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RESILIENT NEW YORK FLOOD MITIGATION INITIATIVE

HONEOYE CREEK, MONROE, LIVINGSTON, & ONTARIO COUNTIES, NEW YORK

Prepared for:

Project Team:

RESILIENT NEW YORK FLOOD MITIGATION INITIATIVE

HONEOYE CREEK, MONROE, LIVINGSTON, & ONTARIO COUNTIES, NEW YORK

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IN NOVEMBER 2018, NEW YORK STATE GOVERNOR ANDREW CUOMO COMMITTED FUNDING TO UNDERTAKE ADVANCED MODELING TECHNIQUES AND FIELD ASSESSMENTS OF 48 FLOOD PRONE STREAMS TO IDENTIFY PRIORITY PROJECTS AND ACTIONS TO REDUCE COMMUNITY FLOOD AND ICE JAM RISKS, WHILE IMPROVING HABITAT. THE OVERALL GOAL OF THE PROGRAM IS TO MAKE NEW YORK STATE MORE RESILIENT TO FUTURE FLOODING.

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ACRONYMS/ABBREVIATIONS

1-D	1-Dimensional
2-D	2-Dimensional
ACE	Annual Chance Flood Event
BCA	Benefit-Cost Analysis
BCC	Bird of Conservation Concern
BCR	Bird Conservation Region
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BRIC	Building Resilient Infrastructure and Communities
CAP	Continuing Authorities Program
CDBG	Community Development Block Grants
CFA	Consolidated Funding Applications
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second (ft3/s)
CON	Continental USA and Alaska
CRISSP	Comprehensive River Ice Simulation System
CRRA	Community Risk and Resiliency Act
CRREL	Cold Regions Research and Engineering Laboratory
CRS	Community Rating System
CSC	Climate Smart Communities
DEM	Digital Elevation Model
DHS	United States Department of Homeland Security
DRRA	Disaster Recovery Reform Act of 2018
EWP	Emergency Watershed Protection
EPA	United States Environmental Protection Agency
FCA	Flood Control Act 1948
FCSA	Feasibility Cost Sharing Agreement
FDD	Freezing Degree Day
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
GLS	Generalized Least-Squares
H&H	Hydrologic and Hydraulic
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HSGP	Homeland Security Grant Program
HUD	United States Department of Housing & Urban Development
IPaC	Information for Planning and Consultation
IPCC	Intergovernmental Panel on Climate Change
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
LP3	Log-Pearson III
MSC	Map Service Center
NAVD88	North American Vertical Datum of 1988

NCEI	National Centers for Environmental Information
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Services
NWI	National Wetlands Inventory
NYCRR	New York Codes, Rules, and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservations
NYSDHSES	New York State Division of Homeland Security and Emergency Services
NYSDOT	New York State Department of Transportation
NYSOEM	New York State Office of Emergency Management
NYSOGS	New York State Office of General Services
NYSOPRHP	New York State Office of Parks, Recreation, and Historic Places
OCSWCD	Ontario County Soil and Water Conservation District
PDM	Pre-Disaster Mitigation
QA/QC	Quality Assurance/Quality Control
RAMBOLL	Ramboll America's Engineering Solutions, Inc.
RC	Circularity Ratio
RCP	Representative Concentration Pathway
RE	Elongation Ratio
REHAB	Watershed Rehabilitation
RF	Form Factor
RICEN	River Ice Simulation Model
RL	Repetitive Loss
ROM	Rough Order of Magnitude
SFHA	Special Flood Hazard Areas
SRL	Severe Repetitive Loss
STORM	Safeguarding Tomorrow through Ongoing Risk Mitigation
TK&T	Tompkinson, Kenyon & Tompkinson Dam
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Service
VERTCON	Vertical Datum Coordinate Conversion Program
WFPO	Watershed Protection and Flood Prevention Operations
WQIP	Water Quality Improvement Project
WRI	Water Resources Investigations
WSEL	Water Surface Elevations

1. INTRODUCTION

1.1 HISTORICAL INITIATIVES

Flood mitigation has historically been an initiative in central New York and in the Honeoye Creek watershed.

The Village of Honeoye Falls, following a hurricane in 1972, undertook a limited program of improvements along Honeoye Creek, including stone-fill for bank protection at isolated locations and the construction of two check dams. A dike providing flood protection for the village's sewage treatment plant, situated north of the commercial center was constructed in 1976 and provides protection to the sewage treatment plant for a 500-year flood. Other than the dyke, no other extensive flood protection measures have been employed along Honeoye Creek in the Village (FIA 1977b).

In the Town of Richmond, improvements to the bridges, culverts, and stream channel of Mill Creek were made in conjunction with the reconstruction of State Route 20A in the late 1950s (FEMA 1984b). In recent years, the Ontario County Soil and Water Conservation District (OCSWCD) has completed multiple flood mitigation and emergency authorization projects along Honeoye and Mill Creeks in the Town of Richmond. In 1999, a weir was installed in the Honeoye Lagoon where Honeoye Lake outlets into Honeoye Creek (NYSDEC 2021a).

In 2017, the OCSWCD and Town of Richmond collaborated to install culverts for flood mitigation along Honeoye Creek north of the Wastewater Treatment Plant, which is downstream of the Main Street/US-20A bridge crossing. Two sets of two 48-inch steel culverts were installed along Honeoye Creek: one set of culverts under an access road adjacent to the wastewater treatment plant that provides overflow relief for Honeoye Creek into nearby wetlands, and a second set of culverts to replace ford crossing and the confluence of Honeoye Creek and an unnamed tributary. The project was approved and completed in July of 2017 (NYSDEC 2021a).

In 2018, the OCSWCD, Town of Richmond, and United States Fish and Wildlife Service (USFWS) submitted a joint application for the Mill Creek Stream Stabilization Project located downstream of the East Lake Road bridge crossing. The project consisted of cross-vanes, toewood, and rock clusters at key meanders and erosional areas along an approximately 2,500-ft-long stretch of Mill Creek downstream East Lake Road. The project was approved and completed in June of 2019 (NYSDEC 2021a).

In 2019, the OCSWCD and Town of Richmond submitted a joint application for a Honeoye Lake Shoreline Stabilization Project at the north end of the lake near the outlet into Honeoye Creek. The project consisted of installing large rock keys, soil lifts, and native plantings in order to stabilize and protect the existing shoreline. The project was approved and completed in October of 2019 (NYSDEC 2021a).

In 2020, the NYSDEC issued an emergency authorization to restore an approximately 90-foot stretch of the Honeoye Outlet near Sandy Bottom Park by removing gravel bars. The project was approved and completed in September of 2020 (NYSDEC 2021a).

There are no special flood protection measures in the Towns of Rush, Mendon, West Bloomfield, and Richmond for Honeoye Creek. Honeoye Lake offers a natural storage area for flood water, but it is not effective for the Towns of Rush and Mendon as it is too far upstream (FIA 1977a; FIA 1977b; FEMA 1981a; FEMA 1981b; FEMA 1984b; FEMA 2008b).

1.2 FLOODPLAIN DEVELOPMENT

General recommendations for high-risk floodplain development follow three basic strategies:

1. Remove the flood-prone facilities from the floodplain
2. Adapt the facilities to be flood resilient under repetitive inundation scenarios
3. Develop nature-based mitigation measures (e.g., floodplain benches, constructed wetlands, etc.) to lower flood stages in effected areas
4. Up-size bridges and culverts to be more resilient to ice jams, high flow events, and projected future flood flows due to climate change in effected areas

In order to effectively mitigate flooding along substantial lengths of a watercourse corridor, floodplain management should restrict the encroachment on natural floodplain areas. Floodplains act to convey floodwaters downstream, mitigate damaging velocities, and provide areas for sediment to accumulate safely. The reduction in floodplain width of one reach of a stream often leads to the increase in flooding upstream or downstream. During a flood event, a finite amount of water with an unchanging volume must be conveyed and, as certain conveyance areas are encroached upon, floodwaters will often expand into other sensitive areas.

A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements within this watershed. Local floodplain regulations should be consistent with the National Flood Insurance Program (NFIP) and Federal Emergency Management Agency (FEMA) regulations since all of the municipalities along Honeoye Creek in Ontario, Livingston and Monroe Counties are participating communities in the NFIP and should involve a floodplain coordinator and a site plan review process for all proposed developments. This review should be in accordance with local regulations and the NFIP requirements, which require the community to determine if any future proposed development could adversely impact the floodplain or floodway resulting in higher flood stages and sequentially greater economic losses to the community. The communities and their NFIP community ID's along Honeoye Creek are as follows:

- Town of Richmond (Ontario County): Community ID #360364
- Town of West Bloomfield (Ontario County): Community ID #360367
- Town of Lima (Livingston County): Community ID #361286
- Village of Honeoye Falls (Monroe County): Community ID #360421
- Town of Mendon (Monroe County): Community ID #360423
- Town of Rush (Monroe County): Community ID #360432

1.3 RESILIENT NY INITIATIVE

In November of 2018, the New York State (NYS) Governor's office announced the Resilient NY program in response to devastating flooding in communities across the state in the preceding years. A total of 48 high-priority flood prone watersheds across NYS are being addressed through the Resilient NY program. Flood mitigation studies were commissioned using advanced modeling techniques and field assessments to identify priority projects in these 48 flood-prone watersheds, develop state-of-the-art studies to reduce flooding and ice jams, and to improve ecological habitats in the watersheds (NYSGPO 2018). The Honeoye Creek watershed was chosen as a study site for this initiative.

The NYS Department of Environmental Conservation (NYSDEC) is responsible for implementing the Resilient NY program with contractual assistance from the New York State Office of General Services (NYSOGS). High-priority watersheds were selected based on several factors, such as frequency and severity of flooding and ice jams, extent of previous flood damage, and susceptibility to future flooding and ice-jam formations (NYSGPO 2018).

The Resilient NY flood studies will identify the causes of flooding within each watershed and develop effective and ecologically sustainable flood and ice-jam hazard mitigation projects. Proposed flood mitigation measures will be identified and evaluated using hydrologic and hydraulic (H&H) modeling to quantitatively determine flood mitigation strategies that would result in the greatest flood reduction benefits. In addition, the flood mitigation studies incorporate the latest climate change forecasts and assess open-water and ice-jam hazards where future flood risks have been identified.

This report is not intended to address detailed design considerations for individual flood mitigation alternatives. The mitigation alternatives discussed are conceptual projects that have been initially developed and evaluated to determine their flood mitigation benefits. A more in-depth engineering design study would still be required for any mitigation alternative chosen to further define the engineering project details. However, the information contained within this study can inform such in-depth engineering design studies and be used in the application of state and federal funding and/or grant programs.

The goals of the Resilient NY Program are to:

1. Perform comprehensive flood and ice-jam studies to identify known and potential flood risks in flood-prone watersheds
2. Incorporate climate change predictions into future flood models
3. Develop and evaluate flood hazard mitigation alternatives for each flood-prone stream area, with a focus on ice-jam hazards

The overarching purpose of the initiative is to evaluate a suite of flood and ice-jam mitigation projects that local municipalities can undertake to make their community more resilient to future floods. The projects should be affordable, attainable through grant funding programs, able to be implemented either individually or in combination in phases over the course of several years, achieve measurable improvement at the completion of each phase, and fit with the community way of life. The information developed under this initiative is intended to provide the community with a basis for assessing and selecting flood mitigation strategies to pursue; no recommendations are made as to which strategies the community should pursue.

The flood mitigation and resiliency study for Honeoye Creek began in November of 2021 and a final flood study report was issued in August of 2022.

2. DATA COLLECTION

2.1 INITIAL DATA COLLECTION

Hydrological and meteorological data were obtained from readily available state and federal government databases, including ortho-imagery, flood zone maps, streamflow, precipitation, flooding, and ice jam reports. Historical flood reports, newspaper articles, social media posts, community engagement meeting notes, and geographic information system (GIS) mapping were used to identify stakeholder concerns, produce watershed maps, and identify current high-risk areas. *New York State Community Risk and Resiliency Act* (NYSDEC 2020) guidelines, New York State Department of Transportation (NYSDOT) bridge and culvert standards, and United States Geologic Service (USGS) *FutureFlow Explorer* v1.5 (USGS 2016), and *StreamStats* v4.6.2 (USGS 2021d) software were used to develop current and future potential discharges and bankfull widths and depths at various points along the stream channel.

Hydrologic and hydraulic (H&H) modeling was performed previously as part of the effective FEMA Flood Insurance Studies (FIS) for each municipality along Honeoye Creek, which includes:

- Town of Richmond (Ontario County): June 18, 1984
- Town of West Bloomfield (Ontario County): December 1977
- Village of Honeoye Falls (Monroe County): September 1977
- Town of Mendon (Monroe County): October 15, 1981
- Town of Rush (Monroe County): November 17, 1981

FEMA released the following updated effective FIS for Monroe County, which included the Village of Honeoye and the Towns of Mendon and Rush, on August 28, 2008.

FEMA did not release an effective FIS for the Town of Lima in Livingston County, so the details of the H&H modeling performed are unavailable.

Updated H&H modeling was performed in this study using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) v6.2.0 (USACE 2021) software to determine water stage at current and potential future levels for high-risk areas, and to evaluate the effectiveness of proposed flood mitigation strategies. These studies and data were obtained and used, all or in part, as part of this effort. Appendix A is a summary listing of data and reports collected.

2.2 PUBLIC OUTREACH

An initial virtual project kickoff meeting was held on December 9, 2021, with representatives of the NYSDEC, Ramboll Americas Engineering Solutions, Inc. (Ramboll), Highland Planning, USACE, NYSDOT, Village of Honeoye Falls, MRB Group, Honeoye Watershed Council, Ontario County Soil and Water Conservation District, Town of Richmond, and Ontario County Department of Public Works (Appendix B). At the project kickoff meeting, project specifics including background, purpose, funding, roles, and timelines were discussed. Discussions included a variety of topics, including:

- Firsthand accounts of past flooding events
- Identification of specific areas that flooded in each community, and the extent and severity of flood damage
- Information on post-flood efforts, such as temporary floodwalls

This outreach effort assisted in the identification of current high-risk areas to focus on during the future flood risk assessments.

2.3 FIELD ASSESSMENT

Following the initial data gathering and agency meetings, field staff from Ramboll undertook field data collection efforts with special attention given to high-risk areas in the Towns of Richmond, West Bloomfield, Lima, Mendon, Rush and the Village of Honeoye Falls as identified in the initial data collection process. Initial field assessments of Honeoye Creek were conducted in March of 2022. Information collected during field investigations included the following:

- Rapid "windshield" river corridor inspection
- Photo documentation of inspected areas
- Measurement and rapid hydraulic assessment of bridges, culverts, and dams
- Geomorphic classification and assessment, including measurement of bankfull channel widths and depths at key cross sections
- Field identification of potential flood storage areas
- Wolman pebble counts
- Characterization of key stream bank failures, head cuts, bed erosion, aggradation areas, and other unstable stream channel features
- Preliminary identification of potential flood hazard mitigation alternatives, including those requiring further analysis

Included in Appendix C is a copy of the Stream Channel Classification Form, Field Observation Form for the inspection of bridges and culverts, and Wolman Pebble Count Form, as well as a location map of where field work was completed. Appendix D is a photo log of select locations within the river corridor. The collected field data was categorized, summarized, indexed, and geographically located within a GIS database. This GIS database will be made available to the NYSDEC and NYSOGS upon completion of the project.

All references to “right bank” and “left bank” in this report refer to "river right" and "river left," meaning the orientation assumes that the reader is standing in the river looking downstream.

3. WATERSHED CHARACTERISTICS

3.1 STUDY AREA

The Honeoye Creek watershed lies within Monroe, Livingston, and Ontario Counties in western and central New York. The watershed encompasses areas between the Towns of Richmond and West Bloomfield in Ontario County, the Town of Lima in Livingston County, and the Towns of Mendon and Rush, including the Village of Honeoye Falls, in Monroe County. The creek flows in a general north-northwest direction with its headwaters in the Town of Richmond at the outlet of Honeoye Lake, and ends at the confluence with the Genesee River in the Town of Rush (Figure 3-1).

Within the Honeoye Creek watershed, two target areas were chosen for this study due to their historical and recent flooding issues, and the hydrologic conditions of the creek in these respective reaches: the confluence with Mill Creek in the Town of Richmond and the Village of Honeoye Falls. Figures 3-2 and 3-3 depicts the stream stationing along Honeoye Creek in Monroe, Livingston, and Ontario Counties, New York and in the two target areas of the Village of Honeoye Falls and confluence with Mill Creek, respectively.

The Town of Rush is located in southern Monroe County, in western New York State. The Genesee River forms the western corporate limits of Rush. The Town of Rush is bordered by the Town of Henrietta to the north, Town of Mendon to the east, Town of Wheatland to the west, and Towns of Caledonia and Avon to the south. Rush is predominately rural and agricultural with several small hamlets. The Town of Rush has a land area of 31 square miles (FEMA 1981b).

The Town of Mendon is located in the southeast corner of Monroe County in western New York State. Mendon is bordered by the Town of Lima (Livingston County) and West Bloomfield (Ontario County) to the south, the Town of Victor (Ontario County) to the east, and the Towns of Pittsford, Henrietta and Rush (Monroe County) to the north, northwest and west respectively. The Village of Honeoye Falls is located at the southwest border of Mendon. The Town of Mendon, including Honeoye Falls, has a land area of 40 square miles (FEMA 1981a).

Honeoye Falls, a village in the Town of Mendon, New York, is situated approximately 14 miles south of Rochester, New York. It is located in the northwestern part of New York State, along the southern boundary of Monroe County. It is bounded on the south by the Towns of Lima and West Bloomfield, and on all other sides by the Town of Mendon. Honeoye Falls is situated in the northeastern section of the Genesee River Basin, approximately 13 miles northwest of Honeoye Lake. The terrain of Honeoye Falls is generally level countryside with a few gently rolling hills. The flood plains abound with commercial and industrial development at the village center, residential development south of the center, and primarily farmland with some residential development north of the center (FIA 1977b).

The Town of West Bloomfield is located in northwestern New York in the northwestern corner of Ontario County. It is bounded on the north by the Town of Mendon, the east by the Town of East Bloomfield, the south by the Town of Richmond, and on the west by the Town of Lima. Honeoye Creek forms the western boundary of the Town of West Bloomfield as well as the boundary between Livingston and Ontario Counties. West Bloomfield is situated approximately 18 miles southeast of Rochester, New York. The Terrain of the Town of West Bloomfield is generally level countryside with a few gently rolling hills. Agricultural activities account for about 72% of the town’s area. Additionally, approximately 26% of the town’s area is characterized by woodlands and wetlands. The remaining 2% is primarily utilized by residential development and extractive industries (FEMA 1977a).

The Town of Richmond is located in Western New York, in the western portion of Ontario County. It is approximately 62 miles east of Buffalo and 25 miles south of Rochester. The Town is bordered on the east by the Towns of Bristol and South Bristol, the south by the Towns of Naples, Canadice, and Springwater, the west by the Towns of Canadice and Livonia, and on the north by the Towns of Lima and West Bloomfield. Development in the town consists primarily of agriculture, with residential development concentrated along the roads and surrounding Honeoye Lake. Many of the cottages along Honeoye Lake are for seasonal use only (FEMA 1984b).

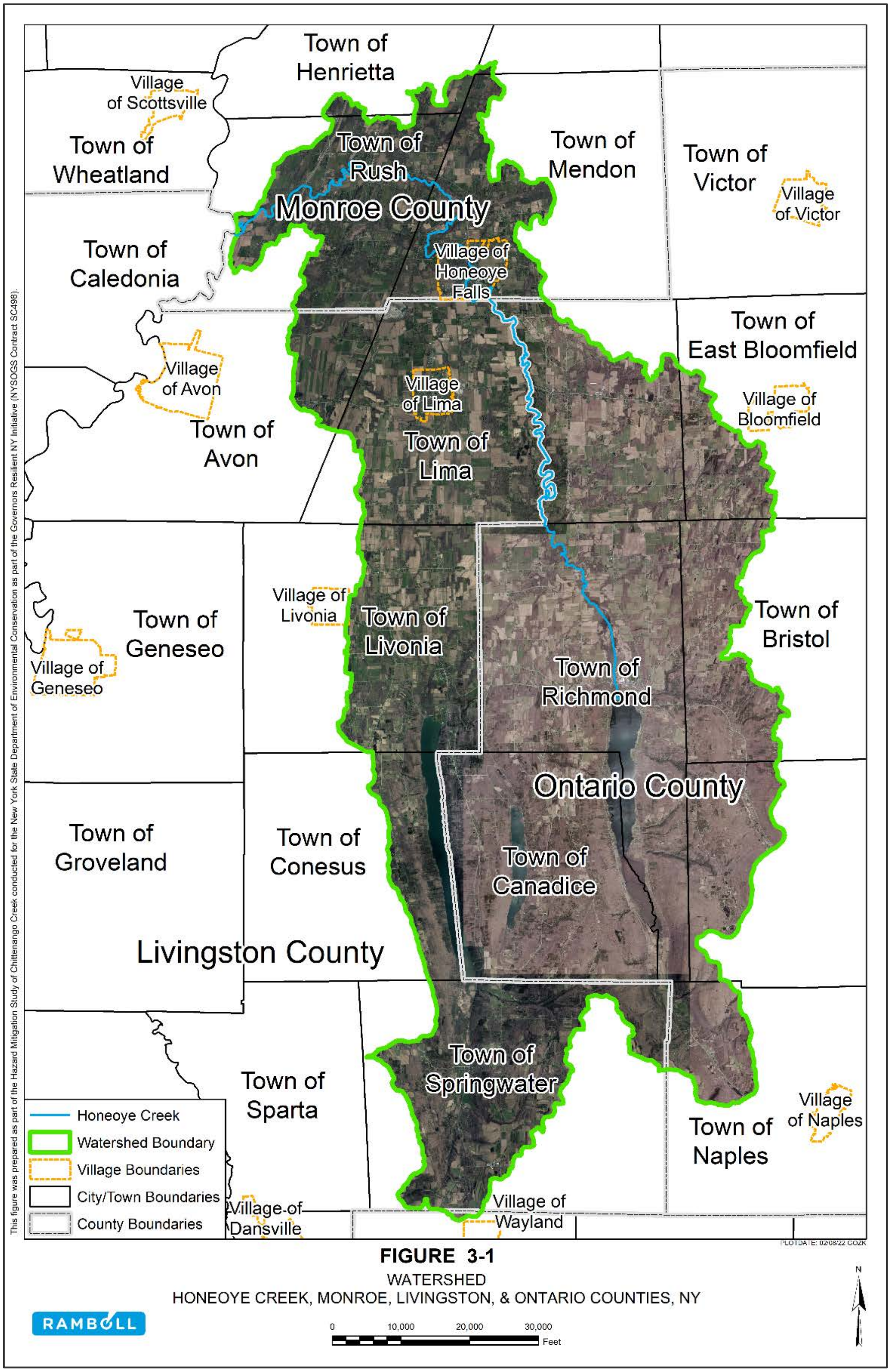


FIGURE 3-1
WATERSHED
HONEOYE CREEK, MONROE, LIVINGSTON, & ONTARIO COUNTIES, NY

Figure 3-1. Honeoye Creek Watershed, Monroe, Livingston, & Ontario Counties, NY.

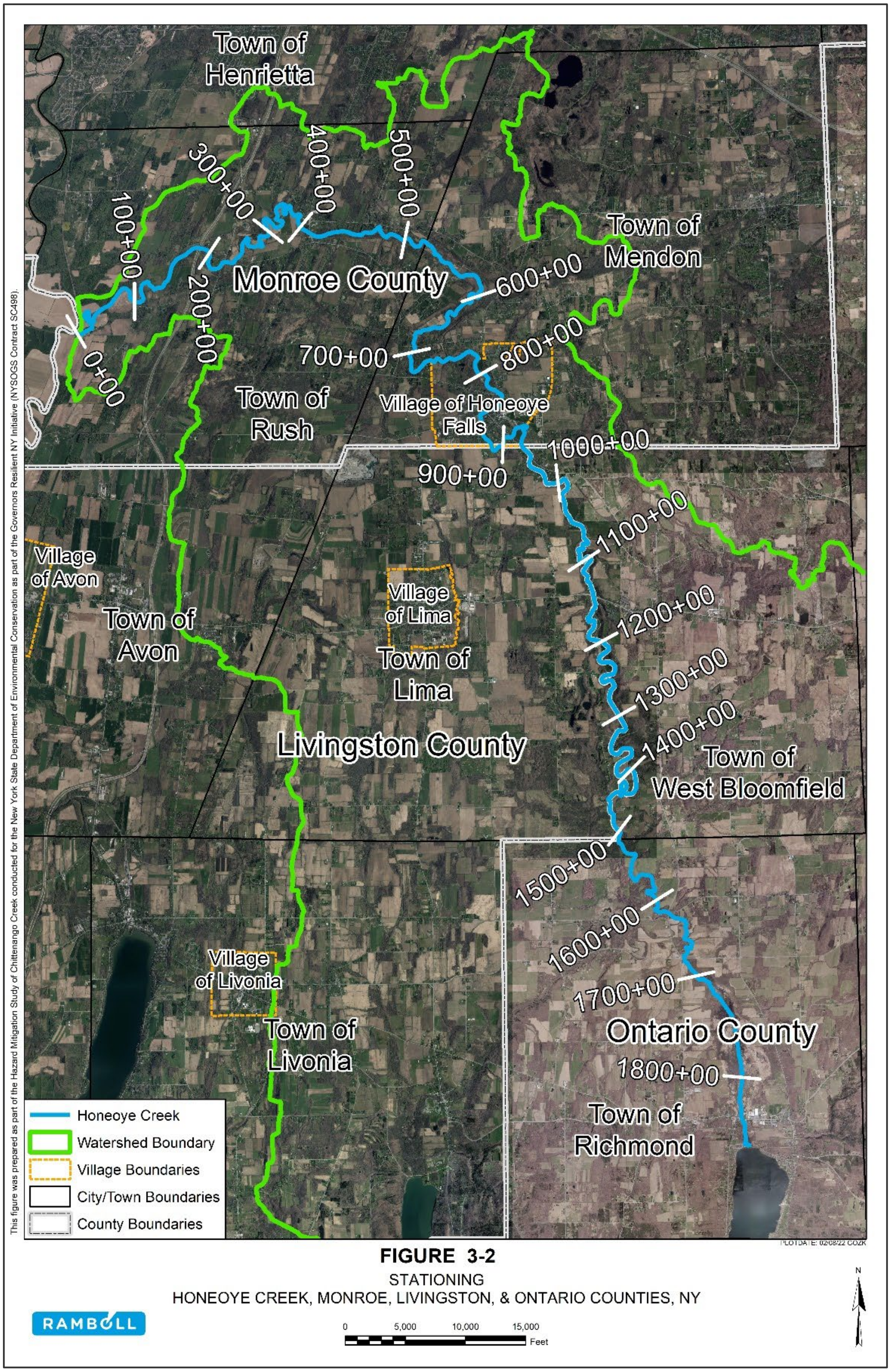


Figure 3-2. Honeoye Creek Stationing, Monroe, Livingston, & Ontario Counties, NY.

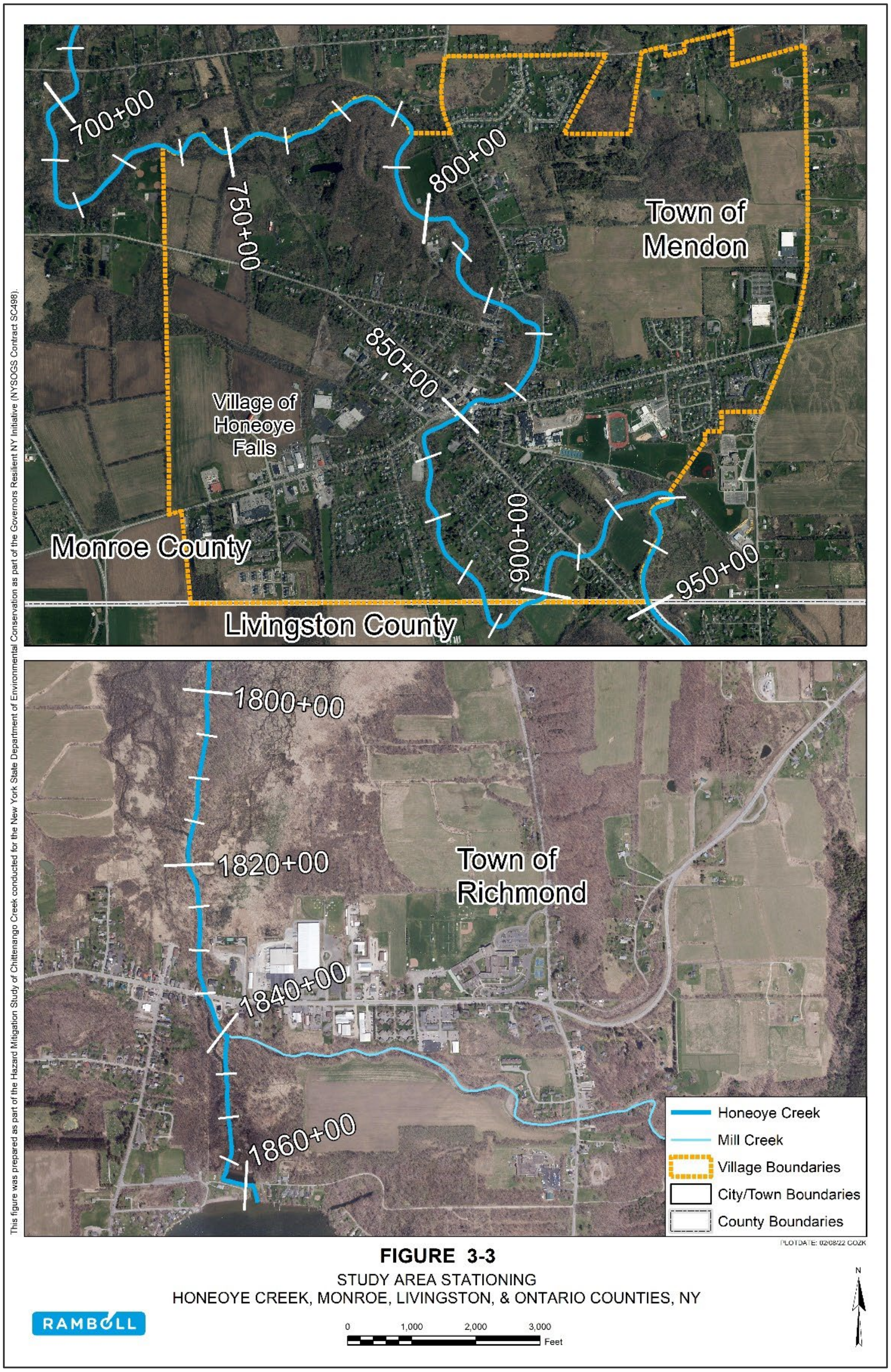


Figure 3-3. Honeoye Creek Study Area Stationing, Monroe, Livingston, & Ontario Counties, NY.

3.2 ENVIRONMENTAL CONDITIONS

An overview of the environmental and cultural resources within the Honeoye Creek watershed was compiled using the following online tools:

- **Environmental Resource Mapper** – The Environmental Resource Mapper is a tool used to identify mapped federal and state wetlands, state designated significant natural communities, and plants and animals identified as endangered or threatened by the NYSDEC (NYSDEC 2022).
- **National Wetlands Inventory (NWI)** – The NWI is a digital map database available on the Environmental Resource Mapper that provides information on the “status, extent, characteristics and functions of wetlands, riparian, and deep-water habitats” (NYSDEC 2022).
- **Information for Planning and Consultation (IPaC)** – Regulated by the United States Fish and Wildlife Service (USFWS), the IPaC database provides information about endangered/threatened species and migratory birds (USFWS 2022).
- **Register of Historic Places** – The New York State Historic Sites and Park Boundaries and National Register of Historic Places datasets list historic places worthy of preservation, as authorized by the National Historic Preservation Act of 1966 (NYSOPRHP 2018a; NYSOPRHP 2018b).

3.2.1 Wetlands

The State Regulated Freshwater Wetlands database shows the approximate location of wetlands regulated by New York State. The National Wetlands Inventory was reviewed to identify national wetlands and surface waters (Figure 3-4). The Honeoye Creek watershed includes riverine habitat, freshwater forested/shrub wetlands, freshwater ponds, and freshwater emergent wetlands (NYSDEC 2022).

Maps of NYS Regulatory Freshwater Wetlands indicate the approximate boundaries of wetlands. Field investigation is necessary to identify the actual regulated wetland boundaries in the field. The NYSDEC regulates freshwater wetlands that are 12.4 acres (5 hectares) or larger and the 100-foot adjacent area surrounding such wetlands.

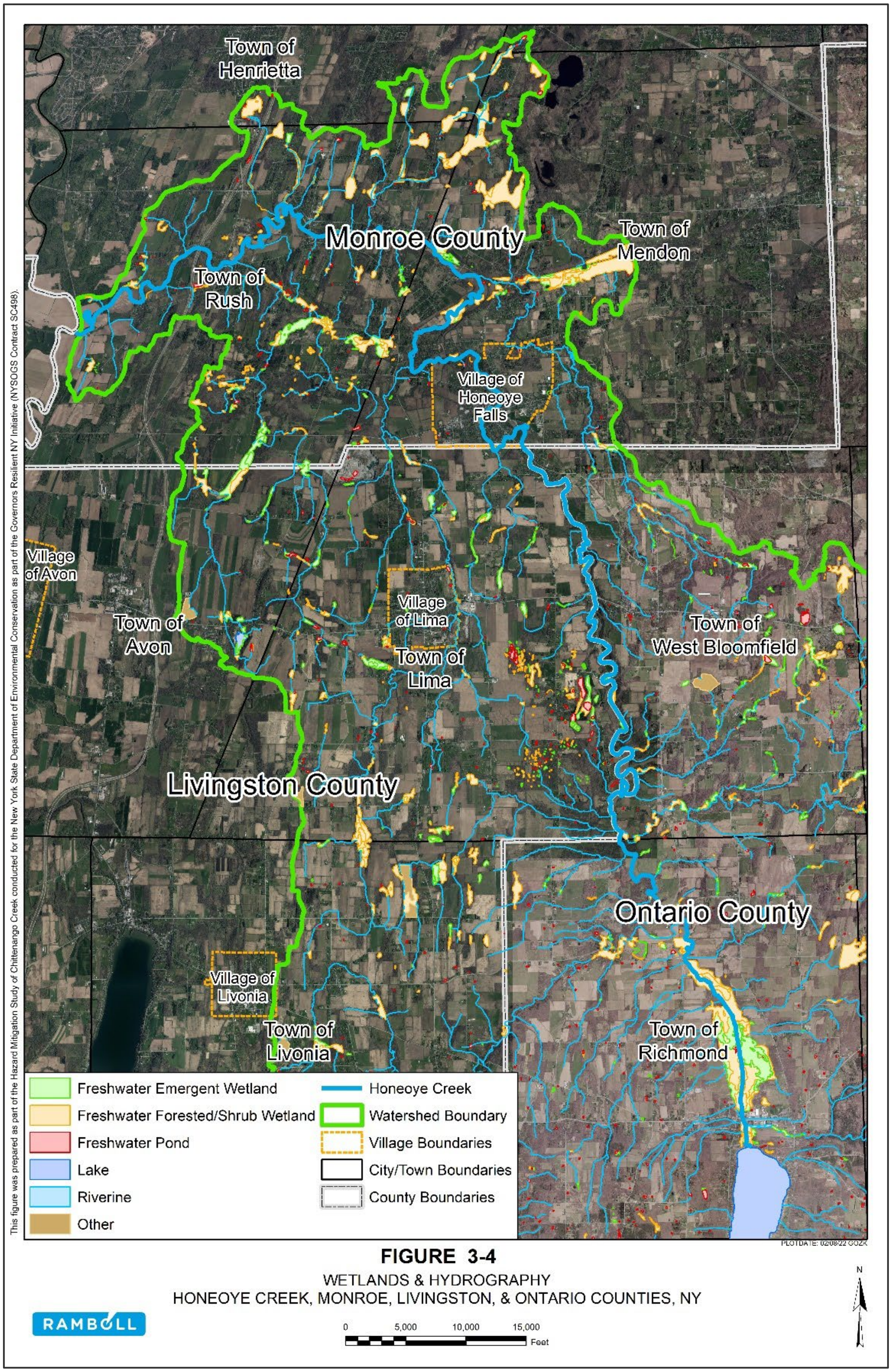


Figure 3-4. Honeoye Creek. Wetlands and Hydrography, Monroe, Livingston, & Ontario Counties, NY.

3.2.2 Sensitive Natural Resources

Areas designated as significant natural communities by the NYSDEC were mapped in the Honeoye Creek watershed. The significant natural communities identified included the following as mapped by the Environmental Resource Mapper (NYSDEC 2022) (Figure 3-5):

- Rich hemlock-hardwood peat swamp in Canadice Wayland Wetlands
- Appalachian oak-hickory forest in Bristol Hills
- Appalachian oak-hickory forest in Canadice Hill
- Appalachian oak-pine forest in Canadice Hill
- Silver maple-ash swamp in Honeoye Inlet
- Silver maple-ash swamp in Hemlock Canadice Inlet
- Silver maple-ash swamp in Canadice Outlet
- Silver maple-ash swamp in the Honeoye Creek Wetlands Richmond
- Shallow emergent marsh in Lima Ponds
- Eutrophic pond in Lima Ponds
- Red maple-tamarack peat swamp in West Bloomfield Swamp
- Limestone woodland in Works Road Woodland East
- Limestone woodland in Rush Oak Opening
- Oak openings in Rush Oak Opening
- Maple-basswood rich mesic forest in Honeoye Creek Woods
- Rich shrub fen in Quaker Pond Fen
- Rich gaminoid fen in Quaker Pond Fen

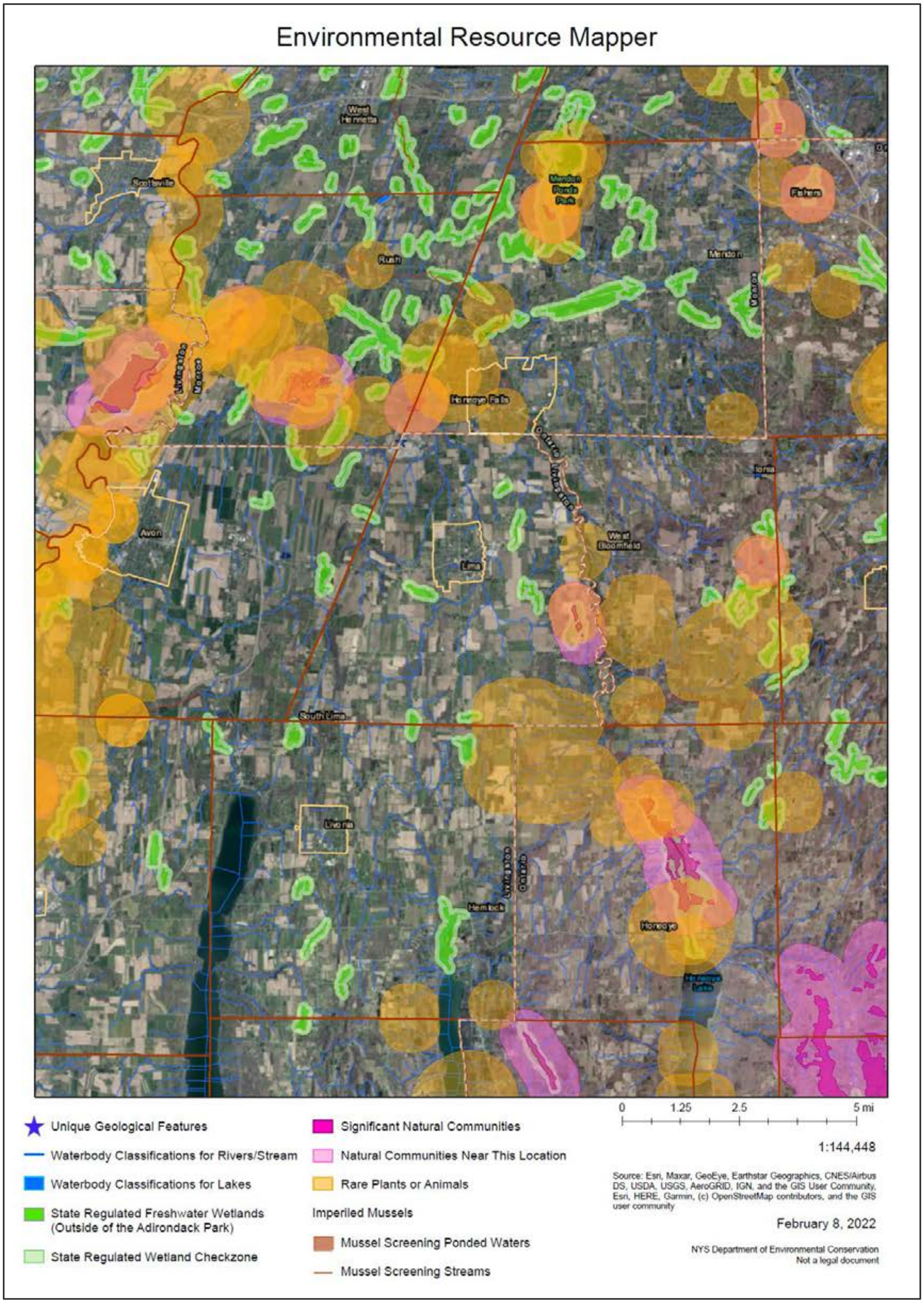


Figure 3-5. Significant Natural Communities and Rare Plants or Animals, Honeoye Creek, Monroe, Livingston, & Ontario Counties, NY.

3.2.3 Endangered or Threatened Species

The Environmental Resource Mapper shows that the watershed basin contains rare plants listed as endangered, threatened, or rare by NYS, and rare animals listed as endangered, threatened or special concern. The rare plants and animals are not specifically listed by the NYSDEC due to their sensitive nature; however, the NYSDEC does indicate rare freshwater mussels are within the Honeoye Creek watershed (NYSDEC 2022).

Opportunities to enhance habitat for some of the endangered or threatened species may exist when restoring floodplains or when constructing retention basins or constructed wetlands. Planning should include consideration of habitat requirements of these species; in particular, the NYSDEC would be concerned about the loss of large tracts of open unforested land. The NYSDEC Regional Office should be contacted to determine the potential presence of the species identified.

It should be noted, coordination with the NYSDEC will be critical to fully understand the implications of any flood mitigation alternative on any endangered species and their habitats within the Honeoye Creek watershed.

The USFWS Information for Planning and Consultation (IPaC) results for the Honeoye Creek watershed lists two endangered species: Monarch Butterfly (danaus plexippus) and the Northern Long-eared Bat (myotis septentrionalis). No critical habitat has been designated for the species at this location. The migratory bird species listed in Table 1 are transient species that may pass over, but are not known to nest within the project area (USFWS 2022).

Table 1. UFWS IPaC Listed Migratory Bird Species

Source: USFWS 2022			
Common Name	**Scientific Name**	**Level of Concern**	**Breeding Season**
American Golden-plover	*Pluvialis dominica*	BCC Rangewide (CON) [1]	Breeds elsewhere
Bald Eagle	*Haliaeetus leucocephalus*	Non-BCC Vulnerable [2]	Breeds Sep 1 to Aug 31
Black-billed Cuckoo	*Coccyzus erythropthalmus*	BCC Rangewide (CON) [1]	Breeds May 15 to Oct 10
Black-capped Chickadee	*Poecile atricapillus practicus*	BCC-BCR [3]	Breeds April 10 to Jul 31
Blue-winged Warbler	*Vermivora pinus*	BCC-BCR [3]	Breeds May 1 to Jun 30
Bobolink	*Dolichonyx oryzivorus*	BCC Rangewide (CON) [1]	Breeds May 20 to Jul 31
Canada Warbler	*Cardellina canadensis*	BCC Rangewide (CON) [1]	Breeds May 20 to Aug 10
Cerulean Warbler	*Dendroica cerulea*	BCC Rangewide (CON) [1]	Breeds Apr 20 to Jul 20

Source: USFWS 2022			
Common Name	**Scientific Name**	**Level of Concern**	**Breeding Season**
Evening Grosbeak	*Coccothraustes vespertinus*	BCC Rangewide (CON) [1]	Breeds May 15 to Aug 10
Golden Eagle	*Aquila chrysaetos*	Non-BCC Vulnerable [2]	Breeds Jan 1 to Aug 31
Golden-winged Warbler	*Vermivora chrysoptera*	BCC Rangewide (CON) [1]	Breeds May 1 to Jul 20
Lesser Yellowlegs	*Tringa flavipes*	BCC Rangewide (CON) [1]	Breeds elsewhere
Long-eared Owl	*Asio otus*	BCC Rangewide (CON) [1]	Breeds Mar 1 to Jul 15
Northern Saw-whet Owl	*Aegolius acadicus*	BCC-BCR [3]	Breeds Mar 1 to Jul 31
Prairie Warbler	*Dendroica discolor*	BCC Rangewide (CON) [1]	Breeds May 1 to Jul 31
Prothonotary Warbler	*Protonotaria citrea*	BCC Rangewide (CON) [1]	Breeds Apr 1 to Jul 31
Red-headed Woodpecker	*Melanerpes erythrocephalus*	BCC Rangewide (CON) [1]	Breeds May 10 to Sep 10
Rusty Blackbird	*Euphagus carolinus*	BCC-BCR [3]	Breeds elsewhere
Wood Thrush	*Hylocichla mustelina*	BCC Rangewide (CON) [1]	Breeds May 10 to Aug 31

[1] BCC Rangewide (CON): This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska (CON).

[2] Non-BCC Vulnerable: There is not a BCC in this area but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

[3] BCC-BCR: There is a BCC only in particular Bird Conservation Regions (BCRs) in the continental USA.

3.2.4 Cultural Resources

According to the National Register of Historic Places, there are 44 registered historic sited and parks within the Honeoye Creek watershed. Consultation with NYS Office of Parks, Recreation, and Historic Places (NYSOPRHP) should be performed to identify the potential presence of archeological resources and the subsequent need to perform a cultural resources investigation (NYSOPRHP 2018a; NYSOPRHP 2018b).

Table 2 lists the NYS Historic Sites and Park Boundaries and National Register of Historic Places sites. Figure 3-6 displays the locations of the historic sites and parks within the Honeoye Creek watershed.

Table 2. New York State Historic Sites and Park Boundaries and National Register of Historic Places Sites

Source: NYSOPRHP 2018a; NYSOPRHP 2018b		
Name	**County**	**City**
Markham Cobblestone Farmhouse and Barn Complex	Livingston	Lima
Moses, Ogilvie, Farmhouse	Livingston	Lima
Clark Farm Complex	Livingston	Lima
Honeoye Falls Village Historic District	Monroe	Honeoye Falls
Sibley, Hiram, Homestead	Monroe	Sibleyville
Gates-Livermore Cobblestone Farmhouse	Monroe	Mendon vicinity
Lower Mill	Monroe	Honeoye Falls
Genesee Wesleyan Seminary and Genesee College Hall	Livingston	Lima
Hillcrest	Livingston	Lima
North Bloomfield School	Livingston	North Bloomfield
Lima Village Historic District	Livingston	Lima
St. John's Episcopal Church	Monroe	Honeoye Falls
St. Rose Roman Catholic Church Complex	Livingston	Lima
US Post Office--Honeoye Falls	Monroe	Honeoye Falls
Leech--Lloyd Farmhouse and Barn Complex	Livingston	Lima
Morgan Cobblestone Farmhouse	Livingston	Lima
School No. 6	Livingston	Lima
Barnard Cobblestone House	Livingston	Lima
Spencer House	Livingston	Lima
Cargill House	Livingston	Lima
DePuy, William, House	Livingston	Lima
Peck, J. Franklin, House	Livingston	Lima
Stanley House	Livingston	Lima
Harmon, William, House	Livingston	Lima
Dayton House	Livingston	Lima
Moses, Zebulon, Farm Complex	Livingston	Lima
Godfrey House and Barn Complex	Livingston	Lima
Bristol House	Livingston	Lima
Martin Farm Complex	Livingston	Lima
Peck, Thomas, Farmhouse	Livingston	Lima

Source: NYSOPRHP 2018a; NYSOPRHP 2018b		
Name	**County**	**City**
Warner, Matthew, House	Livingston	Lima
Warner, Asahel, House	Livingston	Lima
Draper House	Livingston	Lima
Vary, William L., House	Livingston	Lima
Harden House	Livingston	Lima
Leech-Parker Farmhouse	Livingston	Lima
Alverson-Copeland House	Livingston	Lima
Smith, Dr. Justin, House	Livingston	Lima
Adsit Cobblestone Farmhouse	Monroe	Mendon
Hemlock Fairground	Livingston	Hemlock
Corby Farm Complex	Livingston	Honeoye Falls vicinity
Dickson, John and Mary, House	Ontario	West Bloomfield
Ontario & Livingston Mutual Insurance Office	Ontario	West Bloomfield
Peck, Watrous, House	Ontario	West Bloomfield

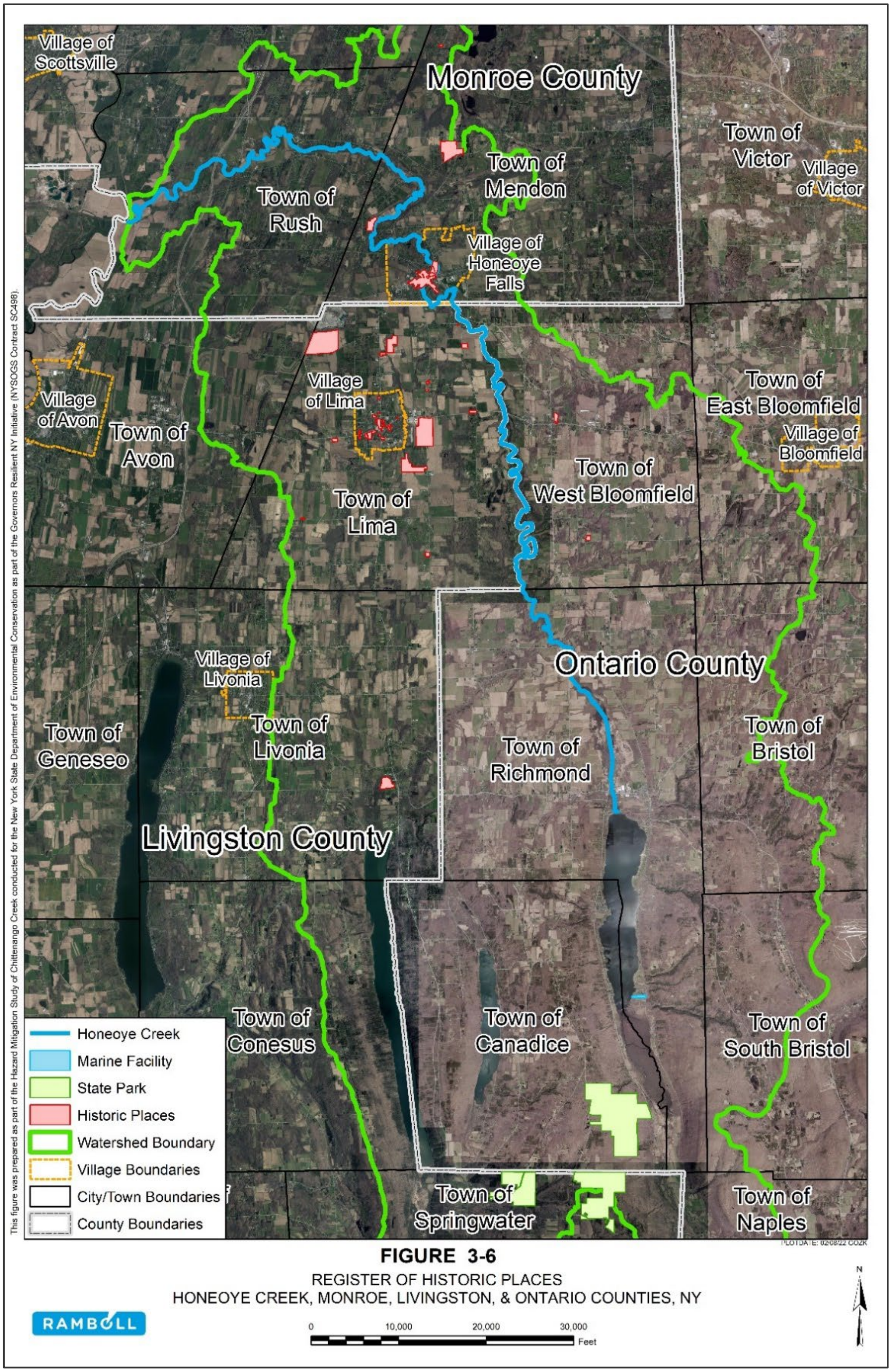


Figure 3-6. Register of Historic Places, Honeoye Creek, Monroe, Livingston, & Ontario Counties, NY.

3.2.5 FEMA Mapping and Flood Zones

The FEMA Flood Map Service Center (MSC) (https://msc.fema.gov/portal/home) is a database that contains FEMA Flood Insurance Rate Maps (FIRMs) for areas that have had FEMA flood insurance studies completed throughout the United States (FEMA 2022). The current effective FEMA FIS reports for the municipalities within the Honeoye Creek watershed are:

- Town of Richmond (Ontario County): June 18, 1984
- Town of West Bloomfield (Ontario County): December 1977
- Monroe County (All Jurisdictions): August 28, 2008

There is no published FEMA FIS for the Town of Lima in Livingston County available through the FEMA MSC database.

According to their respective FIS reports, the H&H analyses for Honeoye Creek were studied using detailed methods for all the municipalities listed. It should be noted that the updated 2008 Monroe County FIS did not include a new detailed analysis for Honeoye Creek, but a re-delineation of the previous effective study. The original FIS H&H analyses for the Towns of Rush and Mendon were completed in 1981 and for the Village of Honeoye Falls In 1977 (FEMA 1981a; FEMA 1981b; FIA 1977b; FEMA 2008b).

For a detailed study, FEMA can perform a limited detailed or detailed study. For both methods, semiautomated hydrologic, hydraulic, and mapping tools, coupled with digital elevation data, are used to predict floodplain limits, especially in lower-risk areas. If the tools are used with some data collected in the field (e.g., sketches of bridges to determine the clear opening), then the study is considered a limited detailed study. Limited detailed analysis sometimes results in the publishing of Base Flood Elevations (BFEs), also referred to as the 100-yr flood elevation, on the maps. The decision to place BFEs on a limited detailed study analysis is based on the desire of the community for the BFEs to be shown, plus the accuracy of the elevation data and the data on bridges, dams, and culverts that may impede flow on the flooding source. A study performed using these same tools and the same underlying map, with the addition of field-surveyed cross sections, field surveys of bridges, culverts, and dams, along with a more rigorous analysis including products such as floodways, new calibrations for hydrologic and hydraulic models, and the modeling of additional frequencies, is a detailed study. Detailed studies provide BFE information, flood profiles, and usually a floodway, whereas approximate studies do not (NRC 2007).

For the portions of Honeoye Creek that flow through Monroe County, a re-delineation study was performed in the updated Monroe County FIS for 2008. Redelineation is the method of updating effective flood hazard boundaries to match updated topographic data based on the computed water surface elevations (WSELs) from effective models. The results of a redelineation update are more accurate floodplain boundaries when compared to current ground conditions. Redelineation of floodplain boundaries can be applied to both riverine and coastal studies. No new engineering analyses are performed as part of the redelineation methodology; however, redelineation can be paired with new engineering studies as part of a larger update. For riverine studies, effective flood profiles and data tables from the FIS report, BFEs from the FIRMs, and supporting hydrologic and hydraulic analyses are used in conjunction with the updated topographic data to formulate new floodplain boundaries. This method combines effective information from the FIRM and FIS report and the supporting analyses with new, more detailed, or more up to-date topographic data to redelineate coastal high-hazard areas (FEMA 2015a).

Honeoye Creek is a Regulatory Floodway, which is defined as the watercourse channel and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than 1 ft over the 1% annual chance flood hazard (ACE) WSEL (i.e., BFE). In the regulatory floodway, communities must regulate encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway, and demonstrate through hydrologic and hydraulic analyses performed in accordance with standard engineering practice, that the proposed encroachment would not increase flood levels within the community during the occurrence of the base flood. Development in the portions of the floodplain beyond the floodway, referred to as the floodway fringe, is allowed as long as it does not increase the BFE more than 1.0 ft (FEMA 2000). Figure 3-7 displays the floodway data from the FIS for Honeoye Creek in the Village of Honeoye Falls, New York (FIA 1977b).

The FIRMs for all of the municipalities that encompass Honeoye Creek indicate Special Flood Hazard Areas (SFHAs), which are land areas covered by floodwaters during the 1% ACE. The flood zones indicated in the Honeoye Creek study area are Zones A and AE, where mandatory flood insurance purchase requirements apply. A Zones are areas subject to inundation by the 1% ACE. Where detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. AE Zones are areas that have a 1% annual chance of flooding where BFEs are provided by FEMA (FIA 1977a; FIA 1977b; FEMA 1981a; FEMA 1981b; FEMA 1984b; FEMA 2008b). Figure 3-8 is a FIRM that includes a portion of Honeoye Creek in the Village of Honeoye Falls, New York (FEMA 2008a).

For the flood zones within Ontario and Livingston Counties, New York, digitized Q3 flood zone data derived from FEMA FIRMs was used to produce flood zone maps in this study. Digital Q3 flood data files contain only certain features from the FIRM hardcopy in effect at the time of scanning and do not replace the existing FIRM hardcopy maps. In addition, the process of georeferencing paper maps to digital images can distort certain features over large areas between known points. This process is not recommended to use for detailed flood zone delineation or analysis (FEMA 1996).

The hydraulic analyses performed by FEMA were based on unobstructed flow for all three communities. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail. With regards to ice-jam flooding, the effective FEMA FIRMs only reflect flooding related to open-water or free-flow conditions (FIA 1977a; FIA 1977b; FEMA 1981a; FEMA 1981b; FEMA 1984b; FEMA 2008b).

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD 1929)	WITHOUT FLOODWAY (NGVD 1929)	DIFFERENCE (FT.)
Honeoye Creek							
A	0.000	111[2]	1,070	6.42	593.0	592.0	1.0
B	0.316	129[2]	1,037	6.61	596.1	595.4	0.7
C	0.631	157[2]	950	6.42	599.0	598.0	1.0
D	0.908	301	1,179	5.56	601.2	600.2	1.0
E	1.125	135	738	9.32	603.0	602.4	0.6
F	1.407	155	1,032	6.67	608.9	608.5	0.4
G	1.648	258	898	6.76	619.2	619.2	0.0
H	1.852	125	839	8.20	621.8	621.8	0.0
I	2.174	200	1,216	5.64	658.5	658.5	0.0
J	2.377	375	612	8.95	661.0	661.0	0.0
K	2.634	261	961	5.54	665.1	664.8	0.3
L	3.057	412[2]	1,207	3.87	667.8	667.2	0.6
M	3.278	172	1,183	5.47	668.4	667.6	0.8
N	3.820	550[2]	959	4.06	670.7	669.9	0.8
O	4.013	115[3]	678	10.14	671.1	670.2	0.9

[1]MILES ABOVE CORPORATE LIMITS [2]PORTION OF THE FLOODWAY IS OUTSIDE THE CORPORATE LIMITS
[3]THIS CROSS SECTION IS NOT SHOWN ON THE FLOOD BOUNDARY AND FLOODWAY MAP (EXHIBIT 2) – FLOODWAY IS OUTSIDE CORPORATE LIMITS

TABLE 2

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

VILLAGE OF HONEOYE FALLS, NY
(MONROE CO.)

FLOODWAY DATA

HONEOYE CREEK

Figure 3-7. Floodway Data, Honeoye Creek, Village of Honeoye Falls, Monroe County, NY (FIA 1977b).

Figure 3-8. FEMA FIRM, Honeoye Creek, Village of Honeoye Falls, Monroe County, NY (FEMA 2008a).

For this study, ice-jam flooding extents were determined using a wide variety of sources, including stakeholder input, news reports, computer models, etc. References to ice-jam flood extents are based solely on these sources and do not reflect the flood zone areas from the effective FEMA FIRMs.

3.3 WATERSHED LAND USE

The Honeoye Creek stream corridor is largely comprised of forested (45%) and agricultural (39%) lands within the basin. Of the forested lands, deciduous (36%) and mixed (7%) forests comprise the largest proportion of these lands, while cultivated crops (22%) and hay/pasture (17%) encompass the largest percentages of agricultural lands (USGS 2021b).

The distribution of different land use and cover types varies throughout the Honeoye Creek basin. The upper portion of the basin, in the Towns of Canadice and South Bristol, is primarily comprised of forested lands including three Finger Lakes: Honeoye Lake, Canadice Lake, and Hemlock Lake. The middle and lower portions of the basin, including the Towns of Richmond, West Bloomfield, Mendon, and Rush are primarily agricultural with cultivated crops and pasture/hay lands. Developed areas of varying intensities along the creek are primarily in the middle and lower portions of the basin in the Villages of Honeoye Falls and Lima (USGS 2021b).

3.4 GEOMORPHOLOGY

The Honeoye Creek watershed encompasses large areas of Monroe, Livingston, and Ontario Counties in western and central New York. Monroe County is in the Erie-Ontario Lake Plain region of western New York. It is approximately 25 miles from north to south and 27 miles from east to west. It has a total area of 430,720 acres, or about 673 square miles. Rochester, the county seat, is in the northern part of the county (SCS 1973).

The most prominent geologic features in Monroe County are those related to the ice age or the Pleistocene Epoch, which began about a million years ago. These features are the result of material accumulated and deposited during the last stage of glaciation, which is the Wisconsin Stage. This stage occurred about 10,000 years ago, and some evidence indicates that it may have persisted until as recently as 5,000 years ago (SCS 1973).

As the glacial ice receded, a series of relatively short-lived postglacial lakes formed. These lakes extended southward from the glacial front and generally drained toward the east. The oldest postglacial lake that affected Monroe County was Lake Warren, then Lake Dana, Lake Scottsville, Lake Dawson, and finally Lake Iroquois, the predecessor of Lake Ontario. Apparently, Lake Iroquois persisted for a longer time than most of the other lakes because it developed a well-defined beach ridge. This ridge generally coincides with the present Ridge Road (U.S. Route 104). Immediately north of the ridge is a well-defined sand plain that extends across the county in an east-west direction (SCS 1973).

Interspersed with the remnants of the glacial lakes are other glacial deposits. Among these deposits are drumlins, moraines, eskers, and kames, which also occur throughout the county (SCS 1973).

Less conspicuous than the glacial features, but equally significant, are the various bedrock formations that underlie all the soils of the county. In shallow soils, bedrock governs the topography of the area. Generally, it also influences the nature of the glacial deposits. All the bedrock is sedimentary; it is made up of material deposited in ancient seas. The dip is toward the south at a gradient of approximately 60 feet per mile, but locally, there are some extreme variations (SCS 1973).

The oldest bedrock formation is Queenston Shale. Medina Sandstone overlies Queenston Shale. Formations of the Clinton Group overlie the Medina Sandstone. At the top of the Clinton Group is the Lockport Dolomite, and above the Lockport Dolomite are other shale or shaly formations, the first or oldest of which is the black Pittsford Shale that underlies intermingled beds of red Vernon Shale and green Camillus Shale. The youngest rock formation in the county is Onondaga Limestone (SCS 1973).

The elevation in Monroe County ranges from 246 feet above sea level on Lake Ontario, to about 400 feet on the lake plain, and a maximum of 900 feet in some areas that have drumlin relief (SCS 1973).

Monroe County is in the drainage system of the St. Lawrence River. Most of the rivers, large streams, and creeks have a dendritic or branching pattern. The Genesee River, which is the major stream, crosses the county from south to north. It meanders through a level to nearly level valley about 1 to 2 miles wide, but where the river passes over a series of falls in the center of Rochester, the valley narrows to a gorge. The main tributaries of the Genesee River are Oatka Creek, Honeoye Creek, Red Creek, and Black Creek, all of which flow into the river south of the City of Rochester (SCS 1973).

Livingston County is in the west-central part of New York State, about midway between the Pennsylvania State line and Lake Ontario. Geneseo, the county seat, is 25 miles south of Rochester, 55 miles east of Buffalo, and 85 miles west of Syracuse. Dansville, in the southeastern part of the county, is the largest village. The county has a land area of approximately 641 square miles and a water area of approximately 8.5 square miles. The southern and the northern boundaries of the county are about 35 miles apart (SCS 1956).

The southern part of Livingston County lies on the northern edge of the Appalachian Plateau, and the northern part on the Erie-Ontario Plain. These physiographic provinces are separated by the Portage Escarpment, which is less well-defined in this area than in counties to the east and west (SCS 1956).

The rock formations that provide most of the parent materials for soils of this county belong to the Devonian period and consist of nearly horizontal layers of limestones and inter-bedded shales and sandstones. The Bertie formation (Silurian age) is the oldest in the county. Onondaga limestone (middle Devonian) is a more recent formation than the Bertie and underlies soils at somewhat higher elevations. More recent than the Onondaga limestone, but of the middle Devonian period, is the Hamilton formation. The

Portage formation (upper Devonian) overlies the Hamilton formation in some parts of the county. The Chemung formation (upper Devonian) occurs in the higher southern parts of the county (SCS 1956).

The entire county was overridden by ice during the glacial period, and the present topography shows the effect of these glaciers. The most important work of the glacier in this area was the transporting of loose rock and soil material and spreading it over the land southward. The glacier did not carry the materials far, but smoothed and rounded hills, filled valleys, and changed the drainage pattern. The preglacial Genesee River had two main branches. The eastern branch cut the wide valley in which Dansville is located, and the western branch formed the valley stretching from Portage to Nuna. A large block of glacial drift diverted the flow of the eastern branch from the valley in which Dansville is located. The western branch of the Genesee River was diverted from the Nunda section by drift filling and was turned westward to cut the Portage and Mount Morris canyons (SCS 1956).

Most of Livingston County now drains into the Genesee River. A small section in the southwest, which includes part of Springwater Town, drains into the Susquehanna through the Cohocton River (SCS 1956).

Ontario County is located centrally in Western New York. It contains 656 square miles, or 419,840 acres of land surface, and about 22.5 square miles, or 14,400 acres of water surface. The county is irregular in shape, though most of its boundaries are right lines. The main body of the county is bounded on the east by Seneca County and Lake Seneca. A southern projection of the western side is bounded on the east by Canandaigua Lake and Yates County. Yates and Steuben Counties, and Springwater Township (Livingston County), bound it on the south. Livingston and Monroe Counties and Hemlock Lake bound it on the west, and Monroe and Wayne Counties on the north (USDA 1910).

The surface features of Ontario County are varied with significant differences between the northern and southern portions of the county in topography. The northern portion consists of a comparatively low-lying region characterized by a rolling to slightly hilly upland that becomes gradually more elevated toward the south, while the southern part consists of a high, hilly country (USDA 1910).

The topography of the northern parts of Farmington, Manchester, and Phelps and northeastern Victor Townships, in the northern region, consists of many low rounded hills, known as drumlins, with intervening valleys and gravel plains. In the region southwest of Canandaigua and south of East Bloomfield, consists of a series of hills of the drumlin type in form between the low northern and high southern upland regions of the county, and are the highest hills of the drumlin type within the state. In western Victor, northwestern East Bloomfield, and northern West Bloomfield Townships the topography is marked by a series of hills of an entirely different character than those of the drumlin type. These hills are of the glacial form known as kame moraines (USDA 1910).

The southern portion of the county consists of a high-hill region greatly carved by preglacial erosive agencies. The hills of this region have for the most part rather flat tops and steeply sloping sides, the intervening valleys being comparatively narrow.

Four of these narrow valleys are in part occupied by long, narrow "finger lakes." Two of these Finger Lakes, Canadice and Honeoye, lie entirely within Ontario County, while the other two, Hemlock and Canandaigua, form wholly or in part natural boundary lines for the county. Two similar valleys, whose northern ends are identified with Ontario County, occur to the east of those occupied by these lakes. One is occupied by Seneca Lake and the other is occupied by a swamp along Flint Creek south of Gorham. Originally this swamp is believed to be a Finger Lake similar to but probably of less depth than most of the existing lakes in the other narrow valleys; however, due to glaciation and the advancement and recession of glaciers, it is believed that this swamp, like many other valleys of this region, have been more or less filled by glacial debris (USDA 1910).

The range in elevation of the different parts of Ontario County is considerable, being about 1,850 ft. The highest point within the county, Gannett Hill, is located in the high-hill region just west of Bristol Springs. Its height above sea level is 2,256 ft. The lowest point, slightly above 400 ft, is in the northwestern corner of the county (USDA 1910).

The drainage of Ontario County, with the exception of about one square mile, belongs to the Finger Lakes-Great Lakes-St. Lawrence system. The area excepted lies in the southeastern corner of Naples Township, and its waters finally reach the sea by way of the Chesapeake Bay (USDA 1910).

The Finger Lakes-Great Lakes-St. Lawrence drainage system in Ontario County consists of three parts. The western portion of the county lies in the basins of Hemlock, Canadice, and Honeoye Lakes, and is drained by Honeoye Creek, the outlet of Honeoye Lake and a tributary of the Genesee River. A considerable portion of the central and southern parts of the county lie in the basin of Canandaigua Lake and is drained by its outlet, the Canandaigua Outlet. The eastern edge of the county lies in the basin of Seneca Lake and is drained by its outlet. The waters of all three of these drainage basins reach Lake Ontario and the St. Lawrence River, but by somewhat different routes. The drainage of the entire northern edge of the county has no direct connection with the Finger Lakes. However, the waters from these regions eventually reach Lake Ontario, as does that of the Finger Lakes (USDA 1910).

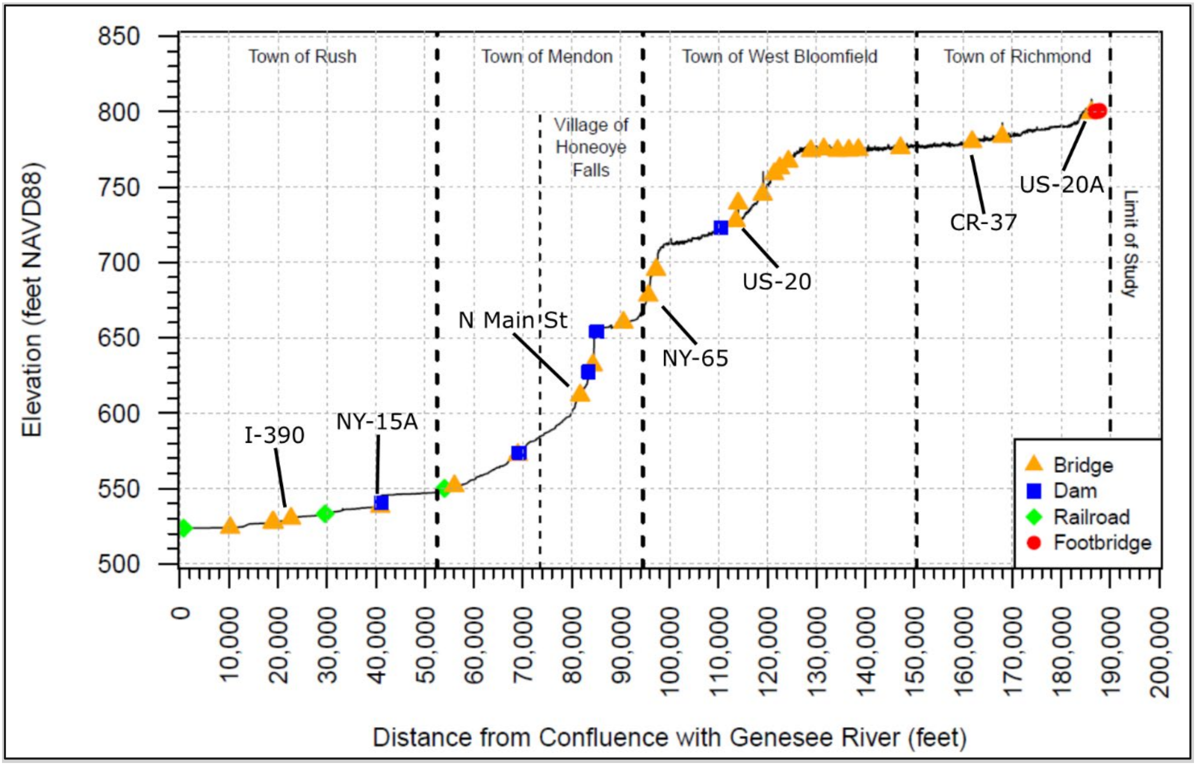


Figure 3-9. Honeoye Creek profile of stream bed elevation and channel distance from the confluence with the Genesee River.

Figure 3-9 is a profile of stream bed elevation and channel distance from the confluence with the Genesee River using 1- and 2-meter light detection and ranging (LiDAR) data for Honeoye Creek. The slope of Honeoye Creek varies through the different reaches along the creek. The upper and lower reaches, consisting of the Towns of West Bloomfield, Richmond and Rush, respectively, are relatively subtle to low sloping areas, while the middle reach, consisting of the Town of Mendon and a portion of the Town of West Bloomfield, is relatively steep sloped with multiple falls (IAGT 2007; MCDES 2017; NYSOITS 2019).

In addition, there are numerous locations where sediment depositional aggradation is occurring within the channel of Honeoye Creek. Aggradation is a natural fluvial process where sediment and other materials are deposited in a stream channel when the supply of sediment is greater than the amount of material that the system is able to transport. Over time, aggradation can lead to the development of sand and sediment bars within the stream channel. These sand and sediment bars may restrict flow by reducing the in-channel flow area and may act as catchpoints for ice pieces during ice breakup events, potentially increasing open-water flood risks and ice-jam formations (Mugade and Sapkale 2015).

3.5 HYDROLOGY

Honeoye Creek drains an area of 265.3 square miles, is approximately 35.3 miles in length, and is located in central and western New York State. The headwater of Honeoye Creek begins at the outlet of Honeoye Lake in the Hamlet of Honeoye in the Town of Richmond, Ontario County. The creek then flows north forming the boundary between the Towns of Lima and West Bloomfield, and Livingston and Ontario Counties, respectively. The creek continues north/northwest into Monroe County meandering through the Village of Honeoye Falls and the Town of Mendon before flowing west through the Town of Rush to its outlet at the Genesee River (USGS 2021a).

There are multiple large tributaries that flow into Honeoye Creek, including:

- Town of Rush (Monroe County): Pinnacle Creek and Stony Brook
- Town of Mendon (Monroe County): Spring Brook
- Town of West Bloomfield (Ontario County): Bebee Creek
- Town of Richmond (Ontario County): Mill Creek and Hemlock Outlet

Of these tributaries, Mill Creek and its confluence with Honeoye Creek in the Town of Richmond has historically been a source of flooding and flood damages within the community. Mill Creek flows westerly into Honeoye Creek within the east central portion of the Town. It drains a small area immediately south of State Route 20A. The flood plains of Mill Creek are undeveloped, with some residences located at the crossing of East Lake Road (FEMA 1984b; USGS 2021a).

Table 3 is a summary of the basin characteristic formulas and calculated values for the Honeoye Creek watershed, where A is the drainage area of the basin in square miles, BL is the basin length in miles, and BP is the basin perimeter in miles (USGS 1978).

Table 3. Honeoye Creek Basin Characteristics Factors

Factor	Formula	Value
Form Factor (R_F)	A / B_L^2	0.20
Circularity Ratio (R_C)	$4*\pi*A / B_P^2$	0.15
Elongation Ratio (R_E)	$2 * (A/\pi)^{0.5} / B_L$	0.51

Form Factor (RF) describes the shape of the basin (e.g., circular or elongated) and the intensity of peak discharges over a given duration of time. Circularity Ratio (RC) gives an indication of topography where the higher the circularity ratio, the lower the relief and less disturbance to drainage systems by structures within the channel. Elongation Ratio (RE) gives an indication of ground slope where values less than 0.7 correlate to steeper ground slopes and elongated basin shapes. Based on the basin characteristics factors, the Honeoye Creek watershed can be characterized as an elongated basin with lower peak discharges of longer durations, high-relief topography with structural controls on drainage, and steep ground slopes (Waikar and Nilawar 2014).

There is one USGS stream gaging station on Honeoye Creek, USGS 04244000 Honeoye Creek at Honeoye Falls, New York. The gage is located downstream from the North Main Street bridge and has been active since 1945 with data available for all time periods aside from October 1970 to September 1972 (USGS 2021c).

As described in Section 3.2.5, there is an effective FEMA FIS for each municipality within the Honeoye Creek watershed, except for the Town of Lima, in which a detailed analysis was performed for both the hydrologic and hydraulic analyses.

For the Towns of Rush, Mendon, and West Bloomfield and Village of Honeoye Falls, hydrologic analyses to determine discharge-frequency relationships and peak discharges for Honeoye Creek were performed using the log-Pearson Type III (LP3)/discharge-drainage area ratio statistical analysis technique using data from the USGS gaging station (FIA 1977a; FIA 1977b; FEMA 1981a; FEMA 1981b).

For the Town of Richmond, no hydrologic analyses was performed for Honeoye Creek. For Mill Creek, discharges were determined from the USGS Water Resources Investigations (WRI) 79-93, which presents techniques for estimating peak discharges on ungaged and unregulated streams in rural New York State through a regional approach and multiple linear regression equations using both a drainage area and a storage index methodology (FEMA 1984b; USGS 1979).

An effective FEMA FIS for Monroe County was issued on August 28, 2008, which was a redelineation study and included drainage area and discharge information for Honeoye Creek for the Towns of Mendon and Rush, and the Village of Honeoye Falls. Since there were existing FIS reports with hydrologic analyses already performed for Honeoye Creek, the Monroe County FIS used performed an updated LP3/discharge-drainage area ratio statistical analysis technique using updated data from the USGS gaging station (FEMA 2008b). Table 4 summarizes the FEMA FIS drainage area and peak discharges, in cubic feet per second, for Honeoye Creek.

Table 4. Honeoye Creek FEMA FIS Peak Discharges

Source: FIA 1977a; FEMA 2008b						
			Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**10-Percent**	**2-Percent**	**1-Percent**	**0.2-Percent**
At confluence with Genesee River	265.3	0+00	4,260	7,150	8,710	13,600
Upstream of Stoney Brook	258.4	235+50	3,950	6,640	8,080	12,600
At Town of Rush/Town of Mendon corporate limits	232.8	525+00	3,840	6,450	7,850	12,250
At railroad	230	544+00	3,810	6,400	7,780	12,130
Below Spring Brook	220	707+00	3,680	6,160	7,500	11,700
At Town of Mendon/Town of Honeoye Falls corporate limits	196	734+00	3,384	5,675	6,914	10,775
At gaging station (Main Street Bridge)	195	817+00	3,371	5,654	6,888	10,734
Downstream of Town of West Bloomfield corporate limit	192	942+00	3,333	5,590	6,809	10,612
Downstream of Confluence of Bebee Creek	176	1500+00	3,125	5,241	6,385	9,950
Upstream of Confluence of Bebee Creek	156	1501+00	2,858	4,793	5,840	9,100

General limitations of the FEMA FIS methodology are the age of the effective FIS H&H analysis, age of the methodology, and lack of H&H analyses for the entire reach of Honeoye Creek. The various H&H analyses for Honeoye Creek were completed between 1977 and 1984 using the LP3/discharge-drainage area ratio methodology. At the time of these FIS reports, there were approximately 30 and 37 years of available gage records, which is sufficient for a statistical analysis. However, performing an LP3 analysis on a dataset with so few data points can lead to biased results due to extreme high and/or low discharge values. Moreover, statistical analyses, such as the LP3, are sensitive towards specific periods of record, so outdated data or analyses performed many years in the past could again introduce bias and over or underrepresent results. In addition, advancements in our understanding of the complex interactions of hydrologic environments, coupled with improvements in hydrologic and hydraulic modeling and technology, has led to increased accuracy and a reduction in possible error in discharge estimations in recent years (USGS 2021c; NRCS 2007).

The USGS *StreamStats* v4.6.2 software is a map-based web application that provides an assortment of analytical tools that are useful for water resources planning and management, and engineering purposes. The primary purpose of *StreamStats* is to provide estimates of streamflow statistics for user selected ungaged sites on streams and for USGS stream gages, which are locations where streamflow data are collected (Ries et al. 2017, USGS 2021d).

Methods for computing a peak discharge estimate for a selected recurrence interval at a specific site depend on whether the site is gaged or ungaged, and whether the drainage area lies within a single hydrologic region or crosses into an adjacent hydrologic region or State. Hydrologic regions refer to areas in which streamflow-gaging stations indicate a similarity of peak-discharge response that differs from the peak-discharge response in adjacent regions. These similarities and differences are defined by the regression residuals, which are the differences between the peak discharges calculated from station records and the values computed through the regression equation. There are currently six hydrologic regions in New York State, and Honeoye Creek is located in Region 6 (Lumia 1991; Lumia et al. 2006).

For gaged sites, such as Honeoye Creek, the generalized least-squares (GLS) regional-regression equations are used to improve streamflow-gaging-station estimates (based on LP3 flood-frequency analysis of the gaged annual peak-discharge record) by using a weighted average of the two estimates (regression and gaged). Incorporating the regression estimate into the weighted average tends to decrease time-sampling errors that result for sites with short periods of record. The weighted-average discharges are generally the most reliable and are computed from the equation:

$$Q_{T(W)} = \frac{Q_{T(g)}(N) + Q_{T(r)}(E)}{N + E}$$

where

$Q_{T(w)}$ is weighted peak discharge at the gaged site, in cubic feet per second, for the T-year recurrence interval;

$Q_{T(g)}$ is peak discharge at gage, in cubic feet per second, calculated through LP3 frequency analysis of the station's peak discharge record, for the T-year recurrence interval;

N is number of years of annual peak-discharge record used to calculate $Q_{T(g)}$ at the gaging station;

$Q_{T(r)}$ is regional regression estimate of the peak discharge at the gaged site, in cubic feet per second, for the T-year recurrence interval; and

E is average equivalent years of record associated with the regression equation that was used to calculate $Q_{T(r)}$ (Lumia et al. 2006).

StreamStats delineates the drainage basin boundary for a selected site by use of an evenly spaced grid of land-surface elevations, known as a Digital Elevation Model (DEM), and a digital representation of the stream network. Using this data, the application calculates multiple basin characteristics, including drainage area, main channel slope, and mean annual precipitation. By using these characteristics in the calculation, the peak discharge values have increased accuracy and decreased standard errors by approximately 10% for a 1% annual chance interval (100-yr recurrence) discharge when compared to the drainage-area only regression equation (Lumia et al. 2006; Ries et al. 2017).

When *StreamStats* is used to obtain estimates of streamflow statistics for USGS stream gages, users should be aware that there are errors associated with estimates determined from available data for the stations, as well as estimates determined from regression equations, and some disagreement between the two sets of estimates is expected. If the flows at the stations are affected by human activities, then users should not assume that the differences between the data-based estimates and the regression equation estimates are equivalent to the effects of human activities on streamflow at the stations (Ries et al. 2017).

StreamStats was used to calculate the current peak discharges for Honeoye Creek and compared with the effective FIS peak discharges. Table 5 is the summary output of peak discharges calculated by the *StreamStats* software for Honeoye Creek at the FEMA FIS locations, including select additional locations for the upstream reach in the Town of Richmond.

Table 5. USGS *StreamStats* Peak Discharge for Honeoye Creek at the FEMA FIS Locations

Source: USGS 2021d						
			Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**10-Percent**	**2-Percent**	**1-Percent**	**0.2-Percent**
At confluence with Genesee River	265	0+00	3,640	5,250	5,960	7,720
Upstream of Stoney Brook	245	235+50	3,430	4,960	5,640	7,330
At Town of Rush/Town of Mendon corporate limits	234	522+00	3,330	4,840	5,510	7,170
At railroad	232	541+00	3,310	4,810	5,480	7,130
Below Spring Brook	219	707+00	3,110	4,520	5,140	6,700
At Town of Mendon/Village of Honeoye Falls corporate limits	195	734+00	2,720	3,950	4,500	5,850
At Gaging Station (Main St. Bridge)	194	817+00	2,740	3,980	4,530	5,900
At downstream corporate limit, Town of West Bloomfield	190	942+00	2,730	3,980	4,540	5,930
Downstream of confluence of Bebee Creek	175	1500+00	3,050	4,570	5,260	6,990
Upstream of confluence of Bebee Creek	155	1501+00	2,730	4,100	4,720	6,280
***Downstream of Hemlock Outlet**	149	1634+50	2,720	4,110	4,740	6,350
***Downstream of Mill Creek/Main Street (NY-20A) Bridge**	56	1835+00	1,200	1,800	2,070	2,750
***Downstream of Honeoye Lake Outlet**	40	1862+00	870	1,310	1,510	2,010

* Note: These locations were not included in the effective FIS for the Town of Richmond and were selected due to their hydrologic importance along Honeoye Creek.

Using the standard error calculations from the regression equation analysis in *StreamStats*, an acceptable range at the 95% confidence interval for peak discharge values at the 10-, 2-, 1-, and 0.2% ACE flood hazards were determined. Standard error gives an indication of how accurate the calculated peak discharges are when compared to the actual peak discharges since approximately two-thirds (68.3%) of the calculated peak discharges would be within one standard error of the actual peak discharge, 95.4% would be within two standard errors, and almost all (99.7%) would be within three standard errors (McDonald 2014). Table 6 is a summary table of the USGS *StreamStats* standard error of estimate at each ACE flood hazard for Region 6 in New York State.

Table 6. USGS *StreamStats* Standard Errors for Full Regression Equations

Source: Lumia 2006				
	Peak Discharges (cfs)			
	10-Percent	**2-Percent**	**1- Percent**	**0.2- Percent**
Standard Error	36.1	37.5	38.7	42.6

Based on the *StreamStats* standard error calculations, the FEMA FIS peak discharges were determined to be outside of the acceptable range (95% confidence interval). For this study, to maintain consistency in the modeling outputs with the FEMA models and to develop a conservative analysis of flood risk in the Honeoye Creek watershed, the effective FIS peak discharges were used in the HEC-RAS modeling software simulations.

In addition to peak discharges, the *StreamStats* software also calculates bankfull statistics by using stream survey data and discharge records from 281 cross-sections at 82 streamflow-gaging stations in a linear regression analysis to relate drainage area to bankfull discharge and bankfull-channel width, depth, and cross-sectional area for streams across New York State. These equations are intended to serve as a guide for streams in areas of the same hydrologic region, which contain similar hydrologic, climatic, and physiographic conditions (Mulvihill et al. 2009).

Bankfull discharge is defined as the flow that reaches the transition between the channel and its flood plain. Bankfull discharge is considered to be the most effective flow for moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphological characteristics of channels (Mulvihill et al. 2009). The bankfull width and depth of Honeoye Creek is important in understanding the distribution of available energy within the stream channel, and the ability of various discharges occurring within the channel to erode, deposit, and move sediment (Rosgen and Silvey 1996). Table 7 lists the estimated bankfull discharge, width, and depth at select locations along Honeoye Creek as derived from the USGS *StreamStats* program.

Table 7. USGS *StreamStats* Estimated Drainage Area, Bankfull Discharge, Width, and Depth

Source: FIA 1977a; FEMA 2008b					
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**Bankfull Depth (ft)**	**Bankfull Width (ft)**	**Bankfull Streamflow (cfs)**
At confluence with Genesee River	265	0+00	4.45	140	2,710
Upstream of Stoney Brook	245	235+50	4.38	135	2,560
At Town of Rush / Town of Mendon corporate limits	234	525+00	4.34	132	2,470
At railroad	232	544+00	4.34	132	2,450
Below Spring Brook	219	707+00	4.29	128	2,350
At Town of Mendon / Village of Honeoye Falls corporate limits	195	734+00	4.19	122	2,160
At Gaging Station (Main St. Bridge)	194	817+00	4.18	122	2,150
At downstream corporate limit, Town of West Bloomfield	190	942+00	4.17	120	2,110
Downstream of confluence of Bebee Creek	175	1500+00	4.09	116	1,990
Upstream of confluence of Bebee Creek	155	1501+00	3.99	110	1,820

3.6 INFRASTRUCTURE

According to the NYSDEC Inventory of Dams dataset (2021), there are six dams along Honeoye Creek as identified by the NYSDEC. Two of the dams are purposed as “Recreation”, while the remaining four are purposed as “Other.” Four of the dams have a hazard classification of A, while the remaining two dams are hazard class D. Class A dams are considered low hazard where a dam failure is unlikely to result in damage to anything more than isolated or unoccupied buildings, undeveloped lands, minor roads such as town or county roads; is unlikely to result in the interruption of important utilities, including water supply, sewage treatment, fuel, power, cable or telephone infrastructure; and/or is otherwise unlikely to pose the threat of personal injury, substantial economic loss or substantial environmental damage. Class D dams are also referred to as “negligible or no hazard” dams, which are defined as dams that have been breached or removed, or have failed or otherwise no longer materially impound waters, or dams that were planned but never constructed and are considered to be defunct dams posing negligible or no hazard. Table 8 lists the dams that are along Honeoye Creek, including hazard codes and purpose for the dam (NYSDEC 2021b).

Table 8. Inventory of Dams along Honeoye Creek

Source: NYSDEC 2021b				
Municipality	**Dam Name**	**River Station (ft)**	**Hazard Code**	**Purpose**
Town of Rush	Town of Rush Dam	412+50	A	Other
Town of Mendon	Harper Sibley Dam	695+00	D	Recreation
Town of Mendon	Tompkinson, Kenyon & Tompkinson Dam	839+00	A	Other
Town of Mendon	Hamilton Mill Dam	856+00	A	Recreation
Town of West Bloomfield	Ray Baker Dam	1099+00	D	Other
Town of Richmond	Honeoye Lake Dam	1863+00	A	Other

There are no large culverts identified by the NYSDOT along Honeoye Creek (NYSDOT 2019c).

Major bridge crossings over Honeoye Creek include Interstate 390 (I-390), State Routes 15, 15a, 5 & 20, and 65, County Roads 15 and 27, and multiple other smaller crossings. Bridge lengths and surface widths for NYSDOT bridges and culverts were revised as of 2019. For structures lacking publicly available data, measurements were taken in the field by the project team. Due to safety concerns and limited access, field staff were unable to perform measurements on some of the waterway crossing structures. Table 9 summarizes the infrastructure data for bridges that cross Honeoye Creek. Bridge lengths and widths for NYSDOT structures were revised as of February 2019 (NYSDOT 2019b). Figure 3-10 displays the locations of different infrastructure along Honeoye Creek.

Table 9. NYSDOT Bridges Crossing Honeoye Creek

Source: FIA 1977a; FEMA 1984b; FEMA 2008b; NYSDOT 2019b; USGS 2021d; Ramboll 2022

Roadway Carried	Structure Type	ID Number	River Station (ft)	Owner	Length [1] (ft)	Width [2] (ft)	Bankfull Width [3] (ft)	Hydraulic Capacity (% Annual Chance)
Livonia, Avon & Lakeville Railroad	Railroad	N/A	8+00	Livonia, Avon & Lakeville Railroad	105	18	140	0.2%
East River Road	Bridge	3317890	102+50	Monroe County	126	42	140	0.2%
I-390 SB	Bridge	N/A	189+00	NYSDOT	439	42	139	0.2%
I-390 NB	Bridge	N/A	191+00	NYSDOT	424	42	139	0.2%
NY-15 / W Henrietta Road	Bridge	1011510	226+75	NYSDOT	104	48	139	1%
Railroad Bridge (1) *	Railroad	N/A	296+45	N/A	107	18	135	0.2%
NY-15A / E Henrietta Road	Bridge	1011610	408+75	NYSDOT	110	53	134	1%
Railroad Bridge (2) *	Railroad	N/A	540+25	N/A	126	48	132	0.2%
Plains Road	Bridge	3317730	560+50	Monroe County	108	32	132	1%
Sibley Road	Bridge	3317750	690+00	Monroe County	90	34	128	1%
NY-65 / N Main Street	Bridge	1028950	822+00	NYSDOT	65	42	122	0.2%
NY-65 / East Street	Bridge	1028940	847+50	NYSDOT	63	43	122	0.2%
NY-65 / Ontario Street	Bridge	1028930	910+50	NYSDOT	111	42	120	1%
NY-65	Bridge	1028920	961+50	NYSDOT	101	43	120	0.2%
Martin Road	Bridge	3316210	972+25	Livingston County	88	31	120	1%
NY 5 & 20 / US-20	Bridge	1001820	1144+00	NYSDOT	127	100	120	0.2%
Factory Hollow Road / Pond Road	Bridge	3318260	1195+00	Ontario County	87	22	119	1%

Source: FIA 1977a; FEMA 1984b; FEMA 2008b; NYSDOT 2019b; USGS 2021d; Ramboll 2022								
Roadway Carried	**Structure Type**	**ID Number**	**River Station (ft)**	**Owner**	**Length [1] (ft)**	**Width [2] (ft)**	**Bankfull Width [3] (ft)**	**Hydraulic Capacity (% Annual Chance)**
Unnamed Road (1) *	Bridge	N/A	1217+00	N/A	88	16	119	1%
Unnamed Road (2) *	Bridge	N/A	1229+00	N/A	88	16	119	1%
Unnamed Road (3) *	Bridge	N/A	1246+50	N/A	88	16	119	1%
Unnamed Road (4) *	Bridge	N/A	1292+00	N/A	88	16	119	2%
Unnamed Road (5) *	Bridge	N/A	1318+50	N/A	88	16	119	Unable to pass 10%
Unnamed Road (6) *	Bridge	N/A	1347+50	N/A	88	16	119	1%
Unnamed Road (7) *	Bridge	N/A	1370+00	N/A	88	16	119	10%
Unnamed Road (8) *	Bridge	N/A	1390+00	N/A	88	16	119	Unable to pass 10%
County Road 37	Bridge	3318460	1622+00	Ontario County	103	42	108	No FIS Data
County Road 15	Bridge	3318720	1682+00	Ontario County	63	42	74.6	No FIS Data
Main Street / US-20A	Bridge	1016220	1835+00	NYSDOT	75	50	68.2	No FIS Data
Footbridge (1) *	Footbridge	N/A	1843+00	N/A	46	6	59	No FIS Data
Footbridge (2) *	Footbridge	N/A	1851+00	N/A	46	6	58.6	No FIS Data
Mill Creek								
East Lake Road	Bridge	3318430	52+00	Ontario County	44	23	34.7	0.2%

[1] Length is measured perpendicular to flow.

[2] Width is measured parallel to creek flow and refers to the curb-to-curb width, which is the minimum distance between the curbs or the bridge railings (if there are no curbs), to the nearest 30mm or tenth of a foot (NYSDOT 2020).

[3] Estimated using the USGS *StreamStats* program.

* Note: Due to safety concerns and lack of access, these structures were measured using a combination of aerial imagery, GIS spatial tools, and high resolution LiDAR data.

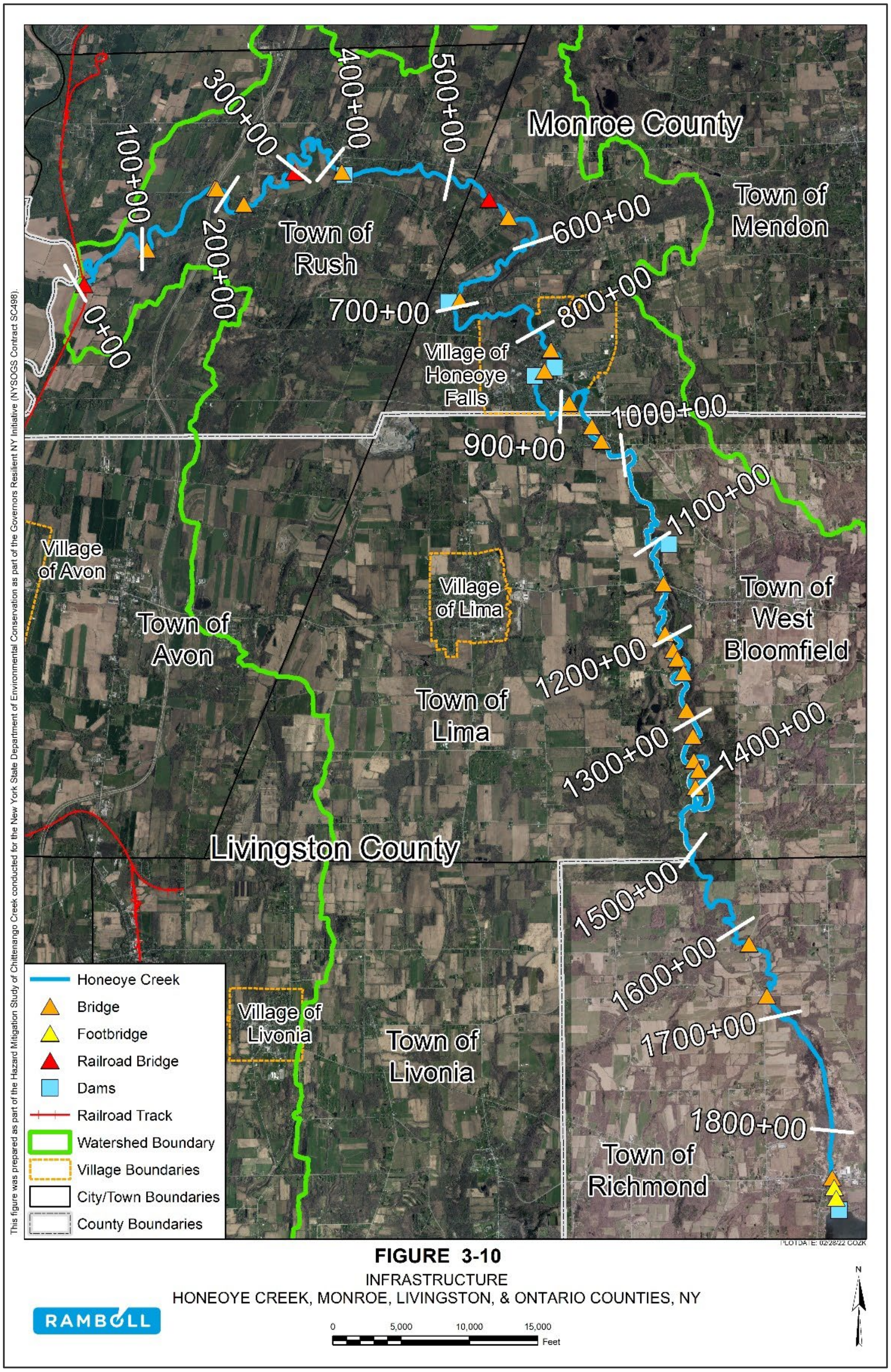


Figure 3-10. Honeoye Infrastructure, Monroe Livingston, and Ontario Counties, NY.

3.7 HYDRAULIC CAPACITY

Hydraulic capacity is the measure of the amount of water that can pass through a structure or watercourse. Hydraulic design is an essential function of structures in watersheds. Exceeding the capacity can result in damages or flooding to surrounding areas and infrastructure (Zevenbergen et al. 2012). In assessing hydraulic capacity of the high-risk constriction point culverts and bridges along Honeoye Creek, the FEMA FIS profile of Honeoye Creek was used to determine the lowest ACE flood elevation to flow under a culvert or the low chord of a bridge, without causing an appreciable backwater condition upstream (Table 9).

In New York State, hydraulic and hydrologic regulations for bridges and culverts were developed by the NYSDOT. The NYSDOT guidelines require a factor of safety for bridges that cross waterways, known as freeboard. Freeboard is the additional capacity, usually expressed as a distance in feet, in a waterway above the calculated capacity required for a specified flood level, usually the base flood elevation (BFE). Freeboard compensates for the many unknown factors that could contribute to flood heights being greater than calculated, such as wave action, minor silt and debris deposits, the hydrological effect of urbanization of the watershed, etc. However, freeboard is not intended to compensate for higher floods expected under future climatic conditions, such as those due to sea-level rise or more extreme precipitation events (NYSDEC 2020).

The Towns of West Bloomfield and Richmond WSEL in the FEMA FIS profiles are reported in the *National Geodetic Vertical Datum of 1929* (NGVD29) vertical datum. The Monroe County FEMA FIS profile WSELs are reported in the *North American Vertical Datum of 1988* (NAVD88) vertical datum. For consistency, all WSELs were converted to the NAVD88 datum using the National Oceanic and Atmospheric Administration (NOAA) Vertical Datum Coordinate Conversion Program (VERTCON) version 3.0 (NOAA 2019). The conversion factor used for Honeoye Creek was -0.5 ft. Table 10 displays the 1% ACE flood levels and freeboard at FEMA FIS infrastructure locations using the FIS profiles for Honeoye Creek.

Table 10. FEMA FIS Profile 1-Percent Annual Chance Flood Hazard Levels and Freeboard Values at Infrastructure Crossing Honeoye Creek

Source: FIA 1977a; FEMA 1984b; FEMA 2008b			
Infrastructure Crossing / Name	**River Station (ft)**	**1-Percent WSEL (ft NAVD88)**	**Freeboard for 1-Percent ACE (ft)**
Livonia, Avon & Lakeville Railroad *	8+00	534.5	2.5
East River Road *	102+50	536.5	6.5
I-390 SB	189+00	545	6.0
I-390 NB	191+00	545	6.0
NY-15 / W Henrietta Road	226+75	543	1.0
Railroad Bridge (1)	296+45	545.5	4.0
NY-15A / E Henrietta Road	408+75	547	1.5
Railroad Bridge (2)	540+25	556.5	3.5
Plains Road	560+50	557.5	1.0
Sibley Road	690+00	579.5	1.5
NY-65 / N Main Street	822+00	619	10.0
NY-65 / East Street	847+50	641	10.0
NY-65 / Ontario Street	910+50	668	1.5
NY-65	961+50	685.5	4.0
Martin Road	972+25	704.5	0.5
NY 5 & 20 / US-20	1144+00	742.5	2.0
Factory Hollow Road / Pond Road	1195+00	755.5	0.0
Unnamed Road (1)	1217+00	766.5	3.0
Unnamed Road (2)	1229+00	770.5	1.0
Unnamed Road (3)	1246+50	776.5	1.5
Unnamed Road (4)	1292+00	785.5	0.0
Unnamed Road (5)	1318+50	786	— 5.0
Unnamed Road (6)	1347+50	788.5	0.5
Unnamed Road (7)	1370+00	789.5	— 3.0
Unnamed Road (8)	1390+00	790.5	— 3.0
Mill Creek			
East Lake Road	52+00	844.5	9.0

* Note: Water surface elevations are affected by backwater from the Genesee River in the Monroe County FIS profiles.

The term “bridge” shall apply to any structure whether single or multiple-span construction with a clear span in excess of 20 ft when measurement is made horizontally along the center line of roadway from face to face of abutments or sidewalls immediately below the copings or fillets; or, if there are no copings or fillets, at six inches below the bridge seats or immediately under the top slab, in the case of frame structures. In the case of arches, the span shall be measured from spring line to spring line. All measurements shall include the widths of intervening piers or division walls, as well as the width of copings or fillets (NYSDOT 2020).

According to the NYSDOT bridge manual (2019) for Region 4, which includes Orleans, Genesee, Wyoming, Monroe, Livingston, Wayne and Ontario Counties, new and replacement bridges are required to meet certain standards, which include (NYSDOT 2019a):

- The structure will not raise the WSEL anywhere when compared to the existing conditions for both the 2- and 1% ACE (50- and 100-yr flood) flows.
- The proposed low chord shall not be lower than the existing low chord.
- A minimum of 2’-0” of freeboard for the projected 2% ACE (50-yr flood) is required for the proposed structure. The freeboard shall be measured at the lowest point of the superstructure between the two edges of the bottom angle for all structures.
- The projected 1% ACE (100-yr flood) flow shall pass below the proposed low chord without touching it.
- The maximum skew of the pier to the flow shall not exceed 10 degrees.

In assessing the hydraulic capacity of culverts, NYSDOT highway drainage standards require the determination of a design discharge (e.g., 50-yr flood) through the use of flood frequencies. The design flood frequency is the recurrence interval that is expected to be accommodated without exceeding the design criteria for the culvert. There are four recommended methodologies: The Rational Method, Modified Soil Cover Complex Method, historical data, and the regression equations. Each method should be assessed and the most appropriate method for the specific site should be used to calculate the design flood frequency and discharge (NYSDOT 2018).

In response to climate change, NYSDOT highway drainage standards require current peak flows shall be increased to account for future projected peak flows for culvert design. Based on the USGS *FutureFlow* software, calculated flows in Monroe, Livingston, and Ontario Counties (Region 4) shall be increased by 10%. These flow increases shall be applied for all methodologies used to determine current flow rates (NYSDOT 2018).

To assess hydraulic capacity for this study, the USGS *StreamStats* tool was used to calculate the bankfull widths and discharge for each structure along Honeoye Creek. Table 11 indicates that the majority structures crossing Honeoye Creek do not have the appropriate width to successfully pass a bankfull discharge event, including major crossings such as: the Livonia, Avon, and Lakeville Railroad; W Henrietta Road/NY-15; E Henrietta Road/NY-15A; N Main Street/NY-65; East Street/NY-65; Ontario Street/NY-65; NY-65; County Road 37; and County Road 15.

The structures with widths that are slightly wider, but still close to the bankfull width, such as the Main Street/US-20A, indicate that water velocities have to slow and contract in order to pass through the structures, which can cause sediment depositional aggradation and the accumulation of sediment and debris. Aggradation can lead to the development of sediment and sand bars, which can cause upstream water surfaces to rise, increasing the potential for overtopping banks or backwater flooding. Since the bankfull discharge required for WSEL to reach the bankfull width is low (e.g., 80% ACE), the likelihood of relatively low-flow events causing backwater and potential flooding upstream of these structures is fairly high.

Table 11. Hydraulic Capacity of Potential Constriction Point Bridges Crossing Honeoye Creek

Source: NYSDOT 2019b; USGS 2021d

Structure Carried	Type	River Station (ft)	Structure Length (ft)	Bankfull Width (ft)	Bankfull Discharge (cfs)	Annual Chance Flood Event Equivalent [1]
Livonia, Avon & Lakeville Railroad	Railroad	8+00	105	140	2,710	> 20-percent
East River Road	Bridge	102+50	126	140	2,690	> 20-percent
I-390 SB	Bridge	189+00	439	139	2,680	> 20-percent
I-390 NB	Bridge	191+00	424	139	2,680	> 20-percent
NY-15 / W Henrietta Road	Bridge	226+75	104	139	2,680	> 20-percent
Railroad Bridge (1)	Railroad	296+45	107	135	2,550	> 20-percent
NY-15A / E Henrietta Road	Bridge	408+75	110	134	2,520	> 20-percent
Railroad Bridge (2)	Railroad	540+25	126	132	2,450	> 20-percent
Plains Road	Bridge	560+50	108	132	2,450	> 20-percent
Sibley Road	Bridge	690+00	90	128	2,350	> 20-percent
NY-65 / N Main Street	Bridge	822+00	65	122	2,150	> 20-percent
NY-65 / East Street	Bridge	847+50	63	122	2,150	> 20-percent
NY-65 / Ontario Street	Bridge	910+50	111	120	2,110	> 20-percent
NY-65	Bridge	961+50	101	120	2,110	> 20-percent
Martin Road	Bridge	972+25	88	120	2,110	> 20-percent
NY 5 & 20 / US-20	Bridge	1144+00	127	120	2,090	> 20-percent
Factory Hollow Road / Pond Road	Bridge	1195+00	87	119	2,080	> 20-percent
Unnamed Road (1)	Bridge	1217+00	88	119	2,080	> 20-percent

Source: NYSDOT 2019b; USGS 2021d						
Structure Carried	**Type**	**River Station (ft)**	**Structure Length (ft)**	**Bankfull Width (ft)**	**Bankfull Discharge (cfs)**	**Annual Chance Flood Event Equivalent [1]**
Unnamed Road (2)	Bridge	1229+00	88	119	2,070	> 20-percent
Unnamed Road (3)	Bridge	1246+50	88	119	2,070	> 20-percent
Unnamed Road (4)	Bridge	1292+00	88	119	2,070	> 20-percent
Unnamed Road (5)	Bridge	1318+50	88	119	2,070	> 20-percent
Unnamed Road (6)	Bridge	1347+50	88	119	2,070	> 20-percent
Unnamed Road (7)	Bridge	1370+00	88	119	2,060	> 20-percent
Unnamed Road (8)	Bridge	1390+00	88	119	2,060	> 20-percent
County Road 37	Bridge	1622+00	103	108	1,770	> 20-percent
County Road 15	Bridge	1682+00	63	74.6	936	> 20-percent
Main Street / US-20A	Bridge	1835+00	75	68.2	807	> 20-percent
Footbridge (1)	Footbridge	1843+00	46	59	633	> 20-percent
Footbridge (2)	Footbridge	1851+00	46	58.6	625	> 20-percent
Mill Creek						
East Lake Road	Bridge	52+00	44	34.7	261	80-percent

[1] Annual Chance Flood Event Equivalent describes the equivalent annual chance flood event for the given bankfull discharge as calculated by the USGS *StreamStats* application. For example, the 80-percent annual chance flood event is equal to a 1.25-yr recurrence interval.

4. CLIMATE CHANGE IMPLICATIONS

4.1 FUTURE PROJECTED STREAM FLOW IN HONEOYE CREEK

In New York State, climate change is expected to exacerbate flooding due to projected increases of 1-8% in total annual precipitation coupled with increases in the frequency, intensity, and duration of extreme precipitation events (events with more than 1, 2, or 4 inches of rainfall) (Rosenzweig et al. 2011). In response to these projected changes in climate, NYS passed the *Community Risk and Resiliency Act* (CRRA) in 2014. In accordance with the guidelines of the CRRA, the NYSDEC released the *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act* (2020) report. In the report, two methods for estimating projected future discharges were discussed: an end of design life multiplier and the USGS *FutureFlow Explorer* map-based web application (NYSDEC 2020).

USGS *FutureFlow Explorer* v1.5 is discussed as a potential tool to project peak flows under various climate scenarios into the future. *FutureFlow* was developed by the USGS in partnership with the NYSDOT. This application is an extension for the USGS *StreamStats* map-based web application and projects future stream flows in New York State. The USGS team examined 33 global climate models and selected five that best predicted past precipitation trends in the region. The results were then downscaled to apply to all six hydrologic regions of New York State. Three time periods can be examined: 2024-2049, 2050-2074 and 2075-2099, as well as two Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway (RCP) greenhouse gas emission scenarios: RCP 4.5 and RCP 8.5. RCP 4.5 is considered a midrange-emissions scenario, and RCP 8.5 is a high-emissions scenario (Taylor et al. 2011; NYSDEC 2020).

In general, climate models are better at forecasting temperature than precipitation and contain some level of uncertainty with their calculations and results. The USGS recommends using *FutureFlow* projections as qualitative guidance to see likely trends within any watershed and as an exploratory tool to inform selection of appropriate design flow. Current future flood projection models will not provide accurate results for basins that extend across more than one hydrologic region in New York (NYSDEC 2020).

Based on the current future flood projection models, flood magnitudes are expected to increase in nearly all cases in New York State, but the magnitudes vary among regions. While the *FutureFlow* application is still being upgraded, it can be used with appropriate caution. Climate model forecasts are expected to improve and as they do, the existing regression approach will be tested and refined further (NYSDEC 2020).

In an effort to improve flood resiliency of infrastructure in light of future climate change, the NYSDEC outlined infrastructure guidelines for bridges (NYSDEC 2020). The minimum hydraulic design criteria for a bridge is 2 ft of freeboard over the 2% ACE elevation, while still allowing the 1% ACE flow to pass under the low chord of the bridge without going into pressure flow. For critical bridges, the minimum hydraulic design criteria is 3 ft of freeboard over the 2% ACE elevation. A critical bridge is considered to be vital infrastructure that the incapacity or destruction of such would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters (NYSDEC 2020; NYSDOT 2019a; USDHS 2010).

The NYSDEC recommends that future peak flow conditions should be adjusted by multiplying relevant peak flow parameters by a factor specific to the expected service life of the structure and geographic location of the project. For Monroe, Livingston, and Ontario Counties, the recommended design-flow multiplier is 10% increased flow for an end of design life of 2025-2100 (NYSDEC 2020). Table 12 provides a summary of the projected future peak stream flows using the FEMA FIS peak discharges and 10% CRRA design multiplier.

Table 12. Honeoye Creek Projected Peak Discharges

Source: FIA 1977a; FEMA 2008b; NYSDEC 2020						
			Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**10-Percent**	**2-Percent**	**1-Percent**	**0.2-Percent**
At confluence with Genesee River	265.3	0+00	4,686	7,865	9,581	14,960
Upstream of Stoney Brook	258.4	235+50	4,345	7,304	8,888	13,860
At Town of Rush/Town of Mendon corporate limits	232.8	525+00	4,224	7,095	8,635	13,475
At railroad	230	544+00	4,191	7,040	8,558	13,343
Below Spring Brook	220	707+00	4,048	6,776	8,250	12,870
At Town of Mendon/Town of Honeoye Falls corporate limits	196	734+00	3,722	6,243	7,605	11,853
At gaging station (Main Street Bridge)	195	817+00	3,708	6,219	7,577	11,807
Downstream of Town of West Bloomfield corporate limit	192	942+00	3,666	6,149	7,490	11,673
Downstream of Confluence of Bebee Creek	176	1500+00	3,438	5,765	7,024	10,945
Upstream of Confluence of Bebee Creek	156	1501+00	3,144	5,272	6,424	10,010

Appendix H contains the HEC-RAS simulation summary sheets for the proposed and future condition simulations. The HEC-RAS model simulation results for the future condition model parameters using the future projected discharge values are similar to the base-condition model output, with the only difference being future projected WSELs are up to 1.0 ft higher at specific locations, generally upstream of bridges due to backwater, as a result of the increased discharges.

Table 13 provides a comparison of HEC-RAS existing condition, using FEMA FIS peak discharges, and future condition, using CRRA 10% design flow multiplier, WSEL at select locations along Honeoye Creek.

Table 13. HEC-RAS Existing and Future Conditions Water Surface Elevation Comparison

Source: FIA 1977a; FEMA 2008b						
			Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**10-Percent**	**2-Percent**	**1-Percent**	**0.2-Percent**
At confluence with Genesee River	265.3	0+00	+ 0.3	+ 0.4	+ 0.4	+ 0.6
Upstream of Stoney Brook	258.4	235+50	+ 0.5	+ 0.6	+ 0.3	+ 0.4
At Town of Rush/Town of Mendon corporate limits	232.8	525+00	+ 0.3	+ 0.4	+ 0.4	+ 0.6
At railroad	230	544+00	+ 0.3	+ 0.4	+ 0.5	+ 0.6
Below Spring Brook	220	707+00	+ 0.2	+ 0.3	+ 0.4	+ 0.3
At Town of Mendon/Town of Honeoye Falls corporate limits	196	734+00	+ 0.3	+ 0.5	+ 0.5	+ 0.7
At gaging station (Main Street Bridge)	195	817+00	+ 0.5	+ 0.7	+ 0.7	+ 1.0
Downstream of Town of West Bloomfield corporate limit	192	942+00	+ 0.1	0.0	+ 0.5	0.0
Downstream of Confluence of Bebee Creek	176	1500+00	+ 0.4	+ 0.6	+ 0.4	+ 0.6
Upstream of Confluence of Bebee Creek	156	1501+00	+ 0.4	+ 0.6	+ 0.4	+ 0.6

[1] Positive changes in water surface elevation indicate the future conditions water surface elevation is higher than the existing condition.

5. FLOODING CHARACTERISTICS

5.1 FLOODING HISTORY

Flooding along Honeoye Creek can occur during any season as a result of numerous natural processes, including: the collusion of a large mass of warm moisture-laden air form the north; from sharp rises in temperature in the spring that melt the snow cover of the basin and are followed by rains; and from localized thunderstorms. Most often, floods occur in the late winter-early spring months when melting snow may combine with intense rainfall to produce increased runoff (FEMA 2008b).

In the Town of Rush, the principal flooding sources are the Genesee River, Honeoye Creek and most of their major tributaries. Heavy rain, especially when occurring in the spring and combined with snow melt, have frequently caused high water and stream flooding. The largest known flood was in March 1865, while other notable floods occurred in 1875, 1902, 1913, 1916, 1960, and June 1972 (Tropical Storm Agnes). Flooding in the Town of Rush affects some of the rural areas that are under pressure for development from the expanding Rochester metropolitan area (FEMA 1981b).

In the Town of Mendon, the principal flooding sources are Honeoye Creek and Irondequoit Creek and the primary tributaries into these two creeks. Heavy rains, especially those in the spring, combined with snowmelt have frequently caused high water and flooding. The most extensive storm to occur in the town was Tropical Storm Agnes from June 21 to June 23, 1972, where approximately 4.5 inches of rain fell in a three day period. On Honeoye Creek the maximum recorded discharge was 4,800 cubic feet per second (cfs) with a recurrence interval of approximately 30-years. The areas of flooding in Mendon are areas that are under pressure to be developed from the expanding Rochester metropolitan area but are presently rural in character (USACE 1973; FEMA 1981a).

In the Village of Honeoye Falls, Honeoye Creek is the only stream of appreciable size in the village, and flood damages tend to be minimal. In the village center, where development is most concentrated, the flood waters often flood basements along Ontario and York Streets, while north of the village center, only a small area of farmland floods (FIA 1977b).

In the Town of West Bloomfield, large magnitude floods have occurred eight times during the fifty-year period from 1917 to 1967, causing extensive damage to business, utilities, transportation, and homes predominately as a result of flooding from the Genesee River. These floods occurred in 1927, 1935, 1942, 1950 (two floods), 1956, 1960, 1961, and June 1972 (Tropical Storm Agnes). Honeoye Creek is the only stream of appreciable size in the town, and damage as a result of flooding is generally minimal. Nevertheless, the flood waters do often damage good farmland. Due to the essentially residential character of the floodplain in the Town, development along Honeoye Creek is minimal and only a few homes very close to the creek encounter basement flooding during flood events (FIA 1977a).

In the Town of Richmond, the principal flood problems consist of overbank flooding at times of high discharges. Areas particularly susceptible to overbank flooding are at the confluence of Mill and Honeoye Creeks and at Frost Hollow on the Hemlock Outlet. Damage estimates are not available (FEMA 1984b).

According to FEMA flood loss data, there has been a total of 85 NFIP claims totaling approximately $1.2 million in building and contents payments since 1979 in the Towns of Rush, Mendon, and Richmond. Data for West Bloomfield was not made publicly available for the Ontario County All Hazard Mitigation Plan (G/FLRPC 2018). In addition, there are two properties identified as repetitive loss, one of which is also identified as a severe repetitive loss property. Both of these properties are located in the Town of Richmond (Tetra Tech 2017; G/FLRPC 2018; FEMA 2019). Table 14 summarizes the total number of NFIP policies, claims, loss payments, and repetitive loss properties for the Towns of Rush, Mendon, and Richmond and Village of Honeoye Falls.

Table 14. FEMA NFIP Summary Statistics from 1979 to 2016

Source: Tetra Tech 2017; G/FLRPC 2018; FEMA 2019

Community Name	No. of Policies	No. of Claims (Losses)	Total Loss Payments ($ USD)	No. of RL Properties	No. of SRL Properties
Rush	10	3	$1,850	0	0
Mendon	23	3	$20,426	0	0
Honeoye Falls *	18	2	$17,355	0	0
West Bloomfield	Data Not Available			0	0
Richmond	49	79	$1,144,568	2	1
Total	82	85	$1,166,844	2	1

* Note: Village of Honeoye Falls data is included in the Town of Mendon data.

A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-yr period, since 1978. A Severe Repetitive Loss (SRL) property is any insurable building for which four or more claims of more than $5,000 (or cumulative amount exceeding $20,000) were paid by the NFIP, or at least two separate claim payments have been made with the cumulative amount exceeding the fair market value of the insured building on the day before each loss within any rolling 10-yr period, since 1978 (FEMA 2019; FEMA 2021). It is important to note that the FEMA flood loss data only represents losses for property owners who participate in the NFIP and have flood insurance.

FEMA FIRMs are available for Honeoye Creek from FEMA. Figures 5-1 and 5-2 display the Zone AE and A (1% ACE) boundaries for Honeoye Creek as determined by FEMA for the Towns of Rush and Mendon in Monroe County, and Towns of West Bloomfield and Richmond in Ontario County, respectively. The maps indicate that in the Honeoye Creek watershed, flooding generally occurs downstream of the outlet of Honeoye Lake in the Hamlet of Honeoye, in the Village of Honeoye Falls, and the confluence with the Genesee River (FEMA 1996; FEMA 2008a).

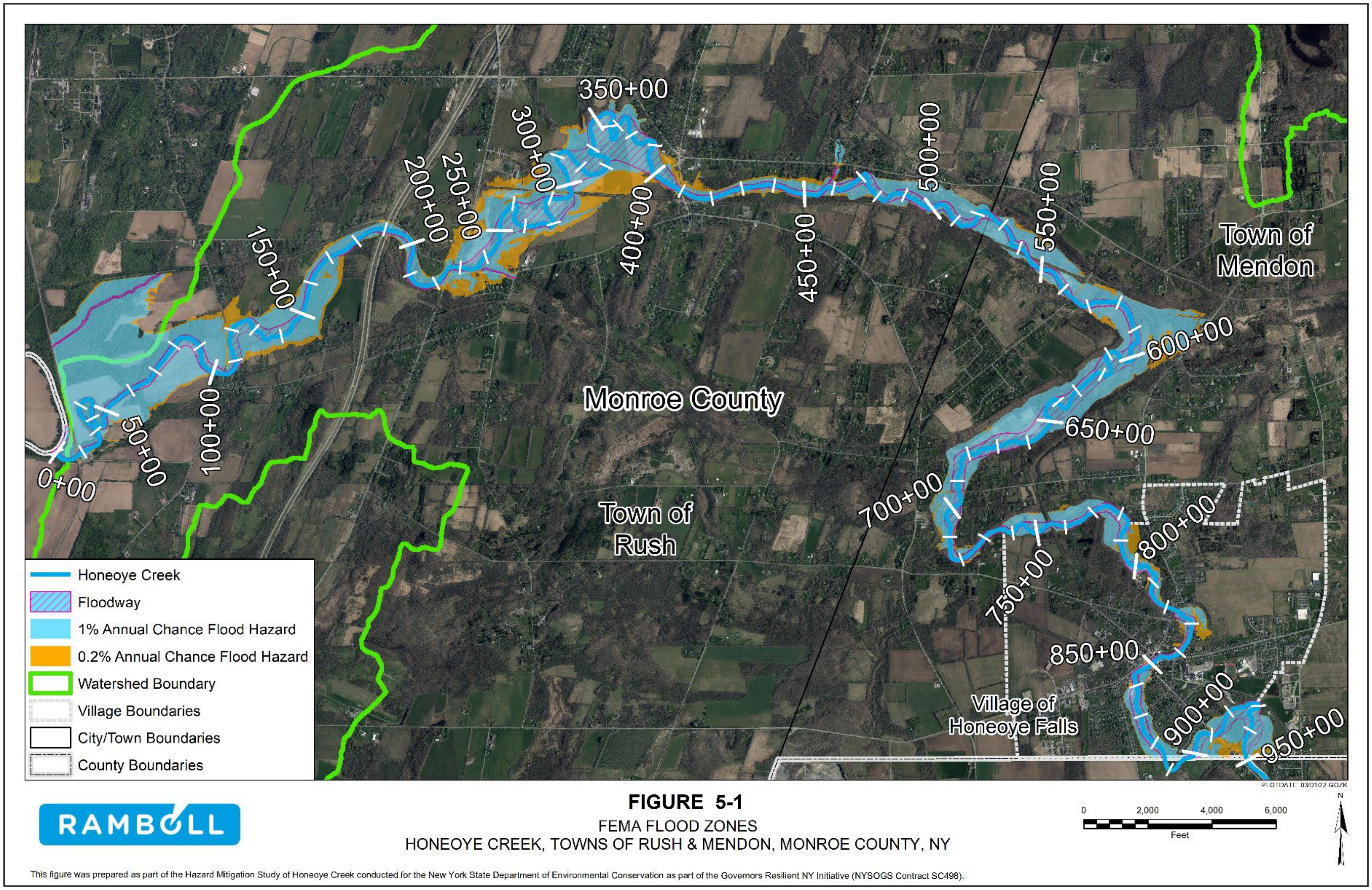
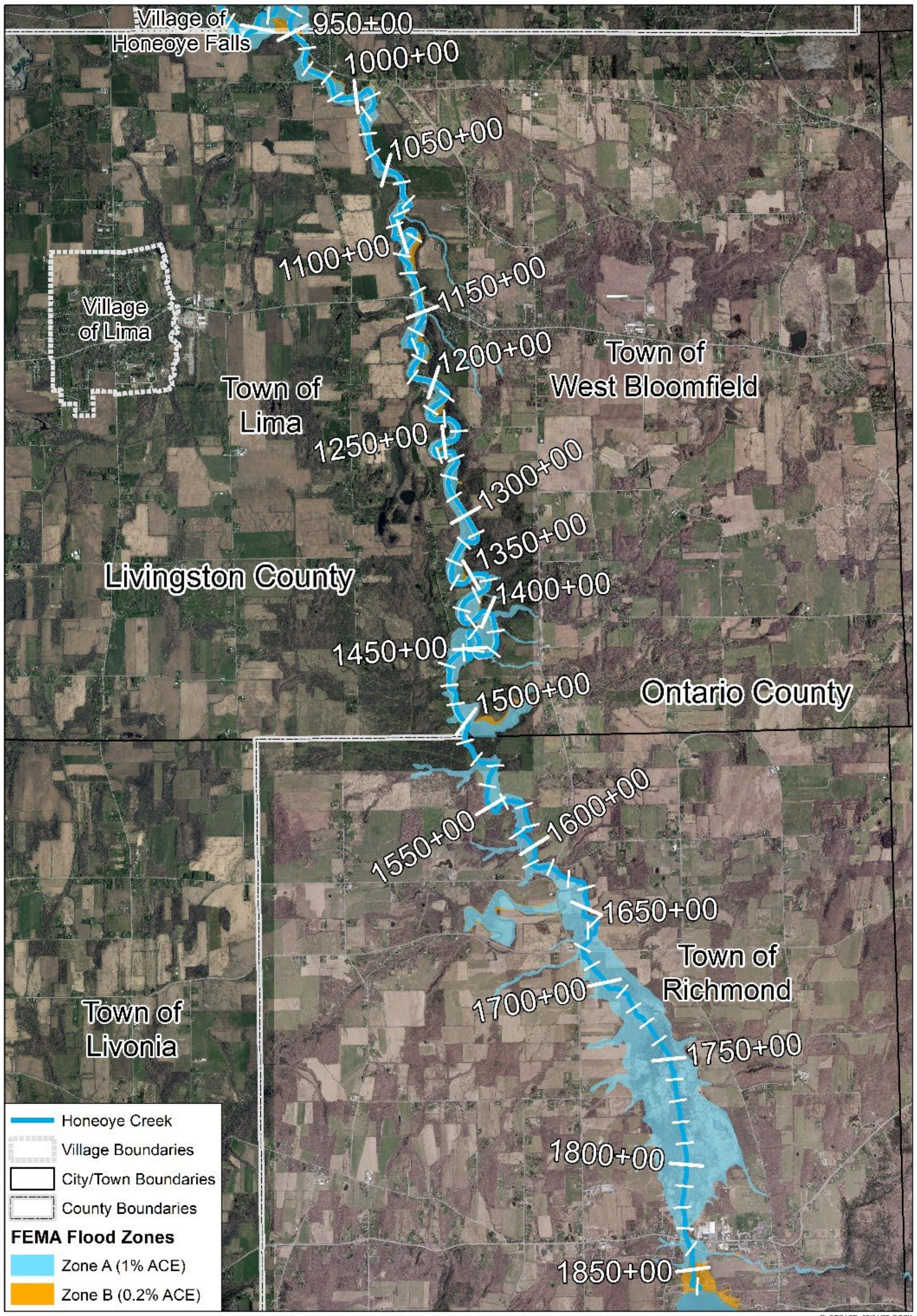


Figure 5-1. Honeoye Creek, FEMA flood zones, Towns of Rush and Mendon, Monroe County, NY.

*Note: This map was created using FIRMs georeferenced to the earth's surface. This figure is not official and may not be used for regulatory purposes.



This figure was prepared as part of the Hazard Mitigation Study of Chittenango Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY Initiative (NYSOGS Contract SC498).

FIGURE 5-2
FEMA FLOOD ZONES
HONEOYE CREEK, TOWNS OF WEST BLOOMFIELD & RICHMOND
ONTARIO COUNTY, NY

Figure 5-2. Honeoye Creek, FEMA flood zones, Towns of West Bloomfield and Richmond, Ontario County, NY.

*Note: This map was created using FIRMs georeferenced to the earth's surface. This figure is not official and may not be used for regulatory purposes.

5.2 ICE-JAM FLOODING

An ice jam typically occurs in the late winter and early spring in ice-covered streams when ice accumulates at man-made (e.g., bridge piers, dams) or natural narrower or shallower sections or meanders of a river slowing down or blocking the incoming ice by bridging the ice across the width of the river (USACE 2006).

As the air temperature drops, the water temperature reaches freezing temperatures and starts to form frazil ice crystals in the water column. These ice crystals travel in the water column (suspended ice) with the river currents, growing in concentration, and losing heat while traveling. They float on the surface (surface ice), and as the crystals grow in size, they form surface frazil ice. As the air temperature continues to drop, temperature losses from the water and frazil ice create more surface ice, and thicken the existing surface frazil ice, increasing the surface ice concentrations on the river as it approaches colder winter temperatures. The presence of surface and suspended frazil ice increases resistance to the flow, thus increasing the water levels of rivers in the wintertime. Increasing concentrations of surface and suspended frazil ice increase the potential for ice jam formation, which can inhibit the flow of water in the channel, affecting both upstream and downstream water levels (USACE 2006).

An existing ice jam can break-up and travel downstream along with larger ice particles with the higher flows of a flash flood and accumulate at a constricted downstream location creating another break-up ice jam, or damage downstream riverbanks or downstream infrastructures severely. Ice-jam flooding presents a complex problem for scientists and engineers since the resulting flood stage can be significantly higher than the flood stage caused from streamflow alone. In other words, a relatively minor discharge of streamflow can result in a major flooding event during an ice jam (USACE 2006).

According to the USACE Cold Regions Research and Engineering Laboratory (CRREL) ice jam database, National Centers for Environmental Information (NCEI) storm events database, and the stakeholder engagement meeting, there have been at least eleven ice-jam flooding events along Honeoye Creek since 1950 (NYSDEC 2021a; CRREL 2022; NCEI 2022).

Based on the historical ice-jam records and stakeholder input, the areas along Honeoye Creek with the highest potential for ice-jam formation is in the Village of Honeoye Falls and Hamlet of Honeoye in the Town of Richmond. The study area for this report focused on the Hamlet of Honeoye in the Town of Richmond and Village of Honeoye Falls and includes an analysis of the effects each flood mitigation measure would have on the aforementioned ice-jam prone area. This area is vulnerable to ice-jam flooding due to a combination of infrastructure, development, and channel characteristics of Honeoye Creek.

In order to determine the most appropriate mitigation measures to address ice-jam flooding along Honeoye Creek, additional hydraulic and hydrologic modeling using ice simulation models and ice-jam specific mitigation measures, as outlined in Appendix E, are recommended for each ice-jam prone area.

6. FLOOD RISK ASSESSMENT

6.1 FLOOD MITIGATION ANALYSIS

For this study of Honeoye Creek, standard H&H study methods were used to determine and evaluate flood hazard data. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-yr period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-yr floods, have a 10-, 2-, 1-, and 0.2% chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. The analyses reported herein reflect flooding potentials based on conditions existing in the watershed at the time of completion of this study (FEMA 1984b).

Hydraulic analysis of Honeoye Creek was conducted using the HEC-RAS v6.2.0 program (USACE 2021). The HEC-RAS computer program was developed by the USACE Hydrologic Engineering Center (HEC) and is considered to be the industry standard for riverine flood analysis. The model is used to compute water surface profiles for 1- and 2-Dimensional (2-D), steady-state, or time-varied (unsteady) flow. In 1-Dimensional (1-D) solutions, the water surface profiles are computed from one cross section to the next by solving the Energy or Momentum equations with an iterative procedure (i.e., standard step backwater method) for Steady Flow. 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 (USACE 2016a).

H&H modeling of Honeoye Creek was completed by FEMA between 1977 and 1984 with an updated redelineation study for Monroe County in 2008. Due to the age and format of the FIS studies, an updated 1-D HEC-RAS model was developed using the following data and software:

- High resolution LiDAR DEM data:
  - 2019 Livingston County 1-meter LiDAR data with a vertical accuracy of 0.164-meters (8 inches) in the NAVD88 vertical datum (NYSOITS 2019)
  - 2017 Monroe County 1-meter LiDAR data with a vertical accuracy of 0.117-meters (6 inches) in the NAVD88 vertical datum (MCDES 2017)
  - 2006 Ontario County LiDAR 2-meter LiDAR data with a vertical accuracy of 0.179-meters (8 inches) in the NAVD88 vertical datum (IAGT 2007)
- New York State Digital Ortho-Imagery Program aerial imagery (NYSOITS 2018; NYSOITS 2020)
- National Land Cover Database (NLCD) data (USGS 2021b)
- RAS Mapper extension in HEC-RAS software (USACE 2021)

- NYSDOT bridge data (NYSDOT 2019b)
- NYSDEC dams data (NYSDEC 2021b)

The hydraulics model developed for Honeoye Creek begins at the confluence with the Genesee River (river station 0+00) and extends upstream to the outlet at Honeoye Lake (river station 1890+00).

6.1.1 Methodology of HEC-RAS Model Development

Using the LiDAR DEM data, orthoimagery, land cover data, and the RAS Mapper extension in the HEC-RAS software, an existing condition hydraulic model was developed using the following methodology:

- LiDAR DEMs were converted to the NYS Plane Central coordinate system to convert DEM units from meters to feet, then the three different DEMs were mosaicked together into one uniform data layer.
- Main channel, bank lines, flow paths, and cross-sections, which were drawn along the main channel at stream meanders, contraction/expansion points, and at structures, were digitized in RAS Mapper.
- LiDAR DEM data, and NLCD land cover data, terrain profiles with elevations, cross-section downstream reach lengths, and Manning's n values were extracted for each cross-section using the built-in RAS Mapper tools.
- The portion of the 1-D model that included Honeoye Falls in the Village of Honeoye Falls caused supercritical flows due to the steep elevation change in this reach. A drop structure at the top of Honeoye Falls was used to model the waterfall to maintain subcritical flow through this reach.
- All features, including cross sections, Manning's n values, ineffective flow areas, and bridge/culvert data, were verified using standard quality assurance/quality control (QA/QC) procedures to ensure accuracy and model stability
- After review, a 1-D steady flow simulation was performed using FEMA FIS peak discharges for existing conditions and the CRRA 10% design life multiplier for future conditions

Downstream boundary conditions for the base and future conditions models were assessed using the Normal Depth method. Normal depth was calculated using the friction slope (Sf in Manning's equation), which is the slope of the energy grade line, and can be estimated by measuring the slope of the bed at the downstream reach (USACE 2022). For this model, the slope between the last three cross sections was used and calculated to be 0.00007.

The Normal Depth method was used as the downstream boundary due to the more conservative nature of the values, appropriateness for the updated H&H modeling being performed, and lack of significant backwater effect from the Genesee River in both the Monroe County and Town of Rush FEMA FIS profile plots.

The existing condition model WSELs were then compared to the effective FEMA FIS water surface and elevation profiles and the effective FEMA FIRMs to evaluate the model results. The 1-D model results for the existing conditions were found to be in line and reasonable with the effective FEMA products. The existing conditions model was then used to develop proposed condition models to simulate potential flood mitigation strategies. The simulation results of the proposed conditions were evaluated based on their reduction in WSELs.

The effectiveness of each potential mitigation strategy was evaluated based on reduction in WSELs within the 1-D H&H model simulations. The flood mitigation strategies that were modeled in 1-D were:

- #1-1: Remove Railroad Abutments
- #1-3: Flood Benches Upstream and Downstream of N Main Street/NY-65
- #1-4: Increase Size of N Main Street/NY-65 Bridge Opening
- #1-6: Flood Benches Upstream of Honeoye Falls
- #1-7: Increase Size of Ontario Street/NY-65 Bridge Opening
- #1-8: Flood Benches Upstream and Downstream of Ontario Street/NY-65
- #2-1: Flood Benches at Confluence of Honeoye and Mill Creeks
- #2-2: Increase Size of Main Street/US-20A Bridge Opening
- #2-4: Sediment Removal Analysis in the Vicinity of Main Street/US-20A

The remaining alternatives were either qualitative in nature or required additional advanced H&H modeling (i.e., 2-D, 3-D, etc.) outside of the scope of this study.

As the flood mitigation strategies discussed in this study are at this point preliminary, inundation mapping was not developed from the computed water surface profiles for each potential mitigation alternative. Inundation shown on figures in Section 7 Mitigation Alternatives is based on the computed 1-D WSELs statically imposed over a 2-D ground surface by the built-in RAS Mapper extension in the HEC-RAS v6.2 software. The software horizontally distributes the computed WSEL over the cross-section and any ground elevation below the computed WSEL is inundated up to the computed WSEL. As a result, areas that are not hydrologically connected to the floodplain (i.e., overbank areas) may appear inundated.

Note that stationing references for Honeoye Creek for Sections 1 through 6 of this report are based on the USGS National Hydrography Dataset (NHD) for Honeoye Creek (USGS 2021a); however, stationing references for the flood mitigation measures (Section 7) are based on the HEC-RAS model software. While every attempt was made to ensure consistency in the stationing values, the values may differ as a result of the differences in the data sources and methodologies.

6.1.2 1-D Model Limitations

For this study, a 1-D HECRAS model was developed to model the existing conditions and effectiveness of the proposed mitigation alternatives. Based on the topographic and geomorphic features of the Honeoye Creek watershed and the recommendations of the USACE for 1-D versus 2-D modeling, the project team concluded the best model for this study was 1-D. However, the project team did determine certain limitations in the 1-D model that should be noted. These limitations include:

- Potential overflow areas, which are areas where WSELs exceed the adjacent terrain geometry, were found in a number of locations along Honeoye Creek. The HEC-RAS program approximates a "vertical wall" at the end of any cross section with an overflow area to maintain model stability. The potential overflow areas along Honeoye Creek were: the confluences with Hemlock Outlet, Bebee Creek, Spring Brook, the Genesee River, and the Hamlet of Rochester Junction adjacent to the Lehigh Valley Trail and Clover Street/NY-65.
- The accuracy of a 1-D model in determining WSELs in the overbank areas outside of the main channel diminishes the further away from the main channel the user defines an overbank area. Portions of the Honeoye Creek watershed, including the confluence with the Genesee River, Hamlet of Rush upstream of West Henrietta Road, Hamlet of Rochester Junction adjacent to the Lehigh Valley Trail and Clover Street/NY-65, and downstream of the Hamlet of Honeoye, have wide and relatively flat floodplains which led to cross sections with large overbank areas in the 1-D model. A more appropriate analysis of overbank areas would require lateral 2-D storage areas in the overbank parallel to the main channel; however, this type of analysis is outside of the scope of this study.
- In general, LiDAR does not capture channel thalweg due to interference and scattering by water of the LiDAR signal. No bathymetric modifications were done to the existing model to correct for this limitation. However, for this study, some of the flood mitigation strategies that were modeled incorporated modifications to the main channel or in the immediate overbank areas, such as the flood bench and sediment removal alternatives.
- The existing conditions model results were compared to the effective FEMA FIS and FIRMs and were found to be in line and reasonable with the effective FEMA products. Therefore, the results from the proposed flood mitigation alternatives model simulations for this study were determined to be reasonable based on the existing conditions model comparison to the effective FEMA products.

6.1.3 Honeoye and Mill Creek 2-Dimensional H&H Modeling

Due to the complex nature of the confluence of Honeoye and Mill Creeks, the project team determined that a 2-D H&H model was necessary to accurately and appropriately model the existing and proposed conditions in the hamlet. An updated 2-D HEC-RAS model was developed using 2-ft contours from the 2006 Ontario County 2-meter LiDAR DEM (IAGT 2007), USGS *StreamStats* peak discharge data (USGS 2021d), and NYSDOT and Ramboll field-measured infrastructure data (NYSDOT 2019b; Ramboll 2022).

The following assumptions and approximations were made during the development of the 2-D model:

- In general, LiDAR does not capture channel thalweg due to interference and scattering by water of the LiDAR signal. No bathymetric modifications were done to the channels of either Mill or Honeoye Creeks to correct for this limitation within the model domain.
- Bathymetric modifications were done at two locations: the Main Street/US-20A (Honeoye Creek) and East Lake Road (Mill Creek) bridge crossings. Modifications were based on NYSDOT as-built designs (for East Lake Road only) and/or field inspections and measurements performed by Ramboll staff. The bathymetry under these infrastructure crossings were approximated using best available data.

The hydraulics model was developed for Mill Creek beginning at the confluence with Honeoye Creek and extending approximately 1,000 ft upstream of the East Lake Road bridge crossing, and for Honeoye Creek beginning at the outlet of Honeoye Lake and extending approximately 3,000 ft downstream of the Main Street/US-20A bridge crossing in the Town of Richmond.

A base condition model was developed using a 2-D computational mesh, which was generated with the available tools within the HEC-RAS software. The mesh was comprised of 30 by 30 feet base elements to best represent the topography of the Honeoye Creek watershed. Flow breaklines were added at both infrastructure crossings (Main St/US-20A and East Lake Road) with refined grid spacing of 10-15 feet to more accurately simulate the effects of these two structures on channel flow.

The 2-D computational mesh consists of approximately 31,804 cells with an average area of 839 square feet. Each cell of the mesh represents an individual solution to a hydraulic equation, which when combined over the entire mesh, produces a solution for the entire model area.

The riverine mesh elements are used to calculate energy losses in the entire system through friction. Frictional losses are typically derived through Manning's equation and the use of a Manning n value for roughness. Manning's n value is highly variable and depends on a number of factors, including size and shape of the channel, stage and discharge, seasonal changes, surface roughness, vegetation, channel irregularities, temperature, channel alignment, obstructions, scour and deposition, and suspended material and bedload. A Manning's roughness of 0.035 was used for the creek, while the remainder of the computational domain was assigned values from the NLCD Land Cover dataset (USACE 2010; USGS 2021b).

The upstream boundary conditions were determined using USGS *StreamStats* for existing conditions and the CRRA design life 10% multiplier for future conditions (USGS 2021d). Design Storm Hydrographs were developed using the Snyder Unit Method for both the existing and future conditions peak discharges. Table 15 displays the peak discharges for Mill and Honeoye Creeks used for the 2-D model.

Table 15. Current and Future Peak Discharges for Honeoye and Mill Creeks in the 2-D HECRAS Model

Source: USGS 2021d						
			Current Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**10-Percent**	**2-Percent**	**1-Percent**	**0.2-Percent**
Mill Creek						
At confluence with Honeoye Creek	13	0+00	800	1,140	1,290	1,640
Honeoye Creek						
Downstream of Main St/US-20A Bridge	56	1835+00	1,200	1,800	2,070	2,750
			Future Peak Discharges (cfs)			
Flooding Source and Location	**Drainage Area (Sq. Miles)**	**River Station (ft)**	**10-Percent**	**2-Percent**	**1-Percent**	**0.2-Percent**
Mill Creek						
At confluence with Honeoye Creek	13	0+00	880	1,250	1,420	1,800
Honeoye Creek						
Downstream of Main St/US-20A Bridge	56	1835+00	1,320	1,980	2,280	3,030

The downstream boundary condition for Honeoye Creek used the Normal Depth method and a value of 0.0013. A computational interval (i.e., time-step) of 2 seconds was used for all the flow scenarios and the simulation length was for 24-hours.

The 2-D existing condition model WSELs were then compared to the effective FEMA FIS water surface and elevation profiles and the effective FEMA FIRMs to evaluate the model results. The 2-D model results for the existing conditions were found to be in line and reasonable with the effective FEMA products. The existing conditions model was then used to develop proposed condition models to simulate potential flood mitigation strategies. The simulation results of the proposed conditions were evaluated based on their reduction in WSELs.

The effectiveness of the modeled potential mitigation strategy was evaluated based on reduction in WSELs within the 2-D H&H model simulations. The flood mitigation strategy that was modeled in 2-D was:

- #3-1: New Channel Geomorphology and Confluence with Mill Creek

The remaining alternatives were either qualitative in nature or required additional advanced H&H modeling (i.e., river ice break-up, sediment transport, etc.) outside of the scope of this study.

6.2 DEBRIS ANALYSIS

According to historical flood reports, stakeholder engagement meetings, and field work, the downstream portion of Honeoye Creek in the Village of Honeoye Falls and upstream portion in the Hamlet of Honeoye were identified as areas susceptible to debris and log jams on the upstream face of infrastructure crossing the creek (NYSDEC 2021a).

Along Honeoye Creek in this downstream reach, there are three bridges and two dams along the creek. Of these five infrastructure crossings, the locations of highest significance and risk of debris and log jams are the three bridge crossings: N Main Street/NY-65, East Street, and Ontario Street/NY-65. In the Hamlet of Honeoye, the Main Street/US-20A bridge crossing was identified as susceptible to debris and log jams (NYSDEC 2021a).

The debris analysis in this study used the 10% ACE (10-yr) to develop an existing condition with debris obstruction model simulation using the built-in Floating Pier Debris tool within the HEC-RAS model software (USACE 2021). Manual calibration of the width and height of the debris obstruction in the model was performed to reproduce historical flood levels caused by debris jams at known locations. The calibration determined that a 25% obstruction of the structure's opening reproduced the historical flood levels.

Using the calibrated debris specifications, the existing condition debris simulation model was used to test the effectiveness of the flood mitigation alternatives that influence flow through Honeoye Creek under both present and future conditions.

6.3 SEDIMENT ANALYSIS

Included in this study is a discussion of various sediment management strategies; however, only preliminary sediment analyses were performed for these strategies. The H&H modeling methodology used within this study was not designed to determine sediment source, transport, and/or loading.

Advanced H&H modeling analyses would be required for a sediment transport analysis to determine sources of sediment within the Honeoye and Mill Creek stream corridors.

6.4 ICE JAM ANALYSIS

The ice jam analysis in this study used the 10% ACE (10-yr) to develop an existing condition with ice cover model simulation at each identified ice-jam susceptible location using the built-in Ice Cover settings within the HEC-RAS model software. Where ice cover was modeled in the vicinity of bridges, the Ice Jam Computation Option under the Bridge/Culvert Data editor was changed to the option "ice remains constant through the bridge" in the HEC-RAS model software (USACE 2021).

Based on historical ice jam data, ice cover lengths and depths were obtained and input into the model. Manual calibration of the length and depth of the ice cover in the model was performed to reproduce historical flood levels caused by ice-jam events at known locations. The calibration determined that an ice cover of 1 ft deep by 1,000 ft long followed by an additional ice cover of 0.5 ft by 1,000 ft long upstream of an identified structure's opening reproduced the historical flood levels.

Using the calibrated ice cover specifications, the existing condition ice-cover simulation model was used to test the effectiveness of the flood mitigation alternatives that influence flow through Honeoye Creek under both present and future conditions.

6.5 COST ESTIMATE ANALYSIS

Rough order of magnitude (ROM) cost estimates were prepared for each mitigation alternative. In order to reflect current construction market conditions, a semi-analogous cost estimating procedure was used by considering costs of a recently completed, similar scope construction project performed in Upstate New York. Phase I of the Sauquoit Creek Channel and Floodplain Restoration Project in Whitestown, New York contained many elements similar to those found in the proposed mitigation alternatives.

Where recent construction cost data was not readily available, *RSMeans CostWorks* 2019 was used to determine accurate and timely information (RSMeans Data Online 2019). Costs were adjusted for inflation and verified against current market conditions and trends.

For mitigation alternatives where increases in bridge sizes were evaluated, bridge size increases were initially analyzed based on 2 feet of freeboard over the base flood elevation for a 1% ACE. Once the optimal bridge size was determined, further analyses were completed, including site constraints and constructability. Due to these additional constraints, for some mitigation measures the size necessary to meet existing and/or CRRA freeboard requirements were not feasible. Cost estimates were only performed for projects determined to be constructible and practical.

Infrastructure and hydrologic modifications will require permits and applications to New York State and/or FEMA, including construction and environmental permits from the state and accreditation, Letter of Map Revision (LOMR), etc. applications to FEMA. Application and permit costs were not incorporated in the ROM costs estimates.

In addition, no benefits-cost analyses were performed for any mitigation alternative due to the conceptual nature and preliminary designs of these alternatives, which would require further analysis and engineering to determine the appropriate benefits-cost ratios.

It should be noted that all ROM cost estimates are calculated at the time of the study. Cost data is based on current cost estimating data and is subject to change based on economic conditions.

6.6 HIGH-RISK AREAS

Based on the FEMA FIS, NCEI storm events database, historical flood reports, and stakeholder input from engagement meetings, two areas along Honeoye Creek were identified as high-risk flood areas in Monroe and Ontario Counties, New York.

6.6.1 High-Risk Area #1: Village of Honeoye Falls, Town of Mendon, Monroe County, New York

High-Risk Area #1 is the Village of Honeoye Falls, which encompasses the area between NY-65 and the County boundary at river station 950+00 downstream to the Village corporate limits at river station 737+50. Flooding in this area poses a threat to numerous residential properties along Ontario and York Streets and commercial properties along Monroe and East Streets. In addition, NYSDOT and County-owned infrastructure, including NY-65, Ontario Street, East Street, and North Main Street bridge crossings and the Wastewater Treatment Plant, are within the FEMA Zone AE (1% ACE) and shaded X (0.2% ACE) flood hazard areas and are at risk of flooding during high-flow or backwater events on Honeoye Creek (Figure 6-1).

According to the FEMA FIS for Monroe County, New York, the Ontario Street bridge is unable to successfully pass the 0.2% ACE hazard and does not provide the CRRA recommended 2 ft of freeboard for the 1% ACE (Figure 6-2).

This reach is also susceptible to sediment aggradation, ice jams, and tree and debris buildup from upstream sources. The former railroad bridge crossing and its abutments, and North Main and Ontario Streets have been identified as areas with the potential for aggradation, ice jams, and/or debris buildup. Aggradation, ice jams, and tree/debris buildup restrict the channel flow area, which can cause water surfaces to rise and potentially overtop banks or back water upstream of structures and/or meanders.

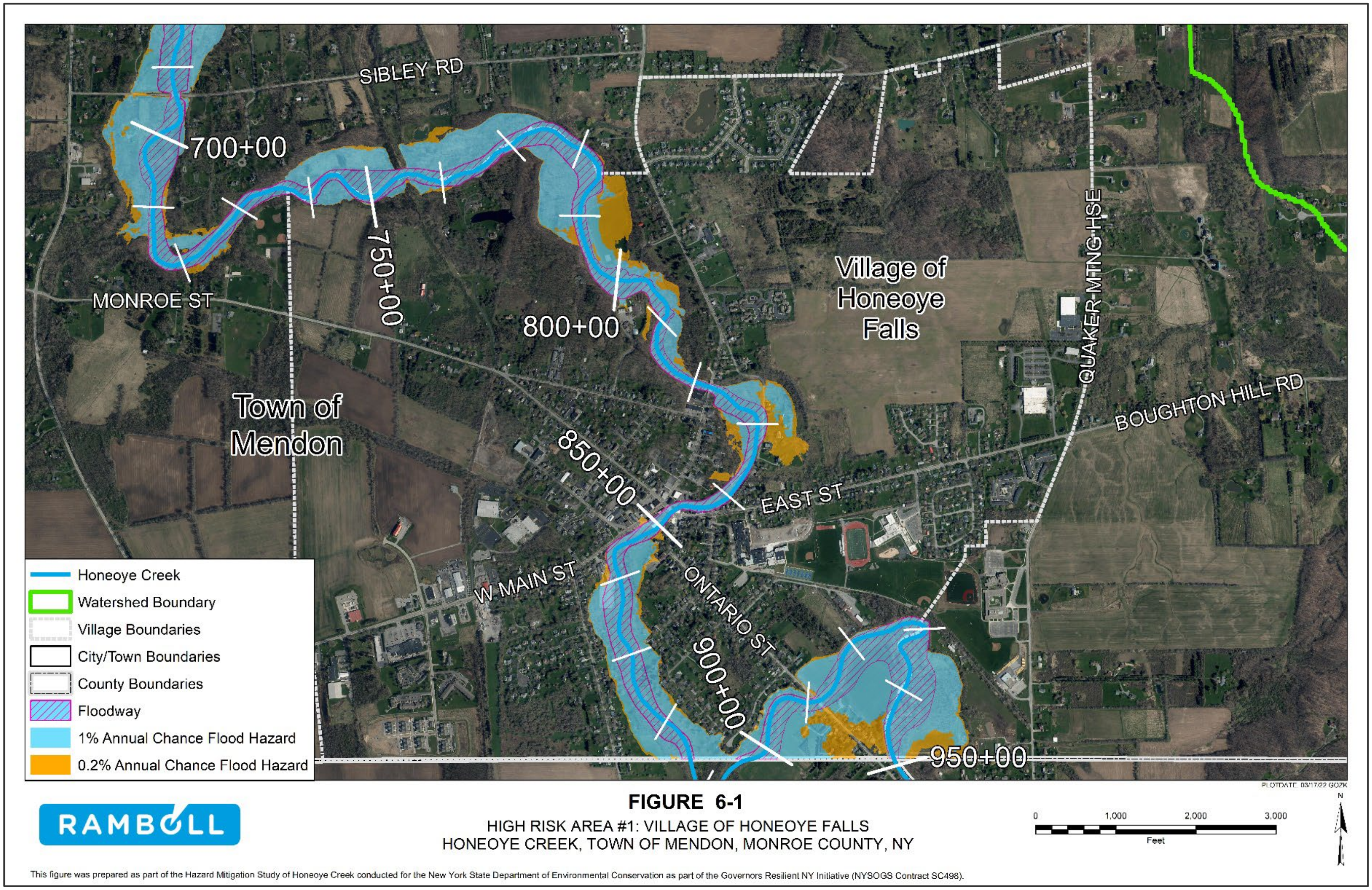


Figure 6-1. High Risk Area #1: Village of Honeoye Falls, Town of Mendon, Monroe County, NY.

*Note: This map was created using FIRMs georeferenced to the earth's surface. This figure is not official and may not be used for regulatory purposes.

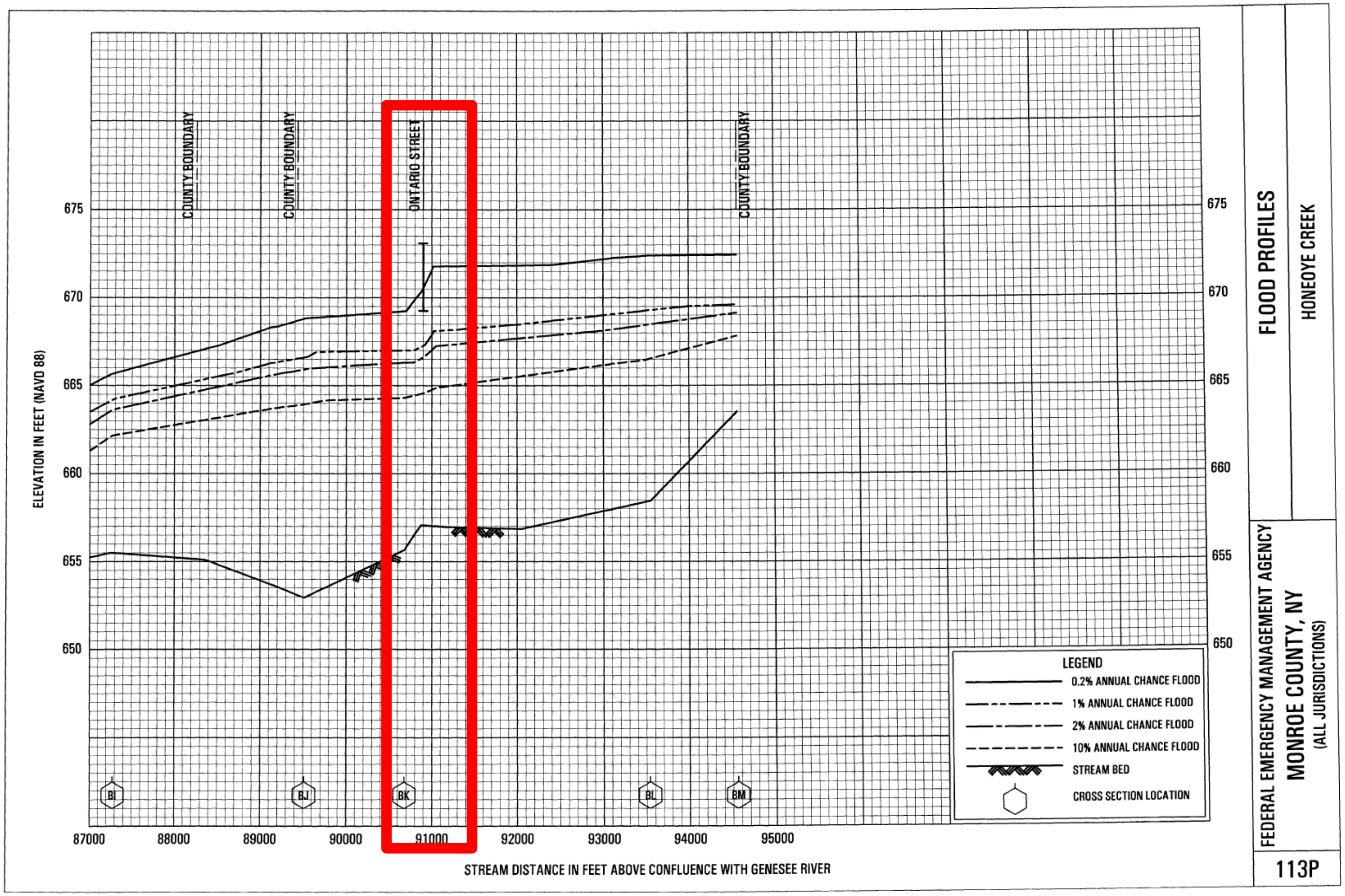


Figure 6-2. FEMA FIS profile for Honeoye Creek in the Village of Honeoye Falls, Town of Mendon, Monroe County, NY.

Note: Ontario Street is located at river station 909+00 on the FEMA FIS profile.

6.6.2 High-Risk Area #2: Hamlet of Honeoye, Town of Richmond, Ontario County, New York

High-Risk Area #2 is the Hamlet of Honeoye, which encompasses the area from the outlet of Honeoye Lake at river station 1870+00 downstream past the Main Street/US-20A bridge crossing to river station 1830+00. Flooding in this area poses a threat to numerous residential and commercial properties along Main Street/US-20A and areas along the Honeoye Creek banks. In addition, NYSDOT and Town-owned infrastructure, including the Main Street/US-20A bridge crossing and Wastewater Treatment Plant, are within the FEMA Zone A (1% ACE) flood hazard area and are at risk of flooding during high-flow or backwater events on Honeoye Creek (Figure 6-3).

According to the FEMA FIRM for the Town of Richmond, the Main Street/US-20A bridge crossing is a constriction point and causes backwater flooding to areas upstream of the bridge (Figure 6-4). In addition, the confluence with Mill Creek occurs immediately upstream of the Main Street/US-20A bridge. Discharge from Mill Creek increases the flow in Honeoye Creek as it passes under the Main Street/US-20A exacerbating any flooding or backwater potential in the area (FEMA 1984a).

This reach is also susceptible to sediment aggradation and debris buildup from upstream sources and Mill Creek. Aggradation and debris buildup restrict the channel flow area, which can cause water surfaces to rise and potentially overtop banks or back water upstream of structures and/or meanders.

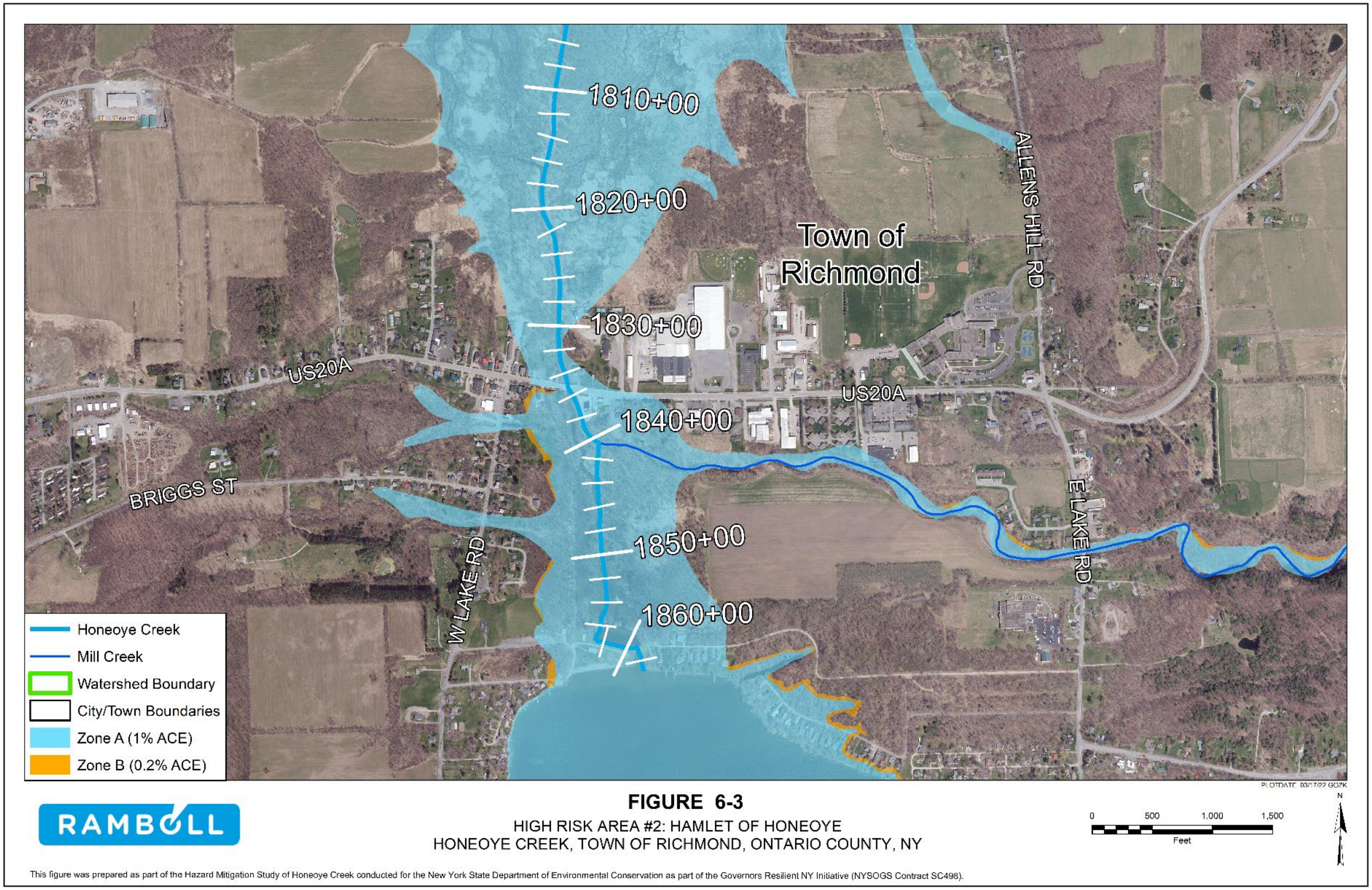


Figure 6-3. High Risk Area #2: Hamlet of Honeoye, Town of Richmond, Ontario County, NY.

*Note: This map was created using FIRMs georeferenced to the earth's surface. This figure is not official and may not be used for regulatory purposes.

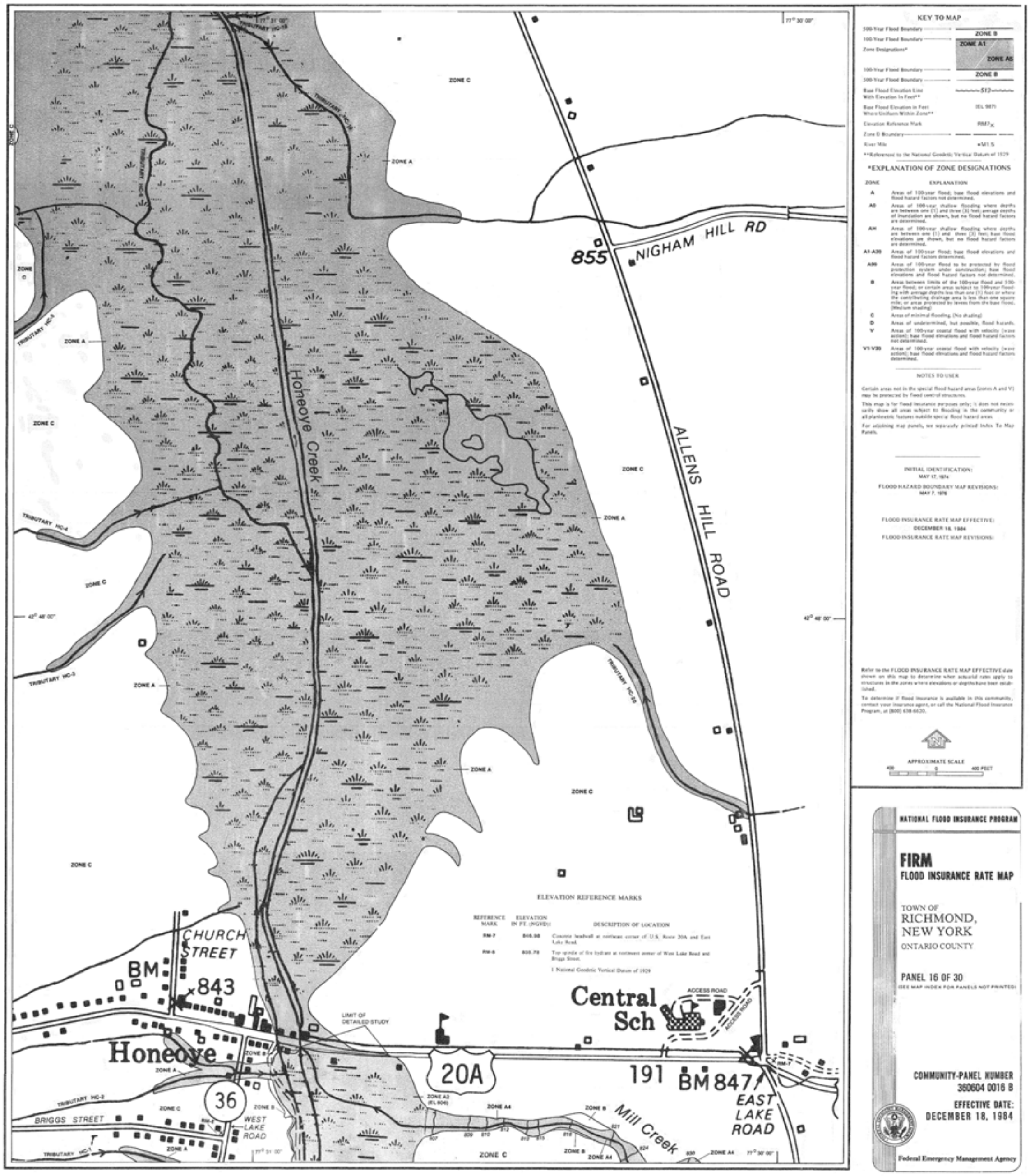


Figure 6-4. FEMA FIRM for the Hamlet of Honeoye, Town of Richmond, Ontario County, NY (FEMA 1984a).

6.6.3 Mill Creek, Town of Richmond, Ontario County, New York

Mill Creek is a small tributary to Honeoye Creek in the Town of Richmond. The downstream portion of Mill Creek within the Hamlet of Honeoye, New York where Honeoye and Mill Creek's merge was included in this study due to the significant impact that water flow and sediment from Mill Creek has on flooding and aggradation along Honeoye Creek within the hamlet. However in this study, only a preliminary analysis of flood risk and mitigation alternatives for Mill Creek was performed. Ramboll recommends performing a flood mitigation study with a focus on sediment and debris for Mill Creek in order to better understand flood risk and sediment transport within the Mill Creek watershed.

Mill Creek flows westerly into Honeoye Creek within the east central portion of the Town. It drains a small area immediately south of State Route 20A. The floodplain of Mill Creek is undeveloped, with some residences located at the crossing of East Lake Road and along Main Street/US-20A (FEMA 1984b).

Mill Creek has historically been a significant contributor to flood risk in the Town of Richmond, primarily at the confluence of Mill and Honeoye Creeks and in the vicinity of East Lake Road. Mill Creek also contributes a significant amount of sediment to Honeoye Creek due to streambank erosion along Mill Creek (NYSDEC 2021a).

The reach of Mill Creek included in this study extends from the confluence of Honeoye Creek (river station 0+00) upstream to the Town of Richmond and Bristol corporate limits (river station 130+00). Mill Creek's confluence with Honeoye Creek is located at river station 1862+50 on Honeoye Creek.

Flooding in this area poses a threat to numerous residential and commercial properties along Main Street/US-20A and East Lake Road. In addition, NYSDOT and County-owned infrastructure, including the Main Street/US-20A and East Lake Road bridge crossings, are within the FEMA Zone A flood hazard area and are at risk of flooding during high-flow or backwater events on Honeoye Creek (Figure 6-3).

According to the FEMA FIRM for the Town of Richmond, the Main Street/US-20A bridge crossing is a constriction point and causes backwater flooding to areas upstream of the bridge (Figure 6-4). Discharge from Mill Creek increases the flow in Honeoye Creek as it passes under the Main Street/US-20A exacerbating any flooding or backwater potential in the area (FEMA 1984a).

This reach is also susceptible to sediment aggradation and debris buildup from upstream sources along Mill Creek. Aggradation and debris buildup restrict the channel flow area, which can cause water surfaces to rise and potentially overtop banks or back water upstream of structures and/or meanders. In addition, Mill Creek is a significant source of sediment to Honeoye Creek exacerbating aggradation and flooding risk in areas downstream of the confluence of Honeoye and Mill Creeks.

7. MITIGATION ALTERNATIVES

The following are flood mitigation alternatives that have the potential to reduce WSELs along high-risk areas of Honeoye Creek. These alternatives could potentially reduce flood related damages in areas adjacent to the creek. Local and state officials and stakeholders should evaluate each alternative and consider the potential effects to the community and the level of community buy-in for each before pursuing them further.

7.1 HIGH-RISK AREA #1

7.1.1 Alternative #1-1: Remove Railroad Abutments

This measure is intended to increase the cross-sectional flow area of the channel and remove any potential impediments or catch points for ice floes and sediment and debris by removing the abutments that previously supported a railroad crossing located at river station 754+00 (Figure 7-1).

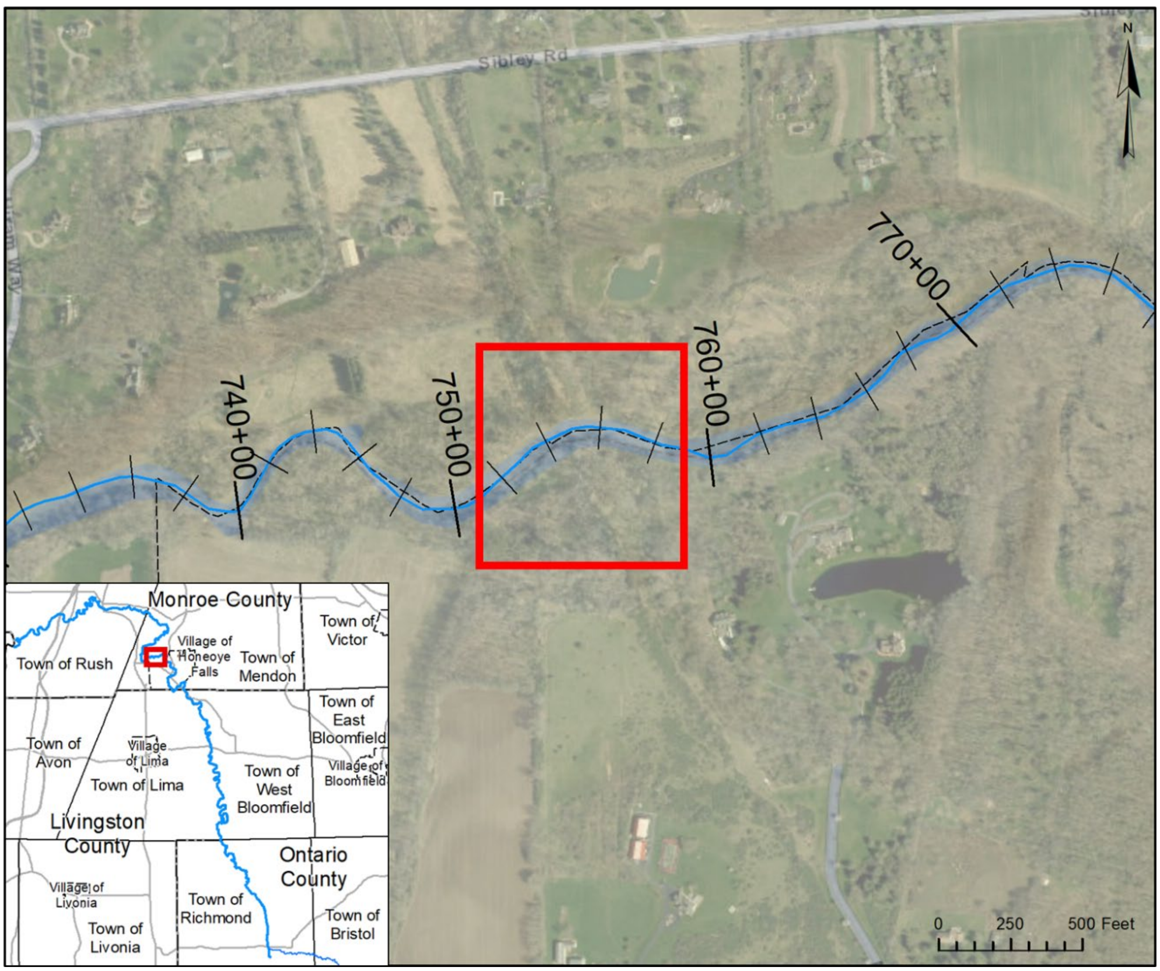


Figure 7-1. Location map for Alternative #1-1.

Based on orthoimagery of the area, meanders in the creek channel both upstream and downstream of the bridge crossing coupled with the railroad abutments in the overbank areas, impede flow and reduce water velocities allowing sediment and debris to aggregate in this area (NYSOITS 2020).

According to the FEMA FIS, the railroad is able to successfully pass the 0.2% ACE; however, this is due to the lack of a railroad bridge crossing and the highly elevated abutments (approximately 50 ft) above the adjacent overbank elevations (FEMA 2008b). The FEMA FIRM indicates significant backwater flooding upstream of the railroad abutments (FEMA 2008a).

By removing the railroad abutments, the cross-sectional flow area of the overbank would increase allowing more water to flow downstream during high-flow events that exceed the channel flow capacity, thereby reducing the severity of the current backwater flooding situation. In addition, with the abutments removed and with a more natural overbank area, the potential for sediment, debris, and ice to accumulate or catch upstream of the abutments would be reduced, which would reduce flood risk to areas adjacent to and immediately upstream of the abutments.

The abutment removal and overbank design selected for the proposed condition model simulation was selected to restore the overbank areas to a more uniform and natural floodplain elevation. To achieve the desired result, approximately 70,000 cubic yards of earthen material would need to be removed from both overbank areas. The overbank elevation was set to 595 ft NAVD88 so that the 1% ACE WSEL would be contained within the channel as it passes through this reach.

The proposed condition modeling confirmed that the railroad abutments are a constriction point along Honeoye Creek. The modeling simulation results indicated water surface reductions of up to 3.7 ft in areas approximately 4,500 ft immediately upstream of the bridge extending from river stations 751+00 to 796+00 (Figure 7-2). The modeling output for future conditions displayed similar results with water surface reductions of up to 4.0 ft. Full model outputs for this alternative can be found in Appendix H.

The primary benefit of removing the railroad abutments would be to increase the flow capacity in the overbank areas and reduce the potential of backwater from high-flow events and sediment, debris, and/or ice catching on the abutments and creating obstructions or jams upstream of the railroad abutments.

It should be noted that by removing the railroad abutments and allowing more water to flow during high-flow events, the potential flood risk for downstream areas could be altered resulting in negative effects to downstream areas. Ramboll recommends additional research, data, and modeling to more accurately determine the effects of removing the railroad abutments to downstream areas.

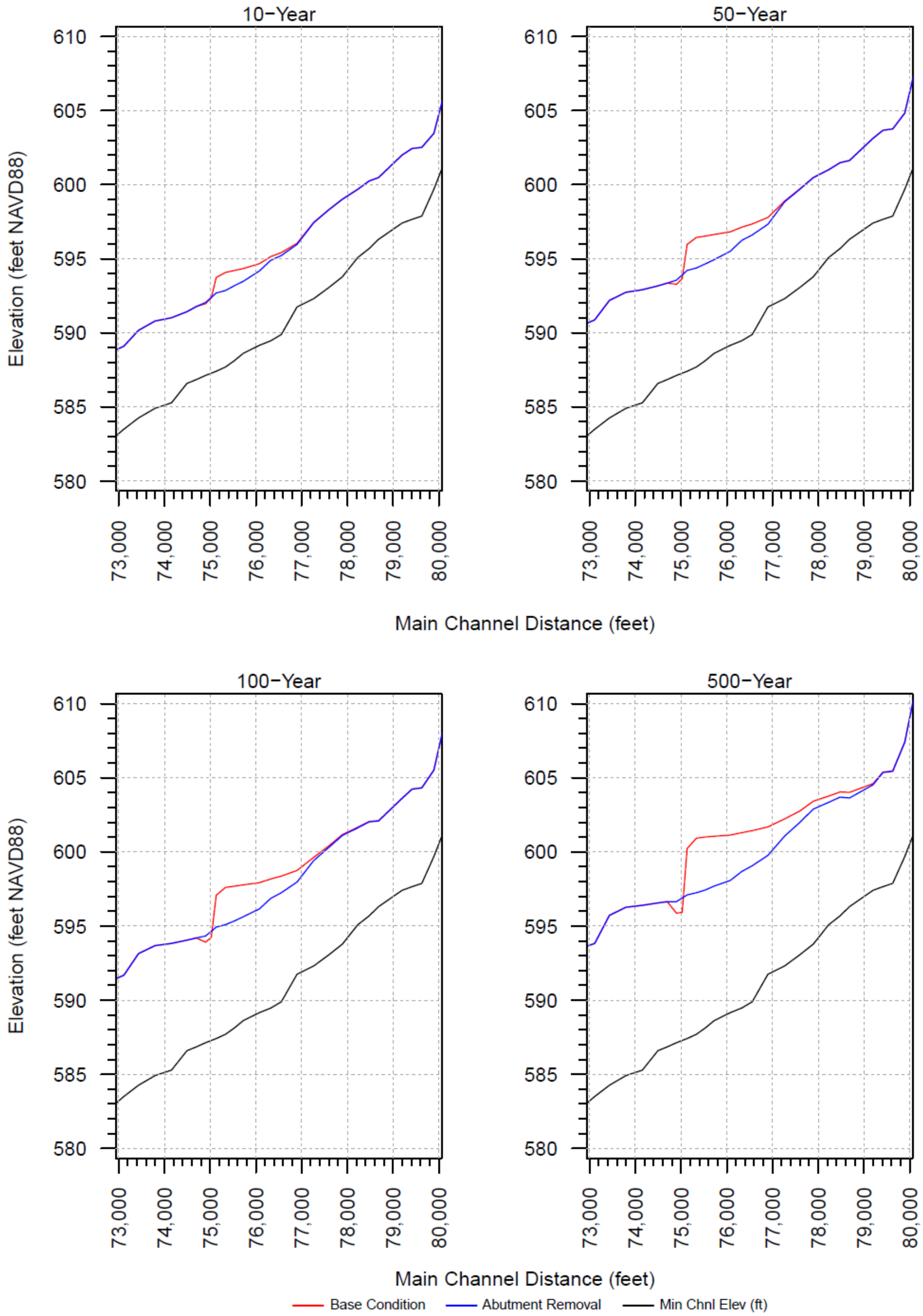


Figure 7-2. HEC-RAS model simulation output results for Alternative #1-1 for the existing condition (red) and railroad abutment removal (blue) scenarios.

The Rough Order Magnitude cost for this strategy is approximately $6.3 million, which does not include land acquisition costs for survey, appraisal, and engineering coordination. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.1.2 Alternative #1-2: Streambank Stabilization in the Vicinity of the Honeoye Falls DPW / WWTP Facility

Streambank erosion is a natural process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the banks in place. The forces that cause erosion increase during flood events, and most erosion occurs at these times. Human disturbances to watersheds that increase frequency and magnitude of runoff events also increase streambank erosion. Human disturbances include logging, mining, agriculture, and urbanization. Typical urban or suburban developments which may impact a stream include houses, garages, parking lots, and walkways, including areas cleared of forest and replaced by tailored lawns (GSWCC 2000).

Loss of streambank and streamside vegetation reduces the resisting forces and makes streambanks more susceptible to erosion. This is often the single greatest contributing factor to harmful or accelerated erosion on small- and medium-size streams. Streambank vegetation may be removed intentionally for various reasons, or its loss may be inadvertent due to trampling by animals or humans (GSWCC 2000).

Streambank stabilization measures work either by reducing the force of flowing water, increasing the resistance of the bank to erosion, or some combination of both. Generally speaking, there are four approaches to streambank protection: 1) the use of vegetation, 2) soil bioengineering, 3) use of rock work in conjunction with plants, and 4) conventional bank armoring. Re-vegetation includes seeding and sodding of grasses, seeding in combination with erosion-control fabrics, and planting of woody vegetation (shrubs and trees). Soil bioengineering systems use woody vegetation installed in specific configurations that offer immediate erosion protection, reinforcement of the soils, and in time a woody vegetative surface cover and root network. The use of rock work in conjunction with plants is a technique which combines vegetation with rock work. Over time, the plants grow and the area appears and functions more naturally. Conventional armoring is a fourth technique which includes the use of rock, known as riprap, to protect eroding streambanks (GSWCC 2000).

Streambank stabilization can also play a vital role in flood risk management in areas located in flood-prone areas. The magnitude of that risk is a function of the flood hazard, the characteristics of a particular location (i.e., elevation, proximity to the waterway, susceptibility to fast-moving flows, etc.), measures that have been taken to mitigate the potential impact of flooding, the vulnerability of people and property, and the consequences that result from a particular flood event. A flood risk management strategy identifies and implements measures that reduce the overall risk, and what remains is the residual risk. In developing the strategy, those responsible judge the costs and benefits of each measure taken and their overall impact in reducing the risk (NRC 2013).

Through historical flood reports, stakeholder engagement meetings, and/or field work, numerous areas along Honeoye Creek in the Village of Honeoye Falls have been identified as areas for potential streambank stabilization strategies. These areas have been outlined in Figure 7-3.

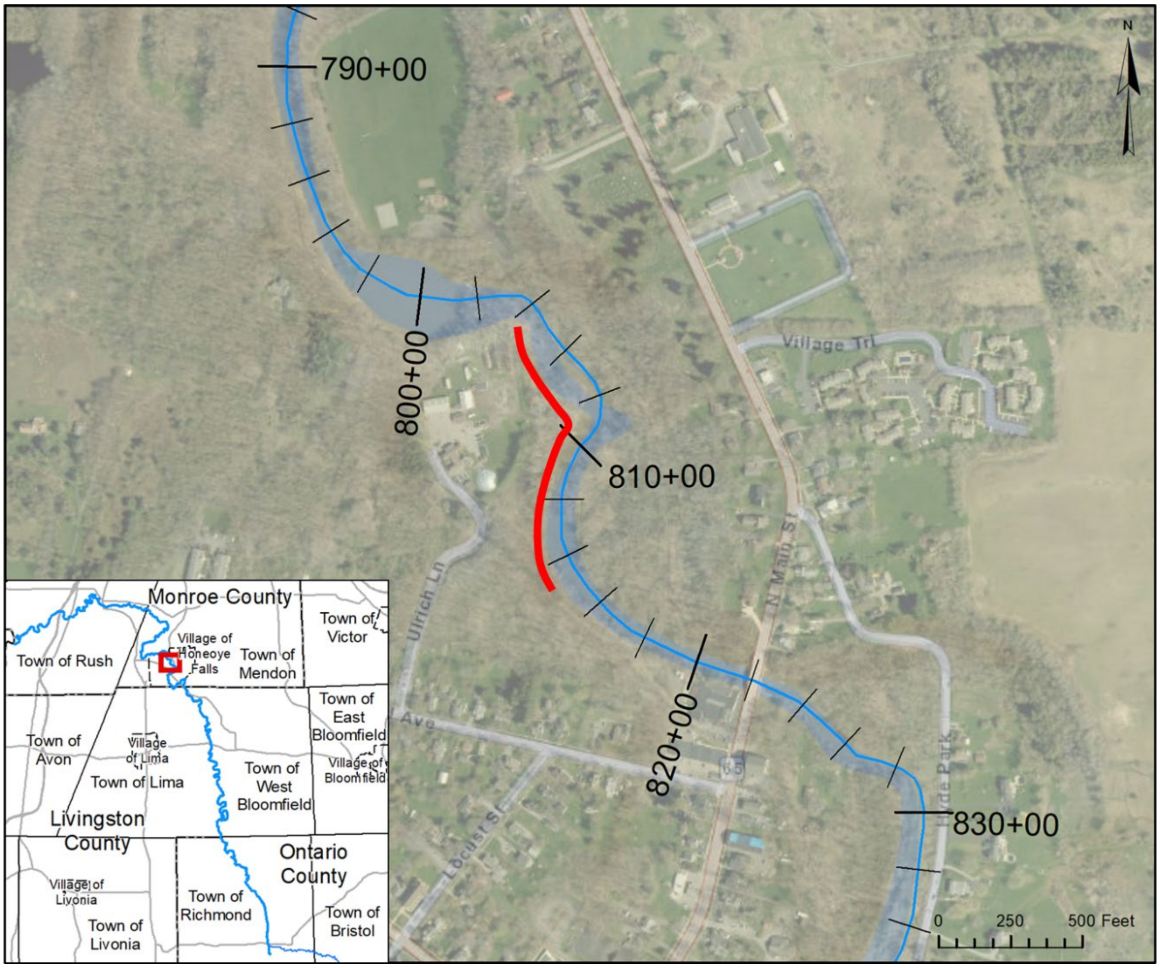


Figure 7-3. Location map for Alternative #1-2.

Appendix G contains detailed discussion of various streambank stabilization strategies, including drawings, definitions, ideal locations, design and construction considerations, maintenance, and ROM costs.

Transport of sediment and debris in streams is predominantly controlled by stream transport capacity, sediment physiochemical characteristics and supply rate. Several hydraulic and geomorphologic factors determine stream transport capacity including channel width, flow depth and cross-sectional geometry, bed slope and roughness, and discharge velocity and volume. In general, the more turbulent energy available for suspension and mobilization of sediment, the greater the sediment transport capacity per unit of stream width, and the larger the size of sediment particles that can be moved (USEPA 2009a).

Larger sediments and debris generally experience more episodic movement over longer time scales through watersheds. Smaller sediments generally move more continuously and within a shorter time scale. This difference is due to the fact that larger sediments and debris rely on larger, more powerful flows for transport, which occur episodically and less frequently than flows able to move smaller particles, such as the bankfull discharge (USEPA 2009a).

To assess the applicability of different streambank stabilization strategies under higher frequency-lower flow conditions, channel velocity (feet per second) and shear stress (pounds per square foot) were calculated using the HEC-RAS software for the existing conditions model at the 10% ACE; the results are summarized in Table 16.

Table 16. HECRAS Existing Condition Model Output of Channel Velocity (ft/s) and Shear Stress (lb/sq ft) at the 10% Annual Chance Event for Alternative #1-2

Source: USACE 2021		
River Station	**Channel Velocity (ft/s)**	**Channel Shear Stress (lb/sq ft)**
816+52	11.02	2.72
815+93	7.58	1.2
814+85	9.92	2.18
812+13	8.6	1.66
809+52	8.35	1.76
807+44	7.91	1.47
805+40	6.29	0.81
802+96	8.42	1.54
800+78	8.14	1.4
798+92	10.65	2.57
796+29	2.69	0.15
794+16	2.54	0.1
791+97	5.28	0.43

Based on the existing conditions model output for channel velocity and shear stress, Table 17 summarizes the applicability of potential streambank strategies for this proposed alternative.

Table 17. Potential Streambank Stabilization Strategies for Alternative #1-2

Source: NRCS 2009	
Type of Treatment	**Type of Sub-Treatment**
Brush Mattresses	Staked only with rock riprap toe (grown)
Coir Geotextile Roll	Roll with Polypropylene rope mesh staked and with rock riprap toe
Gravel/Cobble	12-in
Soil Bioengineering	Live brush mattress (grown)
	Brush layering (initial/grown)
Boulder Clusters	Boulder - Very large (>80-in diameter)
	Boulder - Large (>40-in diameter)
	Boulder - Medium (>20-in diameter)

Due to the variable, conceptual, and site-specific nature of streambank stabilization strategies, no ROM Cost Estimates were determined for this measure. Additional geomorphic and engineering analyses, including additional modeling, would be necessary in order to determine the most appropriate streambank stabilization strategy and its associated costs.

7.1.3 Alternative #1-3: Flood Benches Upstream and Downstream of N Main Street/NY-65

Installing a flood bench would provide additional storage and floodplain width over and above the current storage and width provided by the adjacent overbank areas, which could potentially reduce damages in the event of flooding and address issues within High-Risk Area #1. Two potential flood benches were modeled in the vicinity of N Main Street/NY-65 in the Village of Honeoye Falls (Figure 7-4):

- Flood Bench A is approximately 4.6 acres in size and located between river stations 809+00 to 822+00
- Flood Bench B is approximately 2.5 acres in size and located between river stations 826+00 to 838+00

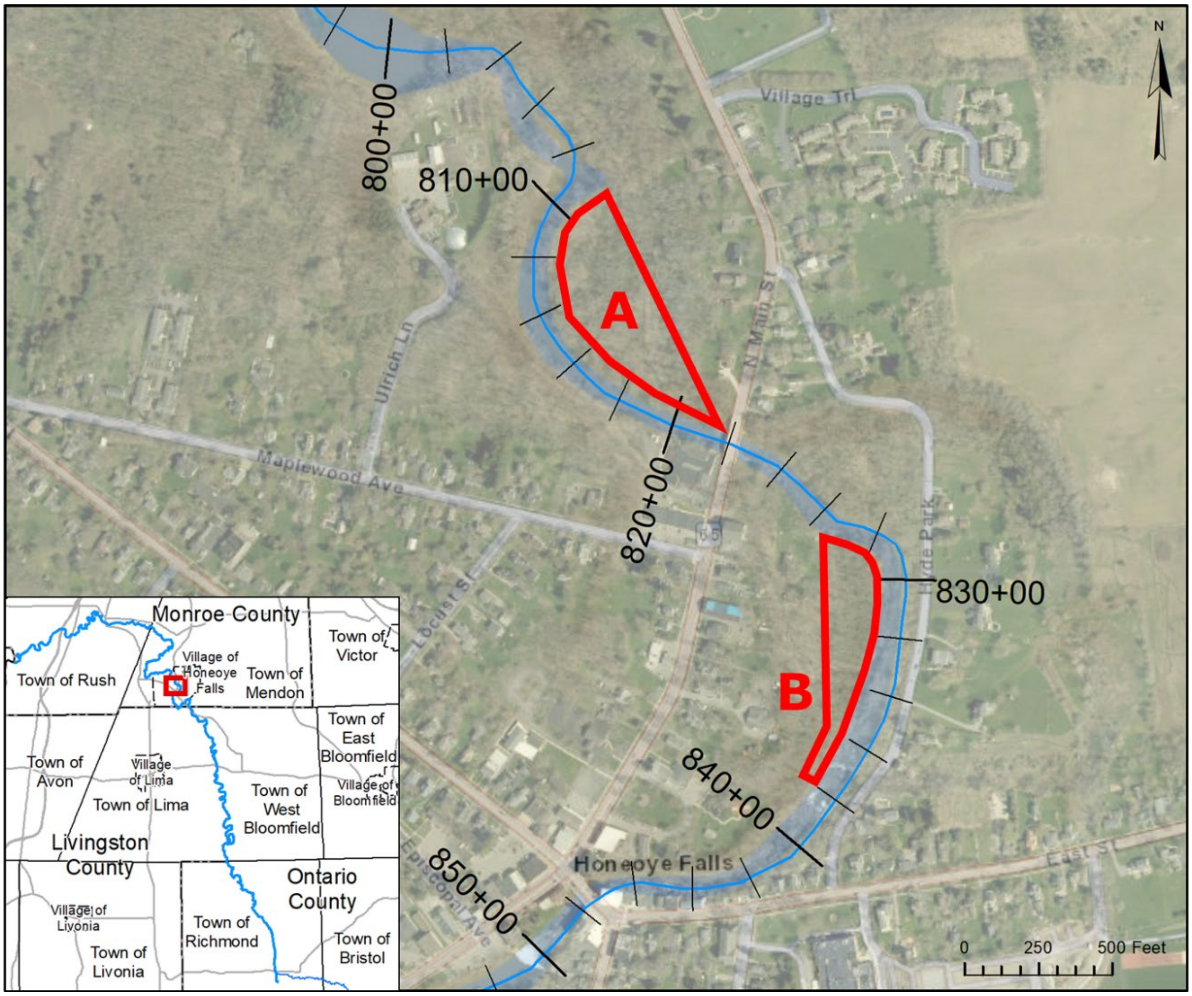


Figure 7-4. Location map for Alternative #1-3.

The flood bench designs used for the proposed condition model simulation set the minimum bench elevation approximately equal to the bankfull elevation, which was an average depth of 6 ft for Flood Bench A and 2 ft for Flood Bench B.

The flood benches are within the FEMA designated SFHA or Zone AE, which are areas subject to inundation by the 1% ACE with base flood elevations determined and where mandatory flood insurance purchase requirements and floodplain management standards apply (FEMA 2008b). Appendix F depicts a flood mitigation rendering of a flood bench illustrating before and after landscape features.

For this alternative, open-water, debris-obstruction, and ice-jam simulations were performed to test the effectiveness of the alternative at reducing WSELs for Flood Bench B only. Flood Bench A is downstream of the bridge and would have minimal influence on WSELs upstream of the bridge crossing.

Table 18 outlines the results of the existing conditions model simulations for each initial condition scenario. Figures 7-5 through 7-8 display the profile plots for each initial condition scenario for the flood bench alternative. Full model outputs for this alternative can be found in Appendix H.

Table 18. Summary Table for Alternative #1-3 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)	
	Flood Bench A	**Flood Bench B**
Open-Water	Up to 1.7-ft	Up to 1.0-ft
Total Length of Benefited Area	1,000-ft	950-ft
River Stations	805+50 to 815+00	823+50 to 833+00
Debris Obstruction	N/A	No Modeled Change in WSEL
Total Length of Benefited Area	N/A	No Modeled Change in WSEL
River Stations	N/A	No Modeled Change in WSEL
Ice Jam	N/A	Up to 1.5-ft
Total Length of Benefited Area	N/A	1,600-ft
River Stations	N/A	817+00 to 833+00

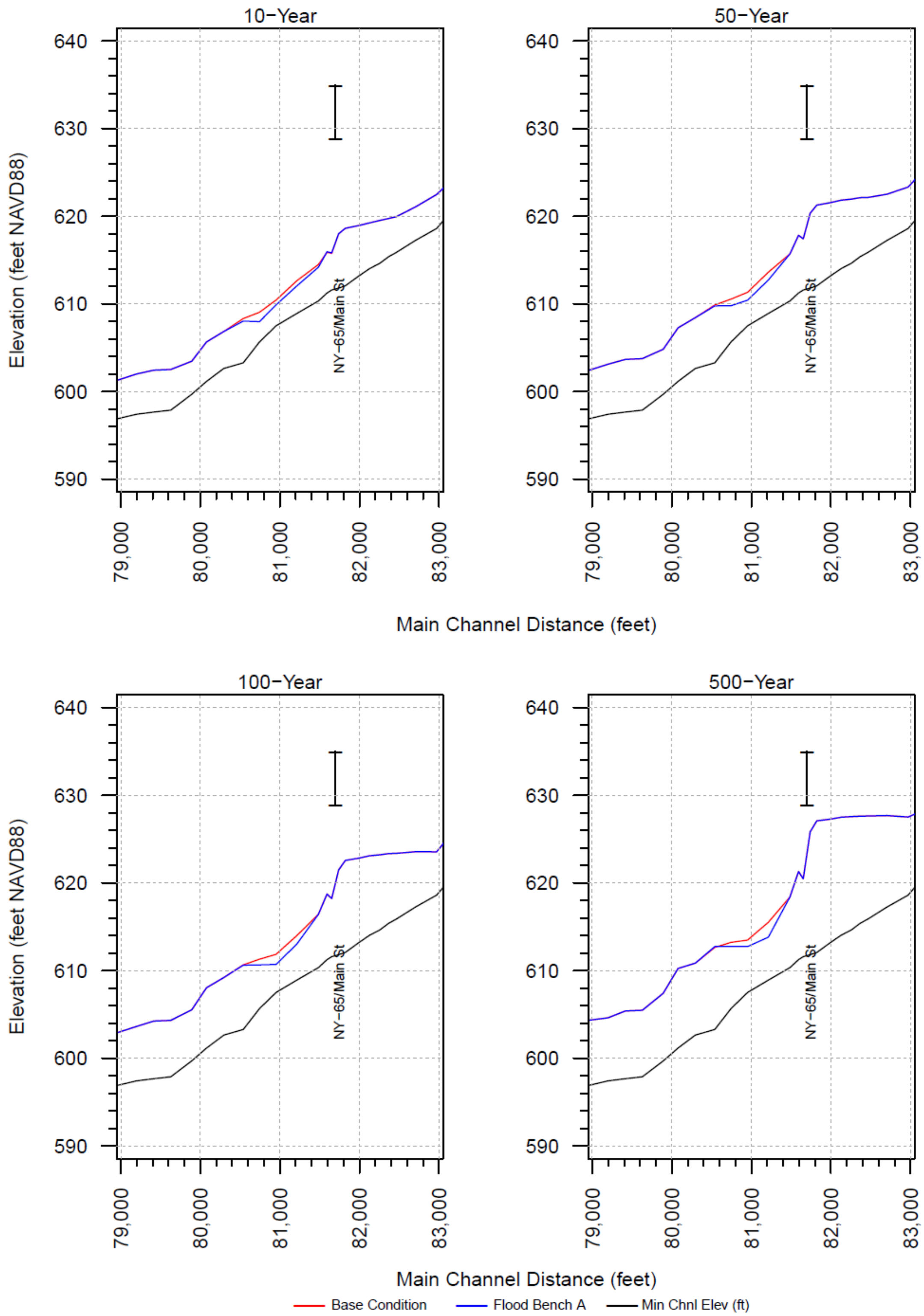


Figure 7-5. HEC-RAS model simulation output results for Alternative #1-3 for the existing condition (red) and Flood Bench A (blue) scenarios.

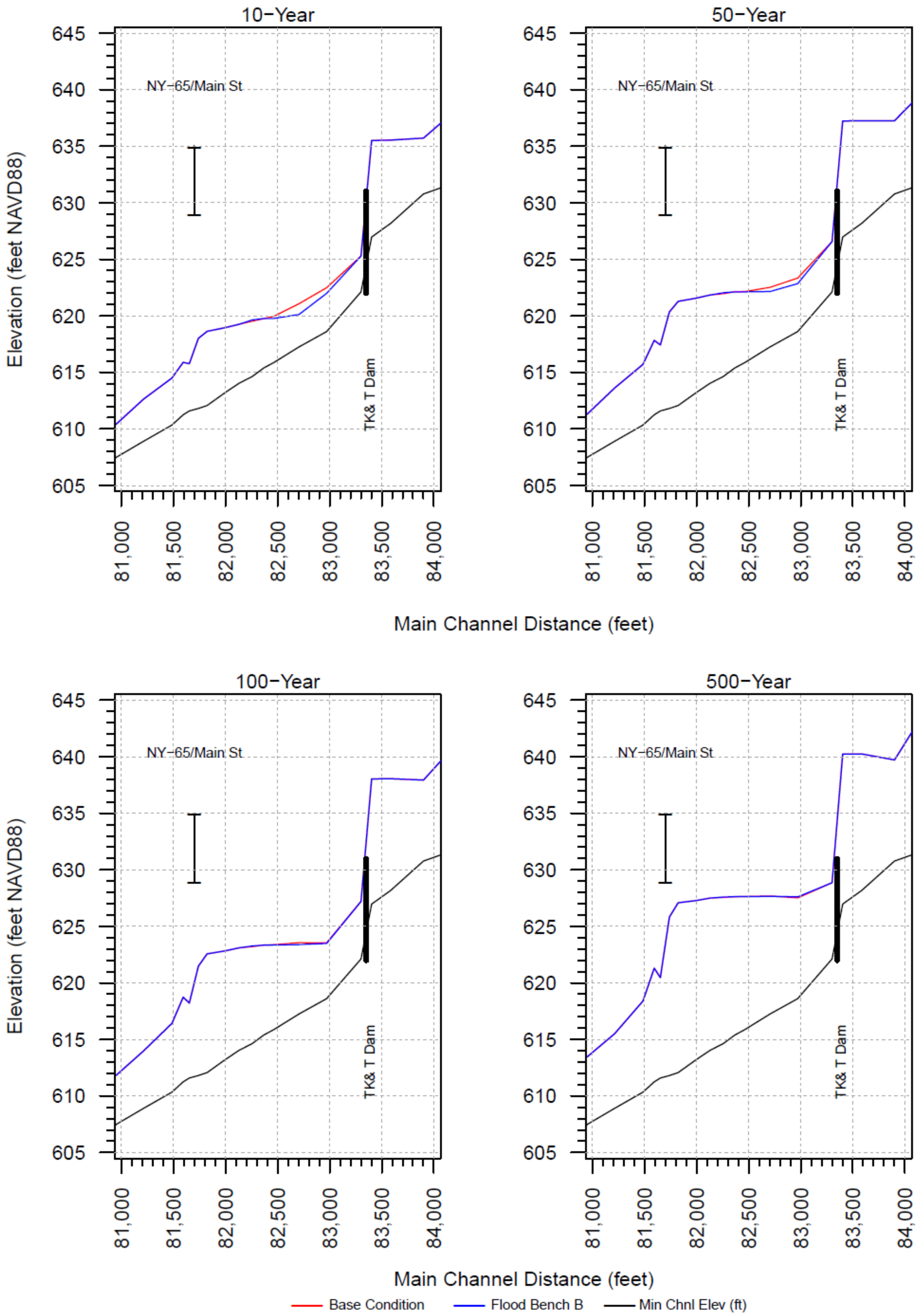


Figure 7-6. HEC-RAS model simulation output results for Alternative #1-3 for the existing condition (red) and Flood Bench B (blue) scenarios.

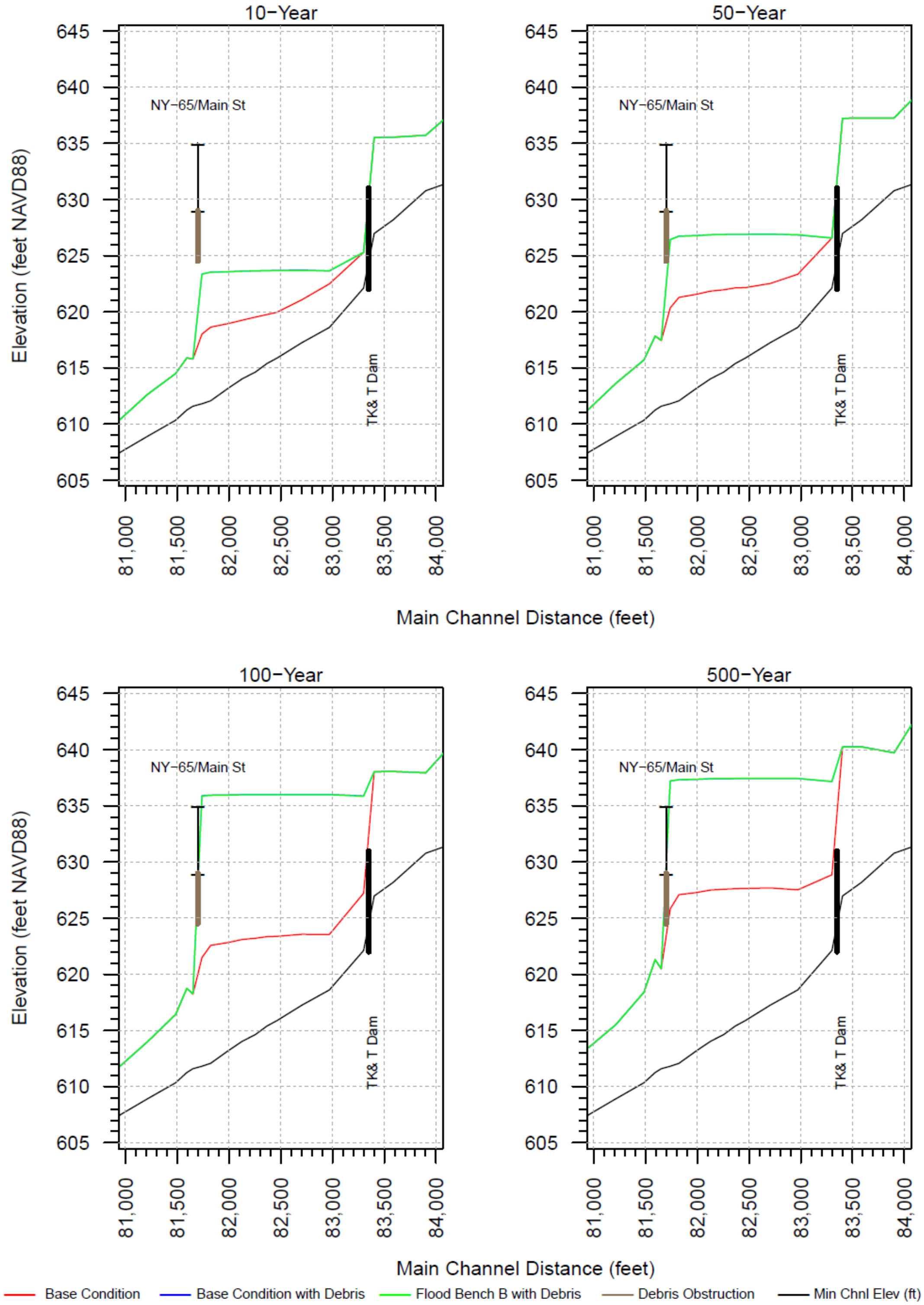


Figure 7-7. HEC-RAS debris-obstruction model simulation output results for Alternative #1-3 for the existing condition (red), existing condition with debris (blue), and Flood Bench B with debris (green) scenarios.

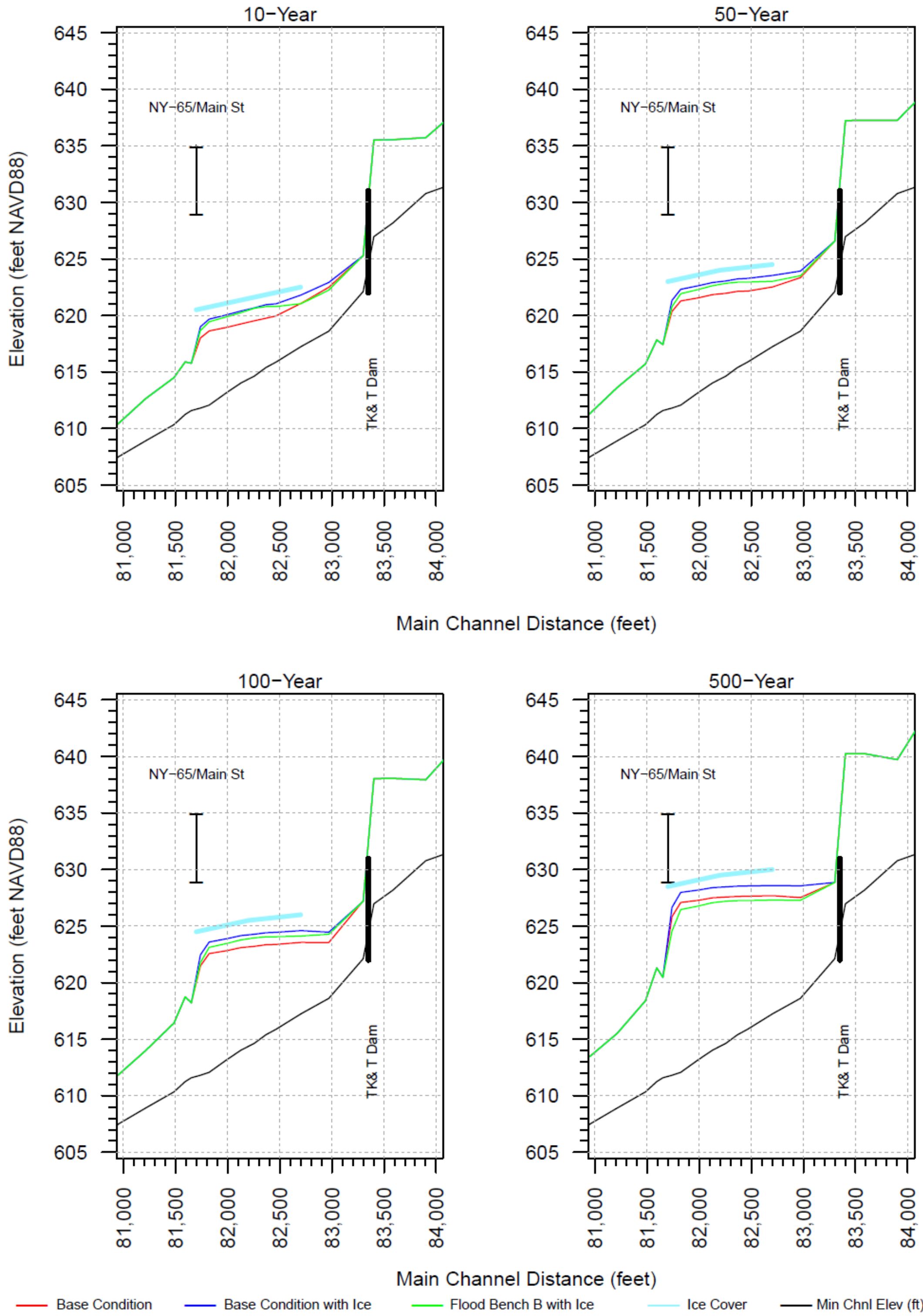


Figure 7-8. HEC-RAS ice cover model simulation output results for Alternative #1-3 for the existing condition (red), existing condition with ice cover (blue), and Flood Bench B with ice cover (green) scenarios.

Table 19 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 19. Summary Table for Alternative #1-3 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	Reductions in Water Surface Elevations (feet)	
	Flood Bench A	Flood Bench B
Open-Water	Up to 1.8-ft	Up to 0.9-ft
Total Length of Benefited Area	1,000-ft	950-ft
River Stations	805+50 to 815+00	823+50 to 833+00
Debris Obstruction	N/A	Up to 0.3-ft
Total Length of Benefited Area	N/A	325-ft
River Stations	N/A	829+75 to 833+00
Ice Jam	N/A	Up to 5.4-ft
Total Length of Benefited Area	N/A	1,650-ft
River Stations	N/A	814+50 to 831+00

Flood benches generally provide flood protection for localized areas in the vicinity of and immediately upstream and/or downstream of the bench. Based on the analysis of high-risk areas, flood benches located both upstream and downstream of N Main Street/NY-65 would provide significant flood protection in this reach from open-water flooding. In addition, a flood bench upstream of the bridge would provide significant flood protection from ice-jam flooding, but not for debris/log jam-related flooding.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed each flood bench independently. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

The Rough Order Magnitude cost for each flood bench alternative is:

- Flood Bench A: $3.2 million
- Flood Bench B: $1.1 million

These ROM cost estimates do not include land acquisition costs for survey, appraisal, and engineering coordination. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.1.4 Alternative #1-4: Increase Size of N Main Street/NY-65 Bridge Opening

This measure is intended to address issues within High-Risk Area #1 by increasing the width of the N Main Street/NY-65 bridge opening, which would increase the cross-sectional flow area of the channel located at river station 822+00 (Figure 7-9).

Figure 7-9. Location map for Alternative #1-4.

The bridge was built in 1996 and is owned by the NYSDOT. The existing bridge is an arch-type structure with a bridge span of 65 ft, width of 42 ft, and minimum deck thickness of 6 ft (Figure 7-10). The flooding in the vicinity of the N Main Street/NY-65 bridge poses a flood risk threat to nearby residential and commercial properties, and federal and state-owned infrastructure. Appendix F depicts a flood mitigation rendering of a bridge widening scenario.

Figure 7-10. N Main Street/NY-65 bridge and a USGS gage station, Honeoye Falls, NY.

Based on orthoimagery of the area, the meanders in the creek channel both upstream and downstream of the bridge crossing act as impediments to flow, reducing water velocities and allowing sediment and debris to aggregate and restrict flow in this area (NYSOITS 2020).

The FEMA FIS for the N Main Street/NY-65 bridge is able to successfully pass the 10-, 2-, and 1% ACE; however, the FIS profile indicates significant backwater upstream of the bridge (FEMA 2008b). In addition, the FEMA FIRM displays significant backwater upstream of the bridge crossing (FEMA 2008a).

By increasing the opening span of the bridge structure, the cross-sectional flow area of the channel would increase and the potential for sediment, debris, and ice to accumulate or catch on the upstream face of the bridge would be reduced, thereby reducing flood risk to areas adajcent to and immediately upstream of the bridge.

The bridge widening design selected for this proposed condition model simulation was selected to ensure that the 1% ACE WSEL could successfully pass under the N Main Street/NY-65 bridge without significant backwater upstream of the bridge. To achieve the desired result, the bridge widening design increased the span of the bridge opening from 64 ft to 84 ft by widening the bridge on both banks by 10 ft, and changing the bridge style from an arch-type bridge to a beam-type with a deck height of 4 ft. This measure would potentially reduce the flood risk and benefit the properties adjacent to and immediately upstream of N Main Street/NY-65.

Table 20 outlines the results of the existing conditions model simulations for each initial condition scenario. Figures 7-11 through 7-13 display the profile plots for each initial condition scenario. Full model outputs for this alternative can be found in Appendix H.

Table 20. Summary Table for Alternative #1-4 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 2.3-ft
Total Length of Benefited Area	1,600-ft
River Stations	817+00 to 833+00
Debris Obstruction	Up to 8.8-ft
Total Length of Benefited Area	1,650-ft
River Stations	817+00 to 833+50
Ice Jam	Up to 2.2-ft
Total Length of Benefited Area	1,600-ft
River Stations	817+00 to 833+00

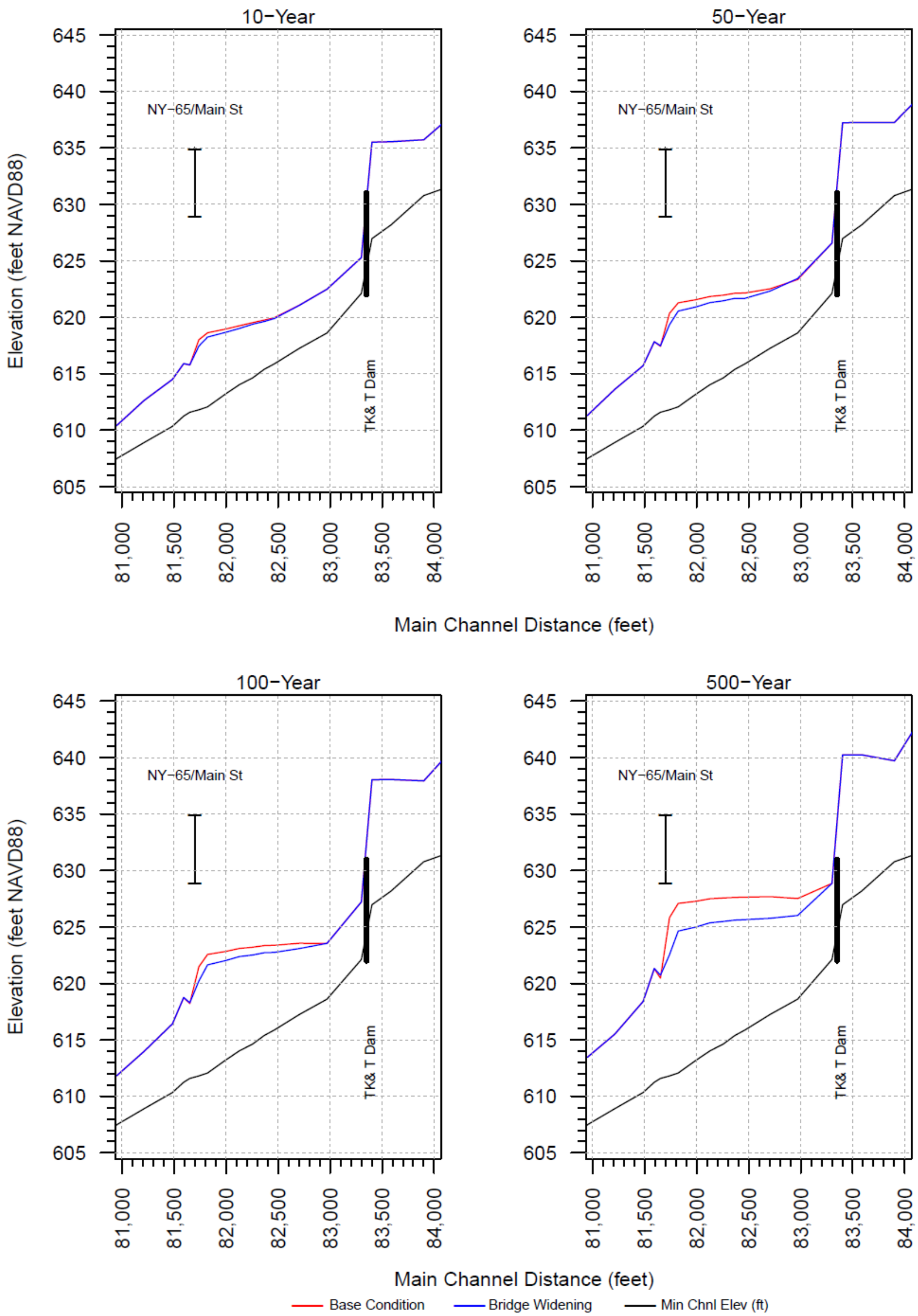


Figure 7-11. HEC-RAS model simulation output results for Alternative #1-4 for the existing condition (red) and bridge widening (blue) scenarios.

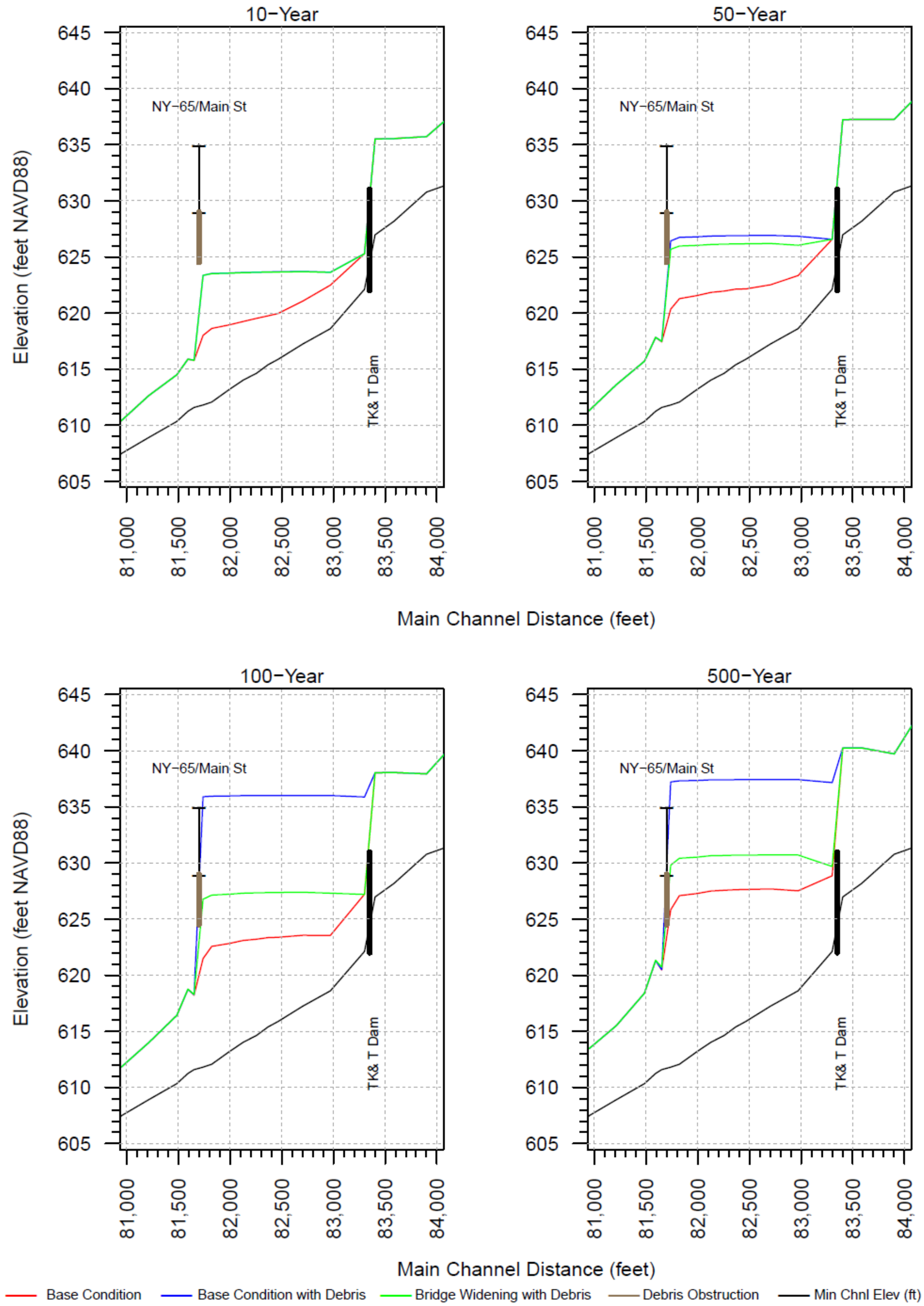


Figure 7-12. HEC-RAS debris obstruction model simulation output results for Alternative #1-4 for the existing condition (red), existing condition with debris (blue), and bridge widening with debris (green) scenarios.

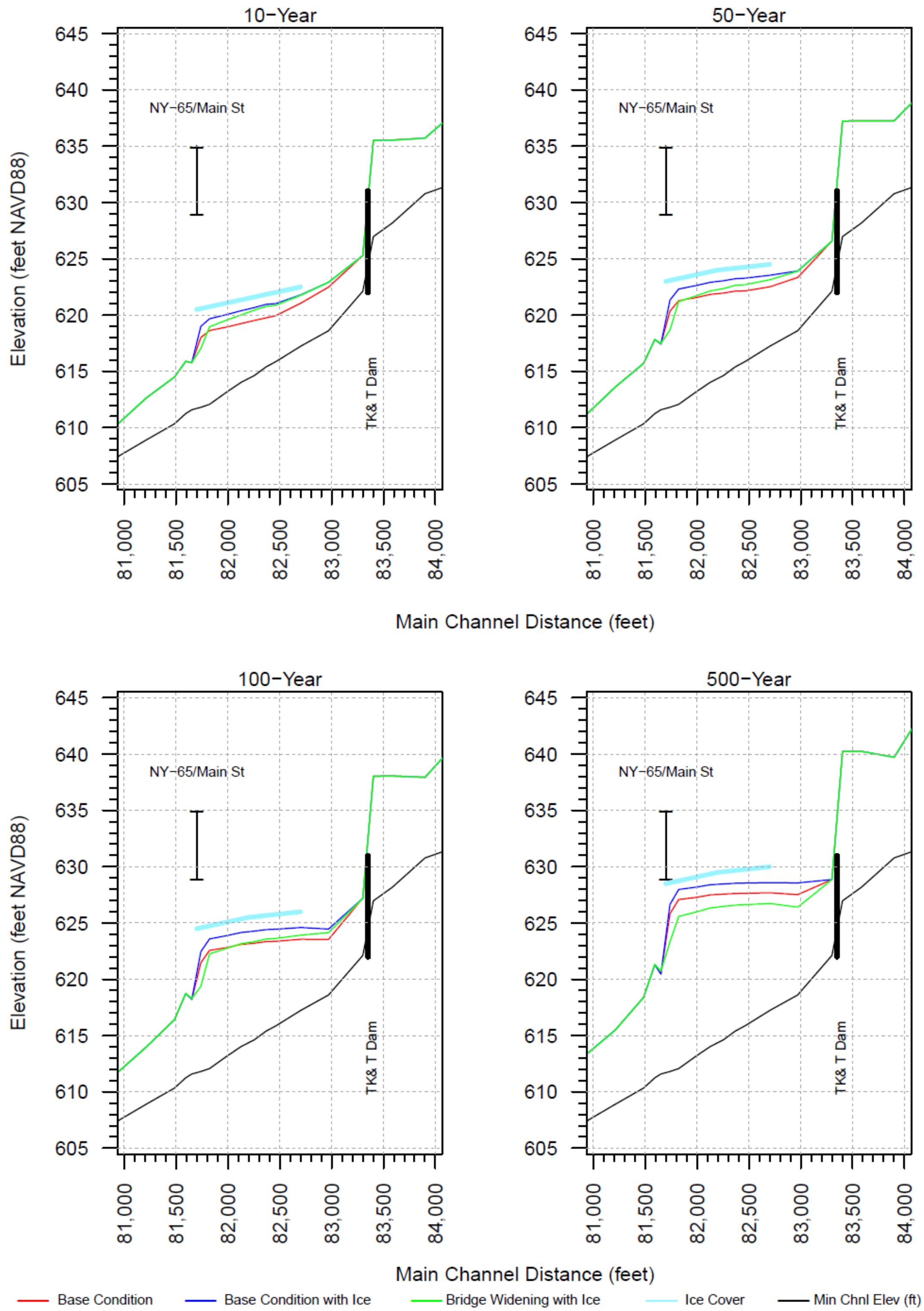


Figure 7-13. HEC-RAS ice cover model simulation output results for Alternative #1-4 for the existing condition (red), existing condition with ice cover (blue), and bridge widening with ice cover (green) scenarios.

Table 21 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 21. Summary Table for Alternative #1-4 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 2.5-ft
Total Length of Benefited Area	1,600-ft
River Stations	817+00 to 833+00
Debris Obstruction	Up to 8.4-ft
Total Length of Benefited Area	1,650-ft
River Stations	817+00 to 833+50
Ice Jam	Up to 6.5-ft
Total Length of Benefited Area	1,650-ft
River Stations	817+00 to 833+50

The potential benefits of this strategy are limited to immediately upstream of the N Main Street/NY-65 bridge. The primary benefit of increasing the bridge opening would be to increase the flow capacity of the bridge structure and reduce the potential of backwater from high-flow events, and debris and ice catching on structures and creating obstructions or jams upstream of the bridge.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed this alternative independent of any other proposed mitigation alternative. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

The Rough Order Magnitude cost for this strategy is approximately $4.6 million, which does not include land acquisition costs for survey, appraisal, and engineering coordination. Additional engineering consideration would also be required to determine if increasing the bridge opening would alter the structural integrity of the bridge in any way.

7.1.5 Alternative #1-5: Streambank Stabilization in the Vicinity of Honeoye Falls and East Street/NY-65

Streambank erosion is a natural process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the banks in place. The forces that cause erosion increase during flood events, and most erosion occurs at these times. Human disturbances to watersheds that increase frequency and magnitude of runoff events also increase streambank erosion. Human disturbances include logging, mining, agriculture, and urbanization. Typical urban or suburban developments which may impact a stream include houses, garages, parking lots, and walkways, including areas cleared of forest and replaced by tailored lawns (GSWCC 2000).

Loss of streambank and streamside vegetation reduces the resisting forces and makes streambanks more susceptible to erosion. This is often the single greatest contributing factor to harmful or accelerated erosion on small- and medium-size streams. Streambank vegetation may be removed intentionally for various reasons, or its loss may be inadvertent due to trampling by animals or humans (GSWCC 2000).

Streambank stabilization measures work either by reducing the force of flowing water, by increasing the resistance of the bank to erosion, or by some combination of both. Generally speaking, there are four approaches to streambank protection: 1) the use of vegetation, 2) soil bioengineering, 3) the use of rock work in conjunction with plants, and 4) conventional bank armoring. Re-vegetation includes seeding and sodding of grasses, seeding in combination with erosion control fabrics, and the planting of woody vegetation (shrubs and trees). Soil bioengineering systems use woody vegetation installed in specific configurations that offer immediate erosion protection, reinforcement of the soils, and in time a woody vegetative surface cover and root network. The use of rock work in conjunction with plants is a technique which combines vegetation with rock work. Over time, the plants grow and the area appears and functions more naturally. Conventional armoring is a fourth technique which includes the use of rock, known as riprap, to protect eroding streambanks (GSWCC 2000).

Streambank stabilization can also play a vital role in flood risk management in areas located in flood-prone areas. The magnitude of that risk is a function of the flood hazard, the characteristics of a particular location (i.e., elevation, proximity to the waterway, susceptibility to fast-moving flows, etc.), measures that have been taken to mitigate the potential impact of flooding, the vulnerability of people and property, and the consequences that result from a particular flood event. A flood risk management strategy identifies and implements measures that reduce the overall risk, and what remains is the residual risk. In developing the strategy, those responsible judge the costs and benefits of each measure taken and their overall impact in reducing the risk (NRC 2013).

Through historical flood reports, stakeholder engagement meetings, and/or field work, numerous areas along Honeoye Creek in the Village of Honeoye Falls have been identified as areas for potential streambank stabilization strategies. These areas have been outlined in Figure 7-14.

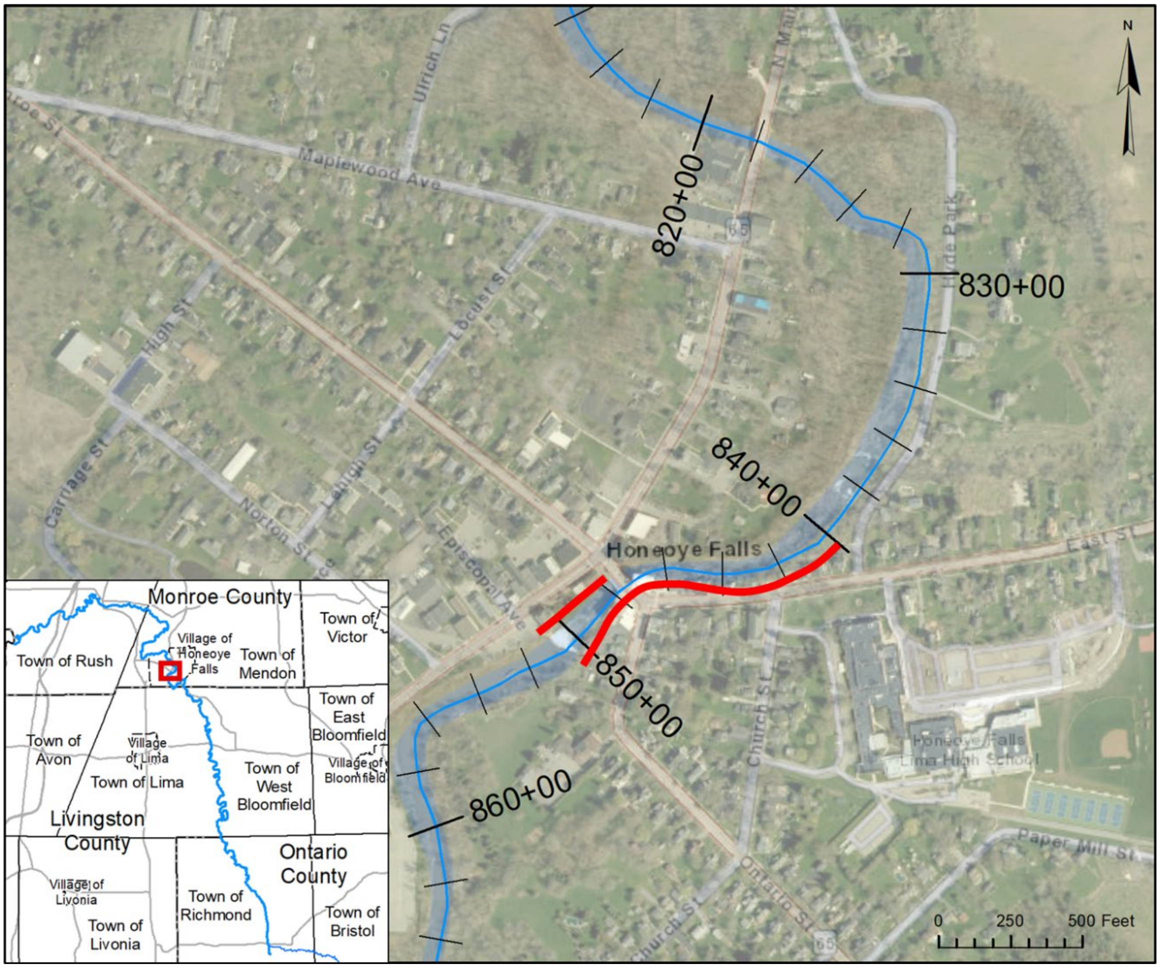


Figure 7-14. Location map for Alternative #1-5.

Appendix G contains detailed discussion of various streambank stabilization strategies, including drawings, definitions, ideal locations, design and construction considerations, maintenance, and ROM costs.

Transport of sediment and debris in streams is predominantly controlled by stream transport capacity, sediment physiochemical characteristics and supply rate. Several hydraulic and geomorphologic factors determine stream transport capacity including channel width, flow depth and cross-sectional geometry, bed slope and roughness, and discharge velocity and volume. In general, the more turbulent energy available for suspension and mobilization of sediment, the greater the sediment transport capacity per unit of stream width, and the larger the size of sediment particles that can be moved (USEPA 2009a).

Larger sediments and debris generally experience more episodic movement over longer time scales through watersheds. Smaller sediments generally move more continuously and within a shorter time scale. This difference is due to the fact that larger sediments and debris rely on larger, more powerful flows for transport, which occur episodically and less frequently than flows able to move smaller particles, such as the bankfull discharge (USEPA 2009a).

To assess the applicability of different streambank stabilization strategies under higher frequency-lower flow conditions, channel velocity (feet per second) and shear stress (pounds per square foot) were calculated using the HEC-RAS software for the existing conditions model at the 10% ACE; the results are summarized in Table 22.

Table 22. HECRAS Existing Condition Model Output of Channel Velocity (ft/s) and Shear Stress (lb/sq ft) at the 10% Annual Chance Event for Alternative #1-5

Source: USACE 2021		
River Station	**Channel Velocity (ft/s)**	**Channel Shear Stress (lb/sq ft)**
84980	5.71	0.49
84615	5.01	0.69
84550	Hamilton Mill Dam	
84489	4.97	0.58
84348	7.16	1.15
84295	5.64	0.73
84250	NY-65/East St	
84209	8.12	1.58
84150	12.02	3.72
83901	10.14	2.76
83586	5.35	0.67
83403	3.78	0.32

Based on the existing conditions model output for channel velocity and shear stress, Table 23 summarizes the applicability of potential streambank strategies for this proposed alternative.

Table 23. Potential Streambank Stabilization Strategies for Alternative #1-5

Source: NRCS 2009	
Type of Treatment	**Type of Sub-Treatment**
Brush Mattresses	Staked only with rock riprap toe (grown)
Coir Geotextile Roll	Roll with Polypropylene rope mesh staked and with rock riprap toe
Gravel/Cobble	12-in
Soil Bioengineering	Live brush mattress (grown)
	Brush layering (initial/grown)
Boulder Clusters	Boulder - Very large (>80-in diameter)
	Boulder - Large (>40-in diameter)
	Boulder - Medium (>20-in diameter)

Due to the variable, conceptual, and site-specific nature of streambank stabilization strategies, no ROM Cost Estimates were determined for this measure. Additional geomorphic and engineering analyses, including additional modeling, would be necessary in order to determine the most appropriate streambank stabilization strategy and its associated costs.

7.1.6 Alternative #1-6: Flood Benches Upstream of Honeoye Falls

Installing a flood bench would provide additional storage and floodplain width over and above the current storage and width provided by the adjacent overbank areas, which could potentially reduce damages in the event of flooding and address issues within High-Risk Area #1. Two potential flood benches were modeled upstream of Honeoye Falls in the Village of Honeoye Falls (Figure 7-15):

- Flood Bench A is approximately 4 acres in size and located between river stations 852+00 to 864+00
- Flood Bench B is approximately 5.5 acres in size and located between river stations 874+00 to 886+00

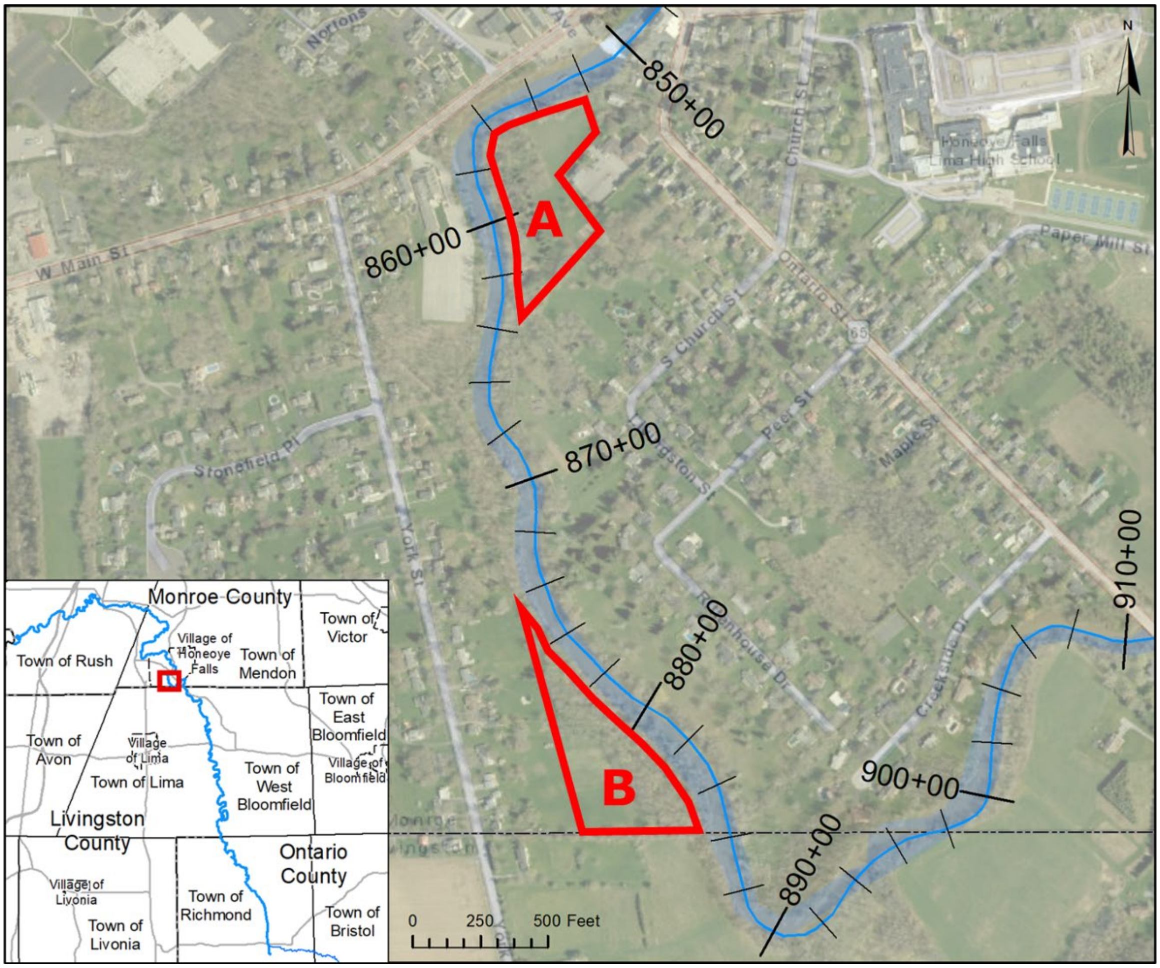


Figure 7-15. Location map for Alternative #1-6.

The flood bench designs used for the proposed condition model simulation set the minimum bench elevation approximately equal to the bankfull elevation, which was an average depth of 2.5 ft for Flood Bench A and 5 ft for Flood Bench B.

The flood benches are within the FEMA designated SFHA or Zone AE, which are areas subject to inundation by the 1% ACE with base flood elevations determined and where mandatory flood insurance purchase requirements and floodplain management standards apply (FEMA 2008b). Appendix F depicts a flood mitigation rendering of a flood bench illustrating before and after landscape features.

For this alternative, open-water, debris-obstruction, and ice-jam simulations were performed to test the effectiveness of the alternative at reducing WSELs for Flood Bench A only. Flood Bench B is upstream of the Falls and would have minimal influence on WSELs in the vicinity of Honeoye Falls and East Street/NY-65.

Table 24 outlines the results of the existing and future conditions model simulations for each flood bench. Figures 7-16 and 7-17 display the profile plots for each flood bench alternative. Full model outputs for this alternative can be found in Appendix H.

Table 24. Summary Table for Alternative #1-6 Existing and Future Conditions for Each Flood Bench Alternative

	Reductions in Water Surface Elevations (feet)	
Existing Conditions	**Flood Bench A**	**Flood Bench B**
	Up to 1.4-ft	Up to 1.3-ft
Total Length of Benefited Area	3,750-ft	3,750-ft
River Stations	850+00 to 887+50	870+00 to 907+50
Future Conditions	Up to 1.3-ft	Up to 1.4-ft

Flood benches generally provide flood protection for localized areas in the vicinity of and immediately upstream and/or downstream of the bench. Based on the analysis of high-risk areas, a flood bench located upstream of Honeoye Falls would provide significant flood protection in this reach from open-water flooding.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed this alternative and each flood bench independently of other alternatives. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

The Rough Order Magnitude cost for each flood bench alternative is:

- Flood Bench A: $1.7 million
- Flood Bench B: $3.4 million

These ROM cost estimates do not include land acquisition costs for survey, appraisal, and engineering coordination. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

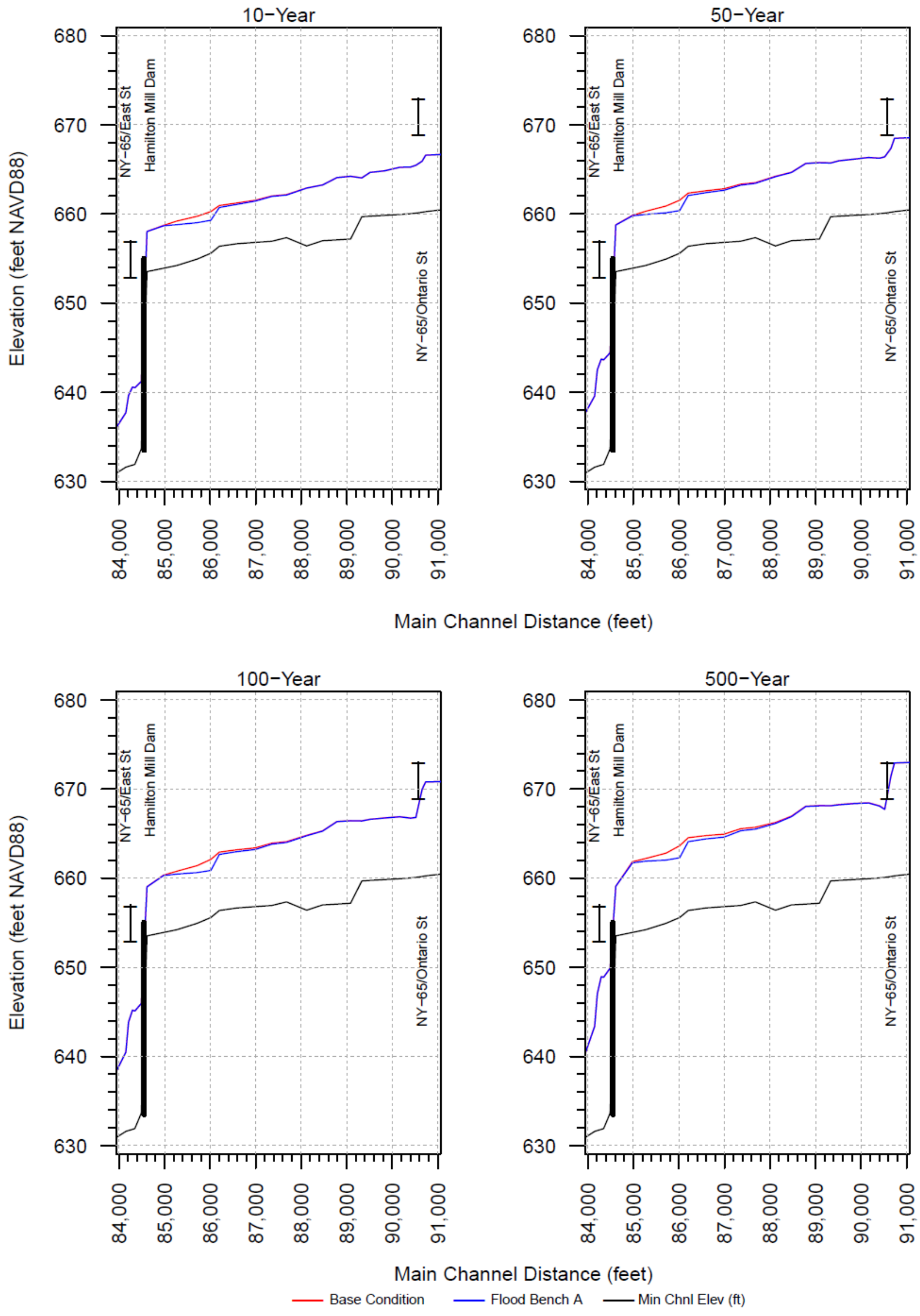


Figure 7-16. HEC-RAS model simulation output results for Alternative #1-6 for the existing condition (red) and Flood Bench A (blue) scenarios.

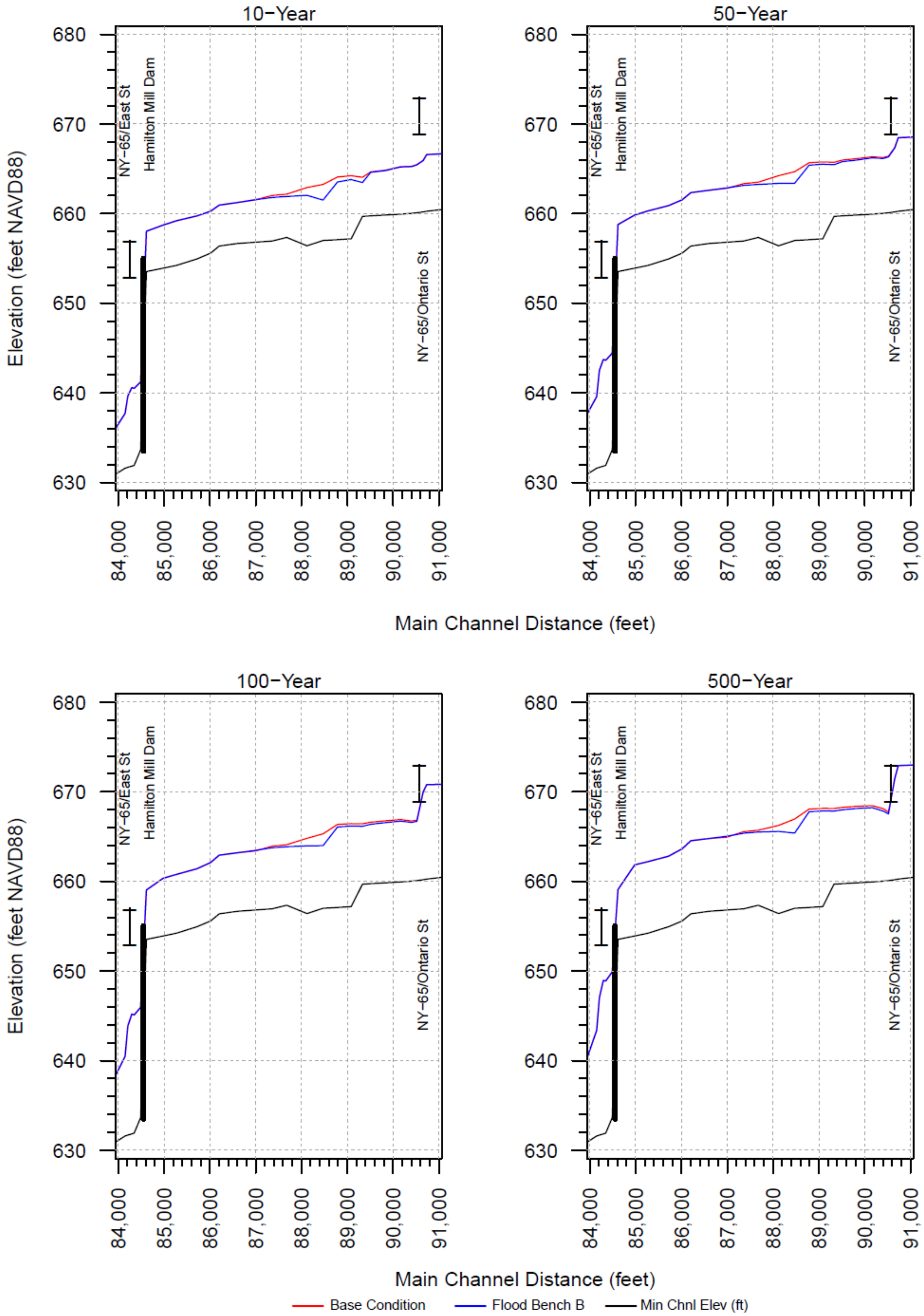


Figure 7-17. HEC-RAS model simulation output results for Alternative #1-6 for the existing condition (red) and Flood Bench B (blue) scenarios.

7.1.7 Alternative #1-7: Increase Size of Ontario Street/NY-65 Bridge Opening

This measure is intended to address issues within High-Risk Area #1 by increasing the width of the Ontario Street/NY-65 bridge opening, which would increase the cross-sectional flow area of the channel located at river station 911+75 (Figure 7-18).

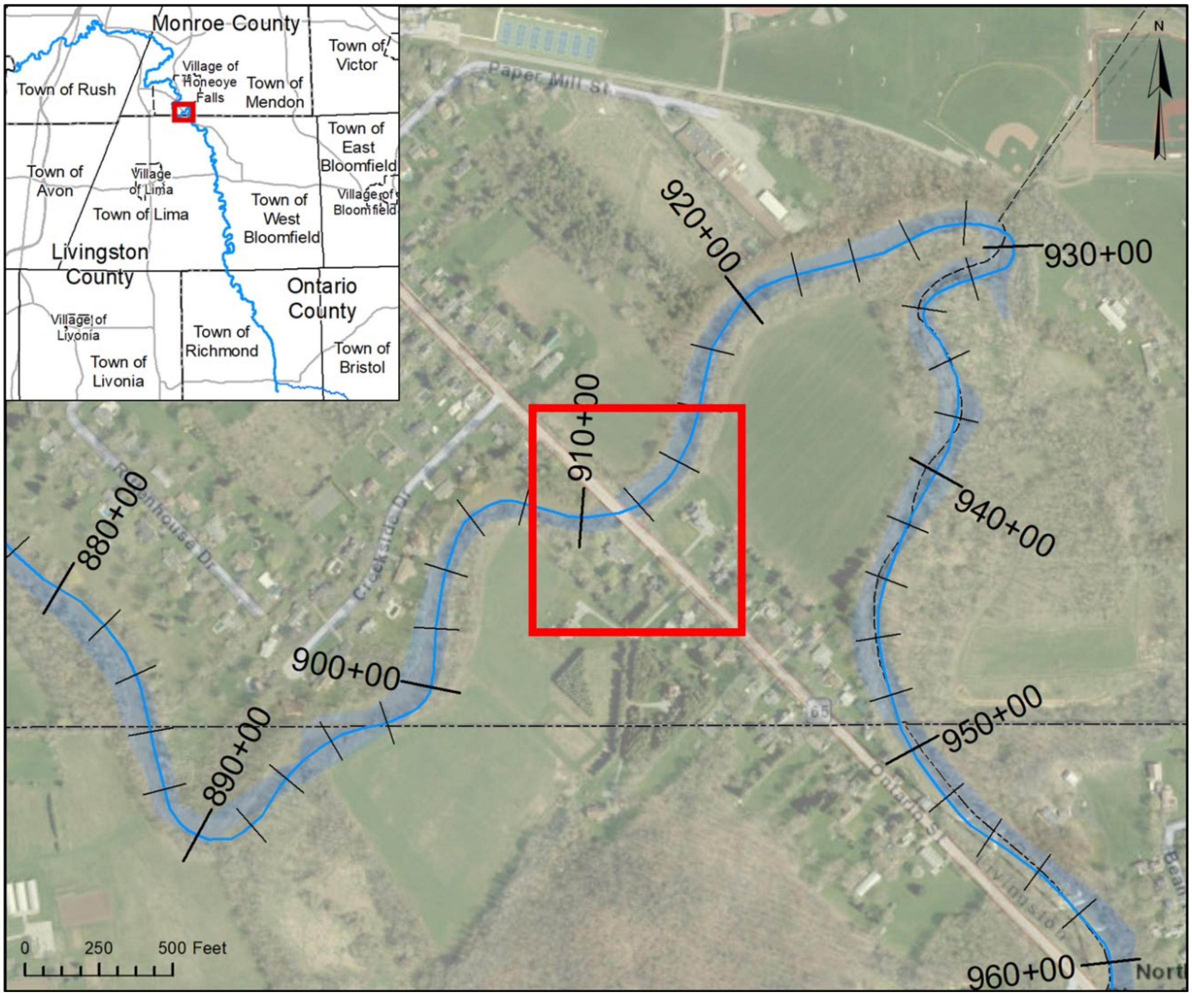


Figure 7-18. Location map for Alternative #1-7.

The bridge is owned by the NYSDOT and has no pier in the channel. The existing bridge structure with a bridge span of 111 ft, width of 42 ft, and deck thickness of 5 ft (Figure 7-19). The flooding in the vicinity of the Ontario Street/NY-65 bridge poses a flood risk threat to nearby residential and commercial properties and state-owned infrastructure. Appendix F depicts a flood mitigation rendering of a bridge widening scenario.

Figure 7-19. Ontario Street/NY-65 bridge, Honeoye Falls, NY.

Based on orthoimagery of the area, the meanders in the creek channel both upstream and downstream of the bridge crossing act as impediments to flow, reducing water velocities and allowing sediment and debris to aggregate and restrict flow in this area (NYSOITS 2020).

As shown in Figure 6-2, the FEMA FIS profile plot for the Ontario Street/NY-65 bridge indicates the bridge is able to successfully pass the 10-, 2-, and 1% ACE; however, there is significant backwater upstream the of the bridge in the FIS profile plot and the bridge does not provide the recommended 2-ft of freeboard (FEMA 2008b). In addition, the FEMA FIRM displays significant backwater upstream of the bridge crossing (FEMA 2008a).

By increasing the opening span of the bridge structure, the cross-sectional flow area of the channel would increase and the potential for sediment, debris, and ice to accumulate or catch on the upstream face of the bridge would be reduced, thereby reducing flood risk to areas adajcent to and immediately upstream of the bridge.

The bridge widening design selected for this proposed condition model simulation was selected to ensure that the 1% ACE WSEL could successfully pass under the N Main Street/NY-65 bridge without significant backwater upstream of the bridge. To achieve the desired result, the bridge widening design increased the span of the bridge opening from 111 ft to 136 ft by widening the bridge on the right bank by 25 ft. This measure would potentially reduce the flood risk and benefit the properties adjacent to and immediately upstream of N Main Street/NY-65.

Table 25 outlines the results of the existing conditions model simulations for each initial condition scenario. Figures 7-20 through 7-22 display the profile plots for each initial condition scenario. Full model outputs for this alternative can be found in Appendix H.

Table 25. Summary Table for Alternative #1-7 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 2.5-ft
Total Length of Benefited Area	3,975-ft
River Stations	905+75 to 945+50
Debris Obstruction	Up to 1.5-ft
Total Length of Benefited Area	3,975-ft
River Stations	905+75 to 945+50
Ice Jam	Up to 0.5-ft
Total Length of Benefited Area	3,975-ft
River Stations	905+75 to 945+50

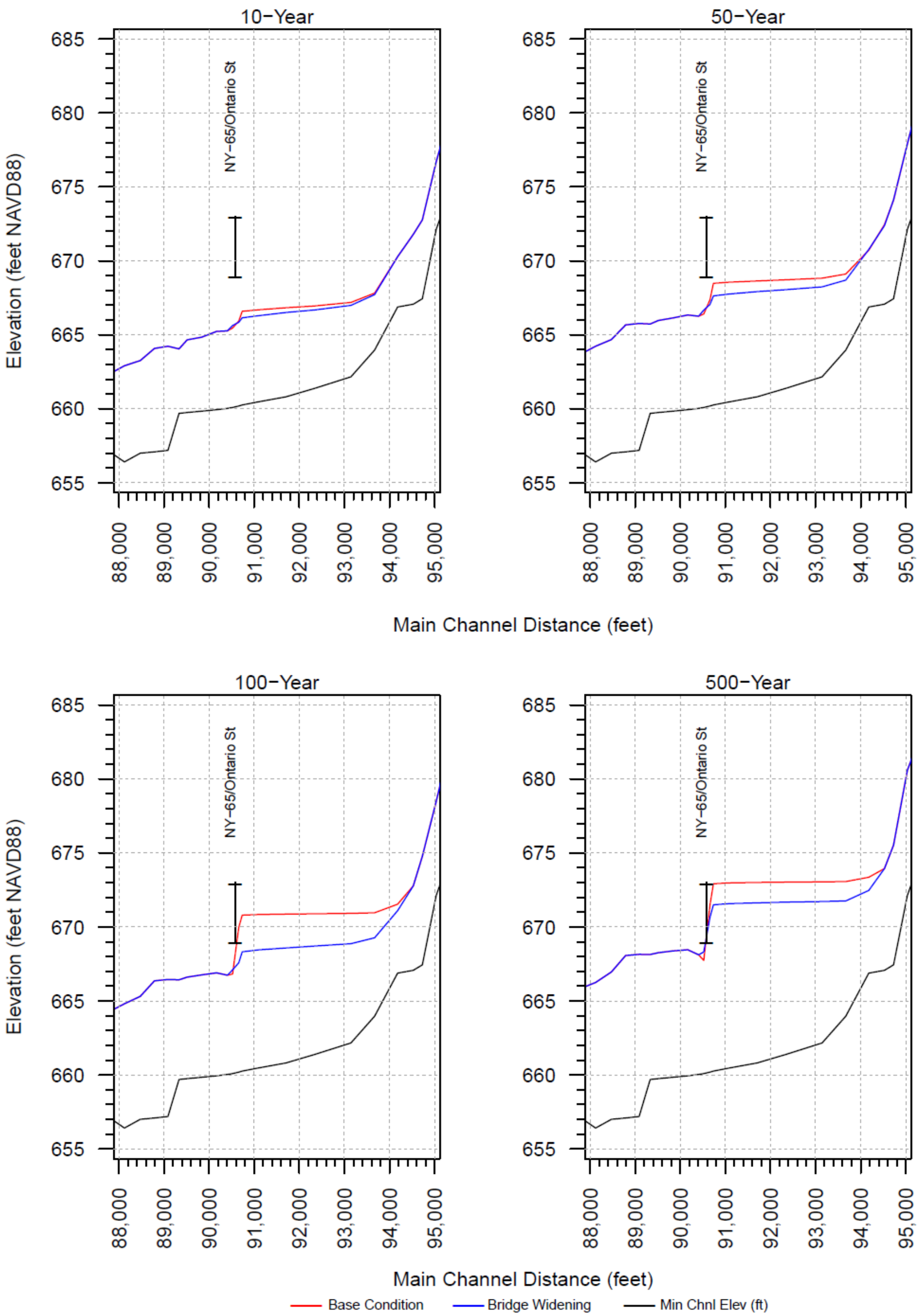


Figure 7-20. HEC-RAS model simulation output results for Alternative #1-7 for the existing condition (red) and bridge widening (blue) scenarios.

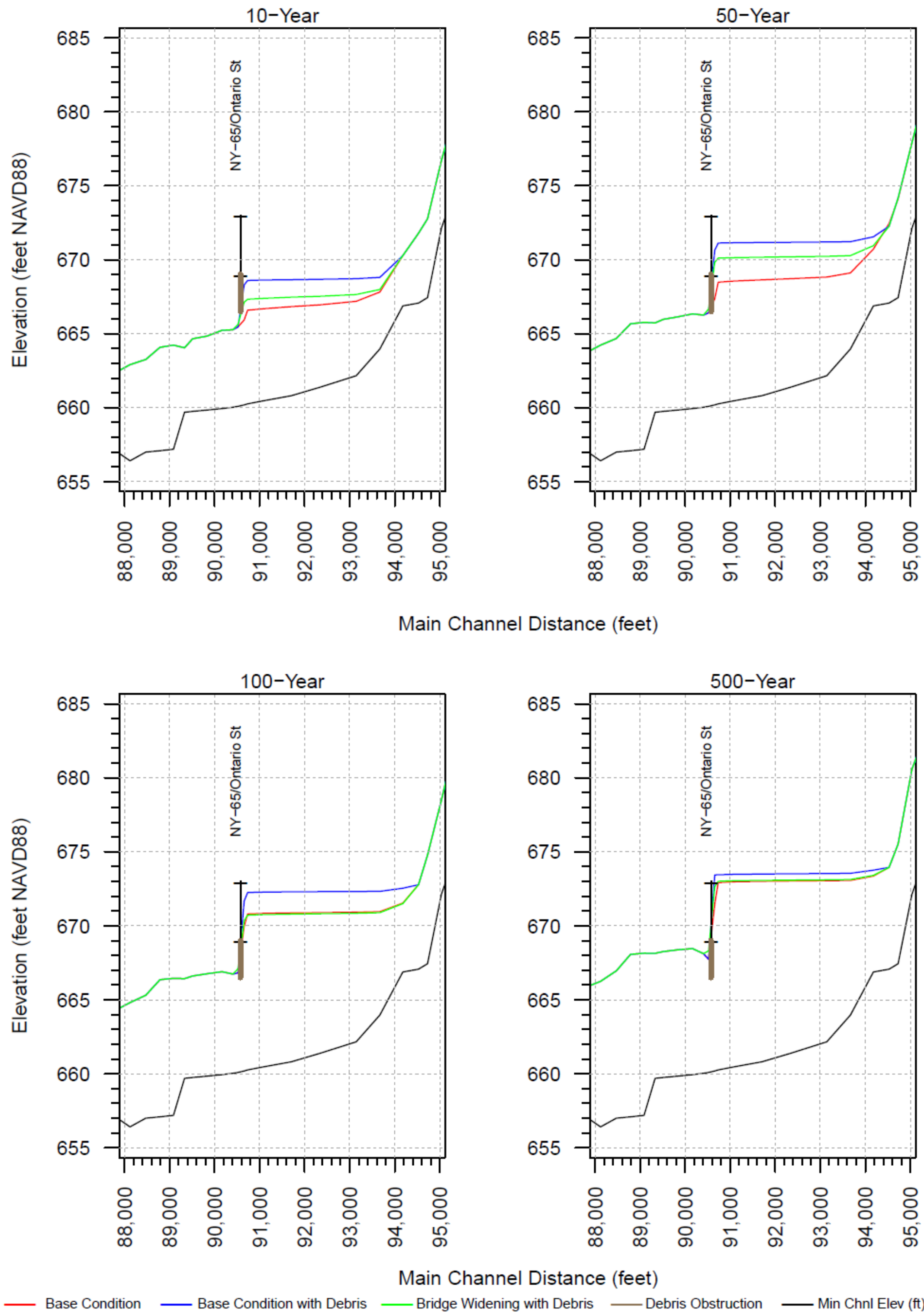


Figure 7-21. HEC-RAS debris obstruction model simulation output results for Alternative #1-7 for the existing condition (red), existing condition with debris (blue), and bridge widening with debris (green) scenarios.

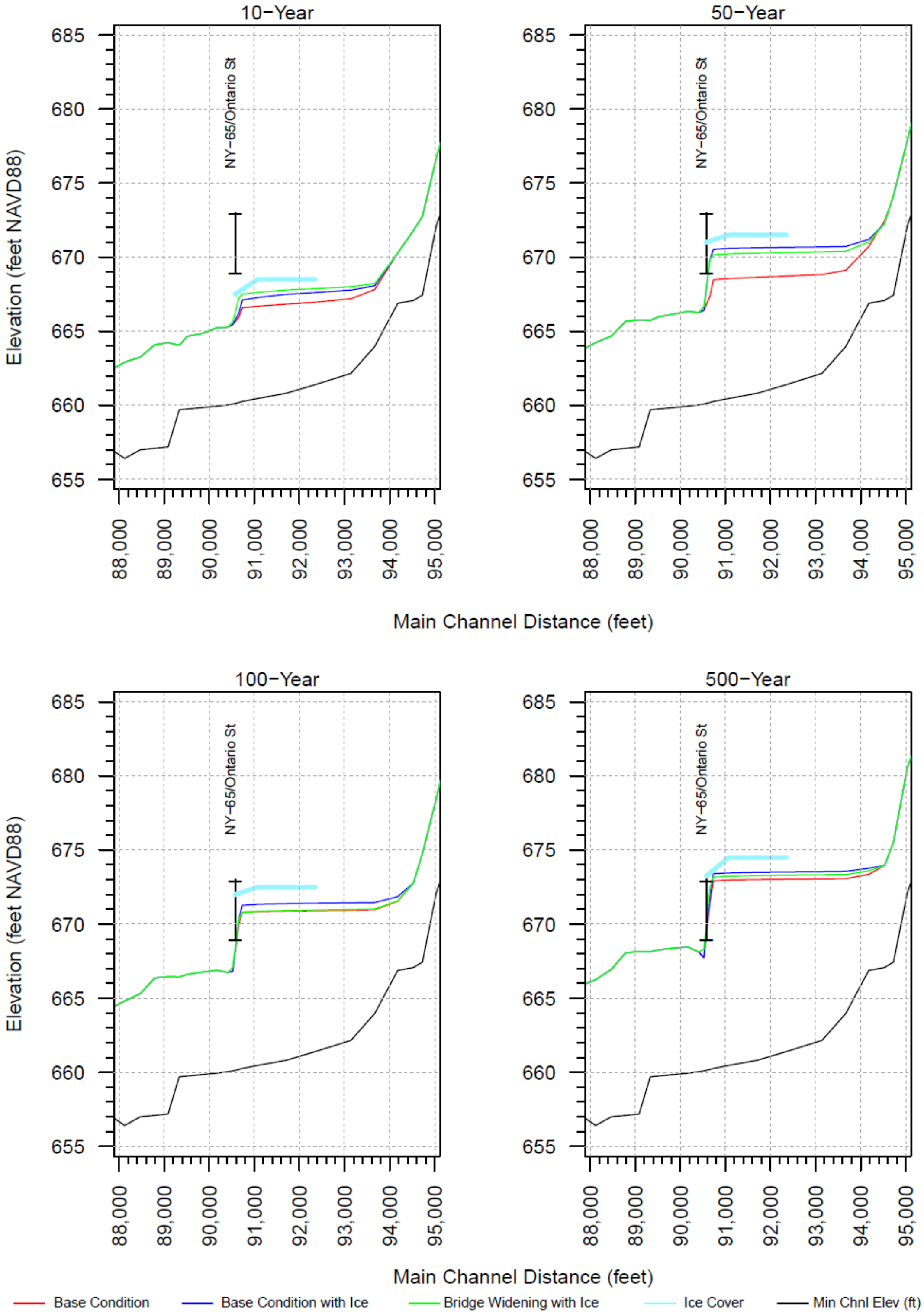


Figure 7-22. HEC-RAS ice cover model simulation output results for Alternative #1-7 for the existing condition (red), existing condition with ice cover (blue), and bridge widening with ice cover (green) scenarios.

Table 26 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 26. Summary Table for Alternative #1-7 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 2.5-ft
Total Length of Benefited Area	3,975-ft
River Stations	905+75 to 945+50
Debris Obstruction	Up to 1.4-ft
Total Length of Benefited Area	3,975-ft
River Stations	905+75 to 945+50
Ice Jam	Up to 0.5-ft
Total Length of Benefited Area	3,975-ft
River Stations	905+75 to 945+50

The potential benefits of this strategy are limited to immediately upstream of the Ontario Street/NY-65 bridge. The primary benefits of increasing the bridge opening would be to increase the flow capacity of the bridge structure, decrease the potential of backwater from high-flow events, and reduce debris and ice catching on structures.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed this alternative independent of any other proposed mitigation alternative. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

The Rough Order Magnitude cost for this strategy is approximately $6.5 million, which does not include land acquisition costs for survey, appraisal, and engineering coordination. Additional engineering consideration would also be required to determine if increasing the bridge opening would alter the structural integrity of the bridge in any way.

7.1.8 Alternative #1-8: Flood Benches Upstream and Downstream of Ontario Street/NY-65

Installing a flood bench would provide additional storage and floodplain width over and above the current storage and width provided by the adjacent overbank areas, which could potentially reduce damages in the event of flooding and address issues within High-Risk Area #1. Two potential flood benches were modeled in the vicinity of Ontario Street/NY-65 in the Village of Honeoye Falls (Figure 7-23):

- Flood Bench A is approximately 8 acres in size and located between river stations 895+00 to 908+00
- Flood Bench B is approximately 5.5 acres in size and located between river stations 914+00 to 924+00

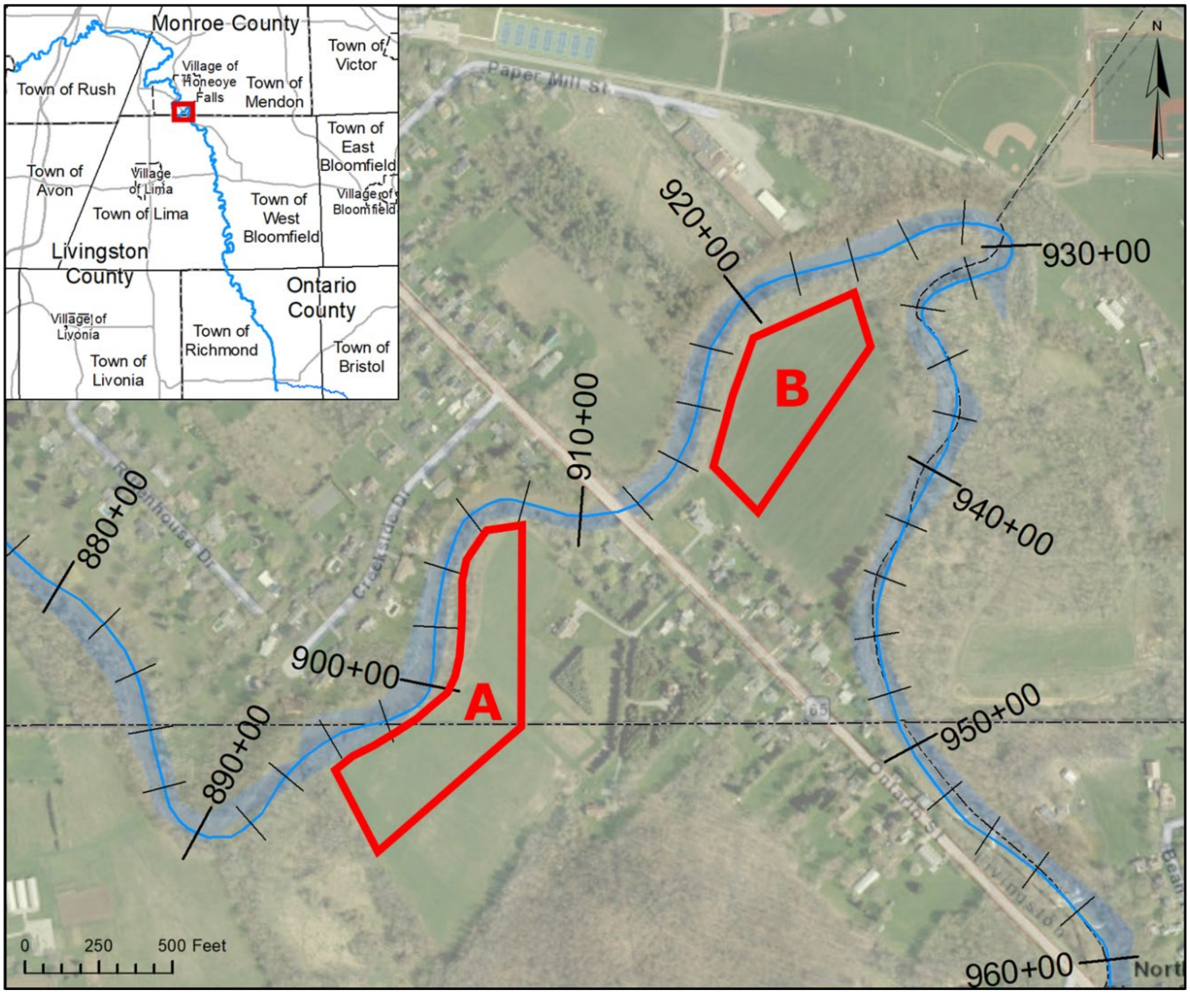


Figure 7-23. Location map for Alternative #1-8.

The flood bench designs used for the proposed condition model simulation set the minimum bench elevation approximately equal to the bankfull elevation, which was an average depth of 2.5 ft for both benches.

The flood benches are within the FEMA designated SFHA or Zone AE, which are areas subject to inundation by the 1% ACE with base flood elevations determined and where mandatory flood insurance purchase requirements and floodplain management standards apply (FEMA 2008b). Appendix F depicts a flood mitigation rendering of a flood bench illustrating before and after landscape features.

For this alternative, open-water, debris-obstruction, and ice-jam simulations were performed to test the effectiveness of the alternative at reducing WSELs for Flood Bench B only. Flood Bench A is downstream of the bridge and WSELs in the vicinity of this bench would not be significantly influenced by debris or ice-jams occurring upstream of the bridge.

Table 27 outlines the results of the existing and future conditions model simulations for each flood bench. Figures 7-24 and 7-27 display the profile plots for each flood bench alternative. Full model outputs for this alternative can be found in Appendix H.

Table 27. Summary Table for Alternative #1-8 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)	
	Flood Bench A	**Flood Bench B**
Open-Water	Up to 0.7-ft	No Modeled Change in WSEL
Total Length of Benefited Area	4,900-ft	No Modeled Change in WSEL
River Stations	893+00 to 942+00	No Modeled Change in WSEL
Debris Obstruction	N/A	No Modeled Change in WSEL
Total Length of Benefited Area	N/A	No Modeled Change in WSEL
River Stations	N/A	No Modeled Change in WSEL
Ice Jam	N/A	No Modeled Change in WSEL
Total Length of Benefited Area	N/A	No Modeled Change in WSEL
River Stations	N/A	No Modeled Change in WSEL

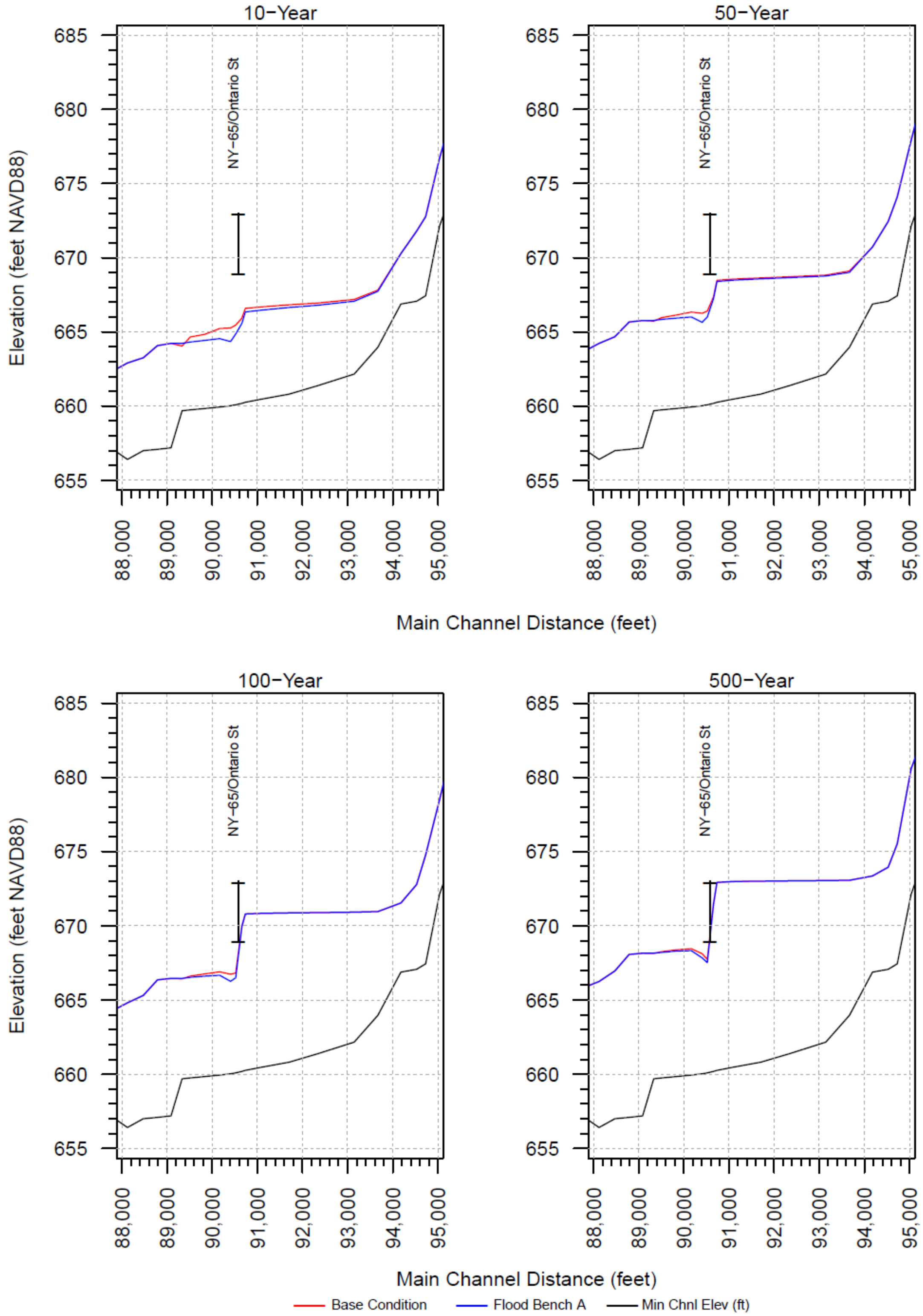


Figure 7-24. HEC-RAS model simulation output results for Alternative #1-8 for the existing condition (red) and Flood Bench A (blue) scenarios.

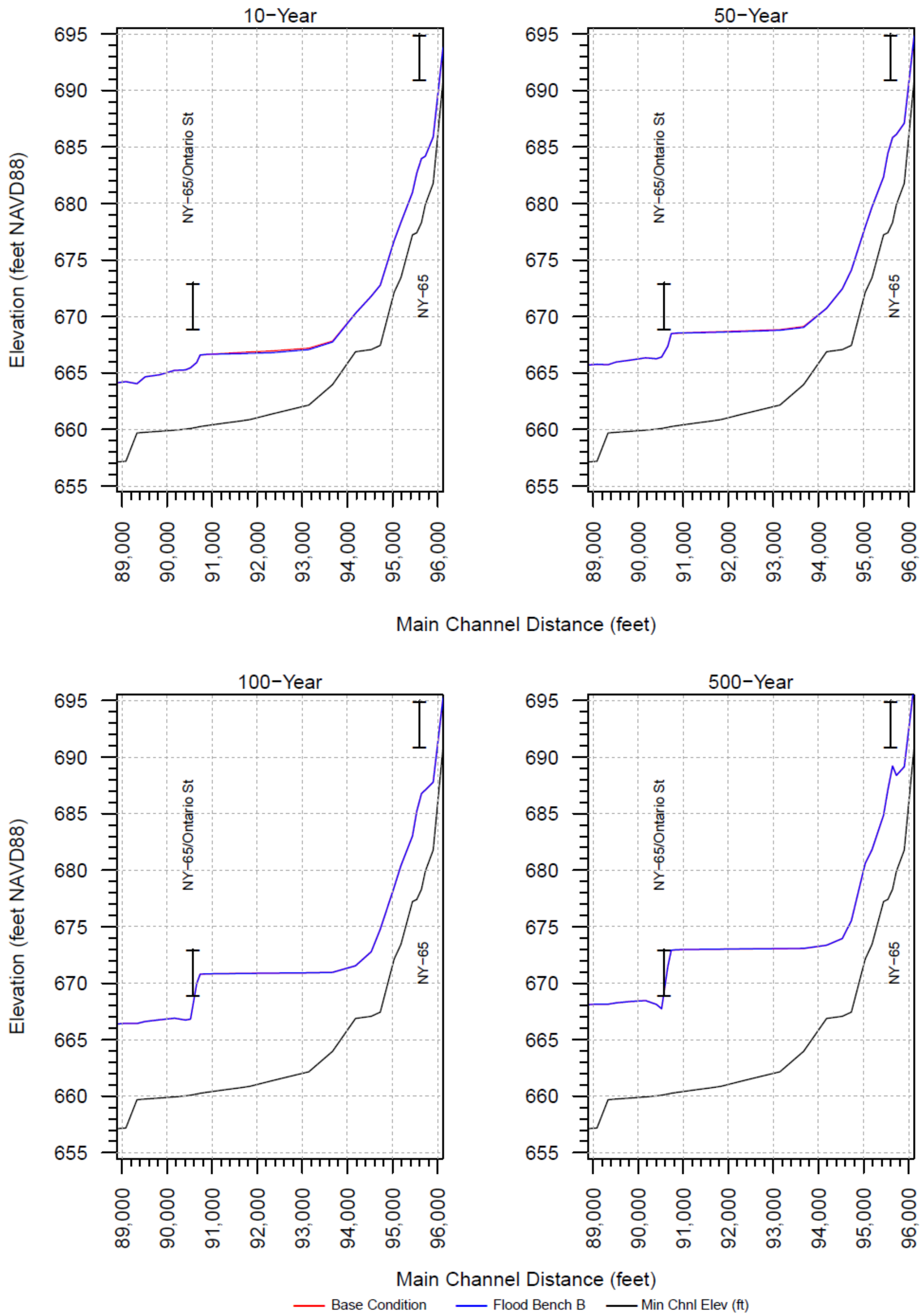


Figure 7-25. HEC-RAS model simulation output results for Alternative #1-8 for the existing condition (red) and Flood Bench B (blue) scenarios.

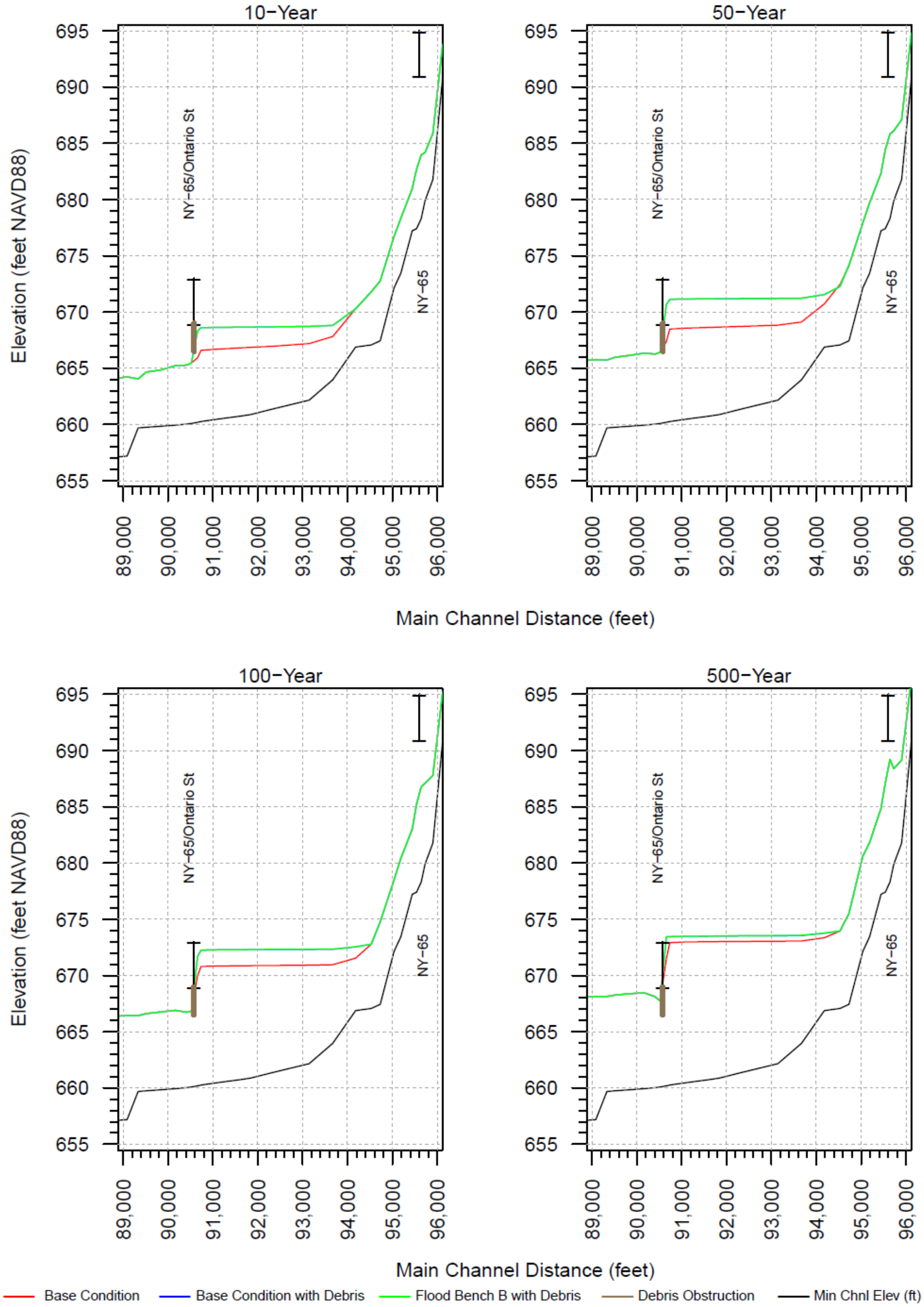


Figure 7-26. HEC-RAS debris obstruction model simulation output results for Alternative #1-8 for the existing condition (red), existing condition with debris (blue), and Flood Bench B with debris (green) scenarios.

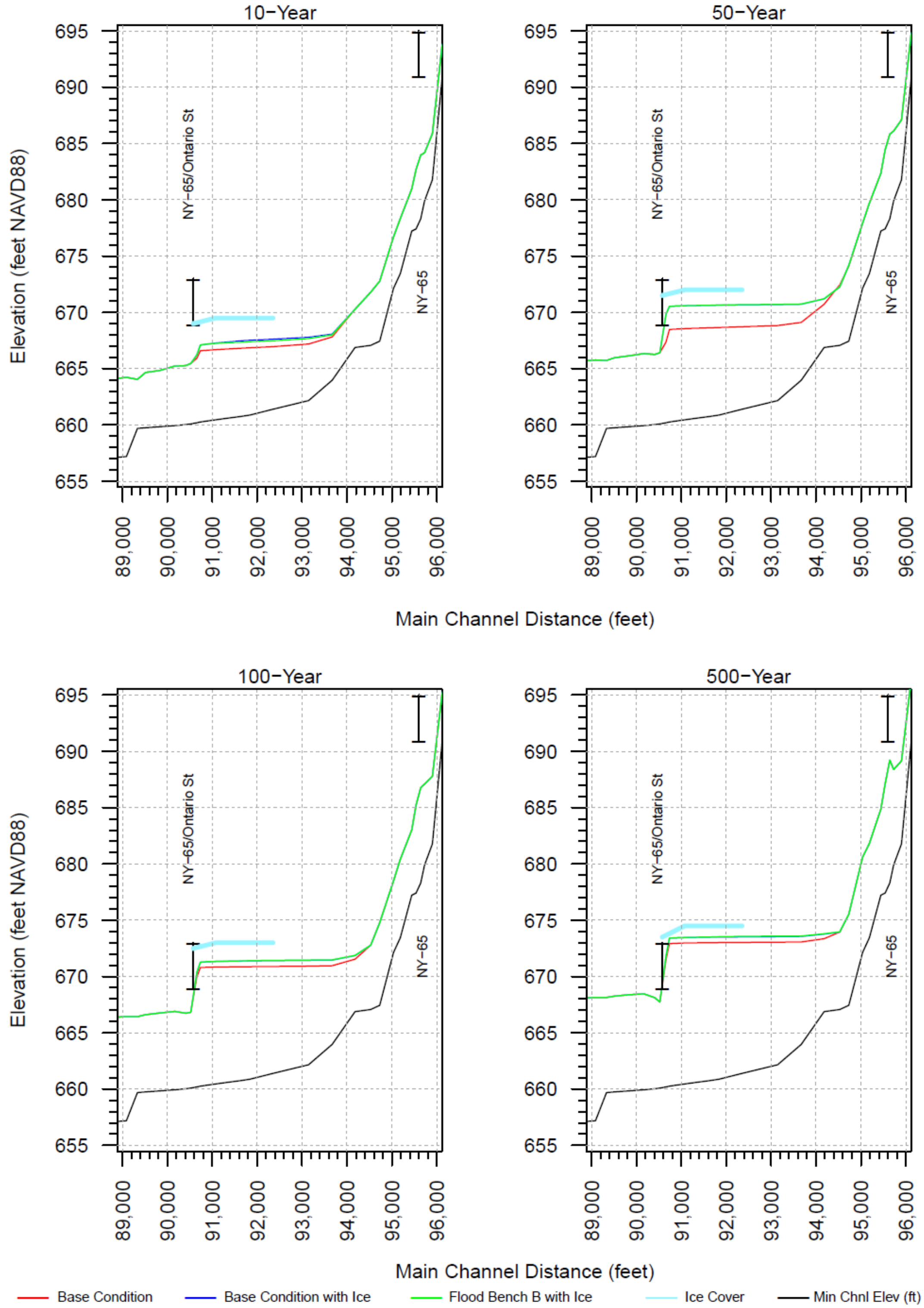


Figure 7-27. HEC-RAS ice cover model simulation output results for Alternative #1-8 for the existing condition (red), existing condition with ice cover (blue), and Flood Bench B with ice cover (green) scenarios.

Table 28 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 28. Summary Table for Alternative #1-8 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	Reductions in Water Surface Elevations (feet)	
	Flood Bench A	Flood Bench B
Open-Water	Up to 0.6-ft	No Modeled Change in WSEL
Total Length of Benefited Area	4,900-ft	No Modeled Change in WSEL
River Stations	893+00 to 942+00	No Modeled Change in WSEL
Debris Obstruction	N/A	No Modeled Change in WSEL
Total Length of Benefited Area	N/A	No Modeled Change in WSEL
River Stations	N/A	No Modeled Change in WSEL
Ice Jam	N/A	No Modeled Change in WSEL
Total Length of Benefited Area	N/A	No Modeled Change in WSEL
River Stations	N/A	No Modeled Change in WSEL

Flood benches generally provide flood protection for localized areas in the vicinity of and immediately upstream and/or downstream of the bench. Based on the analysis of high-risk areas, a flood bench located downstream of Ontario Street/NY-65 would provide flood protection in this reach from open-water flooding; however, a flood bench upstream of the bridge would not provide significant flood protection from open-water, debris, and/or ice-jam conditions.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed each flood bench independently. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

The Rough Order Magnitude cost for each flood bench alternative is:

- Flood Bench A: $3 million
- Flood Bench B: $2.2 million

These ROM cost estimates do not include land acquisition costs for survey, appraisal, and engineering coordination. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.1.9 Alternative #1-9: Dam Removal Analysis within the Village of Honeoye Falls

This measure is intended to assess the effectiveness of removing the Tompkinson, Kenyon & Tompkinson (TK&T) and Hamilton Mill Dams along Honeoye Creek in the Village of Honeoye Falls located at river stations 839+00 and 850+50, respectively (Figure 7-28).

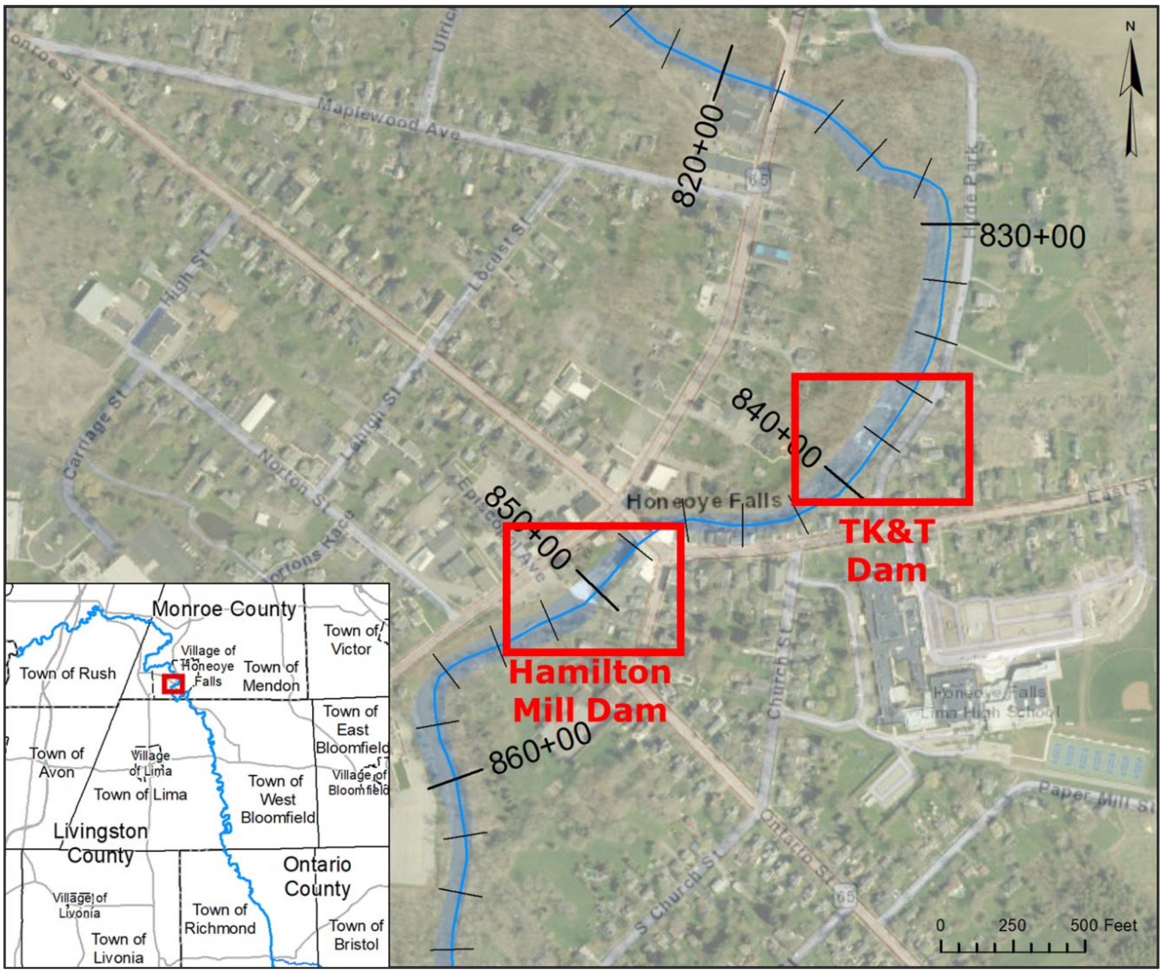


Figure 7-28. Location map for Alternative #1-9.

The existing dam structure of the TK&T Dam has a dam height of 9 ft and length of 175 ft, while the Hamilton Dam has a height of 4 ft and length of 200 ft. Both dams are class A or “low hazard” dams, while the TK&T Dam has a purpose designation of “Other” and the Hamilton Dam is designed as “Recreation” (NYSDEC 2021b). The two dams are in close proximity to each other (approximately 1,300 ft) and are separated by the East Street bridge crossing over Honeoye Creek.

According to the FEMA FIS profile for Honeoye Creek, the TK&T dam experiences backwater as a result of the close proximity of both the East Street bridge and Hamilton Dam (FEMA 2008b). In addition, the FEMA FIRM displays significant backwater flooding upstream of the East Street bridge and the Hamilton Dam (FEMA 2008a).

By removing the dams, the cross-section flow area of the channel would increase and the potential for sediment, debris, and ice to accumulate or catch on the dams would be reduced, thereby reducing the flood risk to areas adjacent to and immediately upstream of the dams. Table 29 outlines the results of the existing conditions model simulations for each dam removal and the combined dam removal scenarios. Figures 7-29 through 7-31 display the profile plots for each dam removal scenario. Full model outputs for this alternative can be found in Appendix H.

Table 29. Summary Table for Alternative #1-9 Existing Conditions Results

Existing Conditions	Reductions in Water Surface Elevations (feet)		
	TK&T Dam Removal	Hamilton Dam Removal	Combined Dam Removal
Open-Water	Up to 6.1-ft	Up to 1.7-ft	Up to 6.1-ft
Total Length of Benefited Area	600-ft	1,700-ft	2,900-ft
River Stations	833+00 to 839+00	845+00 to 862+00	833+00 to 862+00

Table 30 outlines the results of the future conditions model simulations for each dam removal and the combined dam removal scenarios.

Table 30. Summary Table for Alternative #1-9 Future Conditions Results

Future Conditions	Reductions in Water Surface Elevations (feet)		
	TK&T Dam Removal	Hamilton Dam Removal	Combined Dam Removal
Open-Water	Up to 6.3-ft	Up to 1.7-ft	Up to 6.3-ft
Total Length of Benefited Area	600-ft	1,700-ft	2,900-ft
River Stations	833+00 to 839+00	845+00 to 862+00	833+00 to 862+00

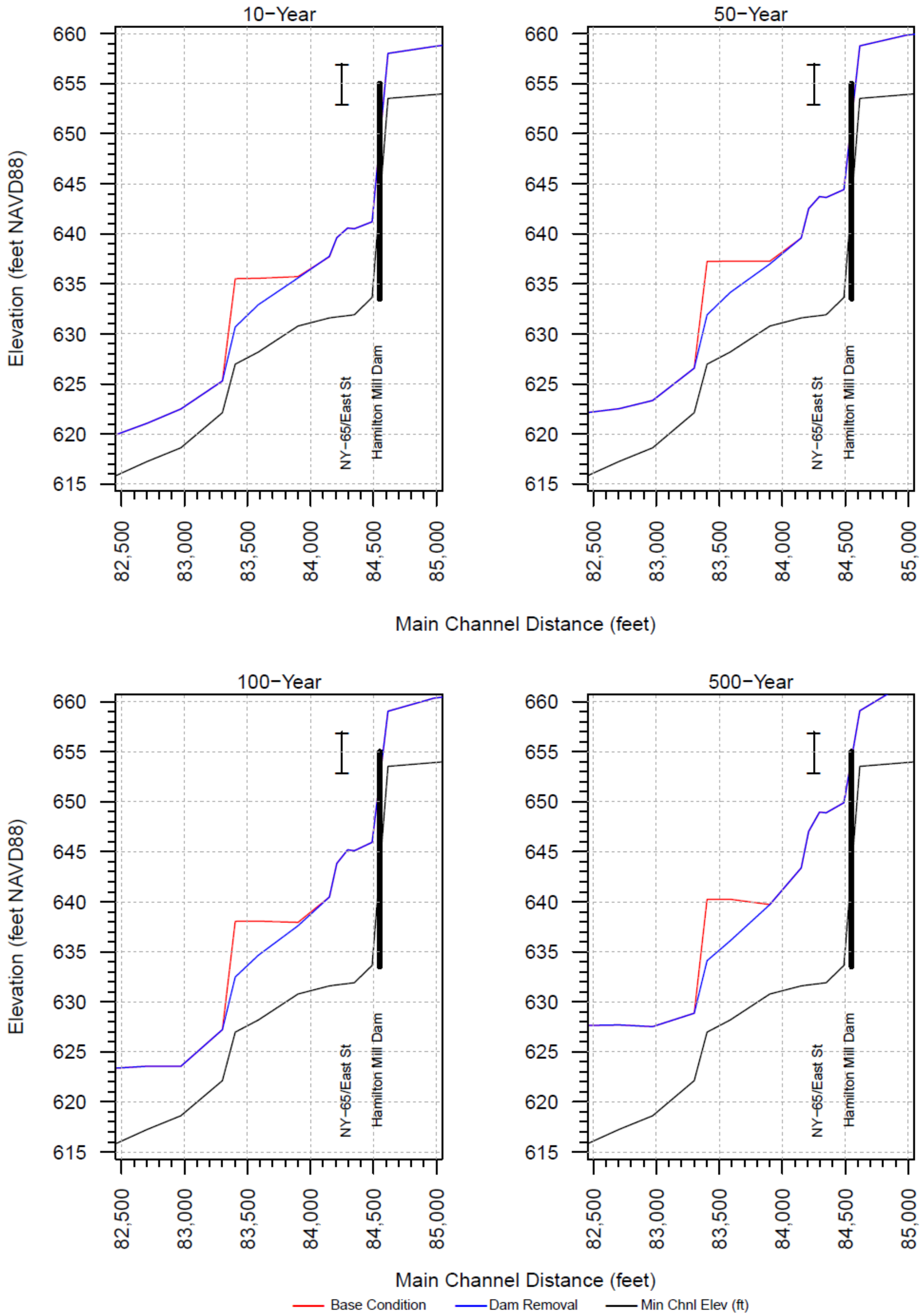


Figure 7-29. HEC-RAS model simulation output results for Alternative #1-9 for the existing condition (red) and TK&T Dam Removal (blue) scenarios.

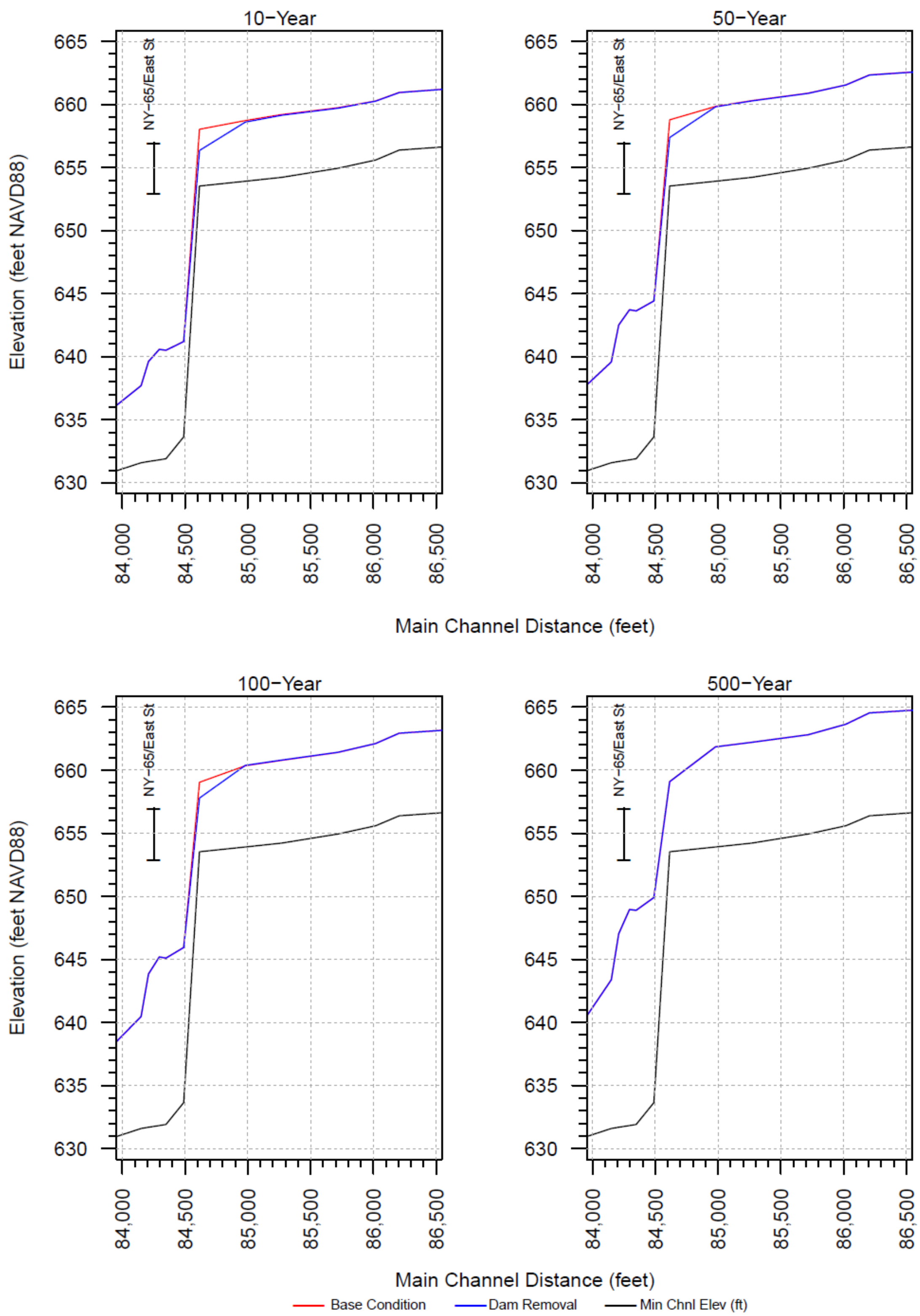


Figure 7-30. HEC-RAS model simulation output results for Alternative #1-9 for the existing condition (red) and Hamilton Dam Removal (blue) scenarios.

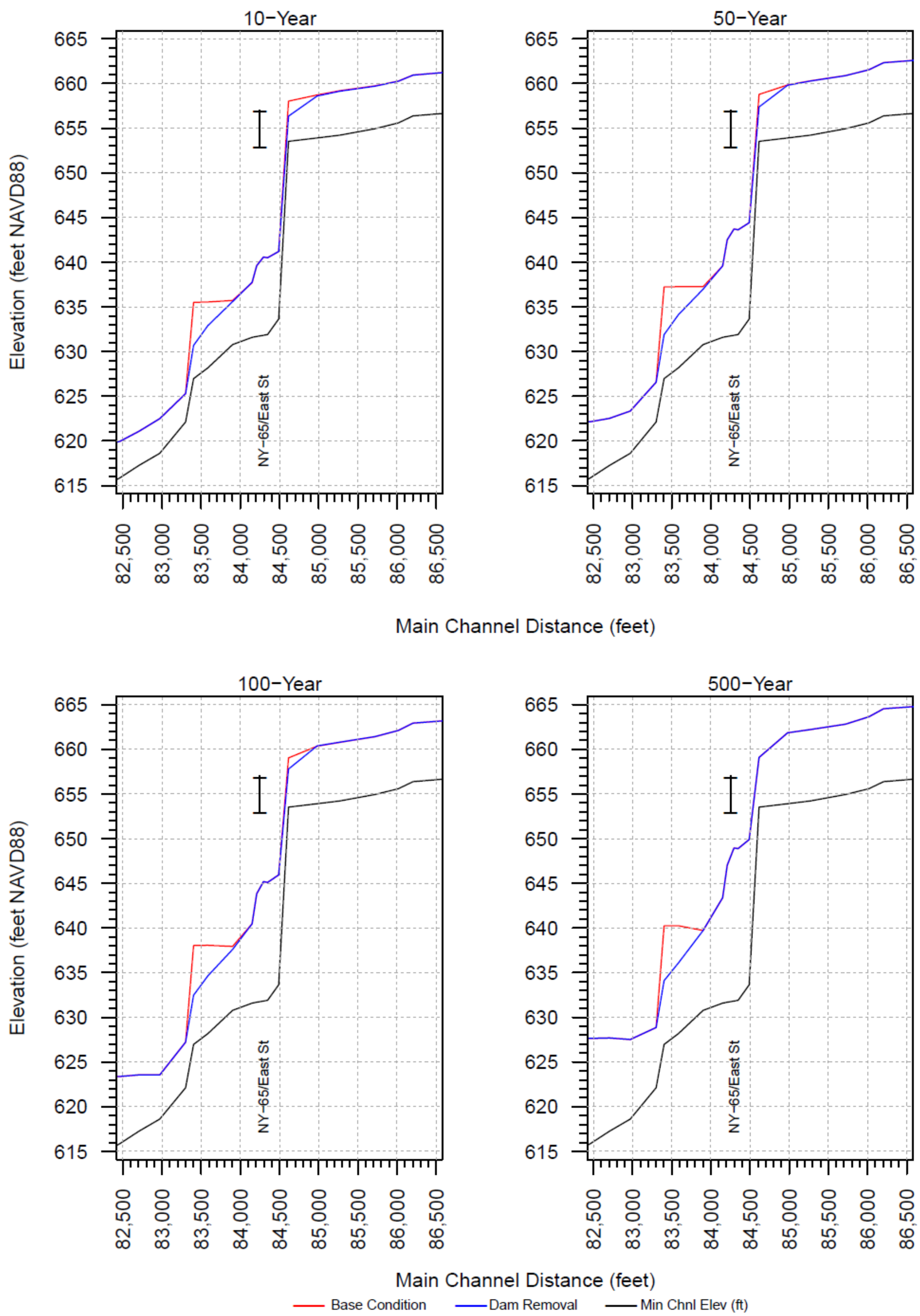


Figure 7-31. HEC-RAS model simulation output results for Alternative #1-9 for the existing condition (red) and Combined Dam Removal (blue) scenarios.

The potential benefits of this strategy are limited to immediately upstream of each dam for the individual and combined dam removal scenarios. The WSELs in the vicinity of East Street remain unchanged from the existing conditions model results. The natural waterfall that exists where the current Hamilton Dam structure is located influences WSELs in this reach and limits the potentially benefitted areas both upstream and downstream of the Hamilton Dam.

Several factors must be considered when evaluating potential dam removal projects, including (Duda and Bellmore 2021):

- Legal requirements, such as obtaining the necessary federal and local permits
- Obtaining funding, identifying and getting input from stakeholders
- Determining whether mitigation projects are necessary or required to minimize dam removal effects
- Technical difficulty, expense, and time horizon of a proposed dam removal
- Dam ownership (whether the dam is publicly or privately owned) and the purpose and size of the dam
- Reservoir sedimentation, the status and ecology of the river and surrounding project lands
- Testing requirements to categorize sediment held behind the dam for the presence or absence of hazardous materials
- Infrastructure downstream of the dam
- Any necessary environmental compliance mandates

Dam removal is an important tool for river restoration and addressing aging infrastructure. It is an ongoing activity that will continue as a large number of aging dams that are no longer serving their original purposes, have become safety liabilities, or represent potential for significant restoration action are taken down (Duda and Bellmore 2021).

Rivers are resilient to the changes and disturbance that accompany the removal of a dam, with many of the changes occurring rapidly and representing an improvement in water quality, hydrological flows, and migratory movement of aquatic animals. Yet, some of the outcomes of dam removal may play out over longer time periods, depending on such factors as the life history of key species or implementation of other complementary river restoration actions (Duda and Bellmore 2021).

In New York State, a joint permit application from the NYSDEC and USACE may be required in order to remove a dam or other impoundment. The NYSDEC is entrusted with the regulatory power to oversee dam safety. To protect people from the loss of life and property due to flooding and/or dam failure, the NYSDEC Dam Safety Section, in cooperation with the USACE, reviews proposed dam removals, conducts dam safety inspections, and monitors projects for compliance with dam safety criteria. Coordination should occur with the NYSDEC as they need to be the non-federal sponsor on these types of projects.

In addition, a FEMA BCA would need to be performed to determine the cost-effectiveness of the alternative prior to applying for FEMA mitigation grant programs funding. The BCR must be greater than or equal to 1.0 in order for the project to be considered cost effective.

The ROM cost estimate for each dam removal scenario is highly dependent on the presence or absence of contaminants in any sediment impounded behind the dam. Therefore, we are unable to calculate a ROM cost at this time.

It should be noted that by removing one or both of the dams the potential flood risk for downstream areas could be altered resulting in negative effects to downstream areas. Ramboll recommends additional research, data, and modeling, including advanced 2-D modeling, to more accurately determine the effects of removing one or both of the dams to downstream areas.

7.2 HIGH-RISK AREA #2

7.2.1 Alternative #2-1: Flood Benches at Confluence of Honeoye and Mill Creeks

Installing a flood bench would provide additional storage and floodplain width over and above the current storage and width provided by the adjacent overbank areas, which could potentially reduce damages in the event of flooding and address issues within High-Risk Area #2. Three potential flood benches were modeled in the vicinity of the confluence of Honeoye and Mills Creeks in the Hamlet of Honeoye (Figure 7-32):

- Flood Bench A is approximately 17 acres in size and located between river stations 1841+00 to 1848+00
- Flood Bench B is approximately 8 acres in size and located between river stations 1838+00 to 1848+00
- Flood Bench C is approximately 13 acres in size and located between river stations 1820+00 to 1830+00

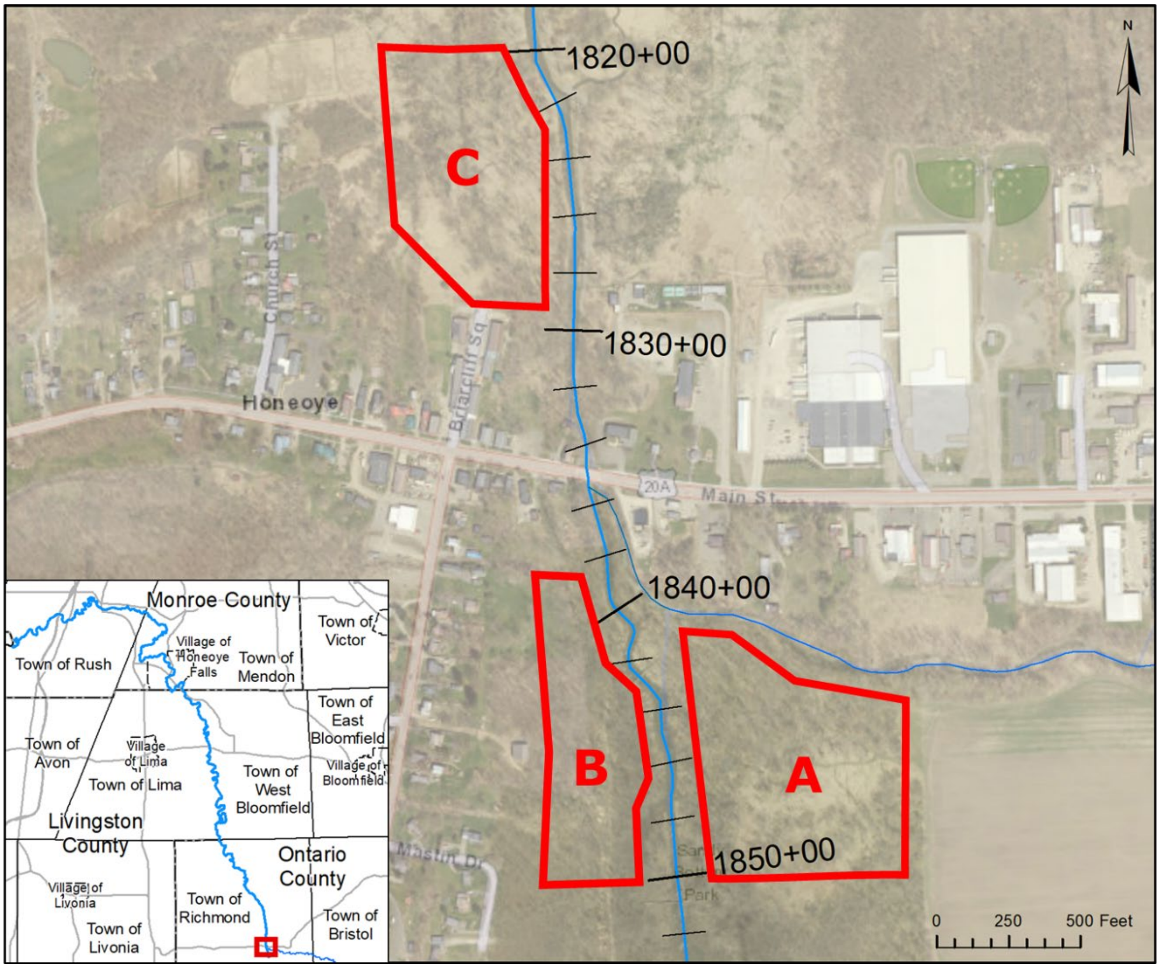


Figure 7-32. Location map for Alternative #2-1.

The flood bench designs used for the proposed condition model simulation set the minimum bench elevation approximately equal to the bankfull elevation, which was an average depth of 6 ft for Flood Bench A, 2 ft for Flood Bench B, and 1.5 ft for Flood Bench C.

The flood benches are within the FEMA designated SFHA or Zone AE, which are areas subject to inundation by the 1% ACE with base flood elevations determined and where mandatory flood insurance purchase requirements and floodplain management standards apply (FEMA 2008b). Appendix F depicts a flood mitigation rendering of a flood bench illustrating before and after landscape features.

For this alternative, open-water, debris-obstruction, and ice-jam simulations were performed to test the effectiveness of the alternative at reducing WSELs for Flood Bench A and B only. Flood Bench C is downstream of the Main Street/US-20A bridge and would have minimal influence on WSELs upstream of the bridge crossing.

Table 31 outlines the results of the existing and future conditions model simulations for each flood bench. Figures 7-33 and 7-39 display the profile plots for each flood bench alternative. Full model outputs for this alternative can be found in Appendix H.

Table 31. Summary Table for Alternative #2-1 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)		
	Flood Bench A	**Flood Bench B**	**Flood Bench C**
Open-Water	Up to 0.8-ft	Up to 0.5-ft	Up to 0.5-ft
Total Length of Benefited Area	2,050-ft	2,050-ft	2,325-ft
River Stations	1867+00 to 1887+50	1867+00 to 1887+50	1833+50 to 1856+75
Debris Obstruction	Up to 0.7-ft	Up to 0.4-ft	N/A
Total Length of Benefited Area	2,050-ft	2,050-ft	N/A
River Stations	1867+00 to 1887+50	1867+00 to 1887+50	N/A
Ice Jam	Up to 0.7-ft	Up to 0.4-ft	N/A
Total Length of Benefited Area	2,050-ft	2,050-ft	N/A
River Stations	1867+00 to 1887+50	1867+00 to 1887+50	N/A

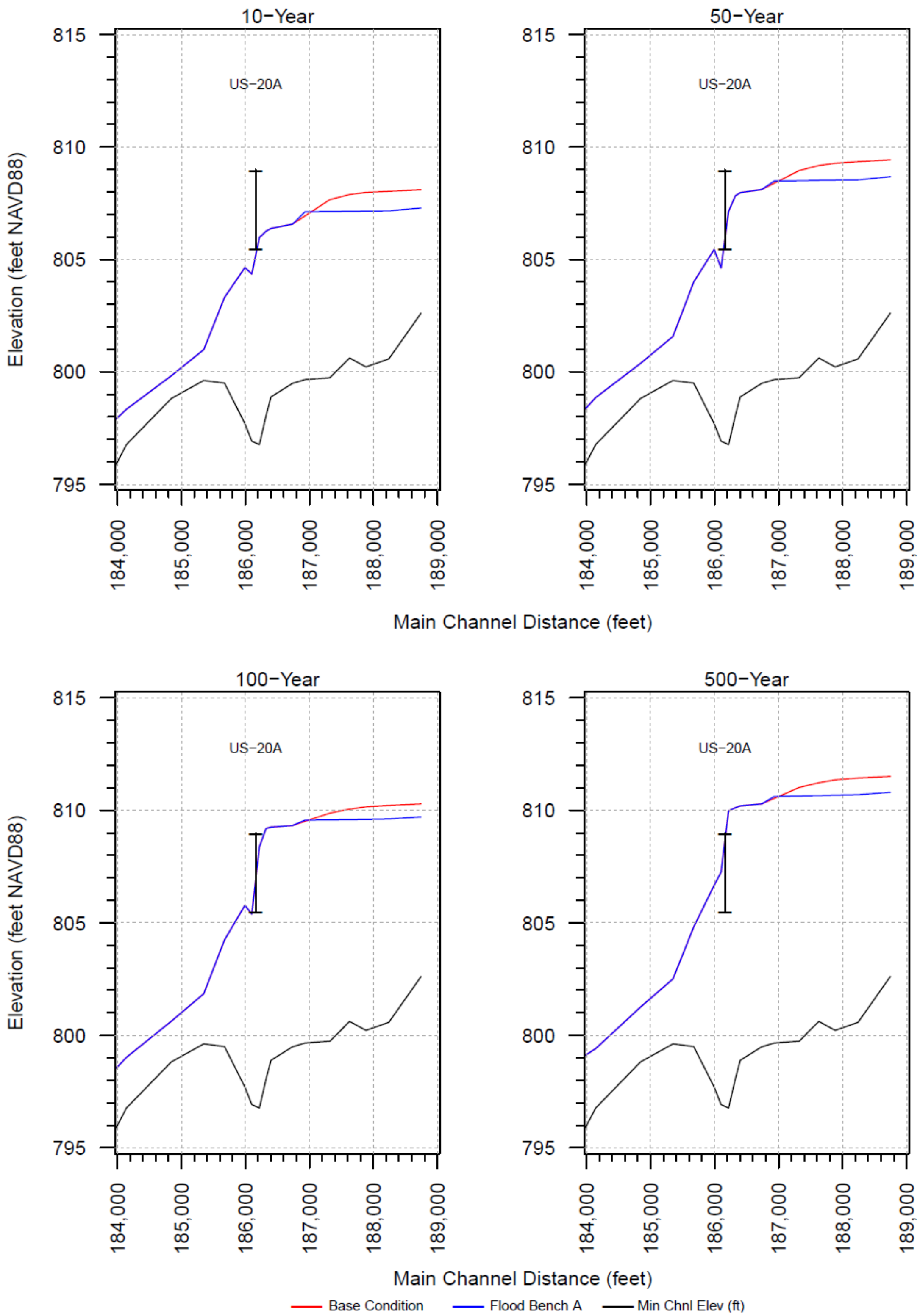


Figure 7-33. HEC-RAS model simulation output results for Alternative #2-1 for the existing condition (red) and Flood Bench A (blue) scenarios.

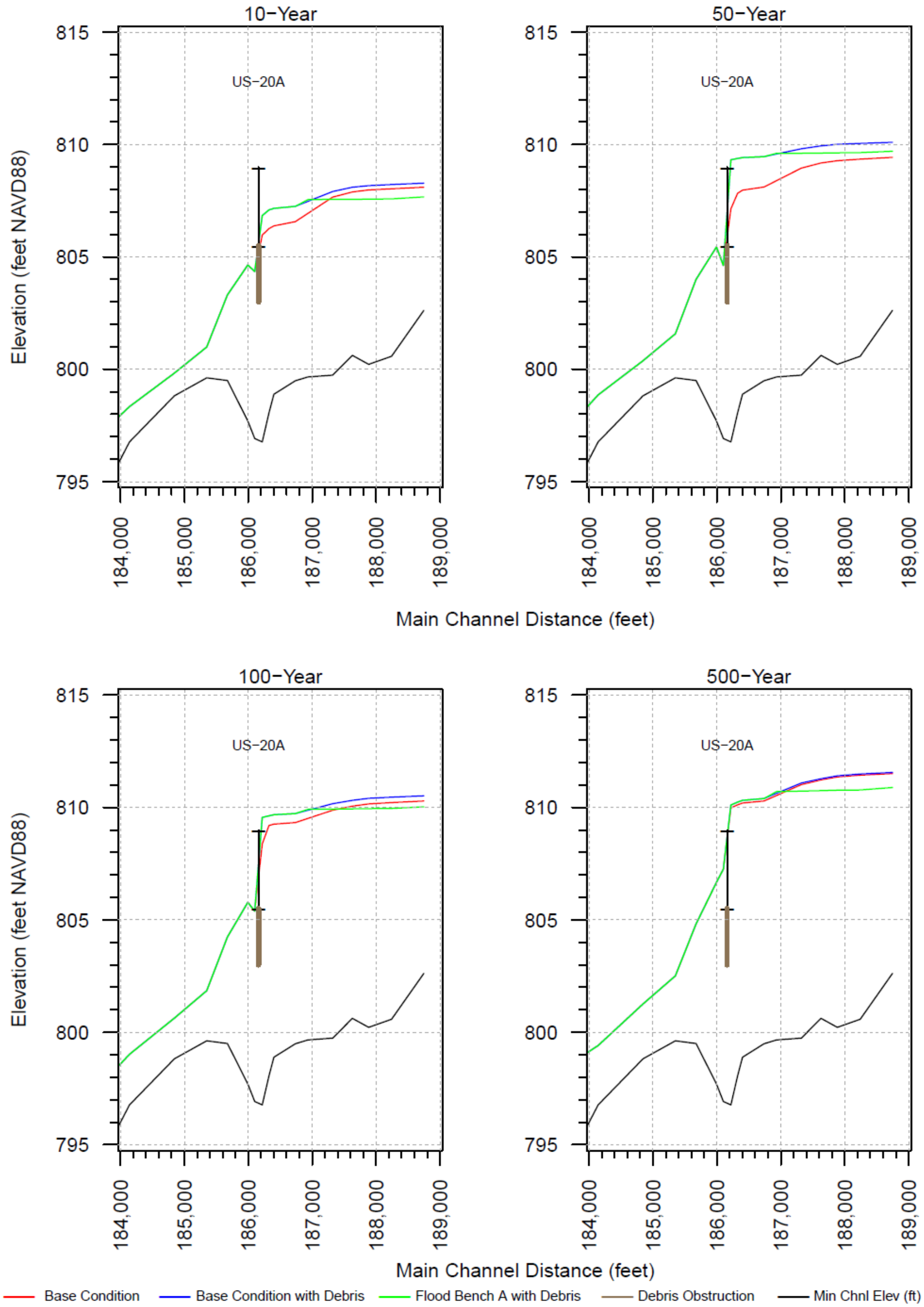


Figure 7-34. HEC-RAS debris obstruction model simulation output results for Alternative #2-1 for the existing condition (red), existing condition with debris (blue), and Flood Bench A with debris (green) scenarios.

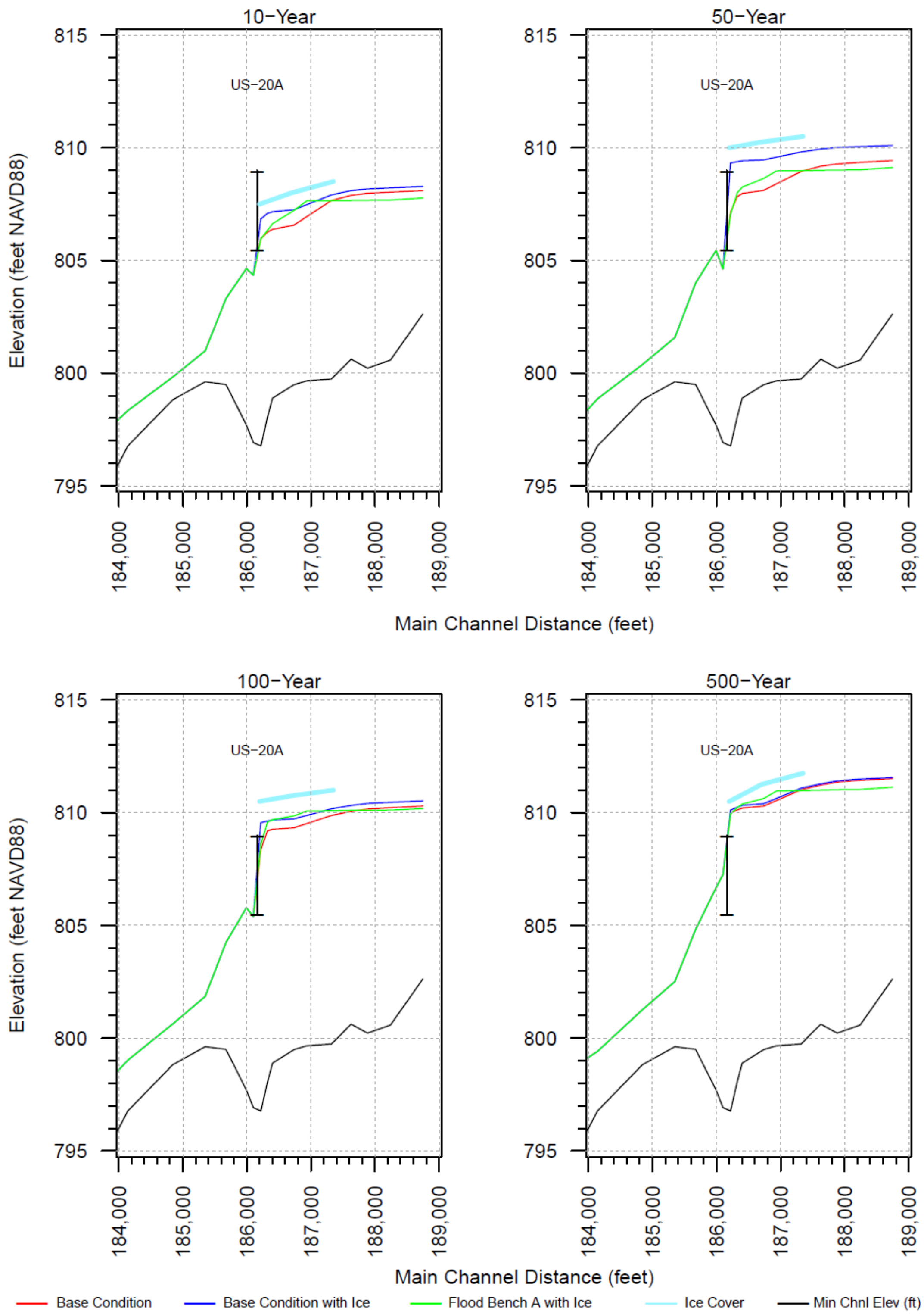


Figure 7-35. HEC-RAS debris obstruction model simulation output results for Alternative #2-1 for the existing condition (red), existing condition with ice cover (blue), and Flood Bench A with ice cover (green) scenarios.

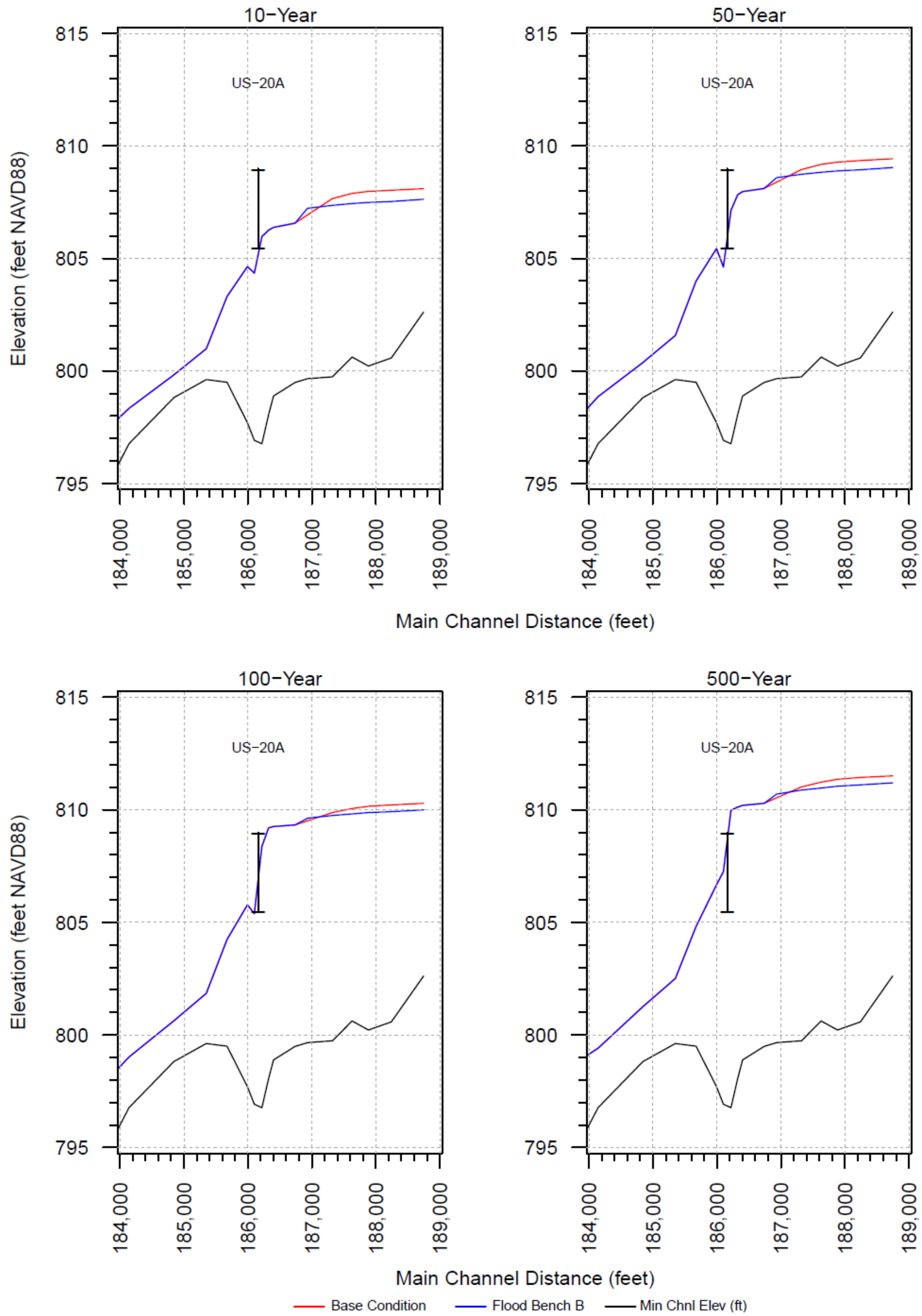


Figure 7-36. HEC-RAS model simulation output results for Alternative #2-1 for the existing condition (red) and Flood Bench B (blue) scenarios.

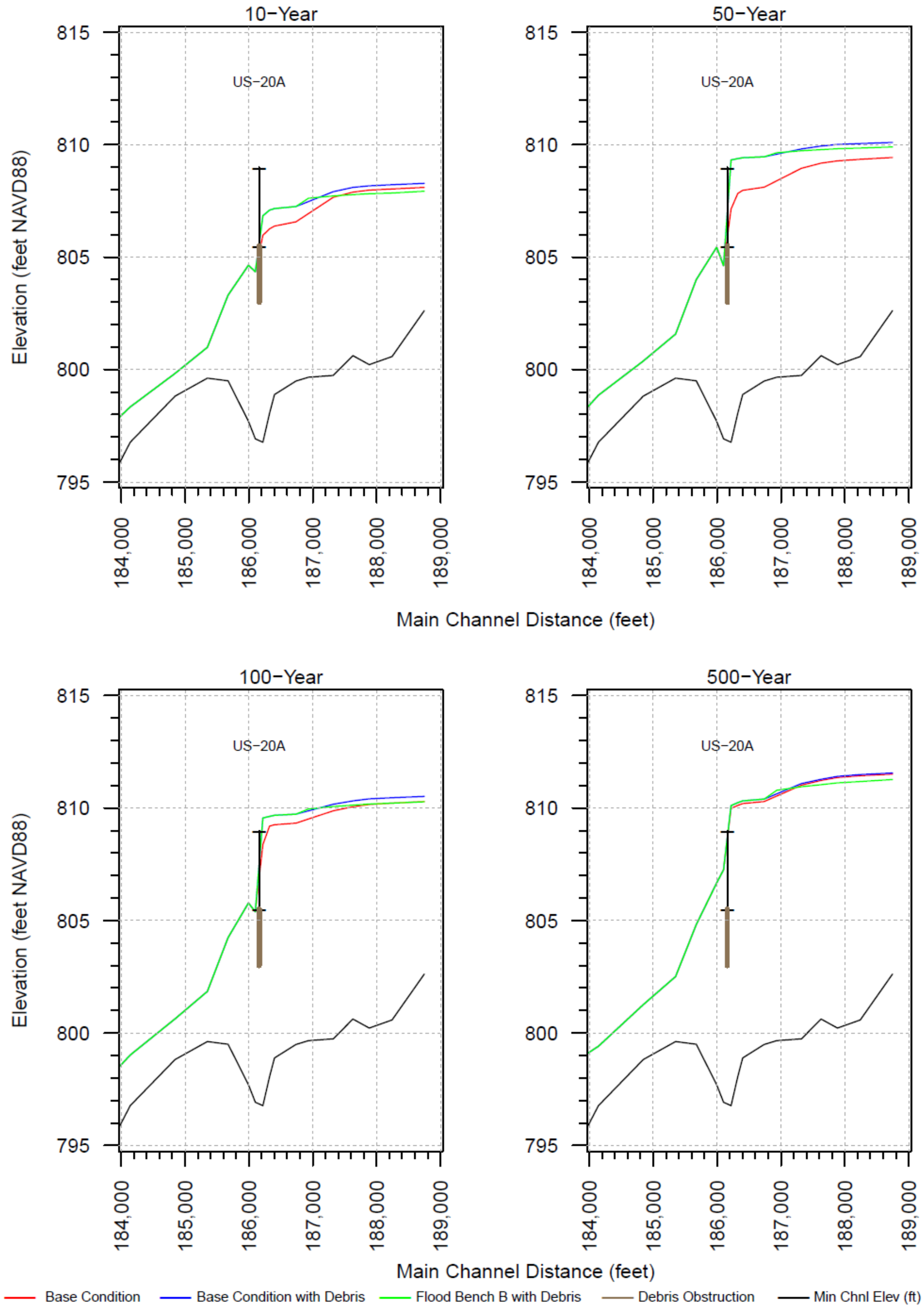


Figure 7-37. HEC-RAS debris obstruction model simulation output results for Alternative #2-1 for the existing condition (red), existing condition with debris (blue), and Flood Bench B with debris (green) scenarios.

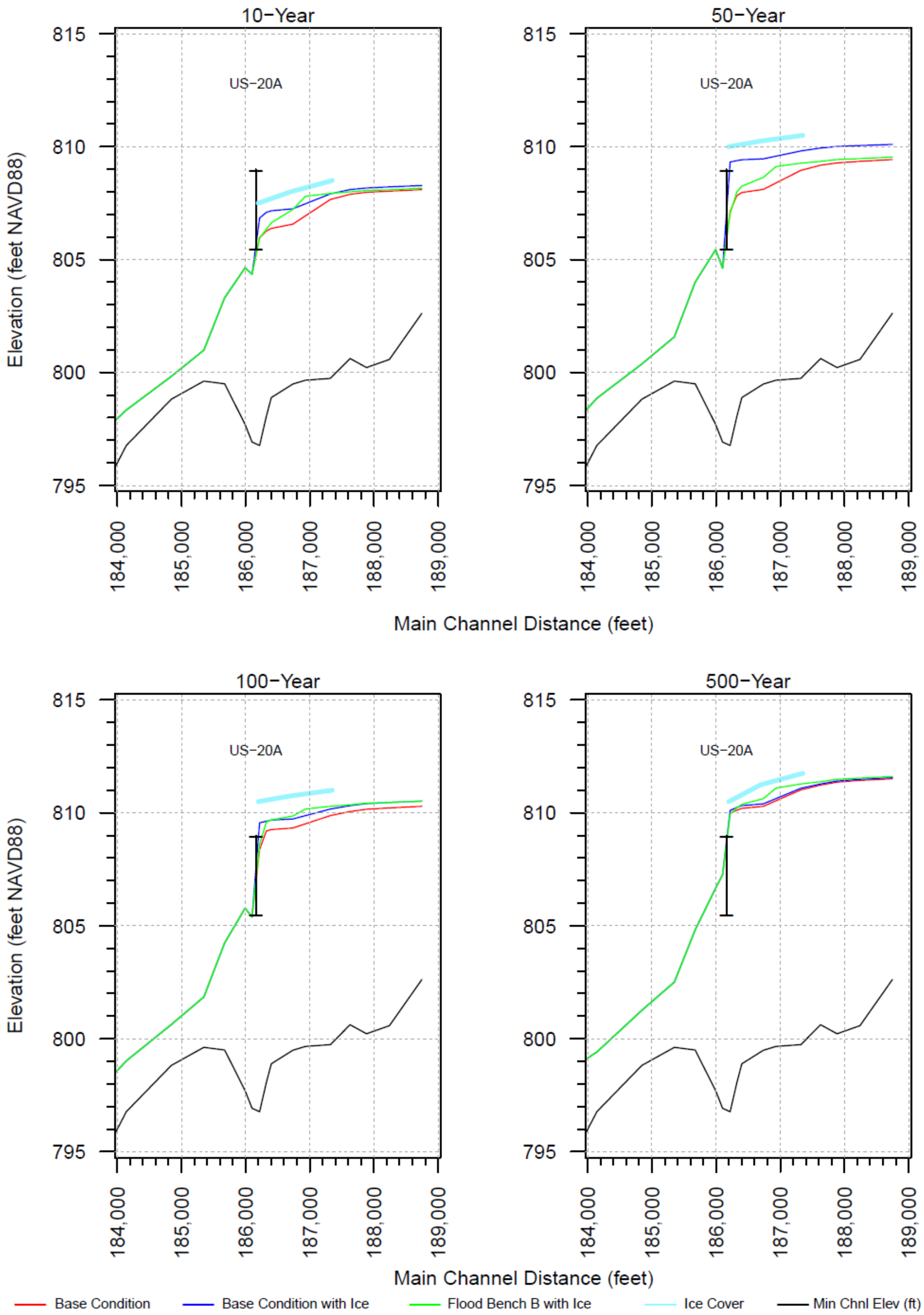


Figure 7-38. HEC-RAS ice cover model simulation output results for Alternative #2-1 for the existing condition (red), existing condition with ice cover (blue), and Flood Bench B with ice cover (green) scenarios.

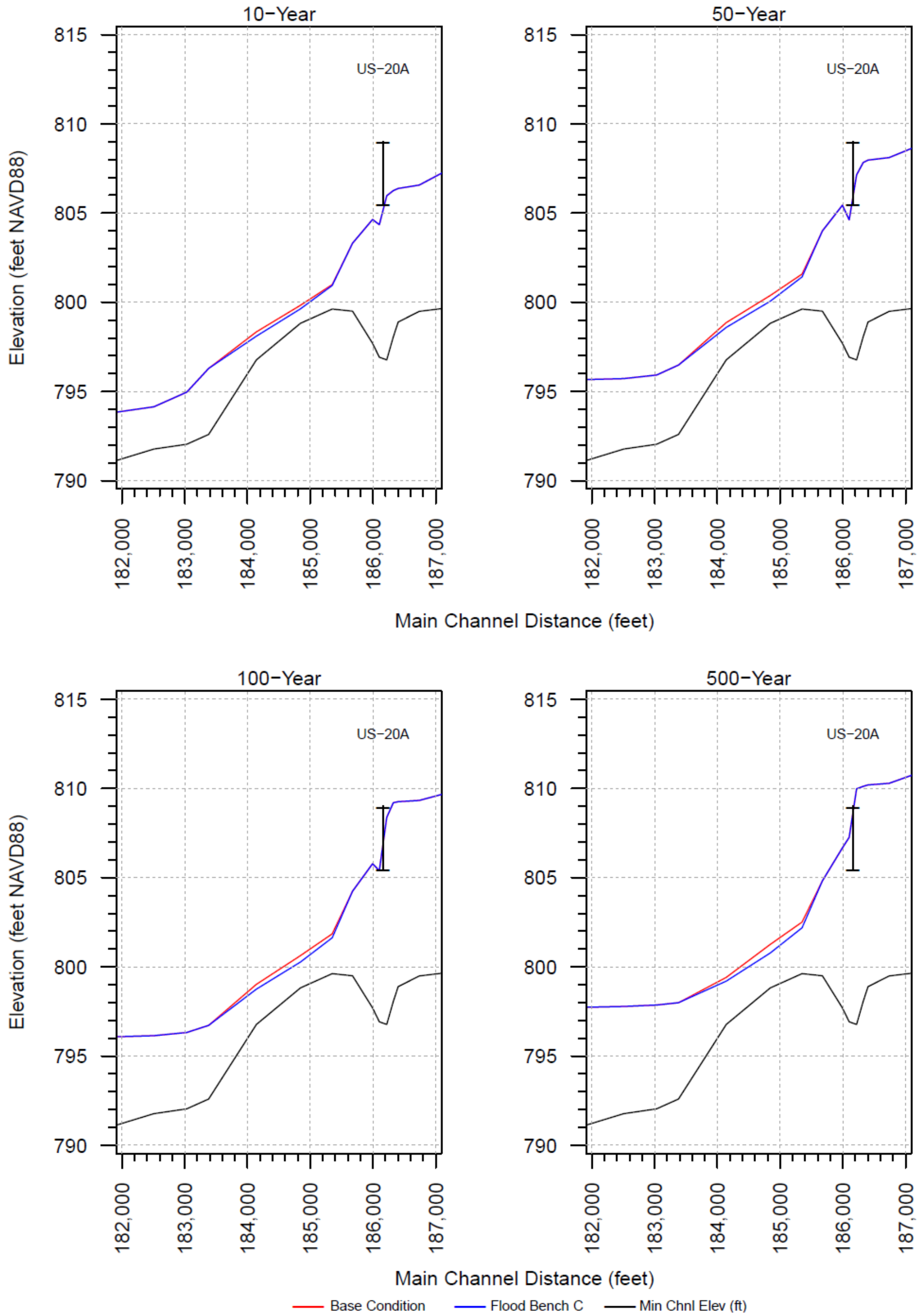


Figure 7-39. HEC-RAS model simulation output results for Alternative #2-1 for the existing condition (red) and Flood Bench C (blue) scenarios.

Table 32 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 32. Summary Table for Alternative #2-1 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	**Reductions in Water Surface Elevations (feet)**		
	Flood Bench A	**Flood Bench B**	**Flood Bench C**
Open-Water	Up to 0.8-ft	Up to 0.5-ft	Up to 0.5-ft
Total Length of Benefited Area	2,050-ft	2,050-ft	2,325-ft
River Stations	1867+00 to 1887+50	1867+00 to 1887+50	1833+50 to 1856+75
Debris Obstruction	Up to 0.7-ft	Up to 0.3-ft	N/A
Total Length of Benefited Area	2,050-ft	2,050-ft	N/A
River Stations	1867+00 to 1887+50	1867+00 to 1887+50	N/A
Ice Jam	Up to 0.8-ft	Up to 0.4-ft	N/A
Total Length of Benefited Area	2,050-ft	2,050-ft	N/A
River Stations	1867+00 to 1887+50	1867+00 to 1887+50	N/A

Flood benches generally provide flood protection for localized areas in the vicinity of and immediately upstream and/or downstream of the bench. Based on the analysis of high-risk areas, flood benches located both upstream of the confluence of Honeoye and Mill Creeks and downstream of the Main Street/US-20A bridge would provide flood protection in this reach from open-water flooding for each flood bench alternative. In addition, flood benches upstream of the confluence would provide flood protection from debris buildup and ice-jam flooding.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed each flood bench independently. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

Also, it should be noted that this alternative was evaluated based solely on Honeoye Creek and its hydrological and hydraulic features. The effects of Mill Creek on Honeoye Creek in this reach were not taken into consideration. Mill Creek and its influences on Honeoye Creek are assessed in Section 7.3.

The Rough Order Magnitude cost for each flood bench alternative is:

- Flood Bench A: $8.6 million
- Flood Bench B: $2.9 million
- Flood Bench C: $4.1 million

These ROM cost estimates do not include land acquisition costs for survey, appraisal, and engineering coordination. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.2.2 Alternative #2-2: Increase Size of Main Street/US-20A Bridge Opening

This measure is intended to address issues within High-Risk Area #2 by increasing the width of the Main Street/US-20A bridge opening, which would increase the cross-sectional flow area of the channel located at river station 1835+00 (Figure 7-40).

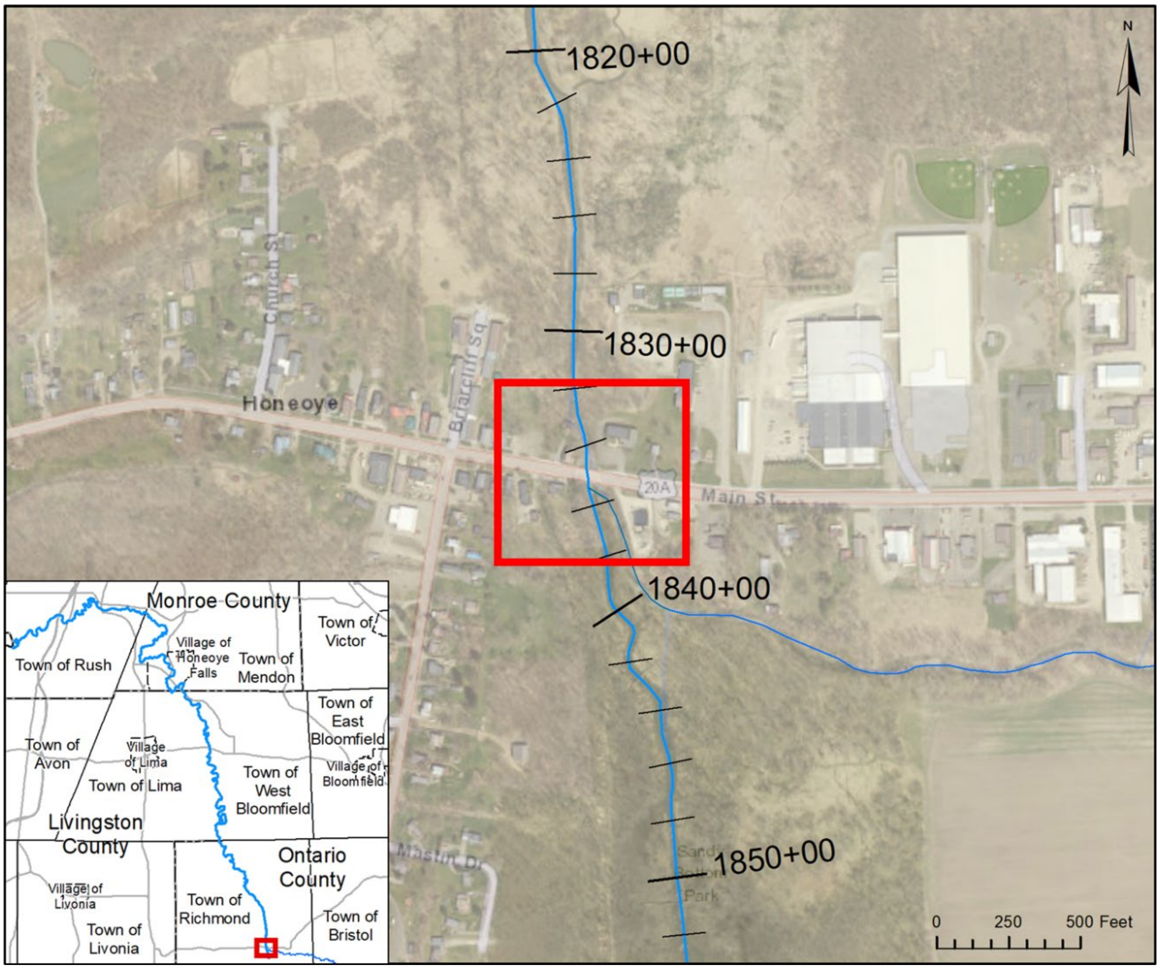


Figure 7-40. Location map for Alternative #2-2.

The bridge is owned by the NYSDOT and has no pier in the channel. The existing bridge structure has a bridge span of 75 ft, width of 50 ft, and deck thickness of 3.5 ft (Figure 7-41). The flooding in the vicinity of the Main Street/US-20A bridge poses a flood-risk threat to nearby residential and commercial properties and state-, county-, and town-owned infrastructure. Appendix F depicts a flood mitigation rendering of a bridge widening scenario.

Figure 7-41. Main Street/US-20A bridge, Honeoye, NY.

Based on orthoimagery of the area, the meanders in the creek channel upstream of the bridge crossing, coupled with the confluence of Mill Creek, act as impediments to flow, reducing water velocities and allowing sediment and debris to aggregate and restrict flow in this area (NYSOITS 2018).

As shown in Figure 6-4, the FEMA FIRM displays significant backwater upstream of the bridge crossing (FEMA 1984a). There are FIS profiles for Honeoye Creek in the Town of Richmond (FEMA 194b).

By increasing the opening span of the bridge structure, the cross-sectional flow area of the channel would increase and the potential for sediment, debris, and ice to accumulate or catch on the upstream face of the bridge would be reduced, thereby reducing flood risk to areas adajcent to and immediately upstream of the bridge.

Typically, the bridge widening design would be selected to ensure that the 1% ACE WSEL could successfully pass under the Main Street/US-20A bridge without significant backwater upstream of the bridge. However, due to the limitations and restrictions in the areas immediately adjacent to the creek in the vicinity of the bridge (i.e., developed areas, structures, etc.), the bridge could not be realistically widened to achieve the desired result. Instead, the bridge widening design selected for this proposed condition model utilized the maximum area available to realistically widen the bridge opening. The bridge widening design increased the span of the bridge opening from 75 ft to 90 ft by widening the bridge on the right bank by 15 ft. This measure would potentially reduce the flood risk and benefit the properties adjacent to and immediately upstream of N Main Street/NY-65.

Table 33 outlines the results of the existing conditions model simulations for each initial condition scenario. Figures 7-42 through 7-44 display the profile plots for each initial condition scenario. Full model outputs for this alternative can be found in Appendix H.

Table 33. Summary Table for Alternative #2-2 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 2.3-ft
Total Length of Benefited Area	2,750-ft
River Stations	1860+00 to 1887+50
Debris Obstruction	Up to 1.9-ft
Total Length of Benefited Area	2,750-ft
River Stations	1860+00 to 1887+50
Ice Jam	Up to 2.9-ft
Total Length of Benefited Area	2,750-ft
River Stations	1860+00 to 1887+50

Table 34 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 34. Summary Table for Alternative #2-2 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 2.3-ft
Total Length of Benefited Area	2,750-ft
River Stations	1860+00 to 1887+50
Debris Obstruction	Up to 1.4-ft
Total Length of Benefited Area	2,750-ft
River Stations	1860+00 to 1887+50
Ice Jam	Up to 3.0-ft
Total Length of Benefited Area	2,750-ft
River Stations	1860+00 to 1887+50

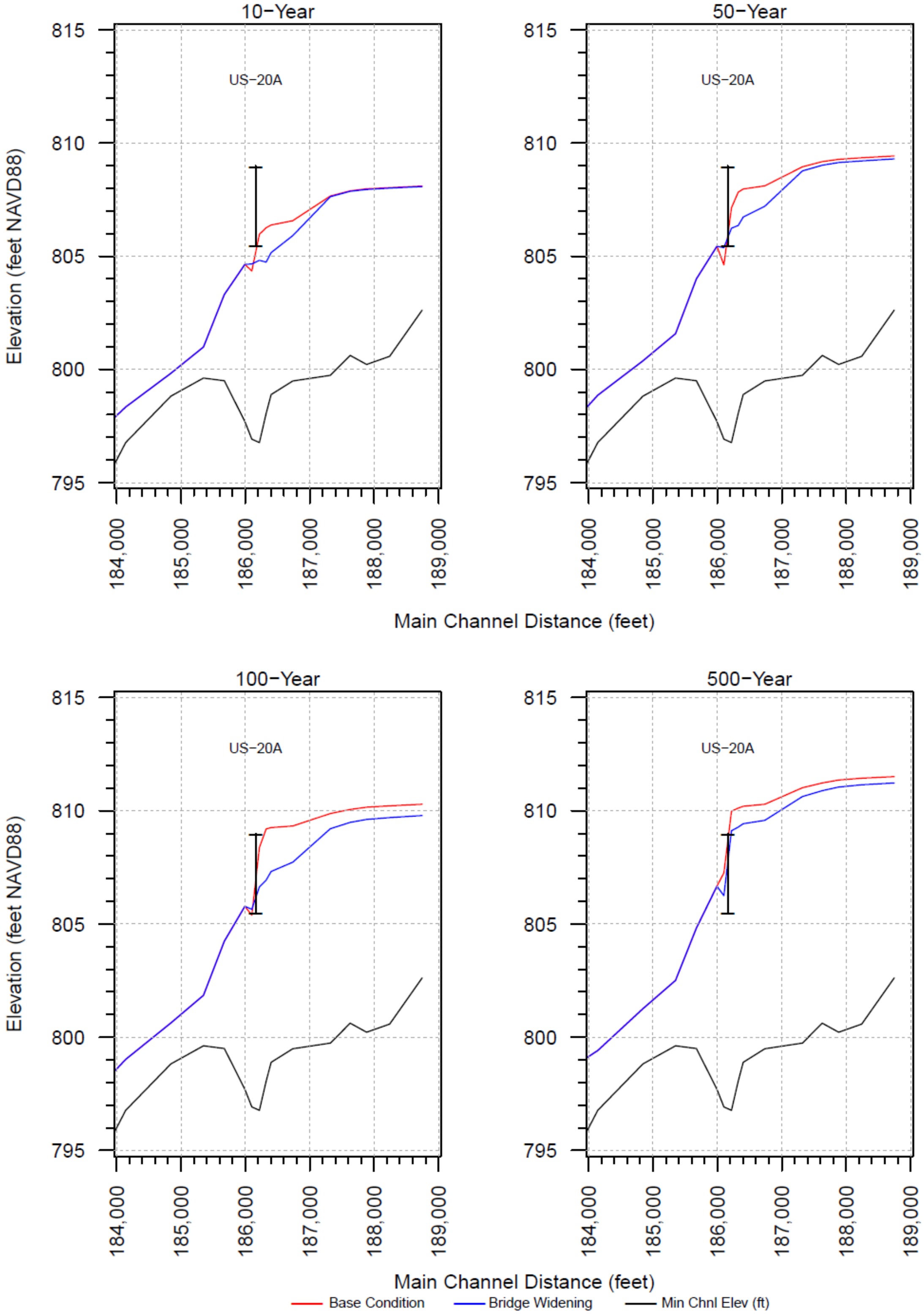


Figure 7-42. HEC-RAS model simulation output results for Alternative #2-2 for the existing condition (red) and bridge widening (blue) scenarios.

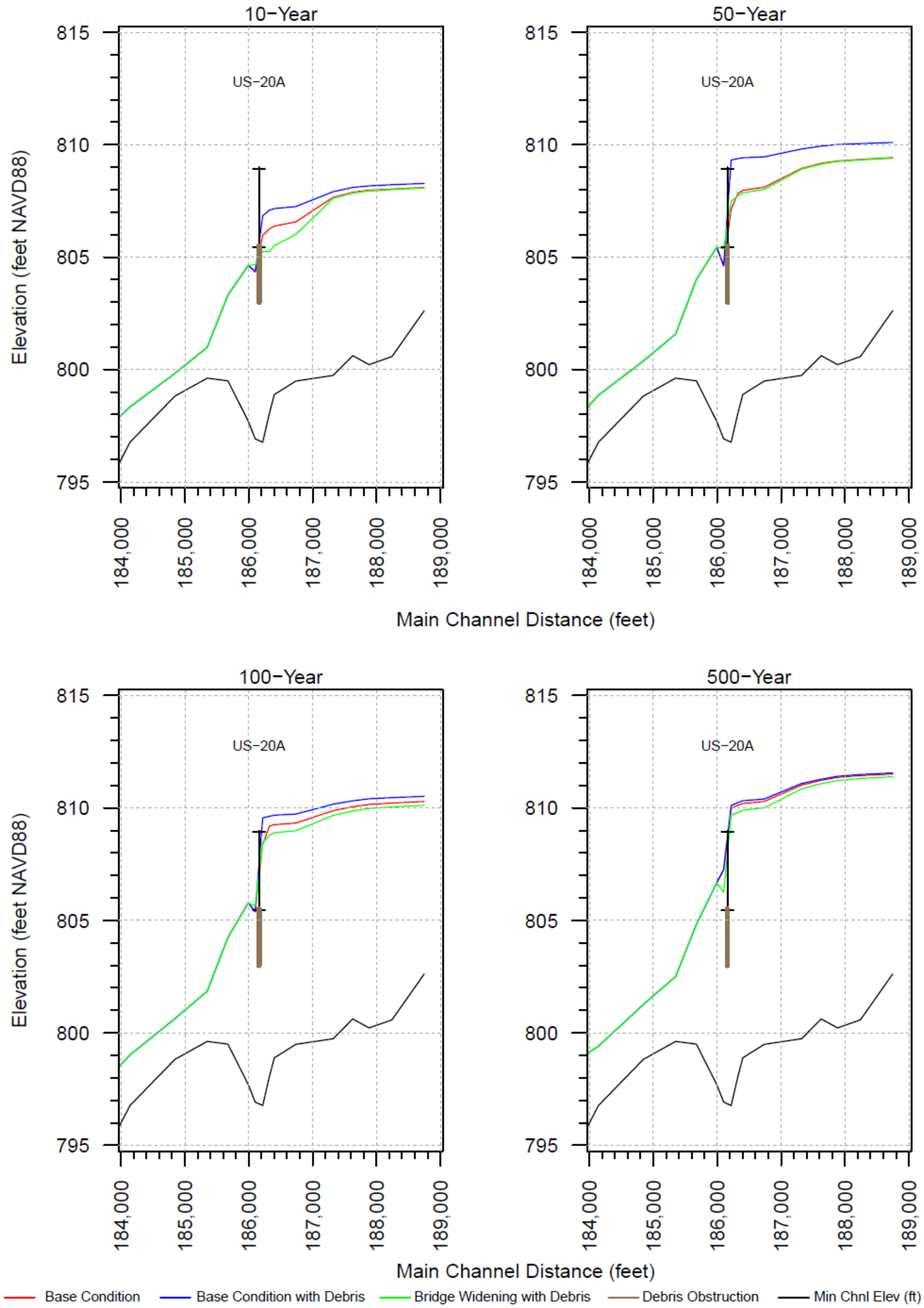


Figure 7-43. HEC-RAS debris obstruction model simulation output results for Alternative #2-2 for the existing condition (red), existing condition with debris (blue), and bridge widening with debris (green) scenarios.

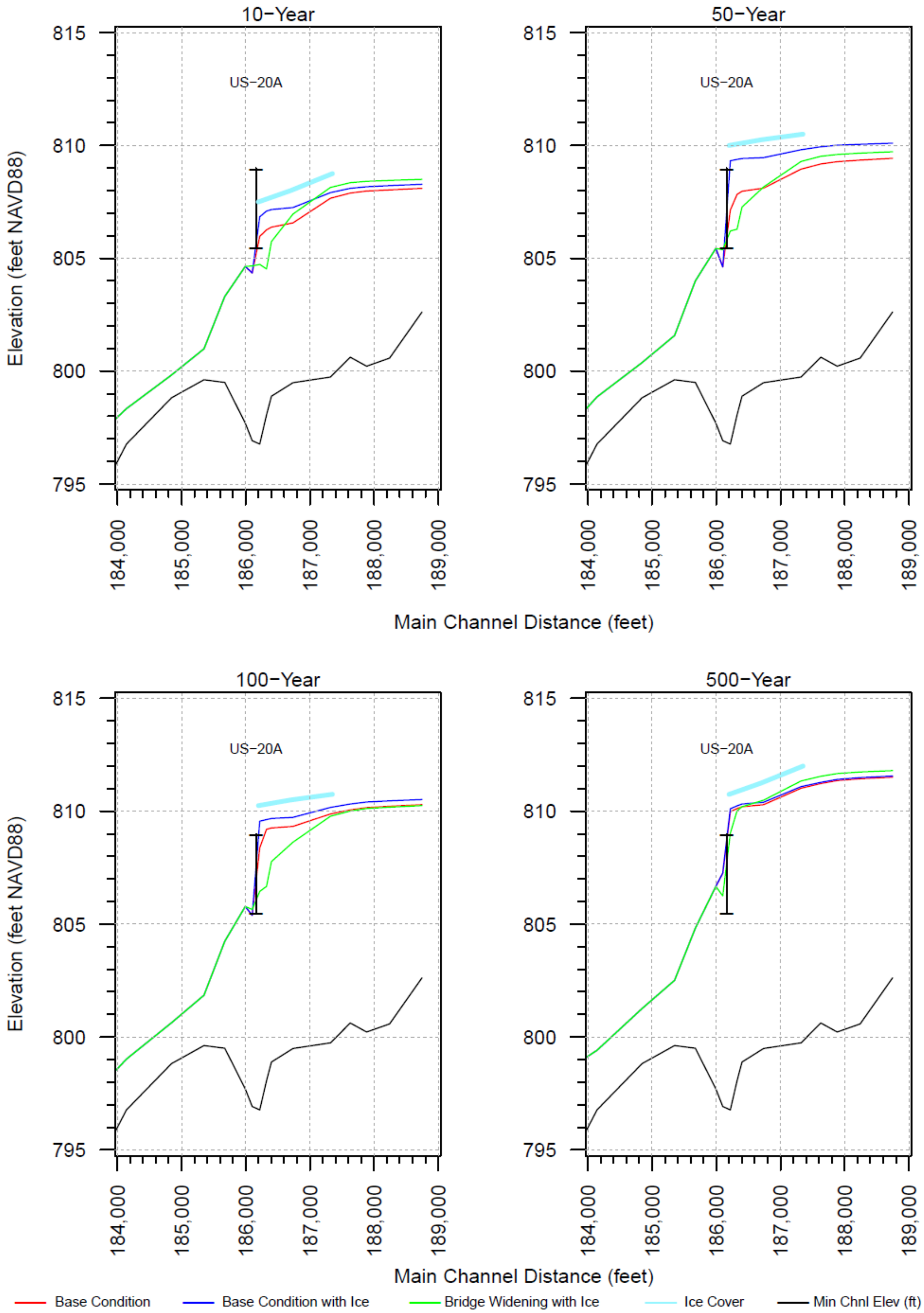


Figure 7-44. HEC-RAS ice cover model simulation output results for Alternative #2-2 for the existing condition (red), existing condition with ice cover (blue), and bridge widening with ice cover (green) scenarios.

The potential benefits of this strategy are limited to immediately upstream of the Main Street/US-20A bridge. The primary benefits of increasing the bridge opening would be to increase the flow capacity of the bridge structure and reduce the potential of backwater from high-flow events, debris obstructions, and ice jams.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed this alternative independent of any other proposed mitigation alternative. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

Also, it should be noted that this alternative was evaluated based solely on Honeoye Creek and its hydrological and hydraulic features. The effects of Mill Creek on Honeoye Creek in this reach were not taken into consideration. Mill Creek and its influences on Honeoye Creek are assessed in Section 7.3.

In addition, widening the bridge opening would potentially allow more water to flow during high-flow events, which could alter the potential flood risk for downstream areas resulting in negative effects to these areas. Ramboll recommends additional research, data, and modeling to more accurately determine the effects of widening the bridge to downstream areas.

The Rough Order Magnitude cost for this strategy is approximately $5.1 million, which does not include land acquisition costs for survey, appraisal, and engineering coordination. Additional engineering consideration would also be required to determine if increasing the bridge opening would alter the structural integrity of the bridge in any way.

7.2.3 Alternative #2-3: Streambank Stabilization Downstream of Main Street/US-20A

Streambank erosion is a natural process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the banks in place. The forces that cause erosion increase during flood events, and most erosion occurs at these times. Human disturbances to watersheds that increase frequency and magnitude of runoff events also increase streambank erosion. Human disturbances include logging, mining, agriculture, and urbanization. Typical urban or suburban developments which may impact a stream include houses, garages, parking lots, and walkways, including areas cleared of forest and replaced by tailored lawns (GSWCC 2000).

Loss of streambank and streamside vegetation reduces the resisting forces and makes streambanks more susceptible to erosion. This is often the single greatest contributing factor to harmful or accelerated erosion on small- and medium-size streams. Streambank vegetation may be removed intentionally for various reasons, or its loss may be inadvertent due to trampling by animals or humans (GSWCC 2000).

Streambank stabilization measures work either by reducing the force of flowing water, increasing the resistance of the bank to erosion, or some combination of both.

Generally speaking, there are four approaches to streambank protection: 1) the use of vegetation, 2) soil bioengineering, 3) the use of rock work in conjunction with plants, and 4) conventional bank armoring. Re-vegetation includes seeding and sodding of grasses, seeding in combination with erosion control fabrics, and the planting of woody vegetation (shrubs and trees). Soil bioengineering systems use woody vegetation installed in specific configurations that offer immediate erosion protection, reinforcement of the soils, and in time a woody vegetative surface cover and root network. The use of rock work in conjunction with plants is a technique which combines vegetation with rock work. Over time, the plants grow and the area appears and functions more naturally. Conventional armoring is a fourth technique which includes the use of rock, known as riprap, to protect eroding streambanks (GSWCC 2000).

Streambank stabilization can also play a vital role in flood risk management in areas located in flood-prone areas. The magnitude of that risk is a function of the flood hazard, the characteristics of a particular location (i.e., elevation, proximity to the waterway, susceptibility to fast-moving flows, etc.), measures that have been taken to mitigate the potential impact of flooding, the vulnerability of people and property, and the consequences that result from a particular flood event. A flood risk management strategy identifies and implements measures that reduce the overall risk, and what remains is the residual risk. In developing the strategy, those responsible judge the costs and benefits of each measure taken and their overall impact in reducing the risk (NRC 2013).

Through historical flood reports, stakeholder engagement meetings, and/or field work, numerous areas along Honeoye Creek in the Hamlet of Honeoye have been identified as areas for potential streambank stabilization strategies. These areas have been outlined in Figure 7-45.

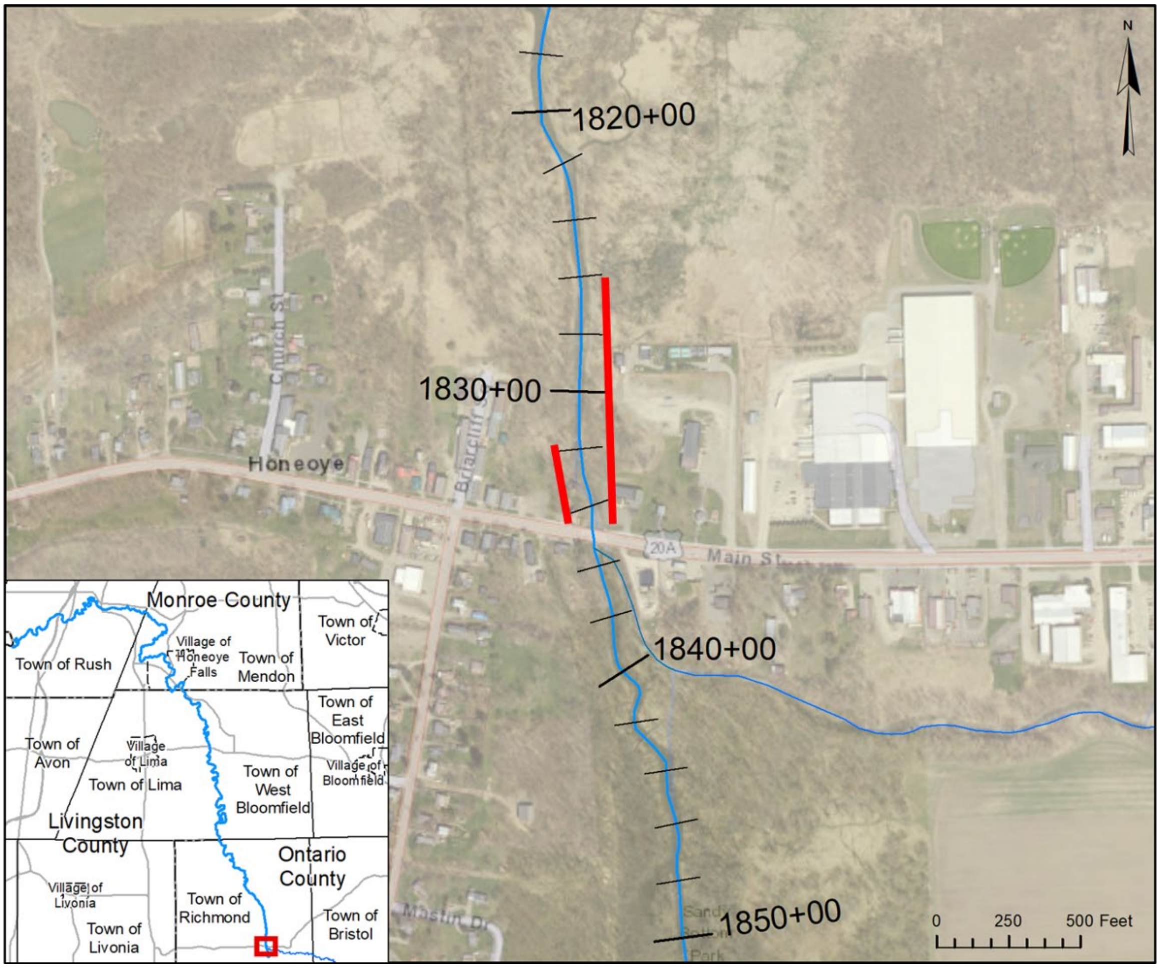


Figure 7-45. Location map for Alternative #2-3.

Appendix G contains detailed discussion of various streambank stabilization strategies, including drawings, definitions, ideal locations, design and construction considerations, maintenance, and ROM costs.

Transport of sediment and debris in streams is predominantly controlled by stream transport capacity, sediment physiochemical characteristics and supply rate. Several hydraulic and geomorphologic factors determine stream transport capacity including channel width, flow depth and cross-sectional geometry, bed slope and roughness, and discharge velocity and volume. In general, the more turbulent energy available for suspension and mobilization of sediment, the greater the sediment transport capacity per unit of stream width, and the larger the size of sediment particles that can be moved (USEPA 2009a).

Larger sediments and debris generally experience more episodic movement over longer time scales through watersheds. Smaller sediments generally move more continuously and within a shorter time scale. This difference is due to the fact that larger sediments and debris rely on larger, more powerful flows for transport, which occur episodically and less frequently than flows able to move smaller particles, such as the bankfull discharge (USEPA 2009a).

To assess the applicability of different streambank stabilization strategies under higher frequency-lower flow conditions, channel velocity (feet per second) and shear stress (pounds per square foot) were calculated using the HEC-RAS software for the existing conditions model at the 10% ACE; the results are summarized in Table 35.

Table 35. HECRAS Existing Condition Model Output of Channel Velocity (ft/s) and Shear Stress (lb/sq ft) at the 10% Annual Chance Event for Alternative #2-3

Source: USACE 2021		
River Station	**Channel Velocity (ft/s)**	**Channel Shear Stress (lb/sq ft)**
186160	Main Street / US-20A	
186101	8.31	1.4
185993	3.99	0.31
185674	9.33	2.12
185350	1.76	0.11
184844	1.8	0.13
184142	1.56	0.09
183381	4.46	0.56
183032	3.69	0.38
182508	1.91	0.11
180910	1.52	0.06

Based on the existing conditions model output for channel velocity and shear stress, Table 36 summarizes the applicability of potential streambank strategies for this proposed alternative.

Table 36. Potential Streambank Stabilization Strategies for Alternative #2-3

Source: NRCS 2009

Type of Treatment	Type of Sub-Treatment
Brush Mattresses	Staked only with rock riprap toe (grown)
Coir Geotextile Roll	Roll with Polypropylene rope mesh staked and with rock riprap toe
Gravel/Cobble	12-inch
Soil Bioengineering	Live brush mattress (grown)
	Vegetated coir mat
	Live willow stakes
	Brush layering (initial/grown)
Boulder Clusters	Boulder - Very large (>80-in diameter)
	Boulder - Large (>40-in diameter)
	Boulder - Medium (>20-in diameter)
	Small (>10-in diameter)

Also, it should be noted that this alternative was evaluated based solely on Honeoye Creek and its hydrological and hydraulic features. The effects of Mill Creek on Honeoye Creek in this reach were not taken into consideration. Mill Creek and its influences on Honeoye Creek are assessed in Section 7.3.

Due to the variable, conceptual, and site-specific nature of streambank stabilization strategies, no ROM Cost Estimates were determined for this measure. Additional geomorphic and engineering analyses, including additional modeling, would be necessary in order to determine the most appropriate streambank stabilization strategy and its associated costs.

7.2.4 Alternative #2-4: Sediment Removal Analysis in the Vicinity of Main Street/US-20A

This measure is intended to address issues within High-Risk Area #2 by increasing the flow capacity of Honeoye Creek by removing the accumulated sediment and/or debris upstream of Main Street/US-20A located at river station 1835+00 (Figure 7-46). The flooding in the vicinity of the Main Street/US-20A bridge poses a flood-risk threat to nearby residential and commercial properties and state-, county-, and town-owned infrastructure.

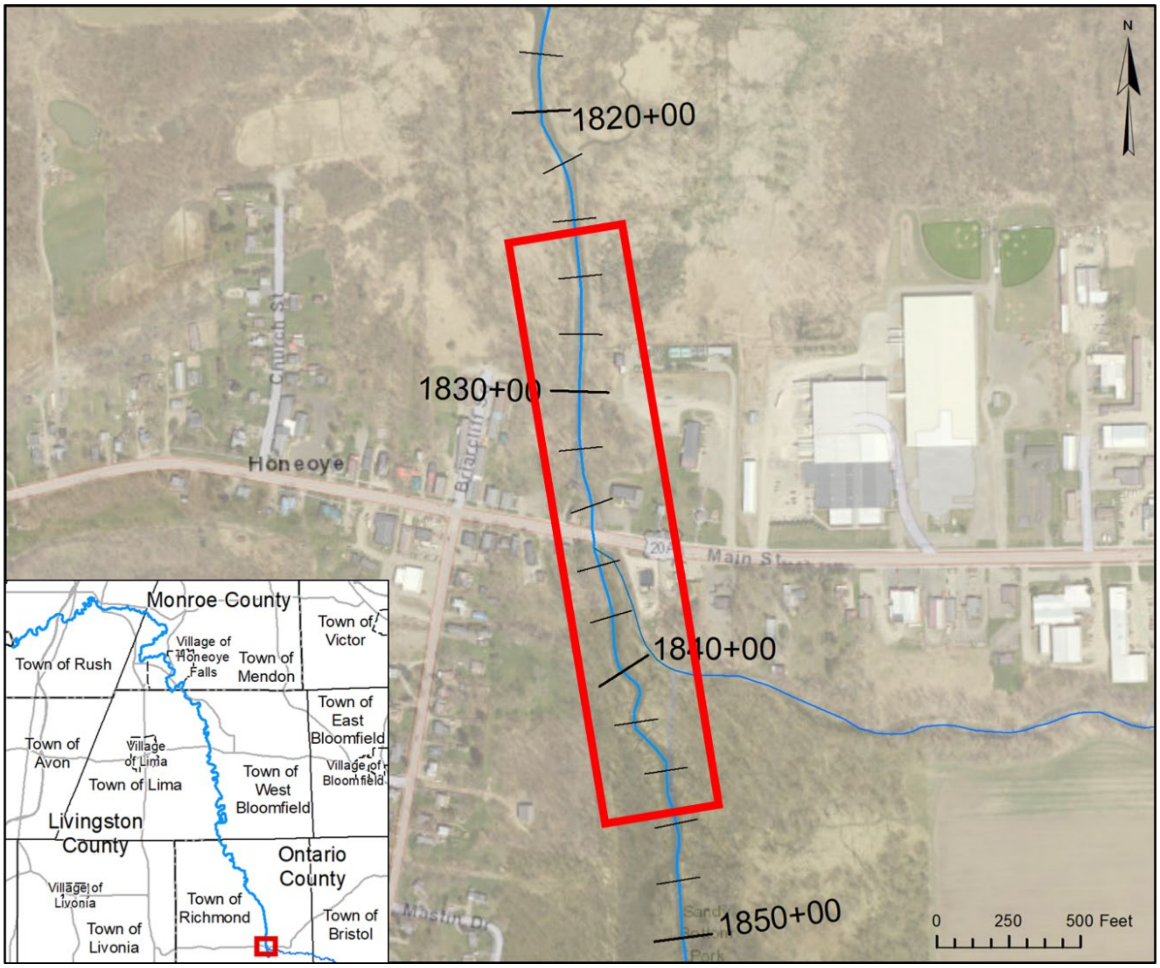


Figure 7-46. Location map for Alternative #2-4.

Based on orthoimagery of the area, the meanders in the creek channel upstream and downstream of the bridge crossing, coupled with the confluence of Mill Creek, act as impediments to flow, reducing water velocities and allowing sediment and debris to aggregate and restrict flow in this area (NYSOITS 2018).

As shown in Figure 6-4, the FEMA FIRM displays significant backwater upstream of the bridge crossing (FEMA 1984a). There are no FIS profiles for Honeoye Creek in the Town of Richmond (FEMA 1984b).

By removing sediment from approximately 1,500 ft upstream of the Main Street/US-20A bridge at an average depth of 1.5 ft, and 2,000 ft downstream at an average depth of 2.5 ft within the Honeoye Creek channel, the flow capacity of the creek can be increased allowing more volume of water to flow through the Main Street/US-20A bridge, potentially reducing flood risk and/or backwater effects from the structure during high-flow events.

In addition, according to historical flood reports, stakeholder engagement meetings, and field work, the Main Street/US-20A was identified as a hydraulic structure that experiences debris blockage and ice jams resulting in backwater flooding during higher peak flow events (FEMA 1984b; NYSDEC 2021a).

For this alternative, open-water, debris-obstruction, and ice-jam simulations were performed to test the effectiveness of the alternative at reducing WSELs. Table 37 outlines the results of the existing conditions model simulations for each initial condition scenario. Figures 7-47 through 7-49 display the profile plots for each initial condition scenario for the sediment removal alternative. Full model outputs for this alternative can be found in Appendix H.

Table 37. Summary Table for Alternative #2-4 Existing Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Existing Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 0.3-ft
Total Length of Benefited Area	2,800-ft
River Stations	1833+50 to 1861+50
Debris Obstruction	Up to 0.3-ft
Total Length of Benefited Area	2,800-ft
River Stations	1833+50 to 1861+50
Ice Jam	Up to 0.3-ft
Total Length of Benefited Area	2,800-ft
River Stations	1833+50 to 1861+50

Table 38 outlines the results of the future conditions model simulations for each initial condition scenario.

Table 38. Summary Table for Alternative #2-4 Future Conditions Results Based on Open-Water, Debris-Obstruction, and Ice-Jam Conditions

Future Conditions	Reductions in Water Surface Elevations (feet)
Open-Water	Up to 0.3-ft
Total Length of Benefited Area	2,800-ft
River Stations	1833+50 to 1861+50
Debris Obstruction	Up to 0.3-ft
Total Length of Benefited Area	2,800-ft
River Stations	1833+50 to 1861+50
Ice Jam	Up to 0.3-ft
Total Length of Benefited Area	2,800-ft
River Stations	1833+50 to 1861+50

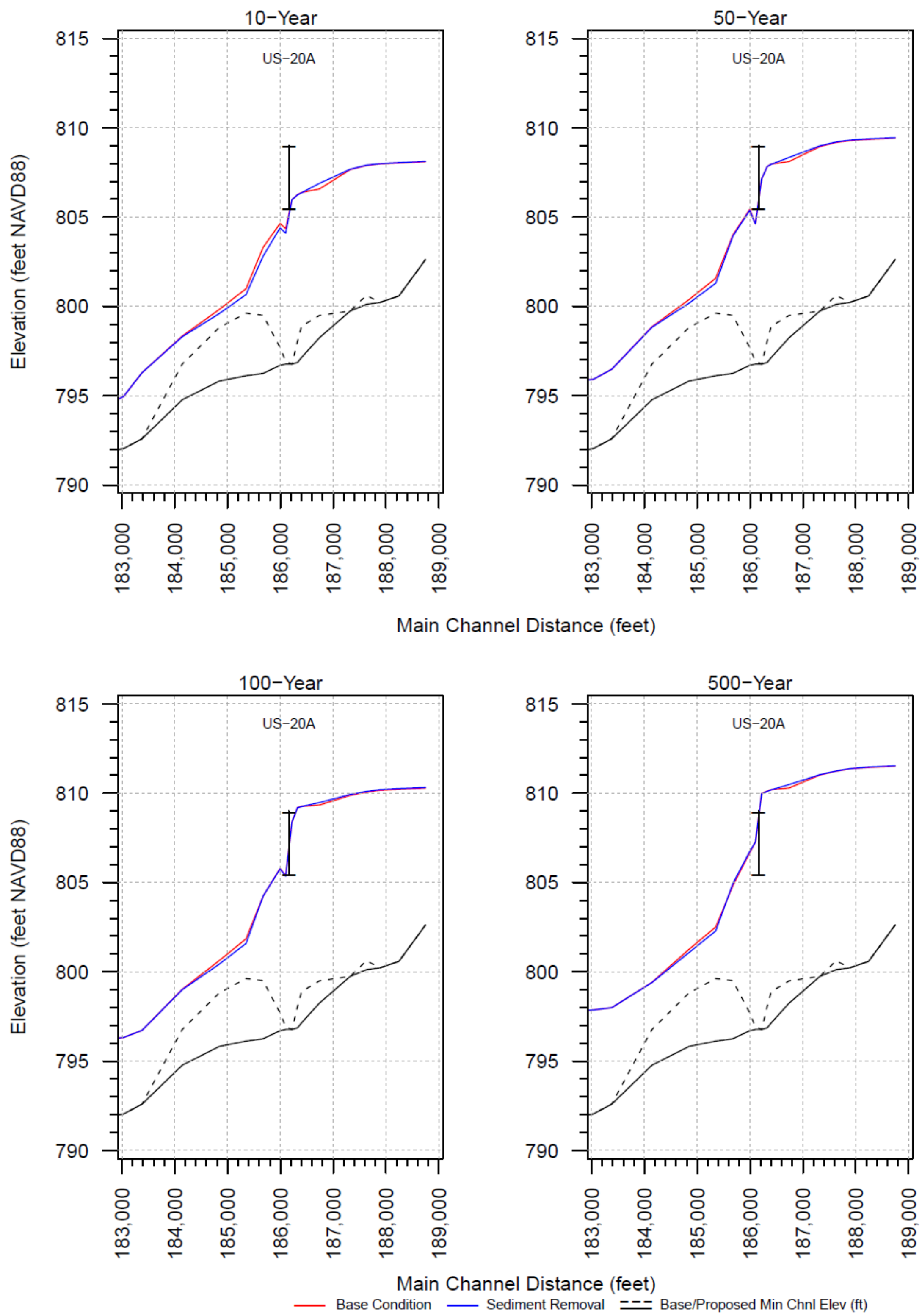


Figure 7-47. HEC-RAS model simulation output results for Alternative #2-4 for the existing condition (red) and sediment removal (blue) scenarios.

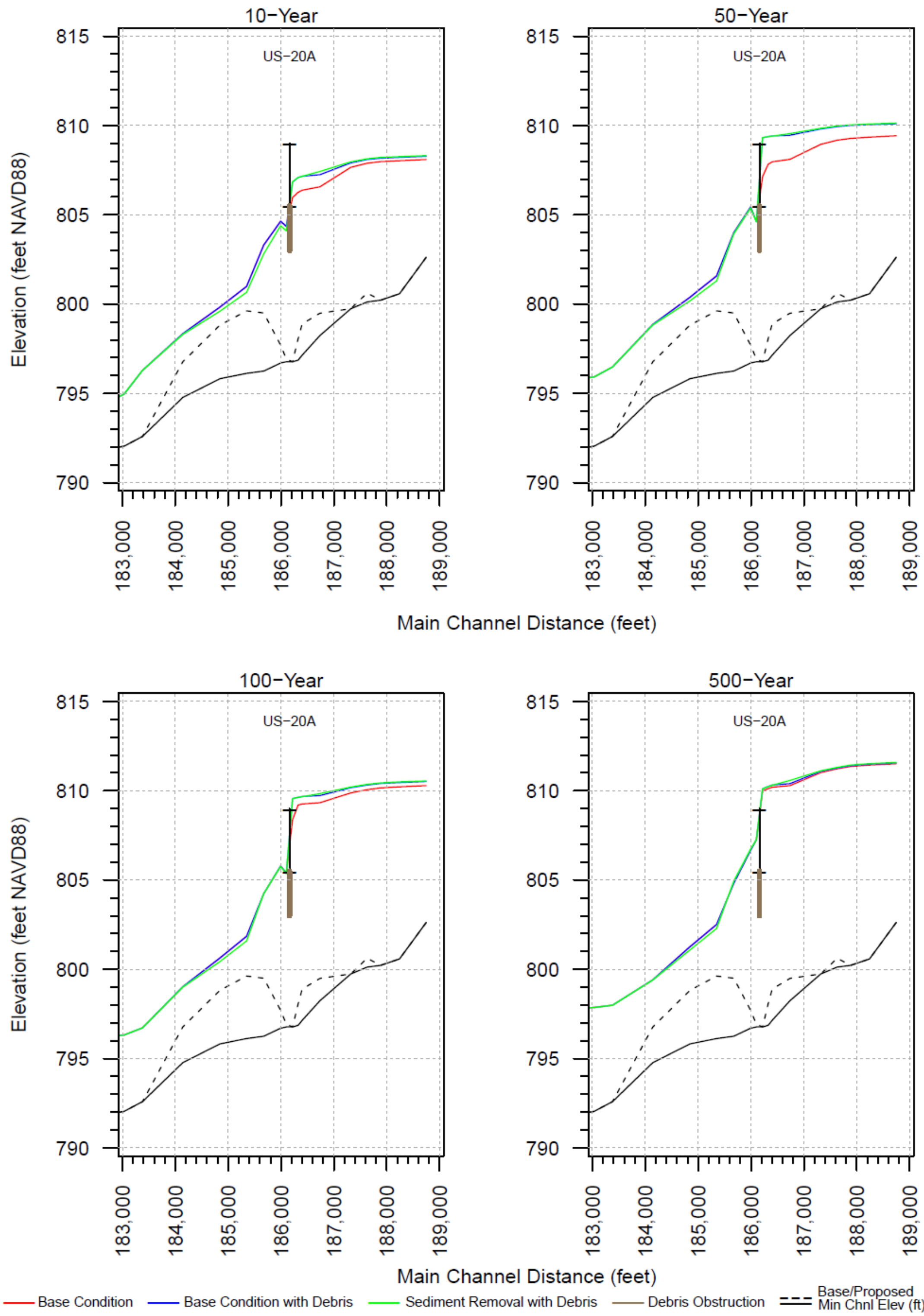


Figure 7-48. HEC-RAS debris obstruction model simulation output results for Alternative #2-4 for the existing condition (red), existing condition with debris (blue), and sediment removal with debris (green) scenarios.

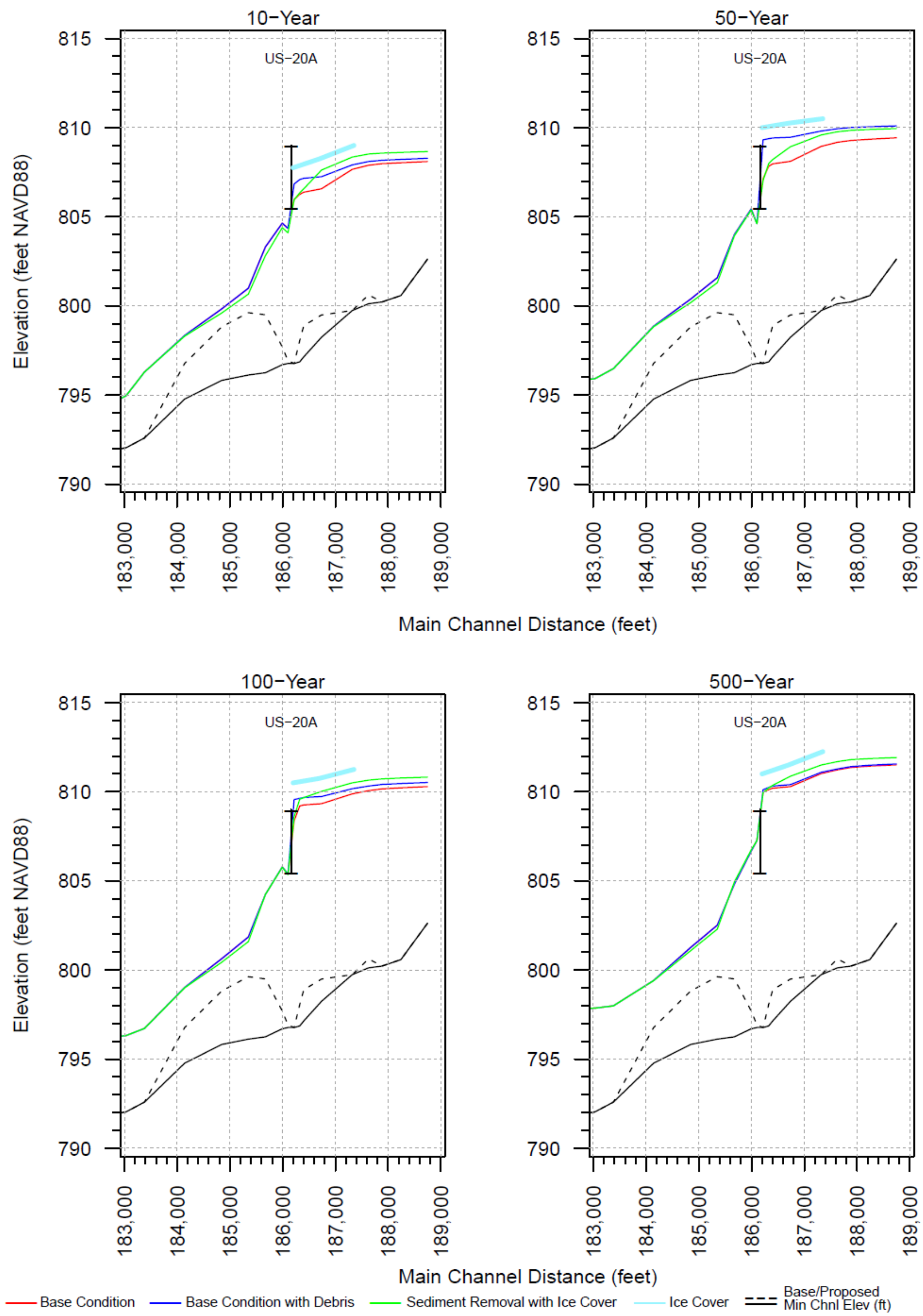


Figure 7-49. HEC-RAS ice cover model simulation output results for Alternative #2-4 for the existing condition (red), existing condition with ice cover (blue), and sediment removal with ice cover (green) scenarios.

Any strategy that involves removing sediment from the channel, such as dredging, requires extensive environmental and modeling studies, application, sampling, testing, certification, permitting, operational and maintenance plans with proof of financial viability, and a significant proposal justification including only viable alternatives and greatest benefit with least amount of impact. The NYSDEC *Technical & Operations Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredged Material* (2004) should be used to determine the procedure and necessary steps in order to develop a sediment removal strategy.

There are a number of federal, state, and local regulatory controls in place which apply to in-water and riparian sediment management projects. The applicability of these controls to each project depends on the particular circumstances of each case, such as the sediment classification and the intended use or management of the removed material (NYSDEC 2004).

Some or all of the following New York State and Federal Permits may be required: Use and Protection of Waters Permit; Freshwater Wetlands Permit; Tidal Wetlands Permit; State Pollutant Discharge Elimination System Permit; Clean Water Act § 401 Water Quality Certification and § 404 Permit and Rivers and Harbors Act § 10 Permits, issued by the USACE. An antidegradation review and Wild, Scenic and Recreational Rivers Program permits may also be required (NYSDEC 2004).

In addition, the process of removing sediment can have negative effects on aquatic ecosystems, including:

- Fundamentally changing the composition of aquatic habitats
- Potentially releasing pollutants into the water column that were previously secured in the channel sediments
- Directly or indirectly leading to the loss of plants and animals that live in sediments
- Reducing sediment supply downstream
- Removing larger gravels and cobbles that can destabilize the channel bed substrate, exposing smaller-sized sediments and making them easier to move downstream
- Increasing flood risk downstream by increasing the volume of water carried
- Triggering erosion of the bed and banks by altering flow velocities and volumes (SEPA 2010)

The potential benefits of this strategy are limited to the vicinity of Main Street/US-20A. The primary benefit of removing sediment would be to increase the flow capacity through the structure and reduce the potential of debris and ice creating obstructions or jams upstream of the structure.

It should be noted that a full geomorphological and sediment analysis would be required in order to progress this alternative. For this study, no historical geomorphological study was performed. In addition, upstream sources of sediment from both Honeoye and Mill Creeks would need to be addressed prior to removing any sediment from Honeoye Creek to maintain the desired flood mitigation benefits.

Also, it should be noted this alternative was evaluated based solely on Honeoye Creek and its hydrological and hydraulic features. The effects of Mill Creek on Honeoye Creek in this reach were not taken into consideration. Mill Creek and its influences on Honeoye Creek are assessed in Section 7.3.

The Rough Order Magnitude cost for this strategy is approximately $2.9 million, which does not include land acquisition costs for survey, appraisal, and engineering coordination, and any removal and/or disposal costs associated with the removed sediment. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.2.5 Alternative #2-5: Debris and Sediment Management Downstream of Main Street/US-20A

This measure is intended to manage sediment and debris downstream of the Main Street/US-20A bridge (Figure 7-50). Sediment sources downstream of the bridge are driven by riverine processes, which occurs due to the natural sediment transport and streambank erosion that happens along Honeoye Creek and its main tributary in the Town of Richmond, Mill Creek. As the sediment aggrades at the bridge and downstream areas, the channel geometry is altered, and the in-channel flow area is reduced. This, in turn, reduces the volume of water that can be transported safely within the channel without overtopping the banks. In addition, if large portions of sediment are transported downstream from upstream sources, such as Mill Creek, then sediment management and reduction measures should be considered and employed first to reduce sediment loads along both Honeoye and Mill Creeks.

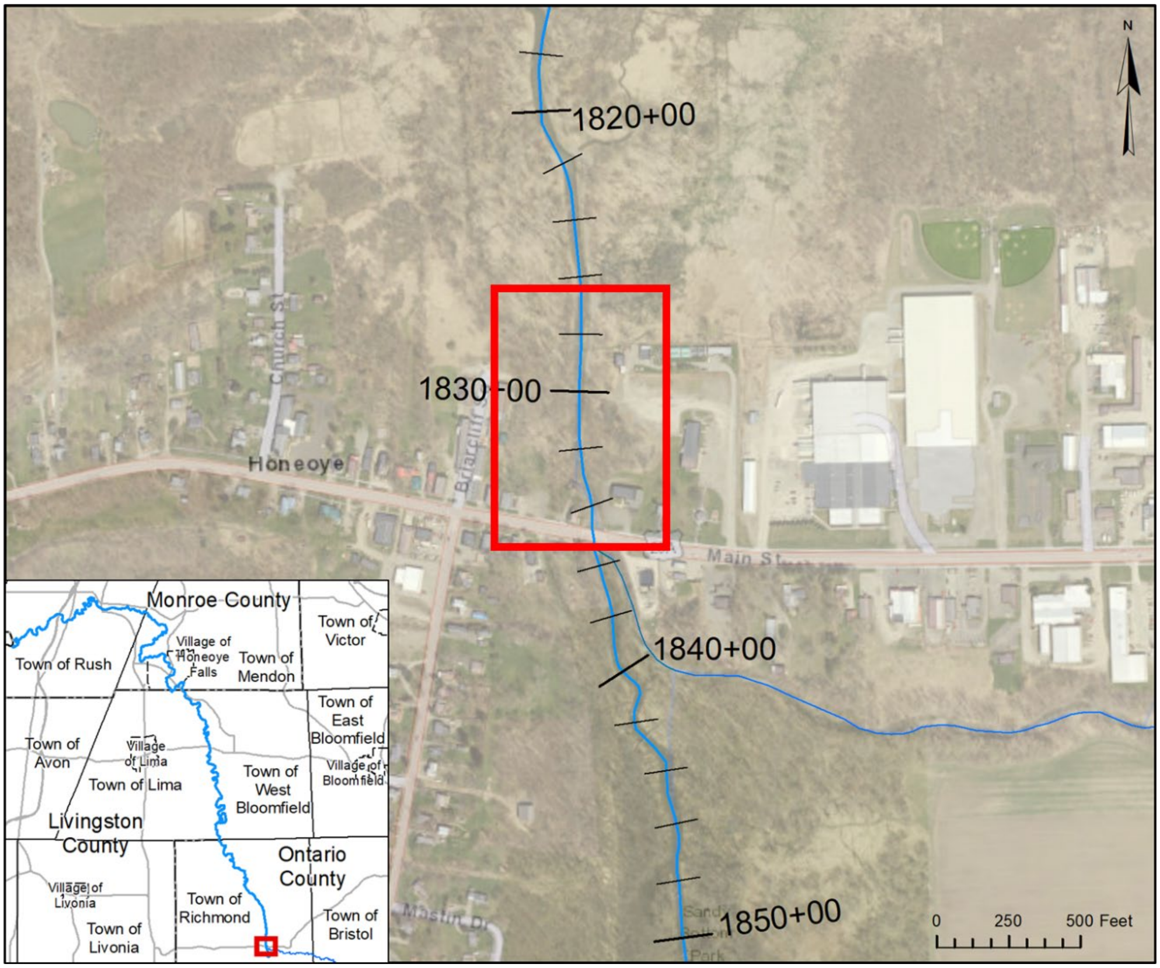


Figure 7-50. Location map for Alternative #2-5.

Sediment and debris management is necessary to address existing conditions downstream of the Main Steet/US-20A. Figure 7-51 displays sediment aggradation and debris downstream of the Main Steet/US-20A bridge (Ramboll 2022). The existing sediment and debris restricts the flow of water and has the potential to cause backwater flooding upstream of the bridge.

Figure 7-51. Sediment aggradation downstream of Main Street/US-20A, Richmond, NY.

A sediment management strategy that involves removing sediment from the channel, such as dredging, requires extensive environmental and modeling studies, application, sampling, testing, certification, permitting, operational and maintenance plans with proof of financial viability, and a significant proposal justification, including only viable alternative and greatest benefit with least amount of impact. The NYSDEC *Technical & Operations Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredged Material* (2004) should be used to determine the procedure and necessary steps in order to develop a sediment removal strategy.

The basic steps involved in the application process and technical review of a sediment assessment and management plan involves the following:

1. A pre-application meeting with the NYSDEC to discuss all application, permitting, and information needs
2. A sampling plan to determine sampling requirements for proper characterization of proposed sediments and material to be removed
3. Laboratory analysis of sampled material
4. Evaluation of laboratory results
5. Determination of appropriate management options based on sediment class
6. Development of permit conditions for the process of removing sediments and materials, and the management of the removed materials
7. Maintenance and monitoring of operations for the management plan (NYSDEC 2004)

Due to the complex nature of sediment transport during riverine processes, no modeling simulations were performed for this alternative. However, it is recommended that any sediment/debris management plan return and/or maintain the natural channel width and area so that the channel can successfully pass the bankfull discharge. According to the USGS *StreamStats* software, the bankfull width and area of Honeoye Creek downstream of Main Street/US-20A is 68 ft and 223 ft^2, respectively (USGS 2021d).

Sediment management at the Main Street/US-20A bridge crossing can improve water quality and in-channel flow area of Honeoye Creek, thereby reducing flood risk for areas in the vicinity of the outlet. However, the process of removing sediment can also fundamentally change the composition of aquatic habitats and potentially release pollutants into the water column that were previously secured in the channel sediments.

Also, it should be noted that this alternative was evaluated based solely on Honeoye Creek and its hydrological and hydraulic features. The effects of Mill Creek on Honeoye Creek in this reach were not taken into consideration. Mill Creek and its influences on Honeoye Creek are assessed in Section 7.3.

The Rough Order Magnitude cost for this measure is $470,000, which does not include engineering coordination or disposal of any dredged materials. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.3 MILL CREEK

Due to the complex nature of the confluence of Honeoye and Mill Creeks, the project team determined that a 2-D H&H model was necessary to accurately and appropriately model the existing and proposed conditions in the hamlet. Model domain, input data, and methodology are all described in Section 6.1.3.

7.3.1 Alternative #3-1: New Channel Geomorphology and Confluence with Mill Creek

This measure is intended to change the channel geomorphology and flow path of Mill Creek at the confluence with Honeoye Creek in the Hamlet of Honeoye, which would reduce erosion, sediment aggradation, and the potential for backwater flooding within the Mill Creek floodplain (Figure 7-52).

Figure 7-52. Location map for Alternative #3-1.

The channel design used for the proposed condition model simulation set the minimum channel elevation to match the upstream to downstream tie-in elevation for both Honeoye and Mill Creeks. The proposed Mill Creek channel is approximately 350-ft shorter than the original channel, with a minimum channel elevation of 802 ft NAVD88. The Honeoye Creek channel elevation would remain unchanged. Channel bank elevations for the proposed Mill Creek channel on the left bank were set to 804 ft NAVD88 (Figure 7-53).

Figure 7-53. HEC-RAS terrain data for Alternative #3-1.

The proposed channel modifications are within the FEMA designated SFHA or Zone A, which are areas subject to inundation by the 1% ACE, but where base flood elevations and flood hazard factors were not determined, and where mandatory flood insurance purchase requirements and floodplain management standards apply (FEMA 1984b).

The FEMA FIS profile plot for Mill Creek indicates significant backwater from Honeoye Lake in the vicinity of the confluence (FEMA 1984b). In addition, the FEMA FIRM displays significant backwater upstream of the Main Street/US-20A bridge crossing and the confluence of Honeoye and Mill Creeks (FEMA 1984a).

Due to the complex nature of 2-D debris and sediment modeling, for this alternative, only open-water simulations were performed to test the effectiveness of the alternative at reducing WSELs. Table 39 outlines the results of the existing conditions model simulations for each initial condition scenario. Figure 7-54 displays the profile plot for the channel modification alternative. Full model outputs for this alternative can be found in Appendix H.

Table 39. Summary Table for Alternative #3-1 Existing and Future Conditions

Existing Conditions	**Reductions in Water Surface Elevations (feet)**
Open-Water	Up to 0.3-ft
Total Length of Benefited Area	850-ft
River Stations	1+00 to 9+50
Future Conditions	Up to 0.3-ft

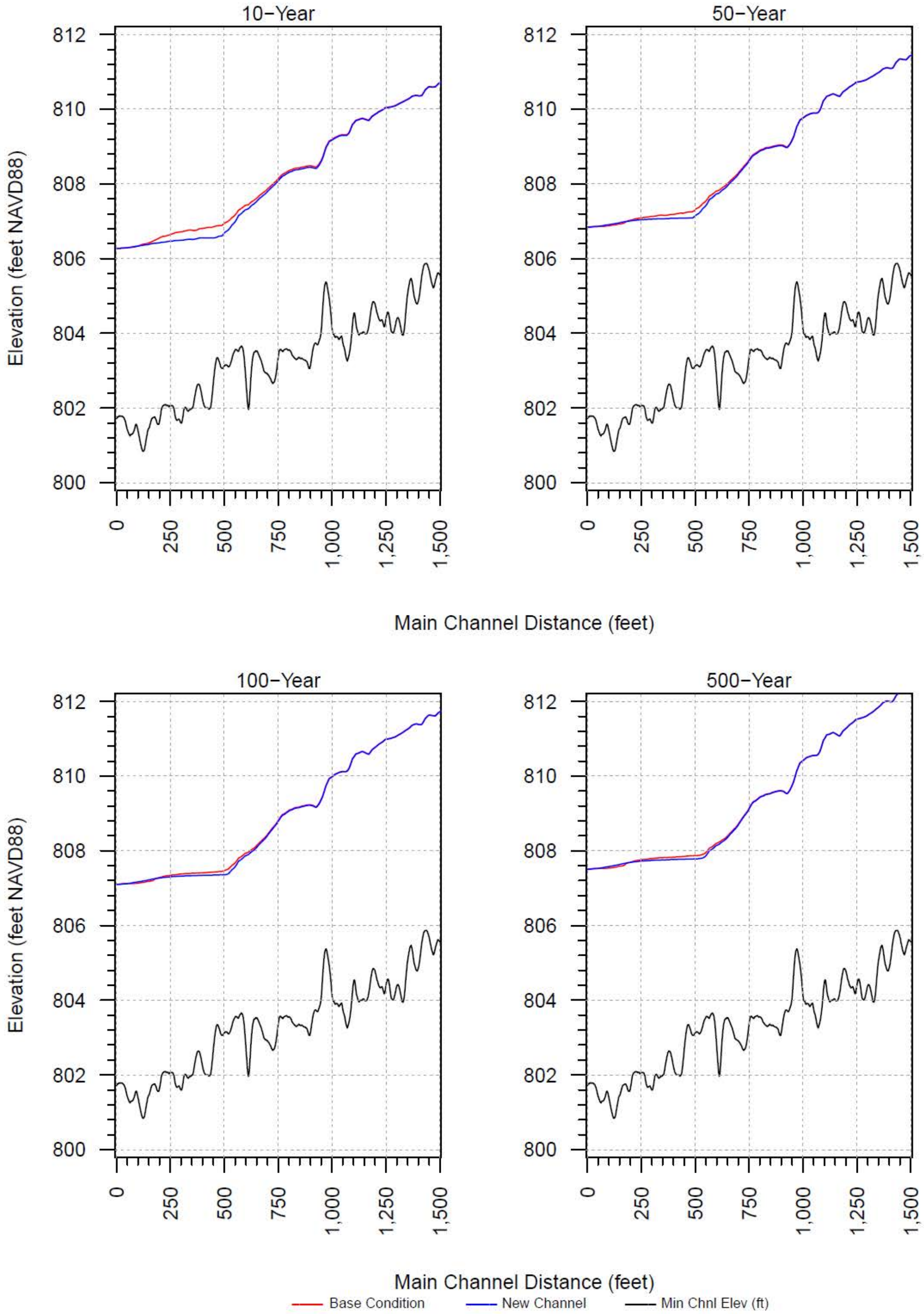


Figure 7-54. HEC-RAS model simulation output results for Alternative #3-1 for the existing condition (blue) and modified channel (red) scenarios.

A sediment management strategy that involves removing sediment from the channel, such as dredging, requires extensive environmental and modeling studies, application, sampling, testing, certification, permitting, operational and maintenance plans with proof of financial viability, and a significant proposal justification, including only viable alternatives and greatest benefit with least amount of impact. The NYSDEC *Technical & Operations Guidance Series (TOGS) 5.1.9 In-Water and Riparian Management of Sediment and Dredged Material* (2004) should be used to determine the procedure and necessary steps in order to develop a sediment removal strategy.

There are a number of federal, state, and local regulatory controls in place which apply to in-water and riparian sediment management projects. The applicability of these controls to each project depends on the particular circumstances of each case, such as the sediment classification and the intended use or management of the removed material (NYSDEC 2004).

Some or all of the following New York State and Federal Permits may be required: Use and Protection of Waters Permit; Freshwater Wetlands Permit; Tidal Wetlands Permit; State Pollutant Discharge Elimination System Permit; Clean Water Act § 401 Water Quality Certification and § 404 Permit and Rivers and Harbors Act § 10 Permits, issued by the USACE. An antidegradation review and Wild, Scenic and Recreational Rivers Program permits may also be required (NYSDEC 2004).

In addition, the process of removing sediment can have negative effects on aquatic ecosystems, including:

- Fundamentally changing the composition of aquatic habitats
- Potentially releasing pollutants into the water column that were previously secured in the channel sediments
- Directly or indirectly leading to the loss of plants and animals that live in sediments
- Reducing sediment supply downstream
- Removing larger gravels and cobbles can destabilize the channel bed substrate, exposing smaller-sized sediments and making them easier to move downstream
- Increasing flood risk downstream by increasing the volume of water carried
- Triggering erosion of the bed and banks by altering flow velocities and volumes (SEPA 2010)

The potential benefits of this strategy are limited to the vicinity of Main Street/US-20A and upstream areas on Honeoye and Mill Creeks. The primary benefits of the channel modification and sediment removal would be to increase the flow capacity through the structure and reduce the potential of debris and ice creating obstructions or ice jams upstream of the structure.

It should be noted that a full geomorphological and sediment analysis would be required in order to progress this alternative. For this study, no historical geomorphological study was performed. In addition, upstream sources of sediment from both Honeoye and Mill Creeks would need to be addressed prior to removing any sediment from Honeoye Creek to maintain the desired flood mitigation benefits.

To evaluate the effectiveness of the flood mitigation impacts, the project team analyzed this alternative independently of other alternatives. However, there is the potential for added benefits (i.e., reduction in WSELs, less flooding, reduced erosion, etc.) when multiple flood mitigation projects are built in conjunction. For areas that experience significant flood damages or chronic flooding, it is recommended that multiple flood mitigation strategies in conjunction be considered and evaluated by affected communities.

The Rough Order Magnitude cost for this measure is $530,000, which does not include land acquisition costs for survey, appraisal, and engineering coordination and acquisition or disposal of any fill or dredged materials. In addition, the NYSDEC will require wetland delineations, an analysis for any endangered and/or threatened species within the proposed project area, and information regarding access during construction for this mitigation alternative.

7.3.2 Alternative #3-2: Streambank Stabilization Adjacent to 8565-8615 Main Street

Streambank erosion is a natural process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the banks in place. The forces that cause erosion increase during flood events, and most erosion occurs at these times. Human disturbances to watersheds that increase frequency and magnitude of runoff events also increase streambank erosion. Human disturbances include logging, mining, agriculture, and urbanization. Typical urban or suburban developments which may impact a stream include houses, garages, parking lots and walkways, including areas cleared of forest and replaced by tailored lawns (GSWCC 2000).

Loss of streambank and streamside vegetation reduces the resisting forces and makes streambanks more susceptible to erosion. This is often the single greatest contributing factor to harmful or accelerated erosion on small- and medium-size streams. Streambank vegetation may be removed intentionally for various reasons, or its loss may be inadvertent due to trampling by animals or humans (GSWCC 2000).

Streambank stabilization measures work either by reducing the force of flowing water, increasing the resistance of the bank to erosion, or some combination of both. Generally speaking, there are four approaches to streambank protection: 1) the use of vegetation, 2) soil bioengineering, 3) the use of rock work in conjunction with plants, and 4) conventional bank armoring. Re-vegetation includes seeding and sodding of grasses, seeding in combination with erosion control fabrics, and the planting of woody vegetation (shrubs and trees). Soil bioengineering systems use woody vegetation installed in specific configurations that offer immediate erosion protection, reinforcement of the soils, and in time a woody vegetative surface cover and root network. The use of rock work in conjunction with plants is a technique which combines vegetation with rock work. Over time, the plants grow and the area appears and functions more naturally. Conventional armoring is a fourth technique which includes the use of rock, known as riprap, to protect eroding streambanks (GSWCC 2000).

Streambank stabilization can also play a vital role in flood risk management in areas located in flood-prone areas. The magnitude of that risk is a function of the flood hazard, the characteristics of a particular location (i.e., elevation, proximity to the waterway, susceptibility to fast-moving flows, etc.), measures that have been taken to mitigate the potential impact of flooding, the vulnerability of people and property, and the consequences that result from a particular flood event. A flood risk management strategy identifies and implements measures that reduce the overall risk, and what remains is the residual risk. In developing the strategy, those responsible judge the costs and benefits of each measure taken and their overall impact in reducing the risk (NRC 2013).

Through historical flood reports, stakeholder engagement meetings, and/or field work, numerous areas along Honeoye Creek in the Hamlet of Honeoye have been identified as areas for potential streambank stabilization strategies. These areas have been outlined in Figure 7-55.

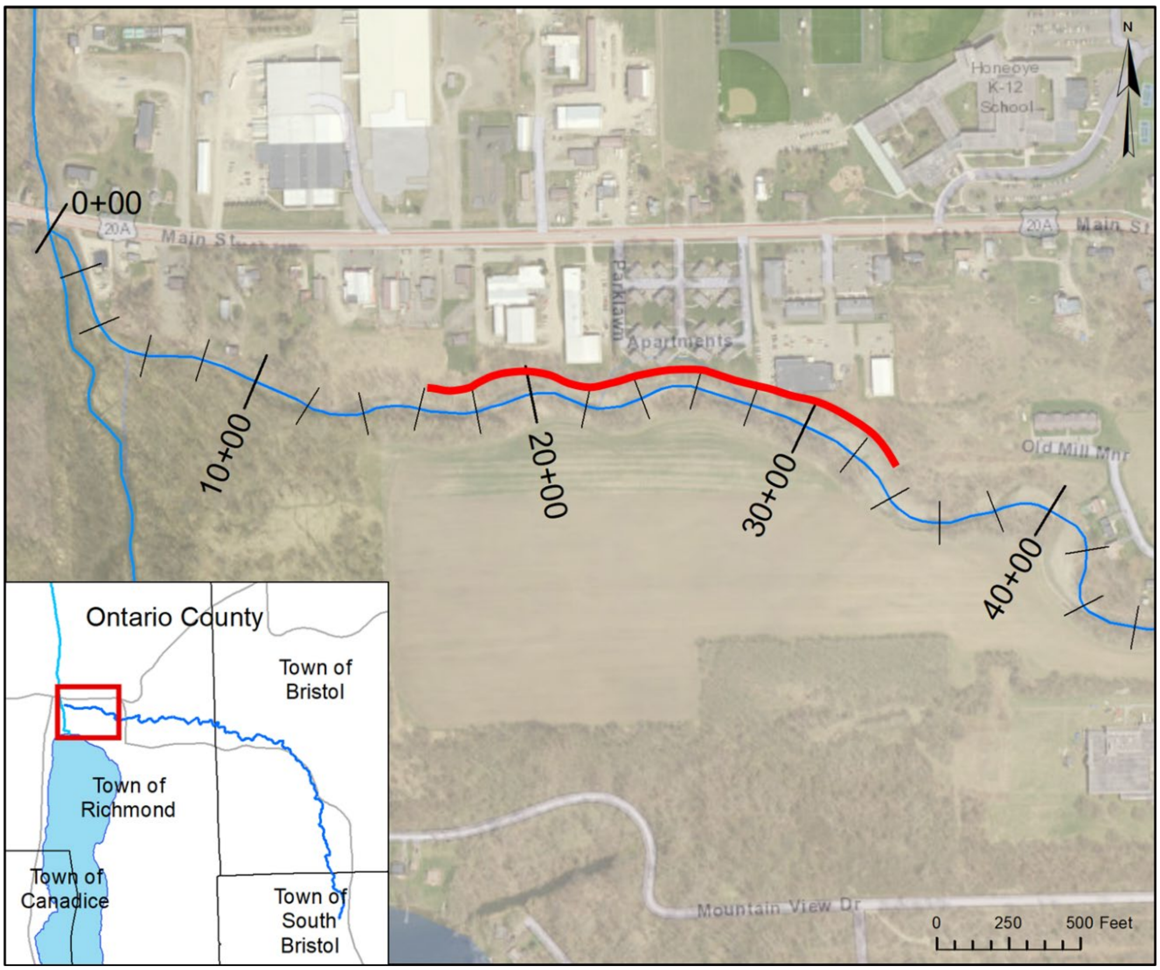


Figure 7-55. Location map for Alternative #3-2.

Appendix G contains detailed discussion of various streambank stabilization strategies, including drawings, definitions, ideal locations, design and construction considerations, maintenance, and ROM costs.

Transport of sediment and debris in streams is predominantly controlled by stream transport capacity, sediment physiochemical characteristics and supply rate. Several hydraulic and geomorphologic factors determine stream transport capacity including channel width, flow depth and cross-sectional geometry, bed slope and roughness, and discharge velocity and volume. In general, the more turbulent energy available for suspension and mobilization of sediment, the greater the sediment transport capacity per unit of stream width, and the larger the size of sediment particles that can be moved (USEPA 2009a).

Larger sediments and debris generally experience more episodic movement over longer time scales through watersheds. Smaller sediments generally move more continuously and within a shorter time scale. This difference is due to the fact that larger sediments and debris rely on larger, more powerful flows for transport, which occur episodically and less frequently than flows able to move smaller particles, such as the bankfull discharge (USEPA 2009a).

To assess the applicability of different streambank stabilization strategies under higher frequency-lower flow conditions, channel velocity (feet per second) and shear stress (pounds per square foot) were calculated using the HEC-RAS software for the existing conditions model at the 10% ACE; the results are summarized in Table 40.

Table 40. HECRAS Existing Condition Model Output of Channel Velocity (ft/s) and Shear Stress (lb/sq ft) at the 10% Annual Chance Event for Alternative #3-2

Source: USACE 2021		
River Station	**Channel Velocity (ft/s)**	**Channel Shear Stress (lb/sq ft)**
33+00	4.151	0.971
31+00	5.706	1.743
29+00	5.155	2.347
27+00	5.813	0.897
25+00	6.614	0.863
23+00	4.563	2.541
21+00	4.29	3.017
19+00	4.106	0.565
17+00	4.836	1.326
15+00	4.134	4.1

Based on the existing conditions model output for channel velocity and shear stress, Table 41 summarizes the applicability of potential streambank strategies for this proposed alternative.

Table 41. Potential Streambank Stabilization Strategies for Alternative #3-2

Source: NRCS 2009

Type of Treatment	Type of Sub-Treatment
Brush Mattresses	Staked only with rock riprap toe (grown)
Soil Bioengineering	Coir Roll
	Vegetated coir mat
	Live brush mattress (grown)
	Brush layering (initial/grown)
Boulder Clusters	Boulder - Very large (>80-in diameter)
	Boulder - Large (>40-in diameter)
	Boulder - Medium (>20-in diameter)
	Small (>10-in diameter)

Due to the variable, conceptual, and site-specific nature of streambank stabilization strategies, no ROM Cost Estimates were determined for this measure. Additional geomorphic and engineering analyses, including additional modeling, would be necessary in order to determine the most appropriate streambank stabilization strategy and its associated costs.

7.3.3 Alternative #3-3: Streambank Stabilization Downstream of East Lake Road

Streambank erosion is a natural process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the banks in place. The forces that cause erosion increase during flood events, and most erosion occurs at these times. Human disturbances to watersheds that increase frequency and magnitude of runoff events also increase streambank erosion. Human disturbances include logging, mining, agriculture, and urbanization. Typical urban or suburban developments which may impact a stream include houses, garages, parking lots, and walkways, including areas cleared of forest and replaced by tailored lawns (GSWCC 2000).

Loss of streambank and streamside vegetation reduces the resisting forces and makes streambanks more susceptible to erosion. This is often the single greatest contributing factor to harmful or accelerated erosion on small- and medium-size streams. Streambank vegetation may be removed intentionally for various reasons, or its loss may be inadvertent due to trampling by animals or humans (GSWCC 2000).

Streambank stabilization measures work either by reducing the force of flowing water, increasing the resistance of the bank to erosion, or some combination of both. Generally speaking, there are four approaches to streambank protection: 1) the use of vegetation, 2) soil bioengineering, 3) the use of rock work in conjunction with plants, and 4) conventional bank armoring. Re-vegetation includes seeding and sodding of grasses, seeding in combination with erosion control fabrics, and the planting of woody vegetation (shrubs and trees). Soil bioengineering systems use woody vegetation installed in specific configurations that offer immediate erosion protection, reinforcement of the soils, and in time a woody vegetative surface cover and root network. The use of rock work in conjunction with plants is a technique which combines vegetation with rock work. Over time, the plants grow and the area appears and functions more naturally. Conventional armoring is a fourth technique which includes the use of rock, known as riprap, to protect eroding streambanks (GSWCC 2000).

Streambank stabilization can also play a vital role in flood risk management in areas located in flood-prone areas. The magnitude of that risk is a function of the flood hazard, the characteristics of a particular location (i.e., elevation, proximity to the waterway, susceptibility to fast-moving flows, etc.), measures that have been taken to mitigate the potential impact of flooding, the vulnerability of people and property, and the consequences that result from a particular flood event. A flood risk management strategy identifies and implements measures that reduce the overall risk, and what remains is the residual risk. In developing the strategy, those responsible judge the costs and benefits of each measure taken and their overall impact in reducing the risk (NRC 2013).

Through historical flood reports, stakeholder engagement meetings, and/or field work, numerous areas along Honeoye Creek in the Hamlet of Honeoye have been identified as areas for potential streambank stabilization strategies. These areas have been outlined in Figure 7-56.

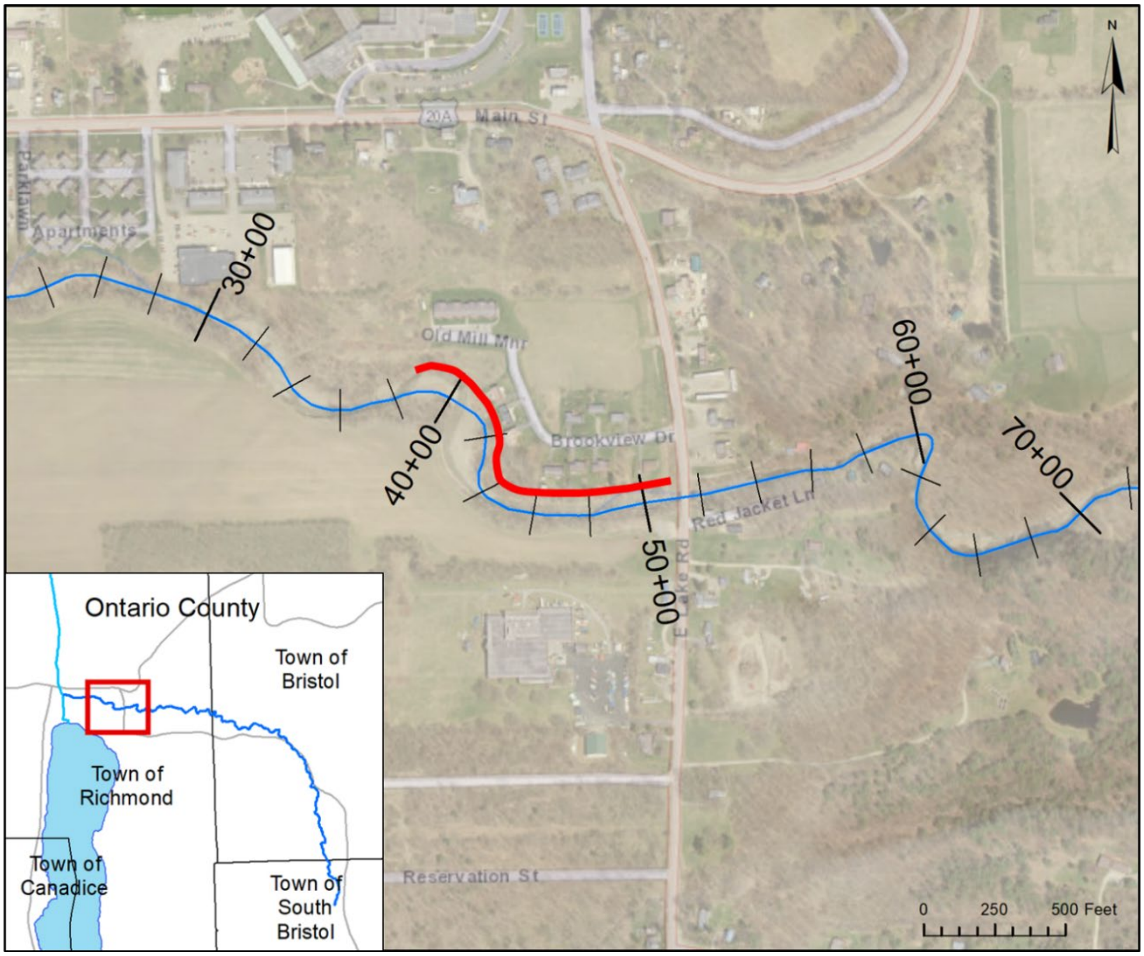


Figure 7-56. Location map for Alternative #3-3.

Appendix G contains detailed discussion of various streambank stabilization strategies, including drawings, definitions, ideal locations, design and construction considerations, maintenance, and ROM costs.

Transport of sediment and debris in streams is predominantly controlled by stream transport capacity, sediment physiochemical characteristics and supply rate. Several hydraulic and geomorphologic factors determine stream transport capacity including channel width, flow depth and cross-sectional geometry, bed slope and roughness, and discharge velocity and volume. In general, the more turbulent energy available for suspension and mobilization of sediment, the greater the sediment transport capacity per unit of stream width, and the larger the size of sediment particles that can be moved (USEPA 2009a).

Larger sediments and debris generally experience more episodic movement over longer time scales through watersheds. Smaller sediments generally move more continuously and within a shorter time scale. This difference is due to the fact that larger sediments and debris rely on larger, more powerful flows for transport, which occur episodically and less frequently than flows able to move smaller particles, such as the bankfull discharge (USEPA 2009a).

To assess the applicability of different streambank stabilization strategies under higher frequency-lower flow conditions, channel velocity (feet per second) and shear stress (pounds per square foot) were calculated using the HEC-RAS software for the existing conditions model at the 10% ACE; the results are summarized in Table 42.

Table 42. HECRAS Existing Condition Model Output of Channel Velocity (ft/s) and Shear Stress (lb/sq ft) at the 10% Annual Chance Event for Alternative #3-3

Source: USACE 2021		
River Station	**Channel Velocity (ft/s)**	**Channel Shear Stress (lb/sq ft)**
50+50	7.995	1.229
48+50	6.602	0.938
46+50	7.715	1.252
44+50	5.346	1.758
42+50	6.302	2.91
40+50	9.462	1.726
38+50	5.378	0.669

Based on the existing conditions model output for channel velocity and shear stress, Table 43 summarizes the applicability of potential streambank strategies for this proposed alternative.

Table 43. Potential Streambank Stabilization Strategies for Alternative #3-3

Source: NRCS 2009	
Type of Treatment	**Type of Sub-Treatment**
Brush Mattresses	Staked only with rock riprap toe (grown)
Coir Geotextile Roll	Roll with Polypropylene rope mesh staked and with rock riprap toe
Gravel/Cobble	12-in
Soil Bioengineering	Vegetated coir mat
	Live willow stakes
	Live brush mattress (grown)
	Brush layering (initial/grown)
Boulder Clusters	Boulder - Very large (>80-in diameter)
	Boulder - Large (>40-in diameter)
	Boulder - Medium (>20-in diameter)
	Small (>10-in diameter)

Due to the variable, conceptual, and site-specific nature of streambank stabilization strategies, no ROM cost estimates were determined for this measure. Additional geomorphic and engineering analyses, including additional modeling, would be necessary in order to determine the most appropriate streambank stabilization strategy and its associated costs.

7.3.4 Alternative #3-4: Sediment and Debris Management Study for Mill and Upper Honeoye Creeks

This measure is intended to perform a sediment and debris management study on Mill Creek and the confluence with Honeoye Creek. The objective of this study would be to provide an effective method to identify areas within the Mill and Upper Honeoye Creek basins where sediment and debris build-up contribute to flooding risk, and to gather information necessary to develop a management plan to reduce those risks. The plan would necessitate the collection and assessment of watershed-wide conditions in a holistic systems-based approach to best understand and plan mitigative measures.

A primary goal will be to reduce flooding by lowering surface water elevations caused by undersized infrastructure, excessive deposition and debris, uncontrolled sediment sources, head cutting or downcutting of the channel, and loss of natural floodplains. Many of these situations are a result of basin-wide conditions related to changes in land use, landcover and runoff, stormwater management, upstream sediment sources, upstream woody debris, and stream bed and bank erosion. Practical solutions and actions would be presented to meet these goals in an ecologically sustainable manner.

Numerous watershed-wide characteristics and conditions can contribute to or cause increased flooding risk. Incompletely understood and poorly planned actions may worsen flooding risk, create negative unintended consequences, be prohibitively expensive, ineffective, a waste of dollars, and cause unnecessary ecological damage.

A management plan is a process that should incorporate the input of all the different people who live, work and play in the watershed when determining how the watershed should be managed. The sediment and debris management plan should be a dynamic, ever changing, process-driven document that helps to define future direction for the watershed and be updated periodically, as and if improvements or changes in conditions within the creek basin occur, such as creation of floodplain areas, bridge/culvert resizing, or alterations to creek channel dimensions.

The study would provide an understanding of the intricacies, complexities, and interrelationships involved in water resource management; outline common issues faced by different municipalities along Mill and Upper Honeoye Creeks; and identify specific strategies and measures to address these issues. Within the Mill and Upper Honeoye Creek basins, diverse solutions and abatement programs of various county, state, local, and federal agencies should be integrated into a coordinated, comprehensive, interagency, watershed-based approach to management. A uniform, organized, well thought-out water resources strategy would provide for a more effective delivery of programs; reduce duplication of efforts and agency conflicts; identify program gaps; clarify agency roles and responsibilities; provide a means of identifying and obtaining future funding opportunities; and would result in the overall enhancement of water resources within the Mill and Upper Honeoye Creek basins.

The ROM cost estimate for a sediment and debris management study would be $80,000.

8. BASIN-WIDE MITIGATION ALTERNATIVES

Non-structural measures attempt to avoid flood damages by modifying or removing properties currently located within flood-prone areas. These measures do not affect the frequency or level of flooding within the floodplain; rather, they affect floodplain activities. In considering the range of non-structural measures, the community needs to assess the type of flooding which occurs (depth of water, velocity, duration) prior to determining which measure best suits its needs (USACE 2016b).

8.1 ALTERNATIVE #4-1: EARLY-WARNING FLOOD DETECTION SYSTEM

Early-warning flood detection systems can be implemented, which can provide communities with more advanced warning of potential flood conditions. Early forecast and warning involve the identification of imminent flooding, implementation of a plan to warn the public, and assistance in evacuating persons and some personal property. A typical low cost early-warning flood detection system consists of commercially available off-the-shelf components. The major components of an early-warning flood detection system are a sensor connected to a data acquisition device with built-in power supply or backup, some type of notification or warning equipment, and a means of communication.

For ice-jam warning systems, conditions are generally monitored using a pressure transducer. The data acquisition system performs two functions: it collects and stores real-time flood stage data from the pressure transducer, and initiates the notification process once predetermined flood-stage conditions are met (USACE 2016b).

This method can also be supplemented by an ice-jam prediction calculation procedure using the freezing degree-day (FDD) method to forecast the ice thickness at critical locations to inform early action to control ice (Shen and Yapa 2011). The method involves a small computer tool that goes through all the ice calculations and gives the output in a graphical format of the predicted ice thickness with time. This can be quickly implemented and can be a very good solution due to its low cost, and low labor and maintenance requirements. The method needs only the forecasted air temperature and current water level at the critical location. During severe winter conditions, the ice thickness prediction can be used to help prepare and coordinate resources needed for a potential ice jam event and consequential flooding. For regular winter conditions, the tool can be used as a quick ice-thickness monitoring mechanism.

The pressure transducer system can be powered from an alternating current source via landline or by batteries that are recharged by solar panels. The notification process can incorporate standard telephone or cellular telephone. Transfer of data from the system can be achieved using standard or cellular telephone, radio frequency telemetry, wireless internet, or satellite transceivers. Emergency management notification techniques can be implemented through the use of radio, siren, individual notification, or a reverse 911 system. More elaborate means include remote sensors that detect water levels and automatically warn residents. These measures normally serve to reduce flood hazards to life, and damage to portable personal property (USACE 2016b).

The Rough Order Magnitude cost for this strategy is approximately $120,000, not including annual maintenance and operational costs.

8.2 ALTERNATIVE #4-2: RIPARIAN RESTORATION

Riparian ecosystems support many critically important ecological functions, but most riparian areas have been severely degraded by a variety of human disturbances within the Honeoye Creek watershed. Restoration, which is defined as the process of reestablishing historical ecosystem structures and processes, is being used more often to mitigate some of the past degradation of these ecosystems (Goodwin et al. 1997).

Adoption of a process-based approach for riparian restoration is key to a successful restoration plan, and in riparian systems, flooding disturbance is a key process to consider. Successful restoration depends on understanding the physical and biological processes that influence natural riparian ecosystems, and the types of disturbances to anthropogenic modifications that cause damage to riparian areas. In this case, alteration of historical flooding processes has caused degradation of the riparian system.

Riparian ecosystems generally consist of two flooding zones: Zone I occupies the active floodplain and is frequently inundated, and Zone II extends from the active floodplain to the valley wall. Successful restoration depends on understanding the physical and biological processes that influence natural riparian ecosystems and the types of disturbance that have degraded riparian areas. Adoption of a process-based approach for riparian restoration is key to a successful restoration plan. Disturbances to riparian ecosystems in the Honeoye Creek watershed have resulted from streamflow modifications by dams, reservoirs, and diversions; stream channelization; direct modification of the riparian ecosystem; and watershed disturbances (Goodwin et al. 1997).

With ecological processes in mind, a successful riparian restoration plan should focus on four key areas: (1) interdisciplinary approaches, (2) a unified framework, (3) a better understanding of fundamental riparian ecosystem processes, and (4) restoration potential more closely related to disturbance type (Goodwin et al. 1997).

Three issues should be considered regarding the cause of the degraded environment: (1) the location of the anthropogenic modification with respect to the degraded riparian area, (2) whether the anthropogenic modification is ongoing or can be eliminated, and (3) whether or not recovery will occur naturally if the anthropogenic modification is removed (Goodwin et al. 1997).

Riparian restoration requires a deep understanding of physical and ecological conditions that exist and that are desired at a restoration site. These conditions must be naturally sustainable given a set of water, sediment, and energy fluxes. If the conditions cannot be naturally sustained, the restoration will fail to meet the original goals (Goodwin et al. 1997).

8.3 ALTERNATIVE #4-3: DEBRIS MAINTENANCE AROUND INFRASTRUCTURE

Multiple areas in the Honeoye Creek watershed were identified as catchpoints for debris and sediment. Areas where debris maintenance should be employed or continued to be employed are:

- The downstream reach of Honeoye Creek from Main Street/US-20A in the Hamlet of Honeoye, which is maintained by the Town of Richmond
- Mill Creek in the vicinity of East Lake Road and downstream to the confluence with Honeoye Creek in the Town of Richmond

Debris, such as trees, branches and stumps are an important feature of natural and healthy stream systems. In a healthy stream network, woody debris helps to stabilize the stream and its banks, reduce sediment erosion, and slow storm-induced high streamflow events. Fallen trees and brush also form the basis for the entire aquatic ecosystem by providing food, shelter, and other benefits to fish and wildlife. In the headwaters of many streams, woody debris influences flooding events by increasing channel roughness, dissipating energy, and slowing floodwaters, which can potentially reduce flood damages in the downstream reaches. Any woody debris that does not pose a hazard to infrastructure or property should be left in place and undisturbed, thereby saving time and money for more critical work at other locations (NYSDEC 2013).

However, in some instances, significant sediment and debris can impact flows by blocking bridge and culvert openings and accumulating along the stream path at meanders, contraction/expansion points, etc., which can divert stream flow and cause backwater and bank erosion. When debris poses a risk to infrastructure, such as bridges or homes, it should be removed. Provided fallen trees, limbs, debris and trash can be pulled, cabled or otherwise removed from a stream or stream bank without significant disruption of the stream bed and banks, a permit from the NYSDEC is not required. Woody debris and trash can be removed from a stream without the need for a permit under the following guidelines:

- Fallen trees and debris may be pulled from the stream by vehicles and motorized equipment operating from the top of the streambanks using winches, chains and or cables.
- Hand-held tools, such as chainsaws, axes, handsaws, etc., may be used to cut up the debris into manageable-sized pieces.
- Downed trees that are still attached to the banks should be cut off near the stump. Do not grub (pull out) tree stumps from the bank; stumps hold the bank from eroding.
- All trees, brush, and trash that is removed from the channel should not be left on the floodplain. Trash should be properly disposed of at a waste management facility. Trees and brush can be utilized as firewood. To prevent the spread of invasive species, such as Emerald Ash Borer, firewood cannot be moved more than 50 miles from its point of origin.

- Equipment may not be operated in the water, and any increase in stream turbidity from the removal must be avoided (NYSDEC 2013).

Any work that will disturb the bed or banks of a protected stream (gravel removal, stream restoration, bank stabilization, installation, repair, replacements of culverts or bridges, objects embedded in the stream that require digging out, etc.) will require an Article 15 permit from the NYSDEC. Projects that will require disturbance of the stream bed or banks, such as excavating sand and gravel, digging embedded debris from the streambed, or the use of motorized vehicular equipment such as a tractor, backhoe, bulldozer, log skidder, four-wheel drive truck, etc. (any heavy equipment), in the stream channel or anywhere below the top of banks will require either a Protection of Waters or Excavation or Fill in Navigable Waters Permit (NYSDEC 2013).

In addition, sediment control basins along Honeoye Creek could be established to reduce watercourse and gully erosion, trap sediment, reduce and manage runoff near and downstream of the basin, and to improve downstream water quality. A sediment control basin is an earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and water detention basin. The basin should be configured to enhance sediment deposition by using flow deflectors, inlet and outlet selection, or by adjusting the length to width ratio of the creek channel. Additional hydrologic and hydraulic studies should be performed to identify the optimal locations for the sediment control basins. Operation and maintenance costs to maintain the embankment, design capacity, vegetative cover, and outlet of the basin should be considered (NRCS 2002).

Consultation with the NYSDEC can help determine if, when and how sediment and debris should be managed and whether a permit will be required.

The Rough Order Magnitude cost for this strategy is up to $20,000, not including annual maintenance and operational costs.

8.4 ALTERNATIVE #4-4: DETENTION BASIN AND WETLAND MANAGEMENT

Stormwater detention basins and wetlands are designed and constructed to contain and/or filter pollutants that flush off of the landscape. Without proper maintenance, nutrients such as nitrogen and phosphorus that are typically found in stormwater runoff can accumulate in the basin and/or wetlands leading to degraded conditions such as low dissolved oxygen, algae blooms, unsightly conditions, and odors. Excess sediment from the watershed upstream can also accumulate in the basins and wetlands. This sediment can smother the vegetation and clog any filtering structures or outlets. In addition, standing water in basins can heat up during the summer months. This warmer water is later released into neighboring waters, which can have negative impacts on aquatic life (USEPA 2009b).

Without proper maintenance, excess pollutants in ponds and wetlands may actually become sources of water quality issues such as poor water color/clarity/odor, low dissolved oxygen leading to plant die-off, and prevalence of algal blooms. When these basins and wetlands are “flushed” during a large rain event, the excess nutrients causing these problems may be transferred to the receiving waterbody (USEPA 2009b).

Maintenance is necessary for detention basins and wetlands to operate as designed on a long-term basis. The pollutant removal, channel protection, and flood control capabilities of basins and wetlands will decrease if any of the following occur (USEPA 2009b):

- Sediment accumulates reducing the storage volume
- Debris blocks the outlet structure
- Pipes or the riser are damaged
- Invasive plants take over the planted vegetation
- Slope stabilizing vegetation is lost
- The structural integrity of the embankment, weir, or riser is compromised

Detention basin and wetland maintenance activities range in terms of the level of effort and expertise required to perform them. Routine basin and wetland maintenance, such as mowing and removing debris or trash, is needed multiple times each year but can be performed by citizen volunteers. More significant maintenance such as removing accumulated sediment is needed less frequently, but requires more skilled labor and special equipment. Inspection and repair of critical structural features such as embankments and risers, needs to be performed by a qualified professional (e.g., structural engineer) who has experience in the construction, inspection, and repair of these features (USEPA 2009b). Water level management, if control structures are available, can be an effective tool to meet a range of pond and wetland habitat and process management objectives.

Program managers and responsible parties need to recognize and understand that neglecting routine maintenance and inspection can lead to more serious problems that threaten public safety, impact water quality, and require more expensive corrective actions (USEPA 2009b).

It should be noted that the NYSDEC would not approve sediment detention ponds below mean high water. However, consideration would be given to plans for such structures that were part of a flood mitigation project, such as a floodplain bench.

8.5 ALTERNATIVE #4-5: ICE MANAGEMENT

This strategy is intended to control ice-jam formation by maintaining ice coverage in high-risk sections of Honeoye Creek. Ice management strategies include various methods of preventing ice jams by breaking ice using various ice cutting patterns and techniques, as well as various equipment and personnel. Ice-jam mitigation strategies are very much site dependent. A strategy that works for a certain reach of a river may not work for another reach in the same river due to river morphology and hydrodynamics. Therefore, each of these strategies need to be analyzed with numerical modeling and simulations to check if they work for a considered area/reach of a river before implementing or recommending with the previous observational experience alone. Suggested locations for ice cutting operations would be provided based on anticipated effectiveness, site accessibility, and historical occurrences of ice jams. Criteria and scheduling would be provided by county and/or state agencies and determined based on environmental conditions (e.g., temperature, ice thickness, weather forecast) (USACE 2016c).

The standard strategies that are widely accepted and practiced in cold-region engineering, such as in central New York, are listed below with greater detail provided in Appendix E:

- Ice breaking – either through the use of explosives or ice-breaker ferries and cutters that either cut ice free from the banks or cross-cut ice to hasten the release of ice in order to prevent ice-jam formations
- Trenchers and special design trenching equipment – used to dig ditches customarily, but can be used to cut ice to hasten release downstream
- Channeling plow – plow mounted to a sledge drawn by a tractor that breaks and clears ice from channel
- Water jet and thermal cutting – supersonic water streams and thermal cutting tools to separate ice and move it downstream
- Hole cutting – drill large holes into the ice to reduce the integrity of the ice cover and curtail ice formation
- Air bubbler and flow systems – release air bubbles and mix heated effluent into the cold water to suppress ice growth
- Ice forecasting systems – systems designed to monitor ice cover on waterways and alert local communities when there is the potential for an ice jam
- Ice retention structures – such as ice booms or inflatable dams designed to force ice floes into or stop ice floes at a specific area
- Removal of bridge piers, heated bridge piers, or heated riverbank dikes (USACE 2006)

Generally, the FDD method as previously discussed, is a good technique to first predict ice thickness at critical locations, such as bridges or flow constriction structures using the forecasted air temperature. This method will let the community officers know the severity of any possible ice jams based on future air temperature, allowing for time to get equipment and labor ready for the forthcoming ice jam. A small computer program could be used to do the iterative calculations faster, so that any non-technical user can use it to foresee the ice jam (Shen and Yapa 2011).

Another technique is maintaining a calibrated ice model to predict possible ice jam locations using forecasted air temperature and flow. This will be a comprehensive 2-D river ice simulation model (RICEN) (Shen et al. 1995) or Comprehensive River Ice Simulation System (CRISSP 2D) (CEATI 2005) that predicts the fate of ice evolution from fall to spring.

Ramboll suggests performing a freeze-up or a break-up ice model simulation study prior to implementing any of the above discussed strategies. The basic data needs and steps involved in an ice simulation analysis are also outlined in Appendix E.

Due to the variable nature of ice jam occurrence and severity, no cost estimates were prepared for this alternative.

8.6 ALTERNATIVE #4-6: FLOOD BUYOUT PROGRAMS

Buyouts allow state and municipal agencies the ability to purchase developed properties within areas vulnerable to flooding from willing owners. Buyouts are effective management tools in response to natural disasters to reduce or eliminate future losses of vulnerable or repetitive loss properties. Buyout programs include the acquisition of private property, demolition of existing structures, and conversion of land into public space or natural buffers. The land is maintained in an undeveloped state for public use in perpetuity. Buyout programs not only assist individual homeowners, but are also intended to improve the resiliency of the entire community in the following ways (Siders 2013):

- Reduce exposure by limiting the people and infrastructure located in vulnerable areas
- Reduce future disaster response costs and flood insurance payments
- Restore natural buffers such as wetlands in order to reduce future flooding levels
- Reduce or eliminate the need to maintain and repair flood control structures
- Reduce or eliminate the need for public expenditures on emergency response, garbage collection and other municipal services in the area
- Provide open space for the community

Resilience achieved through buyouts can have real economic consequences in addition to improved social resilience. According to FEMA, voluntary buyouts cost $1 for every $2 saved in future insurance claims, an estimate which does not include money saved on flood recovery and response actions, such as local flood fighting, evacuation and rescue, and recovery expenses that will not be incurred in the future. In order to achieve these goals, buyouts need to acquire a continuous swatch of land, rather than individual homes in isolated areas, or only some of the homes within flood-prone areas (Siders 2013).

Buyout programs can be funded through a combination of federal, state or local funds, and are generally made available following a nationally recognized disaster. FEMA administers programs to help with buyouts under the Stafford Disaster Act, and the Department of Housing and Urban Development (HUD) administers another program through Community Development Block Grants (CDBG). These funding sources can reduce the economic burden on the local community. However, these funds also come with guidelines and regulations that may constrain policy makers' options on whether to pursue a buyout strategy, and how to shape their programs. FEMA funds may be used to cover 75% of the expenses, but the remaining 25% must come from another non-federal source. In most cases, the buyout must be a cost-effective measure that will substantially reduce the risk of future flooding damage (Siders 2013).

For homes in the SFHA, FEMA has developed precalculated benefits for property acquisition and structure elevation of buildings. Based on a national analysis that derived the average benefits for acquisition and elevation projects, FEMA has determined that acquisition projects that cost $276,000 or less, or elevation projects that costs $175,000 or less, and which are located in the 1% ACE (i.e., 100-yr recurrence interval) floodplain are considered cost-effective and do not require a separate benefit-cost analysis. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criteria. If the cost to acquire or elevate a structure exceeds the amount of benefits listed above, then a traditional FEMA approved benefits-cost analysis must be completed (FEMA 2015).

In the Honeoye Creek watershed, there are approximately 706 tax parcels within the FEMA 1- and 0.2% annual chance flood hazard zones. Of the 706 tax parcels, 485 are classified as residential with a total full market value of $96.7 million, and 82 are classified as commercial with a total full market value of $22.9 million. Table 44 summarizes the number of parcels and their full market value within the three high-risk flood areas (NYSGPO 2021). Figure 8-1 displays the tax parcels that intersect the FEMA flood zones, including generalized locations of FEMA repetitive loss properties. In addition, there are four FEMA Repetitive Loss (RL), including one Severe Repetitive Loss (SRL) property located within the Honeoye Creek watershed (FEMA 2019).

Table 44. Summary Table for Tax Parcels within FEMA Flood Zones in High-Risk Areas along Honeoye Creek

Source: NYSGPO 2021		
High-Risk Flood Area	**Number of Parcels**	**Full Market Value**
#1: Village of Honeoye Falls, Town of Mendon, Monroe County, New York	220	$46.5 million
#2: Hamlet of Honeoye, Town of Richmond, Ontario County, New York	100	$18.6 million
Mill Creek, Town of Richmond, Ontario County, New York	28	$6.2 million
Total	**348**	**$71.3 million**

Due to the variable nature of buyout programs, no ROM cost estimate was produced for this study. It is recommended that any buyout program begin with a cost-benefit analysis for each property. After a substantial benefit has been established, a buyout strategy study should be developed that focuses on properties closest to Honeoye Creek in the highest-risk flood areas and progresses outwards from there to maximize flood damage reductions. In addition, structures located adjacent to flood prone infrastructure (i.e., bridges, culverts, etc.) should also be considered high-risk and prioritized in any buyout program strategy. A potential negative consequence of buyout programs is the permanent removal of properties from the floodplain, and resulting tax revenue, which would have long-term implications for local governments and should be considered prior to implementing a buyout program.

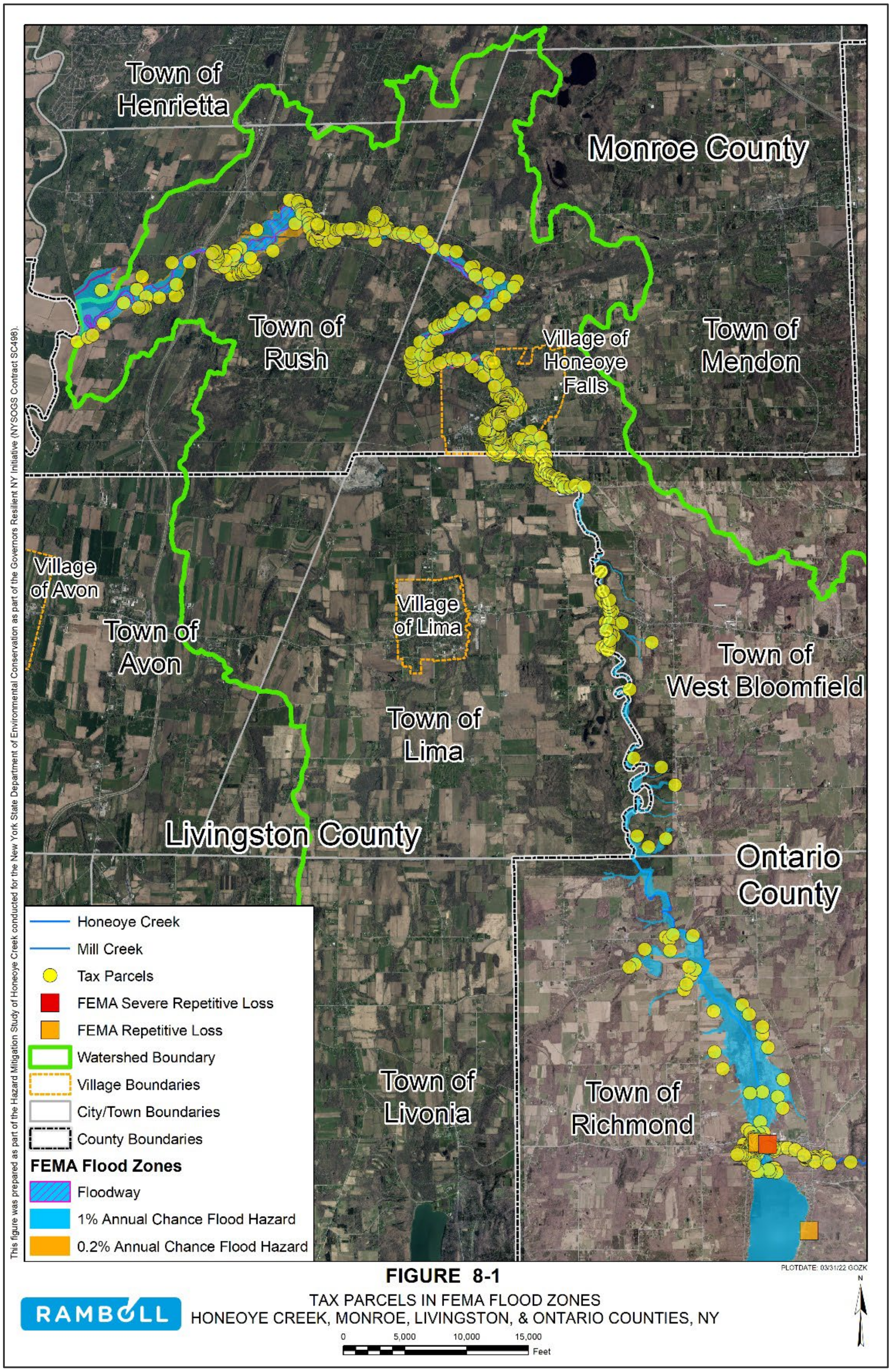


Figure 8-1. Tax parcels within FEMA flood zones, Honeoye Creek, Monroe, Livingston, and Ontario Counties, NY.

8.7 ALTERNATIVE #4-7: FLOODPROOFING

Floodproofing is defined as any combination of structural or nonstructural adjustments, changes, or actions that reduce or eliminate flood damage to a building, contents, and attendant utilities and equipment (FEMA 2000). Floodproofing can prevent damage to existing buildings and can be used to meet compliance requirements for new construction of residential and non-residential buildings.

The most effective flood mitigation methods are relocation (i.e., moving a home to higher ground outside of a high-risk flood area) and elevation (i.e., raising the entire structure above BFE). The relationship between the BFE and a structure's elevation is one of many factors in determining the flood insurance premium. Buildings that are situated at or above the level of the BFE have lower flood risk than buildings below BFE and tend to have lower insurance premiums than buildings situated below the BFE (FEMA 2015b).

In some communities, where non-structural flood mitigation alternatives are not feasible, structural alternatives such as flood proofing may be a viable alternative. The National Flood Insurance Program has specific rules related to flood proofing for residential and non-residential structures. These can be found in the Code of Federal Regulations (CFR) 44 CFR 60.3 (FEMA 2000).

For communities that have been provided an exception by FEMA, the CFR allows for the floodproofing of residential basements as outlined in 44 CFR 60.6 (c) “a permit can be obtained to floodproof a residential building basement, if it can demonstrate an adequate warning time under a flood depth less than 5 feet and a velocity less than 5 fps.” Floodproofing residential basements should be considered during the design phase of a structure prior to construction. For existing structures, floodproofing residential basements can be a difficult, complex, and expensive measure to achieve. Instead, residential structures should be raised above the BFE in accordance with local regulations. Floodproofing is allowed for non-residential structures, with design guidelines outlined in FEMA P-936 – Floodproofing Non-Residential Structures (FEMA 2000; FEMA 2013). The local floodplain administrator should carefully review local ordinances, the CFR and available design guidelines before issuing a permit for structural flood proofing. Floodproofing strategies include:

Interior Modification/Retrofit Measures

Interior modification and retrofitting involve making changes to an existing building to protect it from flood damage. When the mitigation is properly completed in accordance with NFIP floodplain management requirements, interior modification/retrofit measures could achieve the somewhat similar results as elevating a home above the BFE. Keep in mind, in areas where expected base flood depths are high, the flood protection techniques below may not provide protection on their own to the BFE or, where applicable, the locally required freeboard elevation (FEMA 2015b).

Examples include:

- *Basement Infill:* This measure involves filling a basement located below the BFE to grade (ground level).
- *Abandon Lowest Floor:* This measure involves abandoning the lowest floor of a two or more story slab-on-grade residential building.
- *Elevate Lowest Interior Floor:* This measure involves elevating the lowest interior floor within a residential building with high ceilings.

Dry floodproofing

A combination of measures that results in a structure, including the attendant utilities and equipment, being watertight with all elements substantially impermeable to the entrance of floodwater and with structural components having the capacity to resist flood loads (FEMA 2015b).

Although NFIP regulations require non-residential buildings to be watertight and protected only to the BFE for floodplain management purposes (to meet NFIP regulations), protection to a higher level is necessary for dry floodproofing measures to be considered for NFIP flood insurance rating purposes. Because of the additional risk associated with dry floodproofed buildings, to receive an insurance rating based on 1% ACE (100-yr) flood protection, a building must be dry floodproofed to an elevation at least 1 ft above the BFE (FEMA 2013).

In New York State, only non-residential buildings are allowed to be dry floodproofed and the building must be dry floodproofed to an elevation of at least 2 ft above the BFE. New York State has higher freeboard standards than federal regulations at 44 CFR Part 60.3. Care must be taken to check the NYS Building Code for more stringent guidelines.

Examples include:

- *Passive Dry Floodproofing System*: This measure involves installing a passive (works automatically without human assistance) dry floodproofing system around a home to protect the building from flood damage.
- *Elevation*: This measure involves raising an entire residential or non-residential building structure above BFE.

Wet floodproofing

The use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a structure, which is intentionally allowed to flood (FEMA 2015b).

Examples include:

- *Flood Openings*: This measure involves installing openings in foundation and enclosure walls located below the BFE that allow automatic entry and exit of floodwaters to prevent collapse from the pressures of standing water.

- *Elevate Building Utilities*: This measure involves elevating all building utility systems and associated equipment (e.g., furnaces, septic tanks, and electric and gas meters) to protect utilities from damage or loss of function from flooding.
- *Floodproof Building Utilities*: This measure involves floodproofing all building utility systems and associated equipment to protect it from damage or loss of function from flooding.
- *Flood Damage-Resistant Materials*: This measure involves the use of flood damage-resistant materials such as non-paper-faced gypsum board and terrazzo tile flooring for building materials and furnishings located below the BFE to reduce structural and nonstructural damage and post-flood event cleanup.

Barrier Measures

Barriers, such as floodwalls and levees, can be built around single or multiple residential and non-residential buildings to contain or control floodwaters (FEMA 2015b). Although floodwalls or levees can be used to keep floodwaters away from buildings, implementing these measures will not affect a building's flood insurance rating unless the flood control structure is accredited in accordance with NFIP requirements (44 CFR §65.10) and provides protection from at least the 1% ACE (100-yr) flood. Furthermore, floodwalls or levees as a retrofit measure will not bring the building into compliance with NFIP requirements for Substantial Improvement/Damage (FEMA 2013). Barrier measures require ongoing maintenance (i.e., mowing, etc.) which should be factored into any cost analysis. In addition, barrier measures tend to create a false sense of security for the property owners and residents that are protected by them. If a barrier structure is not properly constructed or maintained and fails, catastrophic damages to surrounding areas can occur.

- *Floodwall with Gates and Floodwall without Gates*: These two measures involve installing a reinforced concrete floodwall, which works automatically without human assistance, constructed to a maximum of four feet above grade (ground level). The floodwall with gates is built with passive flood gates that are designed to open or close automatically due to the hydrostatic pressure caused by the floodwater. The floodwall without gates is built using vehicle ramps or pedestrian stairs to avoid the need for passive flood gates.
- *Levee with Gates and Levee without Gates*: These two measures involve installing an earthen levee around a home, which works automatically without human assistance, with a clay or concrete core constructed to a maximum of six feet above grade (ground level). The levee with gates is built with passive flood gates that are designed to open or close automatically due to hydrostatic pressure caused by the floodwater. The levee without gates is built using vehicle access ramps to avoid the need for passive flood gates.

Modifying a residential or non-residential building to protect it from flood damage requires extreme care, will require permits, and may also require complex, engineered designs. Therefore, the following process is recommended to ensure proper and timely completing of any floodproofing project (FEMA 2015b):

- Consult a registered design professional (i.e., architect or engineer) who is qualified to deal with the specifics of a flood mitigation project
- Check your community's floodplain management ordinances
- Contact your insurance agent to find out how your flood insurance premium may be affected
- Check what financial assistance might be available
- Hire a qualified contractor
- Contact the local building department to learn about development and permit requirements, and to obtain a building permit
- Determine whether the mitigation project will trigger a Substantial Improvement declaration
- See the project through to completion
- Obtain an elevation certificate and an engineering certificate (if necessary)

No cost estimates were prepared for this alternative due to the variable and case-by-case nature of the flood mitigation strategy. Local municipal leaders should contact residential and non-residential building owners that are currently at a high flood risk to inform them about floodproofing measures, the recommended process to complete a floodproofing project, and the associated costs and benefits.

8.8 ALTERNATIVE #4-8: AREA PRESERVATION/FLOODPLAIN ORDINANCES

This alternative proposes municipalities within the Honeoye Creek watershed consider watershed and floodplain management practices such as preservation and/or conservation of areas along with land use ordinances that could minimize future development of sensitive areas such as wetlands, forests, riparian areas, and other open spaces. It could also include areas in the floodplain that are currently free from development and providing floodplain storage.

A watershed approach to planning and management is an important part of water protection and restoration efforts. New York State's watersheds are the basis for management, monitoring, and assessment activities. The NYS Open Space Conservation Plan, NYSDEC Smart Growth initiative and the Climate Smart Communities (CSC) Program address land use within a watershed (NYSDEC 2014). Land use planning should be incorporated into a municipalities comprehensive plan or, if a comprehensive plan does not exist, passed as a series of ordinances that consider more restrictive floodplain development regulations besides the New York State minimum requirements.

Natural floodplains provide flood risk reduction benefits by slowing runoff and storing flood water. They also provide other benefits of considerable economic, social, and environmental value that should be considered in local land-use decisions. Floodplains frequently contain wetlands and other important ecological areas which directly affect the quality of the local environment. Floodplain management is the operation of a community program of preventive and corrective measures to reduce the risk of current and future flooding, resulting in a more resilient community. These measures take a variety of forms, are carried out by multiple stakeholders with a vested interest in responsible floodplain management, and generally include requirements for zoning, subdivision or building, building codes, and special-purpose floodplain ordinances. While FEMA has minimum floodplain management standards for communities participating in the National Flood Insurance Program, best practices demonstrate the adoption of higher standards which will lead to safer, stronger, and more resilient communities (FEMA 2006).

For floodplain ordinances, the NYSDEC has a sample of regulatory requirements for floodplain management that a community can adopt within their local flood damage prevention ordinance. If a community is interested in updating their local law to include regulatory language promoting floodplain management, it is recommended that they reach out to the NYSDEC for more information.

In addition, the Community Rating System (CRS) program through FEMA is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Participating communities are able to get discounted rates on the flood insurance premiums for residents in the community. Adopting these enhanced requirements and preserving open space for floodplain storage earns points in the CRS program, which can lead to discounted flood insurance premiums.

Further hydrology and hydraulic model scenarios could be performed to illustrate how future watershed and floodplain management techniques could benefit the communities within the Honeoye Creek watershed.

8.9 ALTERNATIVE #4-9: COMMUNITY FLOOD AWARENESS AND PREPAREDNESS PROGRAMS/EDUCATION

Disaster resilience encompasses both the principles of preparedness and reaction within the dynamic systems, and focuses responses on bridging the gap between pre-disaster activities and post-disaster intervention, and among structural/non-structural mitigation. Integral to these concepts is the role of the community itself, and how the community adapts to being prepared for disasters and, ultimately, how the community takes on the effort of disaster risk reduction. By consulting the community at risk, the local stakeholder concerns can be taken into consideration, and thus be addressed accordingly in the post-disaster recovery stage (Nifa et al. 2017).

Community flood awareness programs should focus on a multi-scale, holistic strategy of preparedness and resilience, and in this way attempt to achieve a substantial reduction of disaster losses, in lives, and in the social, economic, and environmental assets of the community. This approach should incorporate four functions of flood education (Dufty 2008):

1. Preparedness conversion: learning related to commencing and maintaining preparations for flooding.
2. Mitigation behaviors: learning and putting into practice the appropriate actions for before, during and after a flood.