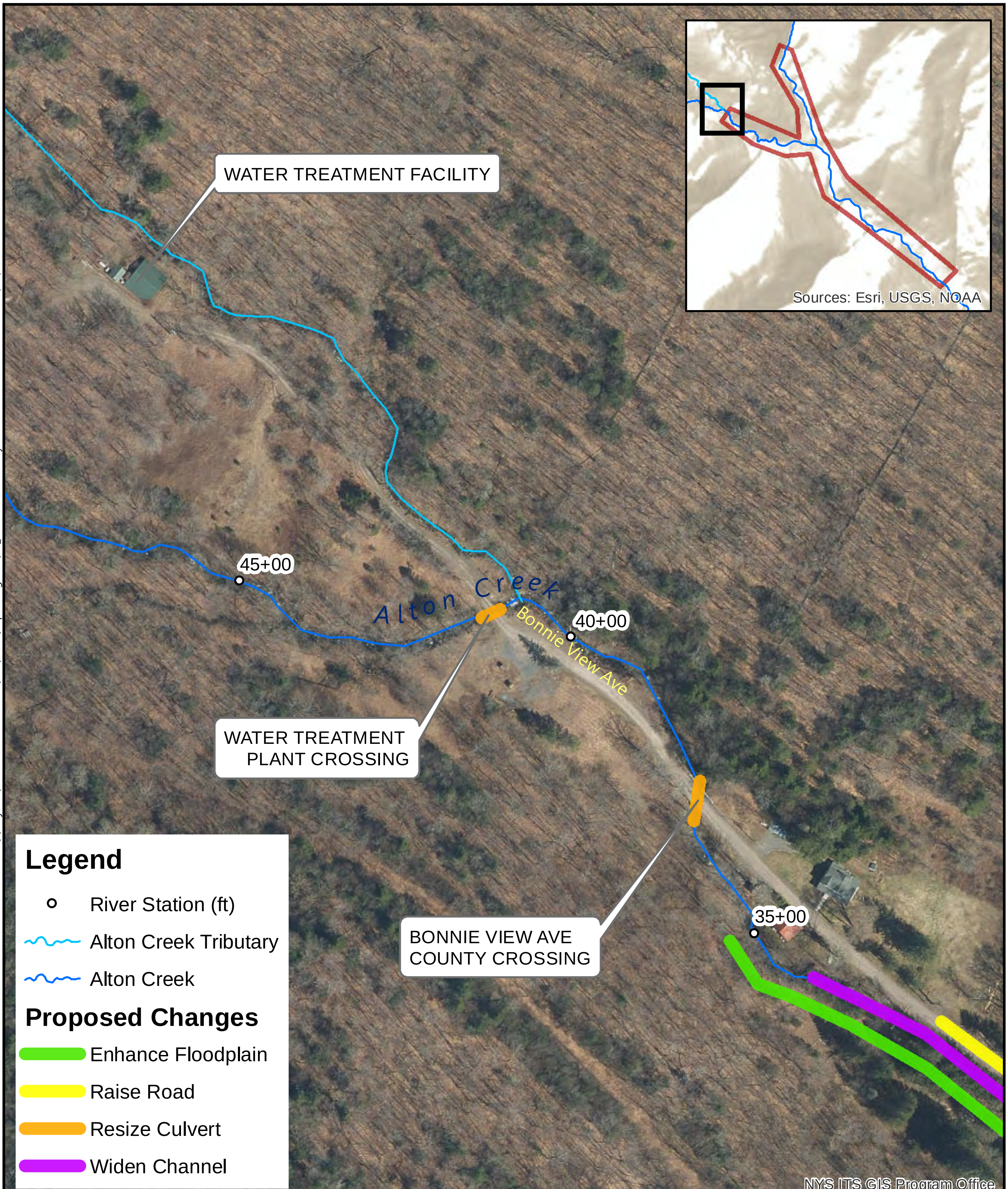

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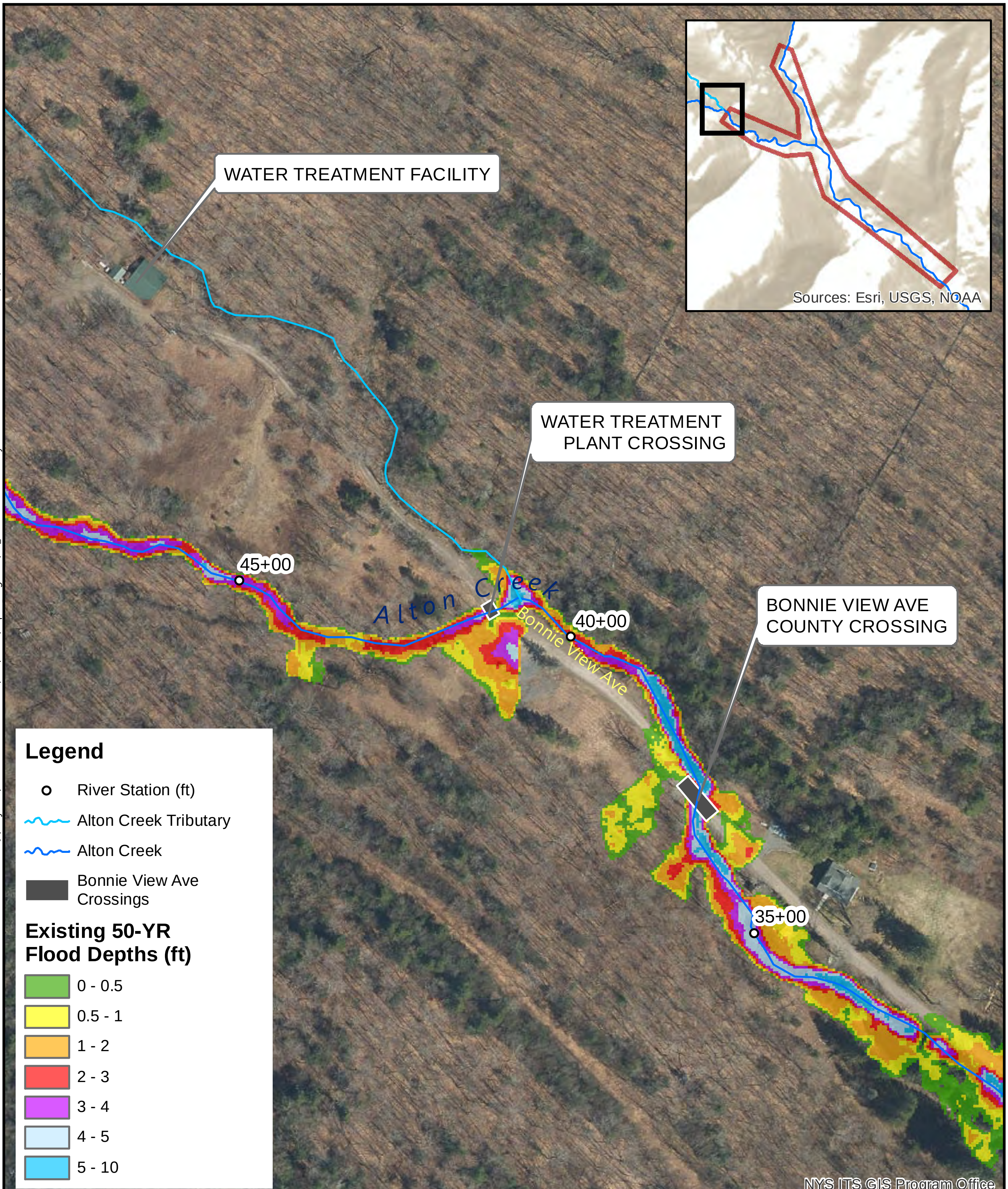
BONNIE VIEW AVE COUNTY CROSSINGS: PROPOSED CHANGES CONCEPT
PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 180 Feet

SCALE 1 " = 177 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.
FIG. 4-4



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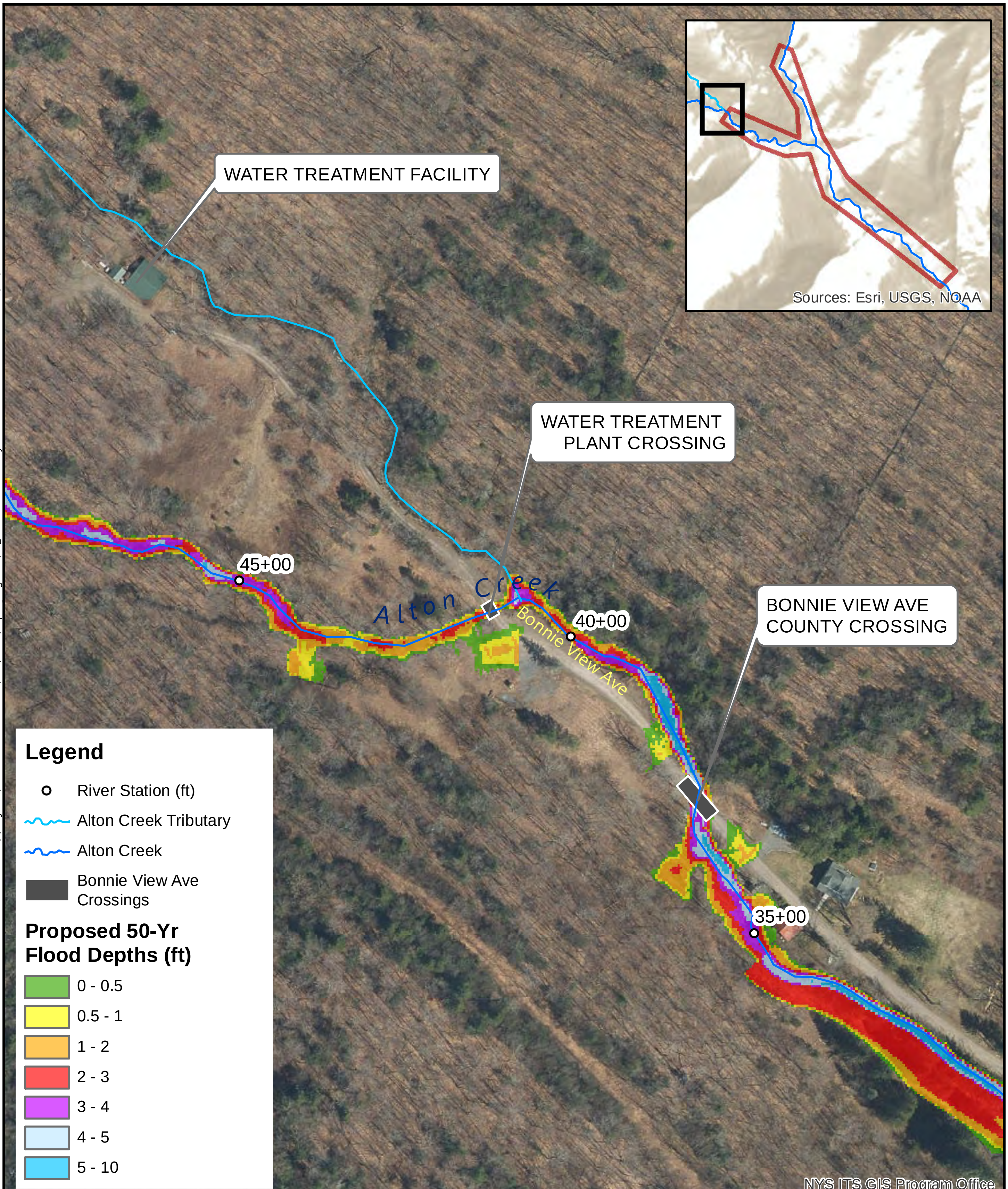
BONNIE VIEW AVE COUNTY CROSSINGS: EXISTING CONDITIONS 50-YEAR
PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 180
Feet

SCALE 1 " = 177 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.
FIG. 4-5



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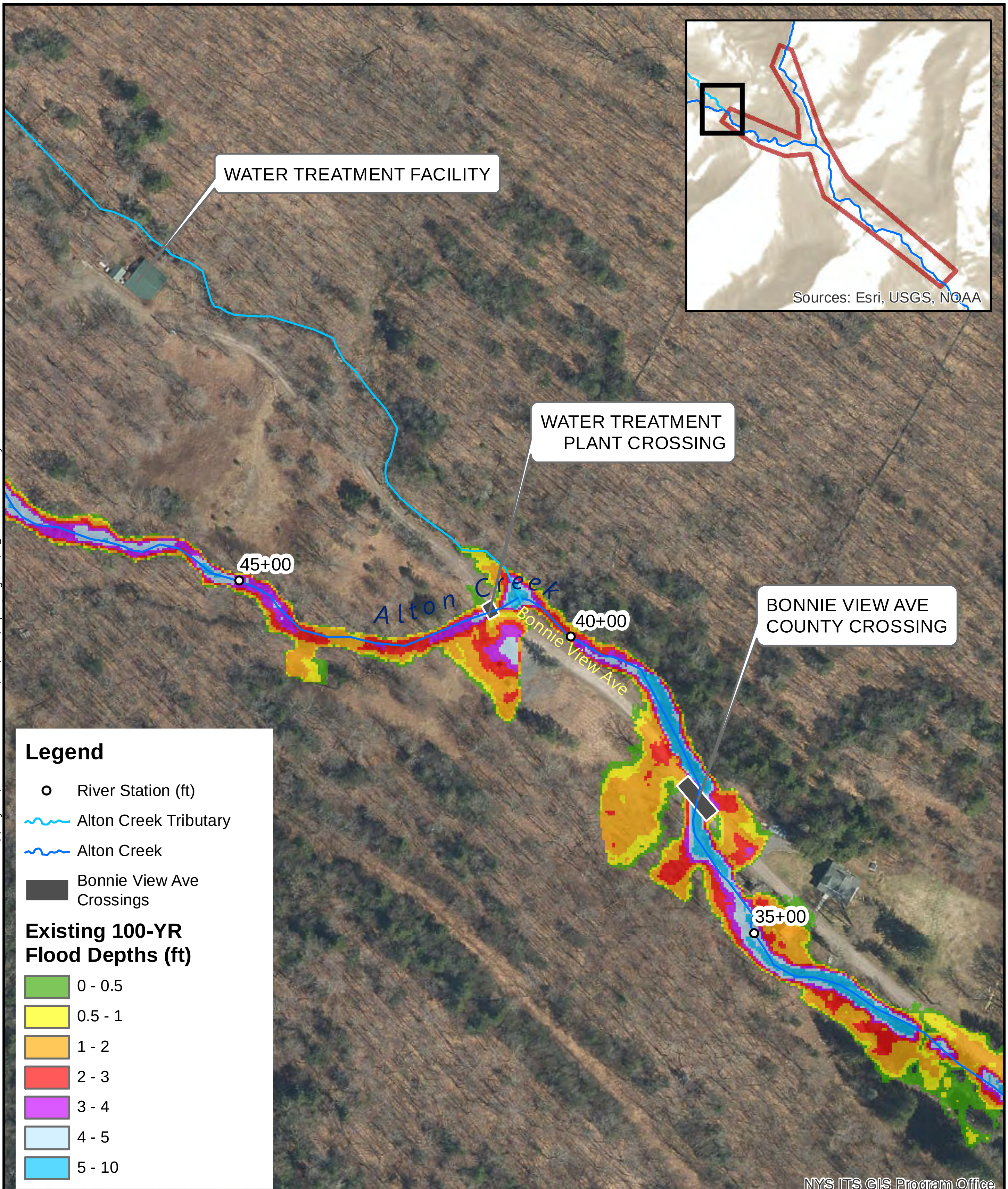
BONNIE VIEW AVE COUNTY CROSSINGS: PROPOSED CONDITIONS 50-YEAR
PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 180
Feet

SCALE 1 " = 177 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.

FIG. 4-6



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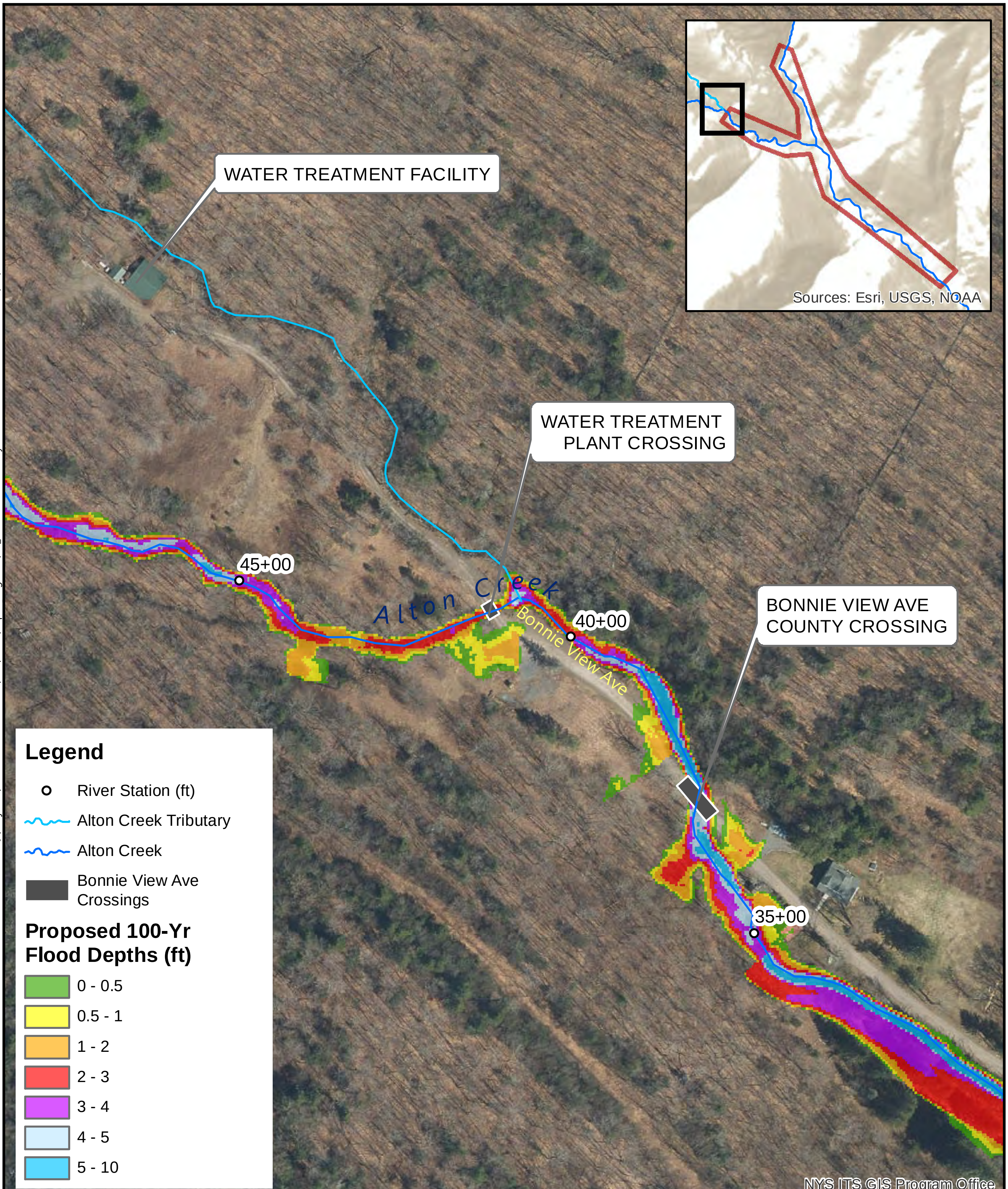
BONNIE VIEW AVE COUNTY CROSSINGS: EXISTING CONDITIONS 100-YEAR
PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 180
Feet

SCALE 1 " = 177 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.

FIG. 4-7



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BONNIE VIEW AVE COUNTY CROSSINGS: PROPOSED CONDITIONS 100-YEAR

PINE HILL LOCAL FLOOD ANALYSIS

HAMLET OF PINE HILL

ULSTER COUNTY

NEW YORK

N

0 180 Feet

SCALE 1 " = 177 '

DATE 11/17/2022

142.14615.00030
PROJ. NO.

FIG. 4-8

4.2.2 PROJECT AREA 1: BONNIE VIEW AVENUE AT STATION ROAD

Bonnie View Avenue crosses Alton Creek again at the intersection with Station Road. There are four structures crossing the creek at this location – both roads, Bonnie View Avenue and Station Road, a stone crossing that supports a pipe, and a platform with a shed on it. Approximately 200 feet further upstream is another crossing, an abandoned private driveway. The channel is entrenched in this stretch, with little to no access to floodplains. The HEC-RAS model shows flooding of the roadway.

4.2.2.1 Private Driveway Crossing

At river station 32+20, an abandoned private driveway crosses Alton Creek. The wood and metal structure sits on top of concrete abutments. The abutments are undercut, and the surface is no longer connected to either bank. The crossing overtops during flows less than the 10-year flood event, and it creates backwater flooding. This structure is a medium priority due to the risk of flooding Bonnie View Avenue. It is recommended for removal.

Figure 4-9: Overgrown private driveway bridge over Alton Creek

4.2.2.2 Bonnie View Avenue at Station Road Crossings

There are four crossings over Alton Creek in close proximity to the intersection of Station Road and Bonnie View Avenue, from river station 28+30 to 30+00. The furthest upstream structure is a shed on top of a concrete slab. The slab has a wall approximately 2 feet tall on the upstream side. The next crossing is a 3-foot-wide stone and metal crossing, which supports a disconnected pipe running across it. The creek then curves to the left, with concrete blocks armoring the right bank in the curve. The third crossing is Station

Road. This bridge is closed to vehicular traffic due to structural deficiencies. The fourth crossing is Bonnie View Avenue, which is open to traffic but also needs structural repairs.

All four crossings are constrictions and overtop in the modeled 10-year flood event. The channel is also undersized in this reach, which pushes floodwaters onto Bonnie View Avenue. The water treatment facility at the end of Bonnie View Avenue is a critical facility and must be accessible. There are no detours available to reach the facility or the houses past the crossing, potentially stranding residents. Due to the high impact of floodwaters caused by the undersized crossings and the structural deficiencies of the road crossings, this location is a high priority for replacement.

The recommended action in this stretch has three components – removal of unnecessary structures, channel and floodplain work, and a new crossing. First, it is recommended to remove the crossing with the shed, the stone crossing, and Station Road crossing. As previously stated, the channel is undersized in this section, with little connection to a floodplain. The channel and floodplain recommendations are given in Section 4.2.2.2. Third, the new crossing for Bonnie View Avenue is recommended to have a span of approximately 65 feet. A full hydraulic and hydrologic analysis is recommended to appropriately size this bridge. The increased span of the Bonnie View Avenue bridge allows for greater capacity that can pass the current 500-year flood and 100-year future flood.

A new layout of the intersection of Station Road and Bonnie View Avenue at the crossing over Alton Creek was discussed with town officials. Figure 4-14 shows the removal of the three crossings and the proposed location of the intersection of Station Road and Bonnie View Avenue. This layout has one connection rather than a fork, which matches the current traffic flow due to the closure of the Station Road crossing. It is navigable by large vehicles such as snowplows and emergency vehicles.

In addition to removal and replacement of the crossings, changes to the channel and floodplain are needed to reduce the flood risk in this project area. The active channel width along this section of Alton Creek is estimated to be 19 feet. The channel is entrenched and varies in width between 12 and 20 feet. The high banks in some sections reduce access to floodplains, which increases the depth and velocity during flood events.

To reduce flood levels and flood velocities, it is recommended to increase the channel width to match the active channel width. Removing the constrictions reduces the floodwater levels and velocities. The right bank in this section is undeveloped and recommended for acquisition to create a floodplain. Lowering the ground elevation gives the creek space during flood events and helps keep the water away from Bonnie View Avenue and the homes along the left bank.

Depending on the extent of channel widening, it may be necessary and beneficial to raise the road as well. Local residents noted that the stormwater drain downstream of the crossing is filled with sediment. Maintenance of the existing system will also help reduce floodwater along the roadway, allowing for safe passage during high water events.

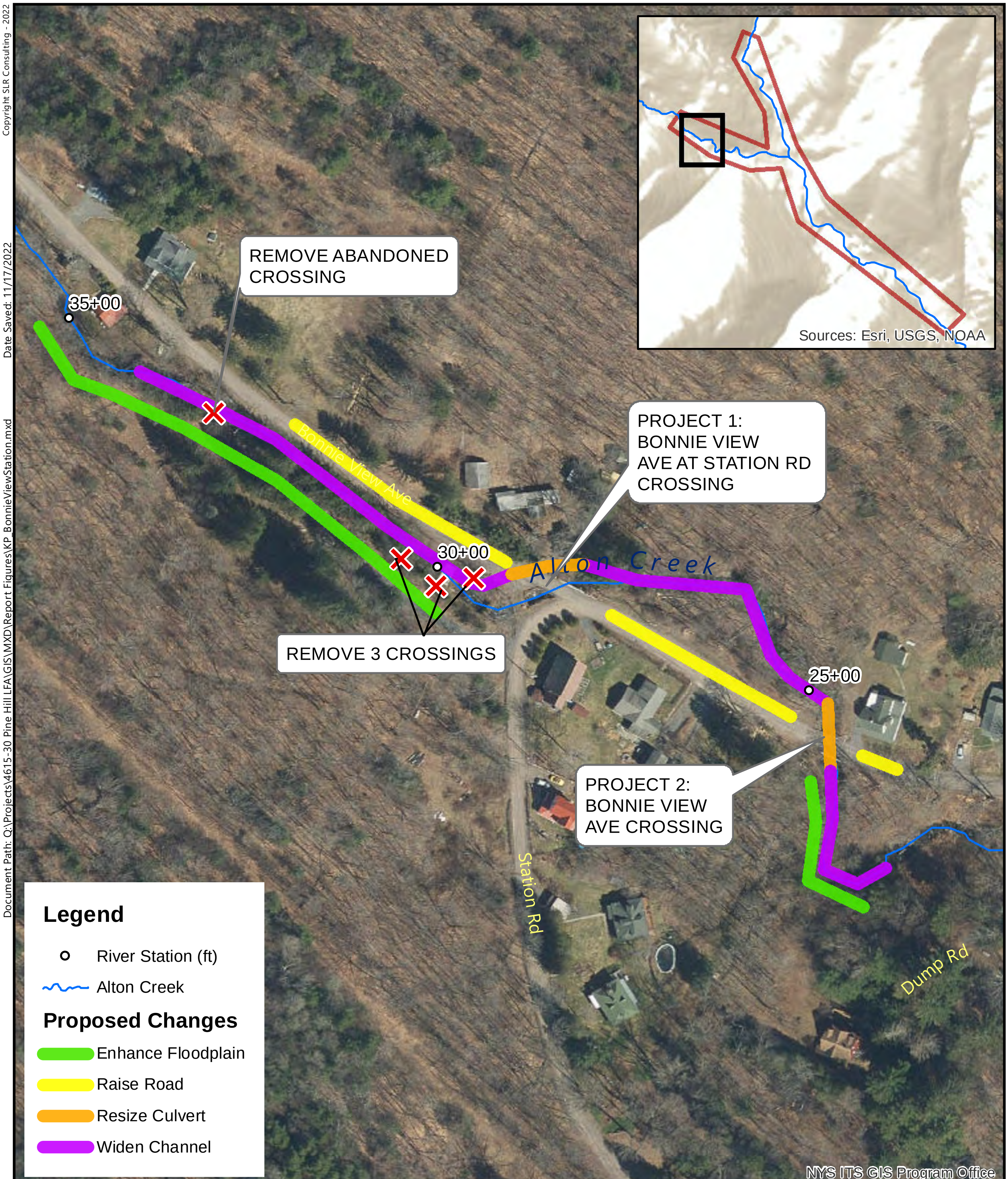
Figure 4-14 is a concept map of proposed changes to Project Area 1, the Bonnie View Avenue crossing at Station Road. Figure 4-15 is a map of the 50-year flows under existing conditions. Figure 4-16 is a map of the 50-year flows under proposed conditions. Figure 4-17 is a map of the 100-year flows under existing conditions. Figure 4-18 is a map of the 100-year proposed conditions.

Figure 4-10: Looking upstream at stone crossing with disconnected pipe


Figure 4-11: Shed over Alton Creek


Figure 4-12: Looking upstream at the most upstream Bonnie View Avenue at Station Road crossing over Alton Creek

Figure 4-13: Looking downstream at the inlet of the most downstream Bonnie View Avenue at Station Road crossing over Alton Creek



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PROJECT 1 & PROJECT 2: PROPOSED CHANGES CONCEPT

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

SCALE 1 " = 145 '

DATE 11/17/2022

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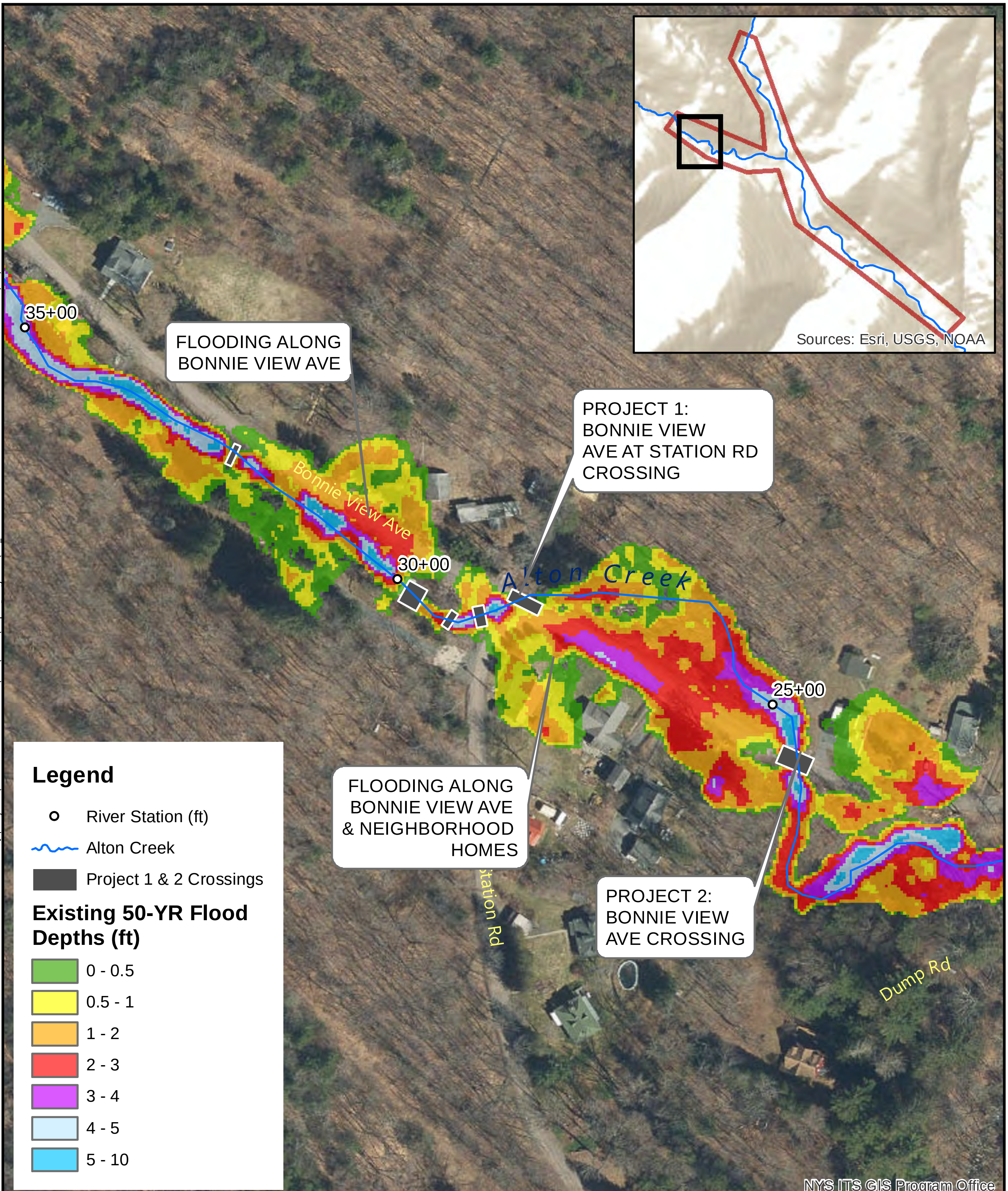
PROJ. NO.

FIG. 4-14



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PROJECT 1 & PROJECT 2: EXISTING CONDITIONS 50-YR

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

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Feet

SCALE 1 " = 145 '

DATE 11/17/2022

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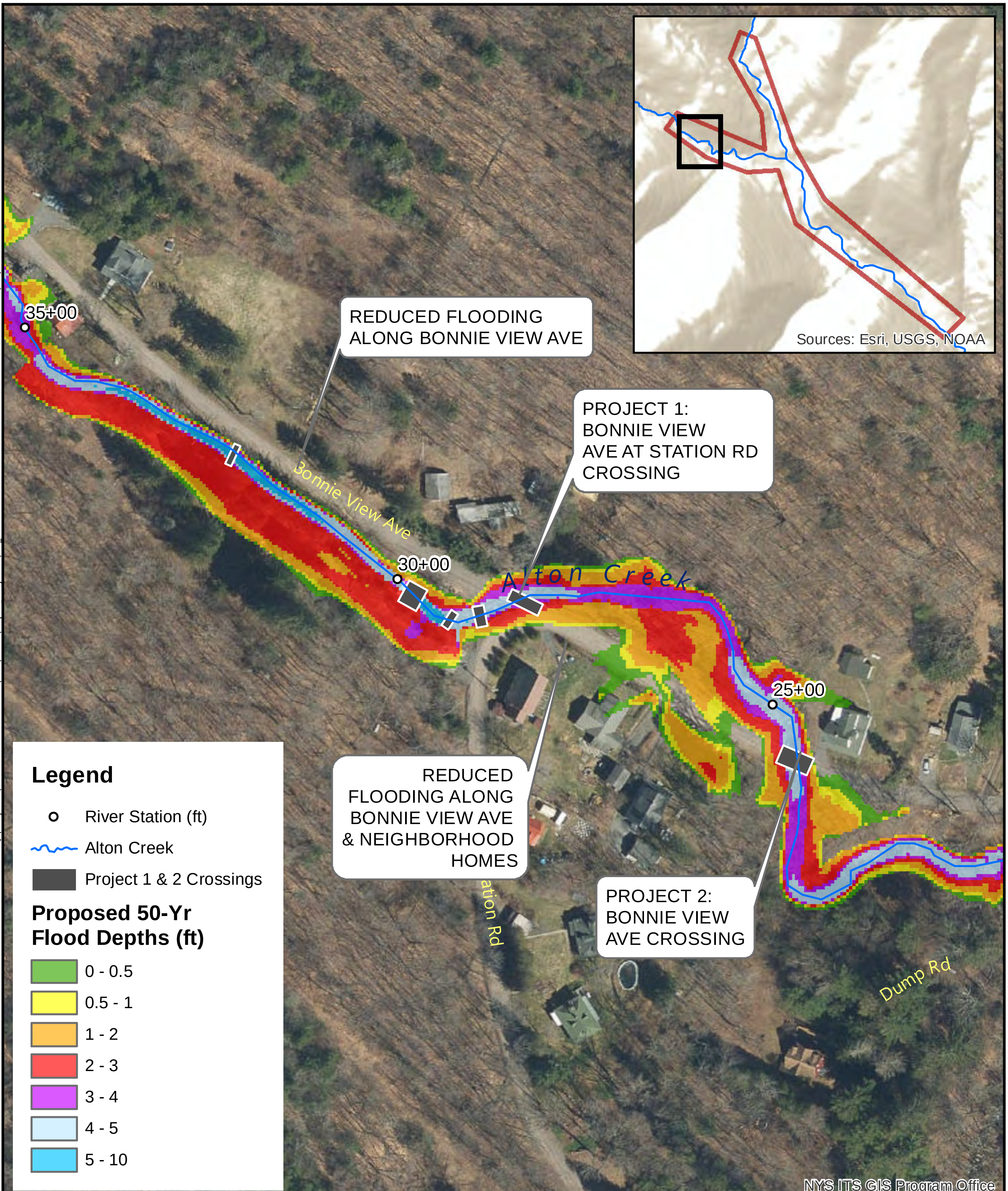
FIG. 4-15



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PROJECT 1 & PROJECT 2: PROPOSED CONDITIONS 50-YR
PINE HILL LOCAL FLOOD ANALYSIS
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FIG. 4-16

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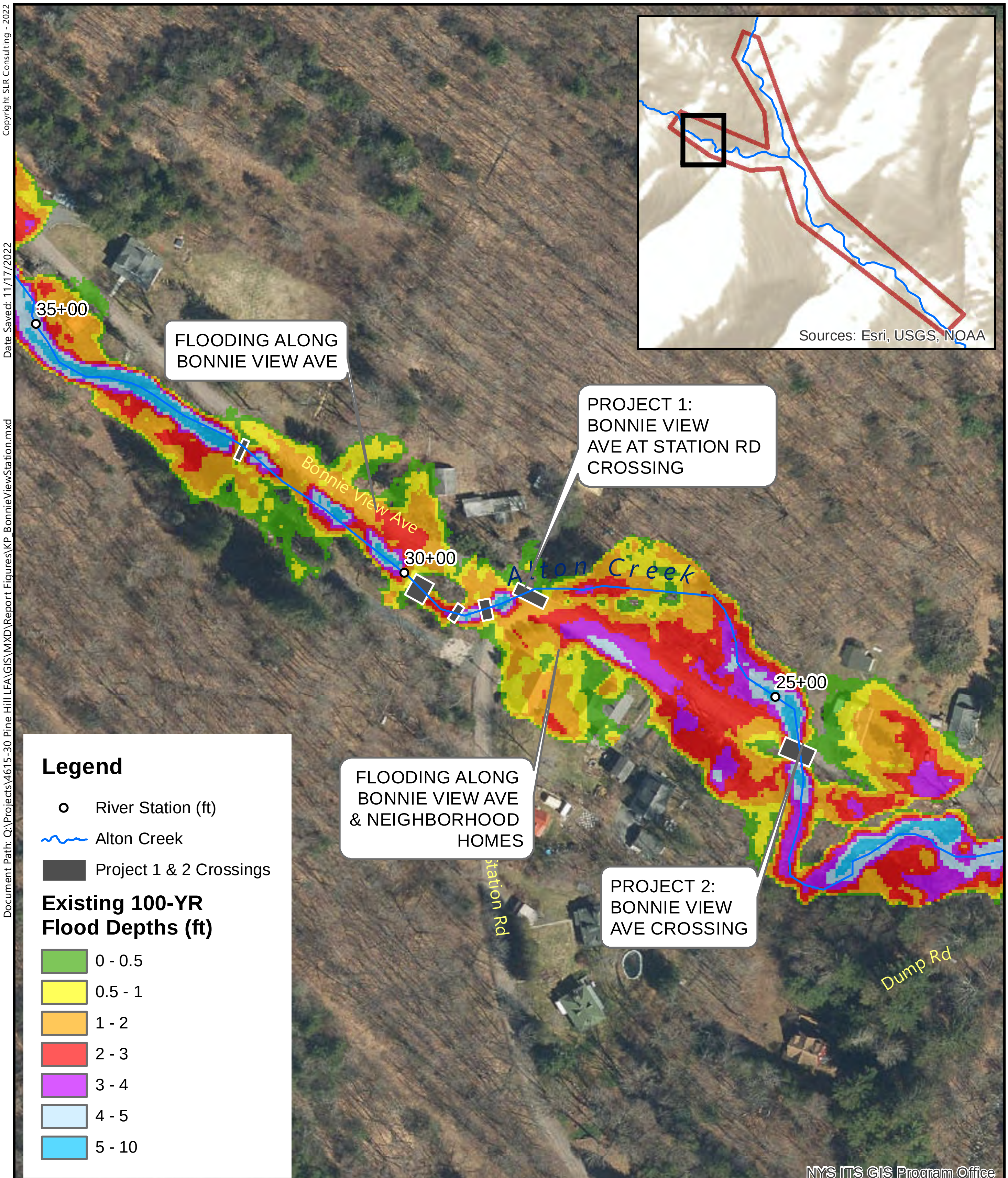

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PROJECT 1 & PROJECT 2: EXISTING CONDITIONS 100-YR

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
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Feet

SCALE 1 " = 145 '
DATE 11/17/2022
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FIG. 4-17

Date Saved: 11/17/2022
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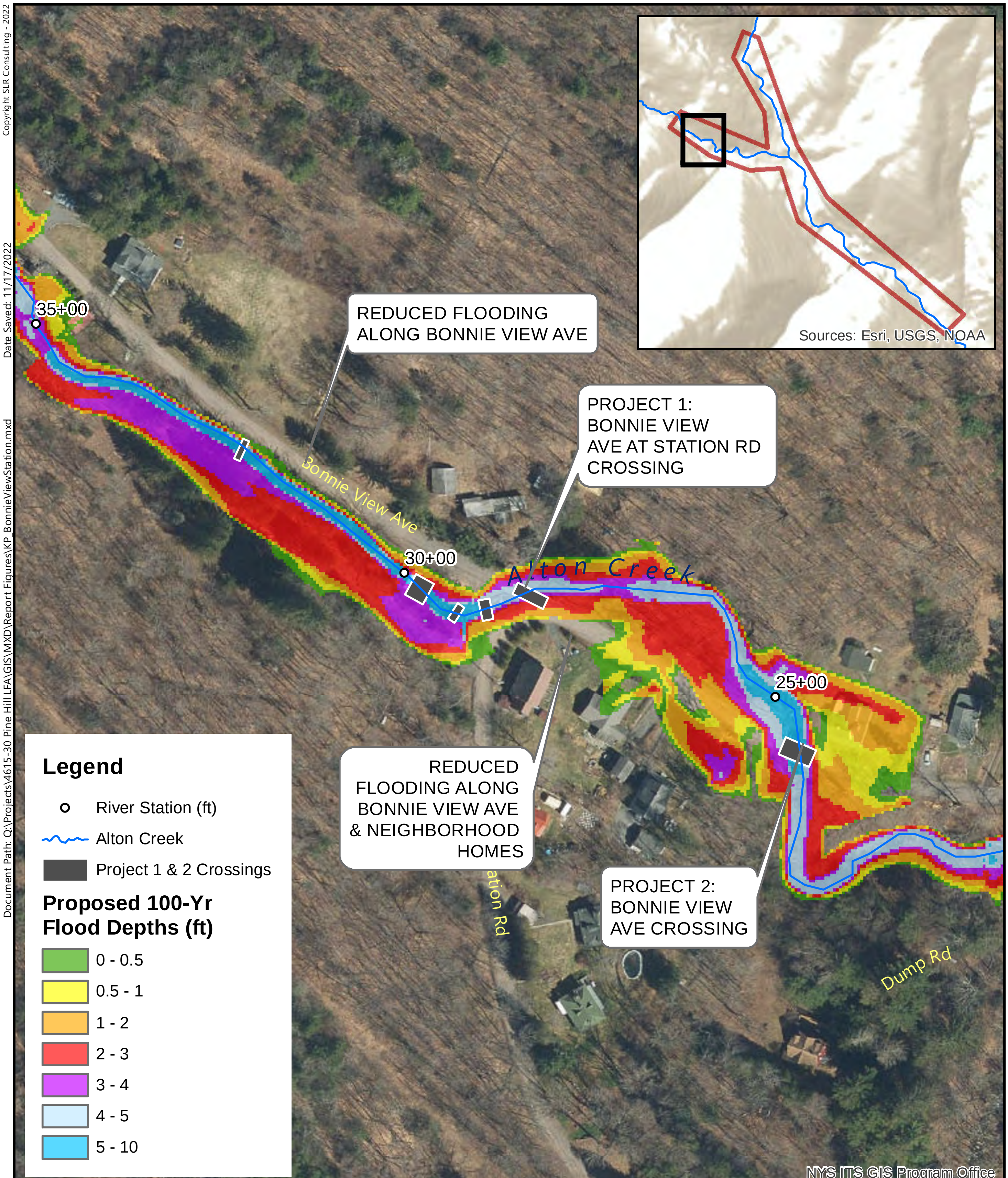

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PROJECT 1 & PROJECT 2: PROPOSED CONDITIONS 100-YR
PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

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Feet

SCALE 1 " = 145 '
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PROJ. NO.

FIG. 4-18

4.2.3 PROJECT AREA 2: BONNIE VIEW AVENUE BETWEEN STATION ROAD AND MILL STREET

Bonnie View Avenue crosses over Alton Creek again further downstream, at river station 24+30. This crossing is structurally in poor condition and in need of replacement. The town wants to ensure that the replacement structure is properly sized to reduce flooding. Metal plates have been placed on the deck due to poor condition. This bridge is due for replacement for structural concerns. It is also limiting the access of construction vehicles to the county bridge, which is also due for repairs.

The current bridge passes the 10-year flood event without overtopping, but with backwater flooding, according to the HEC-RAS model. Overtopping of the bridge and flooding of Bonnie View Avenue may prevent passage and reduce access to some houses and the water treatment facility, a critical facility that must be accessible. There is a detour available via Mill Street and Station Road. However, the route is not passable by large vehicles such as fire trucks due to the rail bridge on Mill Street. Additionally, the route requires passage of two other floodprone locations - the Mill Street crossing (Project Area 3) and the intersection of Station Road and Bonnie View Avenue (Project Area 1). Based on the flood risk and poor structural condition, the bridge is a high priority for replacement. A full hydraulic and hydrological analysis is recommended to properly size the replacement bridge. Based on the HEC-RAS model, a 50-foot-span bridge, with the channel adjustments discussed below, can pass the current and future 50-year flows without overtopping.

Figure 4-19: Looking downstream at the Bonnie View Avenue culvert inlet over Alton Creek

The undersized channel and limited access to floodplain are also contributing to the flood risk in Project Area 2. The existing channel width ranges from 18 to 24 feet downstream of the crossing. The active channel width is expected to be 19 feet. The high banks disconnect the channel from the floodplain. It is recommended to lower the floodplain for more effective use.

Downstream of the crossing, the channel cuts close to the roadway, eroding the bank and cutting close to Bonnie View Avenue. Boulders have been placed to reinforce the bank and protect the road. Increasing the channel width to the right will give the channel the space it needs without further erosion. Additionally, it is recommended to create a floodplain on the undeveloped right bank to further reduce flood levels.

Figure 4-14 shows the proposed changes for the Project Areas 1 and 2. Figures 4-15 through 4-18 show the existing and proposed conditions for both a 50-year and 100-year flood event.

4.2.4 BONNIE VIEW AVENUE – WATER TREATMENT FACILITY ACCESS

The northwestern end of Bonnie View Avenue is a water treatment facility. The critical facility is only accessible via Bonnie View Avenue and a culvert over Alton Creek at river station 41+30. There is no private property past this location. Just downstream of the crossing, a tributary joins Alton Creek. The crossing was noted to be prone to flooding.

The culvert is a 7-foot-span metal pipe with rivets. The active channel width at this location is 15 feet, more than twice the culvert span. The HEC-RAS model shows that the crossing overtops at flows less than the 10-year flood event. There is also backwater flooding of a wooded area. It is necessary to maintain access to the water treatment plant. However, this crossing does not contribute as much to roadway flooding as the high priority crossings along Bonnie View Avenue (the county bridge and Project Areas 1 and 2). Therefore, this culvert is a medium priority for replacement. A full hydrologic and hydraulic study is necessary to properly size the replacement structure. Based on the HEC-RAS model, a 35-foot bridge can pass a current and future 100-year flood event without overtopping the road. The new crossing should also include a natural stream bottom in accordance with the NYSDEC aquatic organism passage recommendations.

Figure 4-4 shows the proposed changes for the crossings. Figures 4-5 through 4-8 show the existing and proposed conditions for both a 50-year and 100-year flood event.

Figure 4-20: Inlet of culvert crossing Alton Creek

4.2.5 PROJECT AREA 3: MILL STREET

At river station 15+75, Mill Street crosses Alton Creek with a historic stone arch culvert. The channel is constricted in this reach with stone vertical walls and a garage on the right bank just upstream of the crossing. Additionally, the creek turns sharply to the right as it passes under the bridge.

The existing culvert's capacity is sufficient to pass a 10-year flood event without overtopping. However, backwater flooding does occur. A detour is possible via Bonnie View Avenue and Station Road. However this detour is not passable by large vehicles such as fire trucks and includes two other floodprone areas – Project Areas 1 and 2. The flood risk at this crossing makes it a medium priority for replacement. Channel widening is also recommended in this area. A full hydraulic and hydrological assessment of the crossing, including any changes to the channel, is recommended to properly size the replacement structure. In concert with the channel changes recommended below, a 35-foot-span bridge will reduce backwater flooding and has the capacity to pass a current 100-year flood and future 50-year flood.

Figure 4-21: Looking downstream at the inlet of the Mill Street culvert over Alton Creek

The banks of Alton Creek are walled in as it approaches Mill Street. Both sides are developed and have structures close to the watercourse. Mill Street runs along the right bank, with a garage just upstream of the culvert. A private residence is on the left bank. These restrict the channel width to a minimum of 12 feet, significantly smaller than the active channel width of 19 feet. There is little space available for a floodplain in this stretch. Widening the channel to the active channel width will support conveyance and reduce the flood risk. It is recommended to remove the garage to create space for a wider channel. Upsizing the culvert and widening the upstream channel results in a 3- to 4-foot decrease in water surface level in a 50- and 100-year flood event.

Figure 4-22 is a concept map of proposed changes to the Mill Street and Main Street bridges (Project Areas 3 and 4). Figure 4-23 is a map of the 50-year flows under existing conditions. Figure 4-24 is a map of the 50-year flows under proposed conditions. Figure 4-25 is a map of the 100-year flows under existing conditions. Figure 4-26 is a map of the 100-year proposed conditions.

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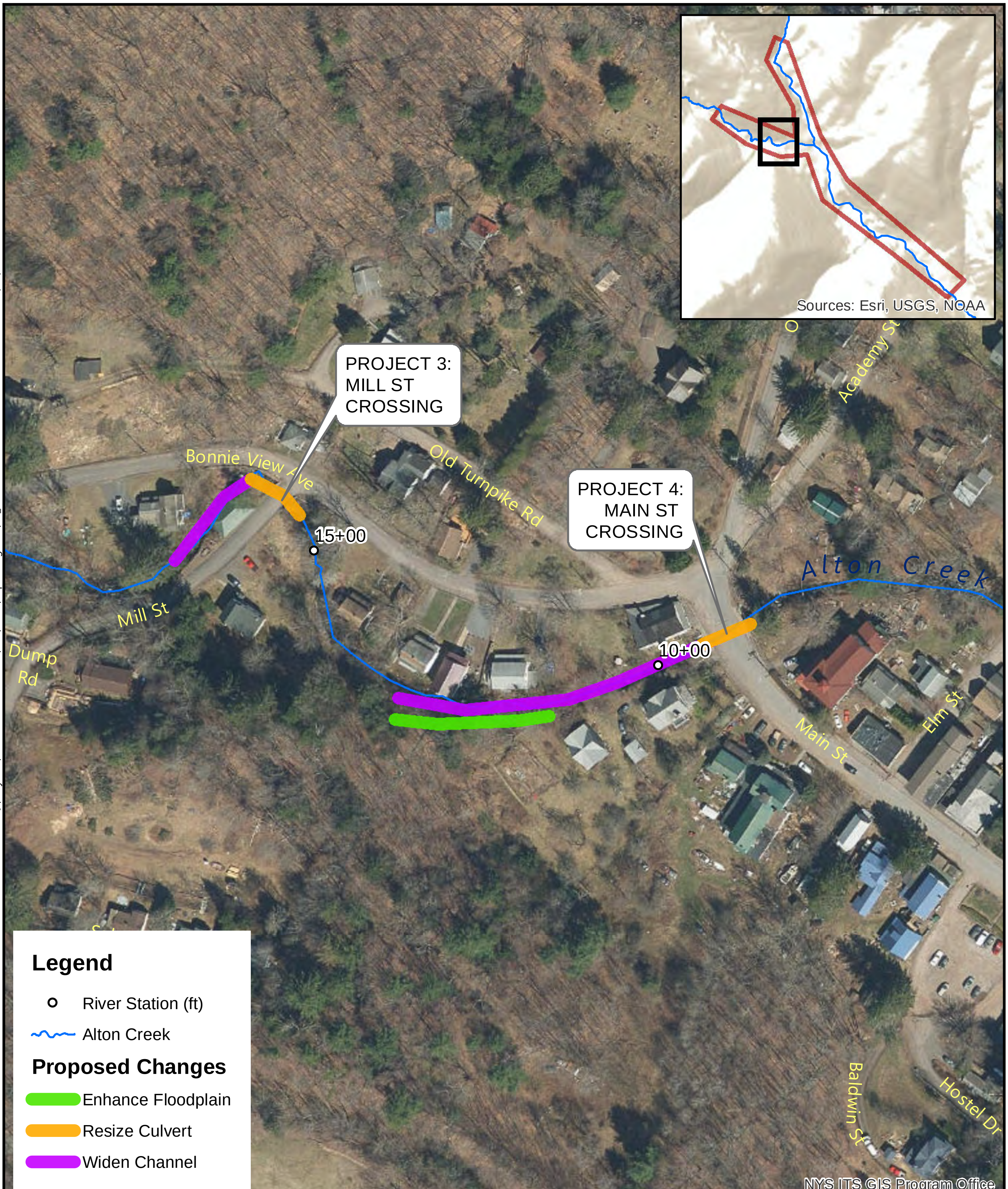

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PROJECT 3 & PROJECT 4: PROPOSED CHANGES CONCEPT

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL

ULSTER COUNTY
NEW YORK

N

0 150
Feet

SCALE 1 " = 150 '

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142.14615.00030
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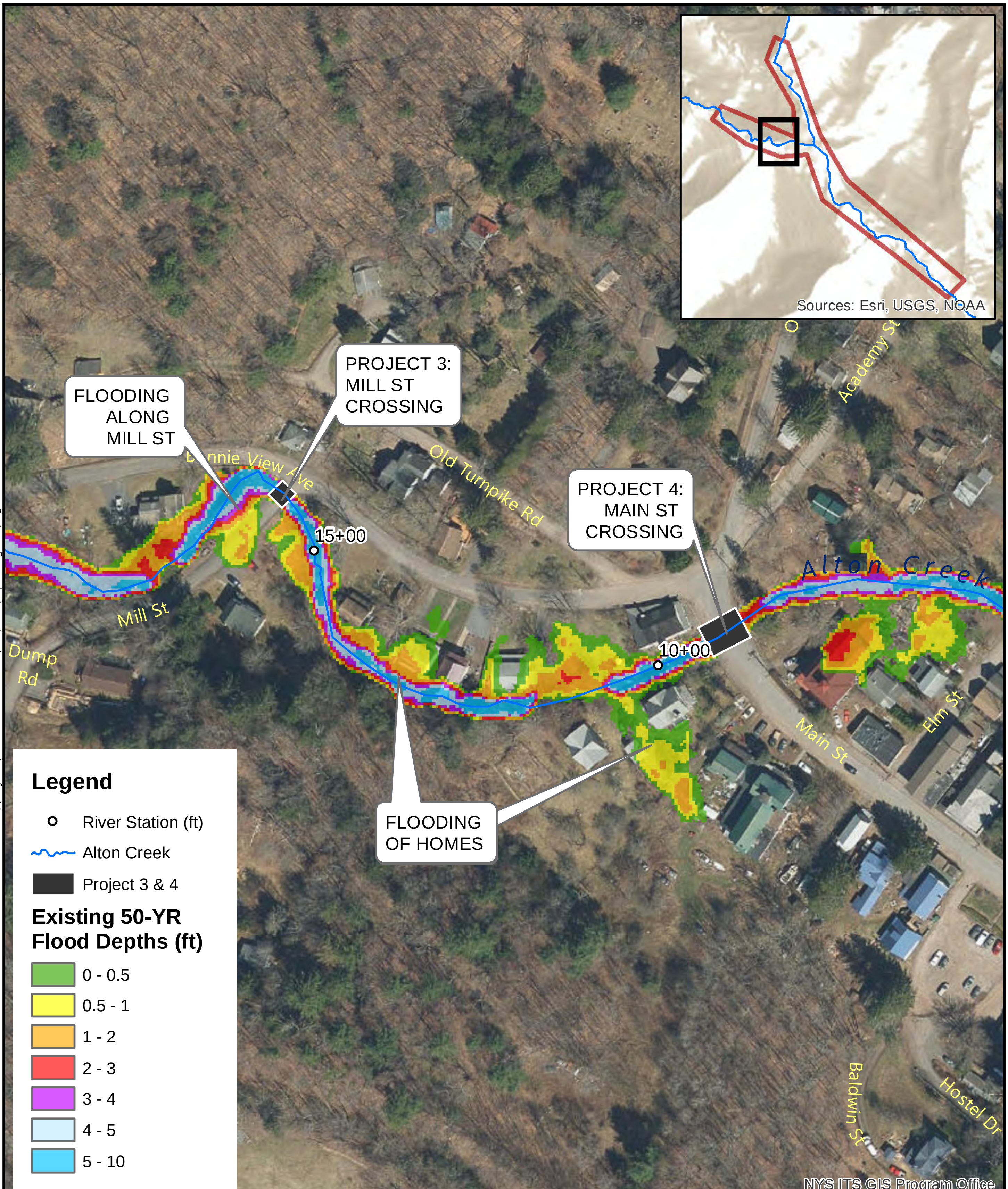
FIG. 4-22



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PROJECT 3 & PROJECT 4: EXISTING CONDITIONS 50-YR

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL

ULSTER COUNTY
NEW YORK

N

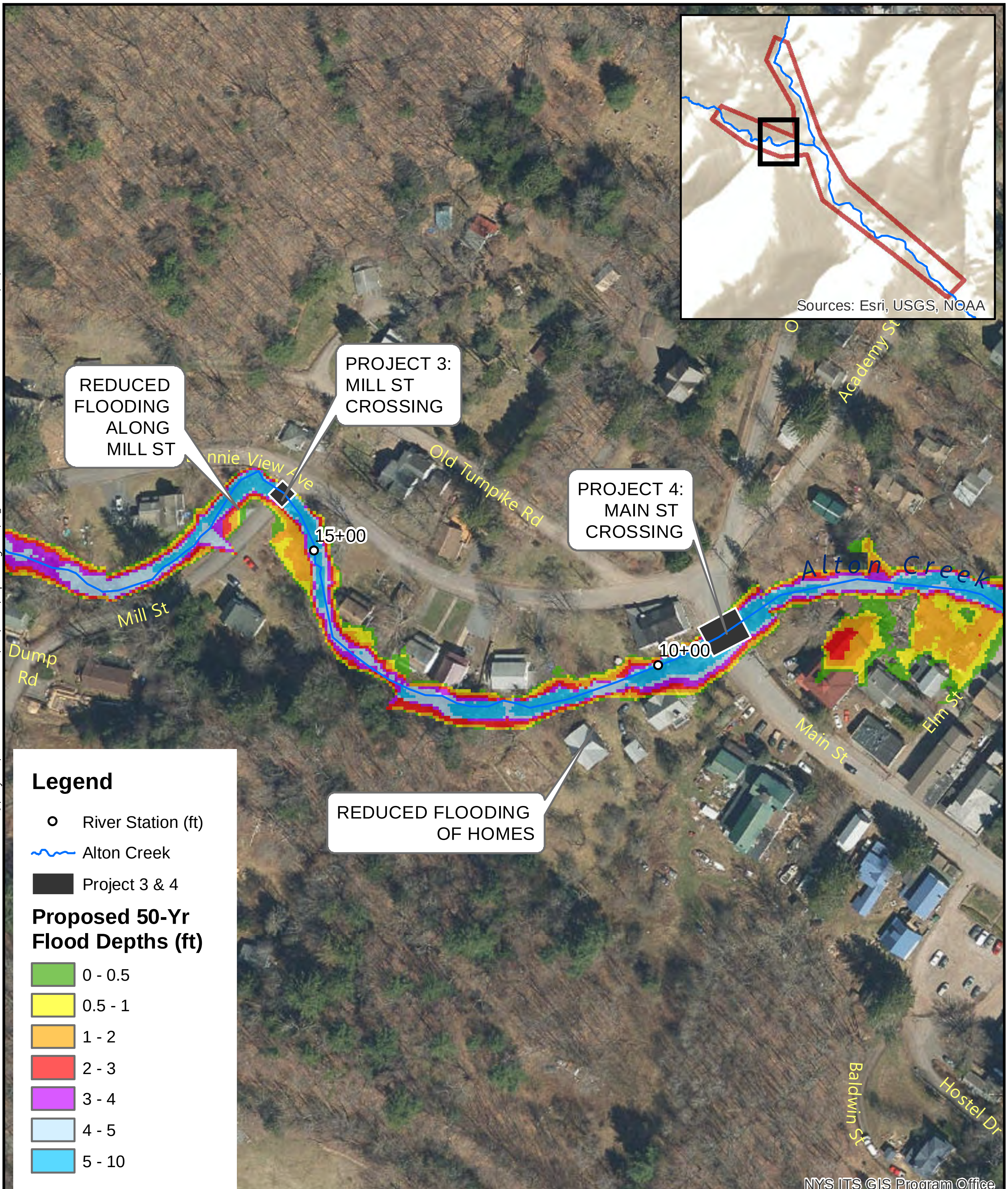
0 150
Feet

SCALE 1 " = 150 '

DATE 11/17/2022

142.14615.00030
PROJ. NO.

FIG. 4-23



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PROJECT 3 & PROJECT 4: PROPOSED CONDITIONS 50-YR

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL

ULSTER COUNTY
NEW YORK

N

0 150 Feet

SCALE 1 " = 150 '

DATE 11/17/2022

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FIG. 4-24

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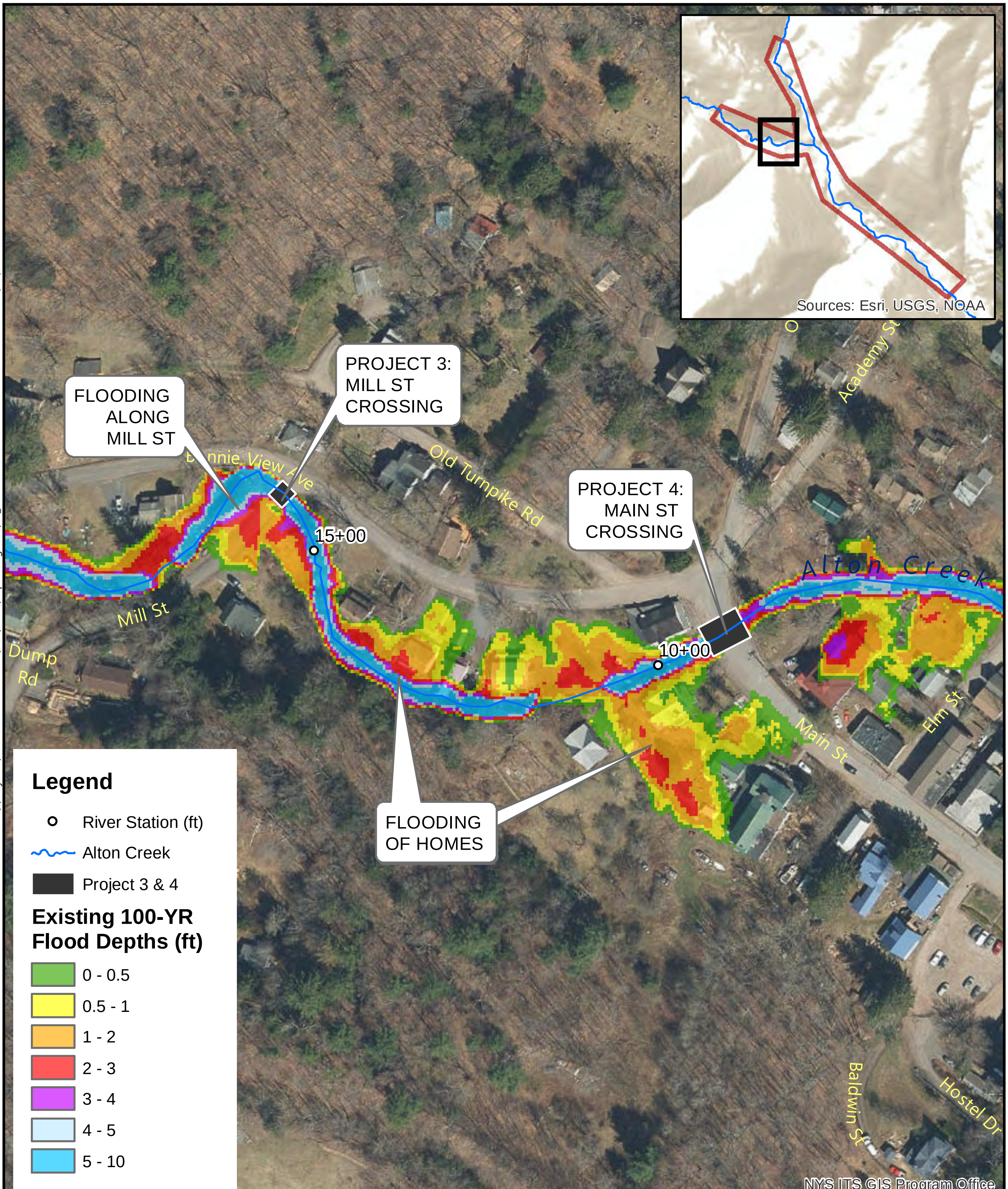

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PROJECT 3 & PROJECT 4: EXISTING CONDITIONS 100-YR

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL

ULSTER COUNTY
NEW YORK

N

0 150 Feet

SCALE 1 " = 150 '

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PROJ. NO.

FIG. 4-25

Date Saved: 11/17/2022
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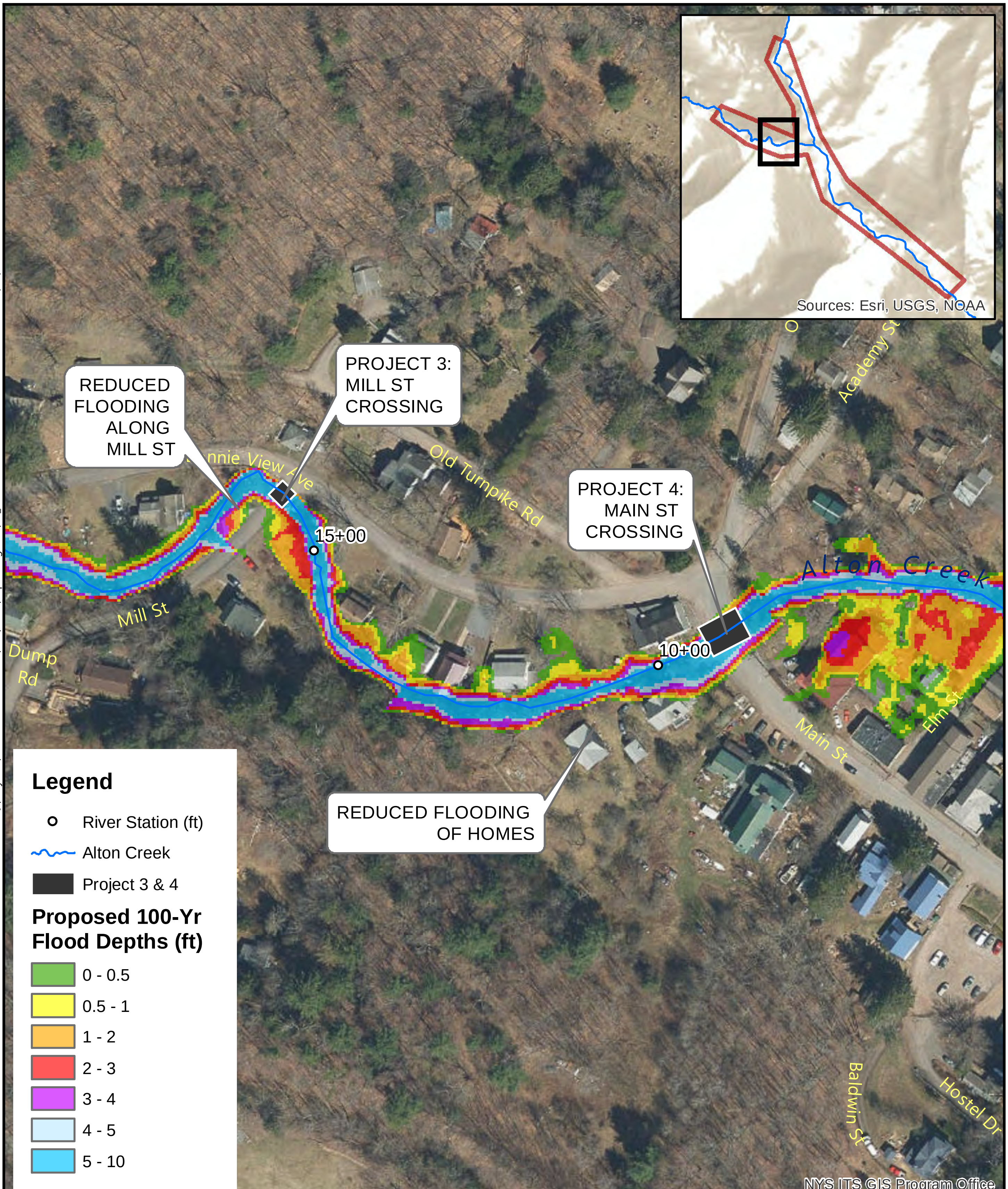

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PROJECT 3 & PROJECT 4: PROPOSED CONDITIONS 100-YR

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL

ULSTER COUNTY
NEW YORK

SCALE 1 " = 150 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.

FIG. 4-26

4.2.6 PROJECT AREA 4: UPPER MAIN STREET – ALTON CREEK

Main Street crosses Alton Creek at river station 9+10 with a 20-foot-span bridge (BIN 2267650). The inlet banks are stacked stone, which have been damaged in past floods. Large stones seen at the outlet have been moved from upstream of the crossing by past floods. The constricted channel has no floodplain in this section, with houses on both sides of the channel upstream of the bridge. Main Street provides access to critical facilities such as the community center and fire station, so safe passage during a flood event is necessary.

The existing structure has a capacity to pass a 50-year flow event without overtopping. Backwater flooding starts at a 10-year flood event. Due to the flooding and damage to the stream walls during high flow events, this crossing is a medium priority for replacement. Critical facilities such as the fire department and the community center are located on Main Street. These facilities must be accessible during flood events. Possible detours around the upper Main Street crossing may include other floodprone crossings – Academy Street (Project Area 5) and lower Main Street (Project Area 6) – causing a longer detour.

A replacement design should also include channel widening as described below. A full hydraulic and hydrological assessment is recommended to properly size a new bridge. This assessment should also include the channel changes. Based on a HEC-RAS model with an increased channel width, a bridge with a span of 35 feet has the capacity to pass the 100-year current and future flood event without overtopping and reduced backwater flooding.

Figure 4-27: Looking downstream at the inlet of the upper Main Street crossing over Alton Creek

Channel improvements are also necessary to reduce the damage during flood events. Upstream of the crossing, the channel is confined by stacked stone walls on both sides. The walls have sustained damage in previous high flow events. The constricted channel leads to high velocities, which can cause damage. The active channel width in this section is recommended to be 22 feet. The current width is about 13 feet. Increasing the channel width will also reduce the flow velocities and subsequent shear stress along the banks.

There are numerous houses close to the banks in this stretch, reducing the availability of floodplains. Therefore, increasing conveyance through increased channel width is needed. If there is an opportunity to remove the house and create floodplain, it should be explored to further reduce the flood risk in this area.

Figure 4-22 shows the proposed changes for the crossings in Project Areas 3 and 4. Figures 4-23 through 4-26 show the existing and proposed conditions for both a 50-year and 100-year flood event.

4.2.7 PROJECT AREA 5: ACADEMY STREET

Academy Street crosses Birch Creek at river station 161+20 with one of the three historic bridges in Pine Hill. The historic stone arch has been retrofitted with a metal pipe at the outlet and concrete box at the inlet. The bridge constricts the flow and causes backwater flooding on Birch Creek Road.

The historic arch has been retrofitted and now includes a 12.5-foot-span corrugated metal pipe. The inlet is a concrete box with a span of 13.4 feet. There is a 1.2-foot drop at the inlet and evidence of scour at the outlet. The span is significantly smaller than the active channel width of approximately 27 feet. A one-dimensional HEC-RAS model of Birch Creek shows that the Academy Street culvert overtops in a 10-year flood event. The resulting flooding covers Birch Creek Road, which may become impassable during a flood. A detour of Academy Street may include other floodprone areas, namely upper Main Street crossing (Project Area 4). The detour of Birch Creek Road via Route 28 and Barley Road is over 4 miles long.

Due to the low capacity of the culvert and the impact of subsequent flooding, this culvert is a medium priority for replacement. The replacement structure is recommended to have a span of 35 feet, which covers the active channel width of 29 feet and passes a current and future 50-year flood event without overtopping. The new crossing should have an open bottom with a constant slope as recommended by the NYSDEC to support aquatic organism passage.

Figure 4-28: Inlet (left) and outlet (right) of Academy Street crossing over Birch Creek

Widening the inlet channel width will also reduce the flood risk in this area. The active channel width in this section of Birch Creek is 29 feet. The channel width in this section is about 24 feet. The flow is constricted as it passes through the undersized culvert. The result is increased velocity through the culvert, causing scour at the outlet. Adjusting the channel width to the active channel width will improve the conveyance of floodwaters in this section. There is limited space for floodplains due to roadways and houses, so sufficient conveyance is necessary.

Figure 4-29 is a concept map of proposed changes to Project Area 5, the Academy Street crossing. Figure 4-30 is a map of the 50-year flows under existing conditions. Figure 4-31 is a map of the 50-year flows under proposed conditions. Figure 4-32 is a map of the 100-year flows under existing conditions. Figure 4-33 is a map of the 100-year proposed conditions.

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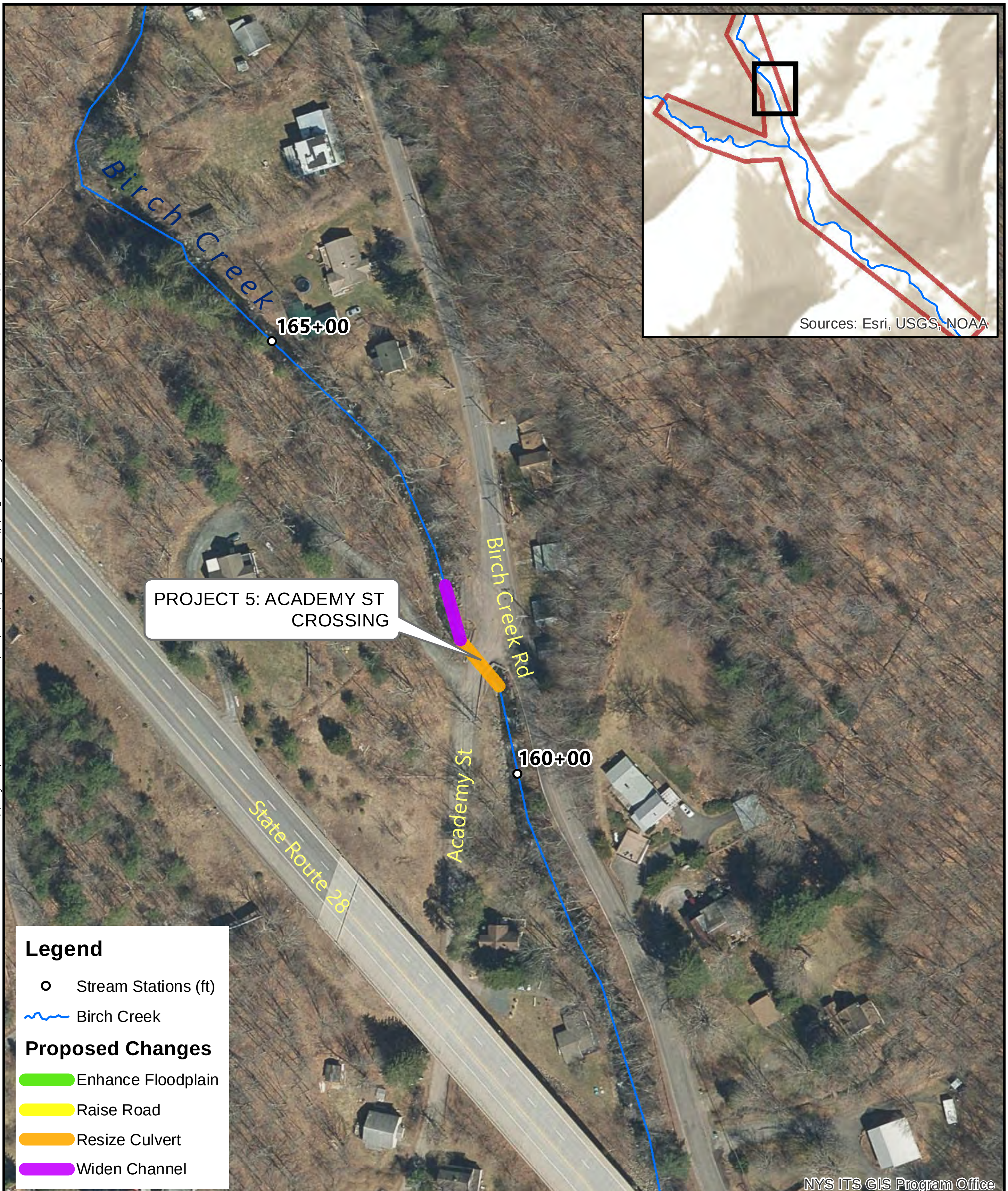

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PROJECT 5: ACADEMY ST - PROPOSED CHANGES CONCEPT

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 1,500 3,000
Feet

SCALE 1 " = 130 '
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FIG. 4-29

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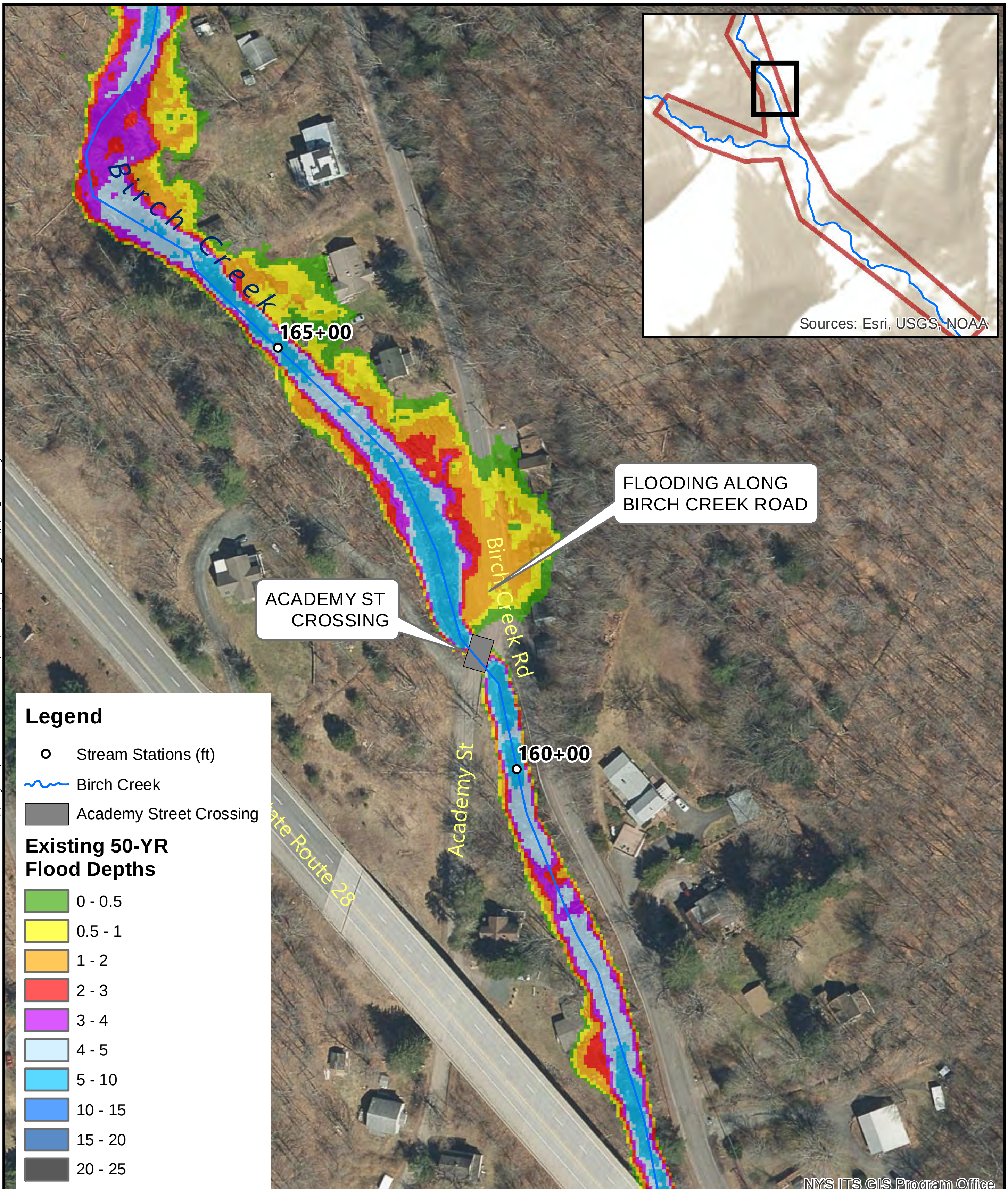

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PROJECT 5: ACADEMY ST - EXISTING CONDITIONS 50-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

SCALE 1 " = 134 '
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FIG. 4-30

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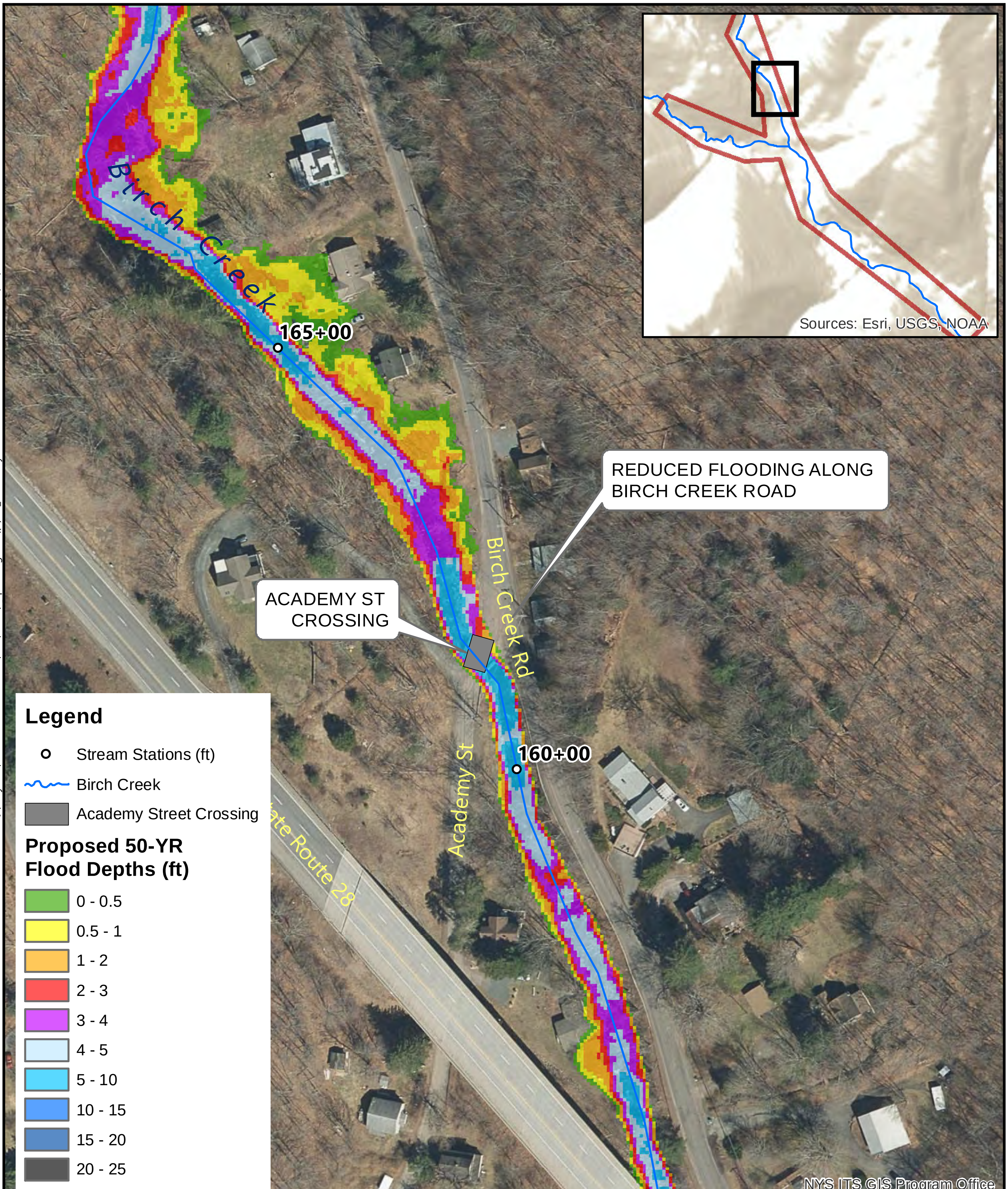

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PROJECT 5: ACADEMY ST - PROPOSED CONDITIONS 50-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 140 Feet

SCALE 1 " = 134 '

DATE 11/17/2022

142.14615.00030
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FIG. 4-31

Date Saved: 11/17/2022
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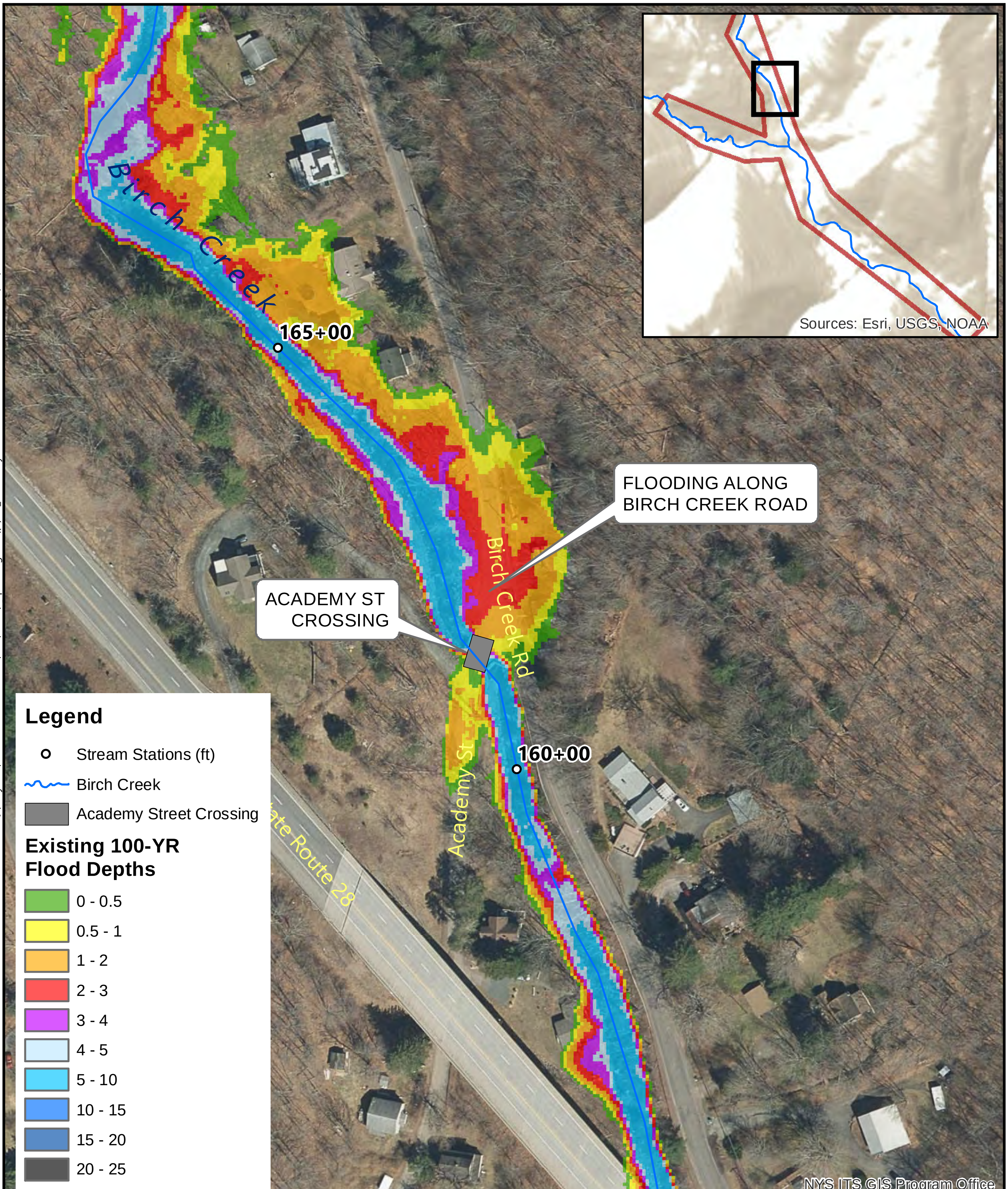

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PROJECT 5: ACADEMY ST - EXISTING CONDITIONS 100-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

SCALE 1 " = 134 '

DATE 11/17/2022

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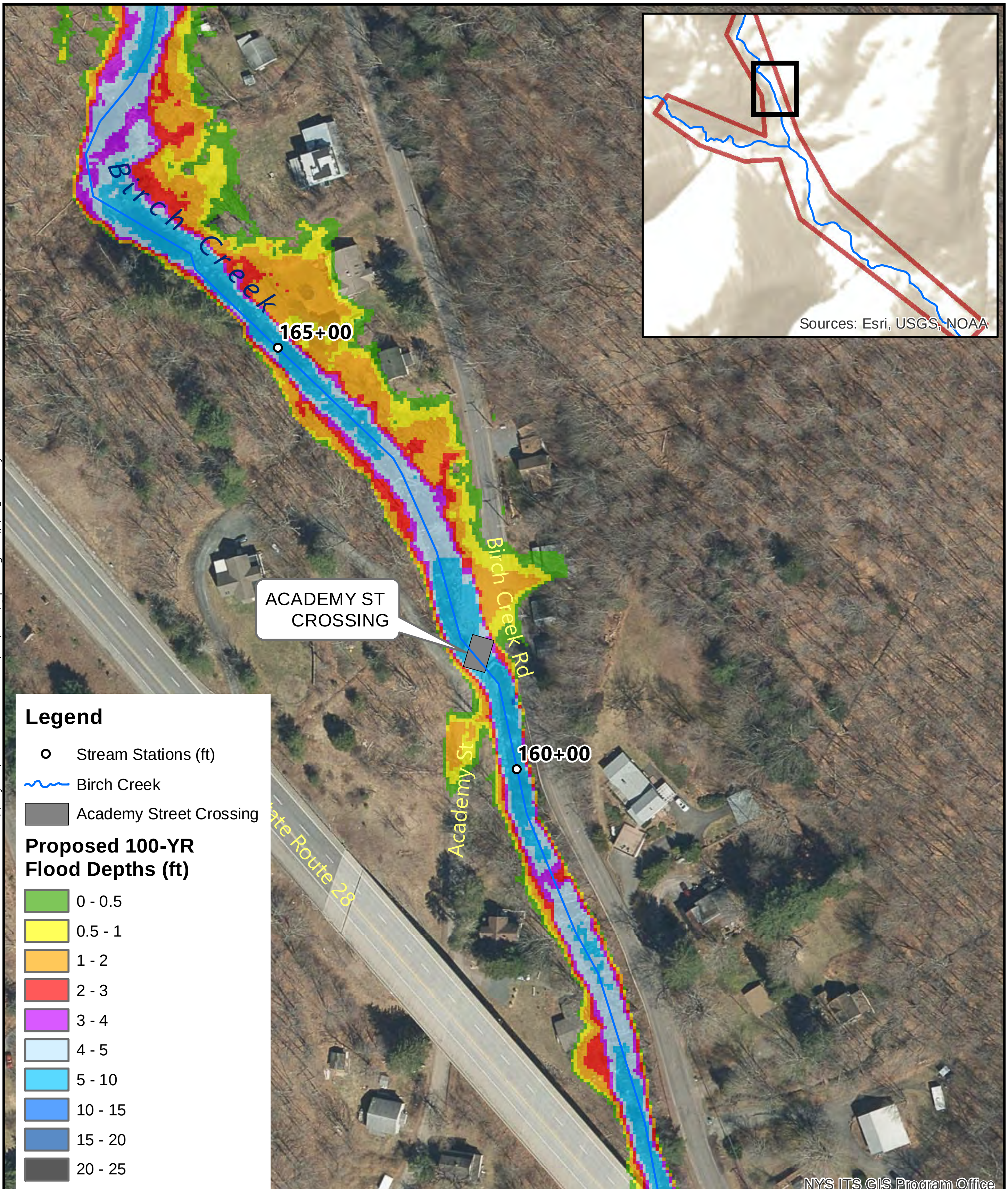
PROJ. NO.

FIG. 4-32



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PROJECT 5: ACADEMY ST - PROPOSED CONDITIONS 100-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 1,500 3,000
Feet

SCALE 1 " = 134 '

DATE 11/17/2022

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PROJ. NO.

FIG. 4-33

4.2.8 PROJECT AREA 6: LOWER MAIN STREET – BIRCH CREEK

Main Street crosses Birch Creek at river station 134+60 with a 35-foot span bridge. Numerous residents cited flooding of this bridge, both from the creek and from water running down Main Street. This crossing is in a low-lying area and has multiple houses on both sides of the watercourse. Main Street has critical facilities, including the fire station and community center, which must be accessible during a flood event. Possible detours may include other vulnerable crossings such as upper Main Street (Project Area 4). There are also fuel tanks near river station 143+00, which may cause water quality issues if flooded.

The HEC-RAS model shows that overtopping occurs at flows greater than the 10-year flood event. However, backwater flooding occurs at flows less than the 10-year flood event. Due to the history of flooding and the low capacity, this crossing has been deemed a medium priority for replacement.

Replacement of this crossing is most effective if done in concert with channel and floodplain adjustments. A full hydraulic and hydrological study should be done to include the channel and floodplain changes to properly resize the crossing. With the channel widening and floodplain creation recommended in this study, the bridge span is recommended to be 60 feet to reduce backwater flooding. The increase in span only slightly reduces the risk of overtopping. Further widening of the bridge and floodplain will require the removal of one or both houses at the outlet.

Figure 4-34: Looking downstream at the lower Main Street crossing over Birch Creek

Birch Creek is prone to flooding both upstream and downstream of the Main Street crossing. Increasing the flow capacity of the bridge will reduce flooding caused by backwater, but it does not address the flooding caused by the undersized channel. The channel width ranges from 18 to 35 feet in this region, compared to the recommended active channel width of 36 feet.

Upstream of the crossing, there is undeveloped land along the right bank, which may be used as a floodplain. This area is already prone to flooding in high flow events. Lowering the level of the floodplain will increase capacity and reduce the reach of the floodwaters.

This is also the case further downstream of the crossing. However, directly downstream of the Main Street crossing, the channel is constricted by houses on both banks. It is recommended to increase the channel width to the active channel width to increase conveyance to the floodplains further downstream.

Figure 4-37 is a concept map of proposed changes to Project Area 6, the lower Main Street bridge. Figure 4-35 is a map of the 50-year flows under existing conditions at the lower Main Street crossing over Birch Creek. Figure 4-38 is a map of the 50-year flows under proposed conditions. Figure 4-36 is a map of the 100-year flows under existing conditions. Figure 4-39 is a map of the 100-year proposed conditions.

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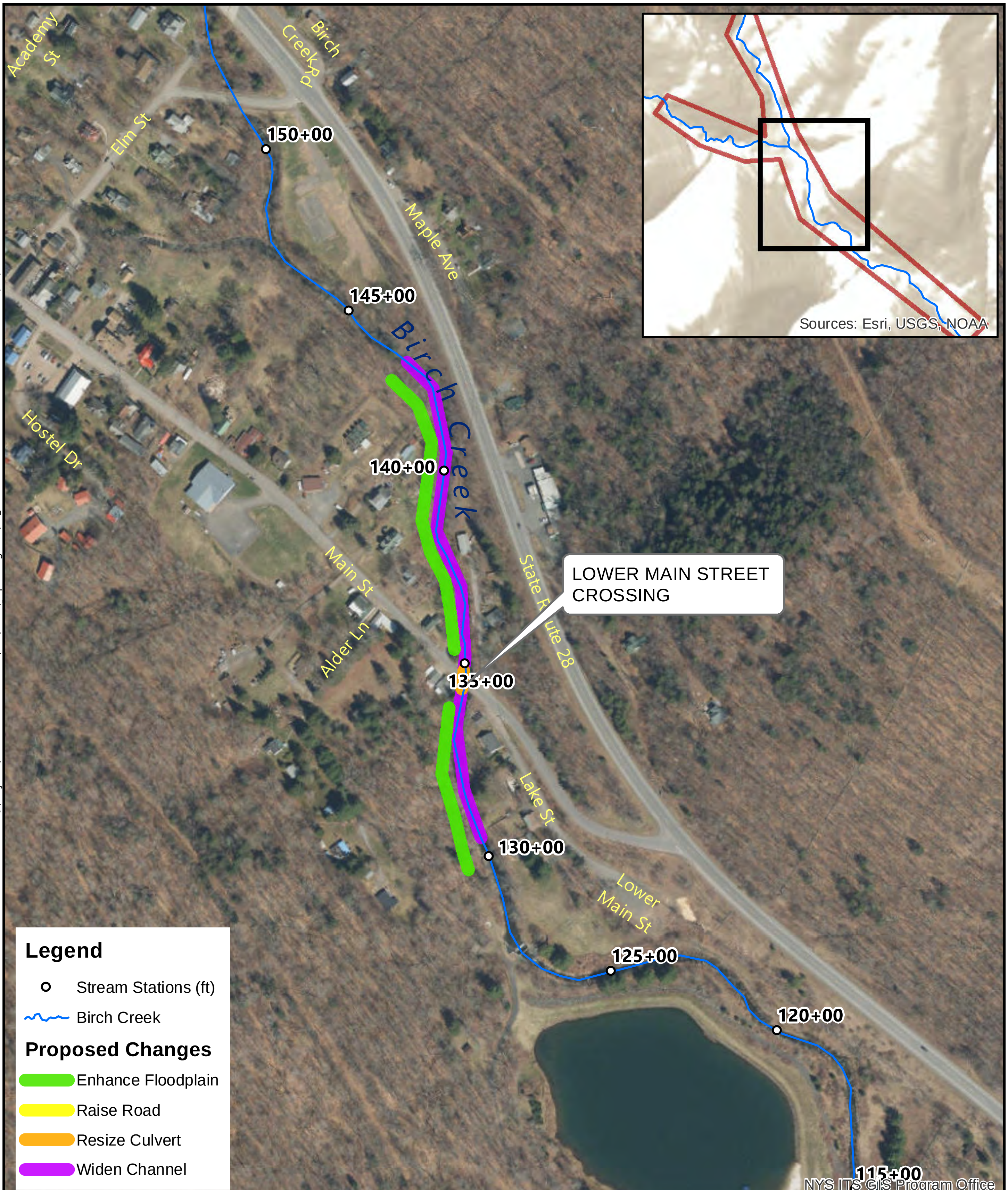

SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

PROJECT 6: MAIN ST - PROPOSED CHANGES CONCEPT

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 1,500 3,000
Feet

SCALE 1 " = 334 '

DATE 11/17/2022

142.14615.00030
PROJ. NO.

FIG. 4-35

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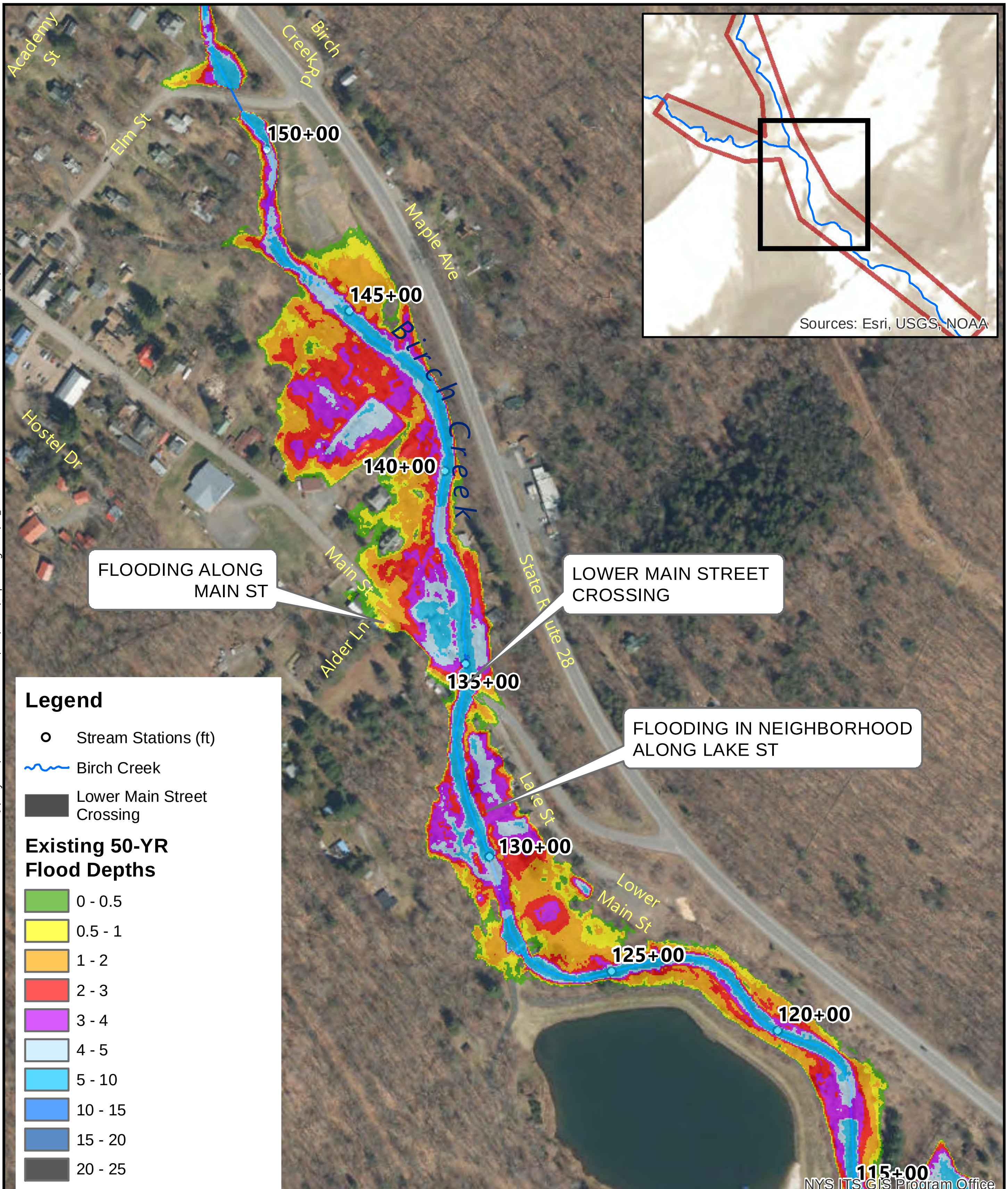

SLR
231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

PROJECT 6: MAIN ST - EXISTING CONDITIONS 50-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 350
Feet

SCALE 1 " = 334 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.

FIG. 4-36

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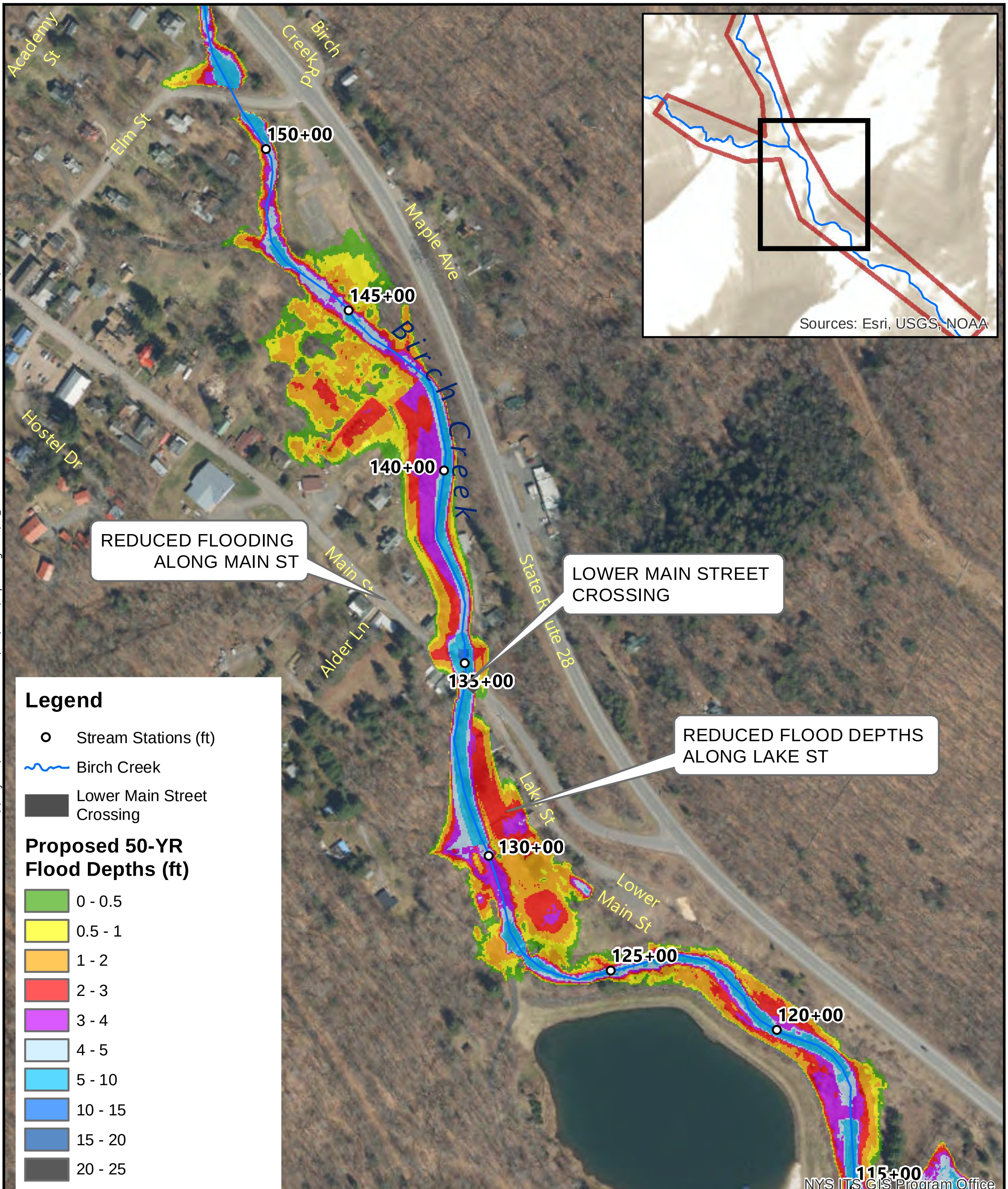

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NEW PALTZ, NY 12561
845.633.8153

PROJECT 6: MAIN ST - PROPOSED CONDITIONS 50-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N
0 350
Feet

SCALE 1 " = 334 '
DATE 11/17/2022
142.14615.00030
PROJ. NO.

FIG. 4-37

Date Saved: 11/17/2022

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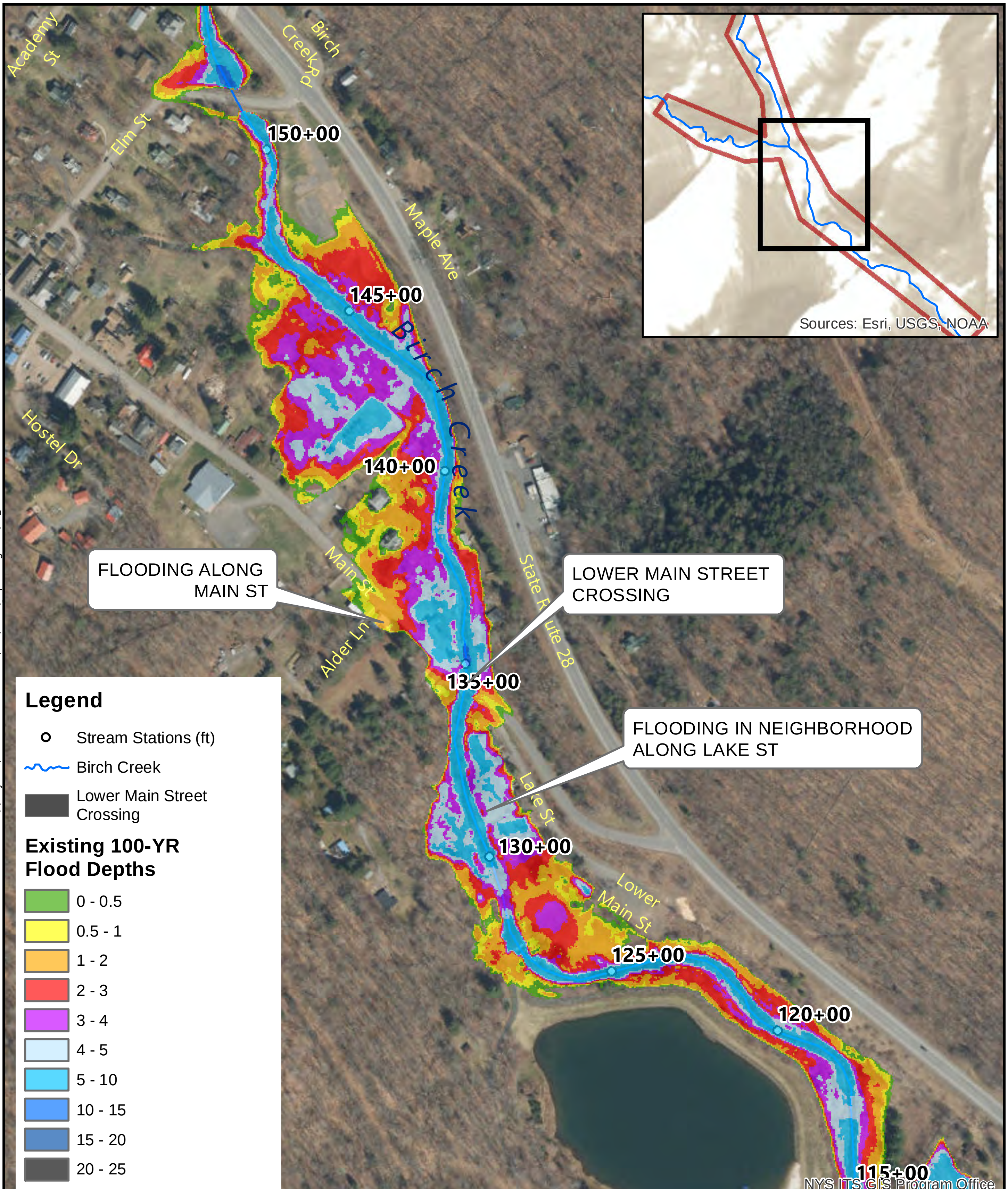


SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

PROJECT 6: MAIN ST - EXISTING CONDITIONS 100-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

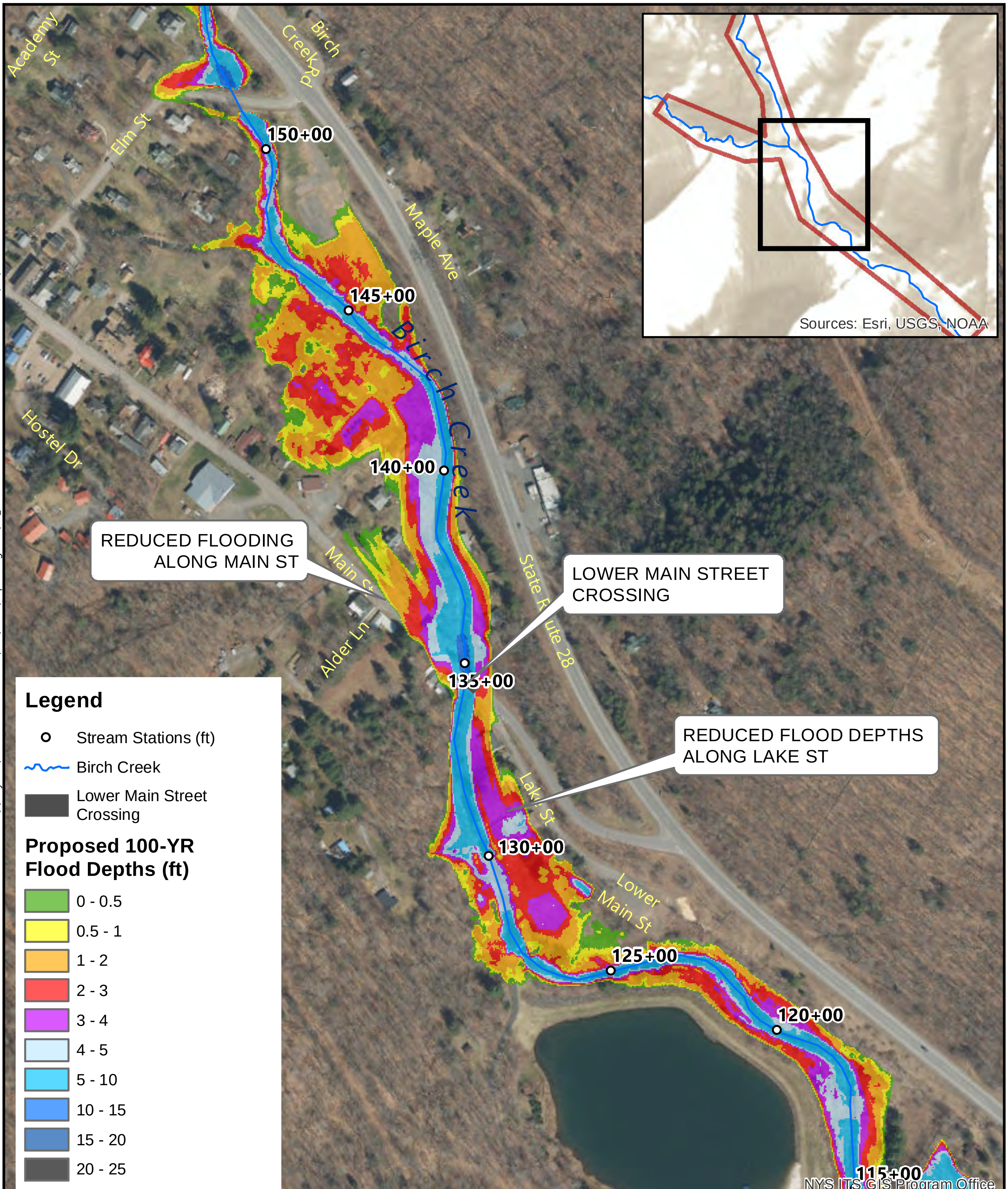
0 350
Feet

SCALE 1 " = 334 '

DATE 11/17/2022

142.14615.00030
PROJ. NO.

FIG. 4-38



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

PROJECT 6: MAIN ST - PROPOSED CONDITIONS 100-YR FLOOD

PINE HILL LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY
NEW YORK

N

0 350 Feet

SCALE 1 " = 334 '

DATE 11/17/2022

142.14615.00030
PROJ. NO.

FIG. 4-39

4.2.9 ADDITIONAL BRIDGE AND CULVERT ASSESSMENTS

Six additional crossings were analyzed as part of this study. They were deemed either a low priority for replacement or that no replacement is necessary at this time due to limited to no impact on flooding.

4.2.9.1 Birch Creek Road – Birch Creek

Birch Creek Road crosses Birch Creek at river station 209+20 with a metal box culvert with a 19.5-foot span. The crossing is 112 feet long. The bottom is curling, allowing water and sediment to pass below it. There is sediment and debris inside the culvert as well. An HY-8 model of the existing culvert shows a capacity of 1,129 cfs, which allows for passage of the 25-year flood event without overtopping the road. The 50-year flood event does exceed the culvert capacity and results in overtopping.

Due to the current capacity and condition of this culvert, it is a low priority for replacement. When it is due for replacement, a detailed hydraulic and hydrologic analysis is recommended to properly size a replacement structure. It is also recommended that an open bottom is used, following NYSDEC recommendations for aquatic organism passage. The HY-8 model used in this study shows that expanding the span to 25 feet, matching the active channel width, as an open-bottom bridge gives a capacity of 1,628 cfs. This is sufficient capacity for the current 100-year flood event and the 50-year future flood event.

Figure 4-40: Looking downstream at Birch Creek Road culvert over Birch Creek

4.2.9.2 Elm Street – Birch Creek

The Elm Street crossing over Birch Creek at river station 151+40 is two open-bottom concrete box culverts, each with a 12-foot span. A one-dimensional HEC-RAS model of Birch Creek shows that the existing capacity of the crossing is sufficient to pass the 50-year flood event without overtopping the road. However, backwater flooding begins at flows greater than the 10-year flood event. Due to the limited reach of this flooding in an undeveloped area, this crossing is determined to be a low priority for replacement.

Figure 4-41: Looking downstream at the Elm Street culvert over Birch Creek

4.2.9.3 Former Lake Street Bridge with Dam

Lake Street formerly crossed Birch Creek and along the west side of what is now Belleayre Lake. While the road no longer crosses the creek, there is a twin arch culvert as part of the dam and intake structure for the lake at river station 127+60. The culverts each have a span of 10 feet, with a length of approximately 2 feet. The HEC-RAS model shows that this structure overtops in a 10-year flood event.

The dam is necessary for the intake of the Belleayre Lake. There is a fish passage structure along the right bank to support aquatic organism passage. It is unclear if the culvert structure is critical for the stabilization of the dam. This structure is a low priority for replacement if replacement is allowable.

Figure 4-42: Dam, old road crossing, and intake for Belleayre Day Use Area

4.2.9.4 Elm Street – Alton Creek

Elm Street crosses Alton Creek at river station 5+50. The historic stone arch has a span of 10 feet. The active channel width in this section of Alton Creek is 22 feet. The undersized channel overtops in a 10-year flood event. The backwater floods the upstream region. Given the limited flooded area and alternative routes available if the road is flooded, this culvert is a low priority for replacement at this time.

Figure 4-43: Historic Elm Street stone arch over Alton Creek

4.2.9.5 Station Road – Woodchuck Hollow

Woodchuck Hollow is a tributary to Alton Creek that joins just upstream of the Mill Street crossing at river station 18+00. Station Road crosses Woodchuck Hollow at river station 8+80 with a metal pipe culvert. Residents reported floodwater coming down Woodchuck Hollow Road during the October 2021 flood event. The observed flooding started farther upstream than the location of the culvert.

An HY-8 model of the culvert shows it passes the 50-year flood event without overtopping. The flow of the October flood was not measured, so the return period is unknown. Given the results of the model, this culvert is not recommended for replacement at this time. Further investigation in the upstream extents of Woodchuck Hollow is needed to determine and resolve the source of past flooding.

Figure 4-44: Outlet and tailwater of Station Road culvert at Woodchuck Hollow

4.2.9.6 Belleayre Day Use Area Driveway – Birch Creek

The access driveway to Belleayre Lake and Day Use Area crosses Birch Creek at river station 110+30 with a covered bridge. Birch Creek runs along the north side of the earthen dam that creates the lake. The outlet of the lake re-enters the creek upstream of the driveway bridge crossing. There are also signs of beaver lodges in the floodplain just upstream of the crossing. The HEC-RAS model shows that the crossing can pass a 100-year flood event without overtopping and that backwater flooding occurs at flows less than the 10-year flood event. The flooding is limited to the floodplain area where the beaver activity was seen. The increase in water levels is due to the beavers rather than confinements due to the bridge. This bridge is not recommended for replacement at this time.

Figure 4-45: Covered bridge over Birch Creek is the only access to Belleayre Day Use Area.

4.3 RECOMMENDATIONS FOR FLOODPRONE HOMES AND BUILDINGS

During the public data-gathering process of the study, there were critical sites within the hamlet project area 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.

4.3.1 RECOMMENDATIONS FOR HISTORIC FLOODPRONE BUILDINGS

The Pine Hill Historic District is a national historic district encompassing 125 contributing buildings, three contributing sites, two contributing structures, and one contributing object. It developed between about 1800 and 1962 and includes notable examples of Greek Revival, Carpenter Gothic (Gothic Revival), Italianate, Stick Style, Second Empire, Queen Anne, Colonial Revival, Classical Revival, and Bungalow/American Craftsman architecture. Located in the district are the separately listed District School No. 14, Elm Street Stone Arch Bridge, Mill Street Stone Arch Bridge, Morton Memorial Library, and Ulster House Hotel. Other notable contributing resources include the John C. Loomis House (c. 1855), Methodist Episcopal Church (c. 1860), Benjamin Franklin Cornish House (c. 1860), Elizabeth Smith House (1876), Orchard Park House (1882), and "The Zepher" (c. 1895). The Pine Hill Historic District was listed on the National Register of Historic Places in 2012.

Rehabilitation of historic residential buildings may qualify for a New York State tax incentive. This program is discussed in Section 6.2 of this report.

The National Park Service has developed guidelines on flood adaptation for rehabilitating historic buildings to provide information about how to adapt historic buildings to be more resilient to flooding risk in a manner that will preserve their historic character.
https://www.nps.gov/articles/000/guidelines-on-flood-adaptation-for-rehabilitating-historic-buildings.htm

4.3.2 RECOMMENDATIONS FOR OTHER FLOODPRONE 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 the hamlet of Pine Hill are available online. Residents may 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 4-47) and residential (Figure 4-48) properties.

- It is recommended that the town identify priority areas and structures that are prone to 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.

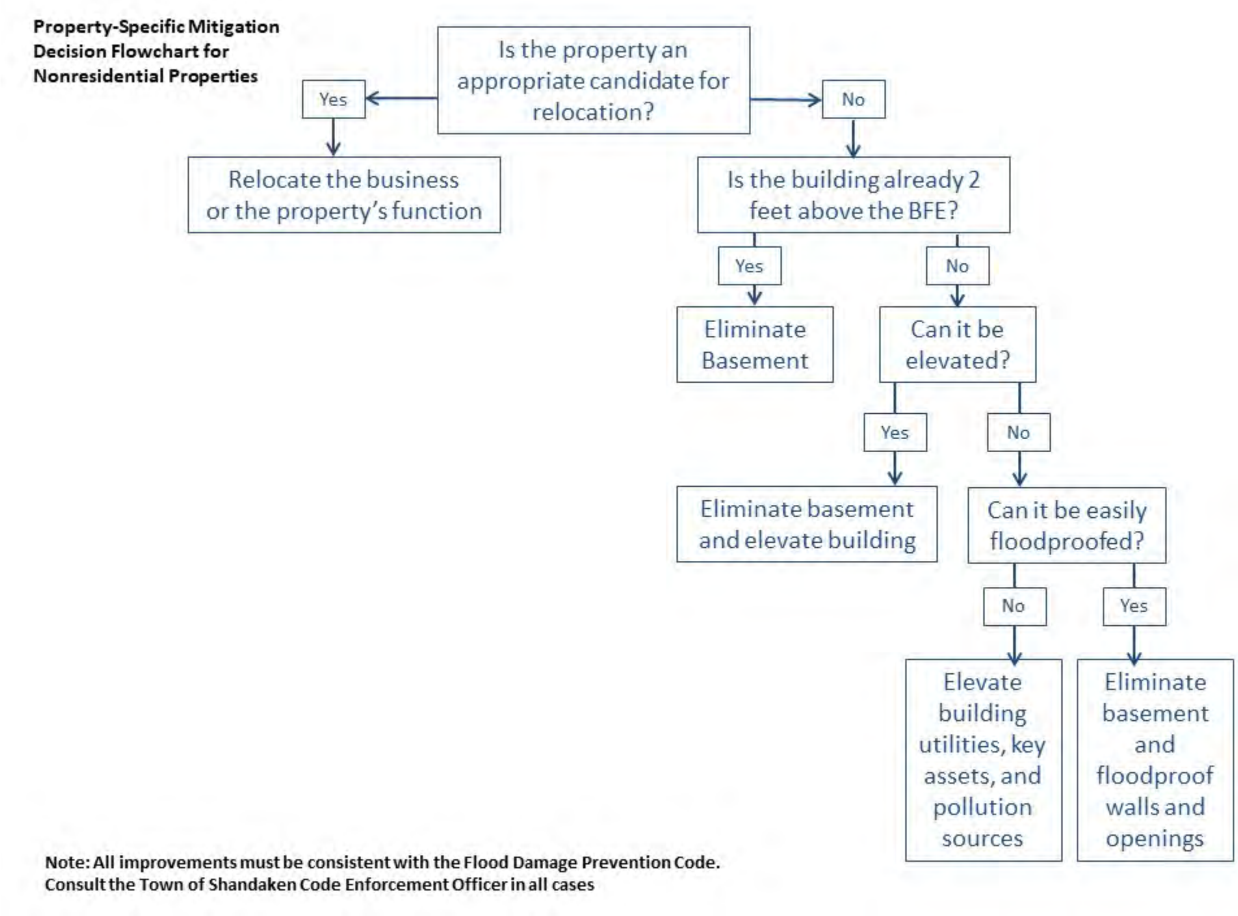


Figure 4-46: Property-specific mitigation for nonresidential properties

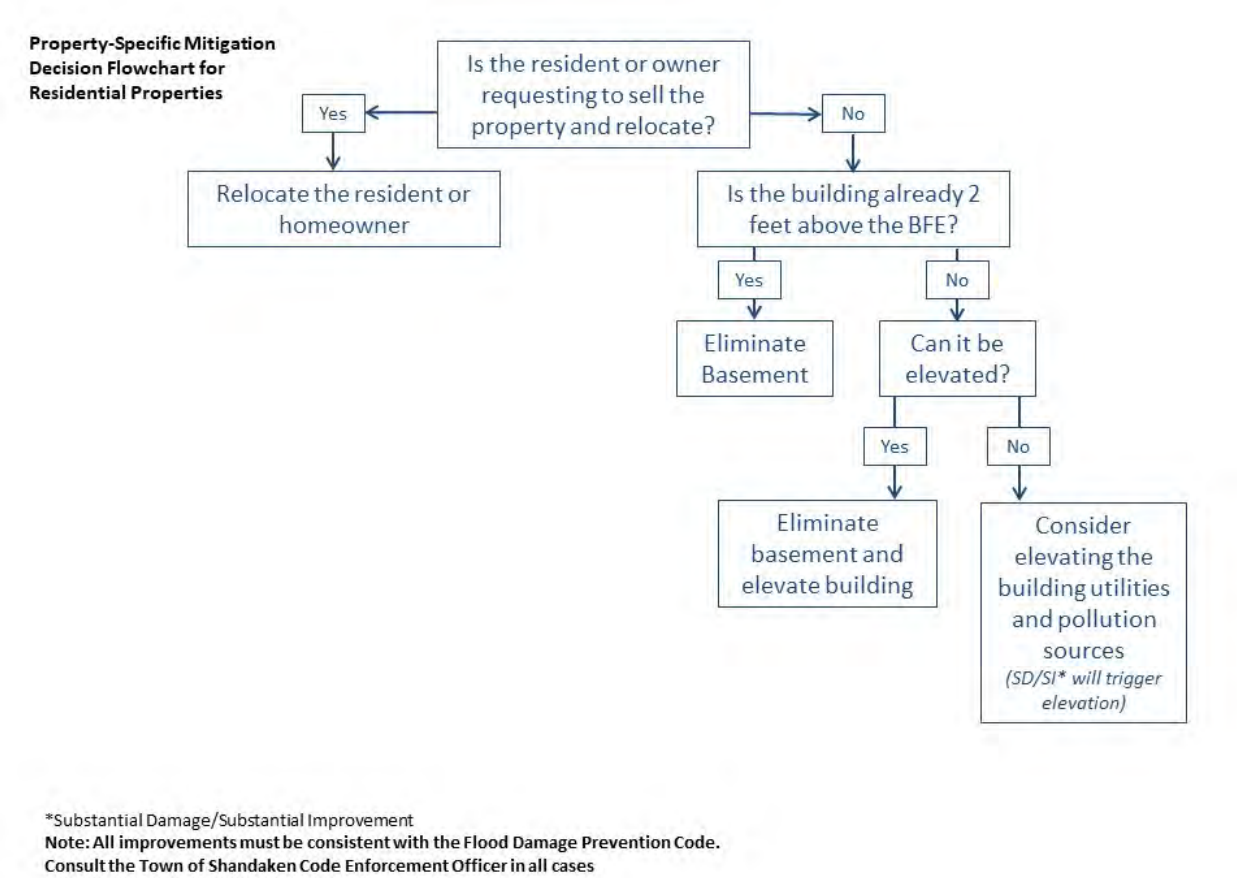


Figure 4-47: Property-specific mitigation for residential properties

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:

Elevation of the structure – 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.

Dry floodproofing of the structure to keep floodwaters from entering – 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.

4.4 RIPARIAN BUFFERS

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 water body are essential characteristics determining the functioning of the buffer.

The benefits provided by riparian buffers to their adjacent water bodies 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.

4.5 GENERAL RECOMMENDATIONS

Flooding of and damage to bridges, culverts, and roadways during flood events has been reported at numerous locations in the villages and hamlet project areas. 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 floodprone 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 hamlet of Pine Hill 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.

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 hamlet of Pine Hill 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. BENEFIT-COST ANALYSIS

5.1 OVERVIEW OF BENEFIT-COST ANALYSIS

A Benefit-Cost Analysis (BCA) is used to evaluate the cost effectiveness of a proposed hazard mitigation project. A BCA is a method by which the future benefits of a project are estimated and compared to its cost. The end result is a benefit-cost ratio (BCR), which is derived from a project's total net benefits divided by its total project cost. The BCR is a numerical expression of the cost effectiveness of a project. A project is considered to be cost effective by FEMA when the BCR is 1.0 or greater, indicating the benefits of the project are sufficient to justify the costs. Other potential project funders, for example CWC, may consider the BCA score when evaluating projects for funding, but a BCR of 1.0 is not necessarily required, and other factors may be considered as well.

To facilitate the BCA, a survey of first FFE of structures in the FEMA 100-year flood zone was carried out in the project area. The following features were noted and verified against data contained in the Ulster County Parcel Viewer (http://ulstercountyny.gov/maps/parcel-viewer/):

- Is the structure commercial or residential?
- If the structure is commercial, is it a retail establishment, a warehouse, or vacant?
- Does the structure have a basement, crawlspace, or slab foundation?
- If the structure has a basement, is it a full basement?
- What is the number of stories?
- Is the structure split level?
- What is the elevation of the first floor in relation to the grade?

Assumptions for the BCA include the following:

- Benefits for acquired/relocated properties were determined as acquisitions.
- Default depth-damage curves were used in the program.
- HEC-RAS modeling was conducted to develop raster maps (depth grid maps) of water surface elevations for the 10-, 50-, 100-, and 500-year discharge events. These maps were exported to *ArcGIS* and used to determine water surface elevations at individual structures.
- The first-floor elevations of 56 structures were surveyed by SLR on September 22, 2022.
- For those structures not surveyed, first-floor elevations were estimated using Digital Elevation Model (DEM) topographic mapping.
- Building information (area, basement, number of stories, etc.) came primarily from the Ulster County Parcel Viewer. Where necessary, this information was supplemented from data collected during a field visit.
- If the area of a structure was not included on the Ulster County Parcel Viewer, it was estimated using aerial imagery and *ArcGIS*.
- Parcel values (full market value) came from assessment data on the Ulster County Parcel Viewer.

- Demolition cost was not included in the calculation of project cost.
- Maintenance years for projects was assumed to be zero.
- Partial basements were considered no basements.
- Finished basements were assumed not to be walkout basements.
- For residential parcels with multiple structures, determination of inundation was based upon the first habitable structure on the property to become flooded.
- It was assumed that two people, both working, reside at each residence.
- For typical commercial parcels with multiple structures, determination of inundation was based upon the first permanent structure on the property to become flooded.

A BCA was run for the six proposed projects. A separate BCA was run for individual, privately held, potentially floodprone properties within the study area.

5.2 BCA RESULTS – PROJECT AREAS

The Flood Module component of the BCA tool was used to determine the benefits for each of the six projects developed within the Pine Hill LFA. The initial results are presented in Table 5-1. The benefits for the projects are derived based solely on flood reductions and affected structures (i.e., homes and businesses).

Table 5-1 Initial LFA Project Area BCA Results

LFA Project Area	BCR*
1 – Bonnie View Avenue at Station Road	0.03
2 – Bonnie View Avenue	0.00
3 – Mill Street	0.06
4 – Upper Main Street Over Alton Creek	0.08
5 – Academy Street	0.00
6 – Lower Main Street Over Birch Creek	0.25

*The benefits are derived based solely on flood reductions and affected structures (i.e., homes and businesses). Benefits derived from replacement of a bridge or culvert can also be calculated but would require additional information about each crossing.

Benefits derived from the replacement of a bridge or culvert can also be calculated using the BCA tool and would increase the BCR but would require additional information about each crossing. Additional information needed to calculate benefits from replacement of a bridge or culvert includes the following:

- Historic Damages: Historical data on past damages for each bridge or culvert includes monetary damages, impact days, and number of volunteers needed due to a flood event.

- Benefits that could be generated for avoiding future cleanup, avoided detours, avoided emergency response, etc.

- Economic Loss Per Day of Loss of Function: This regards surrounding homes and businesses that are affected due to a loss of bridge or culvert. Information needed includes estimated number of one-way traffic detour trips per day, additional time per one-way detour trip, and number of additional miles traveled.

Table 5-2 has additional details about this information for each project area as well as some supplementary data to consider.

Table 5-2 Detour Lengths for Crossings in Project Areas

Project Areas and Crossings	Area Normally Serviced	Detour Length	Additional Time per One-Way Detour Trip	**Crossing Critical to Other Detours**	Estimated Number of One-Way Traffic Detours a Day*	Residents Stranded if Crossing Damaged?	Critical Crossing for Emergency Response?
1 – Bonnie View Avenue at Station Road	1 – 5 Homes 1 Critical Facility	None	N/A	N/A	4-20	Yes	Yes
2 – Bonnie View Avenue between Station Rd and Mill St	6 – 10 Homes	< 1 mile**	1.14 minutes	Yes	24-40	No	No
3 – Mill Street	6 – 12 Homes	< 1 mile	1.14 minutes	Yes	24-48	No	No
4 – Main Street over Alton Creek	16 – 20 Homes, 6 – 10 Businesses	< 1 mile	1.42 minutes	Yes	280 (AADT - 1998)	No	Yes
5 – Academy Street	11 – 15 Homes, 1 Business	< 1 mile	1.42 minutes	Yes	44-60	No	No
6 – Lower Main Street over Birch Creek	21 – 25 Homes, 6 – 10 Businesses, 1 Critical Facility	1 mile	2 minutes	No	271 (AADT - 2017)	No	Yes

*When DOT AADT data is not available, it was assumed there were two people living in each home and each drove across the bridge twice a day.

**While there is a detour for Bonnie View Avenue, the detour includes Mill Street. Mill Street is not accessible for vehicles with wider spans, like fire trucks and, therefore, has an impact on emergency response.

A numerical BCR score derived using the FEMA BCA tool may not adequately capture all potential benefits of a proposed project. For example, a project that mitigates flooding and also removes a known source of water quality impairment, such as a fuel storage facility, from a flood prone area in a drinking water supply watershed may receive a low BCR score if the full scale of water quality benefits are not fully captured in the BCA. Similarly, a culvert replacement project that reduces flooding and also eliminates a known safety hazard, such as roadway washout, may receive a low BCR score if human safety is not adequately considered. For this reason, in addition to the BCR scores in Table 5-1, brief narratives describing each recommended project and its benefits are provided below. The narratives should be considered in combination with the numerical scores when weighing the projects for potential funding.

Project Area 1: Bonnie View Avenue at Station Road

There are four crossings over Alton Creek close to the intersection of Station Road and Bonnie View Avenue. The first crossing is a shed on top of a concrete slab; the next is a stone and metal crossing; the third is Station Road, which is closed to vehicular traffic due to structural deficiencies; the fourth is Bonnie View Avenue, which is open to traffic but also needs structural repairs. All four crossings are hydraulic constrictions and overtop in the modeled 10-year flood event.

This crossing is necessary to access a couple of houses on Bonnie View Avenue and the water treatment facility. No detour is available. The roadway flooding caused by the constricted channel increases the extent of the impact from this crossing, potentially blocking safe access to houses to the east on Bonnie View Avenue as well.

Implementation of the recommended project would reduce channel entrenchment and reduce flood levels and flood velocities by increasing the channel width to match the active channel width and creating floodplain. Removing the unused, undersized stream crossings would further reduce floodwater levels and velocities. Depending on the extent of channel widening, it may be necessary and beneficial to raise the road as well. The combined effect is a reduced risk of flooding along Bonnie View Avenue.

Project Area 2: Bonnie View Avenue between Station Road and Mill Street

This crossing is structurally in poor condition and in need of replacement. Metal plates have been placed on the deck due to poor condition. It is also limiting the access of construction vehicles to the county bridge, which is also due for repairs. The current bridge passes the 10-year flood event without overtopping but with backwater flooding. Based on the flood risk and poor structural condition, the bridge is a high priority for replacement. The town wants to ensure that the replacement structure is properly sized to reduce flooding.

The only detour available for this crossing, via Mill Street and Station Road, is not passable for large vehicles such as fire trucks and may not be available during flood events. The Mill Street culvert (Project Area 3) is also vulnerable to flooding and is recommended for replacement in this report. The intersection of Station Road and Bonnie View Avenue (Project Area 1) is flood prone as well due to channel constrictions, which are addressed in the recommendations for the site.

Alton Creek's high banks disconnect the channel from the floodplain in this project area. It is recommended to lower the floodplain for more effective use. Increasing the channel width downstream of the crossing will give the channel the space it needs and thereby reduces erosion. Additionally, it is recommended to create a floodplain on the undeveloped right bank to further reduce flood levels.

Project Area 3: Mill Street

Mill Street crosses Alton Creek with a historic stone arch culvert. The channel is constricted in this reach with stone vertical walls and a garage on the right bank just upstream of the crossing. The creek turns sharply to the right as it passes under the bridge. The existing culvert's capacity is sufficient to pass a 10-year flood event without overtopping. However, backwater flooding does occur. The flood risk at this crossing makes it a medium priority for replacement.

Culvert replacement and channel widening is recommended in this area. Widening the channel to the active channel width will support conveyance and reduce the flood risk. It is recommended to remove the garage to create space for a wider channel. It is recommended to upsize the culvert in concert with the widened channel.

A couple of houses along Mill Street and Station Road are accessible via the Mill Street crossing. There is a detour available via Bonnie View Avenue and Station Road. However, the detour includes other vulnerable areas such as the Bonnie View Avenue crossing between Station Road and Mill Street (Project Area 2) and the intersection of Bonnie View Avenue and Station Road (Project Area 1). Both sites are included in this report with recommendations to reduce flood risk. Inversely, the Mill Street culvert provides necessary access to the detour for the other two sites.

Project Area 4: Upper Main Street over Alton Creek

With multiple businesses and houses, Main Street is the central artery of Pine Hill. It also provides access to critical facilities such as the community center and fire station, so safe passage during a flood event is necessary. While a detour is available, it includes other vulnerable crossings, namely Academy Street (Project Area 5) or lower Main Street over Birch Creek (Project Area 6).

The Main Street bridge over Alton Creek is at the northwest end of the road. The banks at the inlet are stacked stone, which have been damaged in past floods. Large stones seen at the outlet have been moved from upstream of the crossing by past floods. The constricted channel has no floodplain in this section, with houses on both sides of the channel upstream of the bridge. Due to the flooding and damage to the stream walls during high flow events, this crossing is a medium priority for replacement. It is recommended to increase the channel width to reduce the flow velocities and subsequent shear stress along the banks. The bridge span should then also increase to accommodate the widened channel.

Project Area 5: Academy Street

The historic arch at this location has been retrofitted and now includes a corrugated metal pipe and concrete box inlet. The span is significantly smaller than the active channel width and contributes to scour at the outlet. Modeling of Birch Creek shows that the Academy Street culvert overtops in a 10-year flood event. A detour is available but may not be accessible during a flood event due to other vulnerable crossings such as the upper Main Street bridge over Alton Creek (Project Area 4). During 50- and 100-year flood events, the backwater flooding may also block safe passage along Birch Creek Road. A 4-mile detour is then necessary for residents via Route 28 and Barley Road.

Due to the low capacity of the culvert and the severity of subsequent flooding, this culvert is a medium priority for replacement. The new crossing should have an open bottom with a constant slope as recommended by the NYSDEC to support aquatic organism passage.

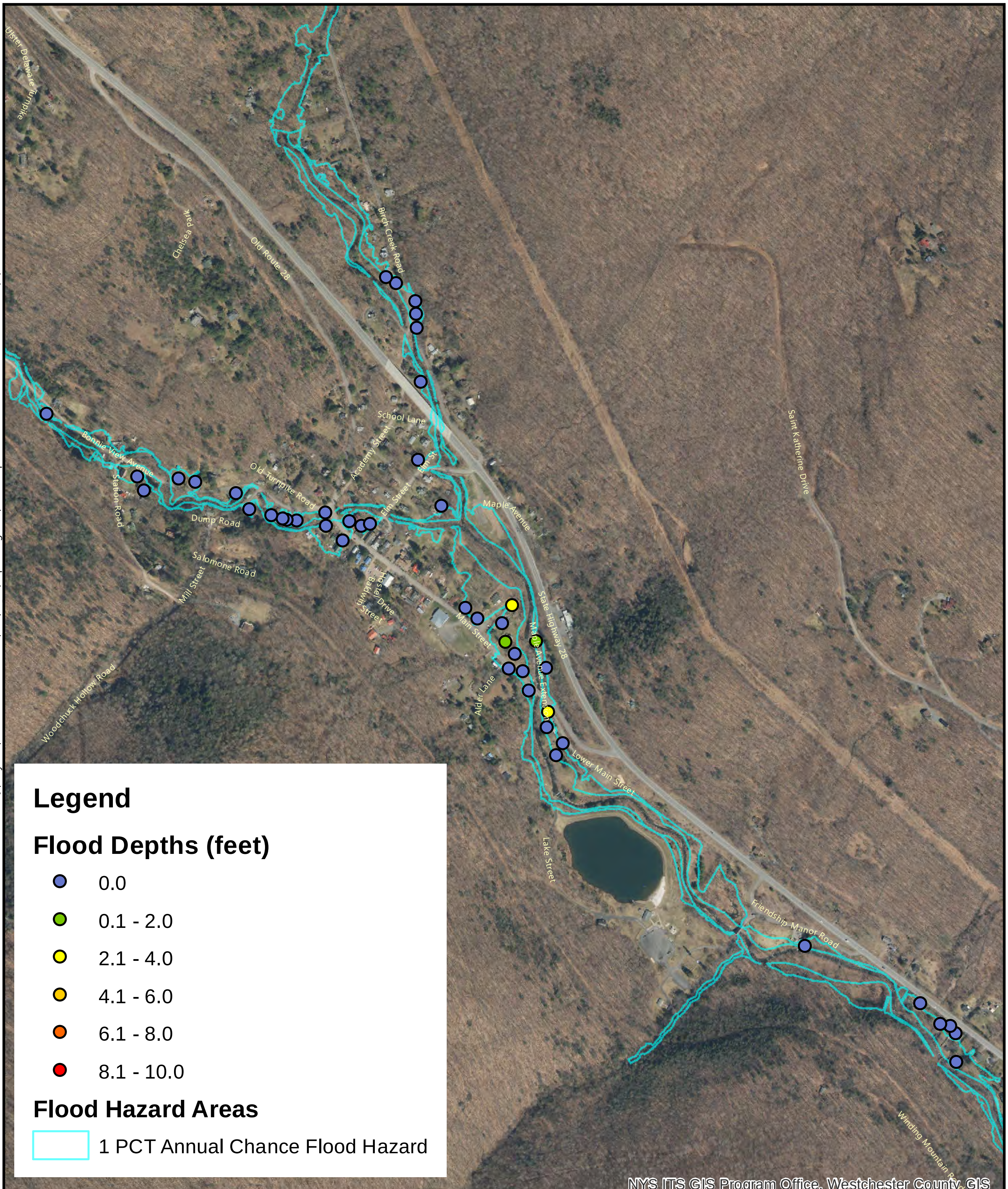
Project Area 6: Lower Main Street over Birch Creek

Main Street is also prone to flooding at the bridge over Birch Creek. Numerous residents cited flooding of this bridge, both from the creek and from water running down Main Street. This crossing is in a low-lying area and has multiple houses on both sides of the watercourse. Main Street has critical facilities, including the fire station and community center, which must be accessible during a flood event. There are also fuel tanks nearby, which may cause water quality issues if flooded.

Birch Creek is prone to flooding both upstream and downstream of the Main Street crossing. Modeling shows that overtopping occurs at flows greater than the 10-year flood event. However, backwater flooding occurs at flows less than the 10-year flood event. Due to the history of flooding and the low capacity, this crossing has been deemed a medium priority for replacement. Increasing the span of the bridge only slightly reduces the risk of overtopping but significantly reduces backwater flooding. Upstream of the crossing, there is undeveloped land along the right bank, which may be used as a floodplain. Lowering the level of the floodplain will increase capacity and reduce the reach of the floodwaters. This is also the case further downstream of the crossing. However, directly downstream of the Main Street crossing is constricted by houses on both banks. Further widening of the bridge and floodplain will require the removal of one or both houses at the outlet. It is recommended to increase the channel width to the active channel width to increase conveyance to the floodplains further downstream.

5.3 INDIVIDUAL PROPERTIES

It was decided by SAFARI that BCA scores for individual properties would not be published as part of this report. Instead, a series of maps was produced showing which properties have first FFE that would be inundated in the 10-, 50-, 100-, and 500-year flood events. These are shown, respectively, in Figures 5-1, 5-2, 5-3, and 5-4. In the 10-year flood event, four FFEs are inundated. In the 50-year flood event, 19 FFEs are inundated. In the 100-year flood event, 25 FFEs are inundated. In the 100-year flood event, 35 FFEs are inundated.



SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

INUNDATED FIRST FLOOR ELEVATIONS - 10 YR FLOOD EVENT

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

0 500
Feet

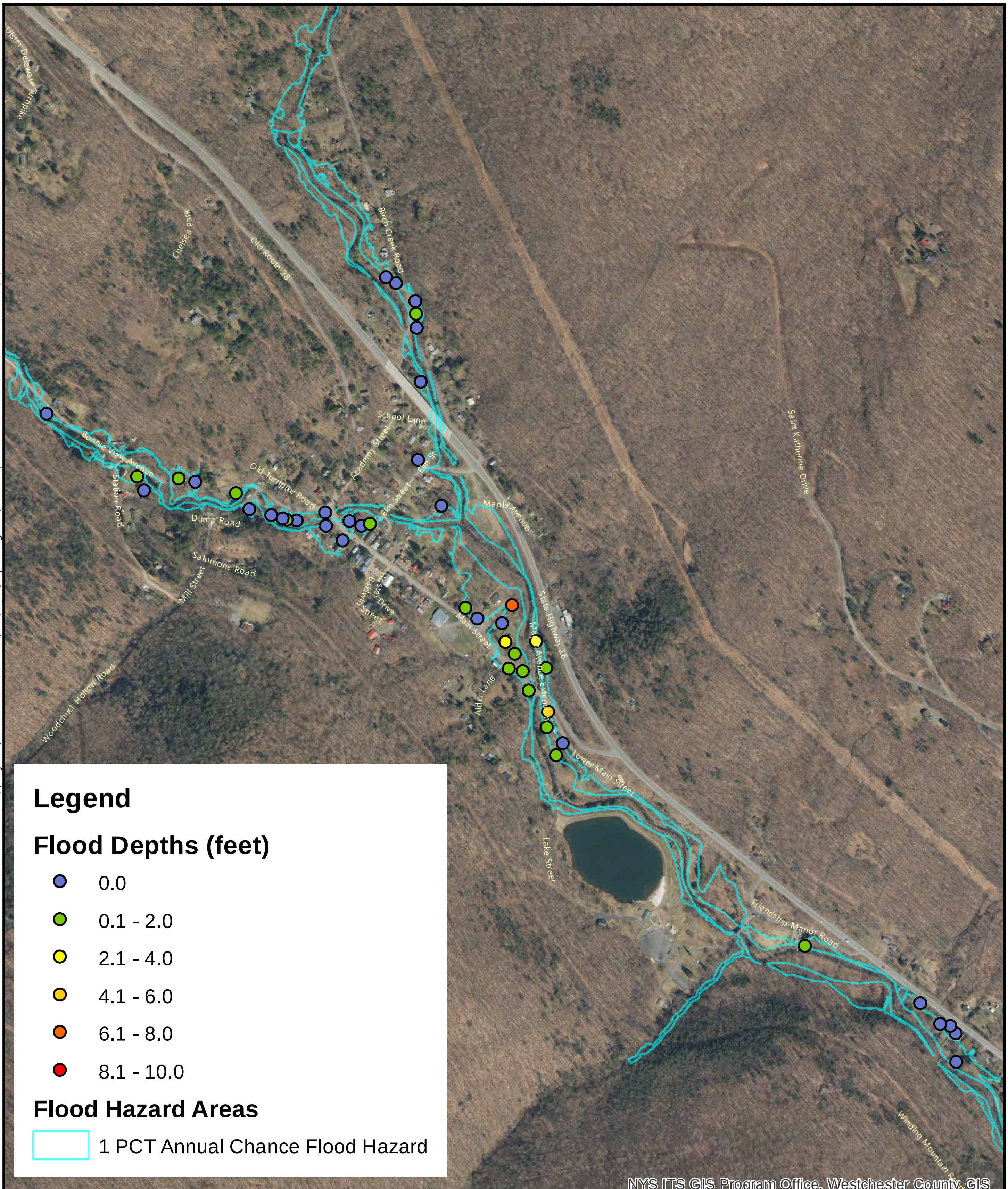
SCALE 1 " = 875 '

DATE 11/3/2022

142.14615.00030
PROJ. NO.

FIG. 5-1

Date Saved: 11/3/2022
Document Path: Q:\Projects\4615-30 Pine Hill LFA\GIS\MXD\Report Figures\FloodDepths.mxd



SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

INUNDATED FIRST FLOOR ELEVATIONS - 50 YR FLOOD EVENT

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

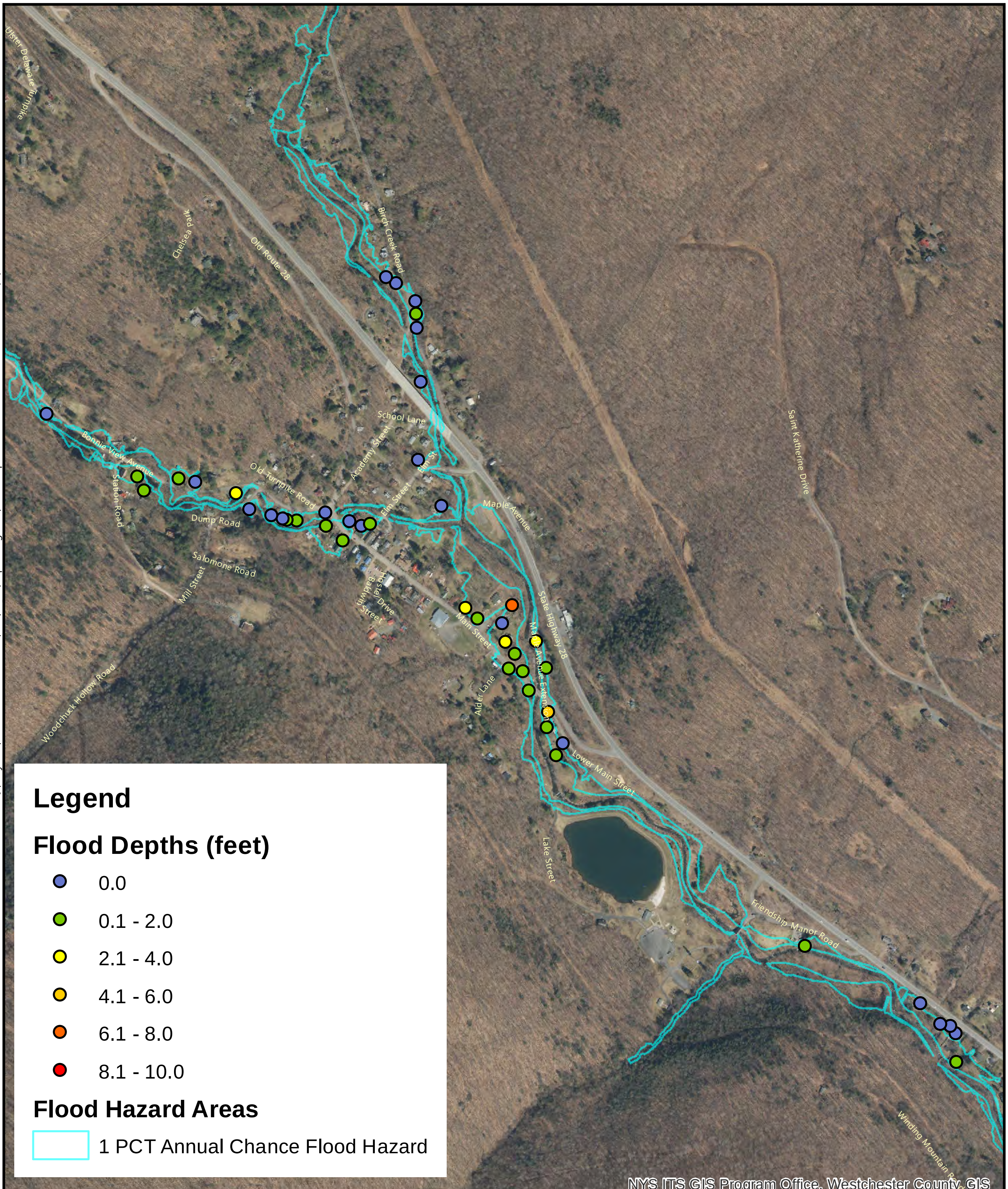
0 500
Feet

SCALE 1 " = 875 '

DATE 11/3/2022

142.14615.00030
PROJ. NO.

FIG. 5-2



SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

INUNDATED FIRST FLOOR ELEVATIONS - 100 YR FLOOD EVENT

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

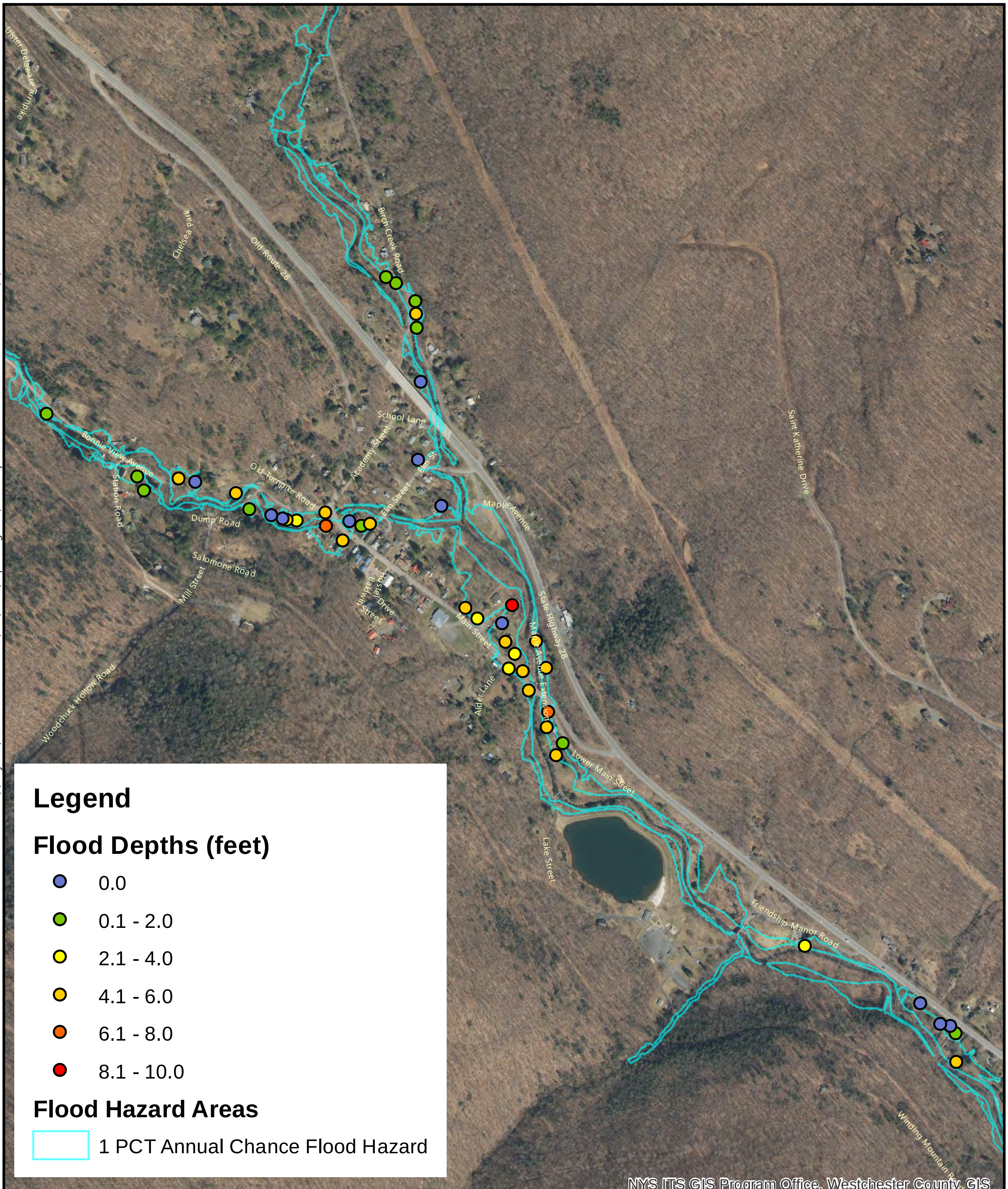
0 500
Feet

SCALE 1 " = 875 '

DATE 11/3/2022

142.14615.00030
PROJ. NO.

FIG. 5-3



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

INUNDATED FIRST FLOOR ELEVATIONS - 500 YR FLOOD EVENT

LOCAL FLOOD ANALYSIS
HAMLET OF PINE HILL
ULSTER COUNTY, NEW YORK

N

0 500
Feet

SCALE 1 " = 875 '

DATE 11/3/2022

142.14615.00030
PROJ. NO.

FIG. 5-4

6. PROJECT COSTS AND FUNDING SOURCES

6.1 ROUGH ORDER OF MAGNITUDE COST ESTIMATES

To assist with prioritization of the above recommendations, Table 6-1 provides an estimated cost range for projects. Due to the conceptual nature of recommended actions and the significant amount of data required to produce a reasonable rough order of magnitude cost, it is not feasible to further quantify the cost of all actions. Costs of land acquisition and easements are not included in the costs.

Table 6-1 Cost Range of Projects

Project	\$500k - \$1M	\$1M – \$2M	\$2M - \$3M
1 – Bonnie View Avenue at Station Road			X
2 – Bonnie View Avenue between Station Road and Mill Street		X	
3 – Mill Street	X		
4 – Upper Main Street over Alton Creek		X	
5 – Academy Street		X	
6 – Lower Main Street over Birch Creek			X

6.2 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 New York State 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 6-2). 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. Given the high cost of the projects recommended in this LFA, state and federal funding will likely be required for project design and implementation.

Table 6-2 Potential Funding Source for Flood Mitigation Alternatives

Recommendation	Potential Eligibility		
	Federal	State	Local
Replacement of assessed bridges and culverts with an appropriately sized structure		Bridge NY, NYSDOT	Ulster County, CWC, AWSMP
Debris removal following floods	USACE, EWP		CWC
Floodplain enhancements	FEMA	NYSDEC, EFC	AWSMP
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, NYCDEP
Anchor fuel tanks			CWC
Feasibility study to assess individual flood mitigation alternatives for individual properties			CWC
Riparian buffer restoration projects		NYSDEC, EFC	AWSMP

AWSMP = Ashokan Watershed Stream Management Program
CWC = Catskill Watershed Corporation
EFC = Environmental Facilities Corporation
EWP = Emergency Watershed Protection Program
FEMA = Federal Emergency Management Agency
NYSDEC = New York State Department of Environmental Conservation
NYCDEP = New York City Department of Environmental Protection
NYSDOT = New York State Department of Transportation
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. In the Ashokan watershed, the program is implemented by AWSMP.

Contact information is as follows:

Cornell Cooperative Extension of Ulster County
Ashokan Watershed Stream Management Program
P.O. Box 667, 3130 Route 28
Shokan, New York 12481
(845) 688-3047

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 Shandaken 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/

It is important to note that 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.

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 floodprone 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.

Historic Homeownership Rehabilitation Credit Program

Rehabilitation of historic residential buildings within the Pine Hill Historic District may qualify for a New York State tax incentive. The Historic Homeownership Rehabilitation Credit program offers a state income tax credit equal to 20 percent of qualified rehabilitation expenses associated with repair, maintenance, and upgrades to historic homes. The value of the credit is applied to the property owner's NYS tax liability to reduce the amount owed. The program covers 20 percent of qualified rehabilitation expenses up to a credit value of $50,000 per year.
https://parks.ny.gov/shpo/tax-credit-programs/#:~:text=Rehabilitation%20of%20historic%20residential%20buildings%20may%20qualify%20for,with%20repair%2C%20maintenance%2C%20and%20upgrades%20to%20historic%20homes.

Other Potential Sources of Funding

New York State Grants

All New York State grants are now 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.

New York State Department of Environmental Conservation Trees for Tribs Program

NYSDEC's Trees for Tribs is a statewide program that has been working to reforest New York's tributaries. The program's goal is to plant trees and shrubs along streams to create a forested riparian (streamside) buffer that helps decrease erosion, reduce flooding damage, improve wildlife and stream habitat, and protect water quality. https://www.dec.ny.gov/animals/77710.html

Private Foundations

Private entities such as foundations are potential funding sources in many communities. The Town of Shandaken and SAFARI 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 Shandaken 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.

7. REFERENCES

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