FLOOD MITIGATION & RESILIENCE REPORT

Blind Brook - SD 969 mod 1

Prepared for:

New York State Department of Environmental Conservation,
in cooperation with the New York State Office of General Services

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New York State Office of General Services
Empire State Plaza
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ACRONYMS

AOP	Aquatic Organism Passage
BFE	Base Flood Elevation
BIN	Bridge Identification Number
CFS	Cubic Feet per Second
CRRA	Community Risk and Resiliency Act
DEC	Department of Environmental Conservation
EFC	Environmental Facilities Corporation
EWP	Emergency Watershed Protection
FEMA	Federal Emergency Management Agency
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*
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HRA	High Risk Area
LiDAR	Light Detection and Ranging
LWRP	Local Waterfront Revitalization Program
MHHW	Mean Higher-High Water
MPH	Miles per hour
MTA	Metro-North Railroad
MWRR	Municipal Waste Reduction and Recycling
NAACC	North Atlantic Aquatic Connectivity Collaborative
NBI	National Bridge Inventory
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
NYRCR	New York Rising Community Reconstruction
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSOGS	New York State Office of General Services
OPRHP	Parks, Recreation, and Historic Preservation
PAS	Planning Advisory Service
PDM	Pre-Disaster Mitigation Program

RCP	Representative Concentration Pathway
RFC	Repetitive Flood Claims
SFHA	Special Flood Hazard Area
SLR	SLR Engineering, Landscape Architecture, and Land Surveying, P.C.
SRL	Severe Repetitive Loss
STA	Station (river)
SUNY	State University of New York
SWPPP	Stormwater Pollution Prevention Plan
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WSP	Water Supply Paper

SUMMARY

This analysis of the Blind Brook watershed is being conducted as part of the Resilient New York Program, an initiative of the New York State Department of Environmental Conservation. The Blind Brook originates in southeastern Westchester County, near the New York/Connecticut border, and drains southward through New York to Long Island Sound. When measured at its outlet, the Blind Brook watershed is 11.5 square miles in size.

Westchester County, including the Blind Brook watershed, has an active history of flooding. According to National Oceanic and Atmospheric Administration (NOAA) historical records, there have been nine direct hits by hurricanes to New York State over the past century. The floods that resulted in the largest magnitude flows on Blind Brook include an April 2007 Nor'easter, the August 2011 Tropical Storm Irene, and the September 2021 Tropical Storm Ida.

The Blind Brook watershed is part of the greater New York Metropolitan Area. Developed land is the most common land cover, representing 80 percent of the watershed. Forested land consists of deciduous, coniferous, and mixed forest types and makes up another 18 percent of the land cover. An analysis of watershed land use is conducted as part of this analysis, and a Flood Resiliency Best Practices Audit is conducted for each community within the watershed.

Floodprone High Risk Areas, or HRAs, within the watershed were identified, and an analysis of flood mitigation considerations within each HRA was undertaken. Factors with the potential to influence more than one HRA were also evaluated and discussed. Flood mitigation recommendations are summarized below and presented in more detail in Section 5 of this report.

High Risk Area (HRA) 1 includes the downstream-most, tidally influenced reach of Blind Brook, which is exposed to variable sources of flooding, including tidal surge flooding at Milton Harbor, riverine flooding along Blind Brook, or a combination of both. A mix of residential and nonresidential buildings are vulnerable to flooding in HRA 1, including the Milton Point Fire House, a critical facility. Flooding is most widespread during a flood event on Blind Brook that coincides with high tide at Milton Harbor. Within HRA 1, several bridges are identified as being hydraulically undersized and are recommended for replacement. Bridges no longer being used are recommended for removal. A new entrance to the Rye Nature Center is recommended, with a driveway that would extend off Boston Post Road just southwest of where it crosses over Blind Brook.

HRA 2 extends from the Central Avenue bridge upstream to just below the I-95/Metro-North bridge. This section of Blind Brook has been heavily channelized and confined by vertical walls as it flows through a densely developed downtown area of Rye. Critical facilities here include the Rye City Hall and the Building Department, City of Rye Fire Department, and medical offices. The hydraulics of Blind Brook through HRA 2 is highly complex, with repetitive flood damage linked to insufficiently sized bridge crossings and an encroached and undersized channel and floodplain. Recommendations in HRA 2 include replacement or removal of undersized bridges and the creation of floodplain along the Blind Brook channel. Strategic acquisition and removal of floodprone homes and businesses will be necessary, both to prevent future

damage to these homes and businesses and also to make room for channel and floodplain improvements. It is recommended that the City of Rye pursue a long-term initiative to create a linear riparian park along Blind Brook throughout HRA 2. This initiative would require the gradual acquisition and demolition of floodprone properties, followed by the establishment of a floodable linear park along Blind Brook.

HRA 3 extends from the I-95/Metro-North bridge over Blind Brook upstream to the I-287 crossing. Here, Blind Brook flows predominantly through residential neighborhoods. The neighborhood between Wappanocca Avenue and Mendota Avenue, which run parallel to Blind Brook, experiences frequent and damaging flooding. HRA 3 also includes a floodprone neighborhood along Wyman Street in the village of Rye Brook. Flooding is driven by a combination of development in floodprone areas and inadequately sized stream crossings. Recommendations in HRA 3 include bridge replacements and floodplain enhancement. The most prominent contributor to flooding in HRA 3 is the crossing that carries the Metro-North railroad and I-95 over Blind Brook. The bridge is a single concrete arch bridge approximately 25 feet wide by 16 feet high. Replacement of this bridge with an adequately sized structure would drastically reduce flood elevations upstream of the crossing.

HRA 4 encompasses Blind Brook in the village of Rye Brook and the town of Harrison in the vicinity of Brook Lane. The brook flows through a trapezoidal channel for most of this section and is tightly squeezed between backyards on the east and a parking lot to the west. At Brook Lane, the construction of a floodplain bench is recommended, measuring approximately 1,200 feet long, with an area of approximately 3.3 acres.

HRA 5 is located at the headwaters of Blind Brook on the SUNY Purchase College campus. Two crossings span Blind Brook in HRA 5. These are Salter Drive, a private road to the SUNY Purchase facilities buildings to the east of the brook, and Lincoln Avenue, a public road. Replacement of the Lincoln Avenue culvert is recommended while channel improvements are recommended immediately upstream and downstream of Salter Drive.

HRA 6 is located near the headwaters of East Branch Blind Brook, a tributary to Blind Brook. The brook flows behind residential buildings within a confined and straighten channel for most of its length. The culverts under Argyle Road, Betsy Brown Road, and Acker Drive were evaluated. Culvert replacements and channel daylighting are recommended in HRA 6.

In addition to the replacement of undersized stream crossings within the HRAs, it is recommended that undersized stream crossings elsewhere in the Blind Brook watershed be identified and prioritized for replacement. Guidance for this prioritization should be based on capacity modeling and on available information regarding the physical condition of the crossing and its impact to aquatic organism passage.

Acquisition and demolition of floodprone properties is a key component to increasing flood resiliency and should be implemented whenever funding is available and landowner willingness exists.

Attenuation of floodwaters in the Blind Brook watershed is being evaluated by others. It is recommended that efforts to increase upstream attenuation of floodwaters, such as at the Bowman Avenue dam, on the SUNY Purchase campus, and along East Branch Blind Brook, be implemented if found to be feasible and cost effective. Watershed municipalities should continue to explore and implement floodwater attenuation scenarios. In addition, further analysis is needed to evaluate downstream impact of upsizing culverts in cases where the culverts impound water during flood events.

A stream gauge was installed along Blind Brook in the early 1940s and decommissioned in 1999. There are currently no active stream gauges on Blind Brook, making statistical analysis difficult. Stream gauges provide valuable data that can be used in future hydrologic analyses and to improve flood monitoring and forecasting. Recommissioning of the former gauge or installation of a permanent new stream gauge is recommended.

An important consideration to mitigate flood damages is to maintain the overall health of the Blind Brook watershed. This includes protection and establishment of wetlands, floodplains, forests, and open space.

The implementation of flood mitigation projects in one area of the Blind Brook watershed has the potential to impact separate areas of the watershed. Therefore, the following recommendations are provided for the prioritization of projects.

- It is important to note that due to the significant impounding effect of the MTA/I-95 bridge and its embankment, increasing the size of the crossing has the potential to increase peak flows downstream of the MTA/I-95 crossing. To offset this potential increase, implementation of upstream detention projects, such as the Bowman Avenue Pond and SUNY Purchase College, should occur prior to replacement of the MTA/I-95 bridge.

- Implementation of recommended improvements through HRA 2, such as replacement of undersized bridges and creation of floodplain benches, should occur prior to replacement of the MTA/I-95 bridge.

- Rigorous hydraulic and hydrologic analyses are recommended as a component on the MTA/I-95 bridge replacement design and the implementation of upstream detention projects to promote further understanding of potential upstream and downstream effects on flooding.

- Implementation of recommended improvements within HRA 3 should begin with replacement of the MTA/I-95 bridge and proceed upstream.

- Aside from the specific recommendations on prioritization made above, improvements can be implemented within each HRA without substantially impacting other HRAs.

- As general guidance, implementation of improvements within each HRA should begin at the downstream end of the HRA and proceed upstream.

Several funding sources may be available for the implementation of recommendation flood mitigation scenarios and are discussed in further detail in this report.

The final section of this report includes an analysis of land use regulations in each watershed municipality as well as best practices that each community can review to assess whether they are already in their municipal code or if there is an opportunity to enhance the code to further protect municipal resources, residents, businesses, and the natural environment from unplanned and unwanted impacts from flooding.

1. INTRODUCTION

1.1 PROJECT BACKGROUND AND OVERVIEW

This work is a component of the Resilient New York Program, an initiative of the New York State Department of Environmental Conservation (NYSDEC), contracted through the New York State Office of General Services (NYSOGS). The goal of the Resilient New York Program is to make New York State more resilient to flooding and climate change. Through the program, flood studies are being conducted across the state, resulting in the development of flood and ice jam hazard mitigation alternatives to help guide implementation of mitigation projects.

Blind Brook originates in southeastern Westchester County near the Connecticut/New York state border. While Blind Brook does not flow through Connecticut a small portion of the state drains into the Blind Brook watershed. Blind Brook drains generally southward through Westchester County, New York, into Long Island Sound. This report begins with an overview of the watercourses and watershed, summarizes the history of flooding, and identifies HRAs within the watershed. An analysis of flood mitigation considerations within each HRA is undertaken. Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor. Flood mitigation scenarios such as floodplain enhancement and channel restoration, road closures, replacement of undersized bridges and culverts, and other strategies are investigated and recommended where appropriate.

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 subject watercourses. Stationing on each watercourse is measured in feet, beginning at station (STA) 0+00 and continuing upstream. Stationing on Blind Brook begins at STA 0+00 at the point where Blind Brook empties into Milton Bay. Stationing on East Blind Brook begins at STA 0+00 at the confluence with the main branch of Blind Brook.

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

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

2. DATA COLLECTION

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

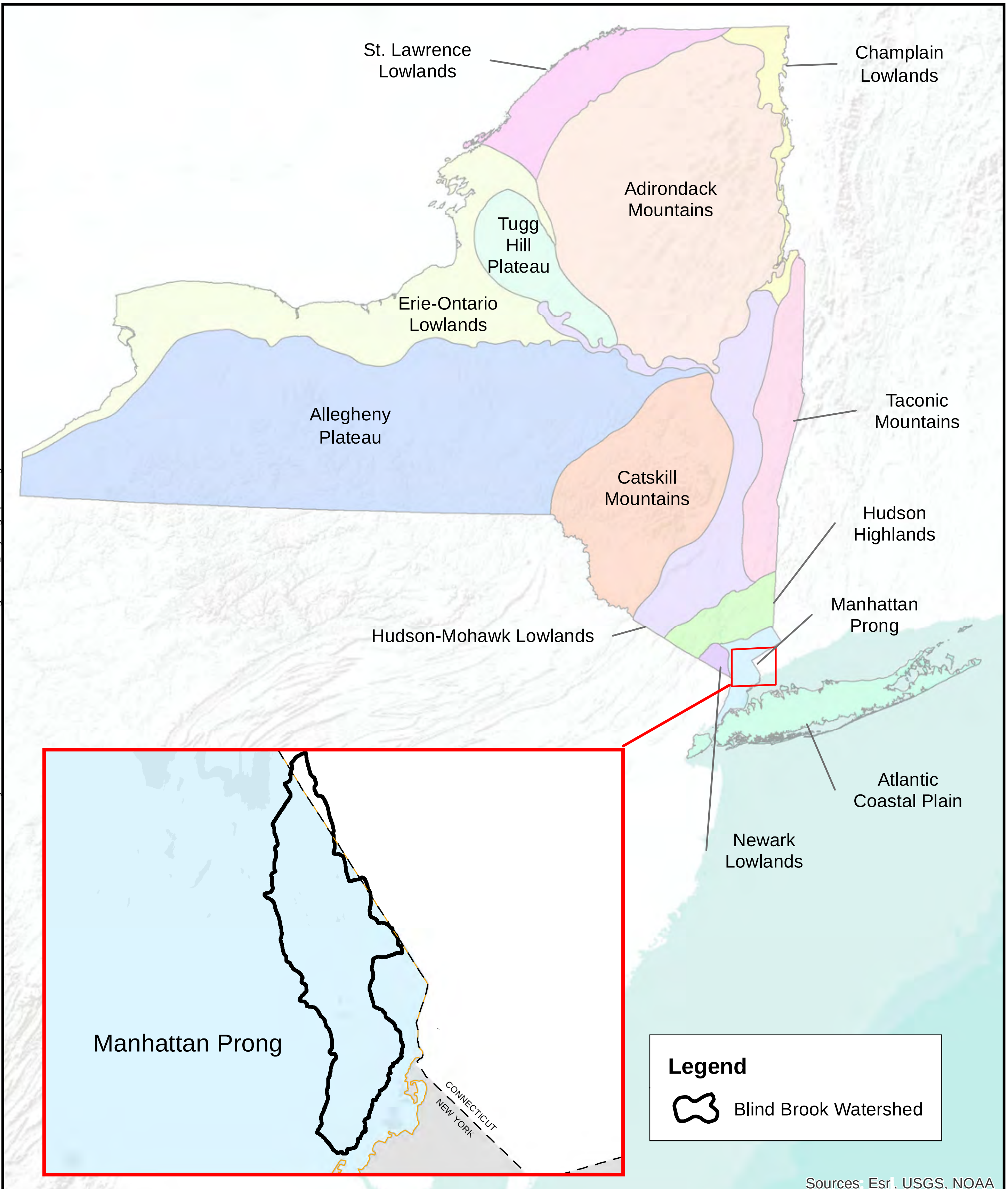
2.1 BLIND BROOK WATERSHED CHARACTERISTICS

The Blind Brook watershed is located in Westchester County, in southeastern New York State, and falls within the physiographic region known as the Manhattan Prong (Figure 2-1). The watershed flows in a generally southerly direction, draining part of the southeastern portions of Westchester County before flowing into Long Island Sound. Nearly the entire village of Rye Brook, the eastern portion of the town of Harrison, and the southeast portion of the village of Port Chester and a portion of the city of Rye drain to Blind Brook.

The Blind Brook watershed is oblong in shape, narrowing toward its outlet to Long Island Sound in New York. When measured at its outlet, the watershed is 11.5 square miles in size. An area of 11 square miles, or just over 95 percent of the watershed, is located within New York State. Figure 2-2 is a watershed map. Figure 2-2A is a watershed map with streets and landmarks. Watershed relief is depicted in Figure 2-3.

The Manhattan Prong is a lowland area with rolling hills and valleys comprised of metamorphic rocks of Early Paleozoic age. The relative age of the following bedrock is unknown but speculated to be sometime within the Cambrian and Ordovician Periods (443.8 to 541.0 million years ago). Two separate sections found in the northern and southern parts of the watershed are mapped as the Hartland Formation, specifically the Schist and Granulite Member. This member is distinguished by brown to gray schist with garnets interbedded with fine-grained granulites. Mapped in the central and most southern section is the Harrison Gneiss, specifically the Quartz Feldspar Gneiss member. This member is comprised of a medium-grained banded gneiss with large, coarse-grained quartz-feldspar segregations. The most northern area of the Blind Brook watershed is mapped as the Manhattan Schist. This formation consists of a dark gray to silvery, medium-grained, foliated schist. Emplaced within the Hartland Formation in the southeastern part of the watershed, a small intrusion of serpentinite is mapped. Serpentinite is a light to medium green weathering, fine-grained metamorphic rock with no foliation or banding present. These rocks and much of southeastern New York rock were tightly folded and metamorphosed primarily during the Taconic Orogeny, a mountain-building event that occurred 450 million years ago. The underlying bedrock influences the topography of the land within the Manhattan Prong, with the metamorphic rocks resistant to erosion making up the hills and the less erosion-resistant rocks creating the valleys.

During the Pleistocene Epoch (11.7 thousand to 2.58 million years ago), New York State was undergoing a period of glaciation. As the glaciers retreated, they deposited mud, sand, and gravel that make the surficial materials seen on land today. Surficial materials underlying the Blind Brook watershed consist primarily of glacial till, with areas mapped as exposed bedrock occurring along the northern and eastern margins of the watershed. A small area mapped as lacustrine silt and clay and outwash sand and gravel exists in the central eastern side of the watershed, near the Connecticut border.



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

NEW YORK STATE PHYSIOGRAPHIC REGIONS

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

SCALE 1 " = 300,000 '

DATE 6/21/2022

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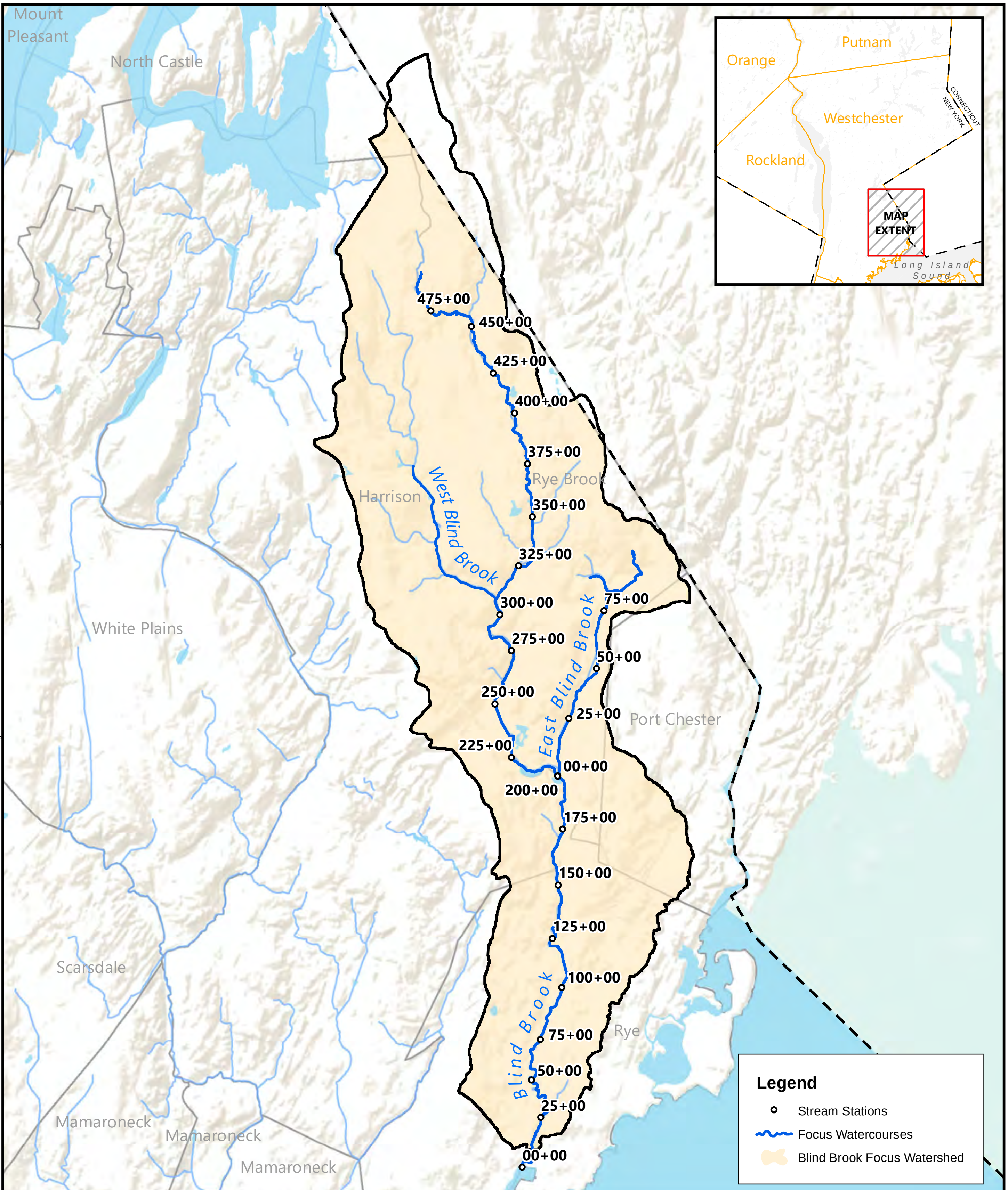
FIG. 2-1



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BLIND BROOK WATERSHED

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

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Feet

SCALE 1 " = 5,500 '

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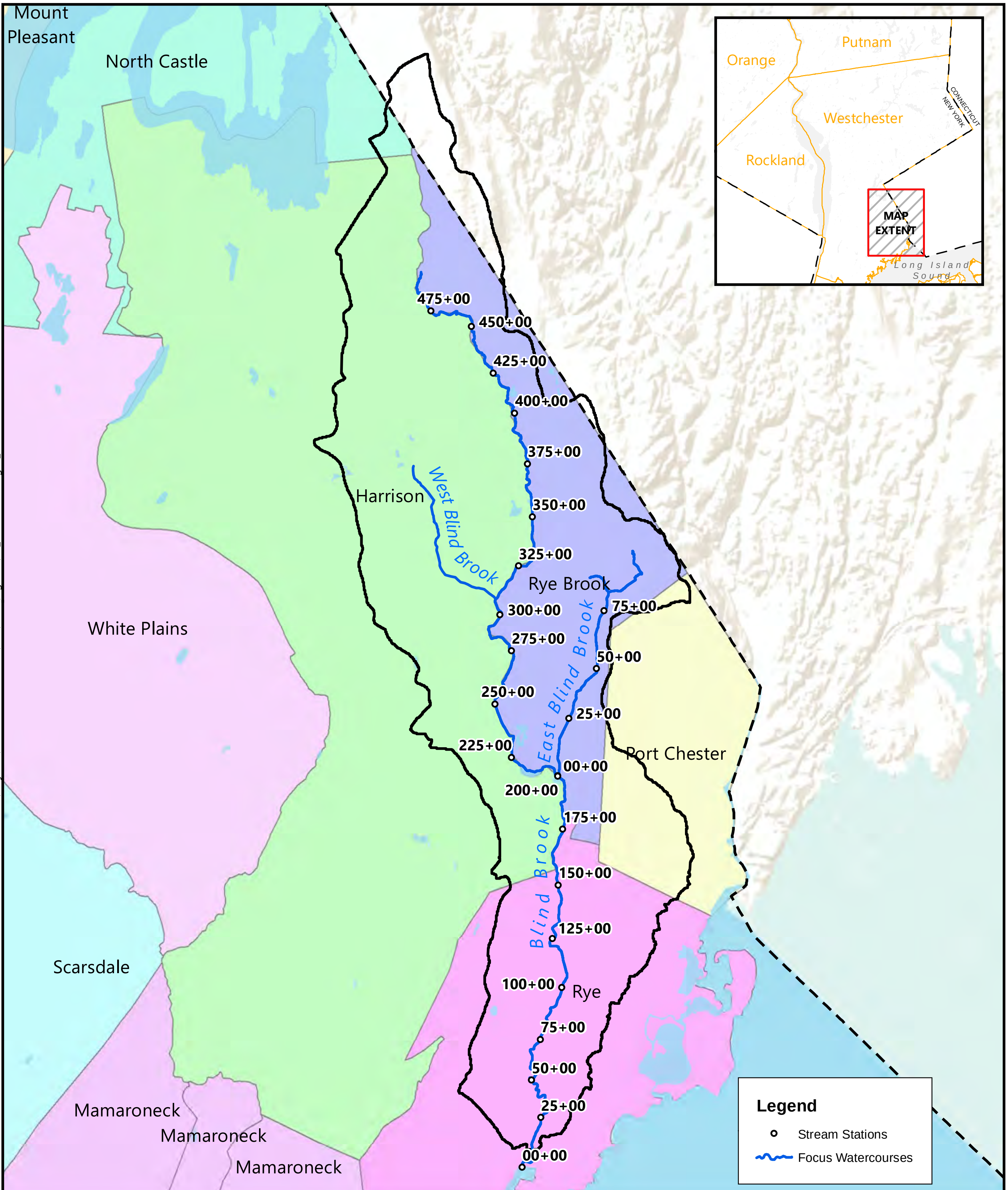
FIG. 2-2



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BLIND BROOK WATERSHED

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969MOD1
WESTCHESTER COUNTY, NEW YORK

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FIG. 2-2A

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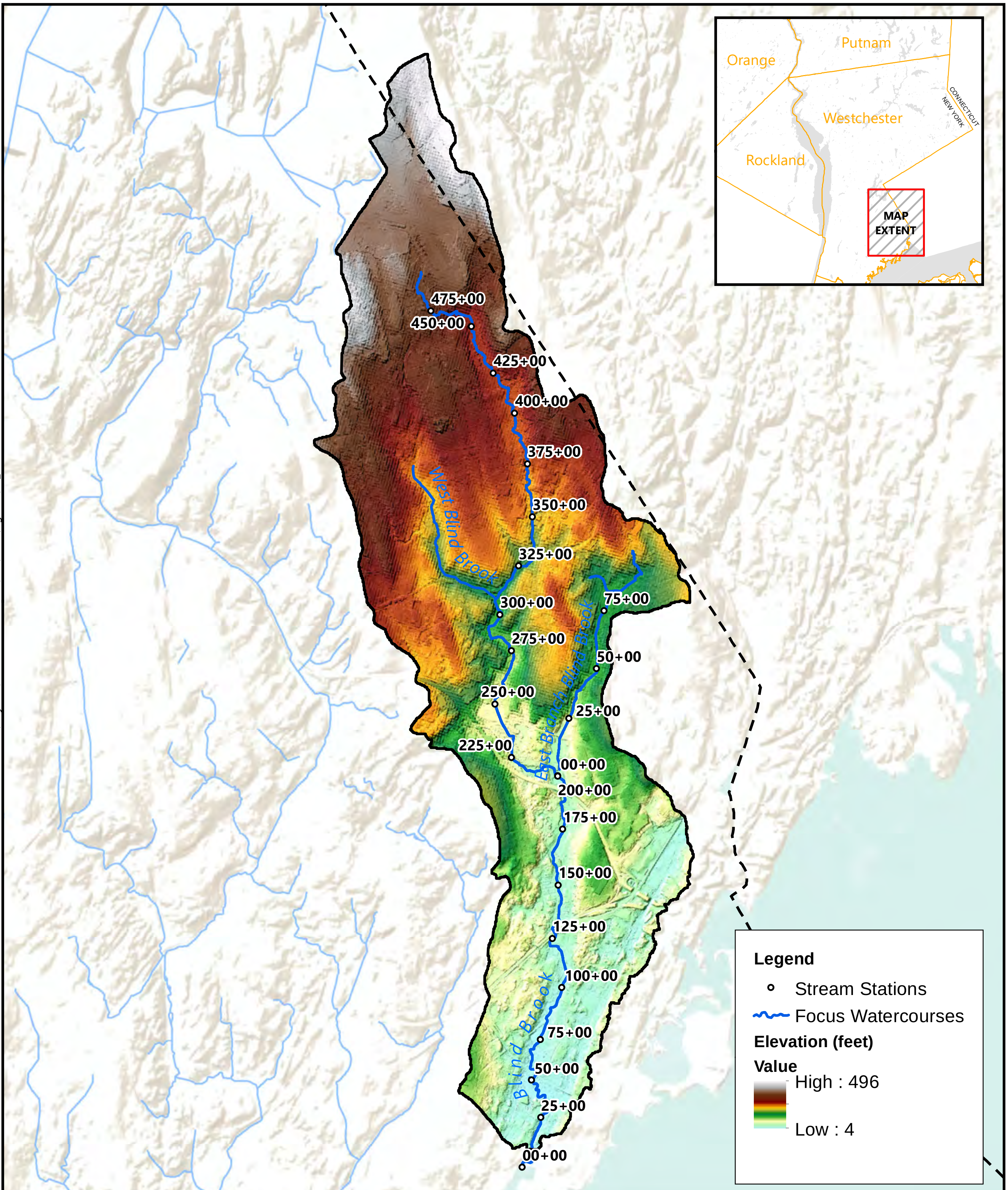

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BLIND BROOK WATERSHED RELIEF MAP

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

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Feet

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FIG. 2-3

During a rainfall event, the proportion of rainfall that runs off directly into rivers and streams or that infiltrates into the ground is greatly influenced by the composition of soils within a watershed. Soils are assigned a hydrologic soil group identifier, which is a measure of the infiltration capacity of the soil. These are ranked A through D. A hydrologic soil group A soil is often very sandy, with a high infiltration capacity and a low tendency for runoff except in the most intense rainfall events; a D-ranked soil often has a high silt or clay content or is very shallow to bedrock and does not absorb much stormwater, which instead is prone to runoff even in small storms. A classification of B/D indicates that when dry the soil exhibits the properties of a B soil, but when saturated, it has the qualities of a D soil. Approximately 50 percent of the mapped soils in the Blind Brook watershed are classified as hydrologic soil group C or D, indicating a low capacity for infiltration and a high tendency for runoff (Figure 2-4). This contributes to flash flooding in the watershed as rainfall runoff moves swiftly into streams rather than gradually seeping through the soils.

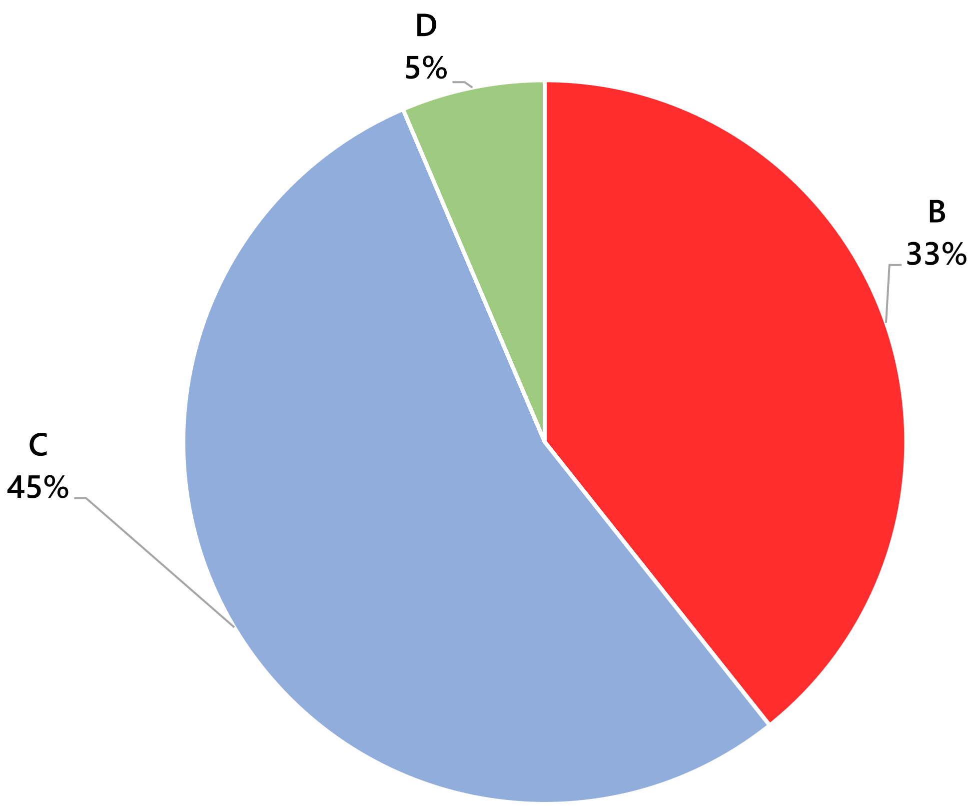


Figure 2-4: Hydrologic Grouping of Soils within the Blind Brook Watershed

Land cover is another important factor influencing the runoff characteristics of a watershed. Land cover within the Blind Brook watershed can be characterized using the 2016 Multi-Resolution Land Characteristics National Land Cover Database for Southeast New York State and is shown graphically in Figure 2-5. Developed land is the most common land cover, representing 80 percent of the watershed. Forested land consists of deciduous, coniferous, and mixed forest types and makes up 18 percent of the land cover in the watershed. Open water and wetlands combined make up 2 percent of the land cover. The remaining 3 percent of the land cover consists of agricultural land, grassland and shrubland, and barren land.

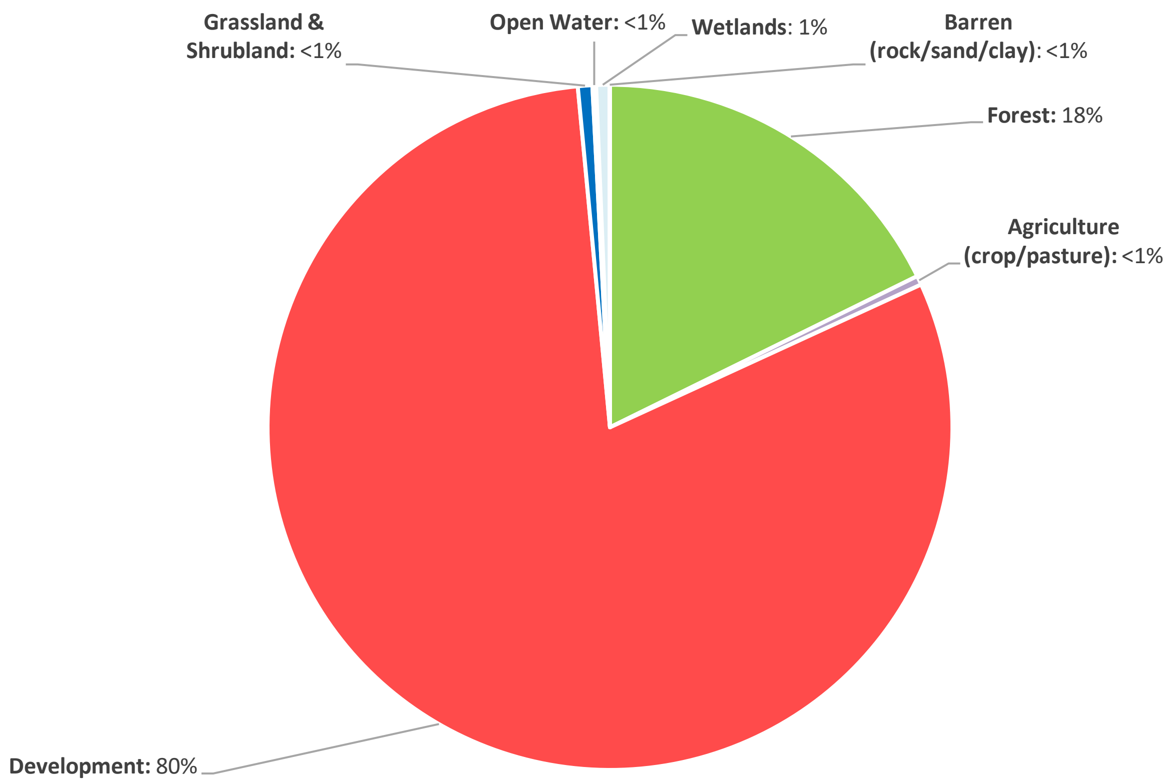


Figure 2-5: Land Cover within the Blind Brook Watershed

> 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.

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 202 acres of wetlands in the Blind Brook watershed, or approximately 3 percent of the watershed. This amount is consistent with the estimate above based on land cover and includes the following types of wetland habitats: estuarine and marine deep water, estuarine and marine wetland, freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, and riverine. NYSDEC-mapped wetlands in the Blind Brook watershed include a 24.8-acre wetland located to the west of the State University of New York (SUNY) Purchase campus and an 18.6-acre wetland east of the campus.

2.2 BLIND BROOK WATERCOURSE

The main stem of Blind Brook originates at Westchester County Airport near the Connecticut/New York border and flows southward, acting as the town border between the town of Harrison and village of Rye

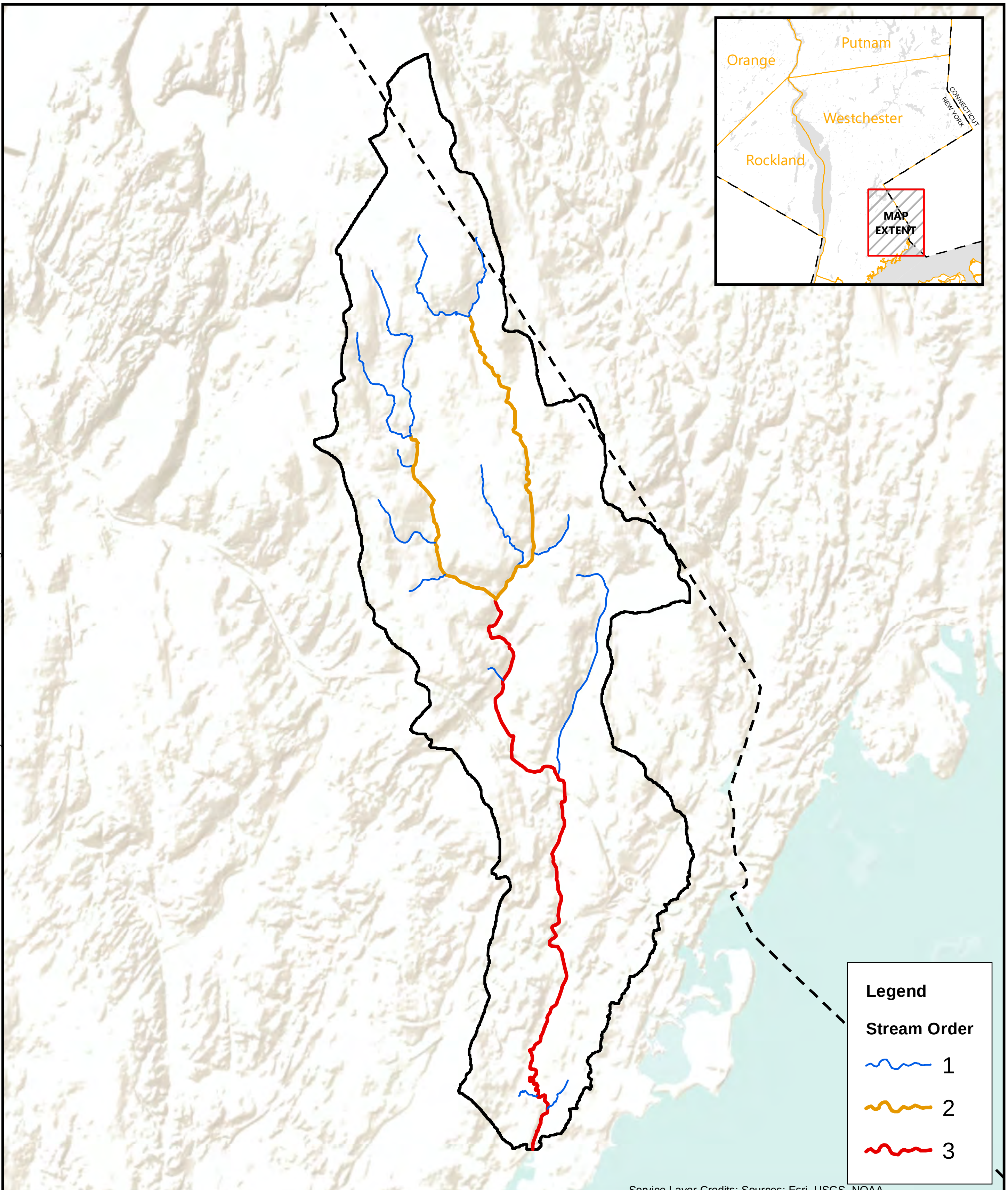
Brook. Blind Brook then continues southward into the city of Rye, eventually emptying into Long Island Sound at Milton Harbor. When measured at the point where Blind Brook enters Milton Harbor, it is approximately 11 miles in length. Named tributaries to the main stem of Blind Brook include the East Blind Brook, West Blind Brook, and Hillside Avenue Tributary.

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 Blind Brook can be characterized as a third-order stream at its outlet where it discharges to Milton Bay. Second-order tributaries include West Blind Brook. First-order tributaries include East Blind Brook and Hillside Avenue Tributary. Figure 2-6 is a map depicting stream order in the Blind Brook watershed.

Characteristics of each order of stream (total length, average slope, and percentage of overall stream network) are summarized in Table 2-1. First- and second-order streams combined account for most of the overall stream length within the Blind Brook watershed (61 percent). First-order streams are steeper in slope than second- and third-order streams.

Table 2-1 Stream Order Characteristics in the Blind Brook Watershed

Stream Order	Total Length (miles)	Percentage of Overall Network Length (%)	Average Slope (%)
1st	9.8	42	2.7
2nd	4.5	19	1.6
3rd	9.2	39	0.6
Total	**23.5**	**100**	



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BLIND BROOK WATERSHED STREAM ORDER

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

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0 2,500 5,000
Feet

SCALE 1 " = 5,500 '

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FIG. 2-6

2.3 HYDROLOGY

Hydrologic studies are conducted to understand historical, current, and potential future river flow rates, which are a critical input for hydraulic modeling software such as Hydrologic Engineering Center – *River Analysis System* (HEC-RAS). These often include statistical techniques to estimate the probability of a certain flow rate occurring within a certain period of time based on data from the past; these data are collected and maintained by 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 2-7.

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

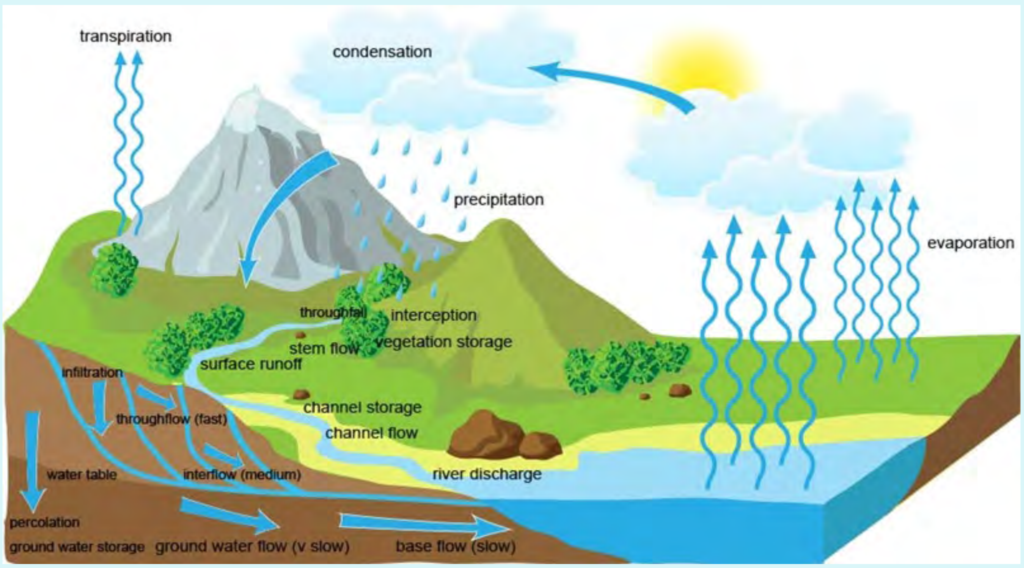

Figure 2-7: Diagram of Simplified Hydrologic Cycle

Flood hydrology for Blind Brook and its tributaries was taken from the FEMA effective Flood Insurance Study (FIS) for Westchester County (36119CV001A, Effective September 28, 2007). The FEMA analysis is the most recently completed hydrologic analysis for Westchester County; therefore, those computed peak flows were used for hydraulic analysis. A preliminary FIS (36119CV001B) has been available since December 2014 but has not yet been adopted. The flood hydrology for Blind Brook and its tributaries reported in the preliminary FIS is unchanged and matches those reported in the effective FIS.

Discharge estimates at various locations along Blind Brook and its tributaries are reported in the FEMA FIS for the 10-, 50-, 100-, and 500-year storm events. Flood estimates along Blind Brook were derived from updated log-Pearson Type III analysis performed on the 46 years of record available at the discontinued USGS stream gauge 01300000 at Rye. Peak discharges were calculated at the gauge site and transferred upstream at various points of interest using drainage area methods described in WRI90-4197 (Lumia, 1990). Mean higher high water on the Long Island Sound was used as the starting water surface elevation and determined via tidal gauge analysis. On East Branch Blind Brook, hydrology was determined using the Rational Method. The 500-year peak discharge amount was extrapolated from the recurrence interval versus discharge log-probability relationship. Normal depth was used for starting water surface elevation. Flood flows in the Blind Brook watershed are presented in Table 2-2.

Table 2-2 Flood Hydrology for Blind Brook Watershed Developed for Westchester County FIS

Watercourse	Location	Drainage Area (sq. mi.)	Peak Flood Discharge (cfs)			
			10 Year	50 Year	100 Year	500 Year
Blind Brook	STA 0+00, at mouth	10.9	1,660	2,731	3,265	4,426
	STA 120+00, at USGS	9.6	1,521	2,497	2,984	4,042
	STA 165+00, at Purchase Street	8.8	1,434	2,353	2,812	3,807
	STA 185+00, at upstream corporate limit	8.3	1,374	2,255	2,694	3,645
	STA 208+00, upstream of confluence with East Branch Blind Brook	7.8	1,317	2,160	2,580	3,490
	STA 260+00, at Bowman Avenue	6.9	1,211	1,986	2,372	3,206
	STA 285+00, at Cross Section O	6.0	1,100	1,803	2,153	2,907
	STA 305+00, at a point approximately 400 feet upstream of Brookside Avenue	3.0	780	1,220	1,535	2,375
	STA 355+00, upstream of New Blind Brook County Club Dam	2.4	575	930	1,135	1,765
	STA 415+00, at Cross Section AM (upstream of Anderson Hill Road)	1.8	425	695	850	1,330
East Branch Blind Brook	STA 0+00, upstream of confluence with Blind Brook	1.2	433	631	717	940
	STA 30+00, upstream of dam	0.9	409	558	648	825
	STA 41+00, upstream of Access Road	0.8	378	519	598	755
	STA 66+00, upstream of Betsy Brown Road	0.7	369	495	576	720
	STA 85+00, upstream of confluence with West branch Blind Brook	0.2	123	165	192	243
Hillside Avenue Brook	STA 0+00, upstream of confluence with East Branch Blind Brook	0.3	188	256	293	350

The web-based tool, "Application of Flood Regressions and Climate Change Scenarios to Explore Estimates of Future Peak Flows," developed by the USGS (Burns et al., 2015a,b) was used to obtain estimates for changes in peak-flood flows under a range of projected climate change scenarios at different periods in the future. This tool was used to assess flooding conditions that may occur in future decades, enabling proactive flood mitigation measures. The web application can be accessed online at the following link: https://ny.water.usgs.gov/maps/floodfreq-climate/

Precipitation data were evaluated for two future scenarios, termed "Representative Concentration Pathways" (RCP), that provide estimates of the extent to which greenhouse gas concentrations in the atmosphere are likely to change through the 21st century. RCP refers to potential future emissions trajectories of greenhouse gases such as carbon dioxide. RCP 4.5 is considered a midrange-emissions scenario, and RCP 8.5 is a high-emissions scenario. Resulting precipitation and runoff estimates are based on five different climate models and are input into the USGS *StreamStats* program, a web-based implementation of regional hydrologic regression equations. Percent increases over *StreamStats* regression estimates based on current climatic data, as computed for the Blind Brook watershed, were applied to corresponding flood flows used in this analysis. The flows based on the more moderate greenhouse gas scenario were used in hydraulic models. Proposed replacement stream crossings were assessed based on the flood flows the structure would be expected to encounter over its design lifetime. When modeling culverts, the 2050 to 2074 projections were employed as a 50-year design life is typical for such structures; the 2075 to 2099 projections were used for bridges, which are often in service for 75 to 100 years or more. Mean estimated increases for the 50- and 100-year floods based on the five climate models are presented in Table 2-3. These are based on regressions for Flood Frequency Region 3 in New York. Current and predicted future flows for Blind Brook and its tributaries at various locations along the watercourses are compared in Table 2-4. It should be noted that the future flow explorer is a tool to approximate future climatic conditions although more appropriate climate change estimation multipliers may be available and required by state regulators. Such values have been derived through detailed methods for specific watersheds at individual hydrologic regions across the state and should be consulted for design purposes.

Table 2-3 Projected Increases (percent) in Flood Flows on Blind Brook

Mean Change in Discharge (%)	2025 to 2049		2050 to 2074		2075 to 2099	
Greenhouse Gas Scenario	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood	50-Year Flood	100-Year Flood
RCP 4.5	16	17	19	20	17	18
RCP 8.5	16	16	17	18	22	23

Table 2-4 Current and Projected Future Flood Flows Used in Hydraulic Analyses in the Blind Brook Watershed

Watercourse	Location	Peak Flood Discharge (cfs) Increase (%)					
		Current		Projected Future (RCP 4.5, 2050 2074)		Projected Future (RCP 4.5, 2075 2099)	
		50 Year	100 Year	50 Year	100 Year	50 Year	100 Year
Blind Brook	At mouth	2,731	3,265	3,250 (19%)	3,918 (20%)	3,195 (17%)	3,853 (18%)
Blind Brook	At USGS	2,497	2,984	2,996 (20%)	3,611 (21%)	2,946 (18%)	3,551 (19%)
Blind Brook	At Purchase Street	2,353	2,812	2,800 (19%)	3,374 (20%)	2,753 (17%)	3,318 (18%)
Blind Brook	At upstream corporate limit	2,255	2,694	2,683 (19%)	3,206 (19%)	2,638 (17%)	3,152 (17%)
Blind Brook	Upstream of confluence with East Branch Blind Brook	2,160	2,580	2,549 (18%)	3,096 (20%)	2,506 (16%)	3,019 (17%)
Blind Brook	At Bowman Avenue	1,986	2,372	2,343 (18%)	2,823 (19%)	2,284 (15%)	2,775 (17%)
Blind Brook	At Cross Section O	1,803	2,153	2,128 (18%)	2,541 (18%)	2,091 (16%)	2,497 (16%)
Blind Brook	At a point approximately 400 feet upstream of Brookside Avenue	1,220	1,535	1,440 (18%)	1,811 (18%)	1,415 (16%)	1,781 (16%)
Blind Brook	Upstream of New Blind Brook County Club Dam	930	1,135	1,079 (16%)	1,317 (16%)	1,060 (14%)	1,294 (14%)
Blind Brook	At Cross Section AM (upstream of Anderson Hill Road)	695	850	799 (15%)	986 (16%)	785 (13%)	969 (14%)
East Branch Blind Brook	Upstream of confluence with Blind Brook	631	717	751 (19%)	853 (19%)	745 (18%)	846 (18%)
East Branch Blind Brook	Upstream of dam	558	648	664 (19%)	778 (20%)	653 (17%)	765 (18%)
East Branch Blind Brook	Upstream of Access Road	519	598	618 (19%)	718 (20%)	607 (17%)	700 (17%)
East Branch Blind Brook	Upstream of Betsy Brown Road	495	576	589 (19%)	691 (20%)	579 (17%)	674 (17%)
East Branch Blind Brook	Upstream of confluence with West Branch Blind Brook	165	192	196 (19%)	228 (19%)	191 (16%)	225 (17%)

Watercourse	Location	Peak Flood Discharge (cfs) Increase (%)					
		Current		Projected Future (RCP 4.5, 2050 2074)		Projected Future (RCP 4.5, 2075 2099)	
		50 Year	100 Year	50 Year	100 Year	50 Year	100 Year
Hillside Avenue Brook	Upstream of confluence with East Branch Blind Brook	256	293	302 (18%)	349 (19%)	297 (16%)	343 (19%)

cfs = cubic feet per second

Long Island Sound flood elevation estimates were obtained from the effective FIS for Westchester County, shown in Table 2-5. Projected sea level rise in the tidal coast was based on New York State Sea Level Rise Projections (6 NYCRR Part 490) that were developed in accordance with the Community Risk and Resiliency Act to help prepare for the coastal impacts of climate change. Projected increases in sea level for the Long Island Region, where Blind Brook is located, are reproduced below as Table 2-6. These are predicted increases over the baseline of the average elevation measured from 2000 to 2004. Several scenarios are possible, ranging from less to more severe; however, "while there is some uncertainty regarding the precise rate at which sea level will rise, there is relative certainty that global sea level will ultimately rise at least six feet over current levels" (6 NYCRR Part 490). For the purpose of this analysis, Long Island Sound tailwater elevations used in hydraulic modeling of future flood scenarios on Blind Brook were increased by 16 inches over the elevations reported in the current effective FIS. This represents the "medium" sea level rise scenario for the 2050s time period.

Table 2-5 Stillwater Flood Elevations in Long Island Sound at City of Rye as Reported in FIS for Westchester County

Flood Event	Stillwater Flood Elevation (feet, NAVD88)
10-Year	8.7
50-Year	11.3
100-Year	12.5
500-Year	16.8

Table 2-6 New York State Sea Level Rise Projections, Long Island Region (from 6 NYCRR 490)

	Projected Sea Level Rise (inches)				
Projection Scenario	Low	Low-Medium	Medium	High-Medium	High
2020s	2	4	6	8	10
2050s	8	11	16	21	30
2080s	13	18	29	39	58
2100	15	22	34	47	72

2.4 HYDRAULICS

To develop hydraulic modeling to assess flood mitigation alternatives, effective FEMA HEC-RAS hydraulic models were sought for areas of the Blind Brook watershed where they were available, which include the Blind Brook, East Branch Blind Brook, and Hillside Avenue Brook. These models were obtained from the NYSDEC, Floodplain Management Section, which is gratefully acknowledged.

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

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

2.5 PREVIOUS STUDIES OF BLIND BROOK

Numerous studies have been conducted, or are currently underway, on Blind Brook and the Blind Brook watershed, many of which have focused on flooding problems. As part of this study, SLR Engineering, Landscape Architecture, and Land Surveying, P.C. (SLR) reviewed the previous studies but did not reevaluate or reanalyze the flood mitigation measures recommended in other studies. Table 2-7 is a summary of known studies.

Table 2-7 Summary of Studies Conducted on Blind Brook and the Blind Brook Watershed

Study	Conducted By	Date
Watershed Plan & Environmental Impact Statement	USDA Soil Conservation Service	July 1979
City of Rye Flood Mitigation Plan	Tessier Environmental Consulting	November 2001
Stormwater Analysis – East Branch Blind Brook	Dolph Rotfeld Engineering, PC	November 2002
City of Rye Hazard Mitigation Plan	Rye City Planning Department and Rye City Manager's Office	April 2007
Flood Mitigation Study – Bowman Avenue Dam Site	Chas. H. Sells, Inc.	March 2008
Blind Brook Watershed Management Plan		March 2009
Update to 1999 Stormwater Management Plan – Westchester County Airport	TRC Engineers, Inc.	December 2010
Bowman Avenue Dam Site – Upper Pond Resizing	WSP Sells/PCR	April 2012
Letter Report – Resizing of Upper Pond	PCR	August 2012
Hydrologic & Hydraulic Analysis – Resizing of Upper Pond	PCR	September 2012
Phase I Supplemental SWPPP – Pepsico Project	JMC	February 8, 2013
Stormwater Reconnaissance Plan for the Coastal Long Island Sound Watershed	Westchester County Department of Planning	August 2013
Hydrologic and Hydraulic Analysis Report (and memos)	Parsons Brinkerhoff	August 2014
NY Rising Community Reconstruction Plan – Rye	NY Rising	December 2014
Upper Bowman Pond Modifications Study (and presentation)	OBG	March 2017
Benefit Cost Analysis for Blind Brook Flood Mitigation	OBG	November 2017
Final Report – Rye Flood Resiliency Projects	OBG	August 2018
Rye Flood Resiliency Projects – Summary of Alternatives and Costs	OBG	September 2018
East Branch Blind Brook Flood Study – Avon Circle, Port Chester Middle School, and Bowman Avenue	AI Engineers	July 2020
Flood Risk Management Study – Federal Interest Determination	US Army Corps of Engineers	April 2021
Ida Flood Review	City of Rye	September 2021
Blind Brook Flood Resiliency – City Council Work Session	Ramboll	May 2022

2.6 STAKEHOLDER MEETINGS

An important component of the data gathering for this study took place through stakeholder engagement. A formal stakeholder meeting was held on February 3, 2022. This meeting was geared toward participation by government agencies and county and municipal staff and included participation from NYSDEC, NYSOGS, Natural Resources Conservation Service (NRCS), and watershed towns and villages. In addition to the formal video conference, many conversations took place with representatives from the watershed municipalities, NYSDEC, NRCS, SUNY Purchase, and other groups and individuals.

2.7 INFRASTRUCTURE

Several bridge and culvert crossings of Blind Brook and its tributaries are contained within identified HRAs and in certain cases may contribute to flooding in these locations. These structures and summary details are listed below in Table 2-8. The span of the crossing and estimated bankfull width of the channel is provided for each crossing location. It should be noted that a crossing span that is narrower than the channel's bankfull width indicates that the crossing may be hydraulically undersized and may be prone to scour or contribute to flooding. Table 2-9 is a summary of dams on Blind Brook and tributaries based on the NYSDEC inventory of registered dams.

Table 2-8 Summary Data for Assessed Bridge and Culvert Crossings of Blind Brook and Tributaries

River	Roadway	River Station (feet)	Structure	NBI BIN* (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
Blind Brook	Oakland Beach Avenue	19+47	Multi-Box Beam or Box Girder Bridge	2225300 (Westchester County)	3	96	49
	Playland Parkway	55+72	Multi-Box Beam or Box Girder Bridge	3349000 (Westchester County)	2	58	47
	Rye Middle/High School	76+43	Unknown	Unknown	1	25	47
	Boston Post Road (1X)	83+79	Masonry Arch Bridge	2225290 (City of Rye)	1	44	47
	Nature Center driveway	87+26	Masonry Arch Bridge	2265280 (City of Rye)	1	32	47
	Nature Center pedestrian bridge	92+54	Concrete Girder and Floor Beam System Bridge	2265290 (City of Rye)	1	25	47
	Central Avenue	100+72	Prestressed Concrete Box Beam Bridge	2225280 (City of Rye)	1	40	46

River	Roadway	River Station (feet)	Structure	NBI BIN* (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
	Orchard Avenue	105+00	Steel Stringer/Multi-Beam or Girder Bridge	225270 (City of Rye)	1	35	46
	Locus Avenue	115+00	Concrete Tee Beam Bridge	2225260 (City of Rye)	1	33	46
	Theodore Fremd Avenue	121+95	Steel Stringer/Multi-Beam or Girder Bridge	3348060 (Westchester County)	1	30	46
	Metro-North Railroad	127+62	Multi-Track Railroad	Not Listed (Metropolitan Transportation Authority)	1	25	46
	NYS I-95	129+00	Concrete Arch Bridge	5514789 (NYS Thruway Authority)	1	30	46
	Highland Road	137+06	Prestressed Concrete Box Beam Bridge	2225250 (City of Rye)	1	31	45
	Purchase Street	165+00	Prestressed Concrete Box Beam Bridge	1037320 (NYSDOT)	1	49	45
	Private Drive	175+00	Unknown	Not Listed	2	41	44
	NYS Route 287	191+99	Concrete Culvert	1044869 (NYSDOT)	3	55	44
	Bowman Avenue (County Road 104)	225+57	Concrete Culvert	3358500 (Westchester County)	2	34	42
	Westchester Avenue (NYS 120A)	241+55	Steel Stringer/Multi-Beam or Girder Bridge	1037380 (NYSDOT)	1	40	42
	Westerleigh Road	295+00	Prestressed Concrete Box Beam Bridge	3348510 (Westchester County)	1	32	40
	Lincoln Avenue	298+09	Steel Stringer/Multi-Beam or Girder Bridge	3348490 (Westchester County)	1	49	40
	Brookside Way Bridge	302+36	Concrete Slab Bridge	2262360 (Town of Harrison)	1	38	40

River	Roadway	River Station (feet)	Structure	NBI BIN* (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
	North Hutchinson River Parkway on ramp	310+00	Concrete Frame Bridge	1077460 (NYSDOT)	1	44	34
	Hutchinson River Parkway	315+00	Concrete Frame Bridge	5524380 (NYSDOT)	1	22	34
	Hutchinson River Parkway	333+28	Concrete Frame Bridge	5524390 (NYSDOT)	1	26	34
	Hutchinson River Parkway	332+32	Concrete Frame Bridge	C890033 (NYSDOT)	1	20	34
	Anderson Hill Road	382+50	Concrete Slab Bridge	3358610 (Westchester County)	1	24	12
East Branch Blind Brook	Bowman Avenue (County Road 104)	5+00	Not Listed	Not Listed (Westchester County)	1	16	25
	Port Chester Middle School footbridge #1	9+58	Not Listed	Not Listed (Unknown)	1	22	24
	Port Chester Middle School footbridge #2	12+80	Not Listed	Not Listed (Unknown)	1	22	24
	Westchester Avenue (NYS 120A)	16+80	Masonry Culvert	C890013 (NYSDOT)	1	5	24
	Longledge Drive	27+63	Not Listed	Not Listed (Unknown)	1	5	24
	North Ridge Road private driveway	41+11	Not Listed	Not Listed (Unknown)	1	10	22
	North Ridge Road long culvert	+/- 55+00	Lot Listed	Not Listed (Unknown)	1	5	22
	Argyle Road	60+90	Not Listed	Not Listed (Unknown)	3	L – 3.8 C –4.5 R – 3.8	21
	Betsy Brown Road	65+80	Not Listed	Not Listed (Unknown)	2	4	21
	Acker Drive	75+00	Not Listed	Not Listed (Unknown)	2	5.5	21

River	Roadway	River Station (feet)	Structure	NBI BIN* (Owner)	Number of Spans/ Barrels	Span (feet)	Bankfull Width (feet) (Regional Regressions)
	Bluebird Hollow	92+20	Not Listed	Not Listed (Unknown)	1	2.5	12

*NBI BIN = National Bridge Inventory Bridge Identification Number

Table 2-9 Summary Data for Dams on Blind Brook and Tributaries

River	River Station (feet)	Description	NYS Dam ID (Owner)	Dam Height (Feet)	Dam Length (feet)
Blind Brook	71+85	Unnamed Low Head Dam near Rye Middle/High School	Not Registered (Unknown)	1	40
	210+00	Bowman Avenue Dam – Hazard Code B	232-1182 (City of Rye)	22	122
	342+92	Unnamed Dam Behind Home on Country Ridge Drive	Not Registered (Unknown)	2	46
	352+66	Blind Brook Club Dam – Hazard Code C	232-2747 (Blind Brook Club)	32	130
	378+25	Unnamed Dam South of Anderson Hill Road Crossing	Not Registered (Unknown)	7	75
East Branch Blind Brook	10+00	Rye Brook Estates Dam – Hazard Code B	232-4333 (Hidden Falls at Rye Brook Homeowners Association)	14	150

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. NYSDEC has provided guidelines for requirements under CRRA, which are summarized in a publication entitled *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act.*

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

- Culverts will be designed to pass the predicted 50-year storm event.
- Bridges will be designed to pass the 50-year storm event with 2 feet of freeboard below the bridge low chord and the 100-year storm event without touching the low chord.
- The structure will not raise the water surface elevations anywhere when compared to existing conditions for both the 50-year and 100-year flood events.
- The proposed bridge's low chord will not be lower than the existing low chord.
- Hydrologic analysis will include an evaluation of future predicted flows. The recommended design-flow multiplier for eastern New York State, which includes the Blind Brook watershed, is 120 percent.
- The maximum skew of the bridge pier(s) to the flow shall not exceed 10 degrees.
- Headwater at culverts will be limited to an elevation that:
    - Would not result in damage to upland property,
    - Would not increase the water surface elevation allowed by floodplain regulations, and
    - Would result in a headwater depth-to-culvert height ratio of not greater than 1.0 for culverts with a height greater than 5 feet and not greater than 1.5 for culverts with a height of 5 feet or less.

NYSDEC stream crossing guidelines recommend, where possible, that the following best management guidelines 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 (AOP).

3. IDENTIFICATION OF FLOOD HAZARDS

3.1 FLOODING HISTORY

Westchester County and the Blind Brook watershed have historically been impacted by hurricanes, tropical storms, and nor'easters. Hurricanes typically produce flooding in the area by generating heavy rainfall over long periods of time, which saturates the soil, and combined with a period of more intense rainfall causes runoff volumes that lead to flooding. There have been nine direct hits by hurricanes to New York State between 1900 and 1996. Table 3-1 is a summary of flood events that impacted Westchester County and the Blind Brook watershed. The flood history is summarized from the FEMA FIS for Westchester County, the Westchester County Hazard Mitigation Plan, and NOAA historical records for Westchester County.

Table 3-1 Westchester County Flood History

Date	Flood Event	Notes
August 1971	Hurricane Doria	Hurricane Doria was the most damaging storm to the United States of the 1971 Hurricane season. 8 to 10 inches of rain fell in southeastern New York. Flooding was extensive. Damages from Hurricane Doria totaled $147.35 million.
June 1972	Hurricane Agnes	Hurricane Agnes produced the largest flow ever recorded at the Blind Brook gauge. USGS gauging station No. 01300000 recorded 2,320 cfs, which is about a 50-year flood. This event caused extensive flooding, which, in turn, damaged houses, yards, streets, and public buildings along the stream.
September 1975	Hurricane Eloise	Hurricane Eloise caused extensive flooding along Blind Brook. USGS gauging station No. 01300000 recorded 2,280 cfs, which is about a 40-year flood. In the southern tier region of New York, over 700 structures were damaged from flooding.
August 1976	Hurricane Belle	Hurricane Belle produced up to 6 inches of rain in southern New York. 30,000 people were evacuated in New York. Damage reported totaled $257 million.
September 1985	Hurricane Gloria	Hurricane Gloria made landfall on Long Island as a Category 2 hurricane. Wind gusts up to 100 mph and 3.4 inches of rain were recorded. $300 million in damage resulted from this storm.
August 1991	Hurricane Bob	Hurricane Bob did not make landfall on New York but came very close. Rainfall amounts totaled 7 inches, and $75 million in damages resulted.

Date	Flood Event	Notes
July 1996	Hurricane Bertha	Hurricane Bertha originally made landfall in North Carolina but had weakened to a Tropical Storm by the time it reached the New York City area. It passed Long Island, producing torrential rain and strong gusty winds. Torrential rain caused flooding of low-lying and poor-drainage areas, streams, and rivers across the area. The heaviest rain fell in a band to the northwest of Bertha's track over the Lower Hudson Valley. Torrential rain caused flooding in Rockland, Orange, Westchester, Nassau, and Suffolk County. Westchester County received 3 inches at Ossining.
October 1996	Unnamed Storm	Heavy rain caused serious widespread flooding. In Westchester County, rainfall amounts ranged from 2.37 inches at Ossining to 4.98 inches at Dobbs Ferry.
January 1999	Unnamed Storm	An intense narrow band of torrential rain developed within a large area of steady rain and passed over Westchester County. Rain fell on frozen ground, which caused rapid runoff that caused extensive flooding in areas across southern New York. In Westchester County, rainfall amounts ranged from 1.67 inches at Yorktown Heights to 2.84 inches at White Plains.
September 1999	Remnants of Hurricane Floyd	Tropical depression by the time it reached Westchester County. Widespread flooding in Rockland, Orange, Putnam, and Westchester Counties; total damage costs estimated at $14.6 million. Rainfall amounts ranged from 5 inches at Tuckahoe to 12.55 inches at Granite Springs.
September 2004	Hurricane Frances	Extensive flooding across Southeastern New York. Rainfall ranging from 1 inch to 6 inches was recorded across Westchester County. In Mamaroneck, Rye, and Harrison, rowboats and payloaders were used to rescue people from flooded homes and vehicles.
October 2005	Unnamed Storm	Periods of heavy rain fell on southern New York from Friday night through Saturday. The heaviest rain fell north of New York City across the Lower Hudson Valley. This resulted in significant flooding on some rivers and throughout urban areas. Rainfall amounts in Westchester County ranged from 5.25 inches at Westchester County Airport in White Plains to 6.28 inches at Yorktown Heights.
March 2007	Unnamed Storm	On March 2, 2007, 4 inches of rain fell on the city of Rye. Combined with snowmelt, this storm caused extensive flooding within the city. Both Blind Brook and Beaver Swamp Brook exceeded their usual capacity and flooded roads and bridges.
April 15-16, 2007	Nor'easter	A nor'easter occurred during Sunday and Monday, April 15 and 16, which brought heavy rain and high winds that caused widespread and significant river, stream, and urban flooding of low-lying and poor-drainage areas. Flooding caused a total of $80 million in damage in the town of Rye. Flooding of the 100-year level occurred on Blind Brook. A recorded 8 inches of rain fell on East White Plains.

Date	Flood Event	Notes
August and September, 2011	Tropical Storm Irene and Tropical Storm Lee	Hurricane Irene formed from a tropical wave on August 21, 2011, in the tropical Atlantic Ocean. It moved northwestward before becoming a hurricane. Irene struck Puerto Rico as a tropical storm. Hurricane Irene steadily strengthened to reach peak winds of 120 miles per hour (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. Later 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 and after Hurricane Sandy (2012), which caused billions of dollars in damages. 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. $296 million in damages were caused across New York State. 7.52 inches of rainfall recorded at Tappan, New York. Large amounts of heavy rainfall caused major flooding across Westchester County. In the city of Rye, extensive damage was done to Indian Village, the Central Business District, businesses along Elm Place, and several other locations. 50,000 customers lost power in Westchester County. Many residents were displaced for weeks due to the damage to their homes caused by flooding.
October 29, 2012	Hurricane Sandy	Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season as well as the second-costliest hurricane in United States history. It was classified as the eighteenth named storm, tenth hurricane, and second major hurricane of the year. Hurricane Sandy made landfall in the United States about 8 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). Record coastal flooding in Lower New York. Town of Rye sustained extensive damage. The shoreline and waterfront assets were devastated.

Date	Flood Event	Notes
August through October, 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 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 Westchester County. Tropical Storm Henri dropped 6 inches of rain on the city of Rye. 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. Westchester County received a major disaster declaration. In the town of Rye, a total of almost 9 inches of rain was recorded during Hurricane Ida. Around 4 inches fell within 1 hour.

There are no active stream gauges in the Blind Brook watershed. USGS gauge (01300000) at Rye was installed in the early 1940s; however, that gauge was decommissioned in 1999. The gauge was located along Elm Place, downstream of the I-95 crossing over Blind Brook. Figure 3-1 is a hydrograph showing annual peak flows recorded through 1999. Flood recurrence information from the FEMA FIS showing the magnitude of the 10-, 50-, and 100-year flood events has been superimposed on the hydrograph. The events that resulted in the largest magnitude flows on Blind Brook at Rye, New York, exceeding the estimated 10-year storm event are called out on the hydrograph. The period of record for the gauge does not include recent, damaging flood events that occurred on Blind Brook, including Tropical Storms Irene (2011), Hurricane Sandy (2012), Tropical Storms Henri and Ida (2021), and other flood events.

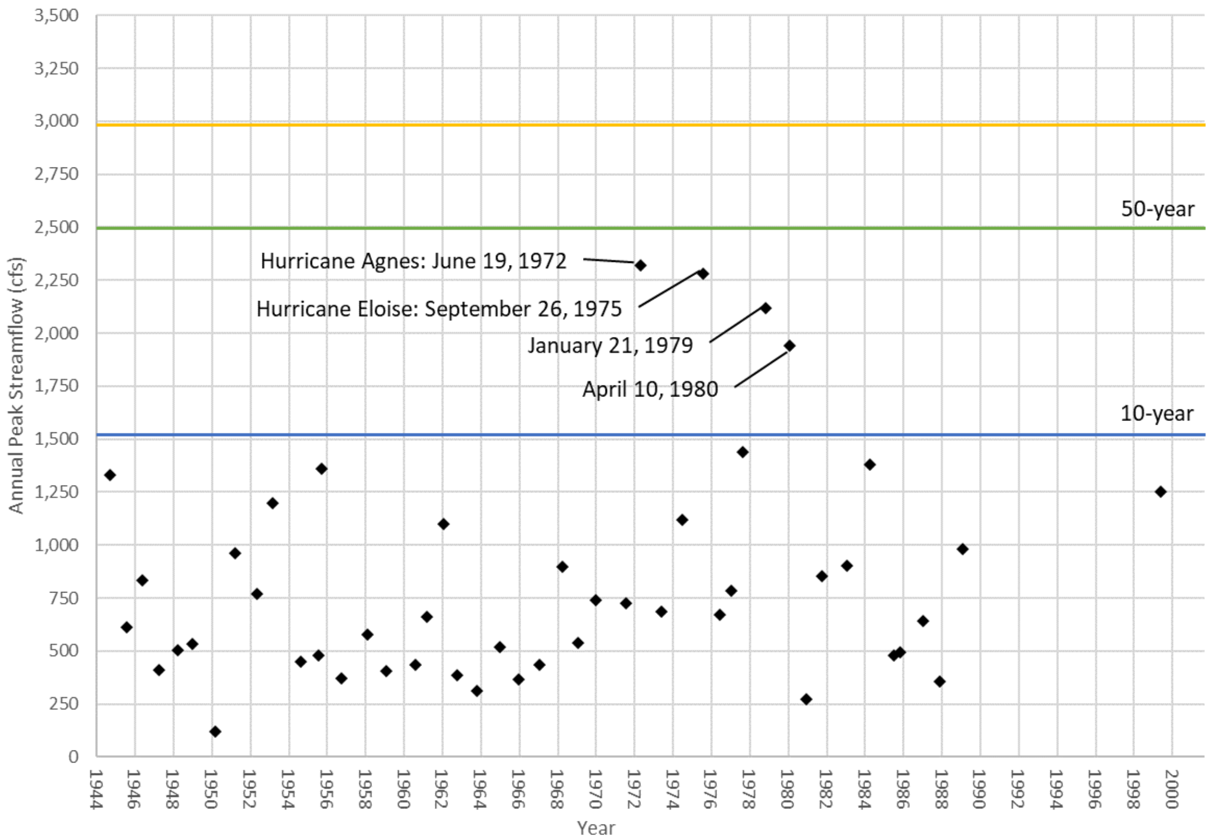

Figure 3-1 Hydrograph of Annual Peak Flow on Blind Brook at Rye, New York 1944 – 1999

Figure 3-2 shows the former location of the decommissioned USGS gauge 01300000 at Rye as well as the locations of two currently active gauges, USGS gauge 01212500 on the Byram River at Pemberwick, Connecticut, and USGS gauge 01302020 on the Bronx River at Bronx Botanic Garden, New York. Active gauges are indicated in green while inactive gauges are shown in red. Active gauges near the Blind Brook watershed provide some indication of the magnitude of more recent flood events that occurred after the USGS gauge on Blind Brook was decommissioned.

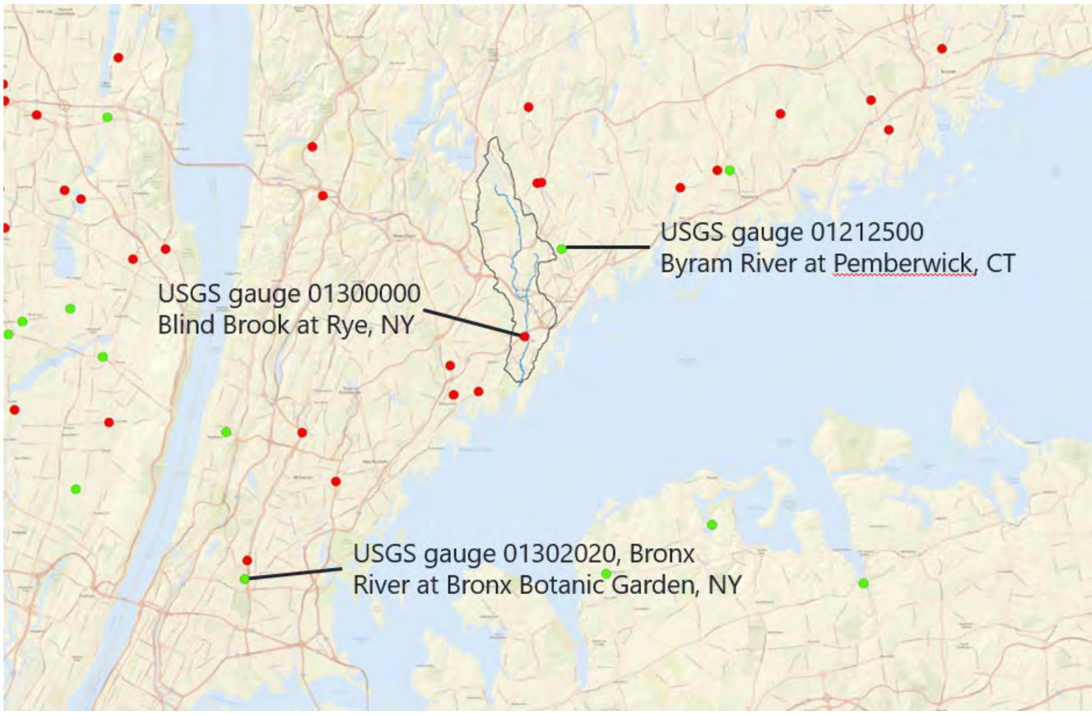

Figure 3-2 USGS Gauges in the Vicinity of Blind Brook Watershed

The closest active gauge to Blind Brook is USGS gauge 01212500 on the Byram River at Pemberwick, Connecticut, which has been active since 2010. During Tropical Storm Ida on September 2, 2021, flows recorded at the gauge were approaching the 10-year flood event when values were affected by flooding conditions at the measurement site (Figure 3-3), and no peak flow was recorded for the Ida flood event.

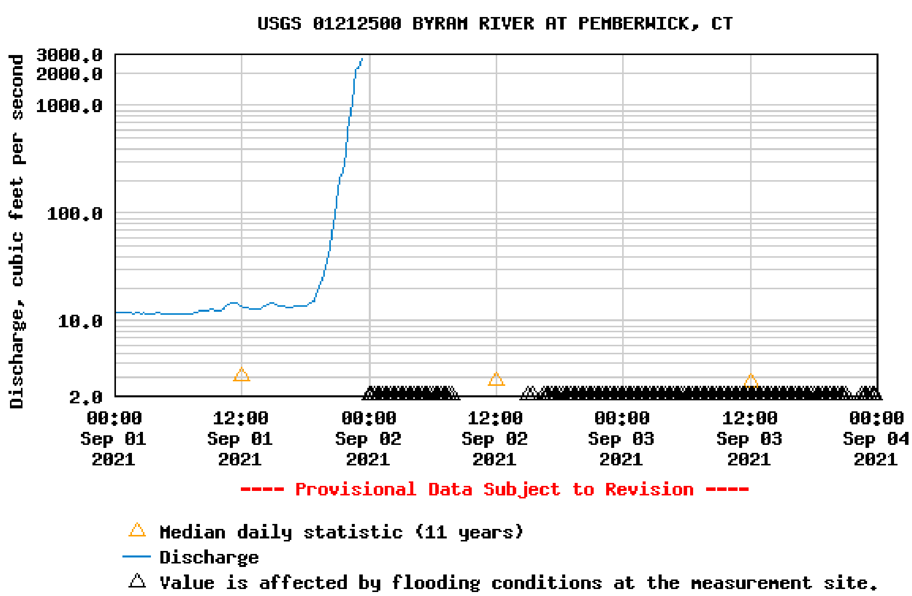

Figure 3-3 Flows on Byram River on September 2, 2021 (TS Ida)

The next closest active gauge to Blind Brook is USGS gauge 01302020 on the Bronx River at Bronx Botanic Garden, New York, active since 2007. During Tropical Storm Ida on September 2, 2021, flows recorded at the Bronx River gauge were close to the 100-year flood event. Figure 3-4 shows annual peak flows recorded at the Bronx River gauge since 2007, including Tropical Storms Ida and Irene and a nor'easter that impacted the region in 2007.

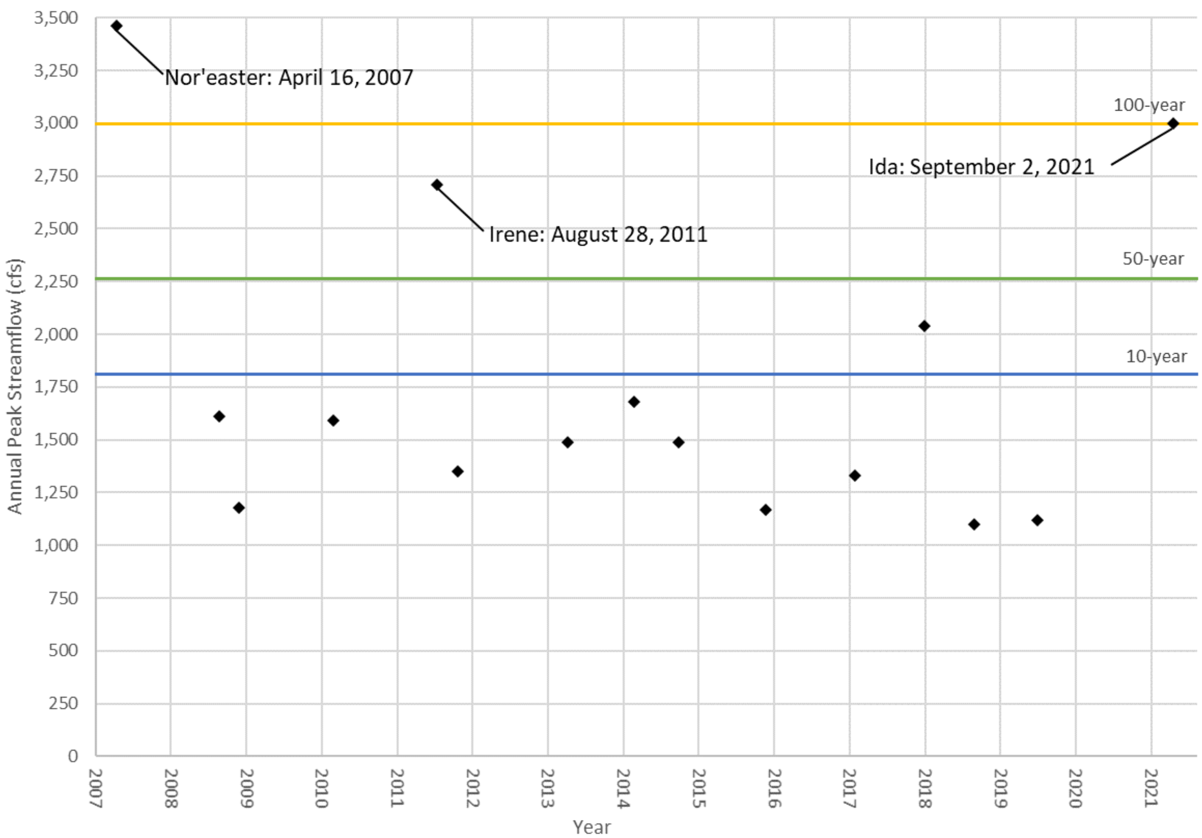

Figure 3-4 Hydrograph of Annual Peak Flow on Bronx River at Bronx Botanic Garden, NY 2007 – current

3.2 FEMA MAPPING

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

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

The FIS for Westchester County (36119CV001A) has been effective since September 2007. A preliminary FIS (36119CV001B) has been available since December 2014 but has not yet been implemented. The flood hazard areas delineated by FEMA are mapped for each focus watercourse. Figures 3-5 through 3-9 depict flood hazard mapping along Blind Brook, and Figures 3-10 and 3-11 depict flood hazard mapping along East Blind Brook. 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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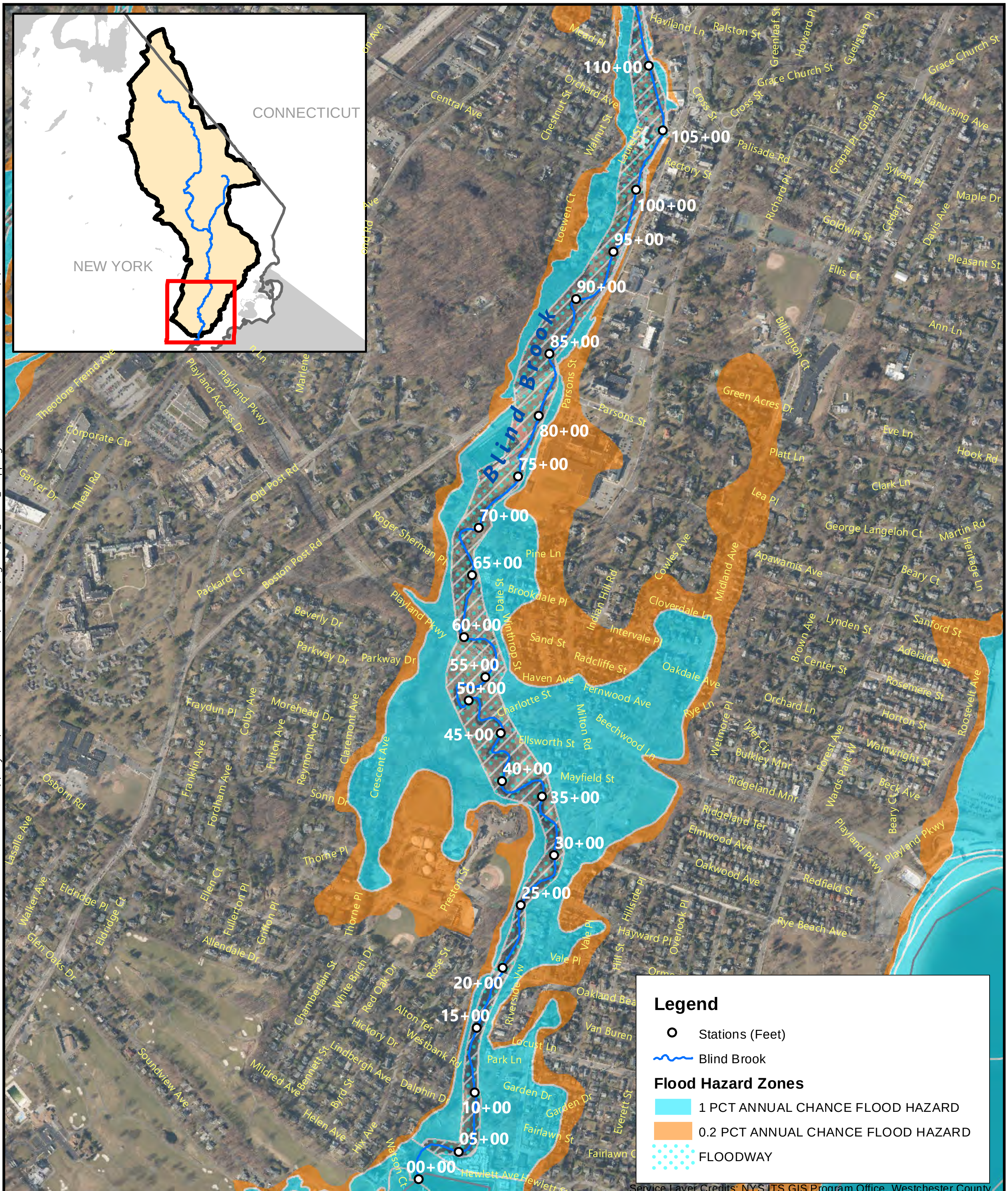

BLIND BROOK FEMA MAPPING

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
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231 MAIN STREET
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N
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FIG. 3-5

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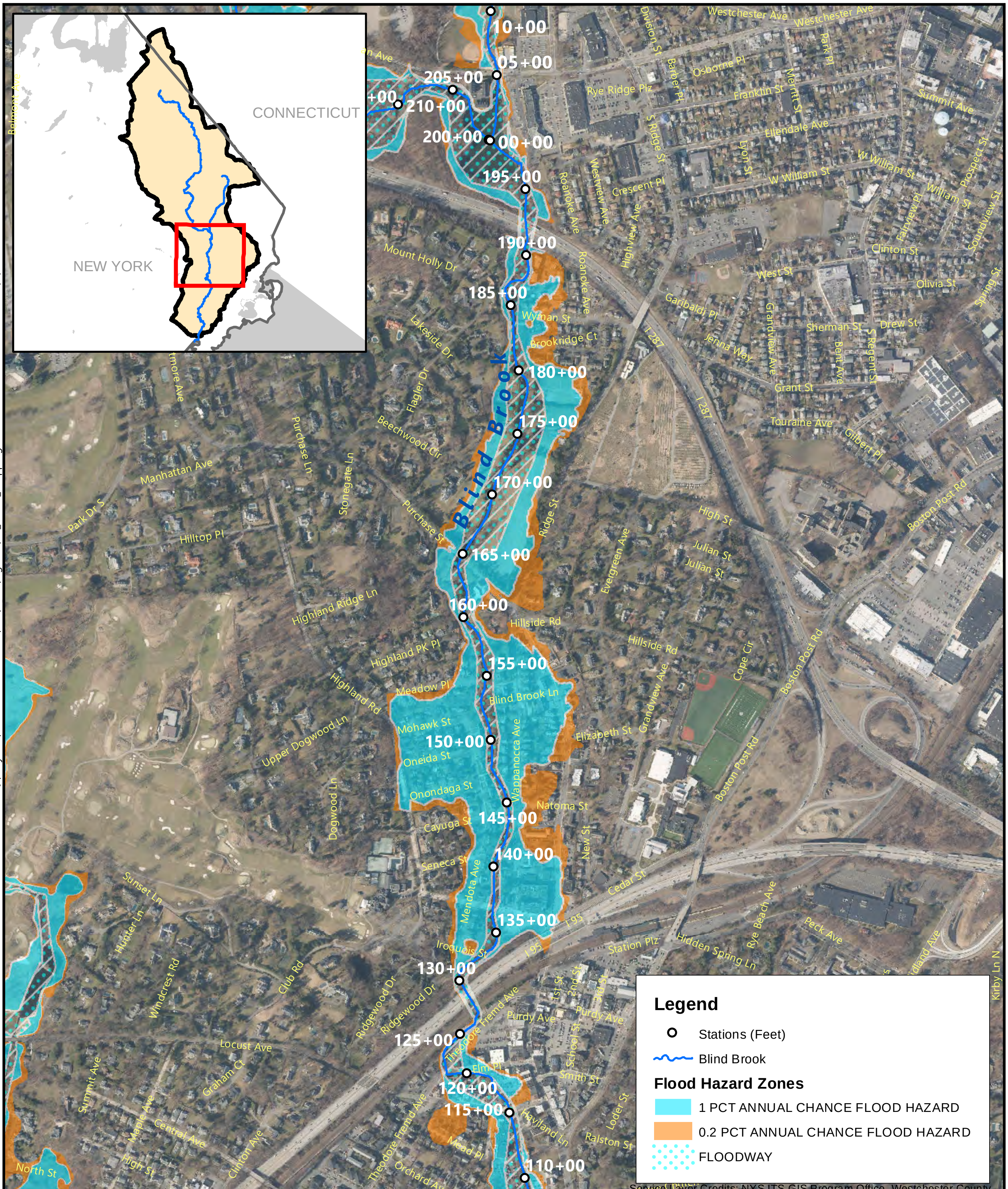

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FIG. 3-6

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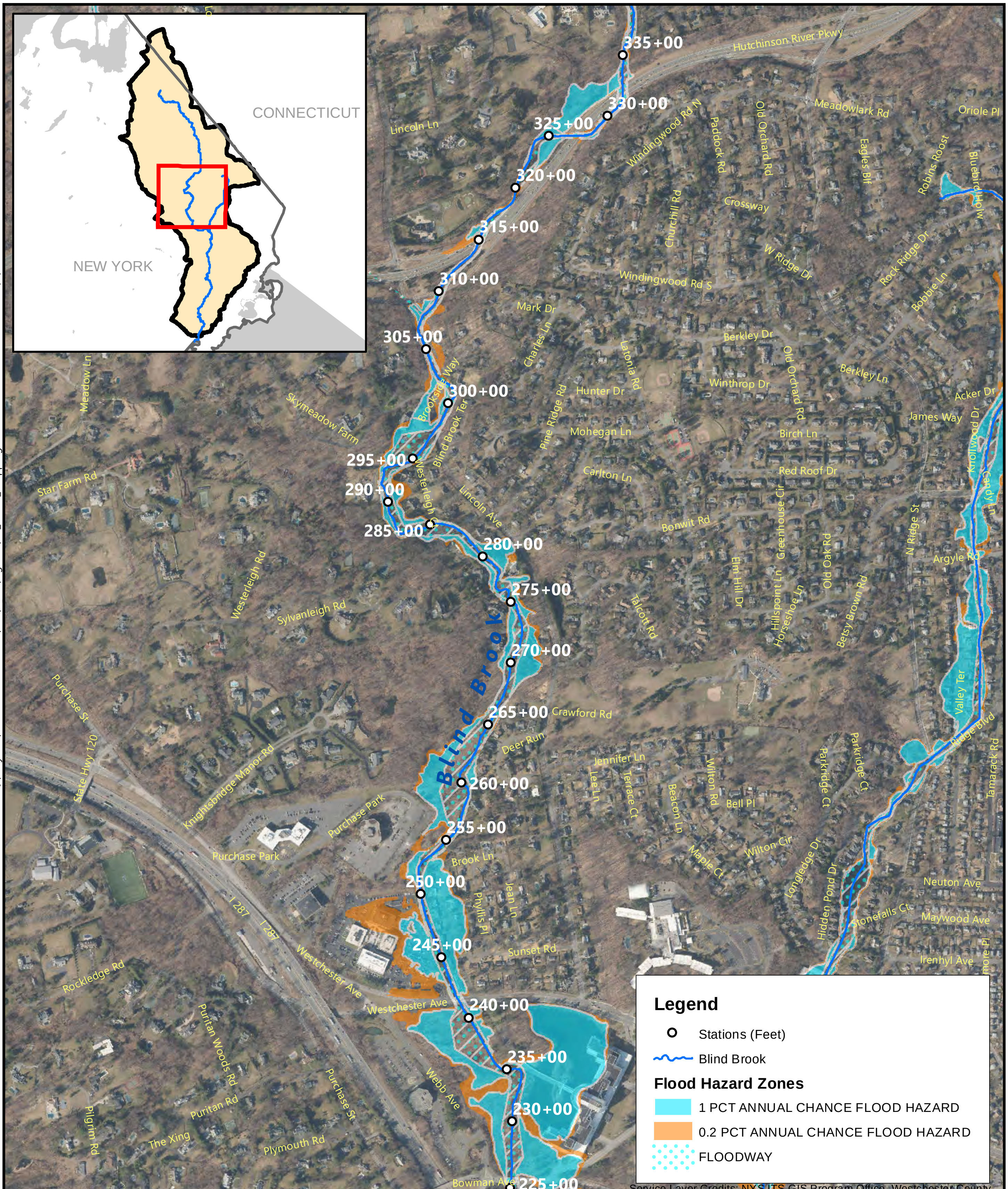

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FIG. 3-7

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FIG. 3-8

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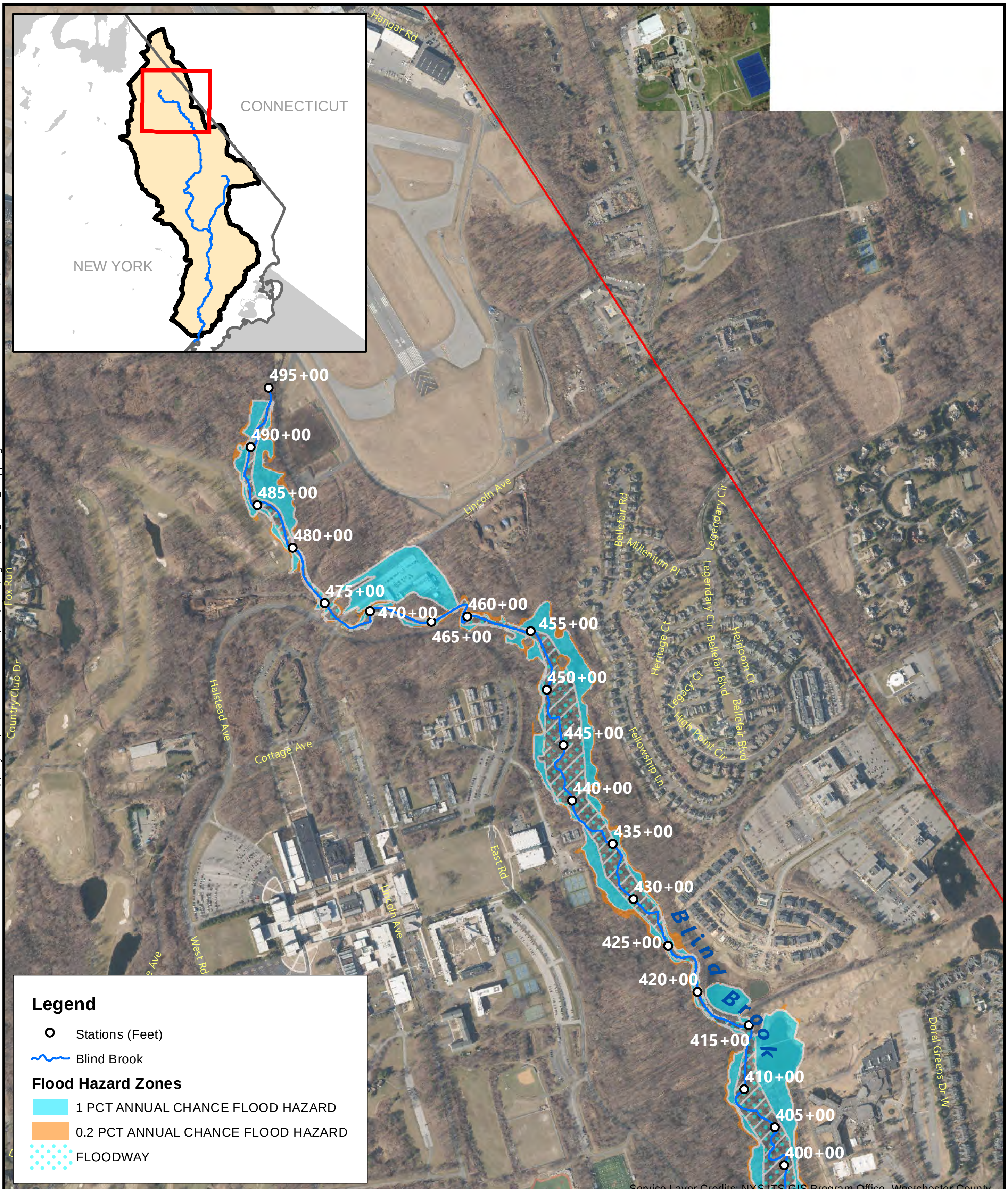

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FIG. 3-9

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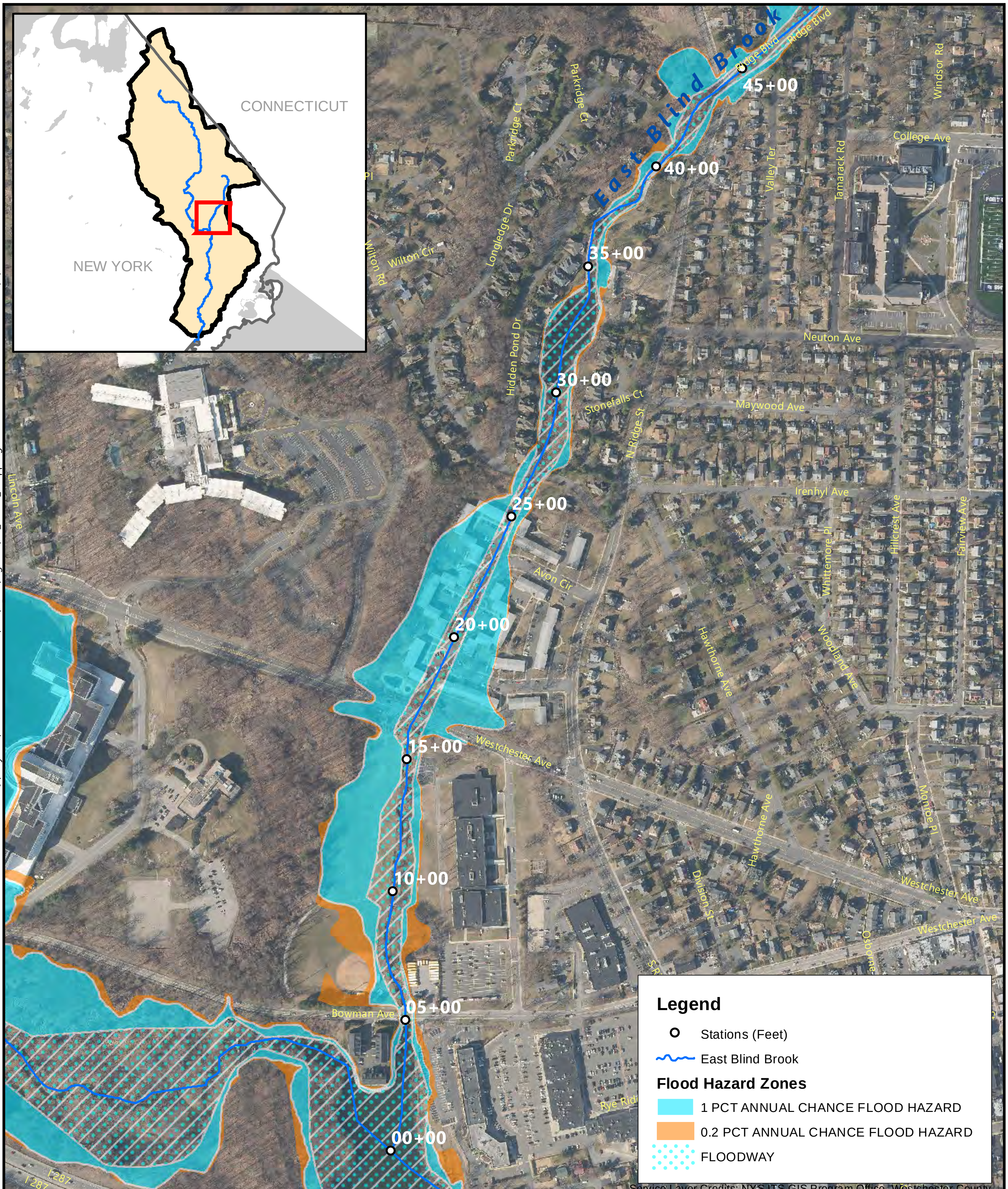

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EAST BLIND BROOK FEMA MAPPING

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FIG. 3-10

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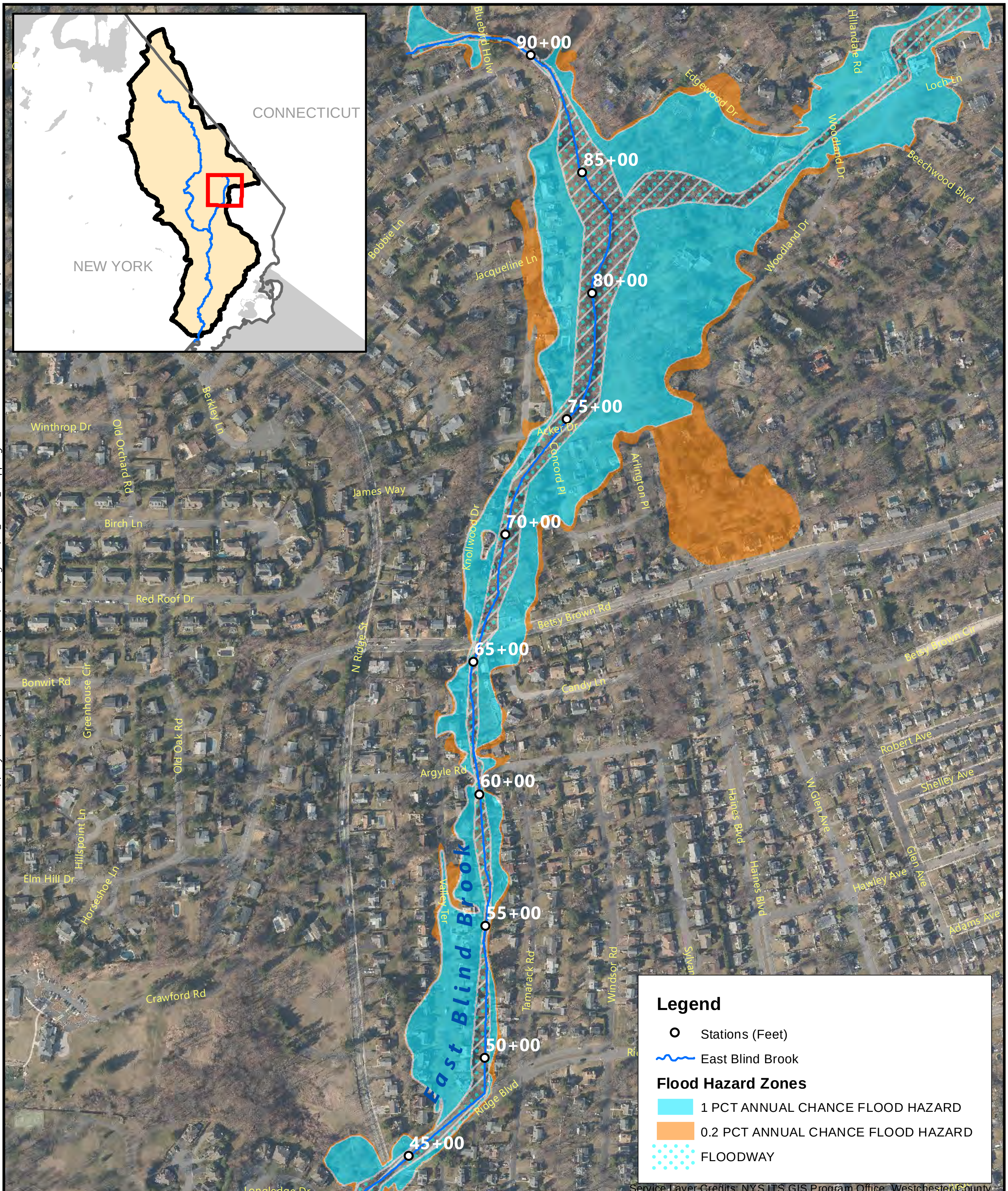

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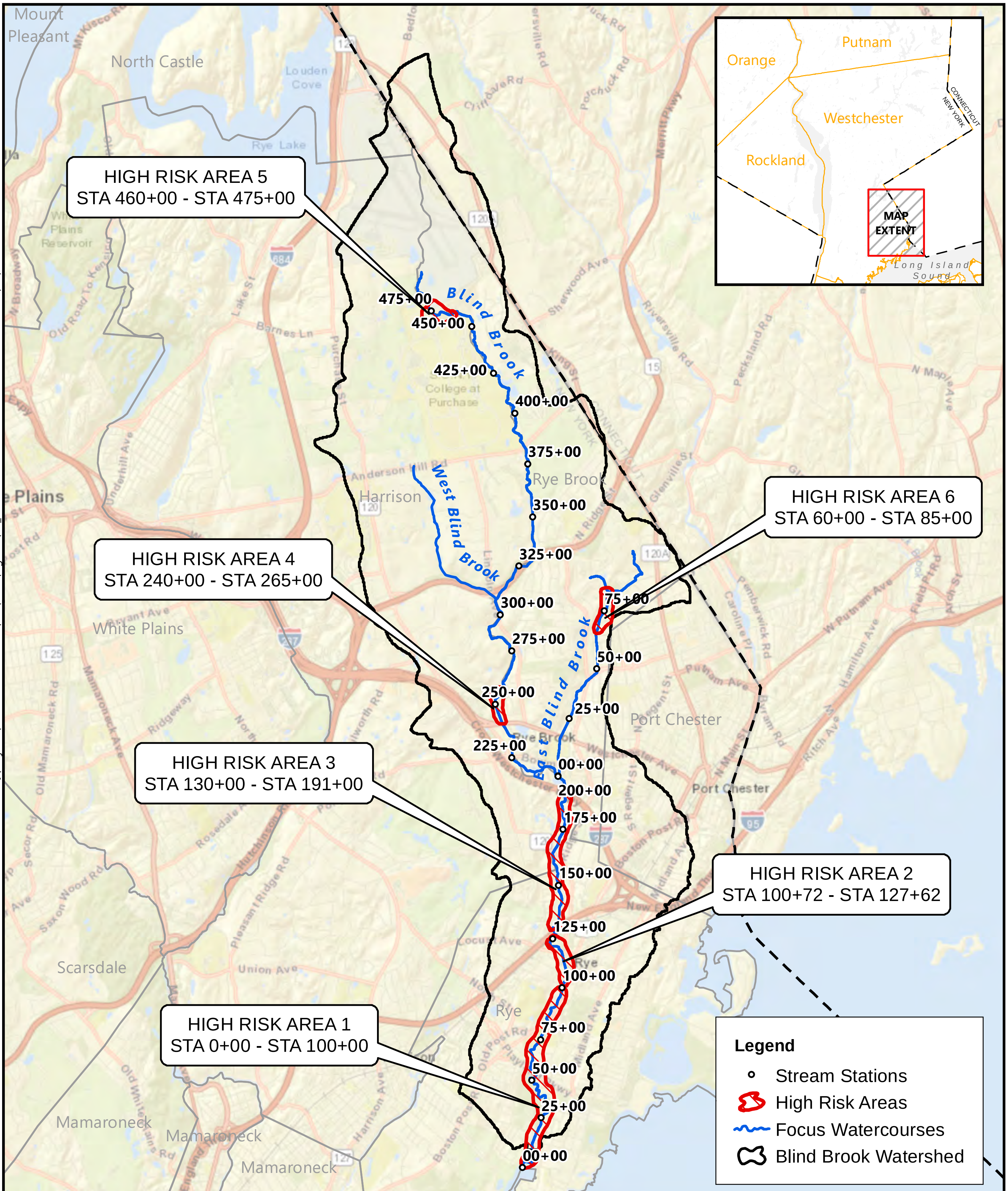
FIG. 3-11

4. FLOOD MITIGATION ANALYSIS

In this section, floodprone areas within the Blind Brook watershed are identified, and an analysis of flood mitigation considerations within each HRA is undertaken. HRAs were identified based on a variety of sources, including comments received during stakeholder meetings; conversations with municipal officials, emergency responders, landowners, and business owners; and through review of FEMA FISs and FIRMs, County Hazard Mitigation Plans, previous flood studies, online sources, and other documents. Factors with the potential to influence more than one HRA are also evaluated and discussed. Figure 4-1 shows the locations of all HRAs within the Blind Brook watershed.



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BLIND BROOK WATERSHED HIGH RISK AREAS
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FIG. 4-1

4.1 HIGH RISK AREA #1 – BLIND BROOK TIDAL REGION

HRA 1 includes the downstream-most reach of Blind Brook from Milton Harbor on Long Island Sound at STA 0+00 upstream to STA 100+00 (Figure 4-2). This section of the brook is moderately developed on its banks, passing alongside Rye Middle/High School, winding close to neighborhoods, under seven bridges, before discharging at Milton Harbor. A mix of residential and nonresidential buildings are mapped within the FEMA SFHA, including the Milton Point Fire House (STA 10+00), a critical facility. Data collected by FEMA indicates that, as of 2019, 44 properties in HRA 1 were identified as repetitive loss or severe repetitive loss. Most of these properties are located along Milton Road, Brookdale Place, Ellsworth Street, and Pine Lane.

This stretch of Blind Brook is exposed to variable sources of flooding, including tidal surge flooding at the harbor, riverine flooding along Blind Brook, or a combination of both. Public reports indicate that flooding is the most widespread during a flood event on Blind Brook that coincides with high tide at Milton Harbor. It was noted in the New York Rising Community Reconstruction (NYRCR) Program for the City of Rye that the tidal influence reaches as far upstream on Blind Brook as the Central Avenue crossing (STA 100+72), approximately 1.9 miles from the mouth of the brook.

Hydraulic analyses were conducted under a range of flood flows on Blind Brook and under a range of tidal conditions at Milton Harbor. The analysis indicated that the severity of flooding in HRA 1 and the ability of bridges over Blind Brook to safely convey flood events without overtopping are highly dependent on the tidal stage in Milton Harbor at the time when peak flow occurs on Blind Brook. Combined with undersized bridges, flooding is further exacerbated at floodprone neighborhoods and infrastructure.

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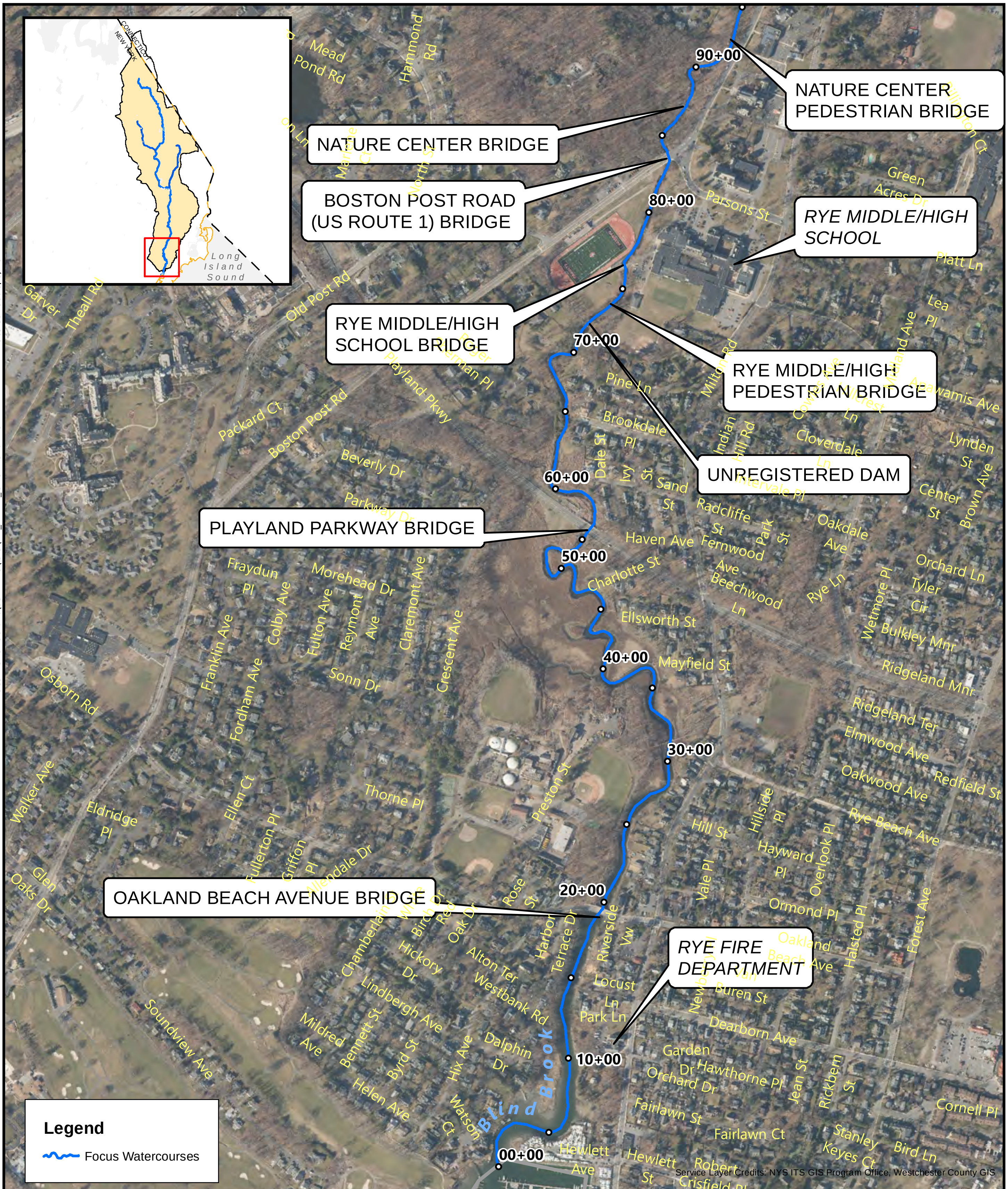

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BLIND BROOK HIGH RISK AREA 1

BLIND BROOK FLOOD & RESILIENCY STUDY

969MOD1

WESTCHESTER COUNTY, NEW YORK

N

0 500 Feet

SCALE 1 " = 800 '

DATE 6/6/2022

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FIG. 4-2

4.1.1 OAKLAND BEACH AVENUE BRIDGE AND PLAYLAND PARKWAY BRIDGE

Blind Brook is spanned by the Oakland Beach Avenue bridge at STA 19+47 (Figure 4-3) and the Playland Parkway bridge at STA 55+72. The bridge at Oakland Beach Avenue measures 96 feet wide, has a 16-foot vertical opening, and is supported by two piers. Hydraulic modeling shows that the Oakland Beach Avenue bridge can pass all modeled existing and future flood flows without overtopping the roadway; however, it behaves like a constriction and produces a significant backwater. This backwater effect acts to raise water surface elevations by 3 feet at the bridge face, extending upstream for about 1 mile before fully diminishing near STA 71+85. This bridge is shown to contribute to upstream flooding at homes on Ellsworth Street and Mayfield Street on the left bank of Blind Brook and is also shown to influence the hydraulic performance of the Playland Parkway bridge upstream.

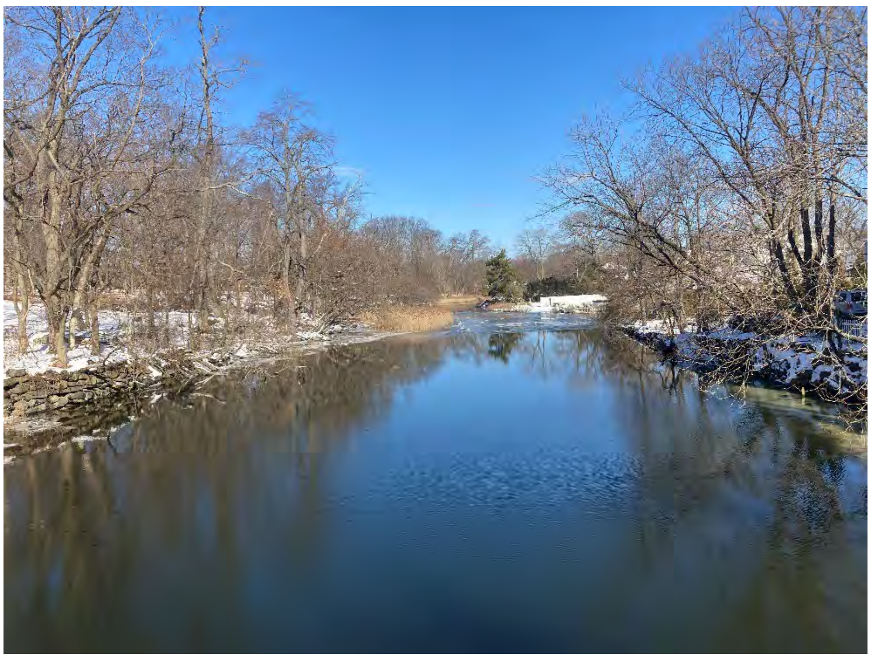

Figure 4-3 Looking upstream of the Oakland Beach Avenue bridge. This section of Blind Brook is broad, flat, and influenced by the tidal stage at Milton Harbor.

The Playland Parkway bridge (STA 55+72) and its roadway embankment transect Blind Brook at a broad and flat portion of the valley. The bridge is a 58-foot, two-span, open-deck box girder bridge built in 1954. The raised approach embankment on the right (west) is 3 to 4 feet taller than the brook's 100-year floodplain and extends over 500 feet, restricting overbank relief of flood flows. The current capacity of the bridge is estimated to only be that of the 10-year flood event before roadway overtopping occurs. The existing structure does not have the capacity to pass the future 10-year flood event. The presence of the bridge raises water surface elevations by 1 and 1.5 feet in the 10-year and 100-year flood events on Blind Brook, respectively, and contributes to flooding of homes on Brookdale Place, Dale Street, and Pine Lane.

A hydraulic modeling scenario was evaluated that entailed increasing the span of the Oakland Beach Avenue and Playland Parkway bridges to 136 feet and removing any bridge piers. In addition, floodplain benches were added near and under the replacement bridge structures where possible. At Oakland Beach

Avenue, a 45-foot-wide, approximately 215-foot-long, and 7-foot-deep floodplain bench was added to the model upstream of the bridge along the right bank (Figure 4-4A). A 180-foot-wide, 360-foot-long, and 5-foot-deep floodplain bench was modeled upstream and downstream of the upsized Playland Parkway bridge along the right bank (Figure 4-4B). Due to the severely constrictive nature of the existing bridges, implementing the proposed floodplain benches alone without modifying the structures themselves is unlikely to produce meaningful flood reduction benefits. Floodplain benches are being recommended here since upsizing the bridges would introduce the opportunity to reconstruct the reach with a properly sized multistage channel and reclaimed floodplain. Together, the bridge replacements and floodplain bench creation would provide substantial reductions of flood depths and lateral flood extents at the neighborhoods upstream of these structures along the left bank from STA 20+00 to STA 50+00 and STA 56+40 to STA 70+00. With the recommended larger spans, both bridges would pass the existing 100-year storm event, although the upsized Playland Parkway bridge would still not pass the future 100-year. Flood reductions under the 10-year flood event are illustrated in Figure 4-4 (existing conditions) and Figure 4-5 (with proposed upsized bridges). Flood reductions during the 50-year flood event are illustrated in Figure 4-6 (existing conditions) and Figure 4-7 (proposed conditions). Flood reductions during the 100-year flood event are illustrated in Figure 4-8 (existing conditions) and Figure 4-9 (proposed conditions). The flood mitigation benefits of the proposed floodplain and bridge replacements are limited by the tailwater control of Milton Harbor and Blind Brook's shallow slope within the approach reach.

The existing and proposed conditions analysis described above was conducted assuming a Mean Higher-High Water (MHHW) tailwater level of 3.7 feet at Milton Harbor. MHHW is the average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch, or the 19-year time period established by the National Ocean Service for collecting observations on water levels and calculating tidal datum values. There is no tidal gauge located at Milton Harbor, but using the closest gauge station on the Long Island Sound (No. 8516945, Kings Point, New York), it is implied that the Great Diurnal Range is approximately 7.8 feet. This indicates that the water level can be anywhere from about 4 feet above to 4 below mean sea level. MHHW is estimated to be a good representation of high tide along Milton Harbor and therefore was used as a baseline comparison for the influence of other tidal conditions moving forward. Table 4-1 lists the various tailwater elevations at Milton Harbor used in the hydraulic model to assess the influence of incoming tides as calculated for the Kings Point, New York, observation gauge.

Table 4-1 Hydraulic Model Tailwater Elevation at Milton Harbor for Various Tidal Stages as Reported at Kings Point, New York, Observation Gauge

Event	Tailwater Elevation in Feet (NAVD88)
Mean Higher-High Water (MHHW)	3.6
Mean Lower-Low Water (MLLW)	-4.2
MHHW with Sea Level Rise (16”)	5.0
Observed High Tide During Tropical Storm Ida 2021	5.0
Observed High Tide During Hurricane Sandy 2012	10.1
Observed High Tide During Tropical Storm Irene 2011	8.1

Under sea level rise and future flow conditions, the hydraulic modeling scenario evaluated above entailing increasing the span of the Oakland Beach Avenue and Playland Parkway bridges, creating floodplain benches, and removing bridge piers would still produce significant reductions in predicted upstream water surface elevations during the lower magnitude events such as the 10-year and 50-year flood events. However, the neighborhoods that currently experience repetitive flood damage will still see extensive, but shallower, flooding during the higher magnitude events such as the 100- and 500-year flood events. Managed retreat from the floodprone areas and individual floodproofing at homes is recommended. Individual property flood protection measures are discussed in Section 5.10 and should be implemented using predicted future flows and future sea level rise data to adequately elevate homes and utilities. In addition, a detailed hydrologic and hydraulic analysis is recommended for the structures at Oakland Beach Avenue and Playland Parkway when due for replacement. A study should be conducted to investigate the impact of increasing the size of these structures and their influence on incoming tidal surge waves at the harbor, which differs from steady-state downstream boundary conditions that were modeled in this analysis. Figure 4-10 depicts proposed conditions under the 100-year future flood event with 16 inches of sea level rise, which represents the "medium" sea level rise scenario for the 2050s time period.

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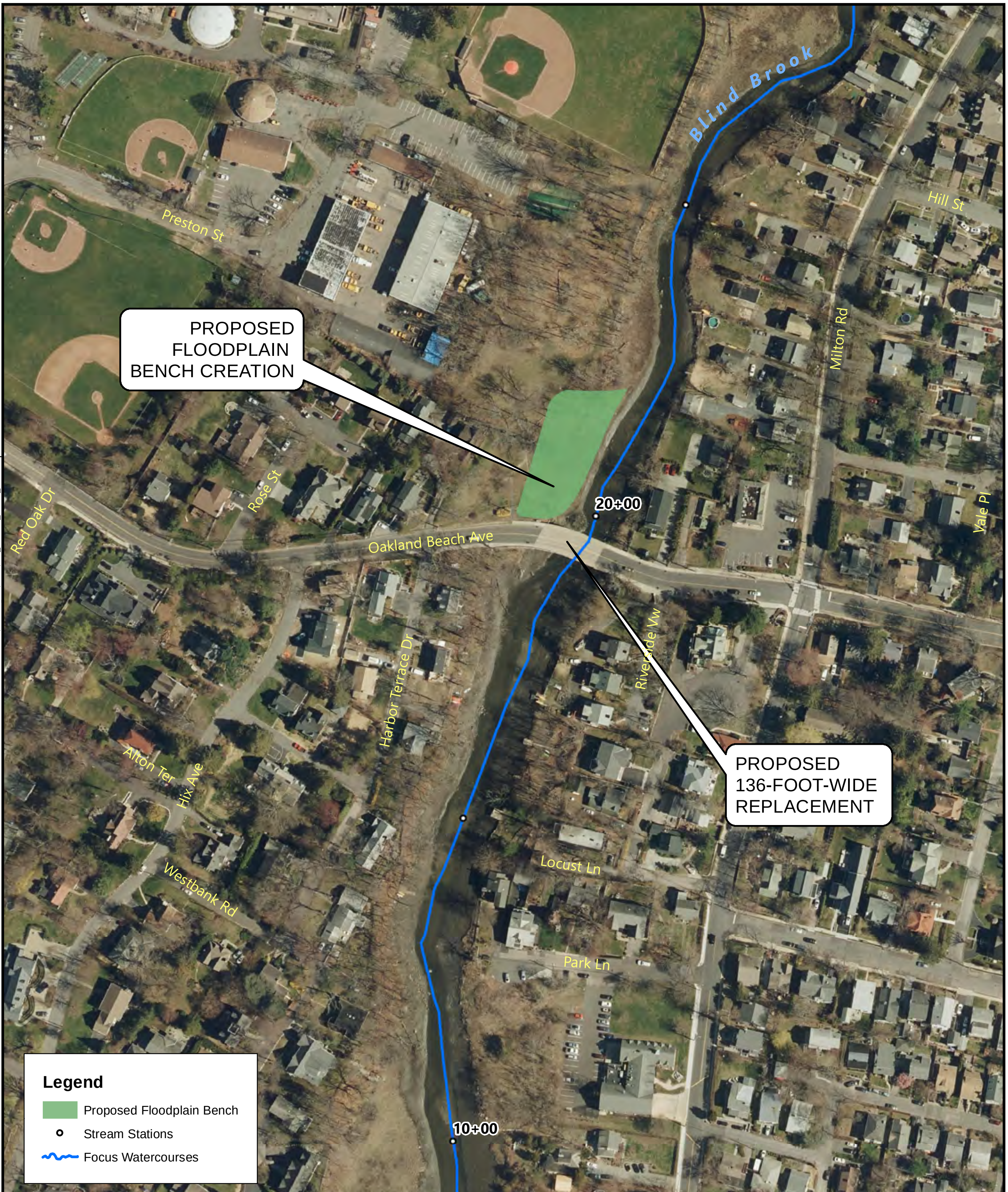

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231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
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HRA #1: OAKLAND BEACH AVENUE CONCEPT

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N

0 210 Feet

SCALE 1 " = 200 '

DATE 7/22/2022

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FIG. 4-4A

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HRA #1: PLAYLAND PARKWAY CONCEPT

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N

0 210
Feet

SCALE 1 " = 200 '

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FIG. 4-4B

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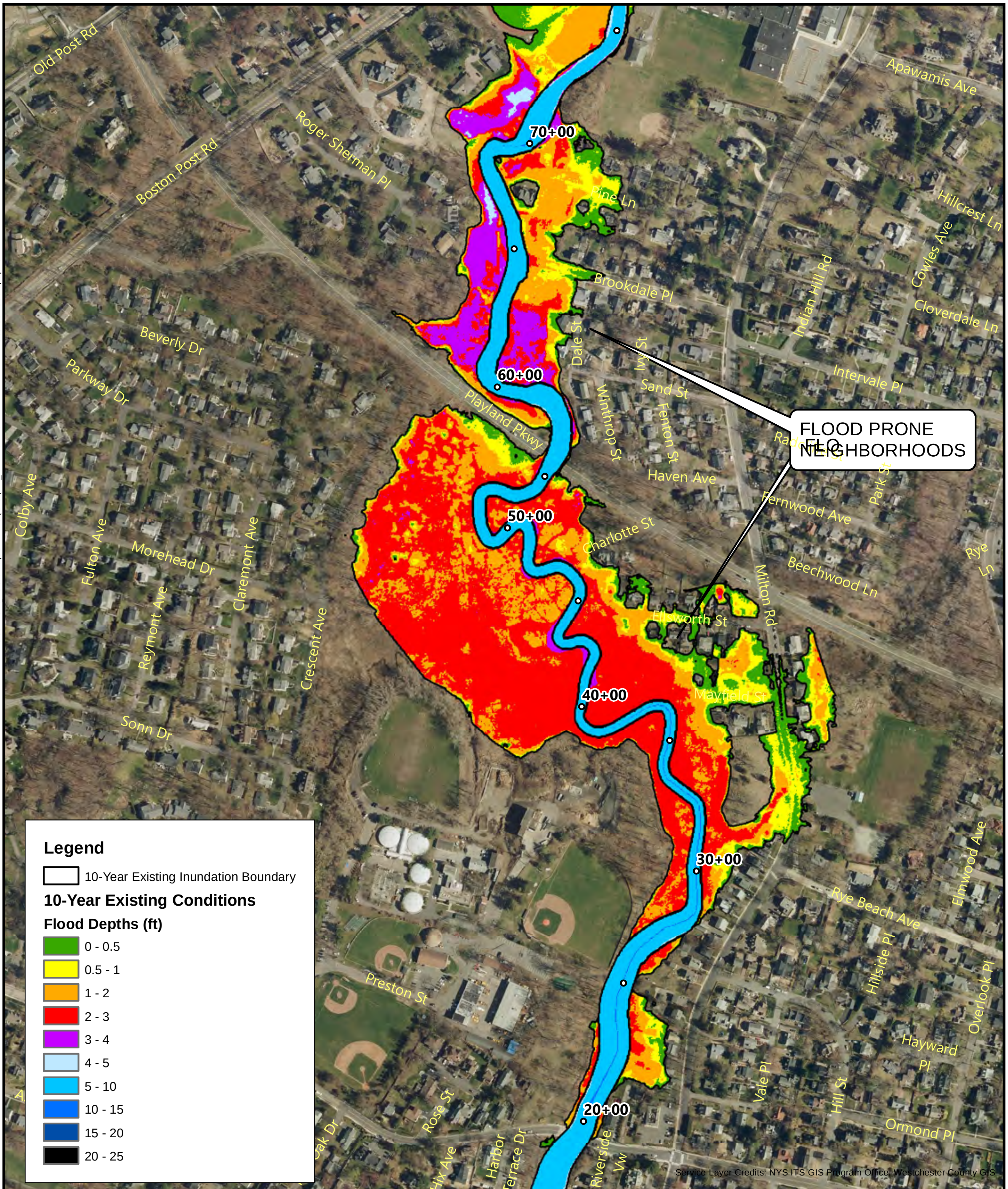

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HRA #1: OAKLAND AVENUE & PLAYLAND PARKWAY

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969MOD1
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N

0 470
Feet

SCALE 1 " = 450 '
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FIG. 4-4

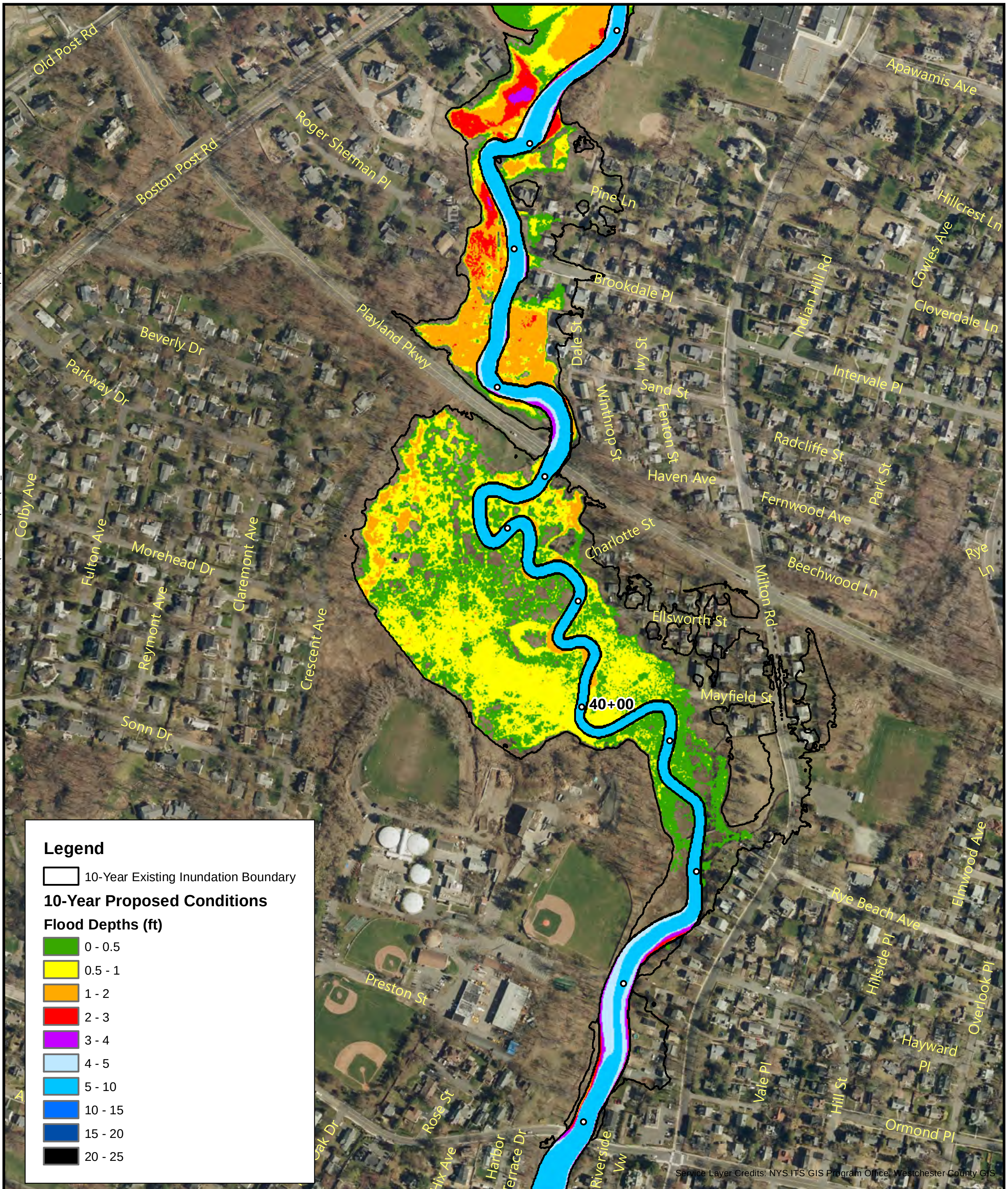

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FIG. 4-5

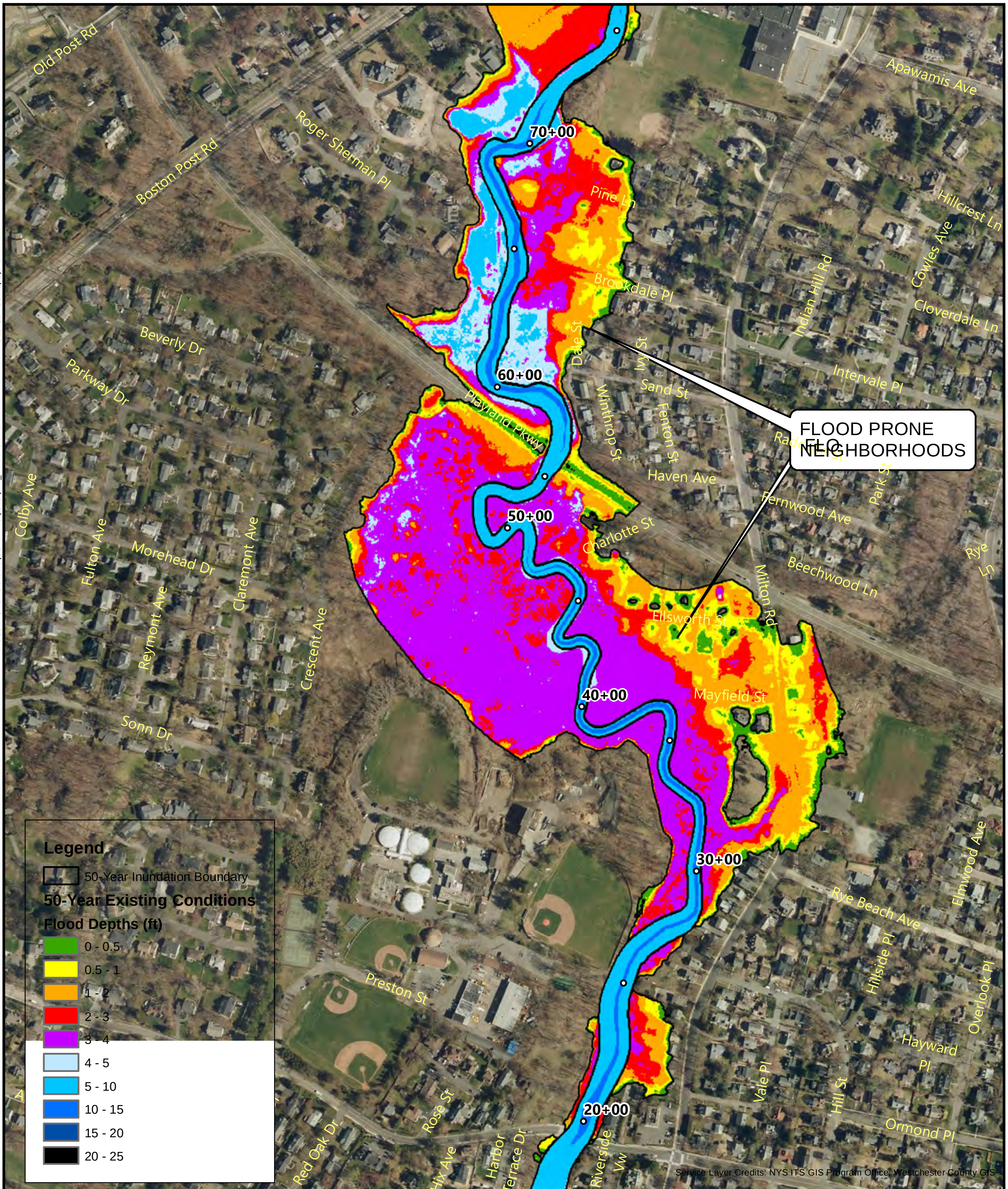

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FIG. 4-6

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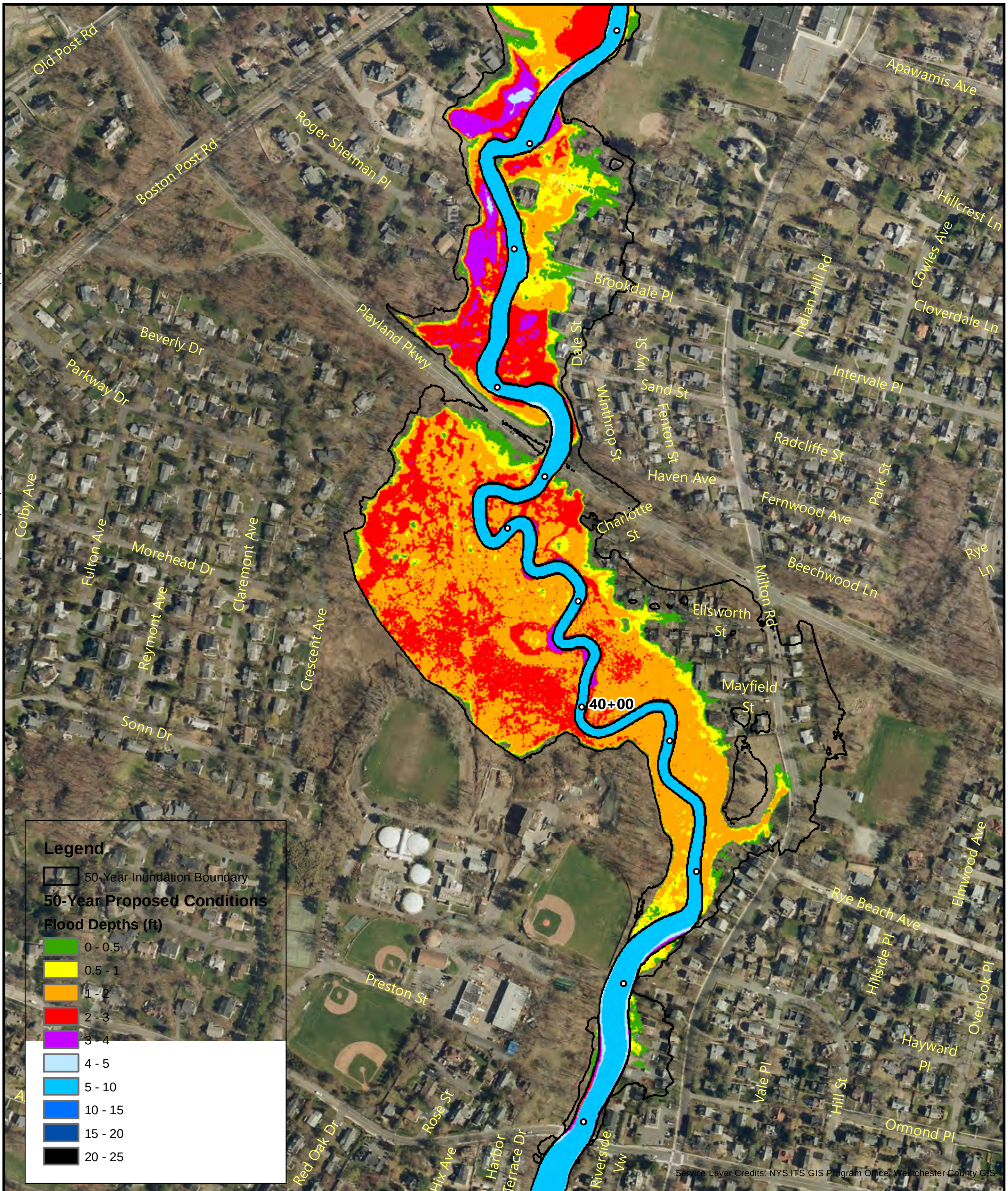

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969MOD1
WESTCHESTER COUNTY, NEW YORK

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FIG. 4-7

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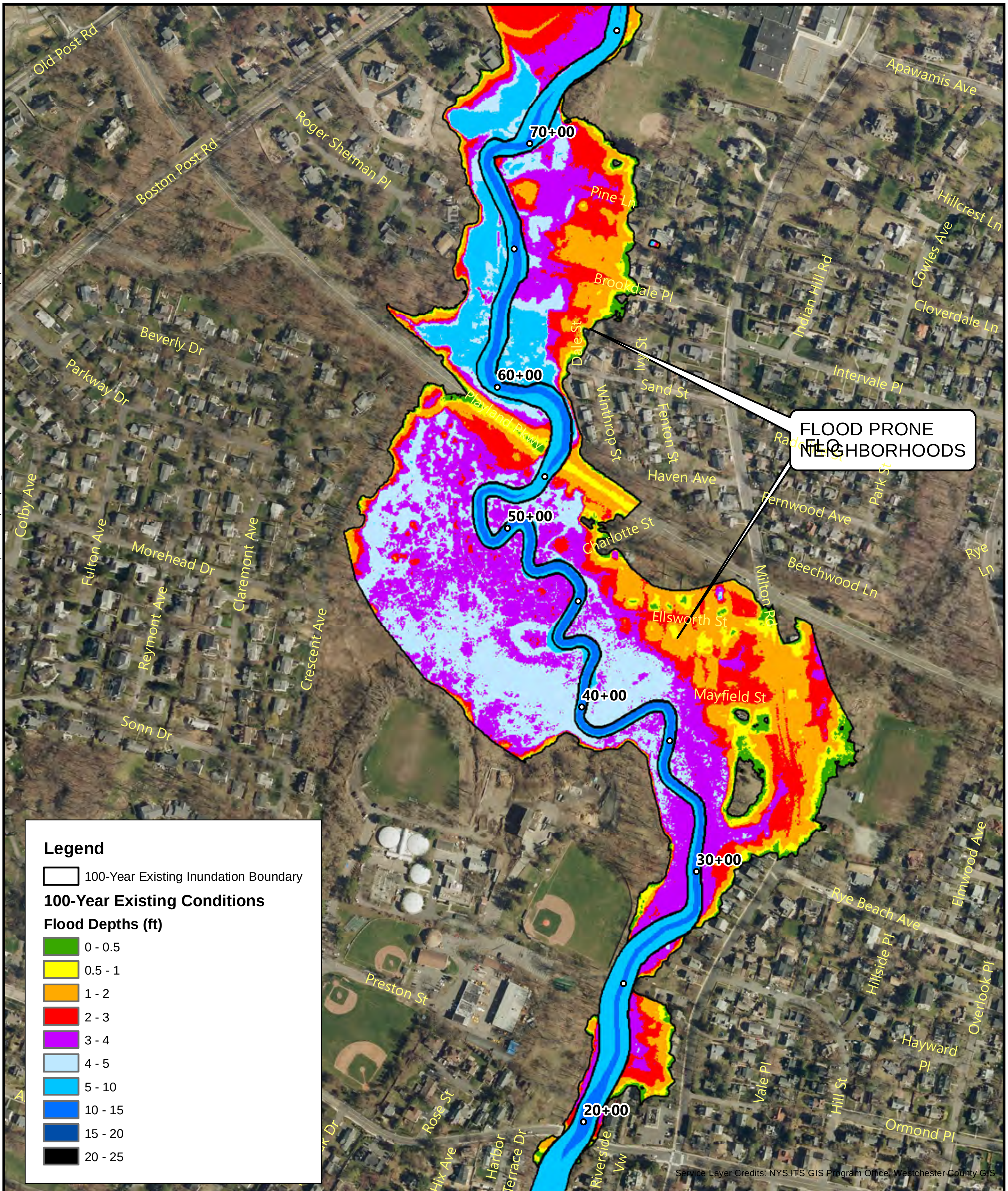

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FIG. 4-8

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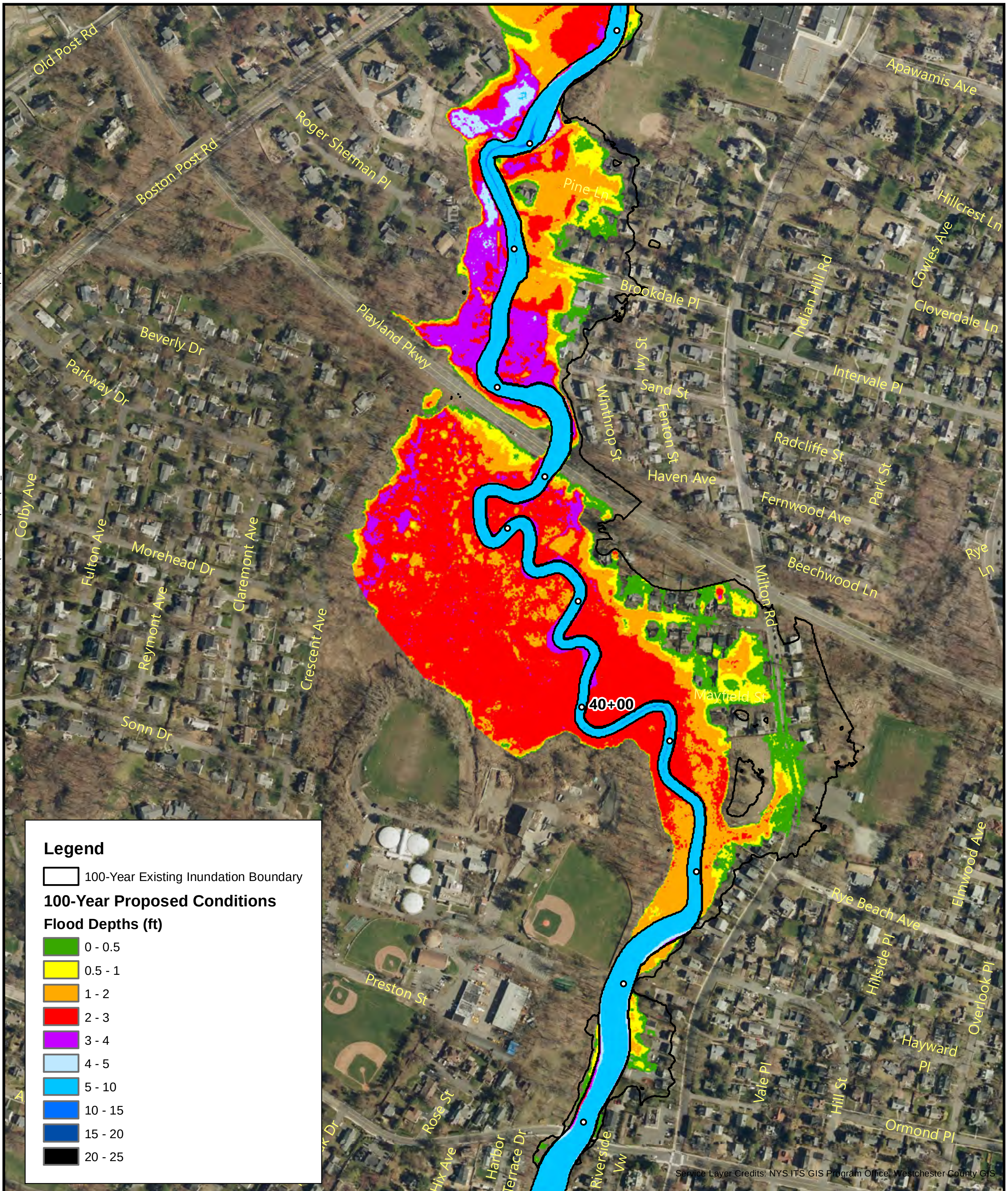

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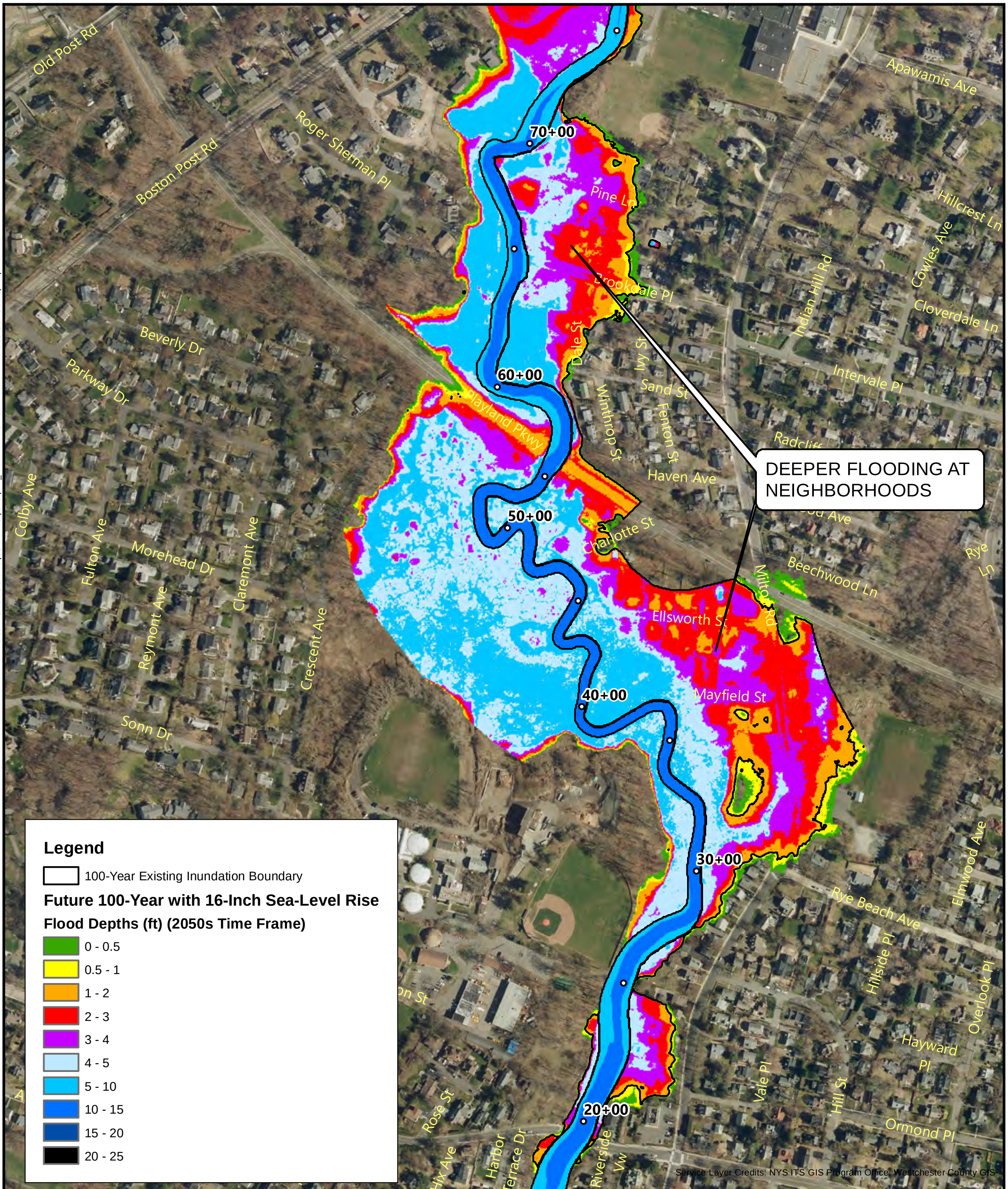
FIG. 4-9



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HRA #1: OAKLAND AVENUE & PLAYLAND PARKWAY

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N

0 470
Feet

SCALE 1 " = 450 '
DATE 8/24/2022
6511.0018
PROJ. NO.

FIG. 4-10

4.1.2 RYE MIDDLE/HIGH SCHOOL BRIDGES

Two small bridges and a low-head inline dam span Blind Brook near the Rye Middle/High School building and sports field. The structures are shown to be marginally influenced by tidal and sea level rise conditions. The school football field to the east of Blind Brook is located within the floodplain and floods regularly (Figure 4-11). Across from the football fields to the west, the Rye school building is shown to be situated outside of the 100-year floodplain although it is mapped within the FEMA 500-year flood hazard zone. City of Rye officials reported that the school building has flooded in the past.

Figure 4-11 Rye High/Middle School football field flooded during Hurricane Irene 2011. The masonry stone arch bridge over Blind Brook is seen underwater (center left). Photo Courtesy of Patch.com News Report.

The unregistered dam near STA 71+85 measures approximately 1 foot high and 40 feet long. Hydraulic modeling shows that this structure has insignificant effects on upstream water surface elevations and does not contribute to flooding, nor does it hinder the hydraulic performance of the school's bridges. Nonetheless, the derelict structure is an obstruction for AOP, and its removal is recommended.

Approximately 170 feet upstream of the dam is a small pedestrian bridge over Blind Brook (STA 74+00). The open-deck bridge spans approximately 30 feet and has a 6-foot vertical opening. At STA 76+43 is another small bridge that serves as the school's primary crossing over the brook to access the football field to the east. This structure spans 25 feet wide and 9 feet high. Both bridges are shown to overtop as frequently as the 10-year flood event, at which point the bridges are constrictive to flood flows. The structures have a minimal tailwater influence on the bridge under Boston Post Road during the 10-year flood event as well. However, neither structure is shown to worsen flooding in the 50-year and higher magnitude flood events when the bridges are several feet underwater.

Due to minimal hydraulic influence of these bridges, there are no further recommendations other than routine inspection and maintenance. If the smaller pedestrian bridge at STA 74+00 is no longer used, removal of the structure should be considered. Furthermore, if the primary bridge to the football fields is washed out in the future, rather than replacing the structure, redirecting traffic via Parson Street and Boston Post Road should be explored. Removing the main bridge would reduce flood depths but would not eliminate flooding at the football fields in the 10-year flood event. Figure 4-12 shows 10-year flood event depth mapping at the football field for existing conditions, and Figure 4-13 shows 10-year flood event depth mapping with the dam and bridge crossings removed.

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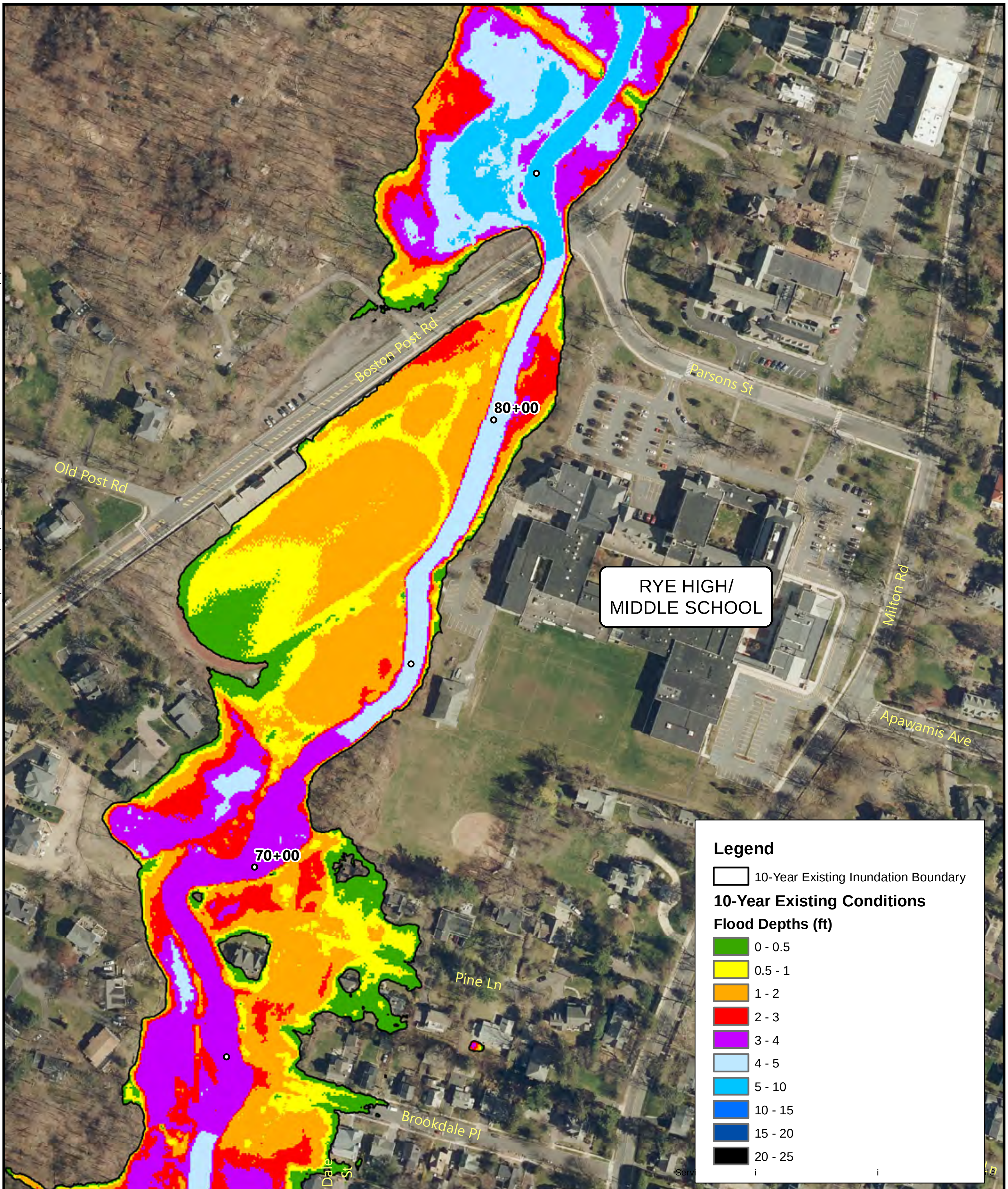

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231 MAIN STREET
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HRA #1: RYE MIDDLE/HIGH SCHOOL BRIDGES

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N

0 250
Feet

SCALE 1 " = 250 '

DATE 6/3/2022

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FIG. 4-12

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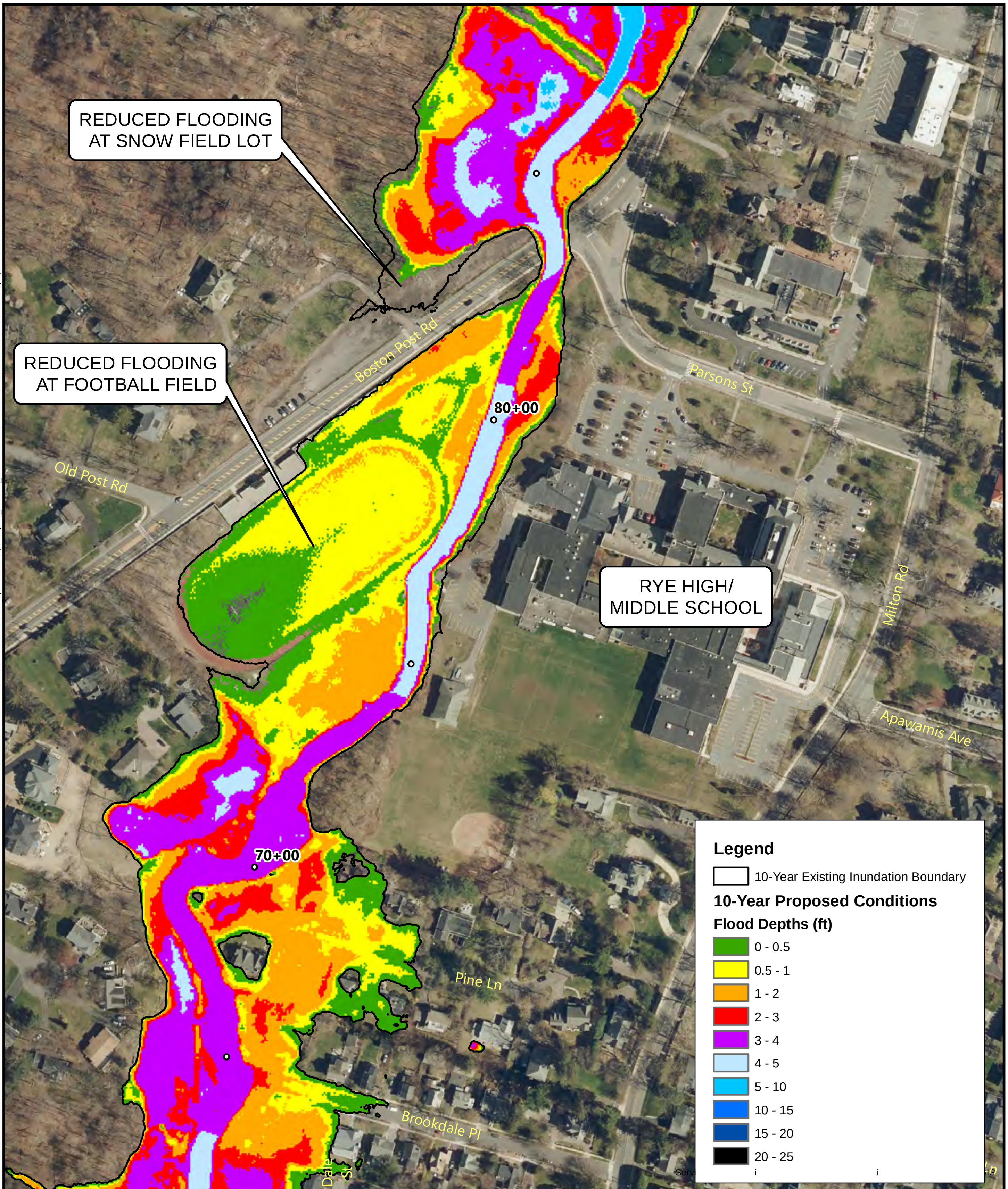

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HRA #1: RYE MIDDLE/HIGH SCHOOL BRIDGES

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FIG. 4-13

4.1.3 BOSTON POST ROAD BRIDGE (US ROUTE 1)

Boston Post Road is carried over Blind Brook by a masonry arch bridge (Figure 4-14) built in 1934 (STA 83+79). The open-bottom deck bridge measures 32 feet wide by 8.5 feet high. The approach roadway embankments to the right (southwest) and left (northeast) severely encroach on the brook's floodplain, limiting flood flow conveyance and causing impounding of floodwaters upstream of the bridge. Hydraulic modeling shows the existing structure being flank to its right starting at the 10-year flood event. Shallow sheet flow over the southwestern approach is projected to occur during the 50- and 100-year flood events. The bridge backwater increases water surface elevations as much 1.7 to 2.0 feet during the 50- and 100-year flood events, respectively, impacting the portion of Blind Brook between the upstream bridge face and STA 100+00. Development on the brook's banks within this reach is sparse, although homes along the right bank near STA 95+00 would benefit from improvements at the bridge. Moreover, approximately 350 feet upstream of Boston Post Road, the Rye Nature Center driveway bridge (STA 92+54) would also benefit from reductions in surface elevations although the crossing itself is also severely undersized, as discussed below.

Figure 4-14: Looking downstream at the Boston Post Road bridge inlet over Blind Brook

Replacing the existing structure at Boston Post Road with a 60-foot span bridge, open-bottom deck with vertical abutments, and raising the bridge low chord by 1 foot is shown to pass the current and future 100-year flood event. The replacement bridge would reduce the frequency of flooding over the southwestern approach and at the Snow Field parking lot located to the north, on the right overbank. Flooding of the roadway would occur only during the 500-year flood event as opposed to commencing at the 10-year flood event. Figure 4-15 (existing conditions) and Figure 4-16 (proposed conditions) illustrate flood depths for the 10-year flood event. Figure 4-17 (existing conditions) and Figure 4-18 (proposed conditions) show depths for the 50-year flood event. 100-year flood event mapping is shown in Figure

4-19 (existing conditions) and Figure 4-20 (proposed conditions). A detailed hydrologic and hydraulic study is recommended when the bridge is to be replaced.

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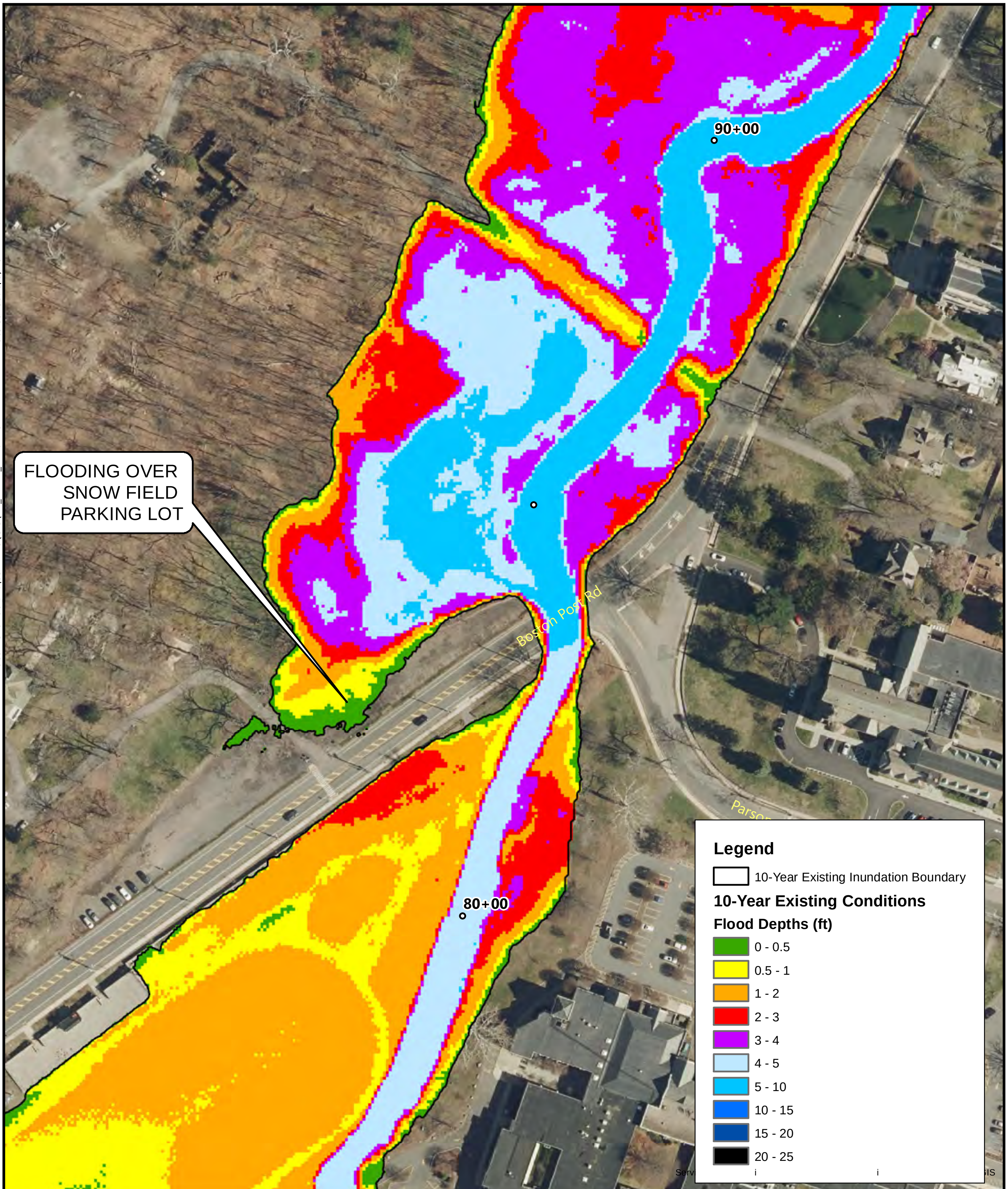

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HRA #1: BOSTON POST ROAD (US ROUTE 1)

BLIND BROOK FLOOD & RESILIENCY STUDY

969MOD1

WESTCHESTER COUNTY, NEW YORK

N

0 150 Feet

SCALE 1 " = 150 '

DATE 6/6/2022

6511.0018
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FIG. 4-15

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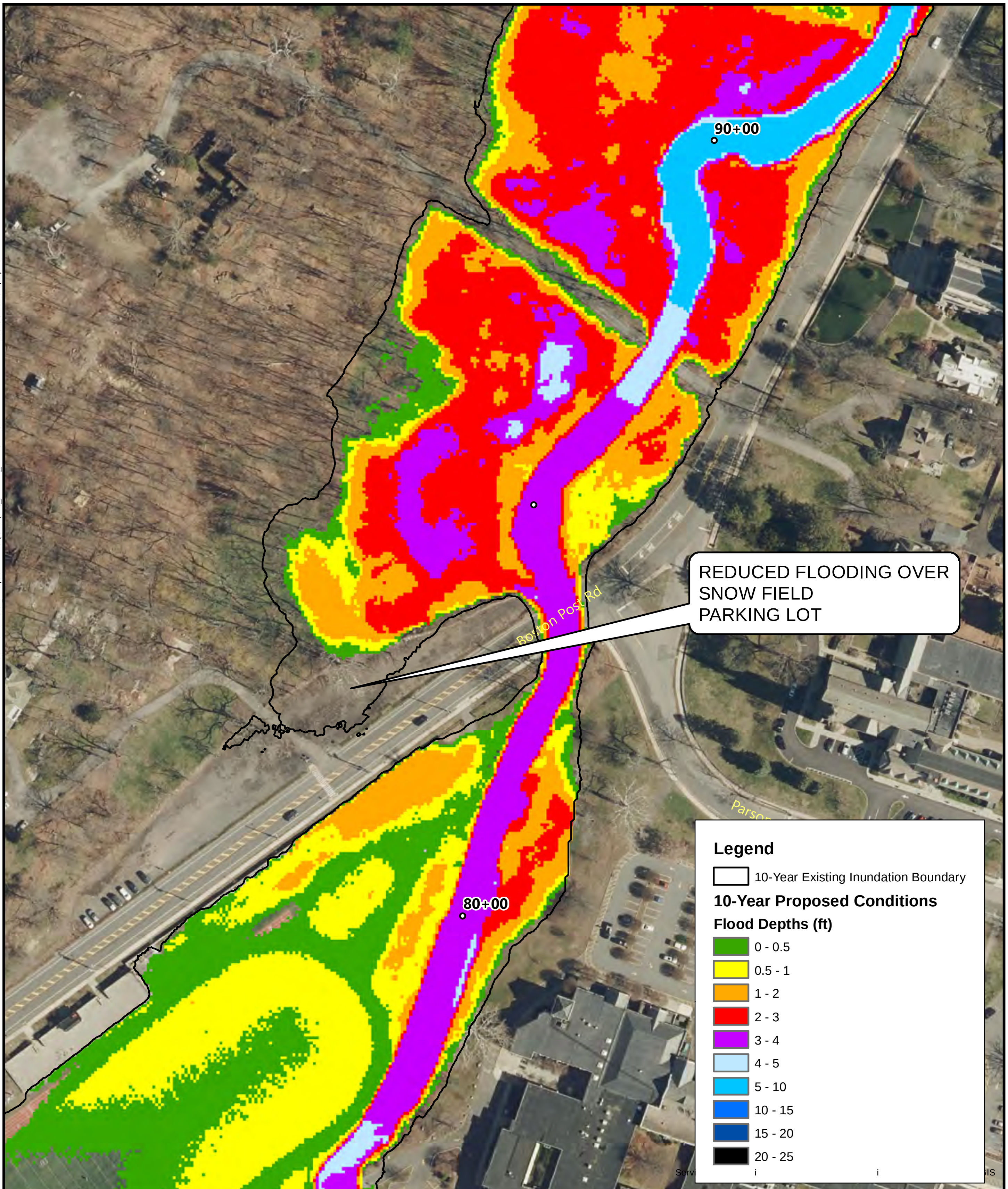

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HRA #1: BOSTON POST ROAD (US ROUTE 1)

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
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Feet

SCALE 1 " = 150 '

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FIG. 4-16

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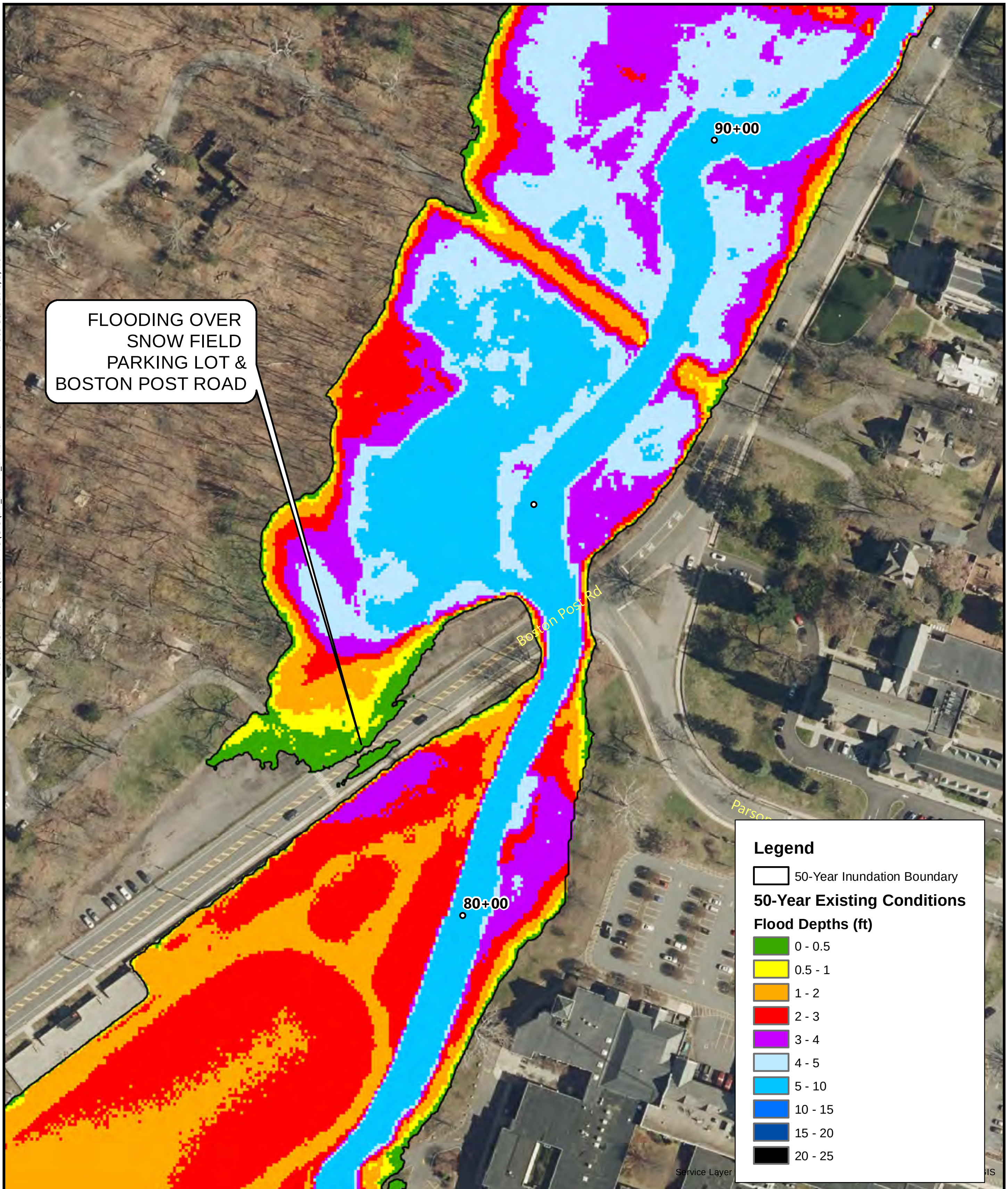

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HRA #1: BOSTON POST ROAD (US ROUTE 1)

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

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Feet

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FIG. 4-17

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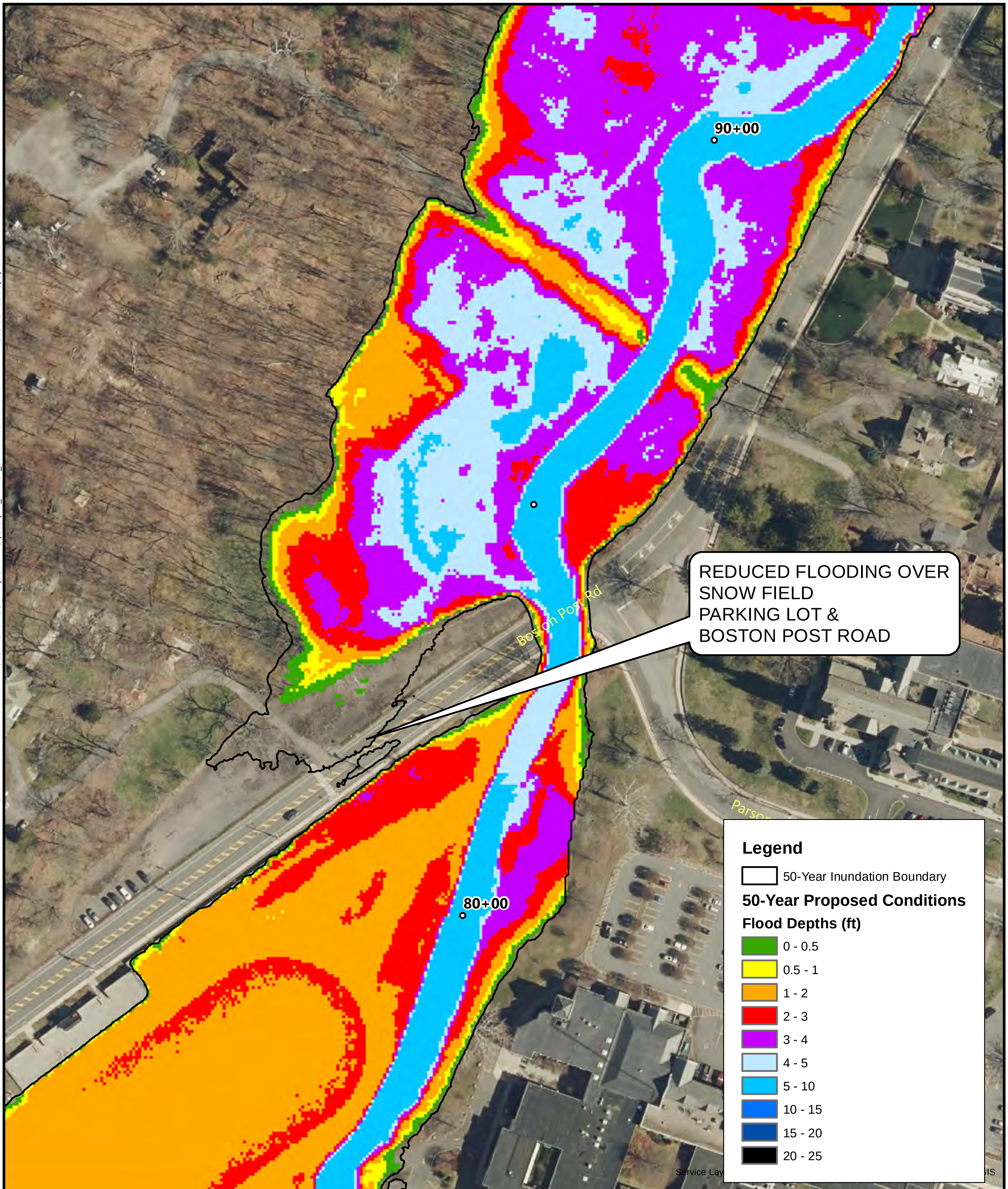

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HRA #1: BOSTON POST ROAD (US ROUTE 1)
BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N
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Feet

SCALE 1 " = 150 '
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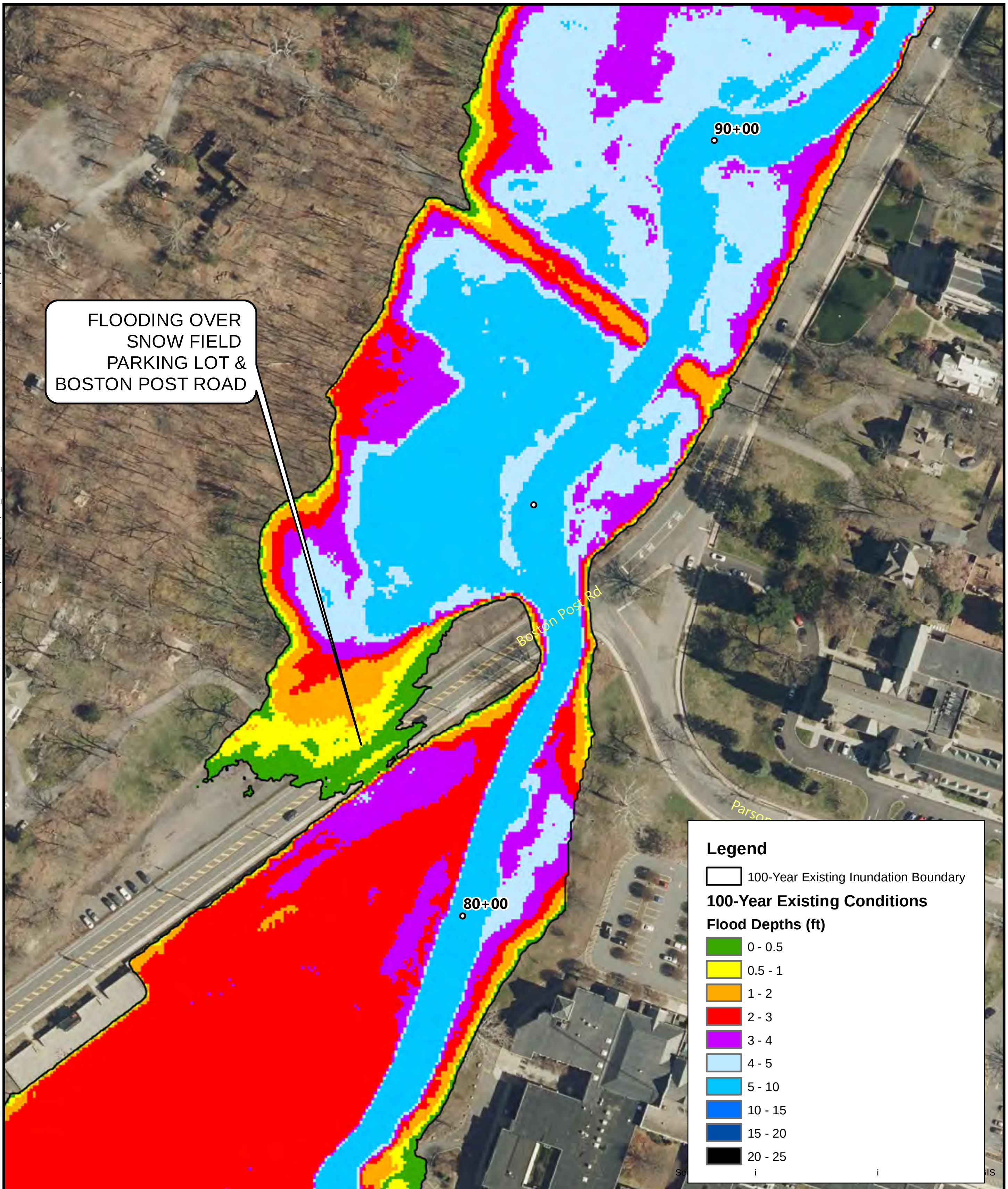
FIG. 4-18



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HRA #1: BOSTON POST ROAD (US ROUTE 1)

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969MOD1
WESTCHESTER COUNTY, NEW YORK

N

0 150 Feet

SCALE 1 " = 150 '
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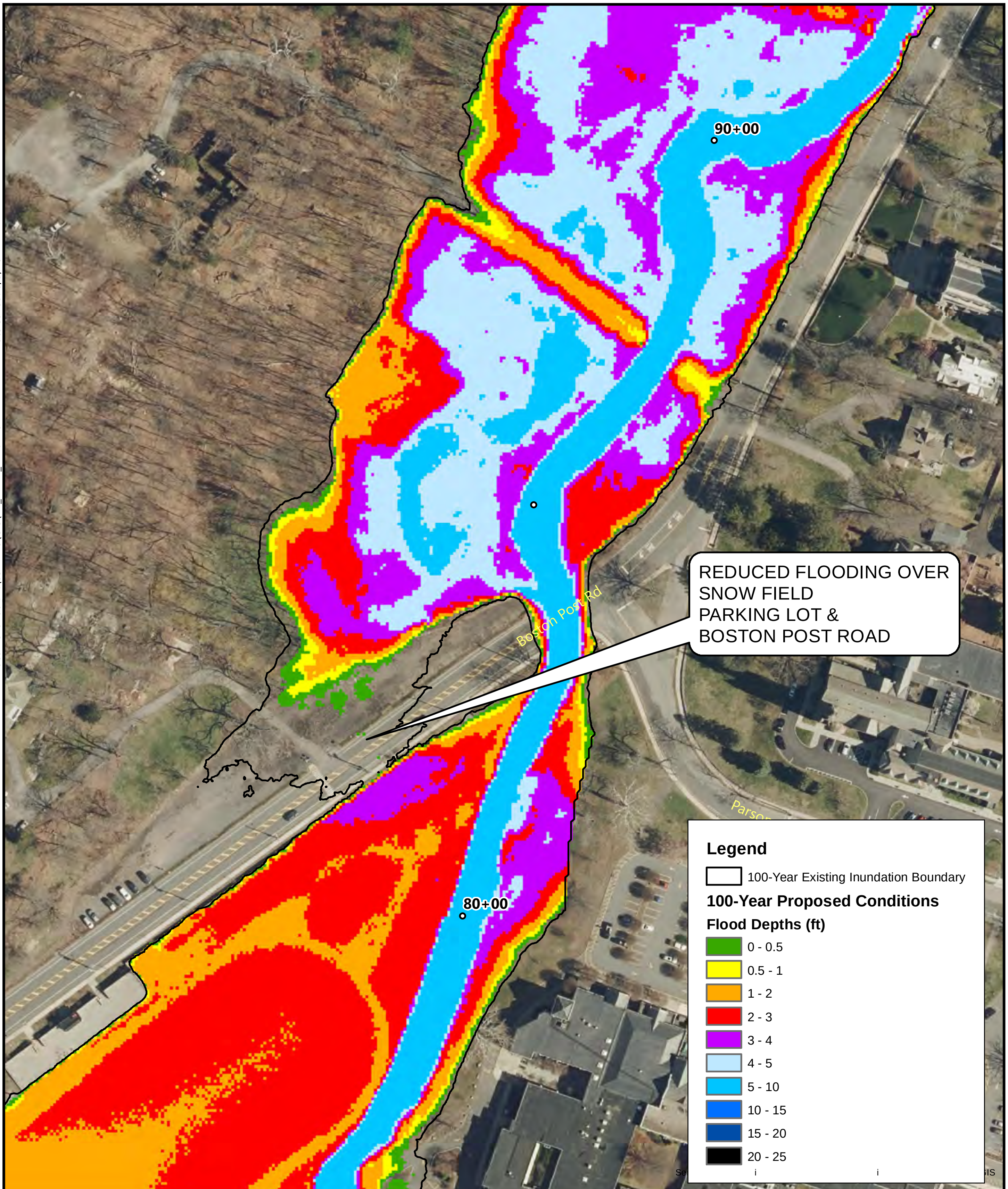
FIG. 4-19



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HRA #1: BOSTON POST ROAD (US ROUTE 1)

BLIND BROOK FLOOD & RESILIENCY STUDY

969MOD1

WESTCHESTER COUNTY, NEW YORK

N

0 150 Feet

SCALE 1 " = 150 '

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FIG. 4-20

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4.1.4 CITY OF RYE NATURE CENTER BRIDGES

The driveway to the Rye Nature Center is carried over Blind Brook at STA 87+26 by a masonry arch bridge built in 1870 (Figure 4-21). NYS Parks, Recreation, and Historic Preservation (OPRHP) deemed this bridge eligible for listing in the NYS historic repertoire by DOT Historic Bridge Inventory 2022 under Criterion C: "*Possessing high artistic values and demonstrates pattern or feature common to a particular bridge type.*" The structure is reported to have flooded during Hurricane Irene, Tropical Storm Lee, and Hurricane Sandy. The bridge has been closed numerous times after floods due to concerns with scour under the structure, consequently interrupting community access to the nature center for extended periods. The bridge has a 32-foot-span and an 8.5-foot-high vertical opening. It has a hydraulic capacity of less than the estimated existing 10-year flood event and creates a backwater that can be traced all the way upstream to just below the Central Avenue bridge at STA 100+00. Without a tailwater influence from the downstream bridge at Boston Post Road, the bridge is still incapable of passing the existing 10-year flood event, with hydraulic modeling showing the right (northeastern) approach road to the bridge under 1 to 2 feet of water.

Figure 4-21: Looking downstream at bridge over Blind Brook to the Rye Nature Center

Approximately 516 feet upstream of the bridge to the Rye Nature Center, there is an abandoned open-bottom concrete pedestrian bridge near STA 92+54 (Figure 4-22). The over 100-year-old structure is listed in the NYSDOT bridge inventory database (BIN 2265290); however, this bridge is not included in the hydraulic model. During a site visit in spring 2022, SLR inspected and gathered measurements of the structure so it could be added to the hydraulic model. The bridge spans 25 feet wide, has an opening approximately 7 feet high, and is shown to overtop starting at the current 10-year flood event. The structure is drowned by the influence from the Nature Center driveway and the Boston Post Road bridges located downstream, although removing this tailwater affect does not improve the performance at the pedestrian bridge. This implies that the bridge is impeding flood flow conveyance and raising water surface elevation upstream anywhere between 1.5 to 1.3 feet in the 10- and 100-year flood events.

Figure 4-22: Looking downstream at pedestrian bridge inlet over Blind Brook. The bridge has been posted and fenced off on both sides to prevent passage.

A new entrance to the Rye Nature Center has been proposed in the past that would eliminate the need for a replacement bridge across Blind Brook at the current location. The new driveway would extend off Boston Post Road just southwest of where Blind Brook crosses under (Figure 4-23). Removal of the Nature Center bridge is recommended if a new entrance is to be established. Additionally, removal of the abandoned pedestrian bridge upstream is recommended. Removal of both structures would reduce flood levels upstream, mitigating flooding of homes on Loewen Court, and would improve the hydraulic performance of the Central Avenue bridge, assuming that the Boston Post Road bridge is no longer acting as a constriction.

Figure 4-24 (existing conditions) and Figure 4-25 (proposed conditions) depict flood depths for the 10-year flood event. Figure 4-26 (existing conditions) and Figure 4-27 (proposed conditions) show depths for the 50-year flood event. 100-year flood event mapping is shown in Figure 4-28 (existing conditions) and Figure 4-29 (proposed conditions).

Figure 4-30 is a concept map showing recommended flood mitigation improvements within HRA 1.

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HRA #1: CITY OF RYE NATURE CENTER BRIDGES CONCEPT

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N
0 260
Feet

SCALE 1 " = 250 '
DATE 6/21/2022
6511.0018
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FIG. 4-23

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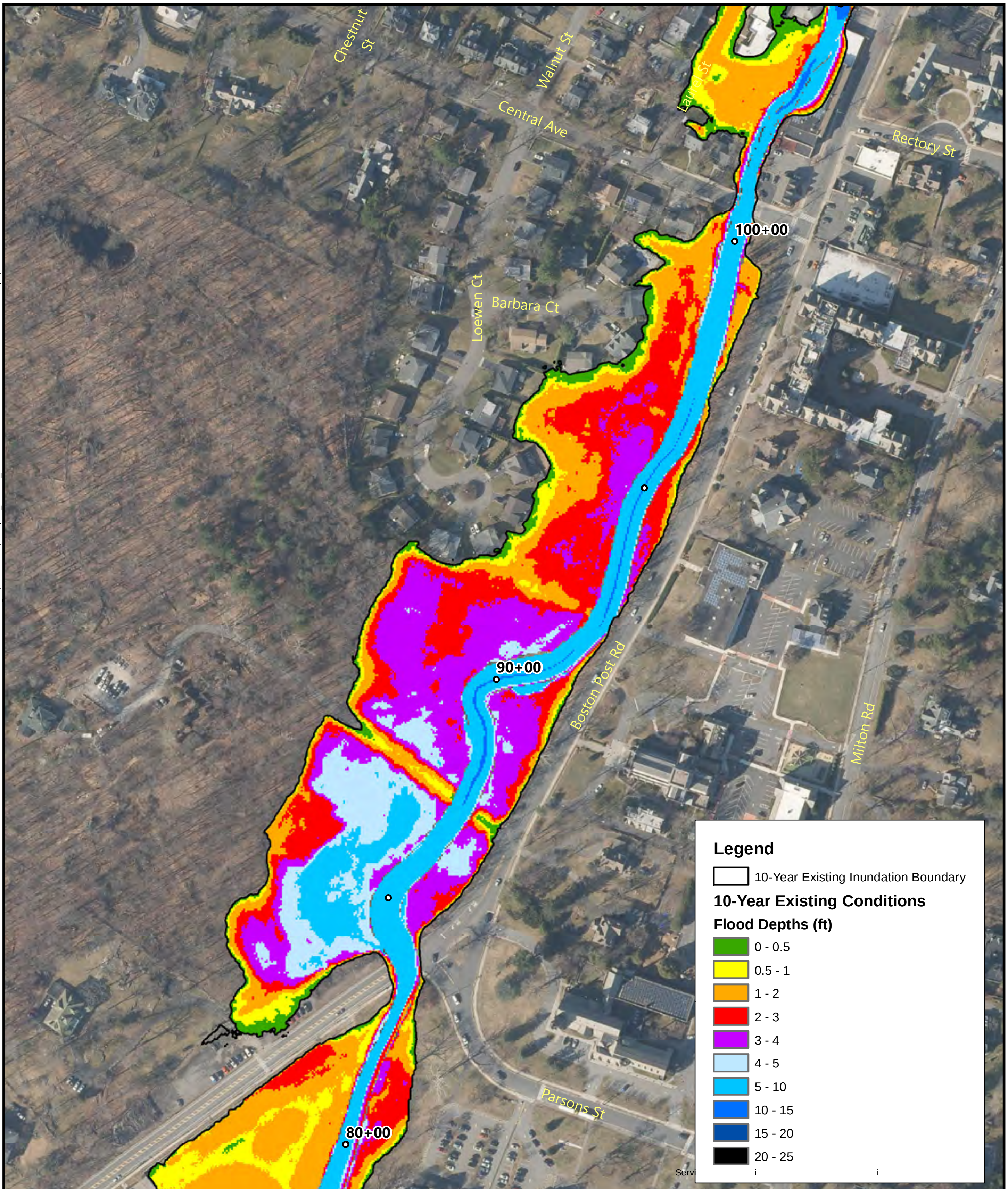

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HRA #1: NATURE CENTER BRIDGES EXISTING CONDITIONS

BLIND BROOK FLOOD & RESILIENCY STUDY

969MOD1

WESTCHESTER COUNTY, NEW YORK

N

0 250 Feet

SCALE 1 " = 250 '

DATE 6/20/2022

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FIG. 4-24

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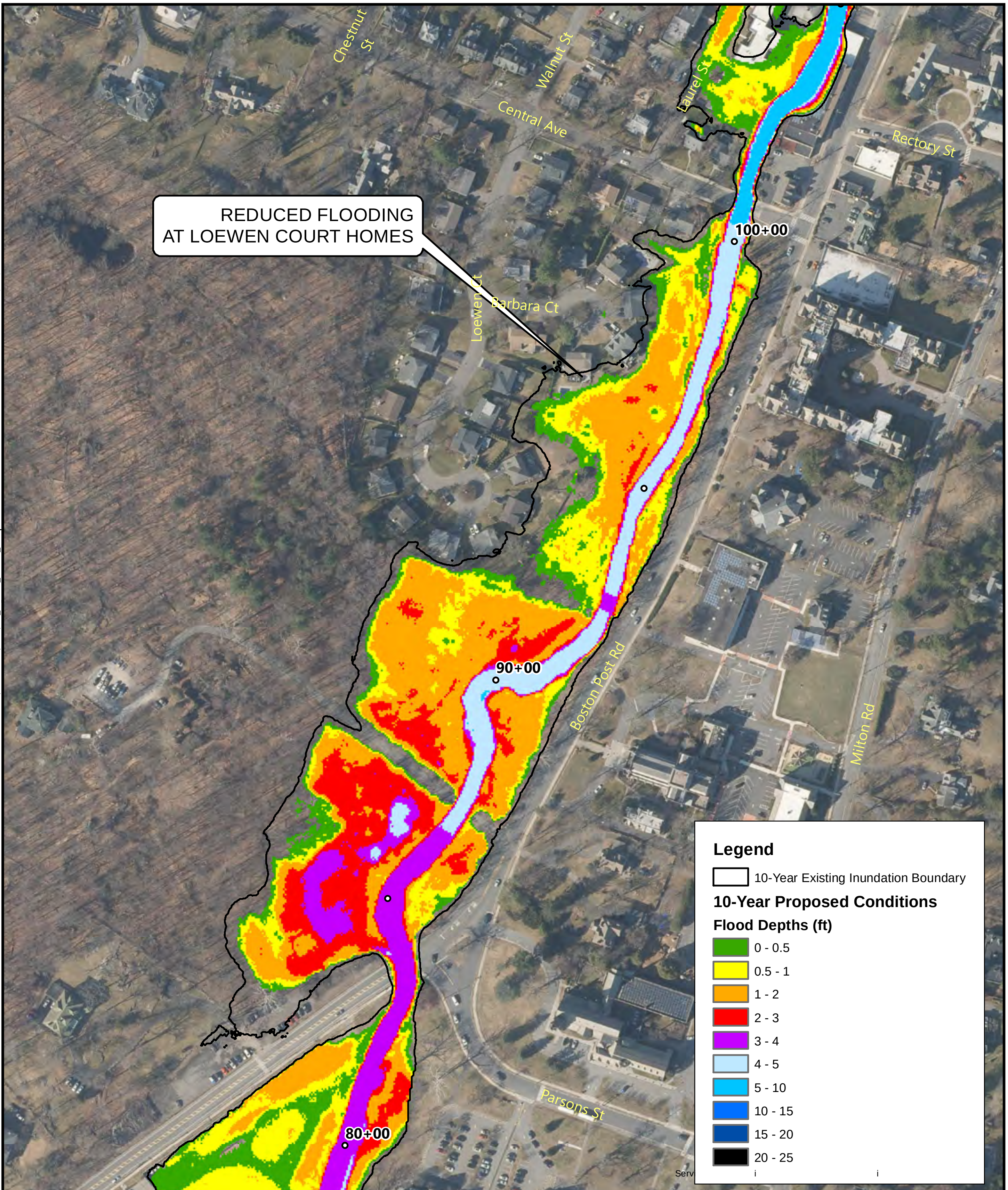

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HRA #1: NATURE CENTER BRIDGES PROPOSED CONDITIONS

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
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0 250
Feet

SCALE 1 " = 250 '
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FIG. 4-25

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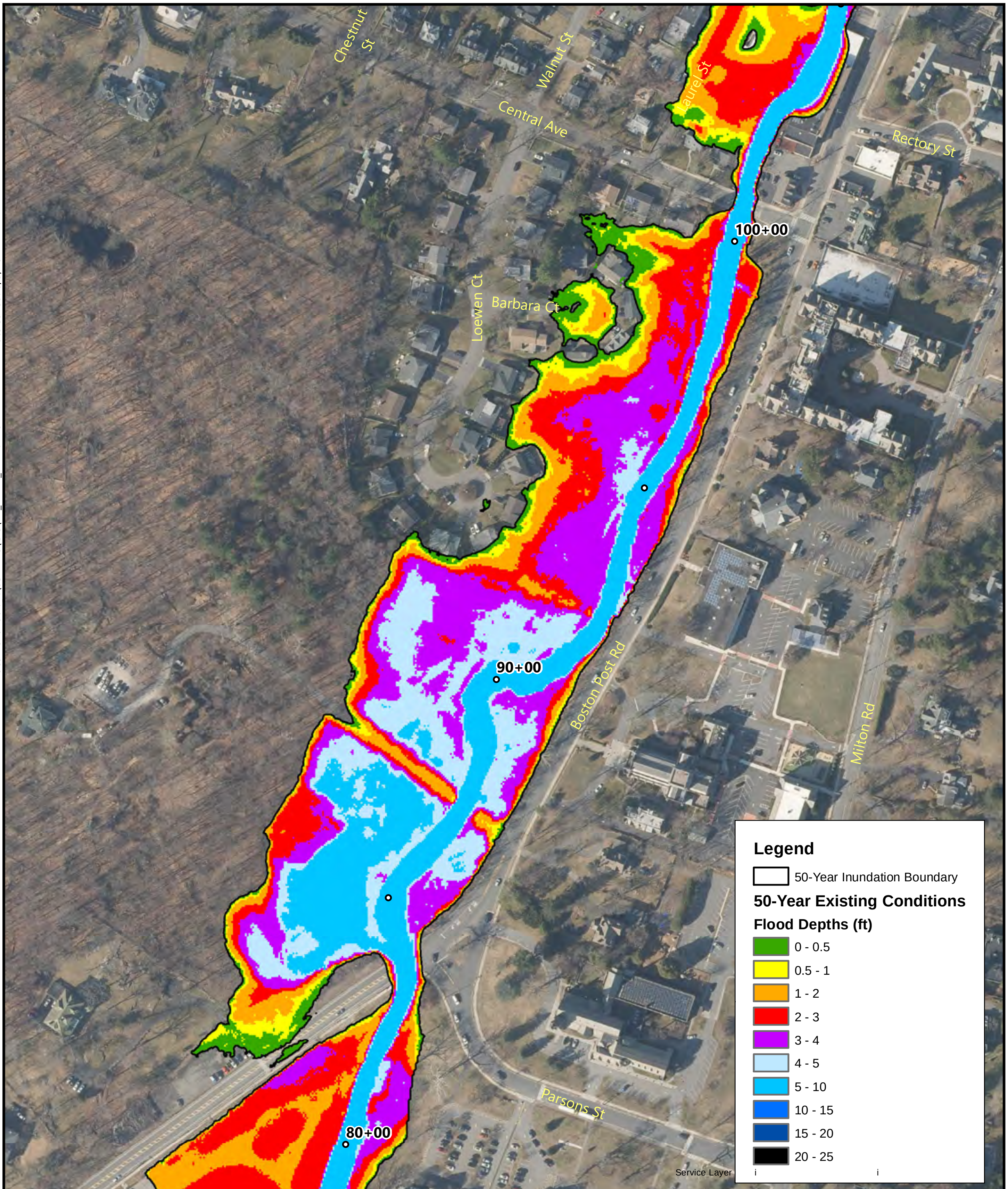

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HRA #1: NATURE CENTER BRIDGES EXISTING CONDITIONS

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

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Feet

SCALE 1 " = 250 '
DATE 6/20/2022
6511.0018
PROJ. NO.

FIG. 4-26

Date Saved: 6/20/2022
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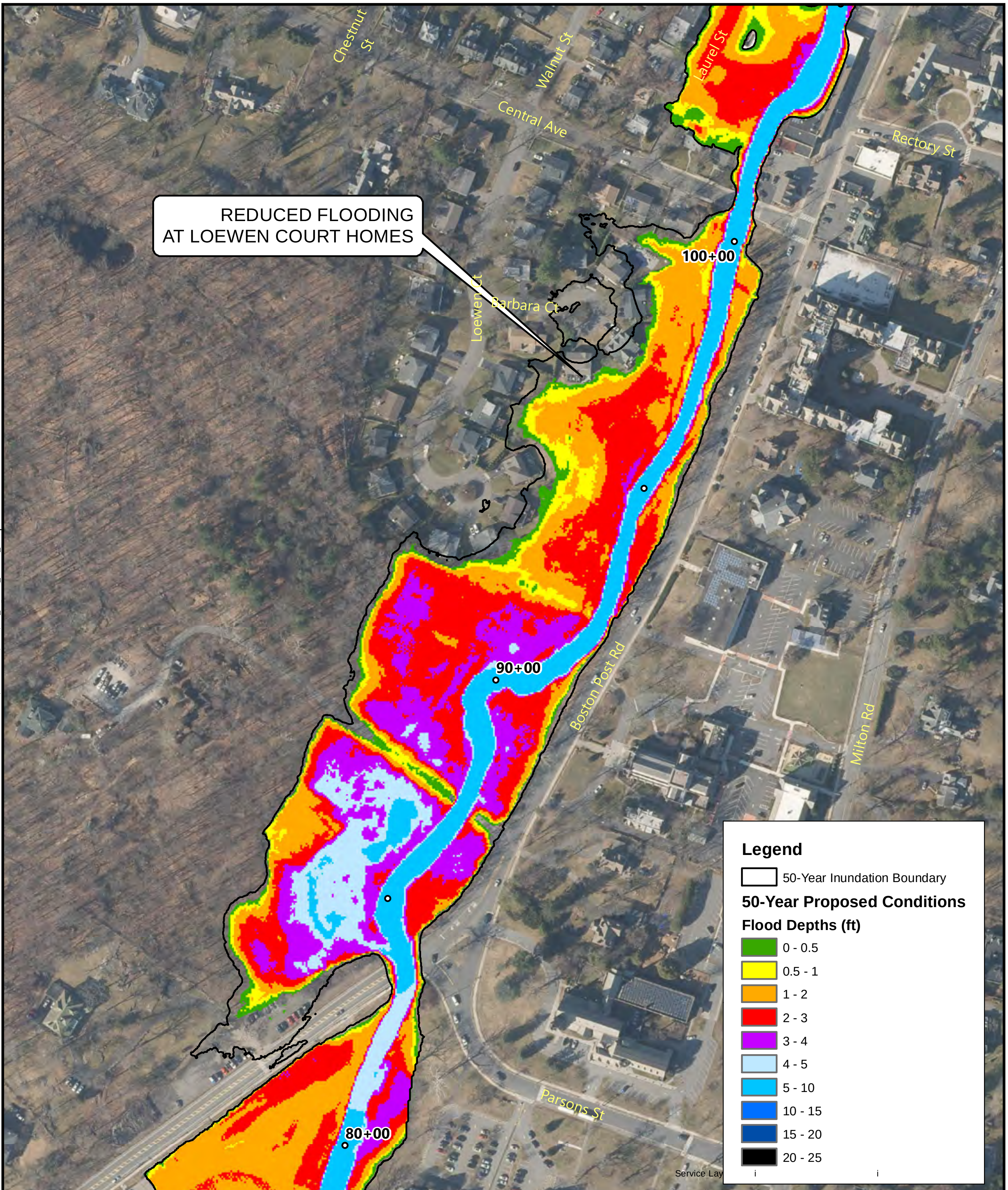

HRA #1: NATURE CENTER BRIDGES PROPOSED CONDITIONS

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

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FIG. 4-27

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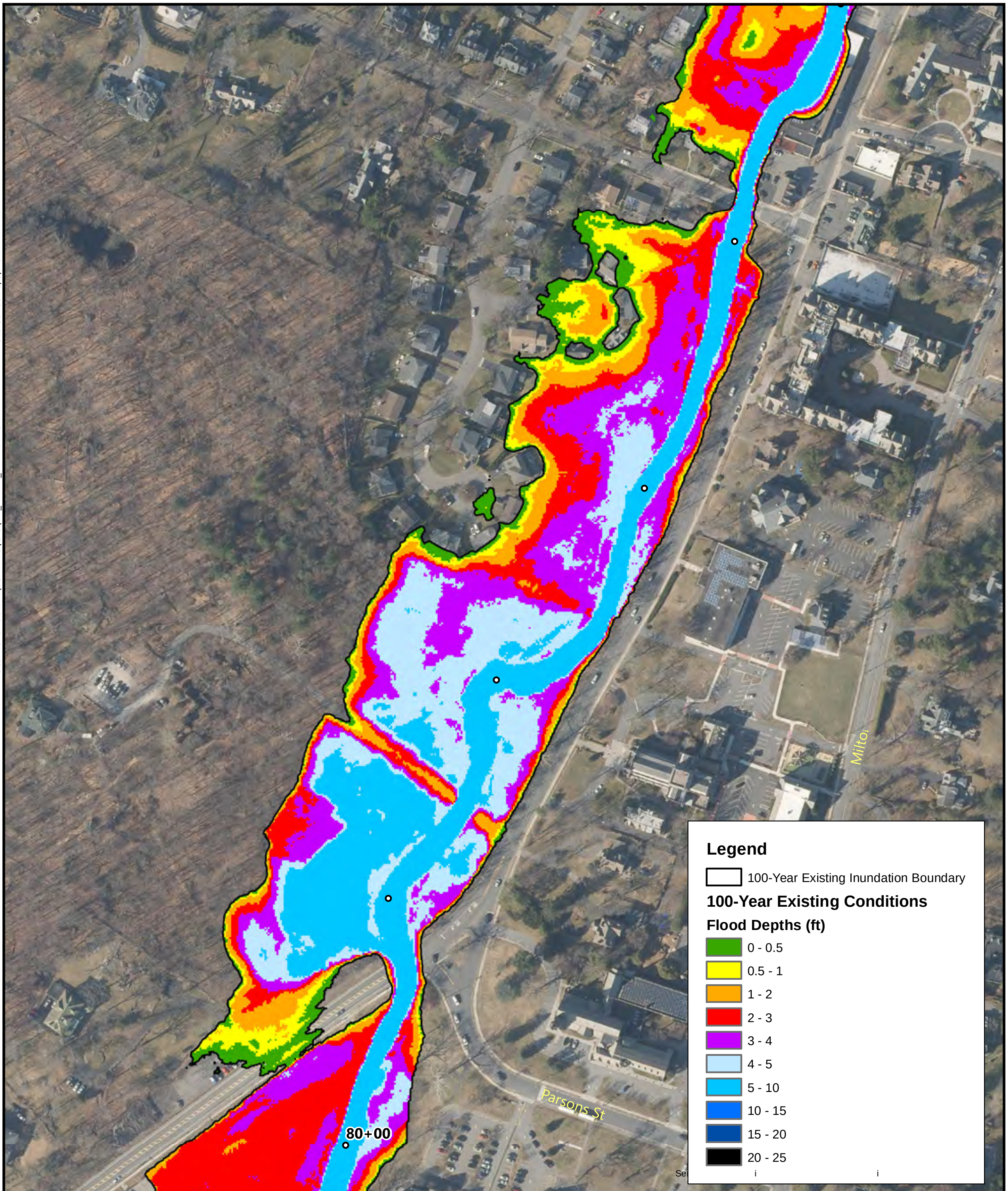

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HRA #1: NATURE CENTER BRIDGES EXISTING CONDITIONS

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
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Feet

SCALE 1 " = 250 '
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FIG. 4-28

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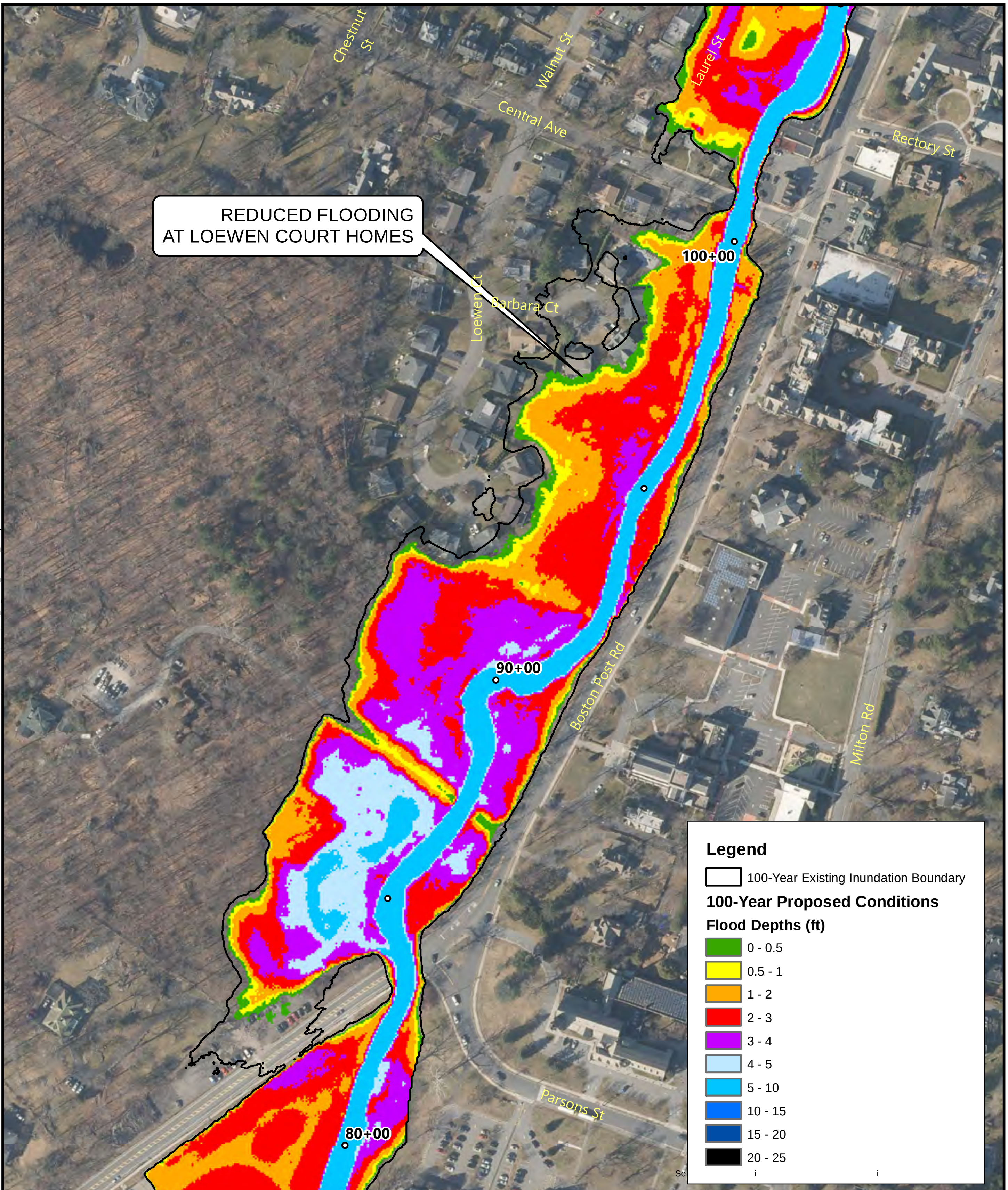

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HRA #1: NATURE CENTER BRIDGES PROPOSED CONDITIONS

BLIND BROOK FLOOD & RESILIENCY STUDY

969MOD1

WESTCHESTER COUNTY, NEW YORK

N

0 250 Feet

SCALE 1 " = 250 '

DATE 6/20/2022

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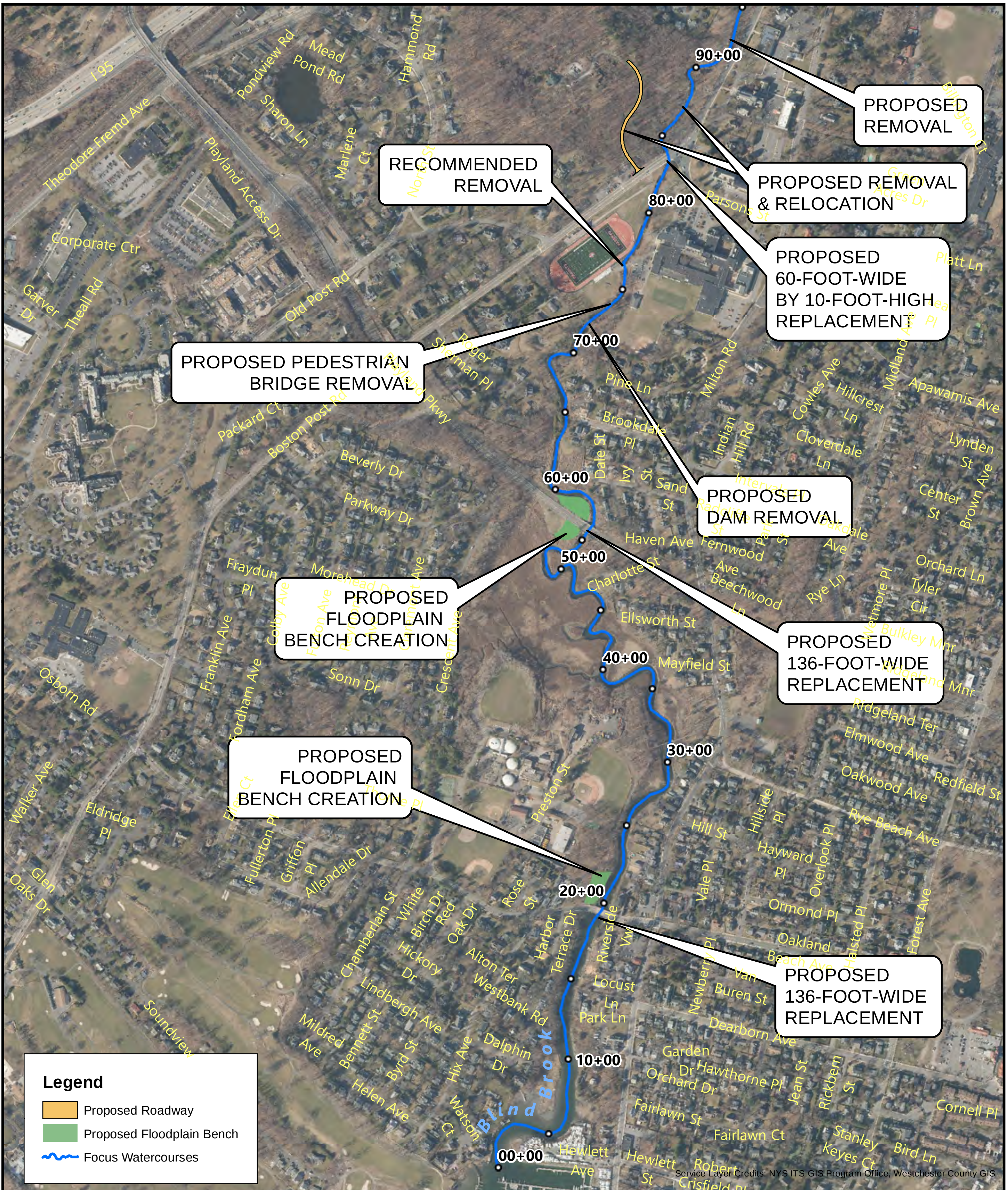
PROJ. NO.

FIG. 4-29



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HRA #1: CONCEPT MAP

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N

0 500 Feet

SCALE 1 " = 800 '

DATE 6/7/2022

PROJ. NO. 6511.0018

FIG. 4-30

4.2 HIGH RISK AREA #2 – BLIND BROOK IN DOWNTOWN CITY OF RYE

HRA 2 encompasses the historical crossroads of the city of Rye and extends from the Central Avenue bridge at STA 100+72 upstream to STA 127+62 just downstream of the I-95/Metro-North bridge. This section of Blind Brook has been heavily channelized and confined by vertical walls for most of its length as it passes through a densely developed area of the city comprised of residential and commercial buildings. Approximately six private and public bridges span the brook within HRA 2, most of which cannot convey the existing 10-year flood event and contribute to upstream flooding. Critical facilities within HRA 2 include the Rye City Hall and the Building Department building, City of Rye Fire Department (Figure 4-31), and medical offices off Purchase Street. Past flood events along Blind Brook have devastated homes and businesses within HRA 2, which accounts for one-fifth of the repetitive loss claims occurred in the city. A map of HRA 2 is illustrated in Figure 4-32.

Figure 4-31: City of Rye firehouse inundated with several inches of water from the remnants of Tropical Storm Ida 2021. Photo taken on Locust Avenue near intersection with Purchase Street, looking southwest toward Blind Brook. Photo courtesy of MyRye.com News Report.

The hydraulics of Blind Brook through HRA 2 is highly complex. Repetitive flood damage is inextricably linked to insufficiently sized bridge crossings and an encroached and undersized channel and floodplain that worsen flooding at infrastructure built within the Blind Brook's floodplain. For this reason, this section of the report is presented in a different manner than the previous section. Sections 4.2.1 through 4.2.5 discuss the current condition and capacity of the four main bridges that span Blind Brook within HRA 2. Proposed conditions findings and recommendations for HRA 2 are detailed in Section 4.2.5.

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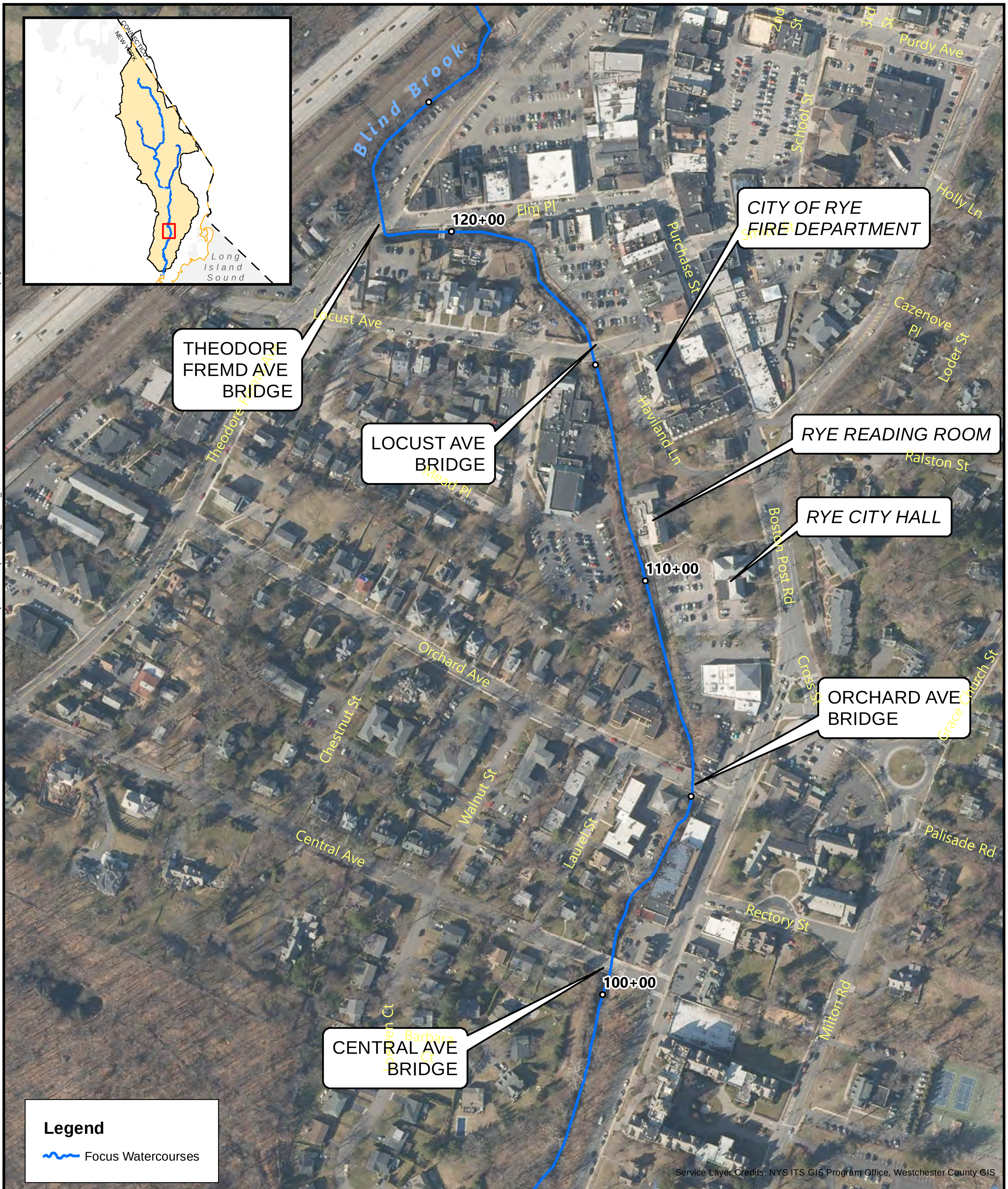

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BLIND BROOK HIGH RISK AREA 2

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N
0 310 Feet

SCALE 1 " = 300 '
DATE 6/14/2022
6511.0018
PROJ. NO.

FIG. 4-32

4.2.1 CENTRAL AVENUE BRIDGE

At the downstream-most margins of HRA 2 near STA 100+72 is the Central Avenue bridge over Blind Brook (Figure 4-33). The bridge was replaced in 2013, substituting the former 30-foot-wide structure with a 40-foot-wide bridge. The hydraulic model predates the bridge replacement; therefore, measurements collected in the field were used to update this crossing in the model. The existing bridge is shown to only pass the existing 10-year flood event and does not pass the future 10-year flood event. During flood events, the bridge is indicated to flank to its right (northwest), inundating a topographically low area near the intersection with Laurel Street and several buildings situated along the right overbank upstream of Central Avenue.

Figure 4-33: Looking upstream at the Central Avenue bridge. The crossing at this location was replaced in 2013 with a larger span bridge.

According to hydraulic modelling, the Central Avenue bridge has insignificant impacts on upstream water surface elevations in the 10-year flood event. For the 50-year and 100-year flood events, the structure is shown to increase water surface elevations by 1.8 feet at the upstream face. Increased water surface elevations propagate upstream for 590 feet to the bridge under Orchard Avenue near STA 105+00, which is also constrictive to flows. The stretch of Blind Brook from Central Avenue to Orchard Avenue is severely channelized and very tightly confined between walls and commercial buildings. According to regional regression equations, a 46-foot bankfull channel width is necessary. The channel width within this stretch is as narrow as 25 feet in some locations.

4.2.2 ORCHARD AVENUE BRIDGE

The 1929 bridge under Orchard Avenue (STA 105+00) is an open-deck concrete bridge that spans 29 feet and is approximately 6.7 feet high (Figure 4-34). In the hydraulic modeling analysis, the existing bridge is shown to flank to its right (northwest) as early as the current 10-year flood event. During the Tropical Storm Ida flood, the bridge indeed was flanked, and floodwater damaged the sidewalk and the bridge parapet to the right as shown in Figure 4-35. The backwater effect from the bridge extends up to the Locus Avenue bridge at STA 115+00. Homes situated to the north of Orchard Avenue, as well as the Rye YMCA parking lot, are shown to inundate starting at the 10-year flood event.

Figure 4-34: Looking at the Orchard Avenue upstream bridge face

Figure 4-35: Looking at sidewalk damage and collapsed portion of the bridge parapet at the upstream bridge face

Assuming no tailwater influence from the Central Avenue bridge, the Orchard Avenue bridge is shown to raise water surface elevations at the upstream bridge face by 2.3 feet and 1.6 feet in the 10-year and 100-year flood events, respectively. Removal of the bridge from the hydraulic model has minimal reductions to modeled flood extents. Upstream of Orchard Avenue, the brook is straight and confined between development on both sides with very little room available for any channel enhancement opportunities. Flooding within this reach of the brook is a combined result of the undersized channel and bridges.

4.2.3 LOCUST AVENUE BRIDGE

Possibly the most hydraulically undersized bridge in HRA 2 is the Locust Avenue bridge near STA 115+00 (Figure 4-36). Floodwaters are known to flank the bridge on either side and erode sidewalks on the downstream side of the structure. Hydraulic modeling indicates that this open-deck concrete bridge, built in 1928, is overtopped as frequently at the 10-year flood event and suggests over a foot of water over the right (western) approach. According to the NYSDOT bridge inventory report, the Locust Avenue bridge was last inspected in March 2021 and has been denoted as being in "poor condition." At the time of this report, the City of Rye was conducting a sewer line replacement project on the upstream side of the bridge, although no work was being performed on the Locust Avenue bridge itself.

Figure 4-36: Looking downstream at the Locust Avenue bridge

Removal of the bridge from the hydraulic model results in reductions in water surface elevations ranging between 1.5 feet and 3.8 feet in the current 10-year and 100-year flood events, respectively, and would extend up to the Theodore Fremd Avenue bridge 665 feet upstream. The absence of the Locust Avenue bridge from the hydraulic model improves the performance at the Theodore Fremd Avenue bridge, allowing it to pass the current 10-year flood event but not the future 10-year event. Reductions in flood levels in the 10-year flood event produce significant drawdown of flood inundation extents in the vicinity between Locust Avenue and Theodore Fremd Avenue. Similarly, in the 50- and 100-year flood events, flooding is reduced although not eliminated at upstream homes and businesses.

4.2.4 THEODORE FREMD AVENUE AND PEDESTRIAN BRIDGES

The bridge carrying Theodore Fremd Avenue over Blind Brook at STA 121+95 is a 1928 open-deck bridge that measures approximately 30 feet wide by 7 feet high (Figure 4-37). The brook makes a sharp bend as it approaches the bridge and then again after passing underneath it. Upstream of the bridge, Blind Brook is narrowly pinched between the Metro-North railroad embankment to the north and the roadway and parking lots to the south. This location is notorious for repeatedly scouring during flood events from water that outlets from the MTA/I-95 crossing. On the downstream side of the Theodore Fremd Avenue crossing, a 9-foot-high by 22-foot-wide rectangular channel transports the brook between Elm Place to the north and residential development to the south. At approximately 130 feet downstream of the Theodore Fremd Avenue bridge, there is a private pedestrian bridge that does not pass any of the peak modeled flood events. The private bridge appears to be in poor condition and exhibits signs of damage from past floods (Figure 4-38).

Figure 4-37: Looking downstream at the Theodore Fremd Avenue bridge

Figure 4-38: Looking downstream at the walled-in section of Blind Brook and the private pedestrian bridge that spans over it. The bridge is missing portions of the guardrail, and yellow caution tape has been added around the structure.

The Theodore Fremd Avenue and pedestrian bridge are shown to increase upstream water surface elevations by 1.0 feet in the 10-year flood event. Based on hydraulic modeling, this increase causes floodwater to spill over the left bank near STA 120+50, leading water to run down Theodore Fremd Avenue and Elm Place behind the commercial buildings in the vicinity during the existing 10-year flood event. The hydraulic model indicates that in the 50- and 100-year flood events, the undersized Blind Brook channel becomes the dominating hydraulic constriction. Additional channel restoration efforts would be necessary to contain flows within the Blind Brook channel and minimize flooding of the commercial district.

4.2.5 PROPOSED FLOOD MITIGATION ACTIONS

A multifaceted mitigation approach would be required to address flooding caused by the interdependency of the existing undersized stream crossings over Blind Brook and undersized channel geometry. Table 4-2 lists the bridges within HRA 2, the modeled proposed replacement bridge size, and details about current and proposed hydraulic capacity. To the extent practical, the proposed bridge spans and low cord elevations were adjusted according to the available space to minimize impacts to adjacent buildings and the need to elevate the roadway profile.

In addition, floodplain bench creation and channel restoration in this analysis was determined according to the available space and sought to reduce the need for removal or relocation of buildings. However, because of the significant amount of development along the banks of Blind Brook, relocation of houses and commercial buildings would be inevitable. Channel restoration would include the creation of a properly sized multistage channel and floodplain, installation of grade control structures and/or scour protection measures along the restored channel to prevent channel incision and protect upstream infrastructure, and installation of native plantings. A summary of the proposed floodplain benches modeled in this analysis follows.

- Floodplain bench #1 from STA 100+89 to STA 105+00 along the left bank of Blind Brook. Excavated about 5 feet below current ground level and approximately 411 feet long and 69 feet wide. Removal of 1 or 2 commercial buildings would be required for construction.

- Floodplain bench #2 from STA 109+20 to STA 112+20 along the right bank. Excavated about 4.5 feet below current ground level and approximately 300 feet long and 50 feet wide. The floodplain bench would require the removal of a portion of the YMCA parking lot.

- Floodplain bench #3 from STA 112+20 to STA 115+00 along the left bank. Excavated about 7.5 feet below current ground level and approximately 300 feet long and 30 feet wide. The floodplain bench would require the removal of a brick sidewalk adjacent to City of Rye firehouse.

- Floodplain bench #4 from STA 115+70 to STA 118+93 along the right bank. Excavated about 4.5 feet below current ground level and approximately 323 feet long and 30 feet wide.

- Floodplain bench #5 from STA 121+44 to STA 127+30 along the left bank. Excavated between 3 to 7.5 feet and approximately 586 feet long and 80 feet at its widest. The floodplain bench would require the decommissioning of Theodore Fremd Avenue.

Flood reductions under the 10-year flood event are illustrated in Figure 4-40 (existing conditions) and Figure 4-41 (with proposed floodplain benches and all crossing improvements implemented). Flood reductions during the 50-year flood event are illustrated in Figure 4-42 (existing conditions) and Figure 4-43 (proposed conditions). Flood reductions during the 100-year flood event are illustrated in Figure 4-44 (existing conditions) and Figure 4-45 (proposed conditions).

Table 4-2 Bridge Size Recommendations at HRA 2

Road/Bridge	Modeled Replacement Structure	Existing Flood Capacity	Proposed Flood Capacity
Central Avenue	66' Span by 12' Rise	10-Year	100-Year
Orchard Avenue	Removal	10-Year	N/A
Locust Avenue	66' Span by 10' Rise	< 10-Year	100-Year
Private Pedestrian Bridge	Removal	< 10-Year	N/A
Theodore Fremd Avenue	Removal	< 10-Year	N/A

The bridge replacements and floodplain benches illustrated here, if implemented, would result in reductions in flood depths and extent across all modeled flood events in HRA 2. However, despite these flood reduction benefits, the improvements would not completely resolve flooding problems along Blind Brook in HRA 2. It is recommended that efforts to increase upstream attenuation of floodwaters, such as at the Bowman Avenue dam and the SUNY Purchase campus, be implemented if found to be feasible and cost effective.

A rigorous hydrologic and hydraulic analysis is recommended for each bridge in HRA 2 when it is due for routine replacement to ensure that each bridge is adequately sized to convey flood flows and does not exacerbate flooding. Feasibility studies should be conducted to find the optimal combination of floodplain bench creation and bridge replacement prioritization and, if desirable, the decommission of bridges that span the Brook. At floodprone neighborhoods where bridge replacements and floodplain benches improve but do not eliminate flooding issues, buyouts and floodproofing at individual floodprone buildings is recommended.

It is recommended that, in combination with the above recommendations, the City of Rye pursue a long-term initiative to create a linear riparian park along Blind Brook throughout HRA 2, extending from Central Avenue upstream to I-95 and the Metro-North Railroad. This initiative would require the gradual acquisition and demolition of floodprone properties, followed by the establishment of a floodable linear park along Blind Brook. During times of normal flow in Blind Brook, the area could be used by city residents and visitors as a scenic park and linear trail, featuring walking and biking trails, lunch tables, food trucks, and other features of a city park. During high flows, the park would be designed to function as a floodplain, conveying excess flows in Blind Brook while reducing the amount of flooding of adjacent municipal buildings, business, and neighborhoods that are currently prone to flooding.

The concept map on Figure 4-39 illustrates the recommended floodplain bench locations and replacement bridges that were assessed. The long-term recommendation to create a linear riparian park along Blind Brook is indicated in concept by the dashed lines on Figure 4-39.

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HRA #2: CONCEPT MAP

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FIG. 4-39

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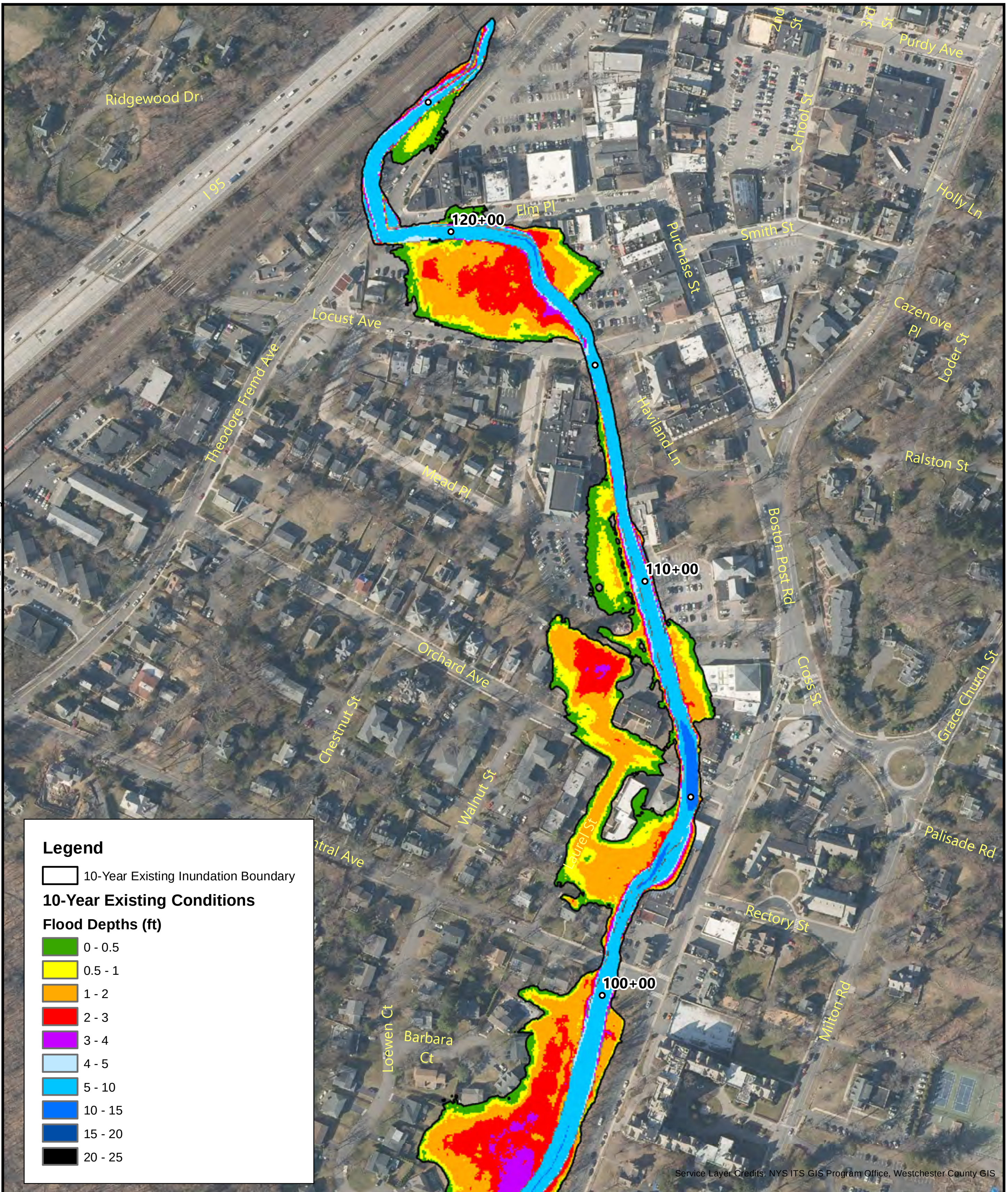

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HRA #2: 10-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG.4-40

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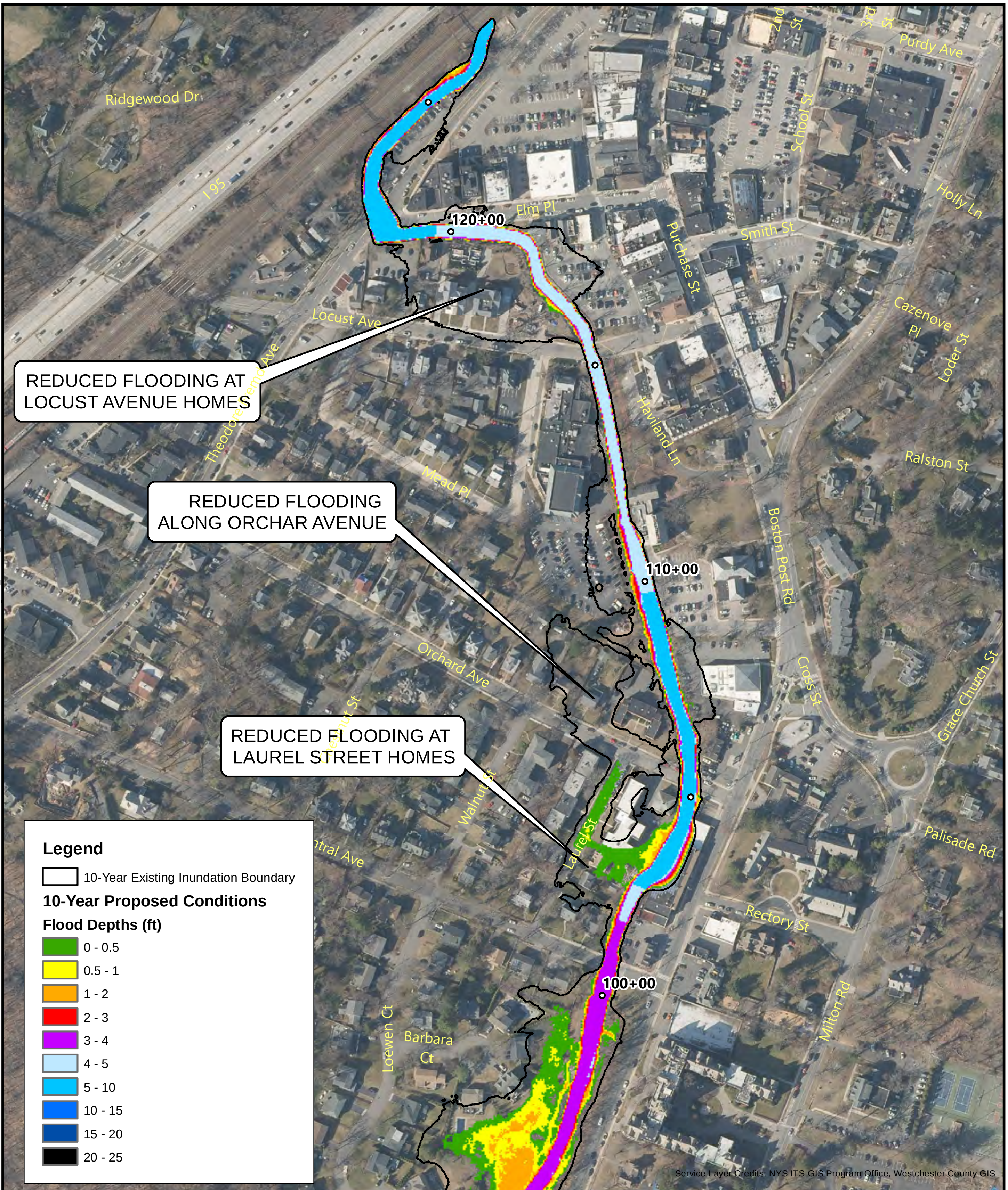

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HRA #2: 10-YEAR PROPOSED CONDITIONS FLOOD DEPTHS

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FIG.4-41

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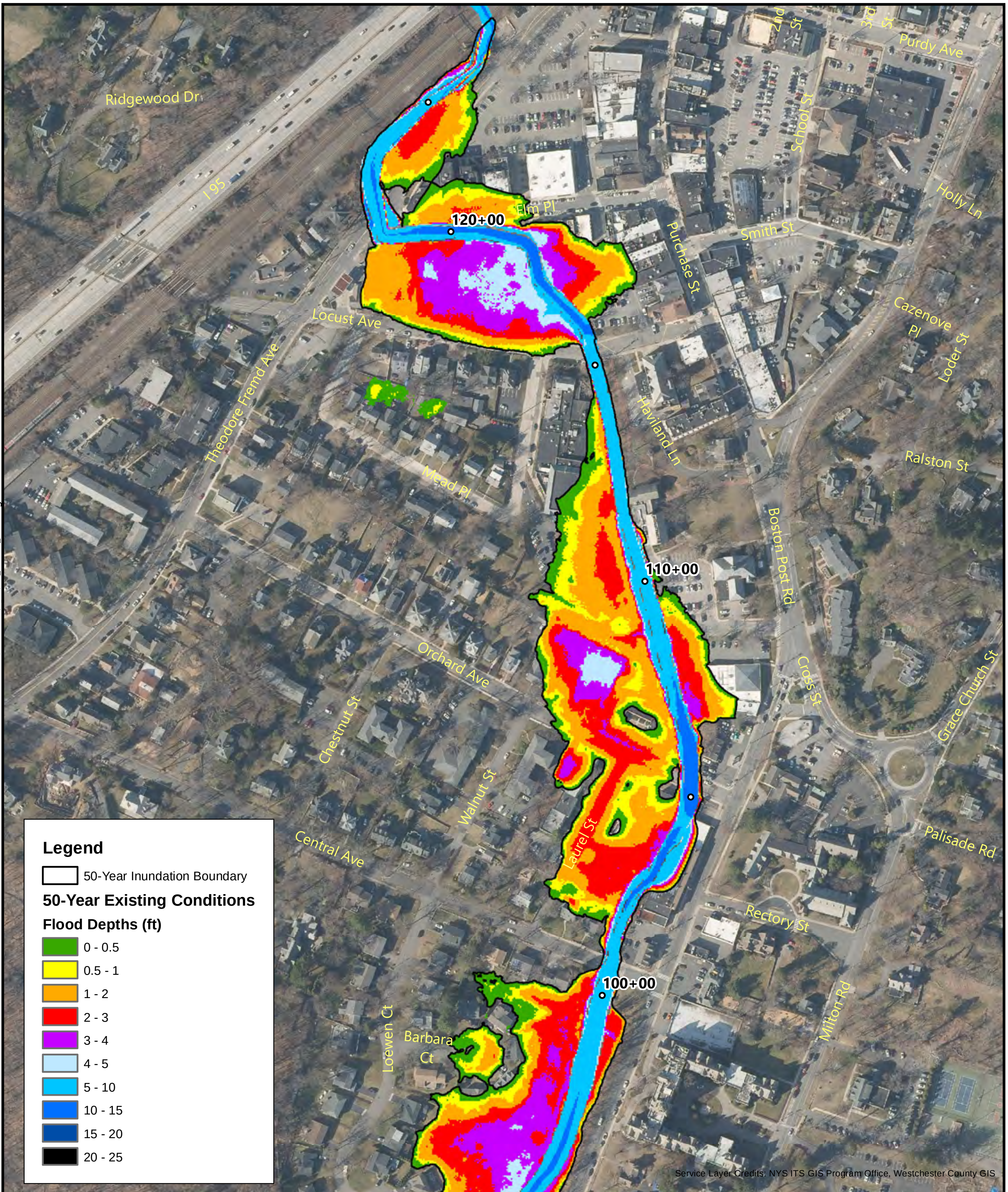

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HRA #2: 50-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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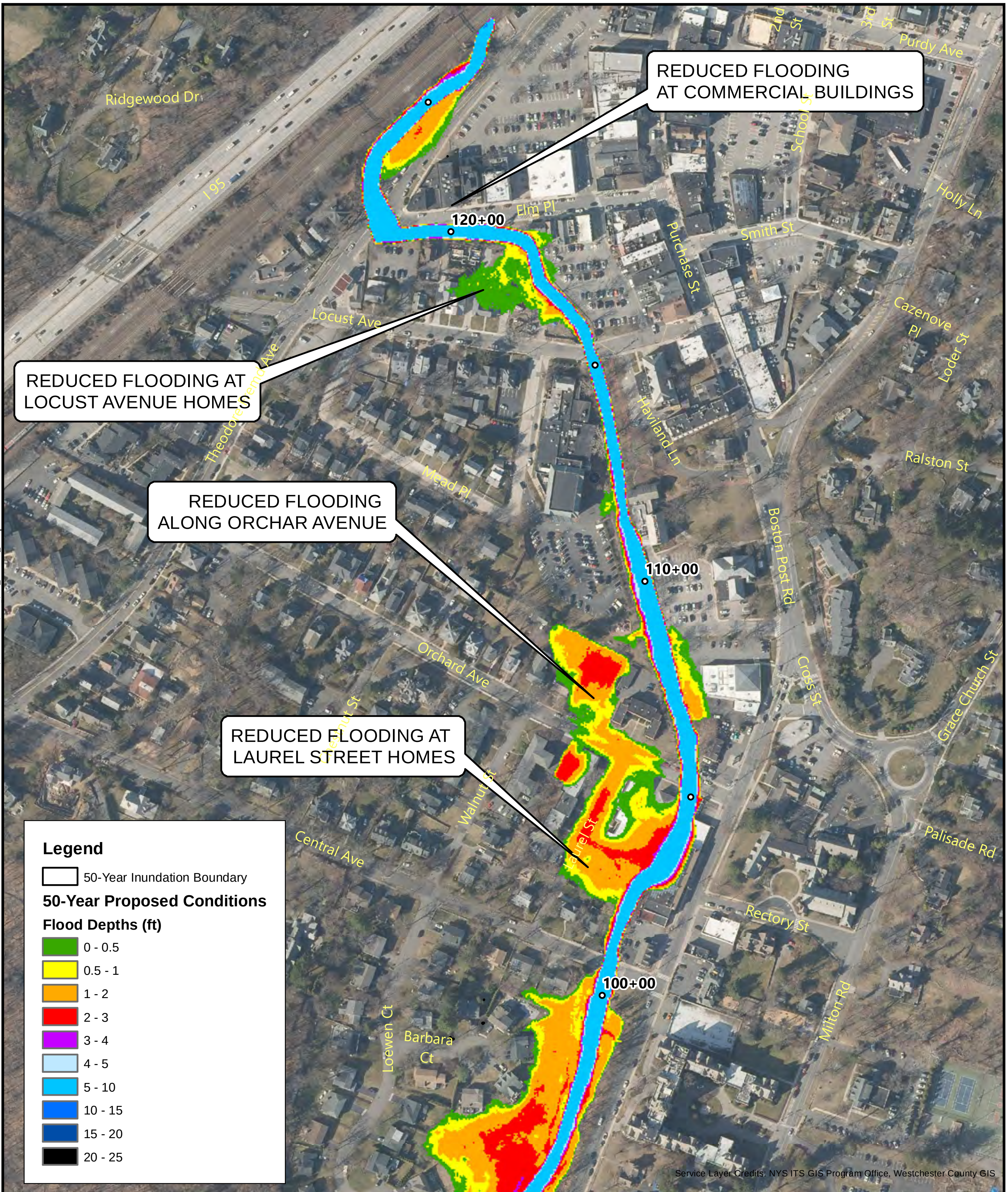
FIG.4-42



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HRA #2: 50-YEAR PROPOSED CONDITIONS FLOOD DEPTHS

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FIG.4-43

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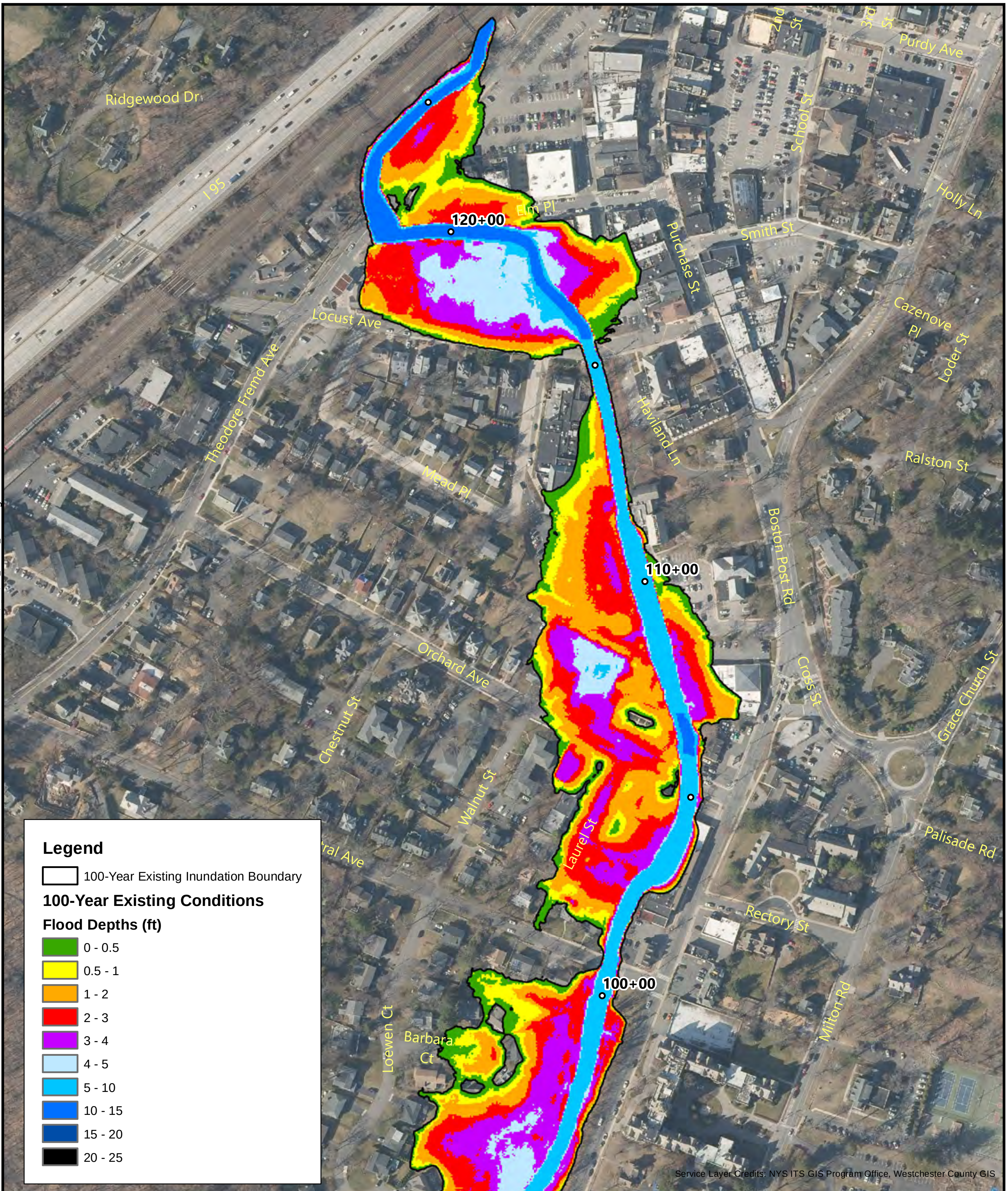

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HRA #2: 100-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG.4-44

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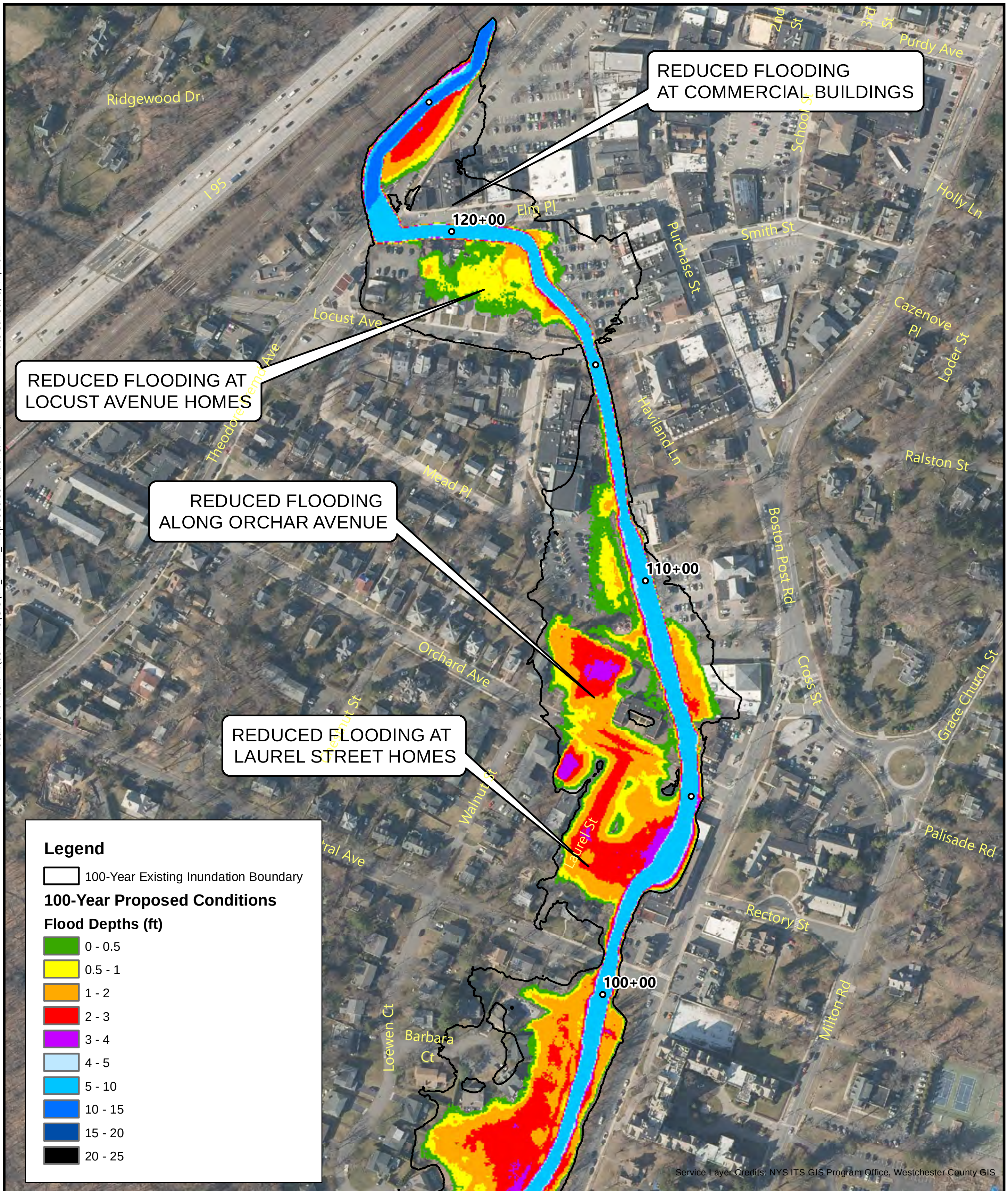

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HRA #2: 100-YEAR PROPOSED CONDITIONS FLOOD DEPTHS

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FIG.4-45

4.3 HIGH RISK AREA #3 – MTA/I-95 CROSSING UPSTREAM TO I-287 CROSSING

HRA 3 extends from STA 130+00 upstream to STA 191+00, from the Metro-North/I-95 crossing over Blind Brook upstream to the I-287 crossing. HRA 3 includes portions of the city of Rye, the town of Harrison, and the village of Rye Brook. Blind Brook flows predominantly through residential neighborhoods within HRA 3. The neighborhood between Wappanocca Avenue and Mendota Avenue, which run parallel to Blind Brook along its left and right bank, respectively, experience frequent and damaging flooding that accounts for one-third of the repetitive loss claims that have occurred in the city of Rye. HRA 3 also includes a floodprone neighborhood along Wyman Street (STA 185+00) in the village of Rye Brook. Flooding in HRA 3 is driven by a combination of development in floodprone areas and inadequately sized stream crossings that impound floodwaters. Stream crossings over Blind Brook in HRA 3 include the Metro-North (MTA)/ I-95 crossing, Highland Avenue, and Purchase Street. Figure 4-46 depicts a map of HRA 3.

Much of HRA 3 within the city of Rye has been designated as a Potential Environmental Justice Area. Potential Environmental Justice Areas are U.S. Census block groups of 250 to 500 households each that, in the Census, had populations that met or exceeded at least one of the following statistical thresholds:

1. At least 52.42 percent of the population in an urban area reported themselves to be members of minority groups; or

2. At least 26.28 percent of the population in a rural area reported themselves to be members of minority groups; or

3. At least 22.82 percent of the population in an urban or rural area had household incomes below the federal poverty level.

The federal poverty level and urban/rural designations for census block groups are established by the U.S. Census Bureau. The thresholds are determined by a statistical analysis of the 2014-2018 American Community Survey data, which is the most recent data available as of the time of the analysis in 2020. See NYSDEC Commissioner Policy 29 on Environmental Justice and Permitting (CP-29) for more information. The following link provides a map to Potential Environmental Justice Areas throughout New York State:

https://www.arcgis.com/home/webmap/viewer.html?url=https://services6.arcgis.com/DZHaqZm9cxOD4CWM/ArcGIS/rest/services/Potential_Environmental_Justice_Area__PEJA__Communities/FeatureServer&source=sd.

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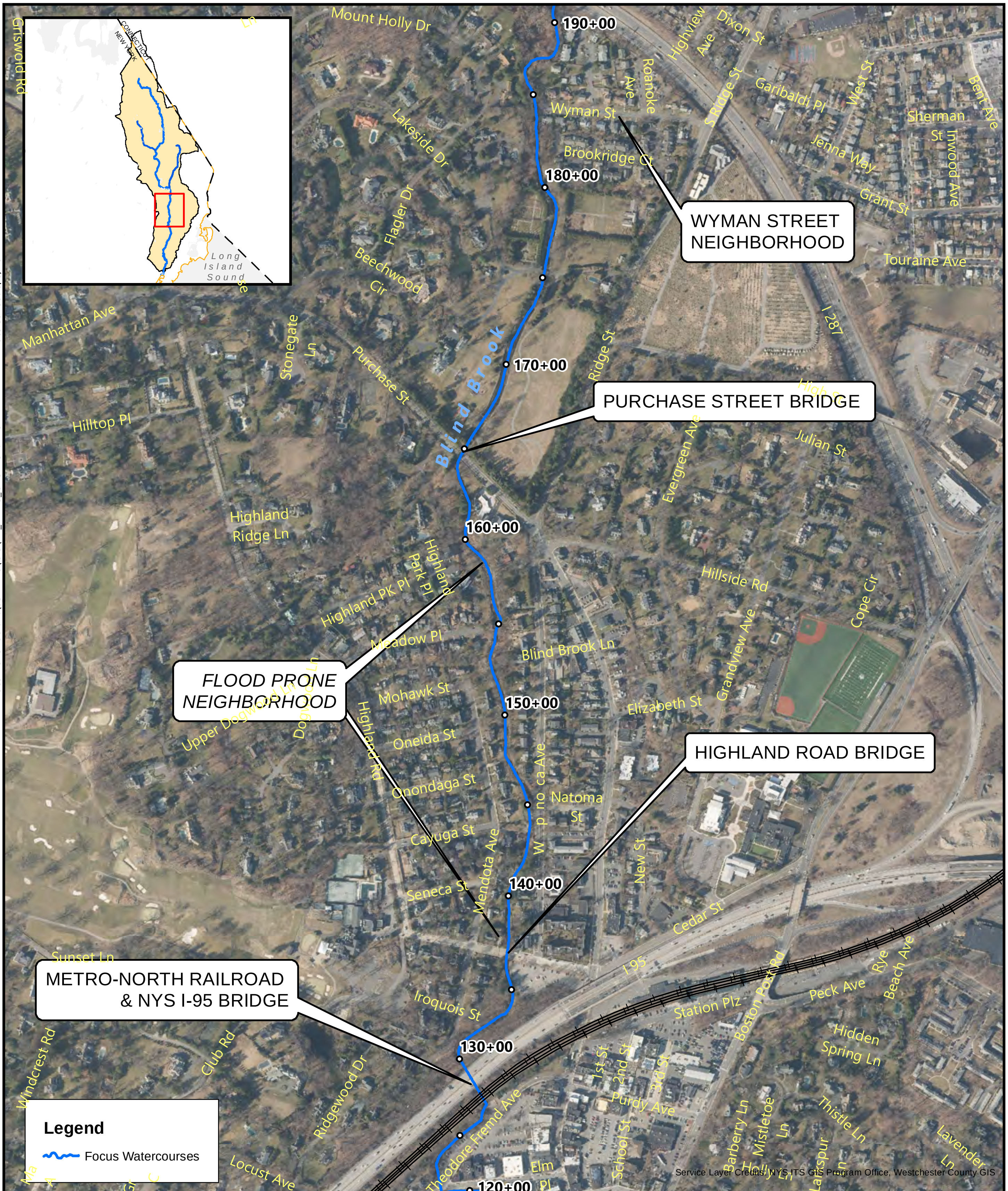

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BLIND BROOK HIGH RISK AREA 3

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FIG. 4-46

4.3.1 NYS I-95 AND METRO-NORTH RAILROAD BRIDGE

The structure transporting Blind Brook under the Metro-North (MTA) railroad and I-95 at STA 129+00 is a single concrete arch bridge approximately 25 feet wide by 16 feet high (Figure 4-47). The Metro-North railroad tracks have been in operation since the late 1840s, serving commuters as part of the New York-New Hampshire transportation line. The NYS I-95 highway crossing was installed in the 1950s immediately upstream of the rail line, and the arch bridge carrying Blind Brook was extended an additional 115 feet to the north.

Figure 4-47: Looking downstream at the Metro-North/I-95 bridge

The railroad and roadway top sits over 20 feet above the top of the arch bridge and are not overtopped in even the largest modeled flood events. Rather, the crossing and its embankments are shown to back up and impound water, resulting in water surface elevations ranging from 3.5 feet to 6.8 feet higher than the unobstructed 10-year and 100-year flood events, respectively. This backwater impact is shown to carry upstream for approximately 1 mile before it fully diminishes. Inundation of homes adjacent to Blind Brook begins at the modeled 10-year flood event and is shown to engulf several of the homes off Highland Road to the west and Wappanocca Avenue to the east during the 50-year and 100-year flood events. Under future flow conditions, flooding is modeled to be more severe at homes currently mapped within the 100-year floodplain and would extend to other homes currently mapped near the fringes.

Replacement of the MTA/I-95 arch bridge with a 60-foot-wide bridge with vertical abutments, and the same vertical opening height that currently exists, would substantially reduce upstream water surface elevations and reduce flooding at homes currently mapped within the FEMA 100-year floodplain. Eliminating the backwater effect from the MTA/I-95 crossing would improve the hydraulic performance of the bridges over Blind Brook extending upstream in HRA 3. Additional bridge replacements and mitigation actions are required to prevent overtopping at these structures. Table 4-3 lists water surface elevation at various points along Blind Brook upstream of the MTA/I-95 bridge for the 100-year and 500-year storm events, under existing conditions and if the MTA/I-95 crossing were to be replaced with a 60-foot-wide bridge.

Table 4-3 Summary of Water Surface Elevations Upstream of the MTA/I-95 Bridge Existing Conditions versus MTA/I-95 Crossing Replaced with 60-Foot-Wide Bridge

Station	Distance upstream of MTA/I 95 Crossing (miles)	Existing Conditions Water Surface Elevations (ft)		Water Surface Elevations with Replaced MTA/I 95 Bridge (ft)		Difference	
		100 year	500 Year	100 year	500 Year	100 year	500 Year
130+00	0.01	30.3	34.4	23.8	24.9	-6.5	-9.6
137+06	0.14	30.7	34.5	26.8	28.6	-3.9	-6.0
155+00	0.47	31.2	35.1	28.1	29.9	-3.1	-5.2
165+00	0.66	31.5	35.2	30.3	31.4	-1.2	-3.9
185+00	1.04	33.7	36.1	33.5	34.7	-0.2	-1.4

Flood reductions during the 50-year flood event are illustrated in Figure 4-48 (existing conditions) and Figure 4-49 (proposed 60-foot-wide replacement bridge at MTA/I-95 crossing). Flood reductions during the 100-year flood event are illustrated in Figure 4-50 (existing conditions) and Figure 4-51 (proposed conditions). Flood reductions during the 500-year flood event are illustrated in Figure-52 (existing conditions) and Figure 4-53 (proposed conditions).

Alternatively, according to the hydraulic model, installing flood relief culverts to the south (right) of the existing arch bridge would also reduce upstream water surface elevations. One scenario investigated adding four 7-foot-diameter corrugated metal pipes, spaced at 10 feet on center, designed to start conveying flows during a 10-year flood event. When compared to existing conditions, the resulting flood depths upstream of the bridge were lowered by 3.6 feet in the 100-year flood event and a little over 4 feet in the 500-year flood event. Other relief culvert designs and configurations may provide further reductions in upstream flood elevations. However, the addition of relief culverts is not recommended in this report and instead replacement of the existing bridge with a single-span structure should be prioritized.

A rigorous hydraulic and hydrologic analysis is recommended as a component on the MTA/I-95 bridge replacement design. It is important to note that due to the significant impounding effect of the MTA/I-95 bridge and its embankment, increasing the size of the crossing will result in an increase in the peak flows downstream of the MTA/I-95 crossing. Using an unsteady-state HEC-RAS model prepared by Parsons Brinckerhoff as part of a prior study on Blind Brook, the downstream attenuating effect of the MTA/I-95 bridge was estimated to range between 2 and 11 percent, depending on the magnitude of the flood event. The modeling also indicates that the increase in peak flow could be offset by implementing upstream detention projects such as the Bowman Avenue Pond and SUNY Purchase College detention projects.

Furthermore, employing the recommendation improvements for HRA 2 would help mitigate a peak flow increase. Recommendation on prioritization of projects is discussed in Section 5.13 of this report.

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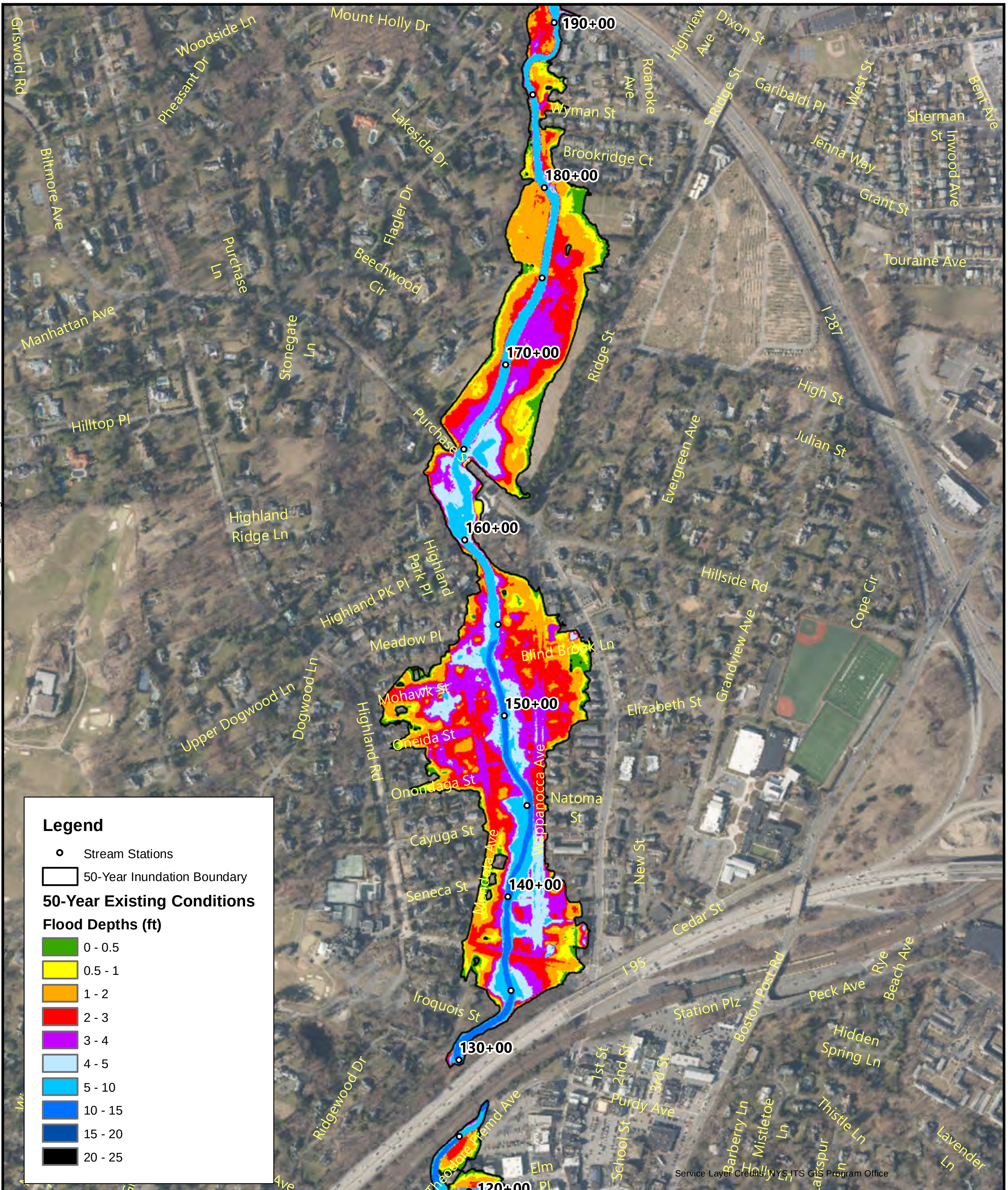

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FIG. 4-48

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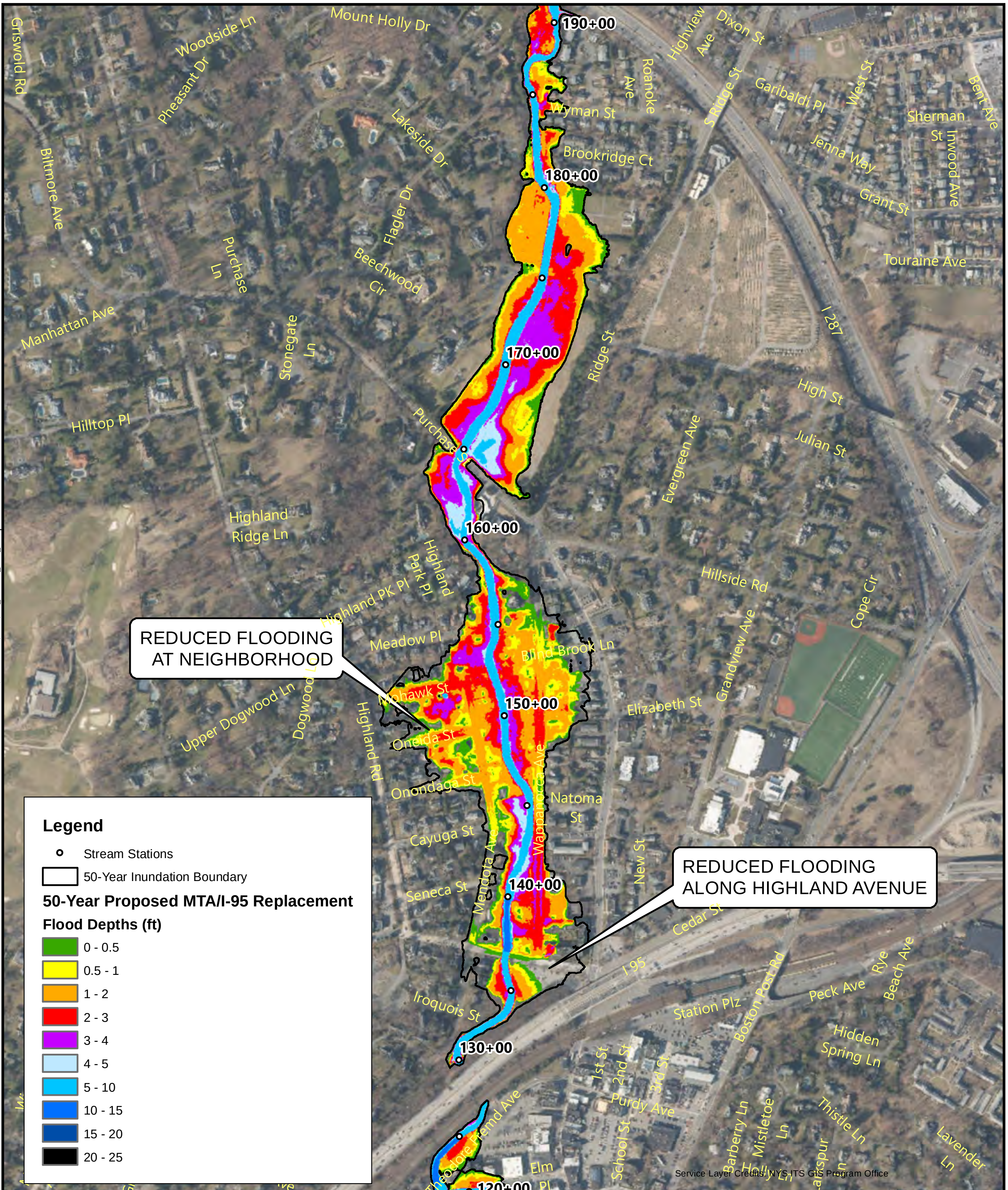

SLR 231 MAIN STREET SUITE 102 NEW PALTZ, NY 12561 845.633.8153	HRA #3: 50-YEAR PROPOSED CONDITIONS FLOOD DEPTHS BLIND BROOK FLOOD & RESILIENCY STUDY 969MOD1 WESTCHESTER COUNTY, NEW YORK	SCALE 1 " = 700 ' DATE 6/8/2022 6511.0018 PROJ. NO. FIG. 4-49

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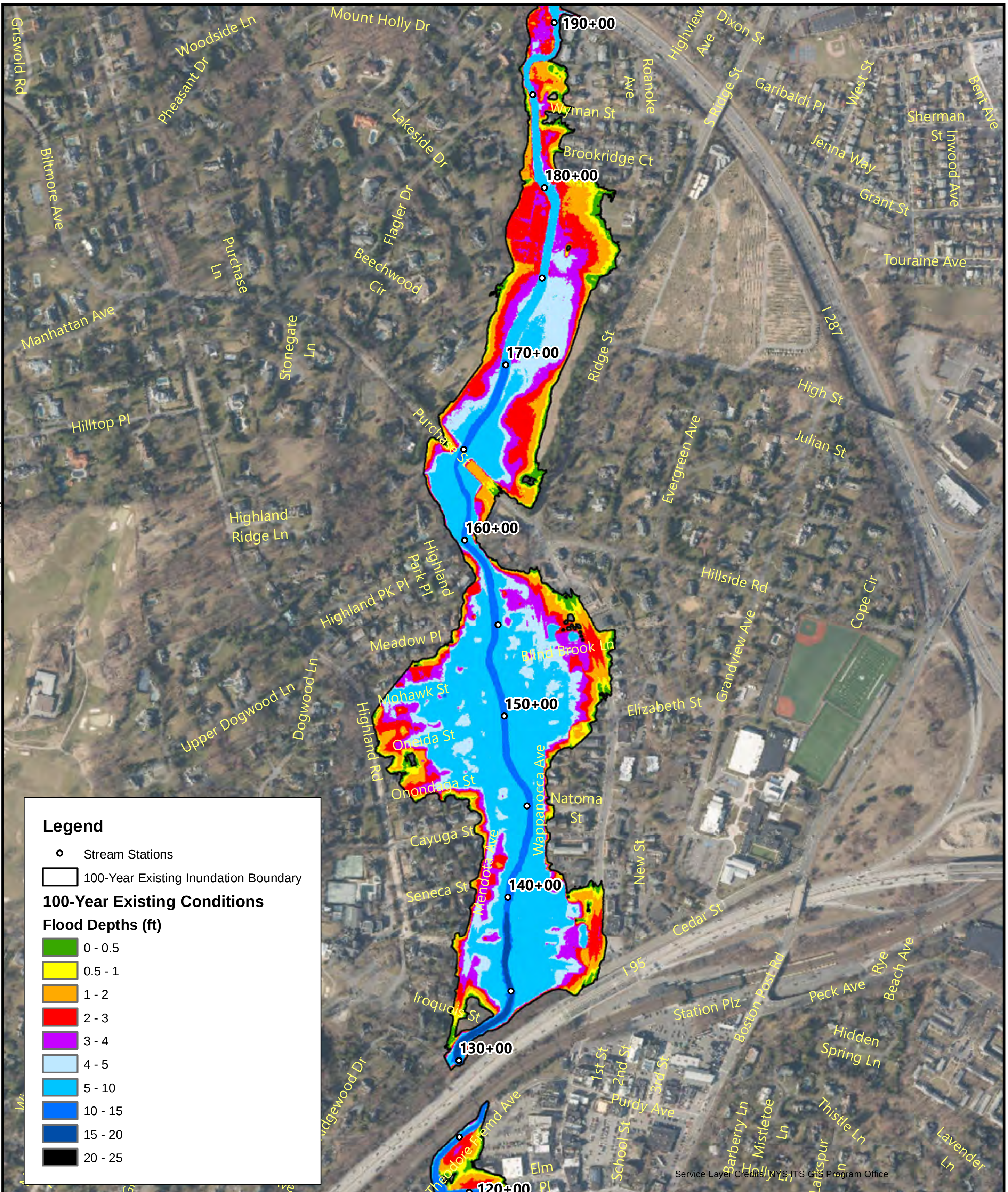

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FIG. 4-50

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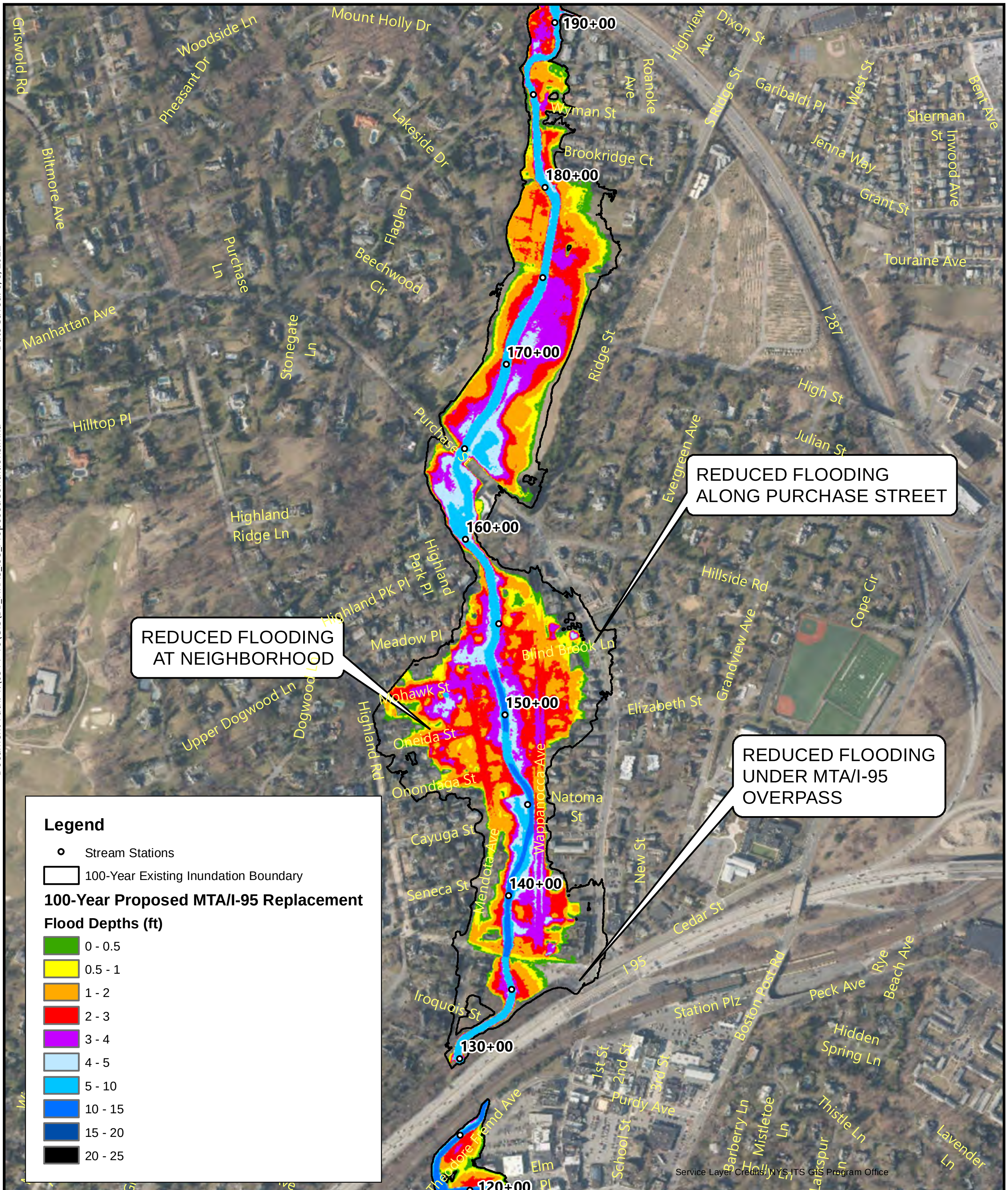

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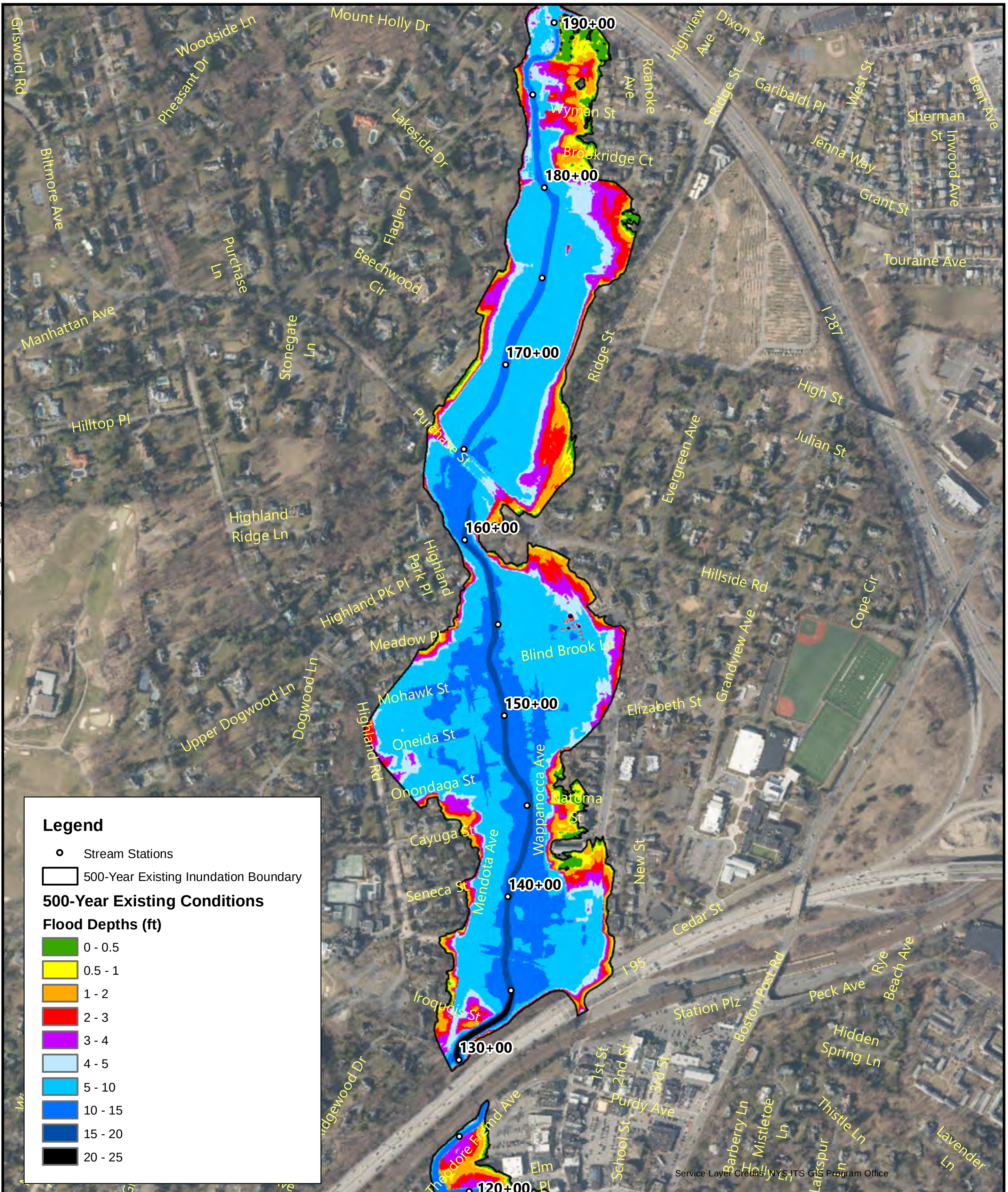
FIG. 4-51



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HRA #3: 500-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG. 4-52

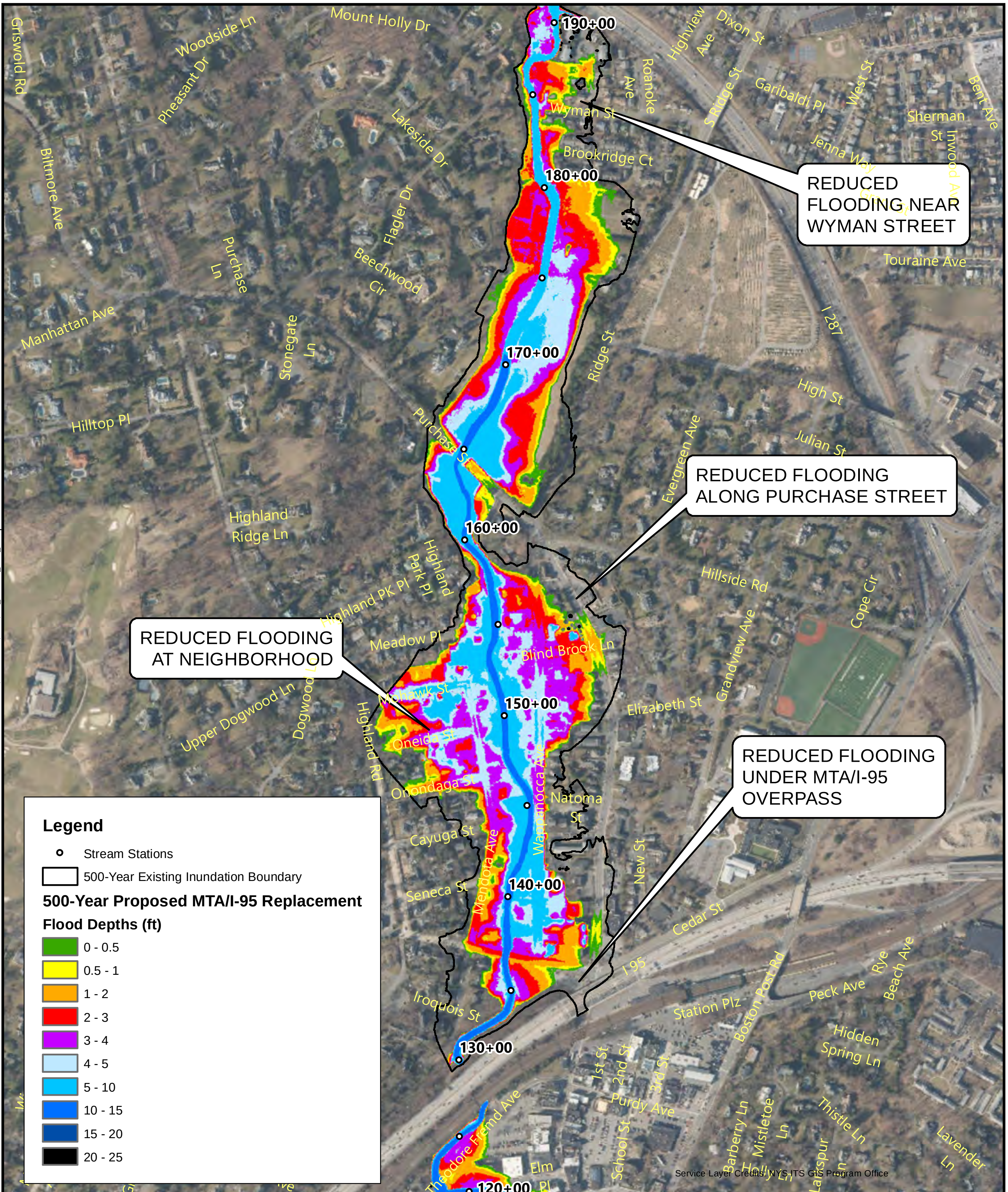

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FIG. 4-53

4.3.2 HIGHLAND AVENUE BRIDGE

The structure carrying Highland Avenue over Blind Brook at STA 137+06 is a 31-foot-wide by 7-foot-high open-deck bridge built in 1989 (Figure 4-54). In its current configuration, with a tailwater influence from the downstream MTA/I-95 arch bridge located 700 feet downstream, it is only able to pass the existing 10-year flood event with no freeboard. The bridge is shown to overtop in the future 10-year flood event with about a foot of water. The Highland Avenue bridge sees little benefit from the removal of the tailwater condition downstream, indicating that the bridge itself is hydraulically inadequate to convey flood flows on Blind Brook and acts as a constriction. Assuming no tailwater influence from the MTA/I-95 crossing (i.e., assuming the MTA/I-95 arch bridge has been replaced with an adequately sized span), the Highland Avenue bridge increases upstream water surface elevations by 1.2 feet in the existing 10-year flood event and 2.2 feet in the existing 100-year flood event. The backwater from the bridge extends upstream until reaching the bridge under Purchase Street at STA 165+00.

Figure 4-54: Looking upstream at the Highland Avenue bridge

Assuming the MTA/I-95 arch bridge has already been replaced with an adequately sized span, replacing the Highland Avenue bridge with a 45-foot-wide structure would reduce flooding upstream of Highland Avenue. The hydraulic model indicates that raising the replacement structure's low chord and the approach roads by 1 to 2 feet would be necessary to convey the existing and future 100-year flood event. Reductions in water surface elevations at the upstream bridge face are shown to be 0.9 feet and 1.2 feet for the 10-year and 100-year flood events, respectively. These reductions propagate upstream for over a quarter mile and fully diminish near STA 160+00.

Flood reductions upstream of the Highland Avenue bridge during the 50-year flood event are illustrated in Figure 4-55 (existing conditions) and Figure 4-56 (proposed replacement 45-foot bridge at Highland Avenue crossing). Flood reductions during the 100-year flood event are illustrated in Figure 4-57 (existing conditions) and Figure 4-58 (proposed conditions). These illustrations assume that the MTA/I-95 arch bridge has already been replaced with an adequately sized span. It is recommended that the replacement of the MTA/I-95 arch bridge precede the replacement of the Highland Avenue bridge.

Although combined replacement of the MTA/I-95 and Highland Avenue bridges would significantly reduce upstream flooding, it will not eliminate flooding at homes built adjacent to Blind Brook. Neighborhoods off Wappanocca Avenue and Mendota Avenue are predicted to still flood. According to the hydraulic model, over 45 homes are expected to remain within the modelled 100-year flood extent. Voluntary buyouts from the floodprone areas and individual floodproofing at homes is recommended. Individual property flood protection measures are discussed in Section 5.10 of this report.

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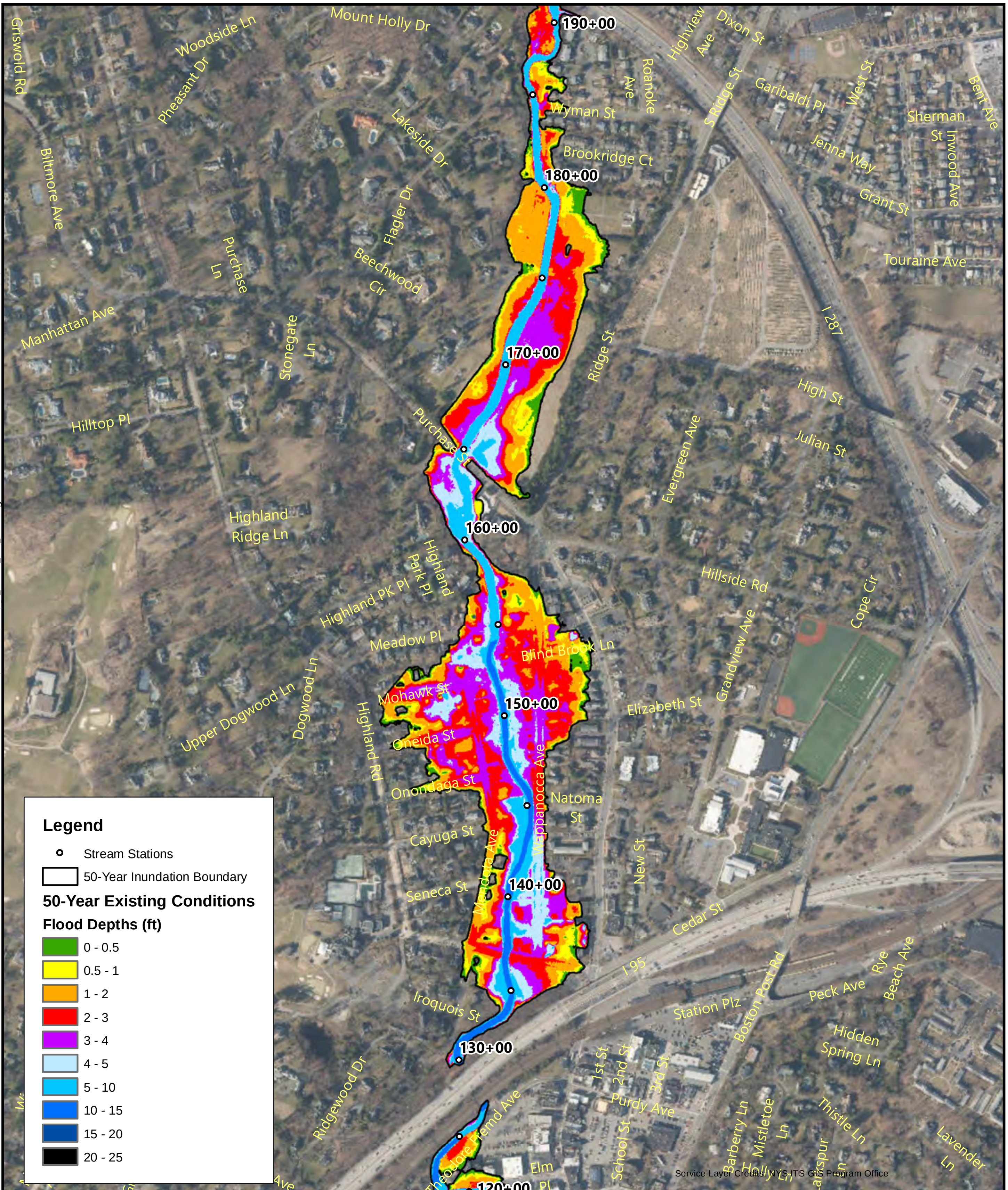

SLR 231 MAIN STREET SUITE 102 NEW PALTZ, NY 12561 845.633.8153	**HRA #3: 50-YEAR EXISTING CONDITIONS FLOOD DEPTHS** BLIND BROOK FLOOD & RESILIENCY STUDY 969MOD1 WESTCHESTER COUNTY, NEW YORK N 0 500 Feet	SCALE 1 " = 700 ' DATE 6/8/2022 6511.0018 PROJ. NO. **FIG. 4-55**

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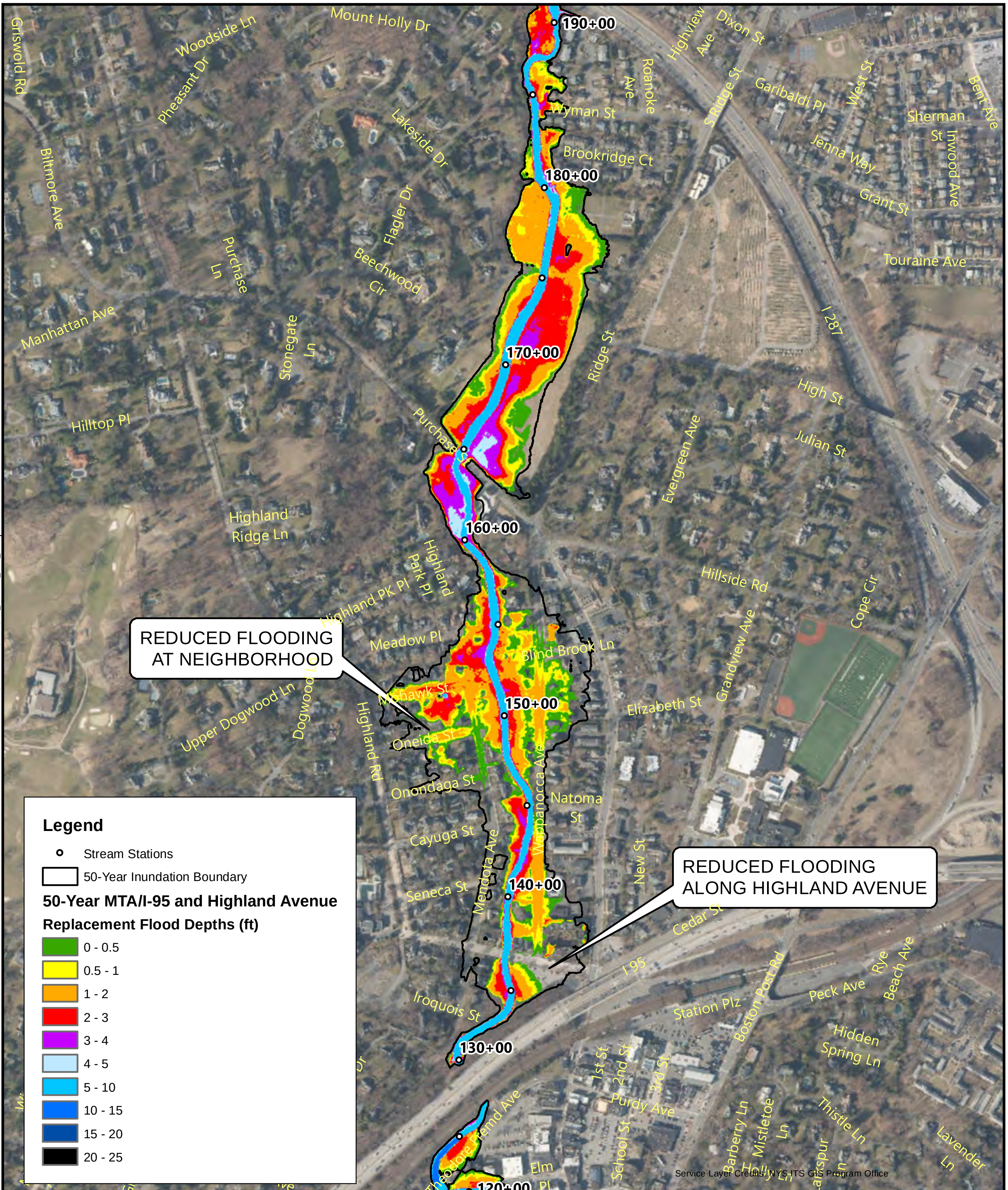

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FIG. 4-56

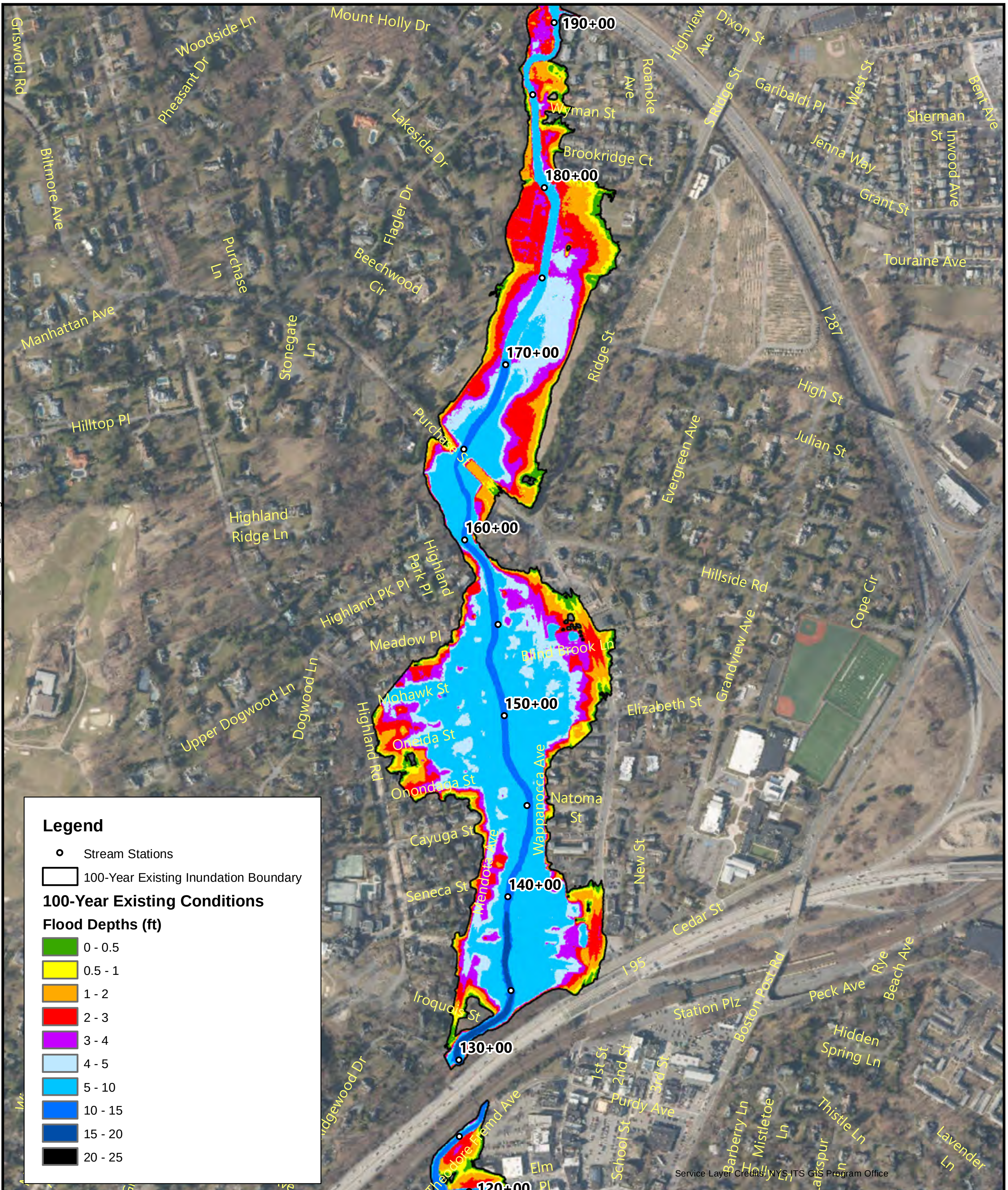

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FIG. 4-57

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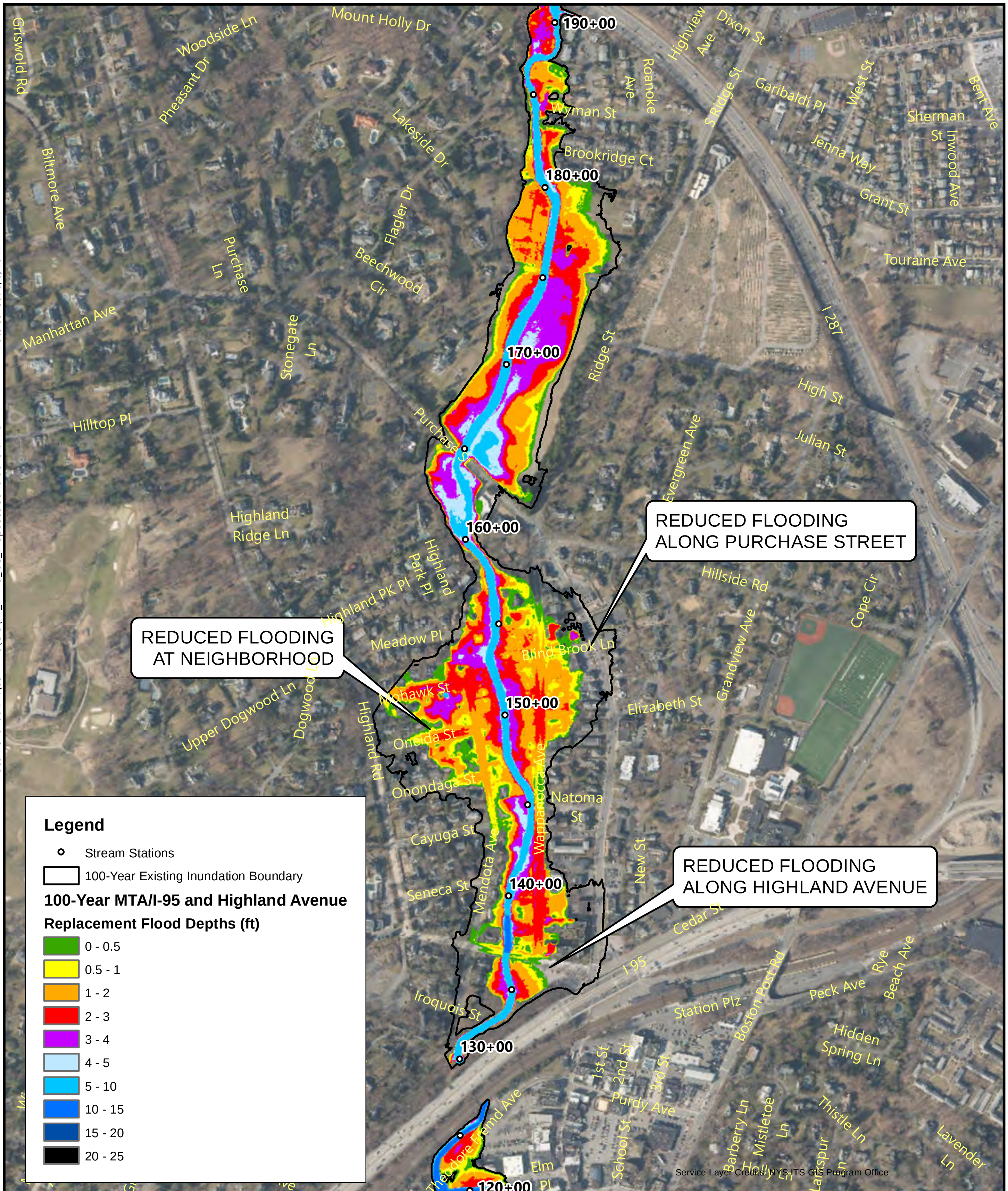

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WESTCHESTER COUNTY, NEW YORK

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FIG. 4-58

A longitudinal profile with water surface elevations in HRA 3 during the 50-year flood event is shown on Figure 4-59. A profile with water surface elevations during the 100-year flood event is shown on Figure 4-60. In both profiles, water surface elevations are shown 1) under existing conditions; 2) with the replacement of the MTA/I-95 arch bridge with a 60-foot-wide bridge; and 3) with the replacement of the MTA/I-95 arch bridge with a 60-foot-wide bridge and the replacement of the Highland Avenue crossing with a 45-foot-wide bridge.

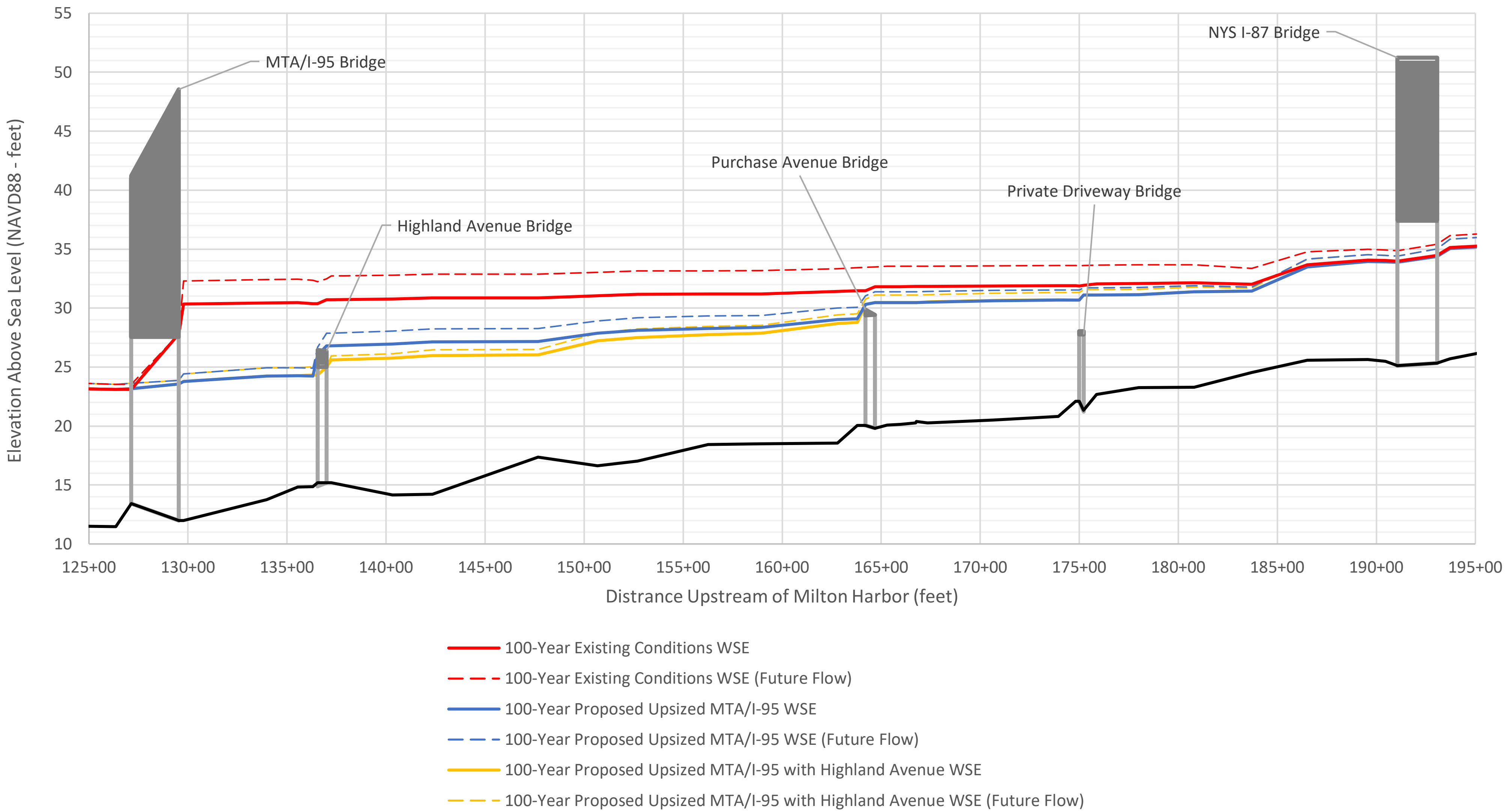


Figure 4-59: Blind Brook Profile for 50-Year Flows Under Current Conditions and After Adjusting Structures Through HRA 3

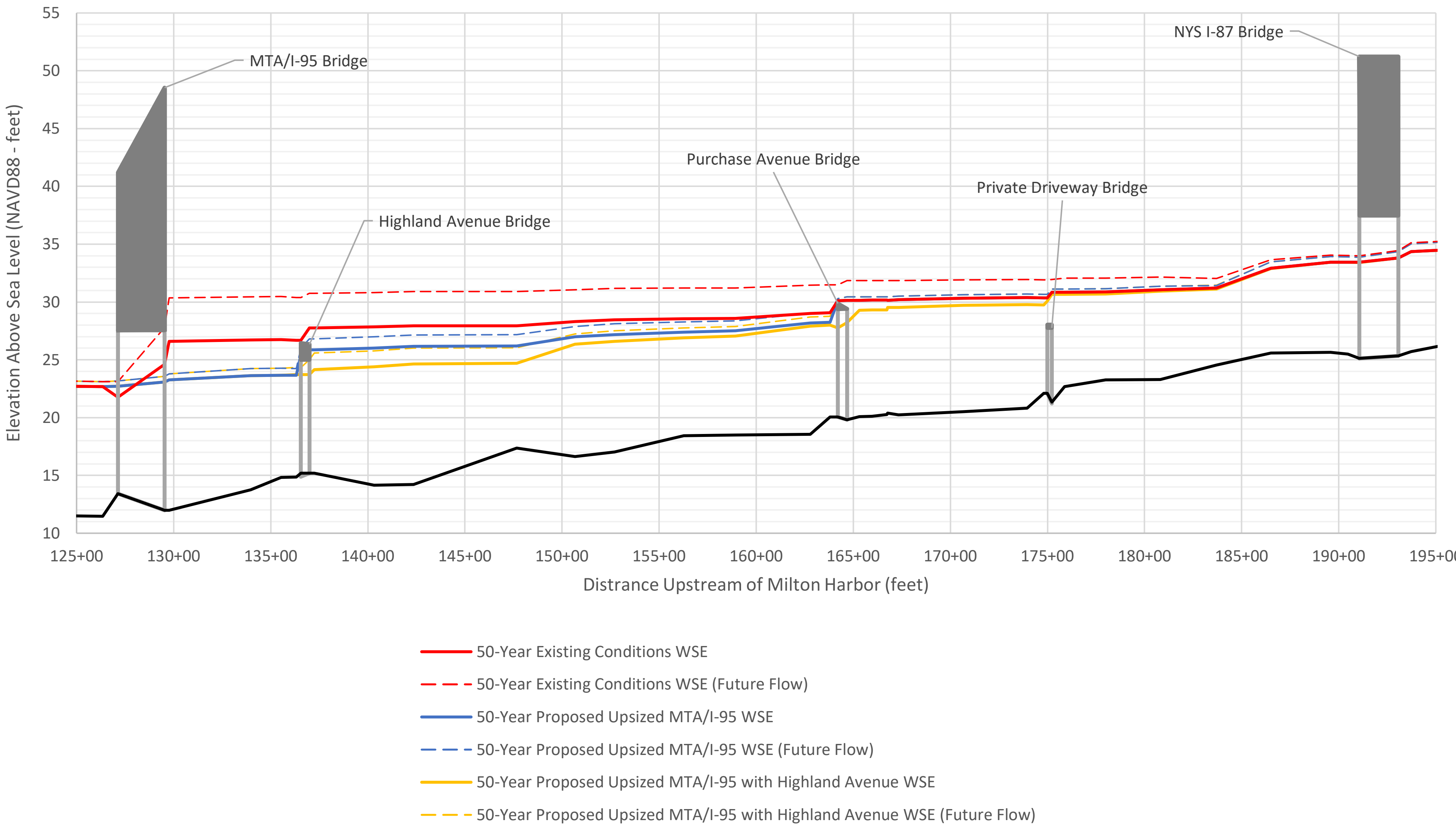


Figure 4-60: Blind Brook Profile for 100-Year Flows Under Current Conditions and After Adjusting Structures Through HRA 3

4.3.3 PURCHASE STREET BRIDGE

Built in 1994, the Purchase Street bridge crosses Blind Brook at STA 165+00 (Figure 4-61). According to the hydraulic model, the roadway is susceptible to being overtopped beginning at the modeled 50-year flood event with the MTA/I-95 and Highland Avenue crossings in their current configuration. Assuming the MTA/I-95 and Highland Avenue crossings have been replaced with adequately sized spans, the Purchase Street bridge can pass the existing 50-year flood event. There is currently no development within the upstream influence of this bridge; therefore, replacement should not be prioritized, and instead, proper signage should be implemented when the roadway is anticipated to become overwhelmed during a storm event. Multiple detours are available for residents in the event of an overtopping storm.

Figure 4-61: Looking upstream at the Purchase Street bridge

4.3.4 WYMAN STREET

Homes along Wyman Street (STA 180+00 to STA 190+00), Figure 4-62, are shown partially flooding starting at the existing 50-year flood event based on hydraulic modeling. Based on FEMA FIRMS and modeling, in the current 100-year flood event, approximately four homes are mapped within the flood inundation extents. Over a dozen buildings are mapped within the current 500-year flood extents. Flooding is a result of downstream backwater influence from the undersized crossings that span Blind Brook, predominantly the MTA/I-95 crossing. Replacement of the downstream bridges will significantly reduce water surface elevations at Wyman Street, although these actions will not eliminate flooding at Wyman Avenue homes immediately adjacent to the brook. NRCS and the Village of Rye Brook are exploring the potential for relocation of homes and floodplain bench creation at Wyman Street. NRCS shared its preliminary floodplain creation concept for SLR to model and evaluate. The proposed floodplain bench measures approximately 380 feet long and would require the relocation of three houses. The floodplain bench would be 130 feet at its widest point and would be excavated between 1.5 to 4.0 feet below the existing ground. It is noted that the presence of underground utilities, such as the village and county sewer pipes under and across Wyman Street, is an important design constriction to consider at this site.

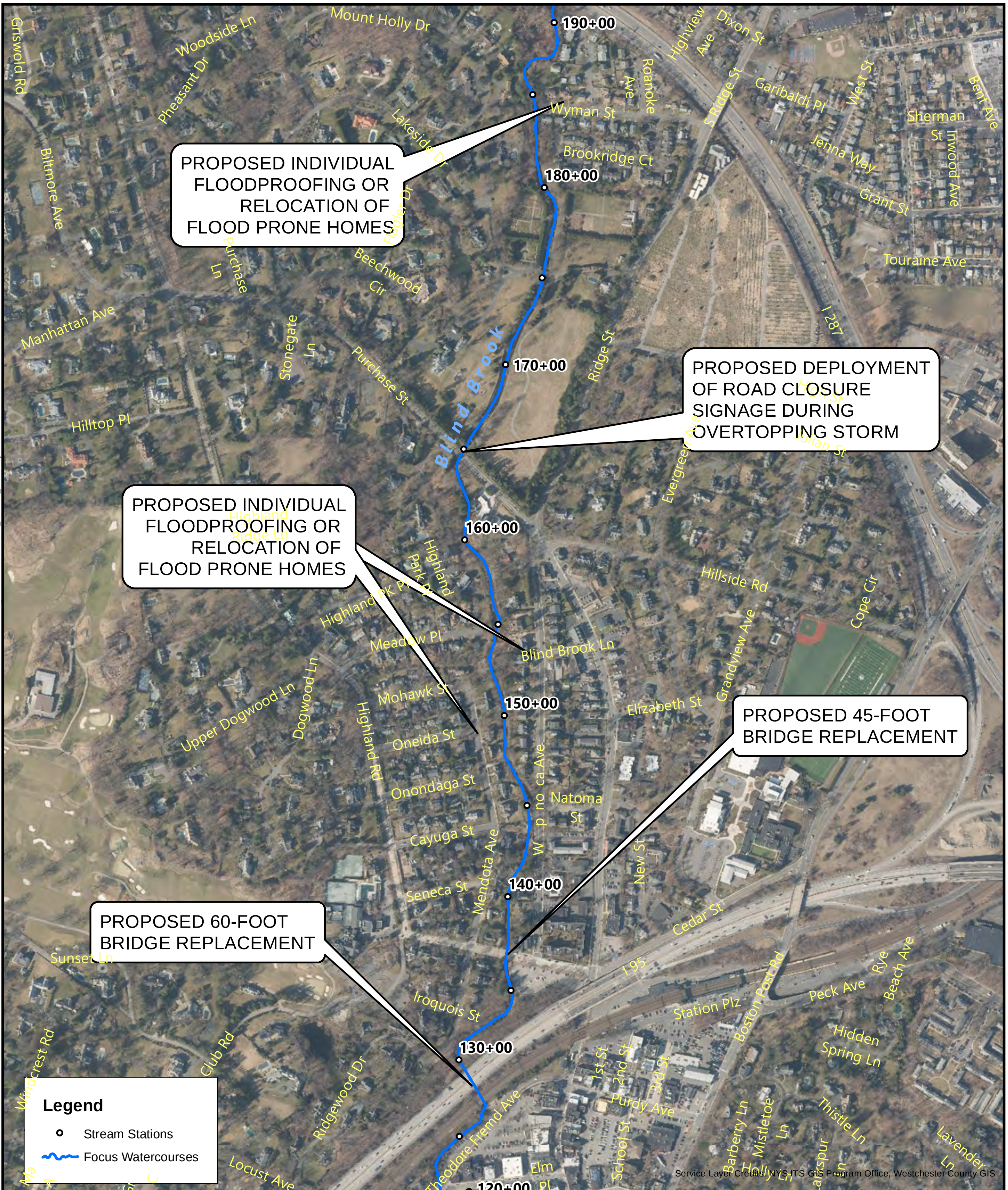
Modeling the floodplain bench with no improvements at downstream crossings produces 3 feet in water surface elevation reduction along Wyman Street during the 100-year flood event. Under this scenario, reductions in flood elevations would benefit a few homes mapped within the extents of the existing 100- and 500-year floods and the future 50- and 100-year floods. Assuming the downstream replacement of the MTA/I-95 arch bridge has been implemented, an additional 2.4 feet in water surface elevation reductions along Wyman Street are estimated. The hydraulic model indicates that demolition and removal of the houses required for creation of a floodplain bench would result in comparable flood reductions to the creation of the floodplain bench when there is no tailwater influence. There are two possible scenarios to consider at Wyman Street:

1. Replace the MTA/I-95 bridge to eliminate the tailwater influence, then acquire and relocate floodprone homes adjacent to Blind Brook at Wyman Street. This scenario would improve floodplain flood conveyance and remove approximately ten buildings from the extents of the current 500-year storm event.

2. Relocate Wyman Street homes and construct floodplain bench to mitigate flooding at four buildings mapped in the extents of the current 500-year flood event. This would be an intermediate solution until the MTA/I-95 bridge can be replaced.

Figure 4-62: Blind Brook as it flows adjacent to Wyman Street

Figure 4-63 is a concept map showing all recommended improvements in HRA 3.



SLR 231 MAIN STREET SUITE 102 NEW PALTZ, NY 12561 845.633.8153	HRA #3: CONCEPT MAP BLIND BROOK FLOOD & RESILIENCY STUDY 969MOD1 WESTCHESTER COUNTY, NEW YORK N 0 500 Feet	SCALE 1 " = 700 ' DATE 6/9/2022 6511.0018 PROJ. NO. **FIG. 4-63**

4.4 HIGH RISK AREA #4 – BLIND BROOK AT BROOK LANE NEIGHBORHOOD

HRA 4 encompasses the section along Blind Brook between STA 240+00 and STA 265+00 in the village of Rye Brook and the town of Harrison. The brook flows through a trapezoidal channel for most of this section and is tightly squeezed between backyards on the east (Figure 4-64) and a parking lot to the west. Flooding was assessed at the Brook Lane neighborhood, which accounts for 20 percent of documented repetitive losses in the village of Rye Brook. Many of the homes along the left bank of the brook have been severely flooded, most recently being from the remnants of Tropical Storm Ida in 2021, where residents had to be rescued from their flooded homes by local emergency services. Brook Lane residents and village officials, in collaboration with NRCS, are working to explore flood mitigation action alternatives, including the potential for property buyouts and a floodplain bench reclamation project. SLR conducted a site walk of the neighborhood with representatives from the village and NRCS to step through their vision and document past flood damage. The Westchester Avenue bridge at STA 241+55 was also evaluated for hydraulic competency and its effect on flooding at the upstream community. A map of HRA 4 is illustrated in Figure 4-65.

Figure 4-64: Blind Brook as it flows adjacent to homes on Brook Lane

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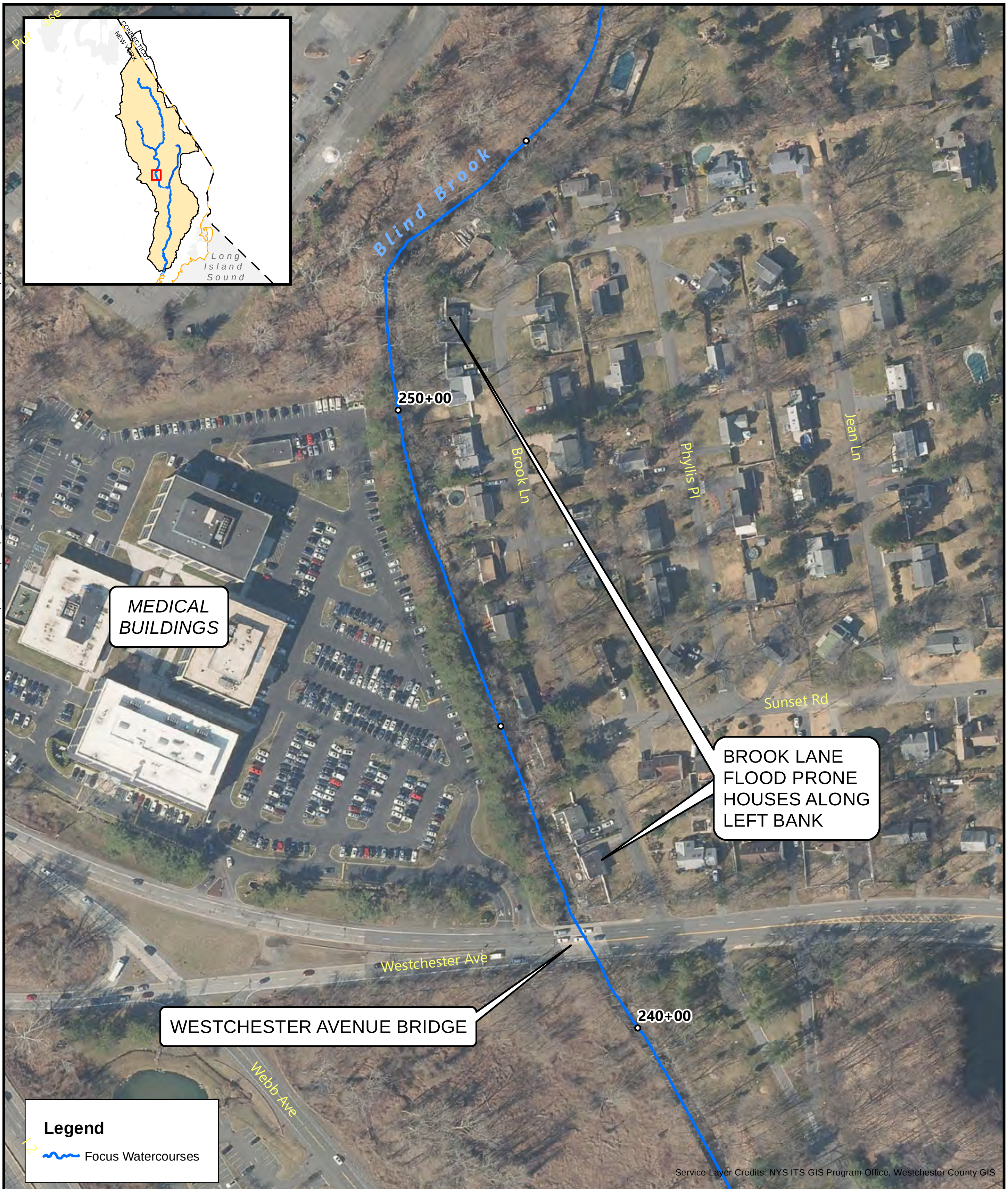

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BLIND BROOK HIGH RISK AREA 4

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FIG. 4-65

The Westchester Avenue bridge spanning Blind Brook (STA 241+55), shown in Figure 4-66, is an open-deck bridge that measures 40 feet wide and has a vertical opening of about 7 feet. The bridge was built in 1997. In the hydraulic model, this structure is shown to pass all modeled current and future storm events without overtopping. The model indicates that a foot of freeboard would exist in the current and future 10-year flood events. Floodwaters would encounter the bridge's low chord starting at the existing 50-year flood event. The bridge is shown to be a moderate constriction during the 100-year flood event by increasing upstream water surface elevations by 2 feet. According to the observations made during a site visit, flooding at the Brook Lane neighborhood during Tropical Storm Ida resembled the severity and flooding extent of a 500-year storm event. Several of the homes immediately adjacent to the brook experienced over 3 feet of flooding at spots, and a few homes to the east of Brook Lane also experienced shallow flooding. This flooding condition is only observed during a 500-year event and therefore was also considered in the evaluation of mitigation design alternatives.

Figure 4-66: Looking downstream at the Westchester Avenue bridge over Blind Brook. A significant amount of woody debris is seen underneath the bridge deck, indicative of flood flows reaching the bridge's low chord.

NRCS prepared a conceptual floodplain bench design and shared it with SLR for comment. The proposed floodplain bench would require the relocation of a dozen homes currently along the left bank of the brook. It would measure approximately 1,200 feet long (from STA 242+04 to STA 255+00), between 106 to 133 feet wide, and would be excavated at about 3 feet below existing grade. The proposed floodplain bench area footprint is approximately 3.3 acres.

The floodplain bench would lower water surface depths between STA 245+00 and STA 252+84 by anywhere from 1.2 to 1.8 feet across all modeled flood events. Furthermore, replacing the Western Avenue bridge with a 50.2-foot-wide span, or 1.25 times the estimated bankfull width, would further reduce water surface elevations throughout this reach. With a bridge replacement, flooding would also be reduced from the bridge face at STA 241+96 to STA 242+04. Table 4-4 summarizes the change in water surface elevations for a floodplain bench scenario against a floodplain bench with a bridge replacement scenario.

Table 4-4 Water Surface Elevation Reductions Measured at STA 250+00

Flood Event	Floodplain Bench Scenario Reductions (ft)	Floodplain Bench and Bridge Replacement Scenario Reductions (ft)
10-Year	-1.6	-1.6
50-Year	-1.6	-1.6
100-Year	-1.8	-1.9
500-Year	-1.2	-1.8
100-Year (Future)	-1.5	-2.0

Alternatively, a floodplain bench along the river right bank across from the Brook Lane neighborhood was investigated. The proposed floodplain would measure approximately 130 feet at its widest, 731 feet long, excavated between 1.5 to 5.0 feet below existing ground. The floodplain bench would consume a portion of a commercial parking lot within the town of Harrison. Assuming replacement of the Westchester Avenue bridge, the resulting flood reductions are almost identical to the floodplain bench scenario discussed above. Although flooding is shown to be reduced, it would not eliminate flooding at three to five homes next to Blind Brook. This suggests that a floodplain bench on the river right bank, in conjunction with replacement of the Westchester Avenue bridge, can potentially reduce the number of home buyouts by nearly half that are required for a floodplain bench on the river left to achieve the same outcome. This alternate floodplain bench concept is presented in Figure 4-67A.

Figure 4-67B illustrates NRCS's proposed concept for HRA 4 and is followed by resultant depth grid mapping. Flood reductions under the 50-year flood event are illustrated in Figure 4-68 (existing conditions) and Figure 4-69 (with the NRCS proposed left-bank floodplain bench and bridge improvement). Flood reductions during the 100-year flood event are illustrated in Figure 4-70 (existing conditions) and Figure 4-71 (NRCS proposed left-bank floodplain bench and bridge improvement). Flood reductions during the 500-year flood event are illustrated in Figure 4-72 (existing conditions) and Figure 4-73 (NRCS proposed left-bank floodplain bench and bridge improvement). A rigorous hydrologic and hydraulic analysis is recommended to identify the most effective combination of a floodplain bench creation along Blind Brook and acquisition of the most floodprone homes on Brook Lane to reduce the number of relocations and mitigate flood damage at Brook Lane.

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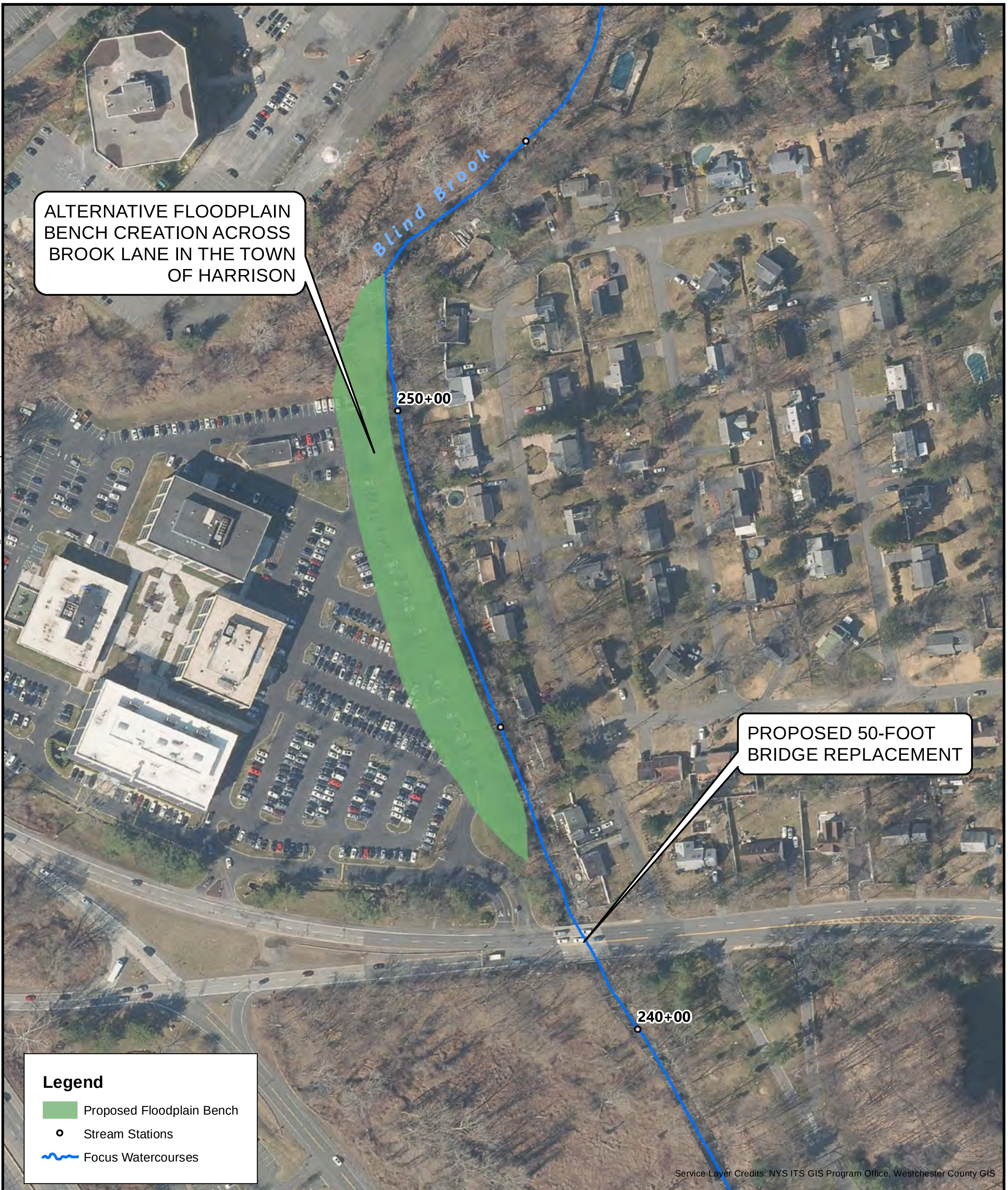

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HRA #4: ALTERNATE FLOODPLAIN CONCEPT MAP

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FIG. 4-67A

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HRA #4: CONCEPT MAP

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FIG. 4-67B

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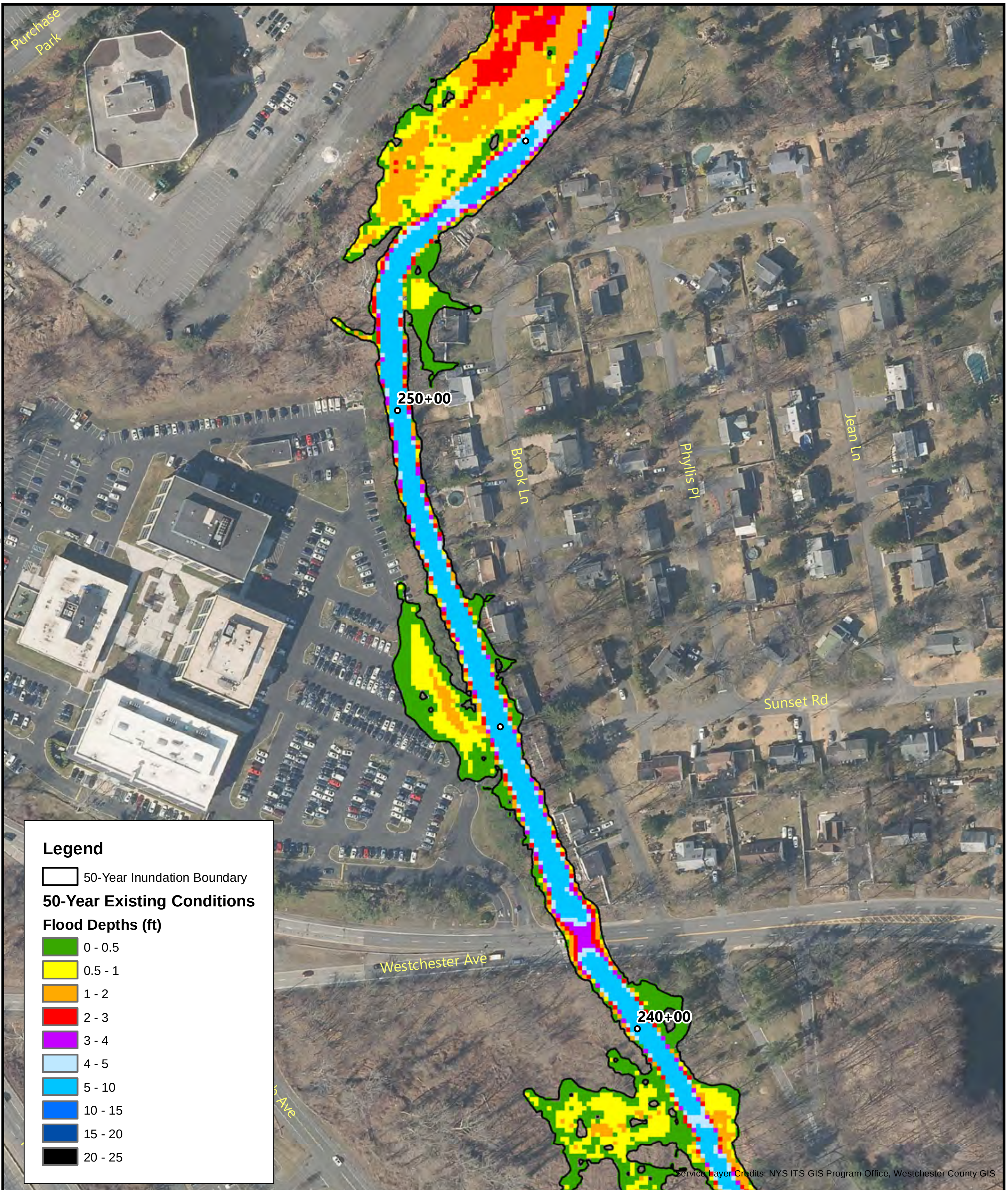

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HRA #4: 50-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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969MOD1
WESTCHESTER COUNTY, NEW YORK

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FIG. 4-68

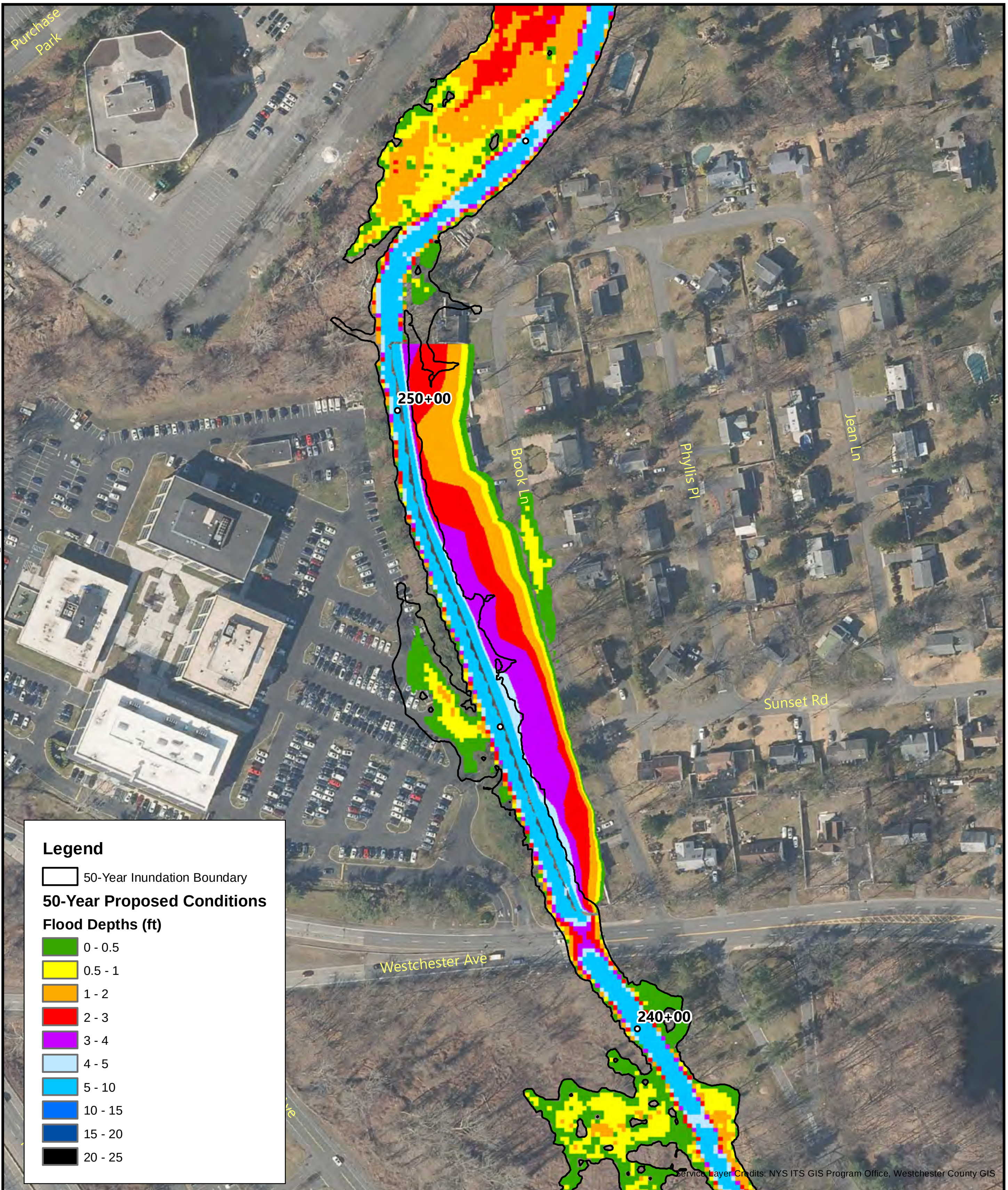

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FIG. 4-69

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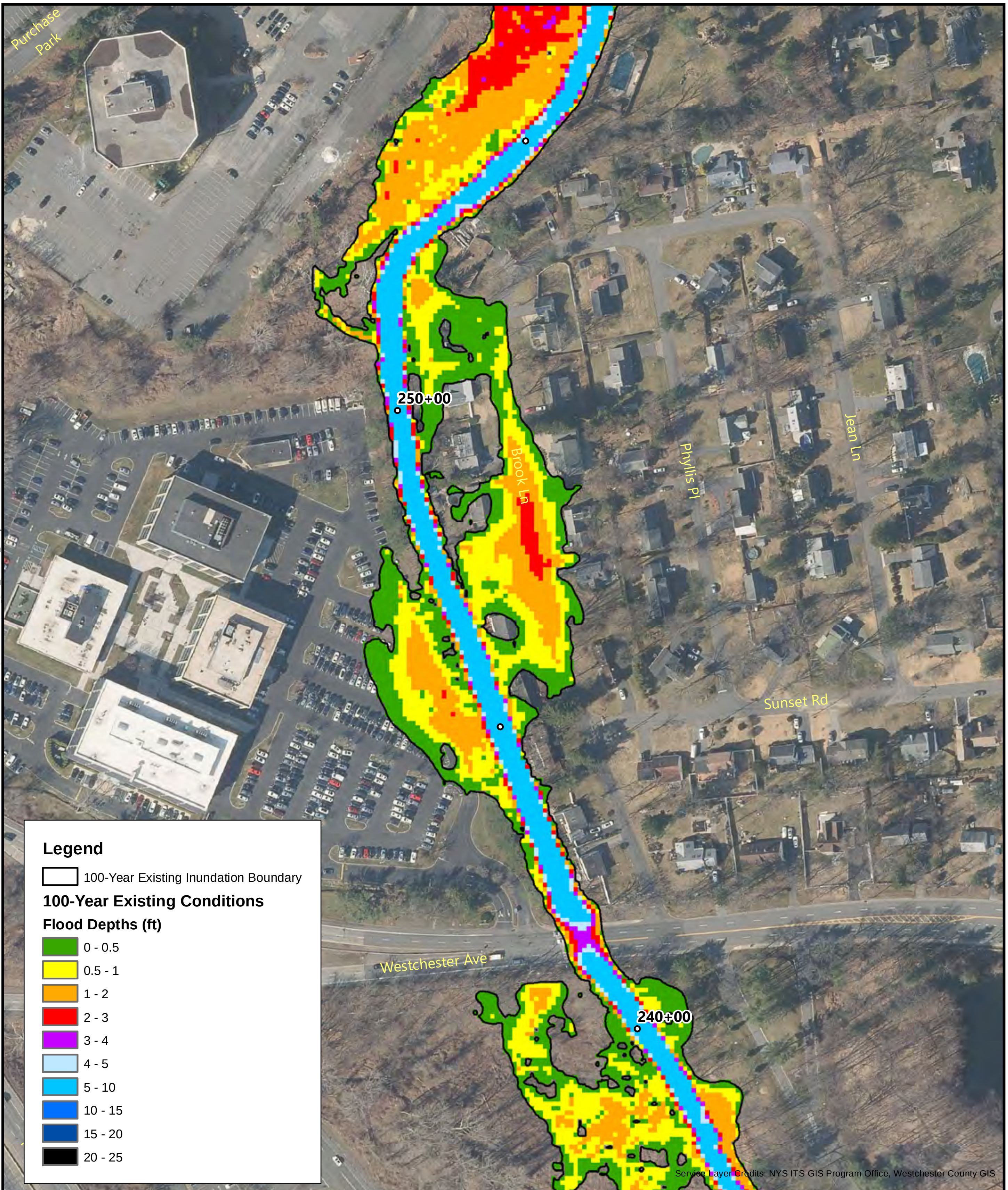

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HRA #4: 100-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG. 4-70

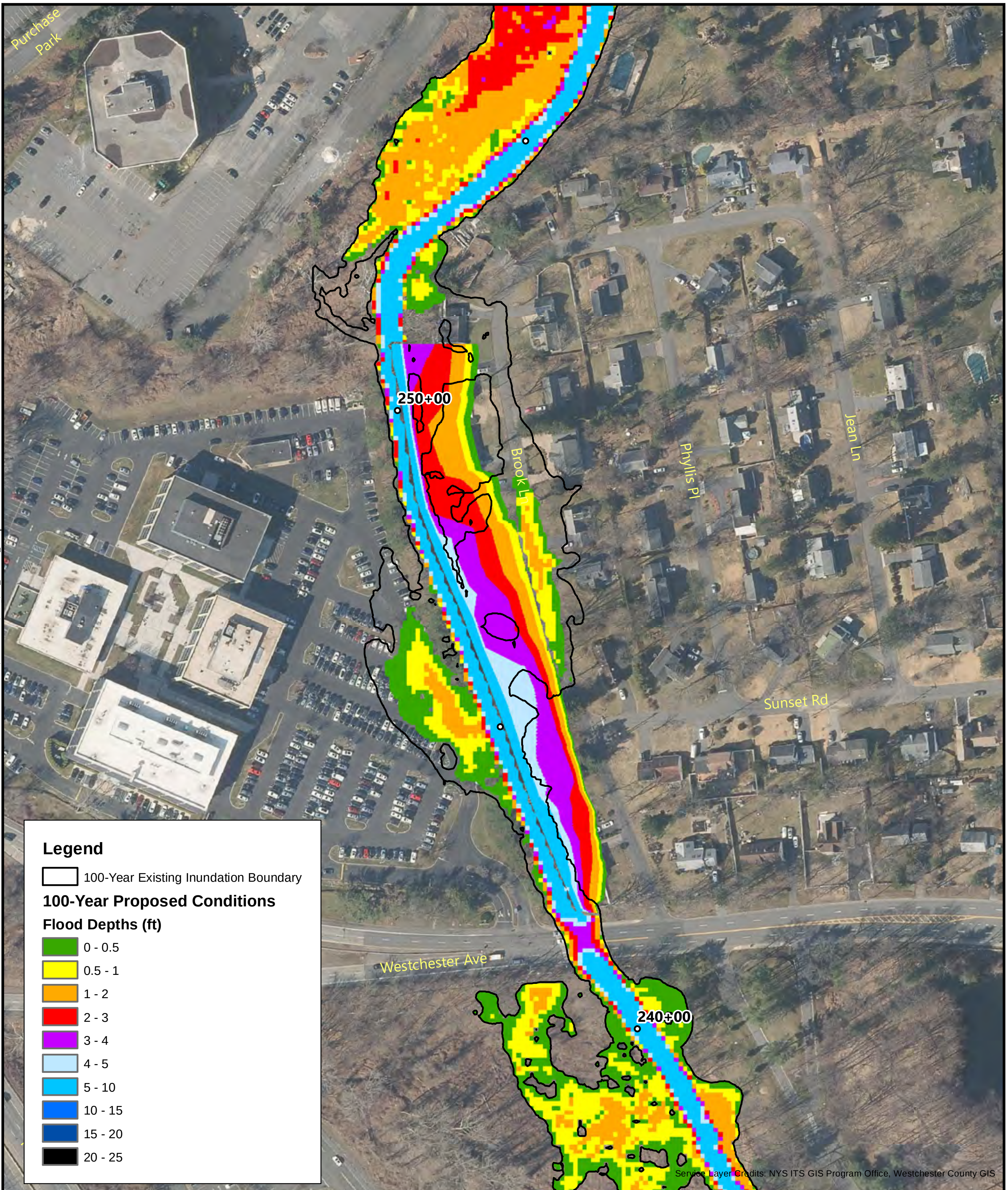

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FIG. 4-71

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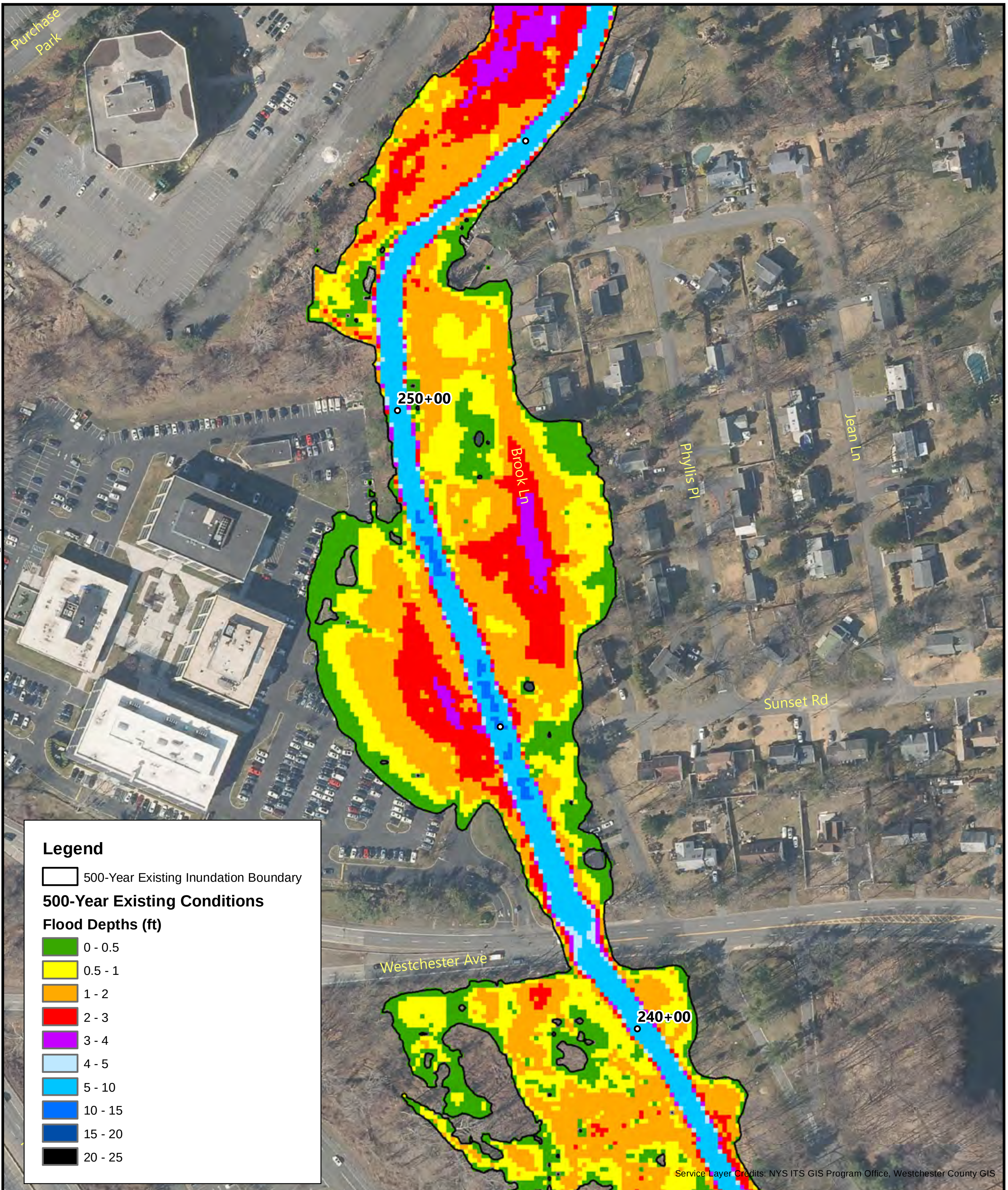

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FIG. 4-72

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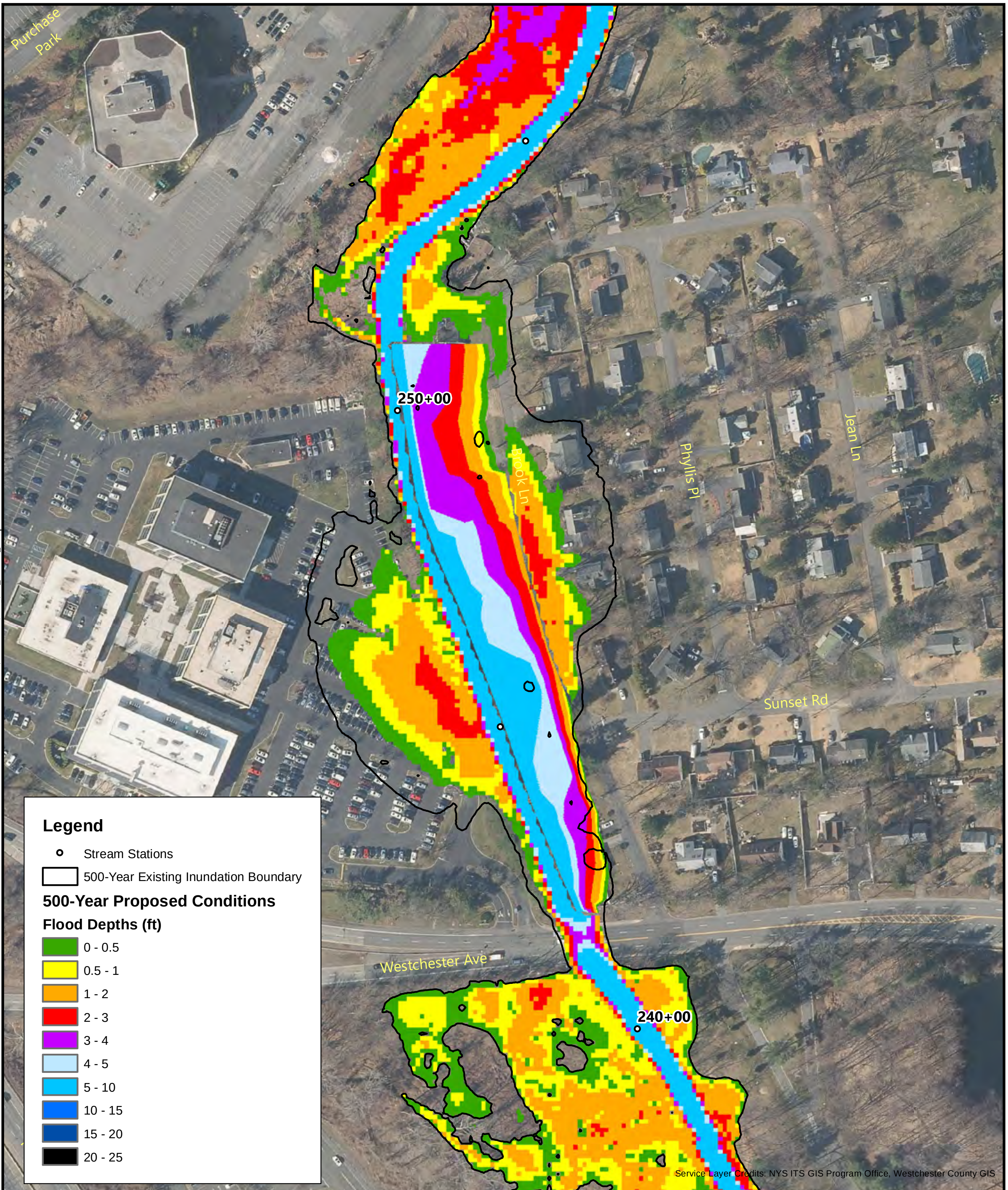

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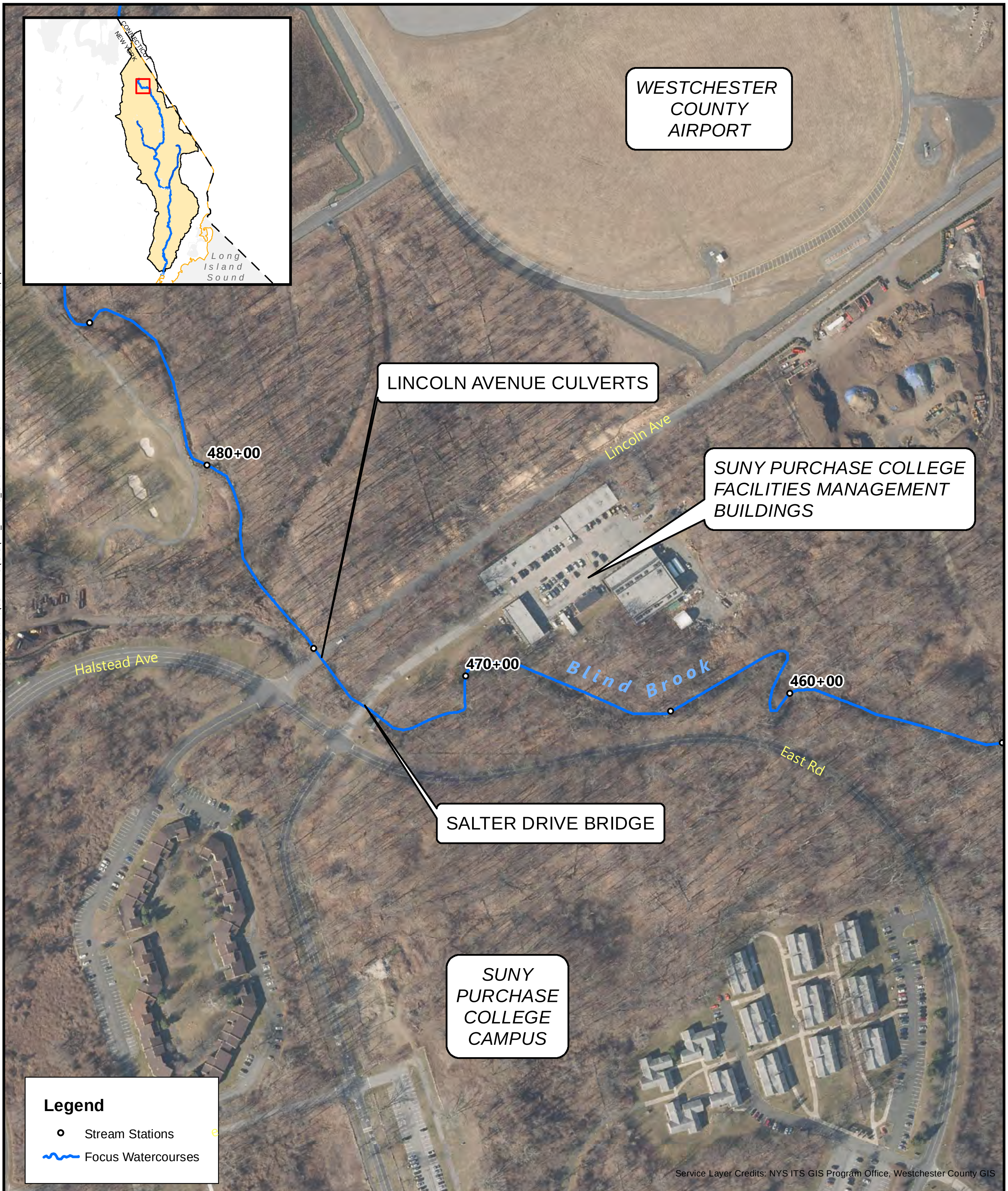
FIG. 4-73

4.5 HIGH RISK AREA #5 – BLIND BROOK AT SUNY PURCHASE COLLEGE

HRA 5 is located at the headwaters of Blind Brook between STA 460+00 and Sta 475+00 on the SUNY Purchase College campus in the village of Rye Brook and the town of Harrison. The brook has a contributing watershed of 5.6 square miles and flows its steepest at a near 4.0 percent grade. Two crossings span Blind Brook at HRA 5. Salter Drive (Figure 4-74), a private road to the SUNY Purchase facilities buildings to the east of the brook, crosses near STA 472+84 while Lincoln Avenue, a public road, crosses at STA 475+00. An overview map of HRA 5 is shown on Figure 4-75.

Figure 4-74: Looking upstream at the Salter Drive culvert. A water line for the SUNY Purchase College Campus Thermal Energy Storage Project runs on the downstream side of the structure.



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BLIND BROOK HIGH RISK AREA 5
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FIG. 4-75

Reports from SUNY Purchase staff revealed that the college's facilities buildings have flooded in the past from both riverine and upland runoff sources. The structure carrying Lincoln Avenue over Blind Brook was mentioned to have overtopped at least twice in the past 5 years and has resulted in closure of the roadway. During a flood, water tends to leave the channel and flank the Lincoln Avenue culverts to the left (east), sending water down to the facility buildings and through their parking lot until reentering the channel near STA 460+00. Additionally, runoff coming from the Westchester County Airport to the north is also said to overwhelm stormwater culverts under Lincoln Avenue and direct water toward the college's buildings. Due to the absence of information regarding the hydrology and hydraulics of the upland runoff from the north, only the hydraulic capacity of the culverts over Blind Brook, for which a model exists, was assessed in this study.

The culvert under Salter Drive on Blind Brook is a four-sided concrete box culvert that spans approximately 21 feet and has a 5.5-foot-high opening. At approximately 235 feet upstream, the structure carrying Lincoln Avenue is comprised of four separate corrugated metal pipes that each measure 3 feet in diameter. According to the hydraulic model, the Salter Drive culvert is shown to pass all modeled storm events while the Salter Drive culverts have a capacity of less than the existing 10-year storm event. The model does indicate that the Lincoln Avenue culverts flank to the left (east) and would divert water away from the main channel during a flood.

Replacing the culverts under Lincoln Avenue with a single 21-foot-wide by 6-foot-high concrete box would convey the existing and future 100-year storm events. Furthermore, reconstruction of the channel reaches immediately upstream and downstream of Salter Drive to at least bankfull dimensions would lower water surface elevations at the culvert and further contain floodwaters within the channel. The Salter Drive culvert itself does not appear to exacerbate flooding, and inspection and maintenance of the structure is proposed until due for replacement. A rigorous hydrologic and hydraulic analysis is recommended for each structure in HRA 5 when it is due for routine replacement to ensure that each bridge is adequately sized to convey flood flows and does not contribute to flooding of the SUNY Purchase College buildings. Furthermore, it is recommended that a stormwater runoff feasibility study be undertaken to explore stormwater mitigation techniques that will reduce flooding caused by excess upland runoff and inadequate roadside drainage along Lincoln Street. Figure 4-76 illustrates a concept map for HRA 5.

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HRA #5: CONCEPT MAP

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FIG. 4-76

4.6 HIGH RISK AREA #6 – EAST BRANCH BLIND BROOK

HRA 6 is located near the headwaters of East Branch Blind Brook, a tributary to Blind Brook, and runs from STA 60+00 to STA 85+00 in the village of Rye Brook (Figure 4-77). The contributing watershed area at this location is just over 0.5 square miles. The brook flows shallow behind residential buildings within a confined and straighten channel for most of its length. Repetitive loss claims within HRA 6 account for about 40 percent of all claims made in the East Branch Blind Brook basin. For this analysis, the structures under Argyle Road, Betsy Brown Road, and Acker Drive were evaluated.

The structures under Argyle Road (STA 60+90) and Betsy Brown Road (STA 65+80) are both comprised of three separate conduits. Argyle Road contains a 4-foot by 4-foot concrete box culvert at its center and two 3-foot-diameter corrugated metal pipes on either side (Figure 4-78). Carrying Betsy Brown Road over East Branch Blind Brook are two 4-foot-diameter corrugated metal pipes and a partially collapsing stone box culvert that is approximately 3 feet wide by 4 feet high (Figure 4-79). Two lengthy 6-foot-diamater corrugated metal pipes run under Acker Drive (Figure 4-80). The Acker Drive culvert outlet is located near STA 72+45 and extends upstream for about 270 feet to its inlet at STA 75+00. Based on hydraulic analysis, all culverts are shown to overtop in the current 10-year flood event.

Replacement of all three crossings described above with new single-span structures with a span between 16 to 19 feet and widening the channel to the bankfull width of 21 feet would result in substantial reductions in flooding. Additionally, channel profile modification would further enhance flow conveyance and allow for the placement of structures with taller vertical openings. A concept map showing these improvements is shown in Figure 4-81. A summary of the hydraulic findings and the recommended proposed replacement structures, evaluated under current and future hydrologic conditions, are listed in Table 4-5.

Flood reductions under the 10-year flood event are illustrated in Figure 4-82 (existing conditions) and Figure 4-83 (with proposed improvement implemented at all crossings). Flood reductions during the 50-year flood event are illustrated in Figure 4-84 (existing conditions) and Figure 4-85 (proposed conditions). Flood reductions during the 100-year flood event are illustrated in Figure-86 (existing conditions) and Figure 4-87 (proposed conditions).

Given the length of the Acker Drive culvert, it is also suggested to daylight the stream channel where it is not required to run underground. Daylighting the structure would include, at minimum, physically uncovering the culvert, removing it, and restoring the channel. Channel restoration would include excavation of a properly sized, multistage channel and floodplain, installation of grade control structures and/or scour protection measures along the restored channel to prevent channel incision and protect upstream infrastructure, and installation of native plantings.

Rigorous hydraulic and hydrologic analyses are recommended as a component of culvert replacement design and should begin at the downstream end of the HRA and proceed upstream. In addition, further analysis is needed to evaluate downstream impact of upsizing culverts in cases where the culverts impound water during flood events. Implementation of downstream flood detention projects on the East Branch Blind Brook can offset the effects of upsizing the crossings described above and should be carried out prior to upsizing culverts.

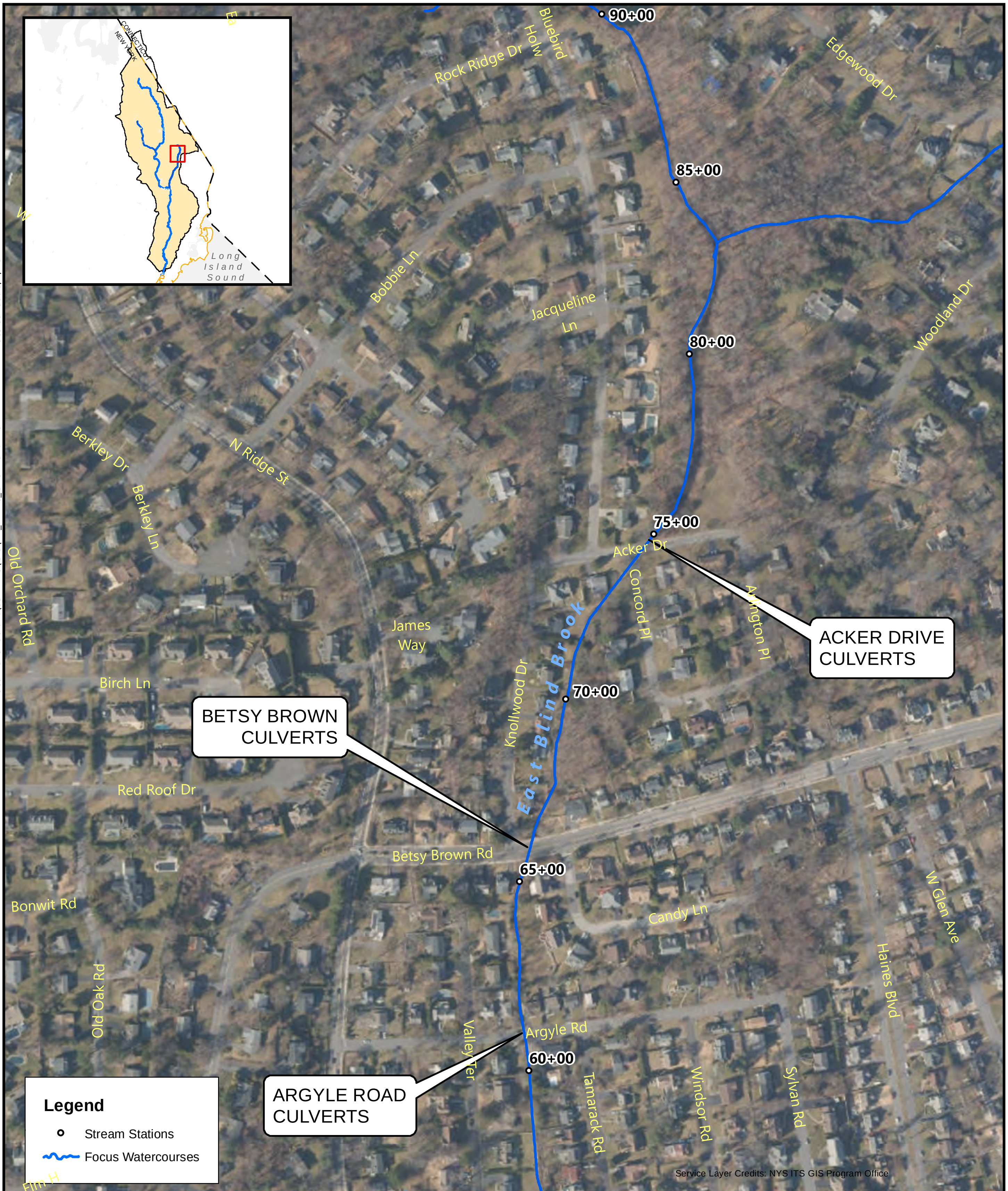

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FIG. 4-77

Figure 4-78: Looking upstream at the culvert structure under Argyle Road

Figure 4-79: Looking downstream at the culvert structure under Betsy Brown Road

Figure 4-80: Looking upstream at the outlet of the culverts that run under Acker Drive. The stream is channelized behind the backyards of homes for most of Its length as depicted.

Table 4-5 Summary of Hydraulic Analysis for HRA 5

Stream Crossing	Existing Structure Description	Existing Flood Capacity	Modeled Replacement Structure	Replacement Structure Flood Capacity	
				Current Hydrology	Projected Future Flows to Account for Climate Change
Argyle Road	L – 4'-Diameter CPM C – 4' span by 4' rise concrete box culvert R – 4'-Diameter CPM	<10-Year	16' Span by 7' Rise Concrete Box Culvert	100-Year	100-Year
Betsy Brown Road	L – 4'-Diameter CPM C – 4'-Diameter CPM R – Partially Collapsing Box Culvert	<10-Year	18' Span by 8' Rise Concrete Box Culvert	100-Year	50-Year
Acker Drive	Twin-Barrel 6'-Diameter CMP	<10-Year	19' Span by 6' Rise Concrete Box Culvert	100-Year	50-Year

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HRA #6: CONCEPT MAP

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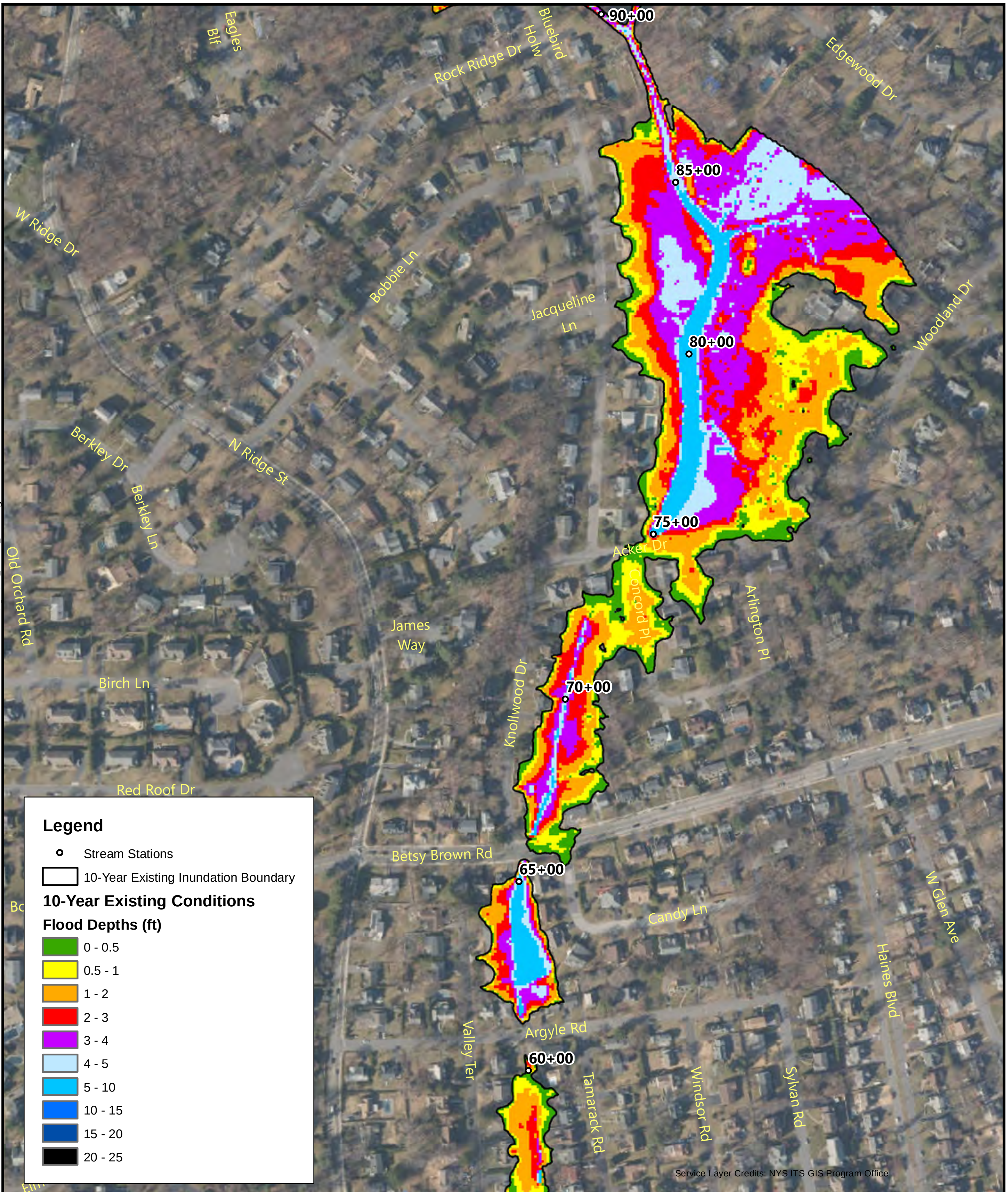
FIG. 4-81



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HRA #6: 10-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG. 4-82

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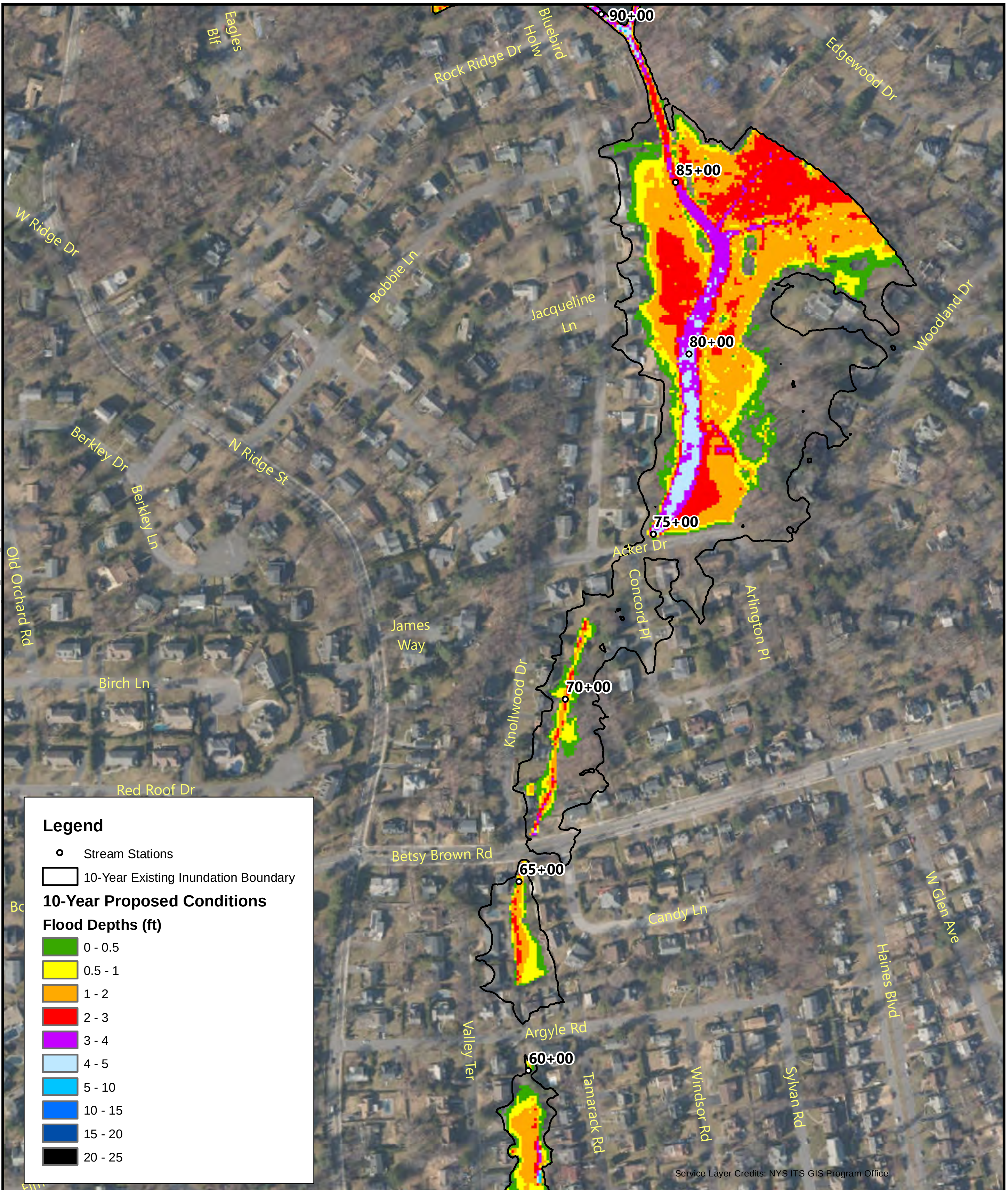

HRA #6: 10-YEAR PROPOSED CONDITIONS FLOOD DEPTHS

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FIG. 4-83

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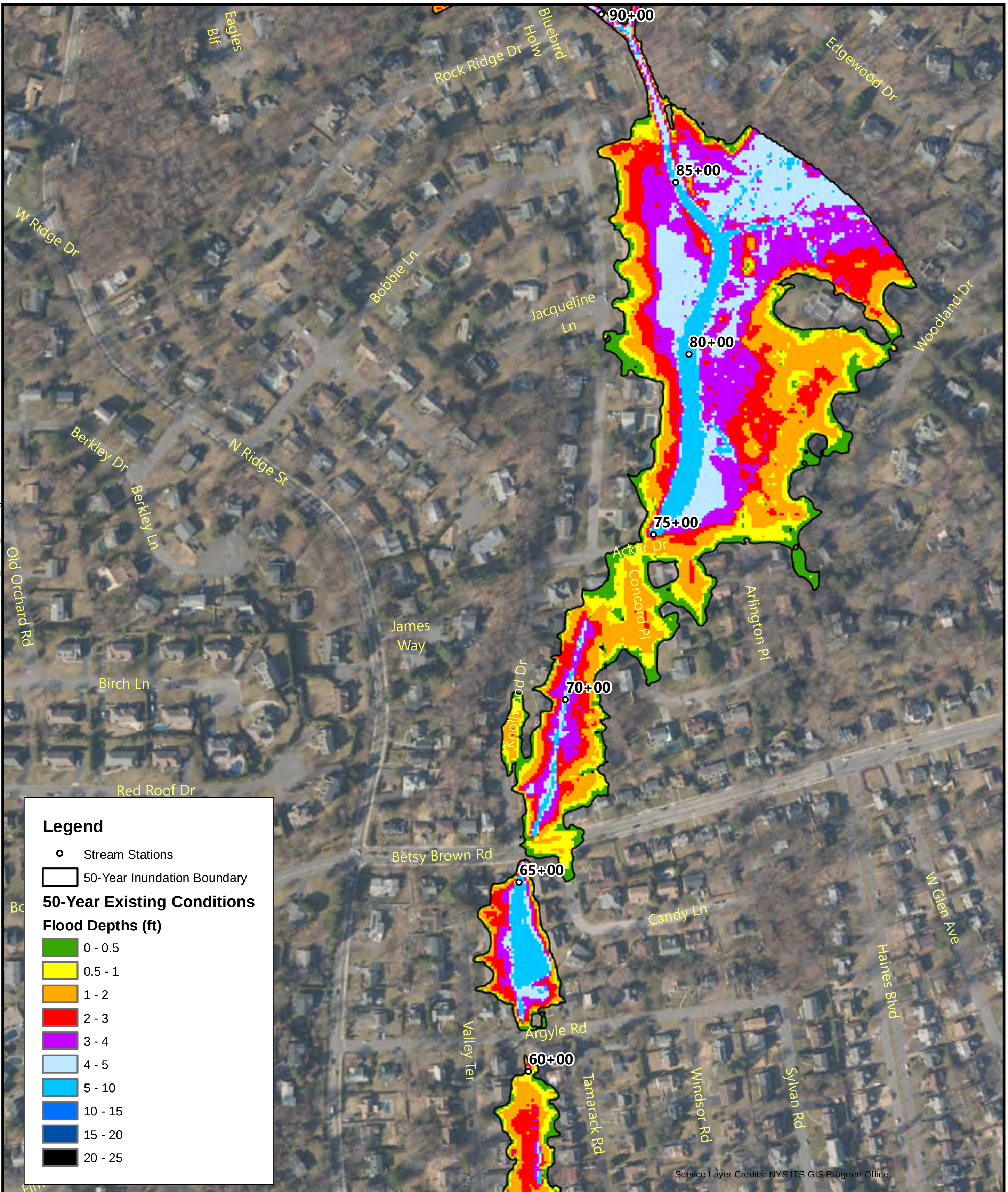

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HRA #6: 50-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG. 4-84

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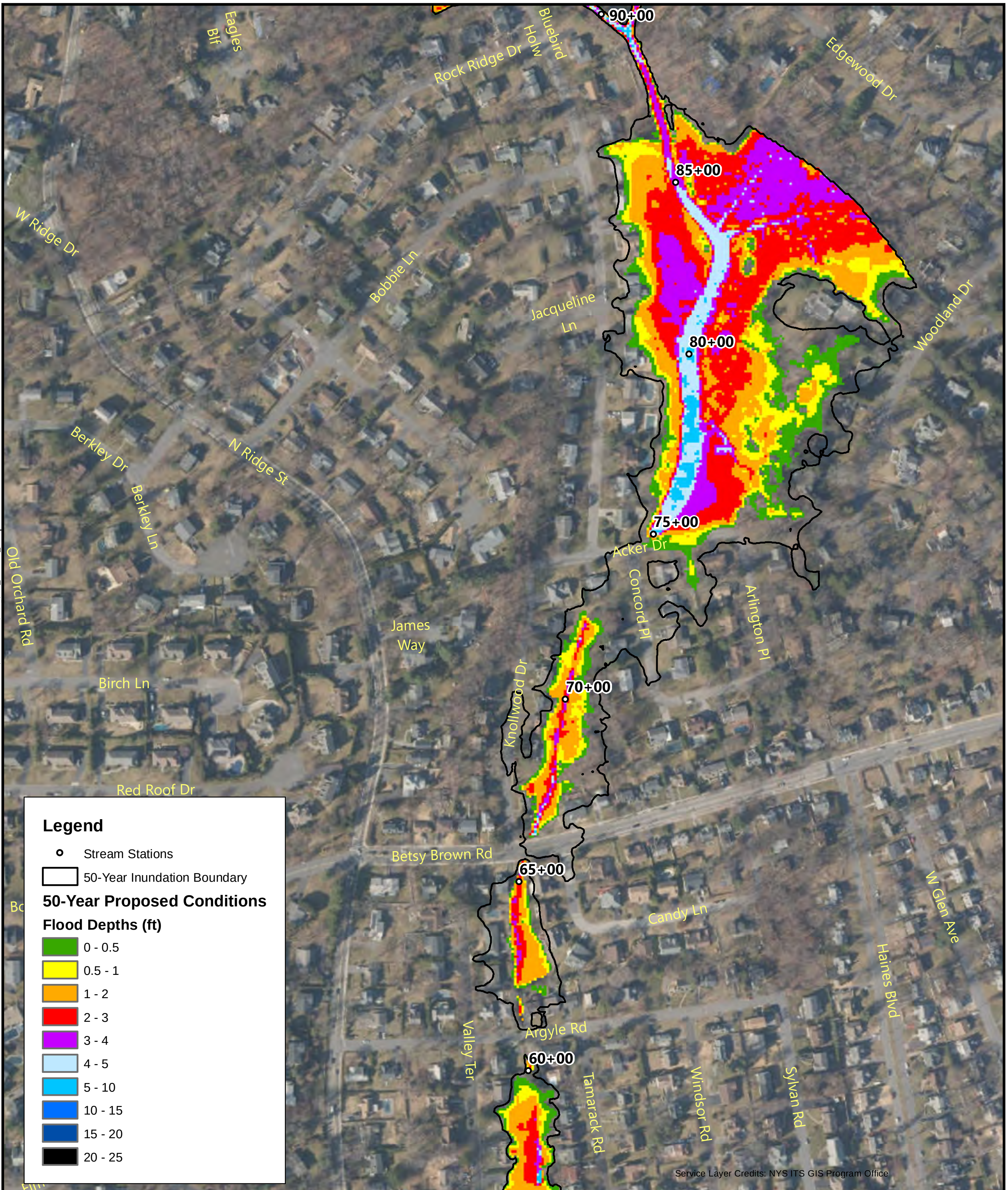

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HRA #6: 50-YEAR PROPOSED CONDITIONS FLOOD DEPTHS

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FIG. 4-85

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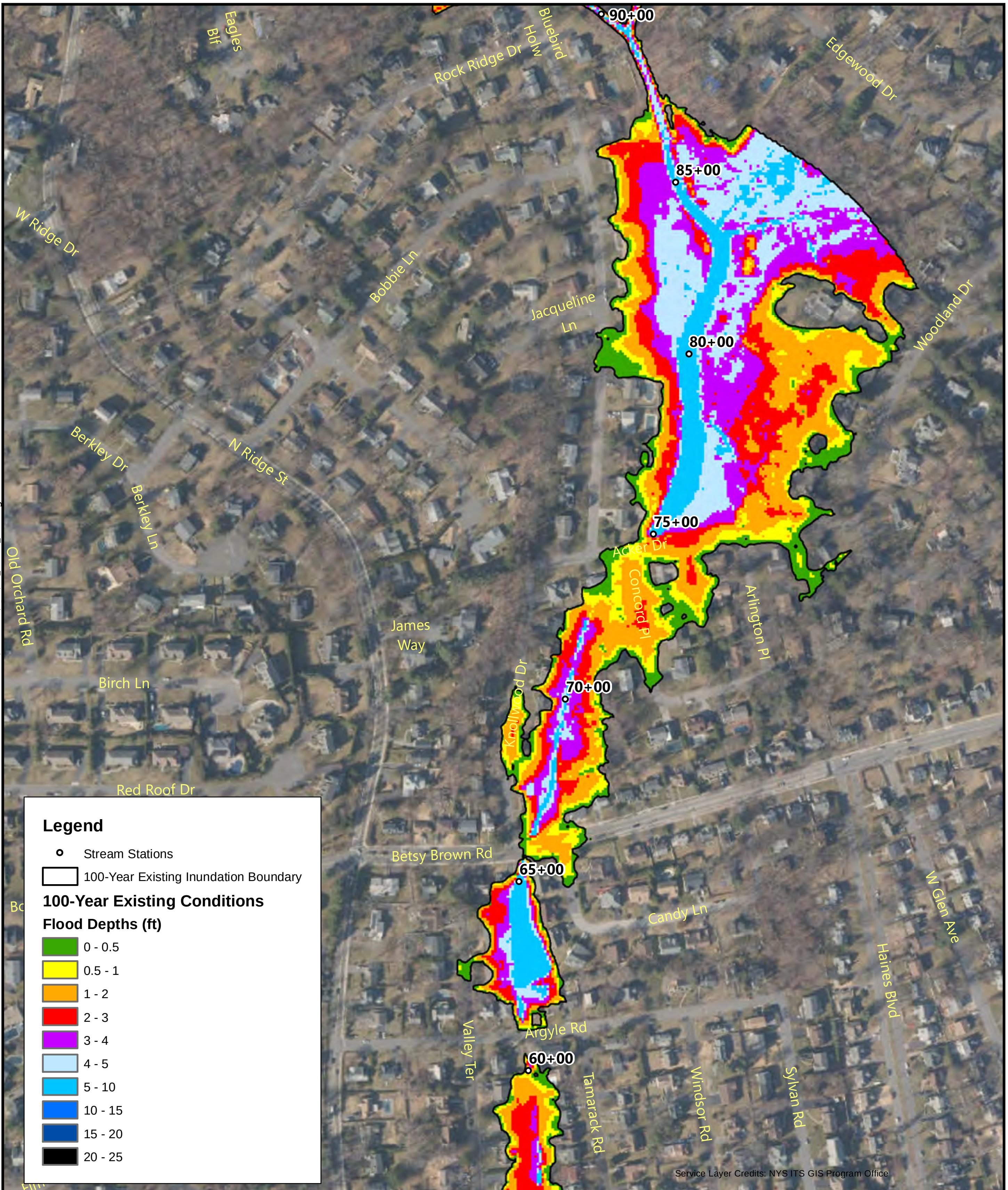

HRA #6: 100-YEAR EXISTING CONDITIONS FLOOD DEPTHS

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FIG. 4-86

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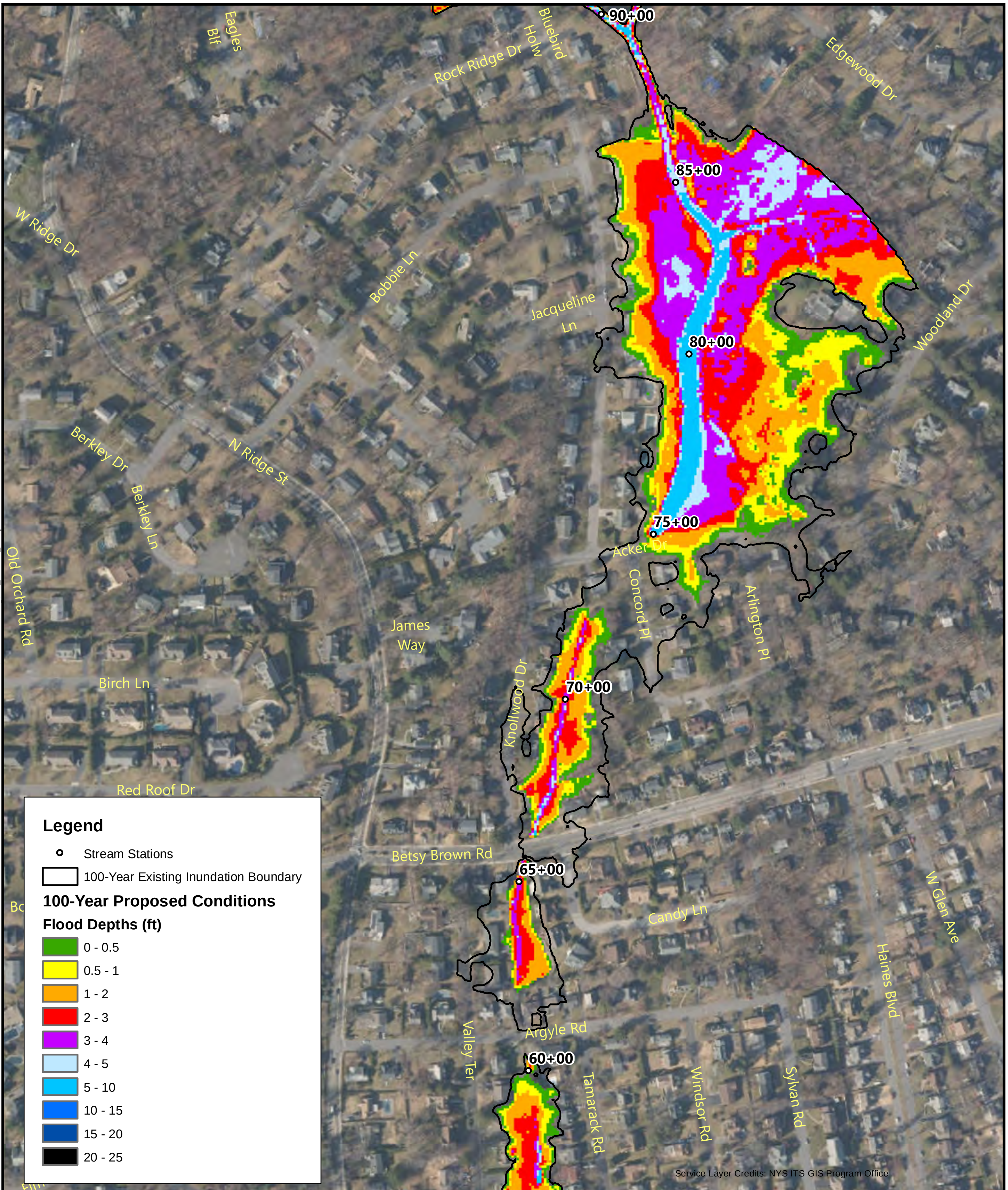

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HRA #6: 100-YEAR PROPOSED CONDITIONS FLOOD DEPTHS

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FIG. 4-87

5. RECOMMENDATIONS

This report identifies HRAs within the Blind Brook watershed. Flood mitigation recommendations are provided either as HRA-specific recommendations or as overarching recommendations that apply to the entire watershed or stream corridor. Flood mitigation scenarios such as floodplain enhancement and channel restoration, road closures, and replacement of undersized bridges and culverts are investigated and are recommended where appropriate. Recommendations for project prioritization are discussed in Section 5.13.

5.1 HRA 1 RECOMMENDATIONS

The following recommendations are provided for HRA 1:

- When due for scheduled replacement, the Oakland Beach Avenue bridge should be replaced with a new bridge with a span of 136 feet and no piers.

- When due for scheduled replacement, the Playland Parkway bridge should be replaced with a new bridge with a span of 136 feet and no piers.

- Detailed hydraulic analysis is recommended for the Oakland Beach Avenue and Playland Parkway bridges when due for replacement.

- At Oakland Beach Avenue, in combination with the bridge replacement recommended above, the creation of a 45-foot-wide, approximately 215-foot-long, and 7-foot-deep floodplain bench is recommended along the right bank.

- At the Playland Parkway bridge, in combination with the bridge replacement recommended above, a 180-foot-wide, 360-foot-long, and 5-foot-deep floodplain bench is recommended upstream and downstream of the bridge along the right bank.

- Removal of the unregistered dam near STA 71+85 is recommended. Hydraulic modeling shows this structure does not contribute substantially to flooding; however, the derelict structure is an obstruction for AOP, and its removal is recommended.

- If the school pedestrian bridge at STA 74+00 is no longer used, removal of the structure should be considered.

- If the primary bridge to the football fields is washed out or otherwise damaged in the future, rather than replacing the structure, redirecting traffic via Parson Street and Boston Post Road should be explored.

- Replacement of the Boston Post Road bridge over Blind Brook with a new bridge with a 60-foot span, open-bottom deck with vertical abutments and raising the bridge low chord by 1 foot is recommended.

- A new entrance to the Rye Nature Center is recommended with a driveway that would extend off Boston Post Road just southwest of where it crosses over Blind Brook. Removal of the current driveway and bridge to the Nature Center is recommended if a new entrance is to be established.

- Removal of the abandoned concrete pedestrian bridge near STA 92+54, upstream of the Nature Center driveway bridge, is recommended.

- Acquisition and removal of homes from the floodprone areas and individual floodproofing at homes in HRA 1 is recommended. Individual property flood protection measures are discussed in Section 5.10 and should be implemented using predicted future flows and future sea level rise data to adequately elevate homes and utilities.

5.2 HRA 2 RECOMMENDATIONS

The following recommendations are provided for HRA 2:

- Replacement of the Central Avenue bridge with a new bridge with a span of 66 feet and a rise of 12 feet.

- Replacement of the Locust Avenue bridge with a new bridge with a span of 66 feet and a rise of 10 feet.

- Floodplain benching at various locations along the Blind Brook channel, as depicted in Figure 4-39 and described in more detail in Section 4.2.5 of this report. This scenario would require the acquisition and removal of multiple buildings and parking areas and should be done in combination with the bridge replacements recommended above.

- A rigorous analysis is recommended for each bridge in HRA 2 when it is due for routine replacement to ensure that each bridge is adequately sized to convey flood flows and does not exacerbate flooding.

- Feasibility studies should be conducted to find the optimal combination of floodplain bench creation and bridge replacement prioritization and, if desirable, the decommission of bridges that span Blind Brook.

- At floodprone neighborhoods, buyouts and floodproofing at individual floodprone buildings is recommended.

- It is recommended that, in combination with the above recommendations, the City of Rye pursue a long-term initiative to create a linear riparian park along Blind Brook throughout HRA 2, extending from Central Avenue upstream to I-95 and the Metro-North Railroad. This initiative would require the gradual acquisition and demolition of floodprone properties, followed by the establishment of a floodable linear park along Blind Brook.

5.3 HRA 3 RECOMMENDATIONS

The following recommendations are provided for HRA 3:

- Replacement of the MTA/I-95 arch bridge with a 60-foot-wide bridge with vertical abutments and with a similar or slightly greater vertical opening height than currently exists.
- A rigorous hydraulic and hydrologic analysis is recommended as a component on the MTA/I-95 bridge replacement design. It is important to note that due to the significant impounding effect of the MTA/I-95 bridge and its embankment, increasing the size of the crossing has the potential to increase peak flows downstream of the MTA/I-95 crossing.
- Increases in peak flow downstream of the MTA/I-95 bridge could be offset by implementing upstream detention projects such as the Bowman Avenue Pond and SUNY Purchase College detention projects, which have been recommended in other analyses.
- Replacement of the Highland Avenue bridge with a 45-foot-wide structure is recommended. The MTA/I-95 arch bridge would need to be replaced with an adequately sized span in order for the benefits of replacing the Highland Avenue bridge to be realized.
- Relocate Wyman Street homes and construct floodplain bench to mitigate flooding at four buildings mapped in the extents of the current 500-year flood event. The proposed floodplain bench measures approximately 380 feet long and would require the relocation of three houses. The floodplain bench would be 130 feet at its widest point and would be excavated between 1.5 to 4.0 feet below the existing ground. This scenario is recommended as an intermediate solution until the MTA/I-95 bridge can be replaced.
- As an alternative scenario to the above, replace the MTA/I-95 bridge to eliminate the tailwater influence, then acquire and relocate floodprone homes adjacent to Blind Brook at Wyman Street.
- At the neighborhoods off Wappanocca Avenue and Mendota Avenue, where the recommendations listed above would drastically reduce but not eliminate flooding, buyouts and floodproofing at individual floodprone buildings is recommended. Consideration to partake in programs such as the NRCS's Floodplain Easement Program should be explored by the City of Rye.

5.4 HRA 4 RECOMMENDATIONS

The following recommendations are provided for HRA 4:

- At Brook Lane, the construction of a floodplain bench measuring approximately 1,200 feet long (from STA 242+04 to STA 255+00), between 106 to 133 feet wide, excavated at 3 feet below existing grade, with an area of approximately 3.3 acres.
- Replacing the Western Avenue bridge with a 50.2-foot-wide span would further reduce water surface elevations throughout this reach.

- Alternatively, it is recommended that a floodplain bench along the river right bank across from the Brook Lane neighborhood be investigated. The proposed floodplain would measure approximately 130 feet at its widest, 731 feet long, excavated between 1.5 to 5.0 feet below existing ground. The floodplain bench would consume a portion of a commercial parking lot within the town of Harrison.

- A rigorous hydrologic and hydraulic analysis is recommended at Brook Lane to identify the most effective combination of a floodplain bench creation and acquisition of the most floodprone homes to reduce the number of relocations and mitigate flood damage.

5.5 HRA 5 RECOMMENDATIONS

The following recommendations are provided for HRA 5:

- Replacement of the multiple culverts under Lincoln Avenue on the SUNY campus with a single 21-foot-wide by 6-foot-high concrete box.

- Reconstruction of the channel reaches immediately upstream and downstream of Salter Drive to at least bankfull dimensions.

- Stormwater management feasibility study to reduce flooding from upland runoff and inadequate roadside drainage along Lincoln Street.

- A rigorous hydrologic and hydraulic analysis is recommended for each structure in HRA 5 when due for routine replacement to ensure that each crossing is adequately sized to convey flood flows and does not contribute to flooding of the SUNY Purchase College buildings.

5.6 HRA 6 RECOMMENDATIONS

The following recommendations are provided for HRA 6:

- Replacement of the culverts under Argyle Road with a single 16-foot-wide by 7-foot-high concrete box.

- Replacement of the culverts under Betsy Brown Road with a single 18-foot-wide by 8-foot-high concrete box.

- Replacement of the Acker Drive culvert with a single 19-foot-wide by 6-foot-high concrete box.

- A rigorous hydrologic and hydraulic analysis is recommended for each structure in HRA 6 when due for routine replacement to ensure that each crossing is adequately sized to convey design flood flows. The analysis of each crossing should investigate the downstream impact of upsizing crossings that backup water during a flood.

- Daylighting of the stream channel at Acker Drive where it is not required to run underground. Daylighting the structure would include uncovering and removing the culvert and restoring the channel. Channel restoration would include creation of a properly sized, multistage channel and floodplain, installation of grade control structures and/or scour protection measures along the restored channel to prevent channel incision and protect upstream infrastructure, and installation of native plantings.

5.7 ATTENUATION OF FLOODWATERS

Floodwater attenuation scenarios have been evaluated in the Blind Brook watershed. These studies are being conducted by others and were not evaluated in detail as part of this analysis. It is recommended that efforts to increase upstream attenuation of floodwaters, such as at the Bowman Avenue dam, on the SUNY Purchase campus, and along East Branch Blind Brook, be implemented if found to be feasible and cost effective. Watershed municipalities should continue to explore and implement floodwater attenuation scenarios.

5.8 REPLACEMENT OF UNDERSIZED STREAM CROSSINGS

Hydraulically undersized stream crossings contribute to flooding and washout of roadways. In addition to the recommendations for the replacement of stream crossings within the HRAs described above, it is recommended that undersized stream crossings elsewhere in the Blind Brook watershed be identified and prioritized for replacement. Guidance for this prioritization should be based on capacity modeling and on available information regarding the physical condition of the crossing and its impact to AOP connectivity.

5.9 INSTALLATION AND MONITORING OF STREAM GAUGE

USGS gauge (01300000) at Rye was installed in the early 1940s and decommissioned in 1999. The gauge was located along Elm Place, downstream of the I-95 crossing over Blind Brook. There are currently no active stream gauges on Blind Brook, making statistical analysis difficult. Stream gauges provide valuable data that can be used in future hydrologic analyses and to improve flood monitoring and forecasting. Recommissioning of the former gauge or installation of a permanent new stream gauge is recommended.

5.10 INDIVIDUAL PROPERTY FLOOD PROTECTION

A variety of measures is available to protect existing public and private properties from flood damage. While broader mitigation efforts are most desirable, they often take time and money to implement. On a case-by-case basis where structures are at risk, individual floodproofing should be explored. Property owners within FEMA-delineated floodplains should also be encouraged to purchase flood insurance under the NFIP and to make claims when damage occurs. Potential measures for property protection include the following:

<u>Elevation of the structure</u> – Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located at least 2 feet 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.

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 basin where implementation of such measures will serve to protect structures.

Dry floodproofing of the structure to keep floodwaters from entering – Dry floodproofing refers to the act of making areas below the flood level watertight and is typically implemented for commercial buildings that would be unoccupied during a flood event. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents can 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. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 100-year flood elevation.

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 (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer 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.

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 in order to increase the eligibility of the property for projects under the various mitigation grant programs.

5.11 ROAD CLOSURES

Approximately 75 percent of all flood fatalities occur in vehicles. Shallow water flowing across a flooded roadway can be deceptively swift and wash a vehicle off the road. Water over a roadway can conceal a washed-out section of roadway or bridge. When a roadway is flooded, travelers should not take the chance of attempting to cross the flooded area. It is not possible to tell if a flooded road is safe to cross just by looking at it.

One way to reduce the risks associated with the flooding of roadways is their closure during flooding events, which requires effective signage, road closure barriers, and consideration of alternative routes.

According to FEMA modeling and anecdotal reporting, floodprone roads exist within the Blind Brook watershed. In some cases, small, unnamed tributaries and even roadside drainage ditches can cause washouts or other significant damage to roadways, culverts, and bridges. Drainage issues and flooding of smaller tributary streams are generally not reflected in FEMA modeling, so local public works and highway departments are often the best resource for identifying priority areas and repetitively damaged infrastructure.

5.12 WATERSHED HEALTH

An additional consideration to mitigate flood damages is to maintain the overall health of the watershed. Watersheds naturally cycle, filter, and store water. Water enters the watershed as rain, which soaks into the ground, fills ponds and wetlands, and trickles into small intermittent streams that run into larger streams and finally rivers. The watershed stores water, moves it along, or transfers it underground to replenish groundwater. Land development activities change the surface of the land in the watershed by adding impervious surfaces, filling small wetlands and rerouting streams. These activities change the path of water and ultimately influence where water goes during heavy storms. The following recommendations are provided:

Recommendations to reduce damages and maintain flood resiliency in the Blind Brook watershed are listed below:

<u>Green Infrastructure Recommendations</u>

- Reroute downspout water to rain barrels, cisterns, or permeable areas that allow it to soak into the soil.
- Create rain gardens that collect and absorb stormwater runoff.
- Create and maintain vegetated channels that collect, slow, and filter stormwater and allow it to soak into the soil.

Vegetated Buffers Recommendations

- Protect existing buffers from removal, damage, major disturbance, and contamination. Consider local policies, zoning overlays, or buffer protection regulations.
- Prioritize the restoration and maintenance of buffers between the water and adjacent intensive land use areas.
- Keep construction, heavy equipment, and impervious surfaces out of the 100-foot buffer area to retain full benefits from the buffer.
- Establish vegetated buffers where there are none and replenish or replace vegetation to maximize buffer effectiveness. Maintain all three layers of vegetation wherever possible: trees, shrubs, herbaceous plants/unmowed grasses.
- Plant trees and shrubs for maximum soil stability and shade over the water.
- Use native plants to maximize sustainability of plantings and reduce cost of maintenance.
- Avoid mowing to the edge of the water. Mowed lawn does not provide the benefits that we receive from well-vegetated buffers but instead increases the amount of runoff and reduces groundwater recharge.

Recommendations for Protecting Forests and Open Space

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

Recommendations for Floodplains

- Adopt or enhance a Floodplain Management Plan for the entire watershed (consistent for all municipalities in the watershed) that may include floodplain ordinances, overlay zones, and guidelines for managing specific sites that are prone to flooding.
- Maintain unimpeded connection between a stream or river and its floodplain to improve floodwater retention and accommodation during floods.

- Use green infrastructure and best management practices within floodplains to improve existing conditions where structures are already present and reduce the extent of impervious surfaces within floodplains.

Recommendations for Streams and Wetlands

- Develop and implement a watershed-wide Aquatic Buffer Ordinance or Water Resources Protection Plan that includes specific guidelines for the size and vegetative composition of buffers along all stream, lake, and wetland edges.
- Develop an inventory of "target" riparian areas for restoration to protect water quality, reduce flood damages, and provide habitat.
- Maintain natural stream channels and banks; avoid deepening or straightening channels.
- If there is uncertainty regarding whether a wetland is present in a particular location, have the site evaluated by a professional wetland delineator. Contact the County Soil and Water Districts for assistance.
- Avoid dumping trash and other debris (including organic debris and yard waste) in wetlands and streams.

5.13 PRIORITIZATION OF PROJECT IMPLEMENTATION

The hydraulics of Blind Brook are complex. The implementation of flood mitigation projects in one area of the Blind Brook watershed has the potential to impact a separate area of the watershed. Therefore, the following recommendations are provided for the prioritization of projects.

- Implementation of upstream detention projects such as the Bowman Avenue Pond and SUNY Purchase College should occur prior to replacement of the MTA/I-95 bridge.

- Implementation of recommended improvements through HRA 2 should occur prior to replacement of the MTA/I-95 bridge.

- Implementation of recommended improvements within HRA 3 should begin with replacement of the MTA/I-95 bridge and proceed upstream.

- Aside from the specific recommendations on prioritization made above, improvements can be implemented within each HRA without substantially impacting other HRAs.

- As general guidance, implementation of improvements within each HRA should begin at the downstream end of the HRA and proceed upstream. For example, in HRA 6, project implementation should begin with stream crossing replacement at Argyle Road, followed by stream crossing replacement at Betsy Brown Road, followed by stream crossing replacement and channel daylighting at Acker Drive.

- Voluntary acquisition and demolition of floodprone properties is a key component to increasing flood resiliency and should be implemented whenever funding is available and landowner willingness exists.

5.14 ROUGH ORDER OF MAGNITUDE COST RANGE OF KEY RECOMMENDATIONS

To assist with prioritization of the above recommendations, Table 5-1 provides an estimated cost range for key recommendations. More specific estimated costs are provided where possible. Due to the conceptual nature of recommended actions and significant amount of data required to produce a reasonable rough order of magnitude cost, it is not feasible to further quantify the costs of all actions. Costs of land acquisition, buyouts, or easements are not included in the costs.

Table 5-1 Cost Range of Recommended Actions

Recommendation	< $100k	$100k $500k	$500k $1M	$1M $5M	$5M $10M	$10M $20M	$20M $30M
HRA 1 – Replacement of Oakland Beach Avenue bridge					X		
HRA 1 – Replacement of Playland Parkway bridge					X		
HRA 1 – Floodplain bench at Oakland Beach Avenue			X				
HRA 1 – Floodplain bench at Playland Parkway bridge			X				
HRA 1 – Removal of the unregistered dam near STA 71+85		X					
HRA 1 – Removal of school pedestrian bridge	X						
HRA 1 – Replacement of Boston Post Road and raising the low chord by 1 foot				X			
HRA 1 – New entrance to the Rye Nature Center				X			
HRA 1 – Removal of abandoned concrete pedestrian bridge near STA 92+54		X					
HRA 2 – Replacement of Central Avenue bridge				X			
HRA 2 – Replacement of the Locust Avenue bridge				X			
HRA 2 – Floodplain benching of Blind Brook channel				X			
HRA 2 – Creation a linear riparian park along Blind Brook throughout HRA 2					X		
HRA 3 – Replacement of the MTA/I-95 arch bridge							X
HRA 3 – Implementation of upstream detention projects recommended in other analyses						X	

Recommendation	< $100k	$100k – $500k	$500k – $1M	$1M – $5M	$5M – $10M	$10M – $20M	$20M – $30M
HRA 3 – Replacement of Highland Avenue bridge				X			
HRA 3 – Creation of floodplain bench along Wyman Avenue		X					
HRA 4 – Construction of floodplain bench at Brook Lane				X			
HRA 4 – Replacement of Western Avenue bridge			X				
HRA 5 – Replacement of multiple culverts under Lincoln Avenue with a single concrete box			X				
HRA 5 – Reconstruction of channel immediately upstream and downstream of Salter Drive		X					
HRA 6 – Replacement of the culverts under Argyle Road			X				
HRA 6 – Replacement of the culverts under Betsy Brown Road			X				
HRA 6 – Replacement of the culverts under Acker Drive			X				
HRA 6 – Daylighting of stream channel at Acker Drive		X					

5.15 FUNDING SOURCES

Several funding sources may be available for the implementation of recommendations made in this report. 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.

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.
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

FEMA Building Resilient Infrastructure and Communities (BRIC) Program
Building Resilient Infrastructure and Communities (BRIC) will support states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters

and natural hazards. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency.
https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities.

FEMA Pre-Disaster Mitigation (PDM) Program

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

FEMA Hazard Mitigation Grant Program (HMGP)

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

The HMGP is one of the FEMA programs with the greatest possible fit to potential projects recommended in this report. 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

<u>FEMA Flood Mitigation Assistance (FMA) Program</u>

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 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

<u>NYS Department of State</u>

The NYS Department (NYSDOS) 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>NYS Department of Environmental Conservation – Municipal Waste Reduction and Recycling (MWRR) Program</u>

The NYS Department of Environmental Conservation (DEC) administers MWRR funding to local government entities for waste reduction and recycling projects. The overall goal of this funding program is to assist municipalities in expanding or improving local waste reduction and recycling programs and to increase participation in those programs.

The MWRR state assistance program can help fund the costs of the following:

- Capital Investment in Facilities and Equipment

Eligible projects are expected to enhance municipal capacity to collect, aggregate, sort, and process recyclable materials. Recycling equipment includes structures, machinery, or devices providing for the environmentally sound recovery of recyclables, including source separation equipment and recyclables recovery equipment.

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 (FPMS) Program. 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 postflood 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.

New York State Grants

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

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

Climate Smart Communities (CSC)

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

Environmental Facilities Corporation

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

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

Bridge NY Program

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

Private Foundations
Private entities such as foundations are potential funding sources in many communities. Communities 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.

Communities 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 communities to identify combinations of funding sources in order to reduce their own requirement to provide matching funds.

6. LAND USE ANALYSIS

6.1 LAND USE AND ZONING REVIEW AND ANALYSIS

Potential changes to land use, particularly development proposals in close proximity to a water body or within a riparian buffer, can bring about issues and consequences both for the impact on those developments should a flood occur but also as a contributor to the flooding problem itself. In New York State, land use is controlled at the municipal level through zoning, subdivision, and other related regulations, including wetlands and floodplain ordinances.

In Westchester County, there has been a significant amount of work conducted by the state, county, and local municipalities, typically following a flood event that creates an immediate need to respond to the disaster as well as an understanding that situations surrounding such disasters need to be assessed and plans developed to mitigate likely future repeat events.

This analysis reviewed publicly available project-relevant documents found online to identify recommendations and opportunities identified for communities to address issues related to flooding through land use and zoning. This analysis also provides best practice recommendations that communities in Westchester County within the Blind Brook watershed can review and discuss implementing, if not already in the municipal code. A significant and positive finding from the literature review effort undertaken is that Blind Brook watershed communities in Westchester County have adopted a Flood Damage Prevention Ordinance or similar regulations. The current regulations, all most recently adopted/revised in 2007, go a long way toward addressing potential issues and concerns related to flooding and land use planning.

Our review of the following documents did not find any detailed municipal-specific land use or zoning recommendations, although there were general discussions about reviewing land use codes and encouraging smart growth and sustainability. We have summarized any potential recommendations related specifically to flooding and sustainability that may be useful to consider when assessing potential changes to existing zoning, subdivision, and other regulations that could impact flood-related conditions:

- All Westchester County communities within the Blind Brook watershed have a flood damage prevention ordinance or similar standards to address flood damage prevention. The standards adopted can vary from community to community, but they all provide construction standards for actions within flood hazard areas.

- All Westchester County communities are under the “umbrella” of the 1996 “Patterns for Westchester” Plan Update. Additionally, there is Westchester’s 2025’s “Context for County and Municipal Planning and Policies to Guide County Planning.” All communities fall within the following recommendations from the plan:
    - Natural Resources and the Environment Section – Encourages municipalities to implement best management practices; designate critical environmental areas; enact wetland, tree preservation, and steep slope protection ordinances; encourage

preservation of lands and conservation easements to protect wetland and riparian systems.

https://planning.westchestergov.com/images/stories/reports/patternsforwestchester.pdf
https://planning.westchestergov.com/images/stories/pdfs/2025ContextPolicies.pdf

- *Cleaner, Greener Communities Mid-Hudson Regional Sustainability Plan (Mid-Hudson Planning Consortium)* 2013
  - This plan was developed to "…set realistic yet ambitious objectives for the long-term sustainable development of the Region, each of which is supported by initiatives and projects that can be implemented in the short-, medium-, and long-term." The plan lists 218 project ideas, some of which are directed toward Westchester County specifically, but none of those projects are flood or land use/zoning focused. That said, there are Mid-Hudson-wide recommended projects related to flooding that are relevant, including the following:
    - Project 63 – Install porous pavement in municipalities
    - Project 188 – Increases in the extent of riparian buffers
    - Project 203 – Watershed remediation. This project will help identify and target funds to specific vulnerable locations to protect roads and other facilities from flooding.
    - Project 212 – Get municipalities involved in green infrastructure. Enable more green infrastructure projects by removing cost and knowledge barriers.

    https://www.orangecountygov.com/DocumentCenter/View/1469/Mid-Hudson-Regional-Sustainability-Plan-PDF

  - The Greenprint for a Sustainable Future, the Westchester County Greenway Compact Plan (2004) includes a policy related to preserving and protecting the county's natural resources, including water bodies, wetlands, and coastal zones.
    https://planning.westchestergov.com/greenway-compact-plan/sustainable-future-greenprint

  - Blind Brook Watershed Management Plan (2009) is a flood mitigation plan for the Blind Brook watershed and also includes an economic assessment for the City of Rye for structural flood damages.
    https://storage.googleapis.com/proudcity/ryebrookny/uploads/2021/11/2009.03-Blind-Brook-Watershed-Management-Plan-Appx6-8_ACOE_Part1.pdf

  - The 2021 Westchester County Hazard Mitigation Plan's mission is to "protect and enhance the health, safety, property, environment, and economy of the communities within Westchester County and to increase resilience by partnering and planning to identify and reduce future vulnerability to natural and other emerging hazards in an equitable, proactive, and efficient manner." Communities within the Blind Brook watershed have Jurisdictional Annexes within the plan developed detailing information about their community as well as recommendations for projects to be undertaken to mitigate different types of hazards, including flooding.
    https://planning.westchestergov.com/hazard-mitigation-planning

6.2 MUNICIPAL ASSESSMENTS

The following section details individual recommendations for each community being assessed within the Blind Brook watershed. Following these write-ups are best practices that each community can review to assess whether they are already in their municipal code or if there is an opportunity to enhance the code to further protect municipal resources, residents, businesses, and the natural environment from unplanned and unwanted impacts from flooding.

6.2.1 VILLAGE AND TOWN OF HARRISON

Zoning and Other Code(s) Analysis

https://ecode360.com/8314019

The Town/Village has a "Floodplain Damage Prevention" code (Chapter 146). The code has standards related to elevation and flood-resistant construction. The Town/Village also has a "Stormwater Management and Erosion and Sediment Control" code (Chapter 267) and a Subdivision of Land code that regulates flooding-related issues (Chapter 275).

Other Land Use documents reviewed:

- Westchester County Hazard Mitigation Plan (HMP) – Town of Harrison Annex - The Annex document did not specifically reference the Blind Brook watershed, but there are recommendations related to mitigation measures for properties prone to flooding and an overall recommendation for the Town/Village to update its flood maps. https://planning.westchestergov.com/hazard-mitigation-planning
- The Town/Village of Harrison Comprehensive Plan (2013) – https://www.harrison-ny.gov/sites/g/files/vyhlif671/f/file/file/adopted_master_plan_2013.pdf
  - The plan discusses water quality concerns and watershed protection. The Blind Brook basin is noted as a Critical Environmental Area.

6.2.2 TOWN OF NORTH CASTLE

Zoning and Other Code(s) Analysis

https://ecode360.com/36929254

The Town has a "Flood Damage Prevention" code (Chapter 177). The code has standards related to elevation and flood-resistant construction. The Town also has a "Stormwater Management" code (Chapter 267) that regulates certain acts that are permitted or prohibited within a stream or watercourse.

The Town code requires the Planning Board to review water supply and sewerage systems to minimize or eliminate flood damage and provide adequate drainage. The code also states that no more than 25 percent of the minimum lot area under water or defined as wetland can be used to satisfy the minimum lot area.

Other Land Use documents reviewed:

- Westchester County HMP – Town of North Castle Annex - The Annex document did not specifically reference the Blind Brook watershed, but there are recommendations related to mitigation measures for properties prone to flooding. https://planning.westchestergov.com/hazard-mitigation-planning
- The Town of North Castle Comprehensive Plan (2018) – This plan does not discuss the Blind Brook watershed but discusses other watershed plans and planning efforts and participation in the Northern Westchester Watershed Committee. https://www.northcastleny.com/sites/g/files/vyhlif3581/f/uploads/2018_comprehensive_plan_amended_2_6-12-19-compressed.pdf

6.2.3 VILLAGE OF PORT CHESTER

Zoning and Other Code(s) Analysis

https://ecode360.com/10911302

The Village has a "Flood Damage Prevention" code (Chapter 181). The code has standards related to elevation and flood-resistant construction. The code includes regulations for coastal high-hazard areas and those areas outside the high-hazard areas. The Village also has a "Stormwater Management" code (Chapter 281).

Other Land Use documents reviewed:

- Westchester County HMP – Village of Port Chester Annex - The Annex document did not specifically reference the Blind Brook watershed, but there are recommendations related to mitigation measures for properties prone to flooding. https://planning.westchestergov.com/hazard-mitigation-planning
- Village of Port Chester Comprehensive Plan (2012) – The plan does not discuss the Blind Brook watershed specifically. The Natural and Environmental Resources Chapter does, however, include a recommendation to "Coordinate planning efforts with neighboring communities, the State and the Federal government to address regional sustainability issues, including transit, air and water quality, brownfield remediation, protection of floodways and wildlife habitat, and provision of recreation areas and bike paths." In March 2022, the Village of Port Chester publicly noticed a plan to begin updating its Comprehensive Plan. https://www.portchesterny.gov/sites/g/files/vyhlif1096/f/uploads/finalportchestercomprehensiveplanadopted12-17-2012_0.pdf
- Village of Port Chester Strategic Plan 2017-2022 (2017) – The plan's resiliency goal discusses priorities related to the environment and emergency management, performing a risk assessment, and developing resiliency plans. The plan also has a smart growth goal. https://www.portchesterny.gov/sites/g/files/vyhlif1096/f/uploads/2335001_portchesterny_strategicplanfinal.pdf

6.2.4 CITY OF RYE

Zoning and Other Code(s) Analysis

https://ecode360.com/6977013

The City has a "Floodplain Management" code (Chapter 100). The code has standards related to elevation and flood-resistant construction. The code includes regulations for coastal high-hazard areas and those areas outside the high-hazard areas. There are specific conditions for developing certain lot types in certain Zoning Districts where buildings are prohibited from being constructed in areas of special flood hazard. These conditions also prohibit development that increases flooding elsewhere within the City of Rye. The City also has a "Stormwater Management" code (Chapter 174).

There are specific regulations related to "Floodplain Zoning" and a "Residential Floodplain and Wetland Preservation District" (Section 197) as well as a Wetlands and Watercourses code (Chapter 195).

Other Land Use documents reviewed:

- Westchester County HMP – City of Rye Annex - The Annex document included recommendations for amendments to City land use regulations to comply with flood mitigation construction measures and hazard-resistant development within floodprone areas. Recommendations discuss floodproofing of critical facilities, the introduction of flood gauges on Blind Brook, work on the Bowman Avenue dam, revisions to the FIRM map along Blind Brook downstream of I-95, and a new entrance to the Rye Nature Center as the bridge is subject to flooding.
  https://planning.westchestergov.com/hazard-mitigation-planning
- City of Rye Development Plan (1985) – The plan discussed acquiring floodprone properties along Blind Brook and creating a Blind Brook trail system.
  https://www.ryeny.gov/home/showpublisheddocument/8938/636679000926070000
- City of Rye Local Waterfront Revitalization Program (1991) – This plan primarily focuses on waterfront recreation expansion and maintenance and public access. The proposed projects include a recommendation for a Blind Brook walkway along Blind Brook from the Rye Nature Center through Disbrow Park to Oakland Beach Avenue for passive recreation.
  https://docs.dos.ny.gov/opd-lwrp/LWRP/Rye_C/Index.html
- City of Rye Flood Mitigation Plan (2001) – The plan discusses mitigation measures for floodprone properties and reviewing codes to determine if the regulations prevent flooding and protect important natural resources.
  https://www.ryeny.gov/home/showpublisheddocument/8940/636679000928730000
- City of Rye, Hazard Mitigation Plan (2007) – The plan discusses areas that are subject to routine flooding, including properties along Blind Brook (especially the Indian Village neighborhood). The plan recommends acquiring property, easements, or development rights in floodprone areas, limiting development in floodprone areas, rehabilitation of the Bowman Avenue dam, improving maintenance of streams and storm drainage infrastructure, flood mitigation construction measures, and flood gauges and early warning systems.
  https://www.ryeny.gov/home/showpublisheddocument/8942/636679000931070000

- Blind Brook Watershed Management Plan (2009) – This plan is a flood mitigation plan for the Blind Brook watershed. It analyzes flood impacts, recommends mitigation improvements, and provides an assessment of structural flood damage reduction alternatives within the City of Rye. Recommendations include construction of a stormwater pond at SUNY Purchase at Anderson Hill Road. It also evaluated construction improvements at the proposed sluice gate and upper pond at Bowman Avenue. Nonstructural mitigation measures were also discussed, including floodproofing, relocation of structures, advance flood warning systems, and land use regulations within the floodplain. A preliminary economic analysis was conducted related to the recommendations. https://ryebrook.org/documents/2009-03-blind-brook-watershed-management-plan-appx6-8_acoe_part1/
- City of Rye NY Rising Community Reconstruction Program (2014) – This plan discusses how the Blind Brook riparian corridor has dense commercial and residential development. During periods of high tides (like during Superstorm Sandy), with high levels of rainfall, large-scale flooding can occur. Proposed projects impacting Blind Brook include improvements to the Bowman Avenue dam, increasing storage volume of the Bowman Avenue dam lower pond, stormwater ponds at Anderson Hill Road (SUNY Purchase), modifications to the sluice gate at Bowman Avenue dam, floodproofing of the Locust Avenue firehouse adjacent to Blind Brook, floodproofing of nonprofit facilities in the Central Business District adjacent to Blind Brook, and expansion of wetland and open space areas along the City's brooks. https://stormrecovery.ny.gov/regional-communities/city-rye
- Blind Brook, City of Rye Flood Risk Management Study: Federal Interest Determination (2021) – This determination recommends a feasibility study for flood risk management for the City of Rye. https://ryebrook.org/documents/2021-04-rye-city-army-corps-blind-brook-flood-risk-mngmt-study/
- City of Rye Ida Flood Review (2021) – This document reviewed the impact from Ida related to flooding from Blind Brook and Beaver Swamp Brook. There was widespread flooding from catch basins, stormwater management systems, and due to the Bowman Avenue dam spillway and dam. https://www.ryeny.gov/home/showpublisheddocument/13794/637679237017000000

6.2.5 VILLAGE OF RYE BROOK

Zoning and Other Code(s) Analysis

https://ecode360.com/10844867

The Village has a "Floodplain Damage Prevention" code (Chapter 130). The code has standards related to elevation and flood-resistant construction. The code includes a requirement that whenever any portion of a floodplain is authorized for development, the volume of space occupied by the authorized fill or structure below the BFE shall be compensated for and balanced by a hydraulically equivalent volume of excavation taken from below the BFE at or adjacent to the development site. The Village also has a "Stormwater Management" code (Chapter 217) and Wetlands and Watercourses code (Chapter 245).

Other Land Use documents reviewed:

- Westchester County HMP – Village of Rye Brook Annex - The Annex document included recommendations related to flooding efforts for some culvert installations and mitigation of floodprone properties. In addition, there are recommendations for an engineering study of Blind Brook, a flood mitigation project at the Bowman Avenue dam, a flood study at the Pine Ridge and Mohegan intersection, and a flood mitigation project (stormwater ponds) at SUNY Purchase near Anderson Road. https://planning.westchestergov.com/hazard-mitigation-planning
- Project Report: Flood Mitigation Study, Bowman Avenue Dam Site (2008) – This study evaluated various flood damage reduction measures at the Bowman Avenue dam site and lower pond so as to reduce downstream flooding between I-287 and I-95. https://www.ryeny.gov/home/showpublisheddocument/7060/636678905745430000
- Blind Brook Watershed Management Plan (2009) – This flood mitigation plan for the Blind Brook watershed analyzes flood impacts, recommends mitigation improvements, and provides an economic assessment on structural flood damages within the City of Rye. Recommendations include construction of a stormwater pond at SUNY Purchase at Anderson Hill Road. It evaluated construction improvements at the proposed sluice gate and upper pond at Bowman Avenue and recommended nonstructural mitigation measures, including floodproofing, relocation of structures, advance flood warning systems, and land use regulations within the floodplain. https://ryebrook.org/documents/2009-03-blind-brook-watershed-management-plan-appx6-8_acoe_part1/
- Blind Brook, City of Rye Flood Risk Management Study: Federal Interest Determination (2021) – This determination recommends a feasibility study for flood risk management for the City of Rye. https://ryebrook.org/documents/2021-04-rye-city-army-corps-blind-brook-flood-risk-mngmt-study/
- Village of Rye Brook Comprehensive Plan (2014) – The plan discusses the Blind Brook watershed, existing conditions, and proposals for Blind Brook. A Natural Environment Goal is to "Maintain and improve the quality of the Blind Brook and the Long Island Sound watershed," including policy statements to improve access and raise awareness of Blind Brook and address stormwater management from a regional and village-wide perspective to reduce flooding impacts. https://docs.ryebrook.org/WebLink/Browse.aspx?id=140978&dbid=0&repo=VillageOfRyeBrook

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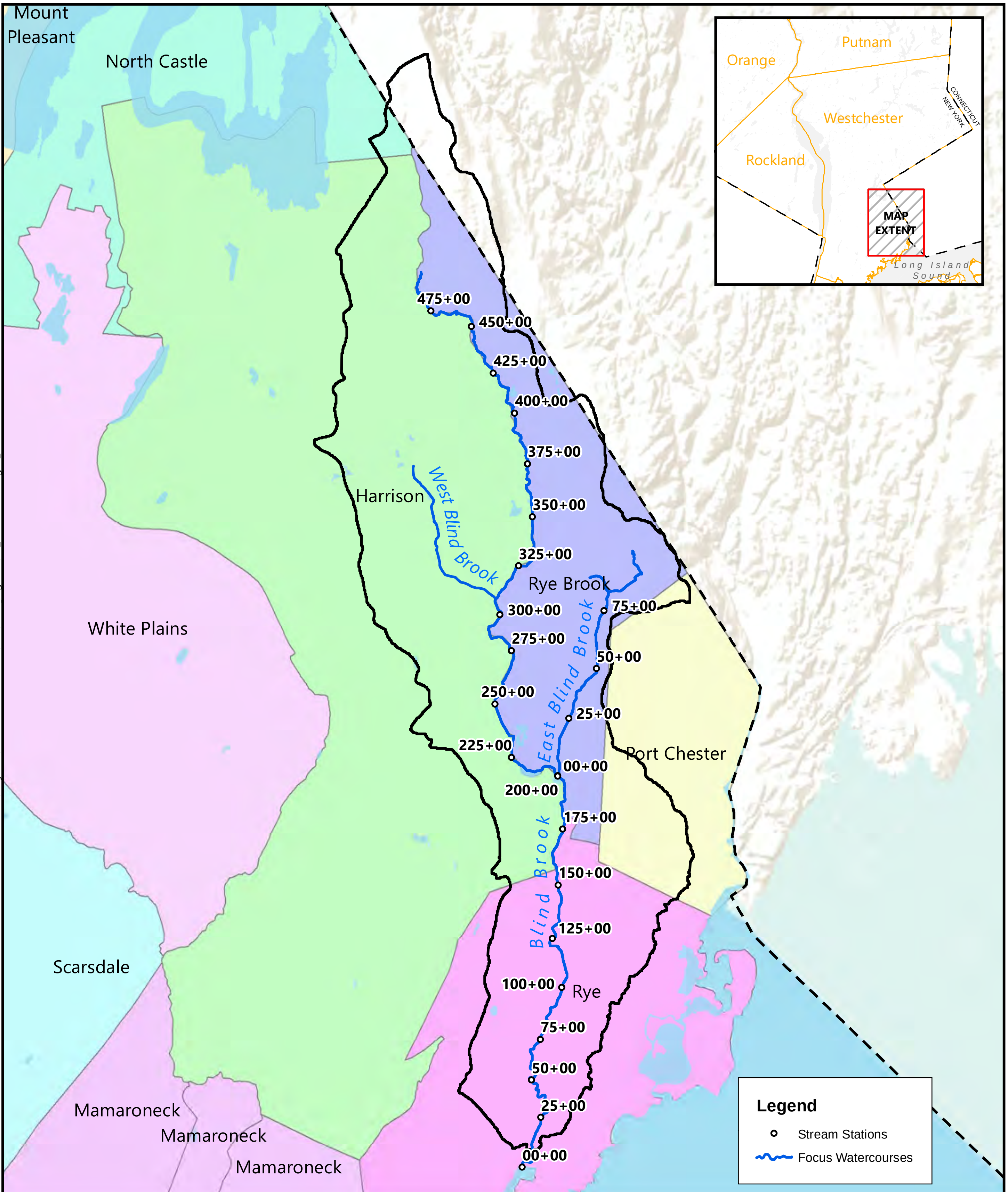

SLR

231 MAIN STREET
SUITE 102
NEW PALTZ, NY 12561
845.633.8153

BLIND BROOK WATERSHED

BLIND BROOK FLOOD & RESILIENCY STUDY
969MOD1
WESTCHESTER COUNTY, NEW YORK

N

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Feet

SCALE 1 " = 5,500 '

DATE 6/21/2022

6511.0018
PROJ. NO.

FIG. 6-1

6.3 BEST PRACTICES RECOMMENDATIONS

The following details best practices concepts and implementation options identified in several documents, including documents assessed from within Westchester County; the American Planning Association Planning Advisory Service (PAS) Report 6 of 2018 and PAS Report 3 of 2016, which summarized flood mitigation actions from across the country; the NYSDOS Model Local Laws Increase Resilience webpage; and New York City Zoning for Flood Resiliency website.

The following divides the best practice recommendations into two categories – zoning and subdivision. As noted in the PAS reports, the "…zoning code can be used to enable local elevation and mitigate its impacts through design standards and bulk regulations. Design standards can help to encourage a continuity of local character and give developers and homeowners a menu of potential options that can mitigate increased height, exposed piers and piles, and open spaces beneath the structure. The zoning and building code can be used to add additional freeboard above the FEMA Base Flood Elevation to account for sea-level rise, and retain and expand existing architectural design elements for raised structures."

These reports note that overlays can be used to protect areas without needing to adjust the underlying zoning. In effect, the Flood Damage Prevention Ordinances and regulations already in place essentially act as an overlay mapped through alternative map resources (FIRM mapping), which provides a specific geographic area within which such regulations apply.

Communities within the Blind Brook watershed have in many cases undertaken the implementation of many positive regulatory actions to help mitigate the impacts of flooding within their communities. Land use planning is an action that is always searching for answers to existing problems and concerns as well as those that are anticipated in the future. Consideration of additional potential best practices to enhance the protection of property, riparian buffers, rivers, tributaries, and other water bodies is essential to continuing the work already undertaken and maximize its impact now and into the future.

The following Zoning regulatory actions should be reviewed and assessed for potential incorporation into local laws, where applicable and feasible.

Resources utilized to develop the best practices audit matrix above included the following:

- https://dos.ny.gov/model-local-laws-increase-resilience
- https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/flood-resiliency-update/zoning-for-flood-resiliency.pdf
- https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/Zoning-Practice-2018-06.pdf
- https://planning-org-uploaded-media.s3.amazonaws.com/document/Zoning-Practice-2016-03.pdf

As a component of this flood analysis, a Flood Resiliency Best Practices Audit was conducted for each watershed community. A map with the boundaries of the Blind Brook watershed and the towns and villages that fall within it is depicted in Figure 6-1. Results of the audit are presented in the following tables:

Table 6-1: Village and Town of Harrison
Table 6-2: Town of North Castle
Table 6-3: Village of Port Chester
Table 6-4: City of Rye
Table 6-5: Village of Rye Brook

Table 6-1: Flood Resiliency Best Practices Code Audit Checklist				
Town of Harrison, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	The subdivision code includes general standards which discuss land subdivision being used safely without danger from flood.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	The code includes residential and nonresidential structure elevation standards. Standards are included that require the lowest habitable flood elevated to between 2' and 3' above BFE or highest adjacent grade in certain zones as well as requirements for drainage paths in other zones for residential structures. There are many additional design and engineering standards that also apply. Non-residential standards require elevation to or above two feet above the base flood elevation or floodproofing below two feet below the base flood level or be completely floodproofed, depending on the zone.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	

Table 6-1: Flood Resiliency Best Practices Code Audit Checklist

Town of Harrison, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. No structure in an area of special flood hazard is permitted without a floodplain development permit and compliance with the code. Encroachments have different regulations depending on their location. For encroachments, assessments and/or a technical evaluation is conducted and the Town applies to FEMA for conditional Firm and floodway revision and approval is received. For streams with a regulatory floodway, the code requires that whenever any portion of a floodplain is authorized for development, the volume of space occupied by the authorized fill or structure below the BFE shall be compensated for and balanced by a hydraulically equivalent volume of excavation taken from below the base flood elevation at or adjacent to the development site.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. New and replacement utilities must located at or above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment notes above). The code requires details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Floodplain Management code requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. Subdivision regulations require preservation, to the extent feasible, of the natural terrain and natural drainage pattern.

Table 6-1: Flood Resiliency Best Practices Code Audit Checklist

Town of Harrison, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Management regulations.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter __ for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 146

Subdivision of Land - Chapter 204

Stormwater Management and Erosion and Sediment Control - Chapter 130

Table 6-2: Flood Resiliency Best Practices Code Audit Checklist				
Town of North Castle, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	The subdivision code includes general standards which discuss land subdivision being used safely without danger from flood.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-	☑	☐	☐	The code includes residential and non-residential structure elevation standards. Standards are included that require between 2' and 3' above BFE or highest adjacent grade in certain zones as well as requirements for drainage paths in other zones for residential structures.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements are prohibited without a valid floodplain development permit. For encroachments, assessments and/or a technical evaluation is conducted and the Town applies to FEMA for

Table 6-2: Flood Resiliency Best Practices Code Audit Checklist				
Town of North Castle, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	conditional FIRM and floodway revision and approval is received.
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be to or above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment note above). The code requires details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property. For the purposes of subdivisions or development proposals, no more than 25% of the minimum lot area required may be satisfied by land which is under water or defined as a wetland.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☑	☐	☐	The Town has Conservation Subdivision regulations.
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. The Subdivision code requires the Planning Board to review subdivision proposals and new developments to ensure all are elevated and constructed to minimize or eliminate flood damage and that adequate drainage is provided so as to reduce exposure to flood hazards. The Planning Board shall also review water supply and sewage systems to minimize or eliminate flood damage and provide adequate drainage. The code states that no more than 25% of the minimum lot area required may be satisfied by land which is under water or defined as a wetland. When no based flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots in Zone A.

Table 6-2: Flood Resiliency Best Practices Code Audit Checklist				
Town of North Castle, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Management regulations.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter __ for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 177

Subdivision of Land - Chapter 275

Stormwater Management - Chapter 267

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist *Village of Port Chester, NY Preliminary Audit*	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	The subdivision code includes general standards which discuss land subdivision being used safely without danger from flood.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	The code includes residential structure elevation standards. Standards are included that require between 2' and 3' above BFE or highest adjacent grade in certain zones outside the coastal high-hazard areas, as well as requirements for drainage paths in other zones for residential structures. Within coastal high-hazard areas, new construction and substantial improvements shall be elevated on pilings, columns or shear walls such that the lowest horizontal structural member supporting the lowest elevated floor is elevated to or above two feet above base flood level so as to not impede the flow of water. There are many additional design and engineering standards that also apply. Non-residential standards for areas outside the coastal high-hazard areas, require elevation to or above two feet above the base flood elevation and floodproofing below two feet below the base flood level or be completely floodproofed, with adequate drainage paths and other requirements to be met. Nonresidential structures in coastal high hazard areas require the bottom of the lowest member of the lowest floor to be elevated to or above the base flood elevation. Floodproofing of structures is specifically listed as not being an allowable alternative to elevating the lowest floor in certain zones.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist

Village of Port Chester, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☐	☐	☐	
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	✓	☐	☐	This exists in a way in the code. Within special flood hazard areas, construction or improvements can not be undertaken without full compliance with the Flood Damage Prevention Chapter. For encroachments, assessments and/or a technical evaluation is conducted and the Village applies to FEMA for conditional FIRM and floodway revision and approval is received.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	✓	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	✓	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	✓	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. Utilities must be to or above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	✓	☐	☐	Coastal high-hazard areas are required to place all new construction and manufactured homes on site 180 days or longer, landward of the reach of high tide. Code prohibits development encroachment if it increases base flood by >1 foot (see encroachment note above). The code requires details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	

Table 6-3: Flood Resiliency Best Practices Code Audit Checklist				
Village of Port Chester, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Flood Damage Prevention Ordinance requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. When no base flood elevation data are available from other sources, the permit applicant for a subdivision or other development shall provide the data for projects greater than 5 acres or 50 lots in Zone A.
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Management regulations
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter __ for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 181

Subdivision of Land - Chapter A402

Stormwater Management - Chapter 281

Watercourse Protection - Section 199-13

City of Rye, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	The subdivision code includes general standards which discuss land subdivision being used safely without danger from flood.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3’ of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18” of freeboard in the “shaded X” area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24”. This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	The code includes residential structure elevation between 2' and 3' above BFE or highest adjacent grade in certain zones outside the coastal high-hazard areas, as well as requirements for drainage paths in other zones for residential structures. Within coastal high-hazard areas, new construction and substantial improvements shall be elevated on pilings, columns or shear walls such that the lowest horizontal structural member supporting the lowest elevated floor is elevated at least two feet above base flood level so as to not impede the flow of water. There are many additional design and engineering standards that also apply. Non-residential standards for areas outside the coastal high-hazard areas, require elevation to or above two feet above the base flood elevation or floodproofing so that the structure is watertight below two feet above the base flood level with adequate drainage paths and other requirements to be met. Nonresidential structures in coastal high hazard areas require the bottom of the lowest member of the lowest floor to be elevated to or above the base flood elevation. Floodproofing of structures is specifically listed as not being an allowable alternative to elevating the lowest floor in certain zones.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	

Table 6-4: Flood Resiliency Best Practices Code Audit Checklist

City of Rye, NY Preliminary Audit	*In Existing Code*	*Consider for Implementation*	*N/A*	*Notes*
Zoning Code Ordinance Best Practices				
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	This exists in a way in the code which states that no land, building or structures in an area of special flood hazard shall be developed, altered, extended, converted or enlarged within the area of special flood hazard except when in compliance with Chapter 100 of the Code - Floodplain Management. No structure in an area of special flood hazard is permitted without a floodplain development permit and compliance with the code. Encroachments have different regulations depending on their location.
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. New and replacement utilities must located at or above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Coastal high-hazard areas are required to place all new construction and manufactured homes on site 180 days or longer, landward of the reach of high tide. Development encroachment is prohibited except in specific cases detailed in the code. The code requires details of any watercourse alteration or relocation. There are permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property. Within certain zones, residential structures, except those in coastal high-hazard areas, have elevation standards for the lowest floor between 2' and 3' above the base flood elevation or highest adjacent grade. Residential structures in coastal high-hazard areas have standards that require elevations on pilings, columns, or shear walls along with other regulations for construction in such areas. Nonresidential structures, except those outside coastal high-hazard areas, have standards requiring the lowest floor to be elevated to or above two feet above the base flood elevation or be floodproofed so that the structure is watertight below two feet above the base flood level with walls substantially impermeable to the passage of water.Nonresidential structures in coastal high-hazard areas shall have the structure and utility and sanitary facilities with the lowest member of the lowest floor elevated to or above the base flood elevation. Floodproofing of structures is not an allowable alternative to elevating the lowest floor.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	

Table 6-4: Flood Resiliency Best Practices Code Audit Checklist				
City of Rye, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.				
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.				
Prohibit subdivisions in floodprone areas.	✓			The Zoning code requires owners of lots with 10 acres or more land located in the R-1 and R-2 Single-Family Residential Zoning Districts where there is 25% or the acreage in wetland and/or in an area of special flood hazard, to develop such lots for residential use without locating buildings in the area of special flood hazard nor in any other way increase flooding elsewhere in the City of Rye. There are several procedures and standards to implement this regulation found within the code. In a subdivision approved by the Planning Commission and in developments within the RFWP District and approved by the Planning Commission, fill may be placed for the purpose of construction of roads and utility systems provided that they are above the base flood elevation and will not result in ponding of water nor significantly affect the runoff of surface water. The Floodplain Management code requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage. The Wetlands and Watercourses code details regulated activities and uses by right.
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:				
Stream stabilization - A few dozen feet to a few hundred feet.				
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)				
Flood attenuation – A few dozen to several hundred feet				
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.				
Protection of cold water fisheries – A few dozen feet to a few hundred feet				
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	✓			The Zoning code requires owners of lots with 10 acres or more land located in the R-1 and R-2 Single-Family Residential Zoning Districts where there is 25% or the acreage in wetland and/or in an area of special flood hazard, to develop such lots for residential use without locating buildings in the area of special flood hazard nor in any other way increase flooding elsewhere in the City of Rye.
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.				
Require restoration of impaired riparian zones as a condition of subdivision approval.				
Restrict potentially problematic uses (Hazardous materials uses, for example)				
Dedicate land for public facilities and services.				
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.				

Table 6-4: Flood Resiliency Best Practices Code Audit Checklist				
City of Rye, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Management regulations.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter __ for source information.

Code Sections Reviewed:

Floodplain Management - Chapter 100

Subdivision of Land - Chapter 170

Stormwater Management - Chapter 174

Floodplain Related General Zoning Sections - 197-5.1, 197-6.1

Residential Floodplain and Wetland Preservation District - 197-13.1

Wetlands and Watercourses - Chapter 195

Table 6-5: Flood Resiliency Best Practices Code Audit Checklist				
Village of Rye Brook, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Elevation Design & Screening				
Require design interventions to screen and mitigate elevation impacts on the streetscape for elevated buildings.	☐	☐	☐	
Use hedges and fencing to separate private and public realms. Screen on-site parking located beneath a structure with foundation plantings and vegetative screening. Screen piers and columns that have been used to raise structures.	☐	☐	☐	
Building entries must face the street on which the building fronts, and walkways should provide direct access from the sidewalk to the front door.	☐	☐	☐	
Building fronts, entry porches and similar features must use materials, colors and proportions appropriate for the local architectural context. Large and multi-family building should use treatments similar to ensure local architectural consistency.	☐	☐	☐	
Guidelines for specific design elements such as canopies, galleries, and local significant materials, colors and design strategies to mitigate height and size perceptions are encouraged.	☑	☐	☐	The subdivision code includes general standards which discuss land subdivision being used safely without danger from flood.
Bulk & Area Requirements				
Ensure that uses below the building Base Flood Elevation are restricted to access, parking and storage.	☑	☐	☐	The code restricts the lowest floor in certain zones to parking, access or storage and to automatically equalize hydrostatic flood forces.
Permit relief from height limits where possible for developers and property owners who wish to go above the Design Flood Elevation.	☐	☐	☐	
Enact new height limits where possible that are based on the new local design flood elevation (one to two feet over the BFE) where side and rear yard relief is possible.	☐	☐	☐	
Given the increased height of buildings due to elevation, turrets, towers and cupolas, ensure total building height does not exceed maximum height(s) desired, but also ensure that maximum building height requirements allow for building elevations without the need for a variance.	☐	☐	☐	
Require an additional 3' of freeboard above the base flood elevation for buildings within the Special Flood Hazard Area and 18" of freeboard in the "shaded X" area, which includes buildings between the 100-year and 500-year floodplains. All new single family detached dwellings outside of defined flood hazard areas need to be elevated 16-24". This approach acknowledges the likelihood of more extreme flooding inside of and more extensive flooding outside of the FEMA-defined flood hazard area (based on historic flooding and not sea-level rise).	☑	☐	☐	The code includes residential and nonresidential structure elevation standards. Standards are included that require the lowest habitable flood elevated to between 2' and 3' above BFE or highest adjacent grade in certain zones as well as requirements for drainage paths in other zones for residential structures. There are many additional design and engineering standards that also apply. Non-residential standards require elevation to or above two feet above the base flood elevation or floodproofing below two feet below the base flood level or be completely floodproofed, depending on the zone.
Permit reduced side or rear yards relative to overall height to allow squatter and more proportional buildings.	☐	☐	☐	
Require riparian and/or floodplain buffers - See also Subdivision Regulations.	☐	☐	☐	
Utilize net density calculations that exclude wetland and floodplain areas in a developable area.	☐	☐	☐	
Establish a maximum percentage of impermeable surface coverage on a lot which limits the density of development and addressing stormwater runoff.	☐	☐	☐	
Other Code Revisions				
Coastal Resilience Overlays could be applied to areas with the highest flood risk. These areas require higher elevations of the first floor, limit parking and hard pavement, and require additional landscaping and open space.	☑	☐	☐	This exists in a way in the code. No structure in an area of special flood hazard is permitted without a floodplain development permit and

Table 6-5: Flood Resiliency Best Practices Code Audit Checklist				
Village of Rye Brook, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Upland Resilience Overlays could be applied to lower-risk areas capable of accommodating growth. New construction within an Upland Resilience Overlay is also permitted to reduce its own resilience requirements in exchange for placing conservation easements on higher-risk properties.	☑	☐	☐	compliance with the code. Encroachments have different regulations depending on their location. Within special flood hazard areas, construction or improvements can not be undertaken without full compliance with the Flood Damage Prevention Chapter. For encroachments, assessments and/or a technical evaluation is conducted and the Village applies to FEMA for conditional FIRM and floodway revision and approval is received. For streams with a regulatory floodway, the code requires that whenever any portion of a floodplain is authorized for development, the volume of space occupied by the authorized fill or structure below the BFE shall be compensated for and balanced by a hydraulically equivalent volume of excavation taken from below the base flood elevation at or adjacent to the development site.
Neighborhood Resilience Overlays could be applied to lower-risk areas, and are intended for more typical cases. They allow for customized design standards that are appropriate to the local context.	☑	☐	☐	
Permit property owners to reallocate lost floor area from the ground floor and sub-grade spaces to elsewhere in the structure.	☐	☐	☐	
Ensure that well heads are above the BFE.	☑	☐	☐	The Code requires water supply systems to minimize or eliminate infiltration of floodwaters into the system.
Add flood resistant construction (flood-proofing) standards such as ensuring buildings are watertight, utilities and sanitary facilities are above the BFE, enclosed within the building's watertight walls, or made watertight and resistance. Standards should also ensure that the building's structural components are also flood resistant.	☑	☐	☐	The Code requires anchoring of new structures and substantial improvements as well as the use of materials, utility equipment, and methods and practices that are resistant to flood damage and that minimize flood damage. New and replacement utilities must located at or above BFE. Water supply systems must minimize or eliminate infiltration of floodwaters. On-site waste disposal systems must be located to avoid impairment to them, or contamination from them, during flood events.
Prohibit new development unless effect on flooding is minimal or zero.	☑	☐	☐	Code prohibits development encroachment if increases base flood by >1 foot (see encroachment notes above). The code requires details of any watercourse alteration or relocation. There are detailed permit application requirements including a technical analysis to determine whether or not proposed development will result in physical damage to any other property. For the purposes of subdivisions or development proposals, no more than 25% of the minimum lot area required may be satisfied by land which is under water or defined as a wetland.
Prohibit substantial improvements to nonconforming uses or structures in flood prone areas.	☐	☐	☐	
Consider acquisition of flood-prone lands, particularly where they include vital riparian areas and/or could provide a public benefit such as a park or passive open space.	☐	☐	☐	
Subdivision Ordinance Best Practices				
Subdivision Ordinance				
Conservation subdivision (cluster development) to encourage development be built in suitable areas of development that protects important natural features.	☐	☐	☐	

Table 6-5: Flood Resiliency Best Practices Code Audit Checklist				
Village of Rye Brook, NY Preliminary Audit	***In Existing Code***	***Consider for Implementation***	***N/A***	***Notes***
Zoning Code Ordinance Best Practices				
Prohibit subdivisions in floodprone areas.	☑	☐	☐	The Floodplain Management code requires subdivisions to be consistent with the need to minimize flood damage, utilities and facilities must be located and constructed to minimize flood damage, and adequate drainage needs to be provided to reduce exposure to flood damage.
Require and maximize the width of riparian buffers. Provide riparian buffer requirements for the following:	☐	☐	☐	
Stream stabilization - A few dozen feet to a few hundred feet.	☐	☐	☐	
Water quality protection – A few dozen to a few hundred feet (a longer distance if sediment removal is desired)	☐	☐	☐	
Flood attenuation – A few dozen to several hundred feet	☐	☐	☐	
Riparian & wildlife habitat – A few dozen feet up to a mile, though the average minimum is approximately 100' to several hundred or a few thousand feet.	☐	☐	☐	
Protection of cold water fisheries – A few dozen feet to a few hundred feet	☐	☐	☐	
Prohibit development immediately adjacent to streams, rivers, lakes, wetlands and other water bodies.	☐	☐	☐	
Inventory riparian areas as part of the subdivision process and preserve unimpaired riparian areas in natural conditions.	☐	☐	☐	
Require restoration of impaired riparian zones as a condition of subdivision approval.	☐	☐	☐	
Restrict potentially problematic uses (Hazardous materials uses, for example)	☐	☐	☐	
Dedicate land for public facilities and services.	☐	☐	☐	
Require adequate access where evacuation may be necessary or where emergency vehicle access may be required.	☐	☐	☐	
Ensure utilities such as electric, natural gas, water and wastewater are hardened. Require electrical components to be mounted above flood levels. Major utility equipment should be considered a critical facility and be required to be located outside of the 500 year floodplain.	☐	☐	☐	
Consider the long-term needs of the community when discussing the potential for a homeowner's association to operate and/or maintain an area prone to flooding.	☐	☐	☐	
Require flood hazard information to be provided on a subdivision plat. Require the 100-year floodplain elevation to be shown on all subdivision plats. Information such as finished building pad elevation or proposed lowest finished floor elevation can also be detailed.	☐	☐	☐	
Any property with a floodplain should be required to show such information on the plan.	☐	☐	☐	
Require conservation easements around flood-prone areas or floodplains.	☐	☐	☐	
Require green infrastructure or low-impact development techniques, where feasible	☑	☐	☐	The code includes Stormwater Management regulations.
Each proposed lot must have a designated buildable site above the special flood hazard area (SFHA) as shown on the most current Flood Insurance Rate Map.	☐	☐	☐	

See Chapter __ for source information.

Code Sections Reviewed:

Flood Damage Prevention - Chapter 130

Subdivision of Land - Chapter 219

Stormwater Management - Chapter 217

Wetlands and Watercourses - Chapter 245

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