Local Flood Analysis

Town of Hamden along the West Branch
of the Delaware River
Delaware County, New York
August 2017

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Delaware County, New York
August 2017

Prepared for:
The Town of Hamden through
the Stream Program of the Delaware
County Soil and
Water Conservation District
Hamden Town Hall
Hamden, New York 13782

MMI #5197-08-06

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ABBREVIATIONS/ACRONYMS

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
CFS	Cubic Feet per Second
CWC	Catskill Watershed Corporation
CDBG	Community Development Block Grant
DCSWCD	Delaware County Soil and Water Conservation District
DEMs	Digital Elevation Models
EWP	Emergency Watershed Protection Program
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPMS	Floodplain Management Services Program
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
LFA	Local Flood Analysis
MMI	Milone & MacBroom, Inc.
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NRCS	Natural Resource Conservation Service
NYCDEP	New York City Department of Environmental Protection
NYCFFBO	New York City Funded Flood Buyout Program
NYSDEC	New York State Department of Environmental Conservation
NYSEG	New York State Electric and Gas
PDM	Pre-Disaster Mitigation
RFC	Repetitive Flood Claims
SRL	Severe Repetitive Loss
SFHA	Special Flood Hazard Area
SCMP	Stream Corridor Management Plan
SMIP-FHM	Stream Management Implementation Program Flood Hazard Mitigation
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WOH	West of Hudson
WSEL	Water Surface Elevation

EXECUTIVE SUMMARY

The Town of Hamden has retained Milone & MacBroom, Inc. (MMI) to complete a Local Flood Analysis (LFA) in the town of Hamden, New York. The LFA evaluates flood risks and assesses potential mitigation measures aimed at reducing flood inundation and the associated damages and water quality impairment that may occur due to floods. The LFA is a program within the New York City water supply watershed initiated following Tropical Storm Irene to help communities identify long-term, cost-effective projects to mitigate flood hazards.

The LFA study area focuses on two hamlets located within the town of Hamden: Hamden and Delancey. The West Branch of the Delaware River is the primary source of flooding within the study area although flooding also occurs along tributaries to the West Branch, including Covert Hollow, Launt Hollow, Chambers Hollow, and Bagley Creek. As part of its scope of services for the Hamden LFA, MMI set up and ran hydraulic models for the purposes of evaluating flood risk and developing flood mitigation recommendations.

The hamlets of Hamden and Delancey have experienced repeated damages from flooding, with significant floods occurring in 2011, 2006, 2005, and 1996. Properties or infrastructure located within the floodplain are at risk from inundation during flood events. Fortunately, the bulk of development has not occurred directly in floodplains. Hydraulic modeling and information collected from Hamden residents and business owners indicates that consistent flooding has been limited to a few areas. These include the following:

- The lower extent of Mill Street and Mill Street Spur
- Launt Hollow from State Route 10 to the confluence with the West Branch of the Delaware River
- Chambers Hollow from State Route 10 to the confluence with the West Branch of the Delaware River

Flooding does occur in other places along the West Branch of the Delaware River. However, it tends to affect a series of separate properties that are not in close proximity to one another. Given the distance between properties that are regularly flooded, an engineering-based solution would benefit only a few properties at most and would therefore not be cost effective. Additionally, much of the land adjacent to the West Branch of the Delaware River and its tributaries is productive, high-value agricultural land. It is not economically feasible to remove this land from production for a flood mitigation project that would have little benefit. As a result, acquisition of properties or moving properties out of floodprone areas is the most cost effective and practical method of reducing damages caused by flooding.

The following is a summary of the recommendations contained in this LFA report:

- Riparian Buffers – Many of the agricultural fields along the watercourses within the study area extend very close to the stream channel leaving little to no riparian buffer. Stream bank instability and erosion have been noted in these areas, particularly along the West Branch of the Delaware River. The establishment of riparian buffers is recommended to help prevent the loss of agricultural area due to bank erosion and mitigate agricultural runoff into neighboring waterbodies.

- Monitor and Repair Bank Erosion and Channel Instability – Bank erosion is an ongoing problem along the West Branch and its tributaries. It is recommended that the town work cooperatively with the Delaware County Soil and Water Conservation District (DCSWCD) to conduct a watershed assessment of Bagley Brook, which will evaluate the problems of channel instability and sediment contribution to the West Branch, and to conduct a stream feature inventory and assess the need for bank stabilization measures along the tributaries flowing under Route 10 and entering the West Branch of the Delaware River.

- The Delaware County Fire Training Facility is a critical facility in the town of Hamden. It is located partially within the 100-year floodplain. Access to critical vehicles and equipment may be impaired during flood events. MMI recommends that critical equipment be moved to a location where it can easily be retrieved during a flood event and that any structures at the facility that will continue to be utilized for equipment storage be wet floodproofed.

- Flooding of Bridge Approaches – Flooding over bridge approach roadways has been reported at the County Route 2, Basin Clove Road, and County Route 26 bridges over the West Branch of the Delaware River. It is recommended that risks associated with the flooding of these roadways be reduced by temporarily closing them during flooding events. This requires effective signage, road closure barriers, and consideration of alternative routes. It is also recommended that when these bridges are due for replacement they be evaluated and designed to ensure that flooding does not overtop the approaches to the bridges at these locations.

- Emergency Access across Bridges – The roadway approaches to the County Route 2, Basin Clove Road, and County Route 26 bridges over the West Branch of the Delaware River are inundated during the 10-year event flood event. As a result, it may not be possible for emergency responders to access residents on the east side of the West Branch of the Delaware River, where there are approximately 77 homes within the extent of the project area. MMI recommends that emergency response vehicles and equipment be stationed on both sides of the West Branch of the Delaware River.

- Water Quality Recommendations – In order to protect water quality during flood events, MMI recommends the following:

    - Propane, oil, and other fuel tanks should be securely anchored.
    - Equipment that has the potential to be washed away in a flood (generators, snowmobiles, all-terrain vehicles (ATVs), construction equipment, etc.) should be securely anchored, housed in a shed/garage, or stored outside of the 100-year flood boundary.
    - Fueling facilities should be securely anchored and raised or protected with a barrier to prevent contact with floodwaters (i.e., fueling facilities at the Delaware County Arc).
    - Equipment at the New York State Electric and Gas (NYSEG) facility along Chambers Hollow (transformers, telephone poles, etc.) should be stored to prevent contact with floodwaters.

- Buyouts and Relocations – Two specific properties in Hamden are recommendations for buyout. If these properties were to be acquired and the structures removed, the sites should be considered for floodplain restoration.

  - 37784 State Highway 10 (Green Thumb Nursery)
  - 166 County Highway 2 (Bell property)

- Individual Property Flood Protection – A variety of measures are available to protect existing public and private properties from flood damage. In areas where properties are vulnerable to flooding, improvements to individual properties and structures may be appropriate. All practices to protect property within a floodplain must comply with local flood law and obtain the approval of the town floodplain administrator or code enforcement officer. Potential measures for property protection are detailed in this report.

- Bridge Opening Maintenance – Bridge openings that are even partially blocked have the potential to cause flooding due to backwater effects. MMI recommends that bridges on the tributaries to the West Branch of the Delaware River be periodically inspected to verify that they have not lost capacity. This report provides recommendations for when maintenance actions should be taken to clear bridge openings on Bagley Brook, Launt Hollow, and Chambers Hollow. When removal of sediment at bridges is necessary, a methodology should be developed to maintain the proper channel dimensions and slope. This is crucial to avoid destabilizing the physical channel, which could have long-term effects.

- Measuring Discharge and Stage on the West Branch – It is recommended that the United States Geological Survey (USGS) gauges on the West Branch in Walton and upstream of Delhi be used by town officials, emergency responders, and Hamden residents as an alert system to predict flooding. It is recommended that the town work with New York City Department of Environmental Protection (NYCDEP) and USGS to explore the possibility of the installation of a stream gauge on the West Branch in Hamden.

Potential sources of funding for project implementation are included in this report. As the recommendations of this LFA are implemented, the Hamden Flood Commission and Town of Hamden will need to work closely with potential funders to ensure that the best combinations of funds are secured.

1.0 INTRODUCTION

1.1 Project Background

The Town of Hamden, utilizing stream management funding provided by the New York City Department of Environmental Protection (NYCDEP) and administered by the Delaware County Soil and Water Conservation District (DCSWCD), has retained Milone & MacBroom, Inc. (MMI) to complete a Local Flood Analysis (LFA) in the town of Hamden, New York. The town is situated in the southwestern area of the Catskill Mountains along the West Branch of the Delaware River. The LFA builds on existing Federal Emergency Management Agency (FEMA) hydraulic models to evaluate vulnerability to flooding in the hamlets of Hamden and Delancey.

The LFA is a program within the New York City water supply watershed initiated following Tropical Storm Irene. The purposes of the program are to help communities identify and mitigate flood hazards as well as protect water quality in the Delaware River watershed of the New York City water supply watershed. In summary, the LFA is an engineering feasibility analysis that seeks to develop a range of hazard mitigation alternatives with the primary focus of identifying options to reduce flood elevations and the costs of damages associated with inundation. The DCSWCD is the lead agency responsible for implementing the LFA program throughout the Delaware River watershed communities.

The LFA is the first step of a larger Flood Hazard Mitigation Program. The purpose of the LFA is to identify flood hazards and mitigation options for the community to implement with potential funding assistance from NYCDEP, Catskill Watershed Corporation (CWC), and DCSWCD.

1.2 Study Area

The study area of the LFA coincides with the main population centers of the town, which are the hamlets of Hamden and Delancey. The study is focused on the West Branch of the Delaware River. The river's headwaters are located in Schoharie County. After entering Delaware County, the river flows in a southwesterly direction before entering the Cannonsville Reservoir, a drinking water supply source to the New York City public water system. The study area also includes Covert Hollow, Launt Hollow, and Chambers Hollow, all of which pass under State Highway 10, and Bagley Brook, which flows through the hamlet of Delancey. Figure 1-1 to the right depicts the West Branch and the East Branch relative to Delaware County and adjacent counties. The town of Hamden is indicated by the red dot.

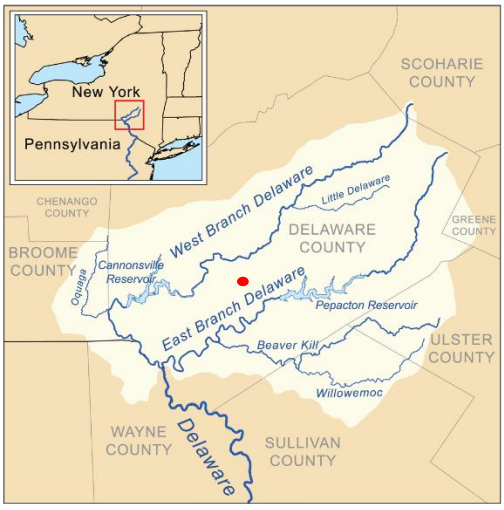


Figure 1-1: East Branch and West Branch Delaware River Watershed

The study area extends almost 4.4 stream miles along the West Branch of the Delaware River through the hamlets of Hamden and Delancey. The upstream boundary is located 0.64 miles upstream of County Route 2 while the downstream boundary is located 0.26 miles upstream of County Route 6. The project

area also extends 500 feet above the State Route 10 crossings of Covert Hollow, Launt Hollow, and Chambers Hollow. Additionally, it extends up Bagley Creek a distance of approximately 1 mile. Figure 1-2 is a location plan of the project area.

1.3 Community Involvement

During the completion of this LFA, MMI worked closely with the Hamden Flood Commission (the Commission). The Hamden Flood Commission is the primary pathway for community involvement in the LFA process. The Commission is composed of Town of Hamden community members, business owners, and elected officials as well as representatives from DCSWCD, CWC, Delaware County, and NYCDEP. Commission members helped MMI understand flood damages and impacts, considered flood mitigation alternatives, and provided financial information for the benefit-cost analysis. The Commission will continue to play an important role as the flood mitigation recommendations in this LFA are implemented.

A public meeting was convened in Hamden on May 5, 2016, to introduce the LFA process to members of the community and to solicit information regarding flooding and flood damages within the town of Hamden. A follow-up public meeting will be held at the conclusion of the study.

Table 1-1 lists the members of the Commission.

TABLE 1-1
Hamden Flood Commission Members

Committee Member	Affiliation
Wayne Marshfield	Hamden Town Supervisor
Richard Smith	Flood Commission Chair and Town Board Member
Bruce Salton	Hamden Property Owner
Roger Dibble	Hamden Highway Supervisor
Mark Jacobs	Hamden Code Enforcer and Floodplain Manager
Thomas Donnelly	Hamden Property Owner and Farmer
Graydon Dutcher	Delaware County Soil & Water Conservation District
Jessica Rall	Delaware County Soil & Water Conservation District
Phil Eskeli	New York City Department of Environmental Protection
Nate Hendricks	New York City Department of Environmental Protection
John Mathiesen	Catskill Watershed Corporation
Dean Frazier	Delaware County Watershed Affairs
Molly Oliver	Delaware County Watershed Affairs
Everett Farrell	Delaware County Planning Department

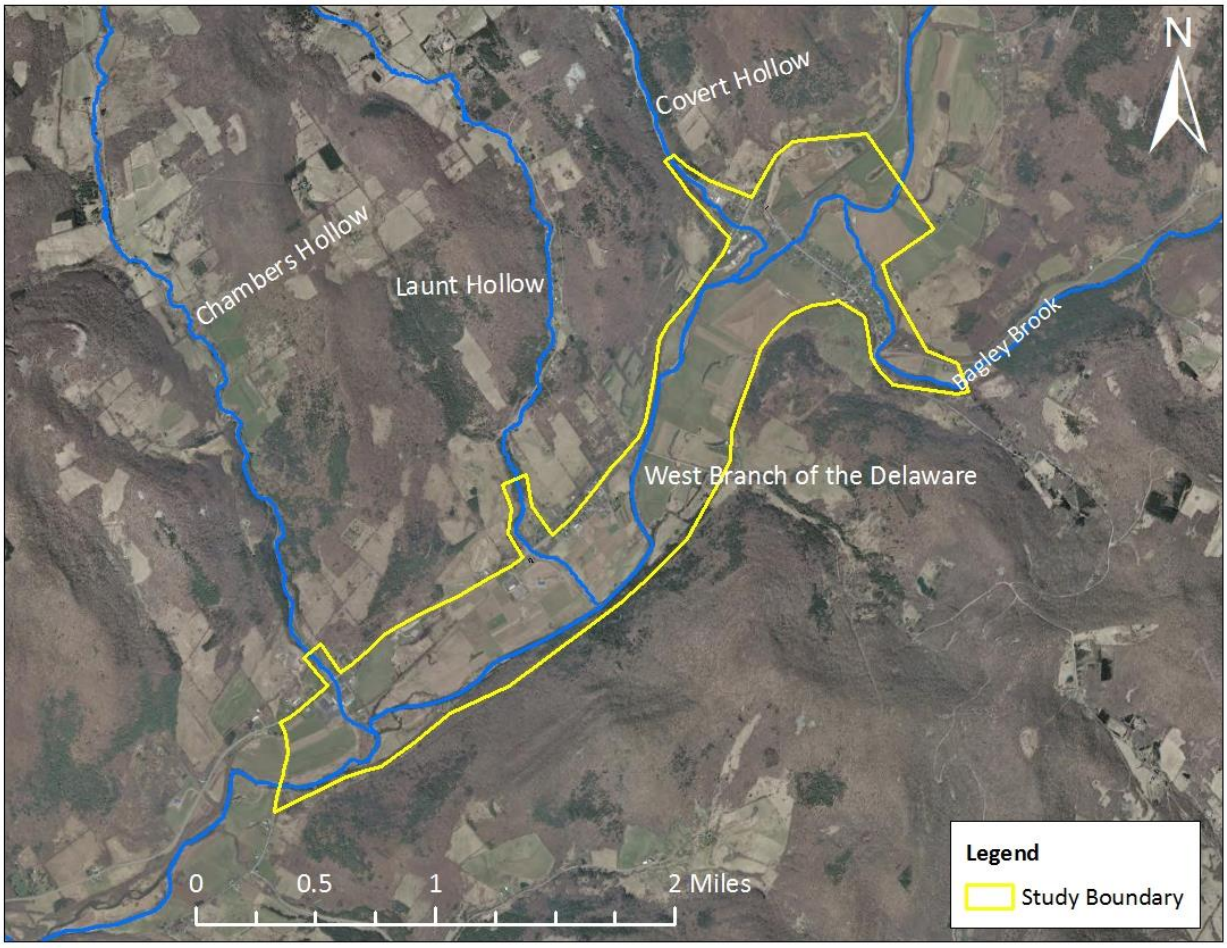


Figure 1-2: Hamden LFA Study Area

1.4 Nomenclature

In order to have a common standard, FEMA's National Flood Insurance Program (NFIP) has adopted a baseline probability called the base flood. The base flood has a 1 percent (one in 100) chance of occurring in any given year. For the purpose of this report, the 1 percent annual chance flood is referred to as the ***100-year flood event***. Other reoccurrence probabilities used in this report include the ***2-year flood event*** (50 percent annual chance flood), the ***10-year flood event*** (10 percent annual chance flood), the ***25-year flood event*** (4 percent annual chance flood), the ***50-year flood event*** (2 percent annual chance flood), and the ***500-year flood event*** (0.2 percent annual chance flood).

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.

Figure 1-3 depicts the FEMA-designated 100-year and 500-year flood zones for the Hamden LFA project area. Figure 1-4 shows the flood zones in more detail for the upper portion of the project area while Figure 1-5 shows the lower portion of the project area.

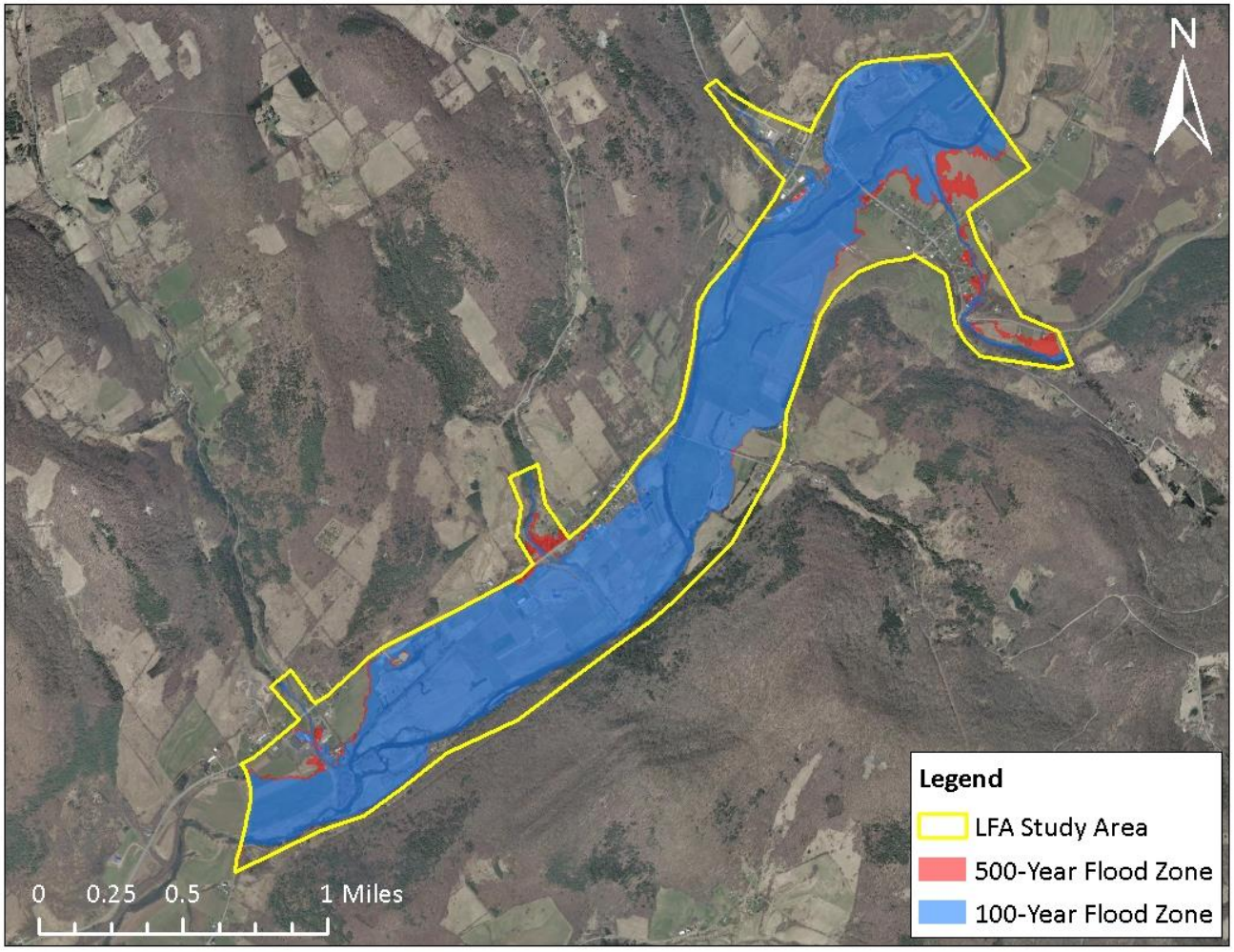


Figure 1-3: FEMA 100- and 500-Year Flood Zones – Hamden

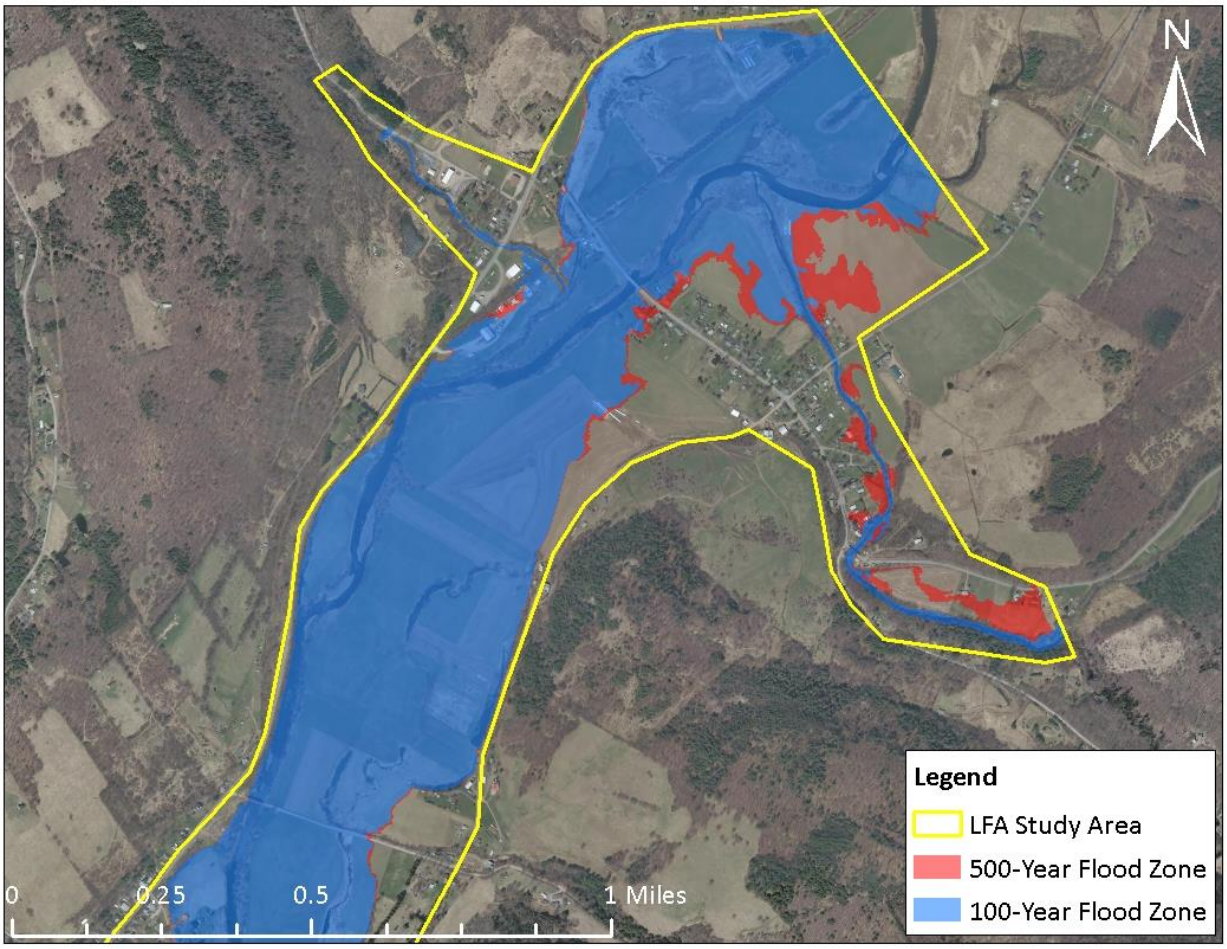


Figure 1-4: FEMA 100- and 500-Year Flood Zones – Upper Project Area

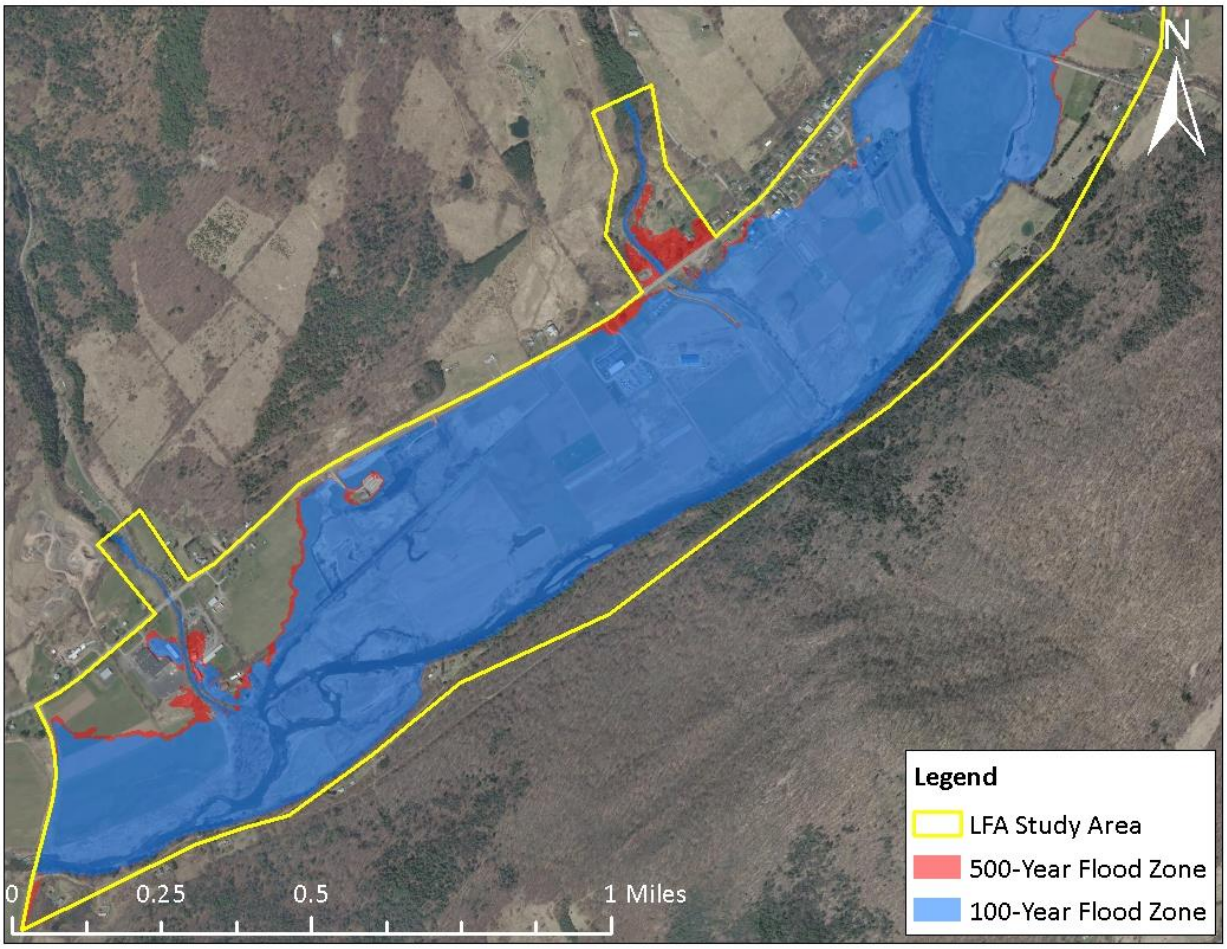


Figure 1-5: FEMA 100- and 500-Year Flood Zones – Lower Project Area

2.0 WATERSHED INFORMATION

2.1 Initial Data Collection

Initial data collected for this study and analysis included publicly available data including the FEMA Flood Insurance Study (FIS) and the 2006 West Branch of the Delaware River Stream Corridor Management Plan (SCMP), which was prepared by DCSWCD. A brief summary of key documents follows.

Flood Insurance Study

Effective June 16, 2016, FEMA published a revised FIS for Delaware County, New York. The study includes the West Branch of the Delaware River, Bagley Creek, Launt Hollow, and Chambers Hollow but does not include an analysis of Covert Hollow. The purpose of the FEMA study was to determine potential floodwater elevations and delineate existing floodplains in order to identify flood hazards and establish insurance rates. The information in this report will be used by communities in Delaware County to update existing flood regulations to comply with the NFIP. Additionally, it will be used by local planners to promote prudent land use and floodplain development.

FEMA's revised hydraulic analysis and flood elevation profiles included in the June 2016 FIS were completed in 2013 using elevation and base map information collected in 2009. An important byproduct of the FIS is a Hydrologic Engineering Center *River Analysis System* (HEC-RAS) computer model that is available for professional use and a key component of the subject study. An additional product of the FIS is Flood Insurance Rate Maps (FIRMs), which illustrate areas flooded during the 100-year frequency event. The area predicted to be flooded during the 100-year frequency event is known as the special flood hazard area (SFHA).

Stream Management Plan

A detailed description of the West Branch of the Delaware River watershed is contained in the 2006 West Branch of the Delaware River SCMP prepared by DCSWCD with the assistance of NYCDEP. The report presents information on the geology, hydrology, flood history, vegetation, land use, fisheries and wildlife, recreation, and water quality. The SCMP also includes an inventory of five stream segments, which are divided into smaller management units. The stability of management units is assessed on site-specific conditions identified during field inspections. A digital copy of the West Branch of the Delaware River SCMP is available online at http://www.dcswcd.org/Watershed%20Plans.htm.

United States Geological Survey (USGS) Stream Gauging Network

The USGS operates and maintains stream flow gauges in the West Branch of the Delaware River watershed. The gauges record daily stream flow, including flood flows that are essential to understanding long-term runoff trends. Gauge data can be utilized to determine flood magnitudes and frequencies. Additionally, real-time data is available to monitor water levels and provide flood alerts. Stream flow data and water levels are available for the West Branch of the Delaware River at http://maps.waterdata.usgs.gov/mapper/index.html.

Multi-Jurisdictional Hazard Mitigation Plan

The 2013 Delaware County Multi-Jurisdictional Hazard Mitigation Plan (HMP) Update provides a concise summary of the natural hazards that could adversely affect the town of Hamden. The report ranks flooding as the number one hazard with "frequent" probability of occurrence. Furthermore, it estimates potential monetary losses of $3,124,000 and $3,514,000 due to structural damages caused by the 100-year and 500-year discharges, respectively. The plan proposes numerous initiatives to mitigate damages caused by flooding. The following initiatives are dependent on available funding that may be modified or omitted based on future hazards of changes in municipal priorities:

- Upsize culverts as they come up for repair or replacement.
- Where appropriate, support retrofitting of structures located in hazard-prone areas to protect structures from future damage, with repetitive loss and severe repetitive loss properties as priority. Identify viable candidates for retrofitting based on cost effectiveness versus relocation. Where retrofitting is determined to be a viable option, consider implementation of that action based on available funding.
- Where appropriate, support purchase or relocation of structures located in hazard-prone areas to protect structures from future damage, with repetitive loss and severe repetitive loss properties as priority. Identify viable candidates for relocation based on cost effectiveness versus retrofitting. Where relocation is determined to be a viable option, consider implementation of that action based on available funding.
- Support flood risk mapping (FIS and FIRMs) and analysis in the Delaware River basin through the RiskMAP program.
- Strive to maintain compliance with and good standing in the NFIP.
- Designate a NFIP Floodplain Administrator who will maintain status as a Certified Floodplain Manager.
- Support county- and state-level programs to support risk assessment efforts.
- Create/enhance/maintain mutual aid agreements with neighboring communities.
- Train municipal officials, staff, and first responders to participate in disaster response efforts.
- Continue to support the implementation, monitoring, maintenance, and updating of the HMP.

The HMP suggests that a more detailed flood loss analysis should be conducted. The analysis should consider the location of buildings and their elevation relative to floodwater elevations estimated by hydraulic modeling. Additionally, property data and assessed or fair market values should be obtained in order to perform a benefit-cost analysis. A digital copy of the HMP may be obtained at http://delawarecountyplanningdept.com/hazard-mitigation/.

Water Quality Reports

The West Branch of the Delaware River is a Class B (T) waterbody suitable for bathing, general recreation, and support of aquatic life. The "T" designation signifies that it is a cold-water (trout) fishery. The river is not included in the 2016 New York State Section 303(d) List of Impaired/Total Maximum Daily Load (TMDL) Waters.

The Waterbody Inventory/Priorities Waterbodies list states that there are no known pollutants having an adverse impact on water quality, and biological testing suggests that the river reflects natural conditions with minimal human disturbance. However, the NYCDEP has entered into partnerships with local communities and nonprofit agencies to develop programs addressing agricultural and wastewater treatment plant nutrient delivery, floodplain restoration, and stream channel restoration.

The tributaries within the project are all categorized, in general, as Class C waterbodies, which are suitable for general recreation and support of aquatic life but not as water supply or for public bathing. At the upper end of the project area, Bagley Brook is classified as a C (TS) waterbody. The TS designation indicates a cold-water fishery suitable for spawning. Currently, this stream is considered to be unassessed although a macroinvertebrate sample taken in 1999 indicated nonimpacted water quality conditions.

Launt Hollow is classified as a C (T) stream, which designates a cold-water (trout) fishery. A biological screening conducted in 2009 found that the macroinvertebrate community was altered from what was expected under natural conditions. The screening also indicated excessive nutrients and other nonpoint source runoff. To date, the specific source of the pollutants has not been identified, and in spite of the minor impacts, aquatic life is considered fully supported. No impairments justify listing the stream, and it is not included on the 2016 New York State Section 303(d) List of Impaired/TMDL Waters.

Chambers Hollow has no known impacts based on sampling conducted on a nearby stream in 2015. The biological sampling conducted by volunteers found nonimpacted conditions. As a result, aquatic life in Chambers Hollow is considered fully supported.

Covert Hollow is not included in the most current Waterbody Inventory/Priority Waterbodies list. However, based upon other tributaries in the project area, it is a Class C stream with little to no impacts and is supportive of aquatic organisms.

Flood Damage Prevention Codes

The Town of Hamden Flood Prevention Code was adopted on April 4, 2012. This code repeals and supersedes the prior codes that were adopted in 1987. The current code is consistent with FEMA floodplain guidance and regulations.

The stated purposes of this local law are to:

- Regulate uses that are dangerous to health, safety, and property due to water or erosion hazards, or that result in damaging increases in erosion or in flood heights or velocities

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

The stated objectives of the local law are as follows:

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

The Code Enforcement Officer or the Building Inspector is empowered as the Local Administrator for administering and implementing the Flood Damage Prevention local law. The primary responsibility of the Local Administrator is the granting or denying of floodplain development permits. The Local Administrator must conduct a thorough permit application review prior to approval and must make periodic inspections during the construction phase of a project after permit approval. Finally, upon completion of a project, the Local Administrator must issue a Certificate of Compliance stating that the project conforms to all requirements of the local law.

The local law identifies a series of Construction Standards for development in the floodplain, broken down into General Standards, Standards for All Structures, Residential Structures, Non-Residential Structures, and Manufactured Homes and Recreational Vehicles.

The General Standards section is broken down into standards for subdivision proposals and encroachments. All new subdivision proposals and other development proposed in a SFHA must be consistent with the need to minimize flood damage, minimize flood damage to utilities, and provide adequate drainage. When encroaching on zones A1-A30 and AE along streams without a regulatory floodway, development must not increase the base flood elevation by more than 1 foot. Along streams with a regulatory floodway, development must not create any increase in the base flood elevation. This guidance is consistent with FEMA regulations.

Standards for all structures include provisions for anchoring, construction materials and methods, and utilities. New structures must be anchored so as to prevent flotation, collapse, or lateral movement during the base flood. Construction materials must be resistant to flood damage, and construction methods must minimize flood damage. Enclosed areas below the lowest floor in zones A1-A30, AE, and AH, and in some cases Zone A, must be designed to allow for the entry and exit of floodwaters. Utility equipment such as electrical, HVAC, and plumbing connections must be located at a minimum of 2 feet above the base flood elevation. Water supply and sanitary sewage systems must be designed to minimize or eliminate the infiltration of floodwaters.

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

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

Recreational vehicles are only allowed in zones A1-A30, AE, and AH if they are on site fewer than 180 consecutive days and are licensed and ready for highway use or meet the construction standards for manufactured homes. Manufactured homes in the A1-A30, AE, and AH zones must be placed on a permanent foundation with the lowest floor elevated at or above 2 feet above the base flood elevation. In Zone A, such structures must be placed on reinforced piers or similar elements that are at least 3 feet above the base flood elevation. In all cases, manufactured homes must be securely anchored to resist flotation, collapse, and lateral movement.

2.2 Field Assessment

MMI staff conducted several visits to the town of Hamden over the course of the LFA. Field visits assessed potential flood risks along the West Branch of the Delaware River as well as the major tributaries in the study area. Special attention was given to bridges, roads, and municipal infrastructure including well heads, pump stations, and the wastewater treatment facility (WWTF). A photo log is included as Appendix B.

Following an initial analysis of floodprone properties and areas, a site visit was made to assess first floor elevations of properties located within the 500-year flood zone. MMI staff also met with Tina Mosier, the Town of Hamden Assessor, to acquire available real property data.

2.3 Watershed Land Use

The West Branch of the Delaware River rises in Schoharie County and flows over a distance of nearly 3 miles before crossing into Delaware County. It then flows along a southwesterly course through the

villages of Stamford, Hobart, and Delhi before reaching the town of Hamden. Within the town of Hamden, it passes through the hamlets of Delancey and Hamden. After leaving the town of Hamden, it flows through the village of Walton before entering Cannonsville Reservoir. The river exits the reservoir and flows in a southeast direction before joining with the East Branch of the Delaware River.

Although the total length of the river is approximately 90 miles, the length comprising the study area is about 4.4 miles. The contributing watershed area of the West Branch of the Delaware River relevant to the study area is 257 square miles. Figure 2-1 is a watershed map of the West Branch of the Delaware River as delineated for the Hamden LFA study area. Figure 2-2 is a watershed map of the West Branch of the Delaware River as delineated for the Cannonsville Reservoir, showing the villages of Delhi and Walton.

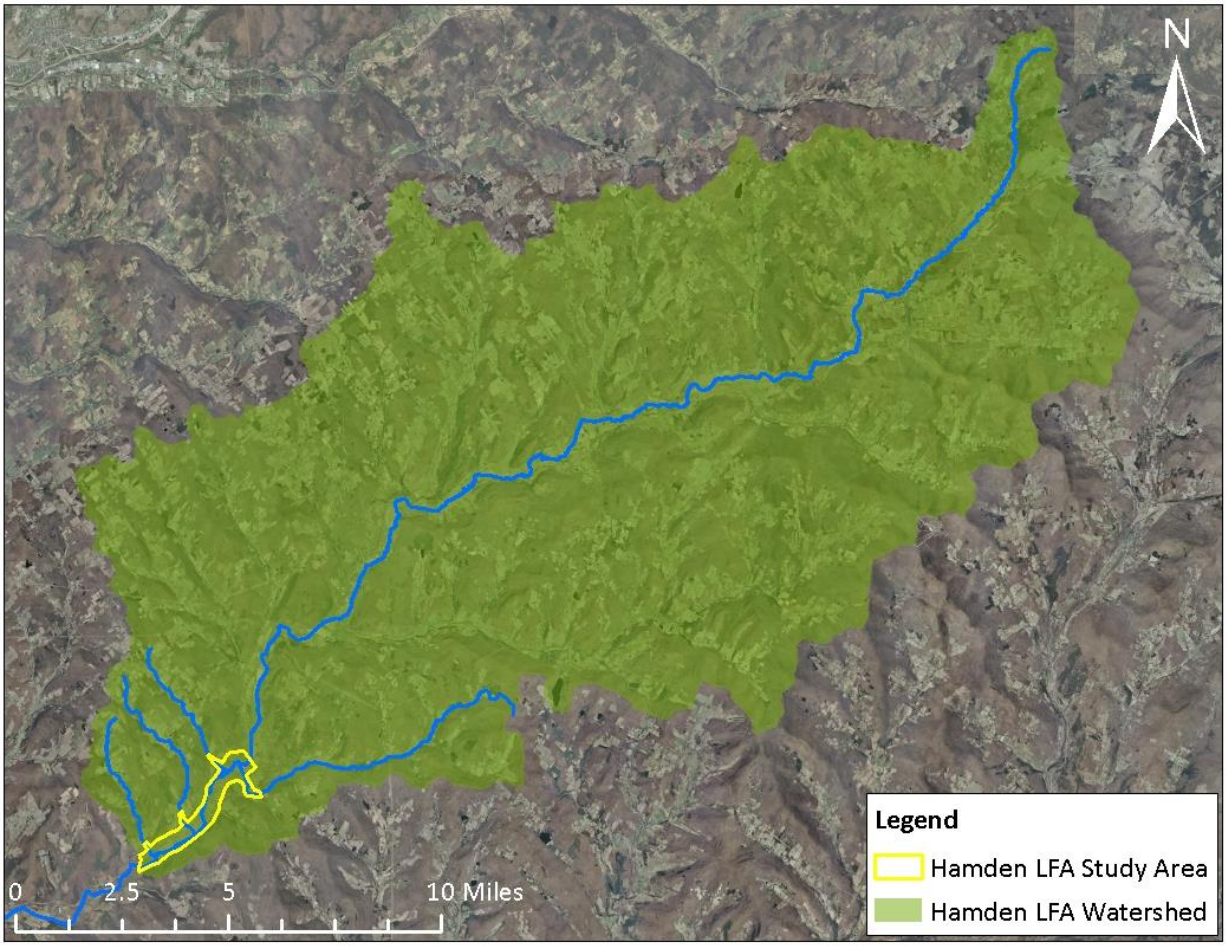


Figure 2-1: Effective Watershed for the West Branch of the Delaware River at Hamden

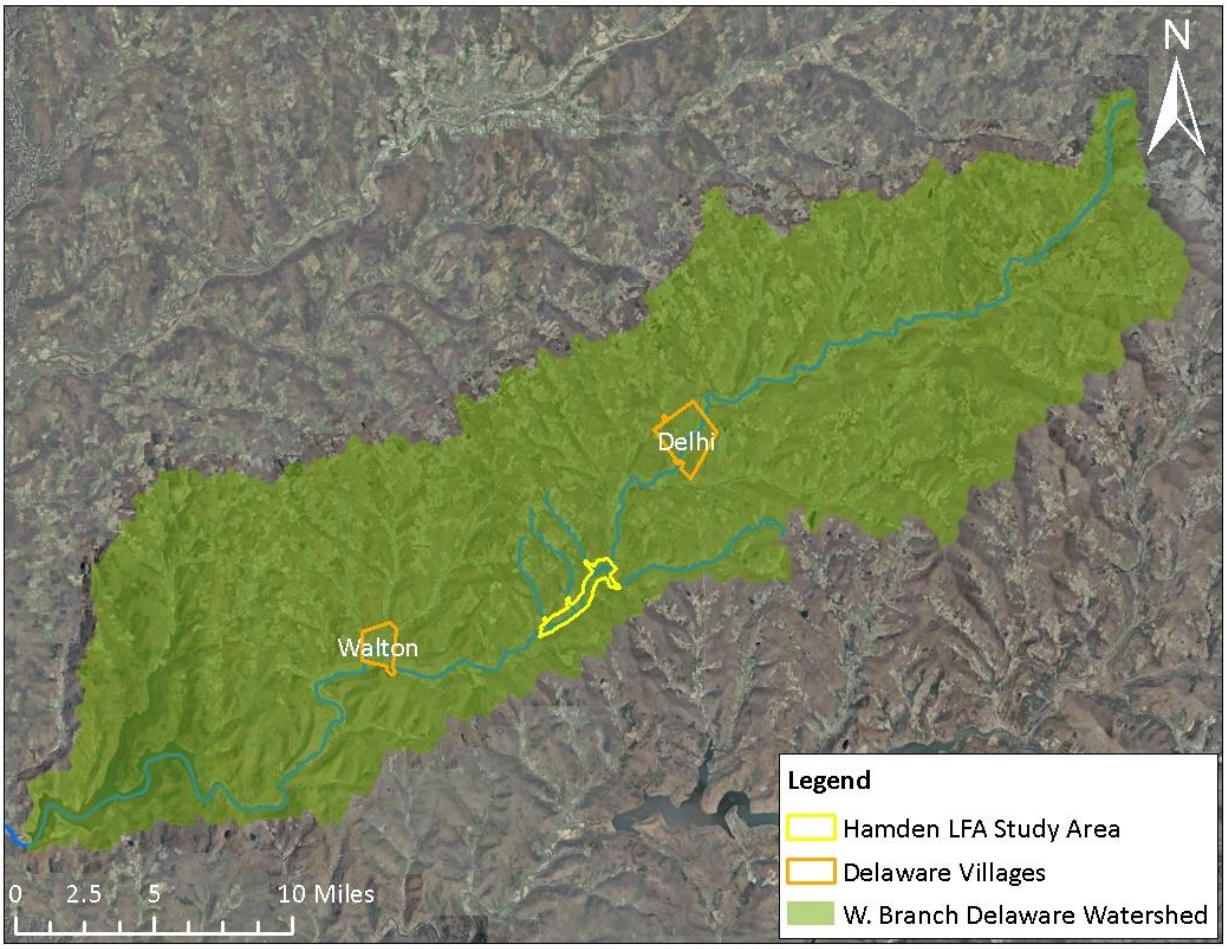


Figure 2-2: Effective Watershed for the West Branch of the Delaware River at Cannonsville Reservoir

The largest category of land use within the entire West Branch of the Delaware River watershed is forest, which makes up 68.8% of the total. The dominant cover type is deciduous tree forest although north-facing slopes are dominated by coniferous species. The next largest category is successional land, which comprises 11.3%. The cover type ranges from grass to a mixture of grass and shrubs. This category type is typically located along watercourses and adjacent hillslopes, indicating a transition from agricultural to new forest. This is a trend that has been in progress over the last several decades (DCSWCD, 2006).

Another major land use category is agricultural lands. This category type is 10.1 % of the total and is generally restricted to river valleys and areas with level topography. The cover types are made up of agricultural crops including grass, corn, and alfalfa (DCSWCD, 2006).

A relatively small but important land use is urban or built-up land. Within the basin, there are four villages and several hamlets, which are mainly located along the West Branch of the Delaware River and its main tributary valleys. This land use category is significant due to the impervious area in close proximity to waterbodies, which has the potential to be a significant source of pollutants if not properly managed (DCSWCD, 2006).

Along river valley corridors where most infrastructure and developed land is located, land use percentages are very different. Within 100 feet of the river, approximately 33% of the land is forested, 23% is agricultural, and 14% is successional (DCSWCD, 2006). Within the bounds of the LFA project area, Figure 1-1 clearly shows that agricultural land use is by far the most dominant.

Within the project area, the West Branch of the Delaware River parallels State Highway 10 on the right bank and Back River Road on the left bank. The river passes under bridges at County Route 2 and Basin Clove Road. Bagley Brook enters the West Branch of the Delaware River from the east, upstream of the hamlet of Delancey. Covert Hollow, Launt Hollow, and Chambers Hollow all enter the West Branch of the Delaware River from the north. The river meanders across the relatively broad valley and is predominately bordered by agricultural fields. The majority of infrastructure and development is focused along County Route 2 and State Highway 10.

2.4 Watershed and Stream Characteristics

The entire watershed of the West Branch of the Delaware River is 354 square miles with a northeast to southwest orientation. The watershed is characterized by mountainous terrain with numerous peaks above 2,000 feet in elevation. Elevations are higher on the east side of the basin with Mount Pisgah at 3,345 feet in elevation and Plattekill Mountain at over 3,340 feet. Ridge-top locations are higher in the northern part of the watershed, generally ranging between 2,200 and 2,300 feet. North-facing hillslopes tend to be steeper while south facing ones are characterized by gentler slopes. Especially above the Cannonsville Reservoir, the river flows down the center of the watershed. Tributaries lie in narrow valleys that intersect perpendicularly with the West Branch of the Delaware River valley (DCSWCD, 2006).

Sedimentary bedrock underlies all of Delaware County including the West Branch of the Delaware River basin. Thin soils cover this bedrock on hilltops with thicker deposits of glacial till occurring on downslope areas, especially on some south-facing hillslopes where accumulation can be over 60 feet thick. These glacial till deposits are coarse textured with a large percentage of gravel to boulder-size particles. Within the main stem and other tributary valleys, coarse lake-laid deposits occur, which are overlain with more recent floodplain deposits. The river itself flows through a relatively level surface of deep alluvial soils (DCSWCD, 2006).

The total length of the West Branch of the Delaware River from its source to the confluence with the East Branch is nearly 90 miles with an average slope of 0.58%. A Rosgen Level II analysis was conducted for the 2006 SCMP. The analysis determined that the vast majority of the river was a Rosgen Type C. This type of stream is characterized by a meandering channel with a riffle/pool morphology that is slightly entrenched with a well-developed floodplain. The analysis noted a trend toward aggradation combined with eroding banks, which were widespread throughout the river. An inspection of aerial imagery going back to 1938 revealed that the planform has been relatively stable since that time. However, there is some evidence that straightening and relocation of the channel was carried out prior to 1938 (DCSWCD, 2006).

2.5 Infrastructure

There are nine bridges in the study area that are critically important (Figure 2-3). Overtopping of these structures would hinder both evacuation and rescue/recovery efforts. There are three bridges that span

the West Branch of the Delaware River, two that span Bagley Brook, and two that cross Chambers Hollow. Covert and Launt Hollows each have a single box culvert that passes flows under State Highway 10. Flood profiles published in the 2016 FEMA FIS and HEC-RAS modeling indicate that none of the bridges are overtopped by the 100-year event, and most are able to pass this discharge comfortably.

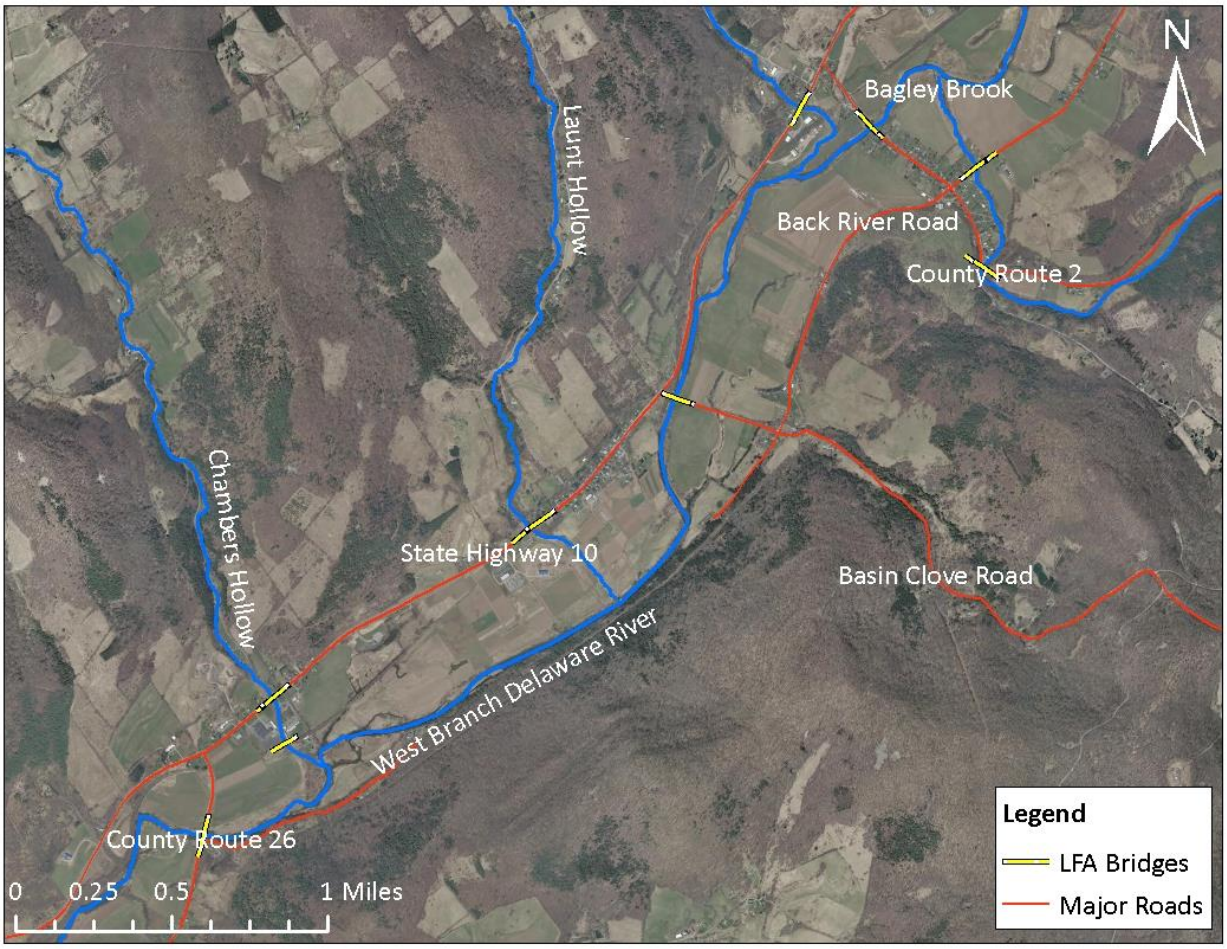


Figure 2-3: Bridge Locations in the Hamden LFA Study Area

On the West Branch of the Delaware River, the 100-year discharge easily passes under the Basin Clove Road bridge. The same discharge hits the lower section of the deck on the County Route 2 and the County Route 26 bridges. All of the bridges spanning Bagley Brook and the State Highway 10 box culvert at Launt Hollow comfortably pass the 100-year flow. In regard to Chambers Hollow, the 100-year discharge easily passes through the box culvert at State Highway 10 but hits the deck of the footbridge.

The 2016 FEMA FIS does not address Covert Hollow. Based on field observations and anecdotal accounts, the box culvert at State Highway 10 appears to have experienced sediment aggradation. Residents estimate that this structure had 5 to 6 feet of clearance when first installed. In 2015, this structure had approximately 3 feet of clearance. However, there is little evidence of flooding due to the reduction in the size of the culvert opening. A longtime homeowner who lives adjacent to the culvert can recall only a single occasion where flooding occurred. In this instance, flooding was thought to be primarily due to an ice jam at the culvert entrance rather than a decrease in culvert capacity.

Although the bridge structure itself may not be overtopped during the 100-year event, the roadway approaching the bridge may be inundated. If flooding along the roadway is sufficiently deep, this may render the bridge impassable and hinder rescue and recovery operations. Hydraulic modeling indicates that bridge approaches to the County Route 2, Basin Clove Road, and County Route 26 bridges over the West Branch of the Delaware River are inundated by the 10-year event.

Table 2-1 lists the bridges in the project area from upstream to downstream. Water surface elevations were derived from baseline hydraulic modeling and are consistent with elevations in the 2016 FEMA FIS bridge profiles. In all cases, the bridge decks are at a higher elevation than the FEMA 100-year flood elevation.

TABLE 2-1
Bridges Crossing Structures in Hamden LFA Project Area

Stream/River	Bridge Crossing	Bridge Deck Elevation (ft)	Predicted 100-Year WSEL (ft)	Difference (ft)
West Branch of the Delaware River	County Route 2	1,295.5	1,288.2	7.3
West Branch of the Delaware River	Basin Clove Road	1,284.5	1,273.9	10.6
West Branch of the Delaware River	County Route 26	1,262.5	1,259.8	2.7
Bagley Brook	County Route 2	1,347.7	1,330.0	17.7
Bagley Brook	Back River Road	1,309.5	1,304.4	5.1
Covert Hollow	State Highway 10	*	*	*
Launt Hollow	State Highway 10	1,286.3	1,282.8	3.5
Chambers Hollow	State Highway 10	1,299.3	1,294.9	4.4
Chambers Hollow	Footbridge	1,273.6	1,273.3	0.3

*No data available in FEMA 2014 Revised Preliminary FIS or FEMA HEC-RAS model
WSEL = Water surface elevation

Important municipal facilities within the town of Hamden include municipal water supply well heads, a chlorine pump station, a stormwater pump station, a sanitary sewer pump station, and a WWTP. Figure 2-4 shows the locations of Hamden's municipal facilities in the vicinity of County Route 2 crossing over the West Branch of the Delaware River. Figure 2-5 shows locations of municipal facilities along State Highway 10. A complete list is given below:

- Delancey Pump/Chlorine Station
- Delancey Well Head
- Stormwater Pump Station
- Sanitary Sewer Pump Station
- Launt Hollow Well Head
- Launt Hollow Upper Pump Station
- Launt Hollow Lower Pump Station
- Waste Water Treatment Plant

The WWTP is of special concern as flooding of the structure would result in potential health hazard as well as water quality degradation along the West Branch of the Delaware River.

Figure 2-4: Municipal Facilities in the Vicinity of County Route 2 crossing over the West Branch

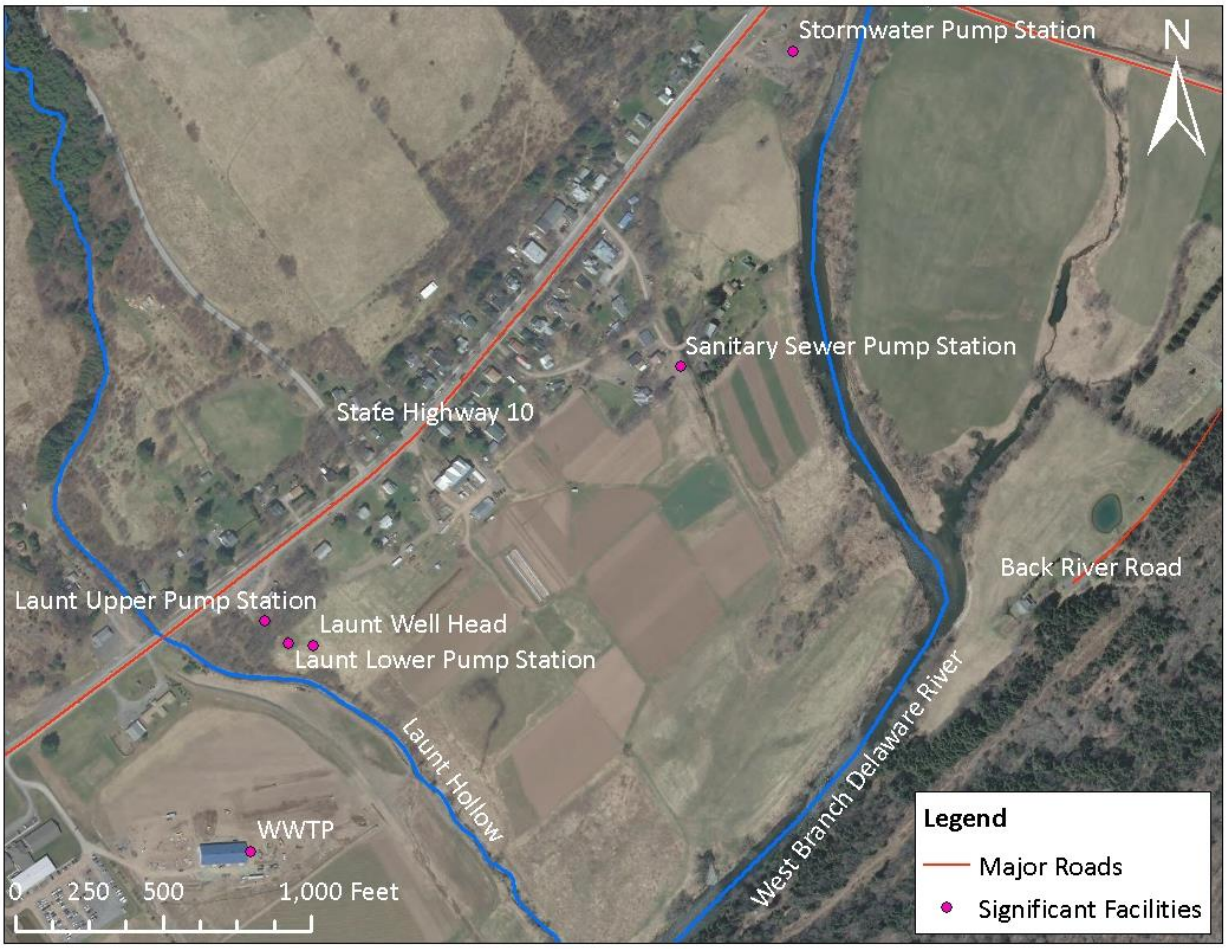


Figure 2-5: Municipal Facilities along State Highway 10

2.6 Hydrology

USGS operates and maintains streamflow gauges that record daily streamflow, including flood flows. This data is essential to understanding long-term trends. Gauge data can be utilized to determine flood magnitudes and frequencies. Table 2-2 is a list of relevant USGS gauges along the West Branch of the Delaware River. No USGS gauges were located on Bagley Brook, Covert Hollow, Launt Hollow, or Chambers Hollow. All of the active USGS gauges are located outside of the project area. Gauge 01423000 is located about 8 miles downstream in Walton, New York. Gauge 01421900 is located approximately 7 miles upstream near Delhi, New York, while the streamflow gauge in Hobart, New York, is situated even further upstream. Due to the distance of these gauges from the project and the lack of gauges on other streams of interest, discharge estimates from other sources such as FEMA and USGS *StreamStats* will be especially important in estimating peak flow rates.

TABLE 2-2
USGS Gauging Stations along the West Branch of the Delaware River

USGS Gauge Number	Location	Drainage Area (square miles)	Period of Record
01421610	At Hobart, NY	15.5	August 2000 to Present
01421900	Upstream from Delhi, NY	134	April 1937 to Present
01422000	At Delhi, NY	142	April 1937 to September 1970
01422700	At Hawleys Downsville Road	256	October 1959 to June 1967
01423000	At Walton, NY	332	October 1952 to Present

The most current FEMA FIS that includes the town of Hamden is a revised study with an effective date of June 16, 2016. The purpose of the FEMA study is to determine potential floodwater elevations and delineate existing floodplains in order to identify flood hazards and establish insurance rates. Flood frequency gauge analysis was employed to estimate peak discharges along the West Branch of the Delaware River for the 10-, 50-, 100-, and 500-year events. Analysis of gauge data to determine peak flows was performed using USGS *PEAKFQ* software. *PEAKFQ* analysis is based on the guidelines in USGS *Bulletin 17B*. For ungauged sites located between two gauges, under the influence of both gauges, peak flows were estimated using Equation 6 in the USGS publication *SIR 2006-5112*. Peak discharges for locations within the influence of a single gauge were estimated using a method in Chapter 14 of the *National Engineering Handbook* (FEMA, 2016).

The 2016 FEMA FIS employed USGS *StreamStats* to estimate peak discharge for Bagley Brook, Launt Hollow, and Chambers Hollow. *StreamStats* is a web implementation of USGS *Report SIR 2006-5112,* which provides methods of computing flood discharges in New York based on regression equations. These equations relate discharge to the mean annual precipitation and several other parameters based on watershed basin characteristics within a number of geographically distinct regions in New York State. The watersheds of interest fall within USGS Region 4 for New York State. The parameters required for the Region 4 regression equations include watershed area, basin storage, slope ratio, main channel slope, and average basin slope. As the 2016 FEMA FIS did not include a detailed analysis of Covert Hollow, MMI employed USGS *StreamStats* to determine peak discharges for the 10-, 25-, 50-, 100-, and 500-year events.

Table 2-3 lists the peak discharges for the West Branch of the Delaware River, Bagley Creek, Covert Hollow, Launt Hollow, and Chambers Hollow. Except for Covert Hollow, all flows were determined by FEMA and reported in the FIS (FEMA, 2016).

TABLE 2-3
FEMA Peak Discharges for Hamden LFA (all flow values in cfs)

Stream/River	Location	Drainage Area (sq. mi.)	10-year	25-year	50-year	100-year	500-year
West Branch of the Delaware River	1.35 miles below Andes Delancey Road	220.66	11,661	*	16,347	18,332	23,076
West Branch of the Delaware River	Near Hawleys Downsville Road	255.75	13,622	*	19,103	21,478	27,005
Bagley Brook	Upstream of Back River Road	15.6	1,480	1,850	2,140	2,440	3,150
Covert Hollow	Upstream of State Highway 10	2.78	314	407	481	559	749
Covert Hollow	At Confluence with West Branch of the Delaware River	3.23	369	478	565	655	877
Launt Hollow	Downstream of Crawford Road	3.83	418	541	639	741	991
Launt Hollow	Upstream of State Highway 10	3.94	441	570	673	781	1,040
Launt Hollow	At Confluence with West Branch of the Delaware River	3.99	455	588	694	805	1,080
Chambers Hollow	At Confluence with West Branch of the Delaware River	3.14	342	444	525	610	818

*No data available in FEMA 2016 FIS

3.0 EXISTING FLOODING HAZARDS

3.1 Flooding History

The town of Hamden covers a total area of 59.9 square miles with the population centers located in the hamlets of Hamden and Delancey. Approximately 1.6 miles of the town's land area is located within the 100- and 500-year flood boundaries. However, all development or infrastructure situated on floodplains should be considered vulnerable (2013 Tetra Tech). According to the 2013 Delaware County Multi-Jurisdictional Hazard Mitigation Plan Update, there are 99 properties located within the 100-year flood boundary and 103 properties within the 500-year flood boundary (2013).

USGS gauges have been in place along the West Branch of the Delaware River since the 1930s. As a result, we have a fairly clear record of the magnitude of flood events since that time. Based on a review of background material and USGS streamflow gauge records, bankfull stage or greater flood events on the West Branch of the Delaware River typically occur as a result of two conditions. The first condition is a rain-on-snow event, which usually takes place during late winter or spring. In many cases, the soils were saturated due to rain prior to the actual flood event, which reduced infiltration capacity (DCSWCD, 2006). The second cause of extreme flooding is hurricanes or tropical storms occurring in late summer or fall (FEMA, 2012).

Over 20 flood events exceeding the 5-year discharge have occurred on the West Branch of the Delaware River between the villages of Delhi and Walton (DCSWCD, 2006; USGS, 2016). During these floods, several lives have been lost, and millions of dollars in damages were incurred. The table below provides dates and discharges for major events within the town of Hamden (Table 3-1). As the town of Hamden lies between the villages of Delhi and Walton, the table includes gauge data for both of those locations.

TABLE 3-1
Peak Discharges during Major Flood Events

Date of Discharge Event	Discharge at USGS Gauge in Delhi, NY	Discharge at USGS Gauge in Walton, NY
01/22/59	5,500	15,700
03/05/64	6,330	15,800
12/21/73	6,070	14,700
01/19/96	13,000	25,000
11/09/96	7,000	18,200
04/03/05	5,700	18,200
06/28/06	8,060	28,600
08/28/11	8,860	16,000*

(DCSWCD, 2006; USGS, 2016)
* Actual peak discharge date was August 29, 2011.

The flood that occurred on January 19, 1996, was especially severe and was the result of a rain-on-snow event. Snowstorms in early January resulted in accumulation of snow on the ground in excess of 2 feet in many locations. On January 18, 1996, temperatures climbed to the 60° F range and were accompanied by 2 to 2-1/2 inches of rain. Although this flood was close to the 70-year recurrence event based on the measurement at the USGS gauge in Walton, it was estimated to exceed the 100-year event in other parts of the watershed. The flood was extremely destructive resulting in six deaths and $30,000,000 worth of damages in Delaware County, New York (DCSWCD, 2006). The Bell property (located at 166 County Route 2) was damaged in the 1996 flood and is now abandoned.

The largest flood on the West Branch of the Delaware River, as measured at the USGS gauge in Walton, occurred on June 28, 2006. The cause of the flood was extremely heavy rainfall between June 24 and June 28. The National Weather Service estimated that 6 to 15 inches of rain fell on the upper Delaware River watershed. The measured discharge at the USGS gauge in Walton was 28,600 cubic feet per second (cfs), which exceeds the 100-year recurrence interval discharge of 28,137 cfs (DCSWCD, 2006; FEMA, 2016).

The magnitudes of the 1996 and 2006 flood events at the downstream end of the project site were estimated using graphical analysis. Additionally, the magnitudes of these events were calculated based on the area and discharge at the upstream and downstream gauges in Delhi and Walton relative to the downstream area of the project at Hawleys Downsville Road/County Route 6. These methods gave nearly identical results. Based on these analyses, the discharges of the 1996 and the 2006 events were approximately 20,394 cfs and 20,716 cfs, respectively. These flows fall between the 50- and 100-year peak flows in the 2016 FEMA FIS and the FEMA HEC-RAS model.

One important note is that the discharge for the 2006 flood in the FEMA HEC-RAS model was larger. Between the Green Thumb Nursery and the Hawleys Downsville Road bridge, the discharge of the 2006 flood event was 25,160 cfs, which is between the 100- and 500-year peak flows. This difference may result from the value used for the 2006 event in the vicinity of the Delhi, New York, USGS gauge. In the FEMA HEC-RAS model, the discharge of the 2006 flood was 13,987 cfs, which is greater than the 500-year event discharge of 12,372 cfs. In comparison, the 2006 peak flow measured at the USGS gauge was 8,060 cfs. Although there is a discrepancy between the FEMA HEC-RAS model and the USGS gauge at Delhi, there is no discrepancy at the Walton, New York, USGS gauge. At this location, the HEC-RAS model uses a value of 28,600 cfs, which matches the peak discharge from the USGS gauge.

The last major flood event in the town of Hamden occurred on August 28 and 29, 2011. This event was precipitated by Tropical Storm Irene. Although this was a major storm event, it did not reach the magnitude of the 1996 or the 2006 floods.

3.2 Damage to Municipal Infrastructure

Given the number of large floods that the town of Hamden has experienced, there has been relatively little damage to municipal infrastructure. During the 1996 inundation event, flooding on Launt Hollow resulted in erosion that exposed approximately 50 feet of the 6-inch municipal water supply main coming off the Launt Hollow well head. The Town of Hamden received approximately $20,000 from FEMA to reposition the water main and increase the depth at which it was buried.

In 2011, flooding caused by Tropical Storm Irene resulted in the loss of two dry wells in the West Branch of the Delaware River near County Route 2 and County Route 26. The wells were used as a water source by the Town of Hamden Fire Department for fire suppression. An estimate for replacement of both dry wells was provided by Lamont Engineering in August 2016. The estimate of the total project cost was between $20,000 and $30,000 and included engineering design, permits and approvals, bidding, administration, and construction. The estimate was to be used to secure a grant for the replacement of the wells. As of the present time, a grant has not been secured, and the wells have not been replaced.

The 2006 flood caused substantial damage along Chambers Hollow. The flood created numerous head cuts in this confined valley, which set off multiple slope failures resulting in significant erosion and downstream sediment issues. Emergency Watershed Protection Program (EWP) projects in these valleys attempted to address the bed degradation and stabilize the failing slopes while protecting the roads and property in the valley. The Natural Resources Conservation Service EWP addressed seven sites in Chambers Hollow at a cost of $680,000 in 2007. Additional EWP work was completed in 2014 by DCSWCD at a cost of $60,000.

3.3 FEMA Mapping

FEMA FIRMs are available for the study area and can be accessed at the FEMA website (https://msc.fema.gov/portal#). The FIRMs depict the SFHA, which is the area inundated by flooding during the 100-year flood event. The maps also depict the FEMA-designated floodway, which is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood. Floodwaters are typically deepest and swiftest in the floodway, and anything in this area is in the greatest danger during a flood (FEMA, 2008). Within the project area, there are five watercourses of interest: Bagley Brook, Covert Hollow, Launt Hollow, Chambers Hollow, and the West Branch of the Delaware River. In some cases, structures are at risk of inundation from more than one of these watercourses.

According to FEMA mapping, there are only three properties in the floodway. The first of these is the Green Thumb Nursery (37784 State Highway 10), which is located on the right bank of the West Branch of the Delaware River at the upstream end of the project area. The other two properties are 166 County Route 2 and Mountain Transport (37032 State Highway 10). Both of these properties are located on the right bank of the West Branch immediately downstream of the County Route 2 bridge.

Overall, FEMA mapping indicates that relatively few structures in the town of Hamden are inundated by the 100-year frequency event. Along both Bagley Brook and Covert Hollow, no inhabited structures are flooded at the 100-year discharge. Only a single accessory structure located just downstream of the County Route 2 bridge over Bagley Brook is shown to be in the SFHA. Along both sides of Launt Hollow, several properties south of State Highway 10 are located in the SFHA. These include private homes and municipal facilities (well head and two pump houses) as well as self-storage units and the Delaware Opportunities building. In regard to Chambers Hollow, there are three permanent structures located in the SFHA. Two of the structures are located at the lower end of Chambers Hollow on the Delaware County Fire Training Facility property. The third structure is the NYSEG facility. Although the facility is largely out of the SFHA, the northwest corner falls just within the SFHA.

Along the corridor of the West Branch of the Delaware River, there are four areas where structures are at risk of inundation during the 100-year event. The first location is in the vicinity of the County Route 2

bridge. The properties within the SFHA are the same properties located within the floodway: Green Thumb Nursery (37784 State Highway 10), 166 County Route 2, and Mountain Transport (37032 State Highway 10). The next area of interest is the region of Mill Street and Mill Street Spur. This is an area of low relief located close to the West Branch with several properties located squarely in the SFHA. The third at-risk area is in the vicinity of Launt Hollow. The structures of concern in this area are the greenhouses associated with the Lucky Dog Organic Farm, the Delaware Opportunities facility, and the WWTP. The most downstream area of concern is where Chambers Hollow enters the West Branch. The structures of concern here are two buildings associated with the Delaware County Fire Training Facility.

4.0 FLOOD MITIGATION ANALYSIS AND ALTERNATIVES

In general, properties and infrastructure within the town of Hamden are not at considerable risk from inundation due to flooding along the West Branch of the Delaware River or its major tributaries. However, several properties and areas of interest were identified. Analysis of existing conditions was carried out to determine baseline levels of inundation. After performing the baseline analysis, removal of bridges along the West Branch of the Delaware River and its tributaries was modeled. This was done to determine if the bridges were undersized and whether their removal or replacement would provide significant flood reduction benefits. The results of baseline analysis and bridge removal are discussed in the sections below. A benefit-cost analysis was performed for those alternatives that showed the most merit for reducing flood levels. The results of the benefit-cost analysis are summarized later in this report.

4.1 Analysis Approach

Hydraulic analysis of the West Branch of the Delaware River and its major tributaries was conducted using the HEC-RAS program. The HEC-RAS software (*River Analysis System*) was written by the United States Army Corps of Engineers (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 one-dimensional, steady-state, or time-varied flow. The system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions.

Water surface profiles are computed from one cross section to the next by solving the one-dimensional energy equation with an iterative procedure called the standard step method. Energy losses are evaluated by friction (Manning's Equation) and the contraction/expansion of flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence.

In order to carry out hydraulic modeling of baseline conditions and alternatives, MMI obtained the effective FEMA HEC-RAS models for Bagley Brook, Launt Hollow, and Chambers Hollow from NYCDEP in March 2016. The effective FEMA HEC-RAS model for the West Branch of the Delaware River was previously obtained from NYCDEP for another project. In addition to the effective models, NYCDEP also provided a noneffective model for Covert Hollow, which was constructed using approximate methods.

The HEC-RAS models provided by NYCDEP provided the starting point for the current analysis. Duplicate effective models were created for the West Branch of the Delaware River, Bagley Brook, Launt Hollow, and Chambers Hollow. The output of the duplicate effective models was compared to those provided by the NYCDEP and found to be identical. Additionally, the duplicate effective HEC-RAS models were run, and the resulting water surface elevations were compared to those published in the FEMA FIS and verified for accuracy. Model cross sections, Manning's "n" coefficients, site conditions, and expansion/contraction coefficients were reviewed for each hydraulic model.

One important discrepancy was identified during the process of validating the FEMA model. The County Route 2/Andes Delancey Road bridge is depicted in the FEMA HEC-RAS model as a single-span bridge.

However, the bridge actually has six 4.92-foot-diameter flood relief culverts located on the northern bridge approach. MMI created a corrected effective model using engineering drawings created by the Delaware County Department of Public Works, which were provided by DCSWCD.

The addition of these culverts resulted in a minor decrease in water surface elevations for the 100-year discharge at the cross section immediately upstream of the bridge. At the next three cross sections upstream, a slight increase in water surface elevations was noted.

A discrepancy was also noted in the hydraulic model of Launt Hollow. A bridge spans Launt Hollow approximately 570 feet upstream of the confluence with the West Branch of the Delaware River. This footbridge is not included in the FEMA model. The bridge is fairly small and located in agricultural fields. Given its location and size, it is not likely to have any significant effects on water surface elevations. As a result, it was not added to the hydraulic model.

4.2 Existing Conditions Analysis

The HEC-RAS corrected effective model was used to model baseline water surface elevations along the West Branch of the Delaware River. Baseline water surface elevations for Bagley Brook, Launt Hollow, and Chambers Hollow were calculated using copies of the respective duplicate effective FEMA HEC-RAS models. Baseline conditions for Covert Hollow were not analyzed as the FEMA HEC-RAS model was only an approximate study. Furthermore, anecdotal evidence and FEMA inundation mapping (https://msc.fema.gov/portal) indicated that there is little risk of flooding from the stream.

All baseline models were run in a subcritical flow regime. Modeling in a subcritical flow regime will tend to result in slower water velocities and higher water surface elevations. This provides a worst-case scenario for expected flood surface elevations.

As the hydraulic models for Bagley Brook, Launt Hollow, and Chambers Hollow were identical to the FEMA effective models, there were no alterations to previously established baseline conditions. However, there were changes to the baseline conditions of the West Branch of the Delaware River compared to the FEMA effective model. Changes to water surface elevations occurred in the vicinity of the County Route 2 bridge due to the addition of six flood relief culverts. Upstream of the bridge, the addition of the culverts resulted in modest decreases in water surface elevations at the 50-, 100-, and 500-year discharges and a slight decrease at the 10-year discharge. Appreciable changes occurred in the three cross sections immediately upstream of the bridge, a distance of 1,885 feet. Downstream of the bridge, there were only very slight decreases in water surface elevations at the next cross section (Table 4-1, Figure 4-1).

TABLE 4-1
Difference in Water Surface Elevations between FEMA Effective and MMI Corrected Effective Model

HEC-RAS Cross Section	Profile	FEMA Effective Model Water Surface Elevation (ft)	MMI Corrected Effective Model Water Surface Elevations (ft)	Change (ft)
282840	10-year	1,289.36	1,289.37	-0.01
"	50-year	1,290.41	1,290.31	0.1
"	100-year	1,290.83	1,290.73	0.1
"	500-year	1,291.77	1,291.68	0.09
281408	10-year	1,287.66	1,287.76	-0.1
"	50-year	1,289.12	1,288.86	0.26
"	100-year	1,289.66	1,289.41	0.25
"	500-year	1,290.76	1,290.58	0.18
279646	10-year	1,286.28	1,286.53	-0.25
"	50-year	1,288.08	1,287.58	0.5
"	100-year	1,288.67	1,288.24	0.43
"	500-year	1,289.82	1,289.55	0.27
279608	10-year	1,286.05	1,286.32	-0.27
"	50-year	1,287.83	1,287.26	0.57
"	100-year	1,288.41	1,287.91	0.5
"	500-year	1,289.5	1,289.19	0.31
279523	Bridge			
279405	10-year	1,285.08	1,284.79	0.29
"	50-year	1,286.12	1,286.09	0.03
"	100-year	1,286.54	1,286.5	0.04
"	500-year	1,287.39	1,287.33	0.06

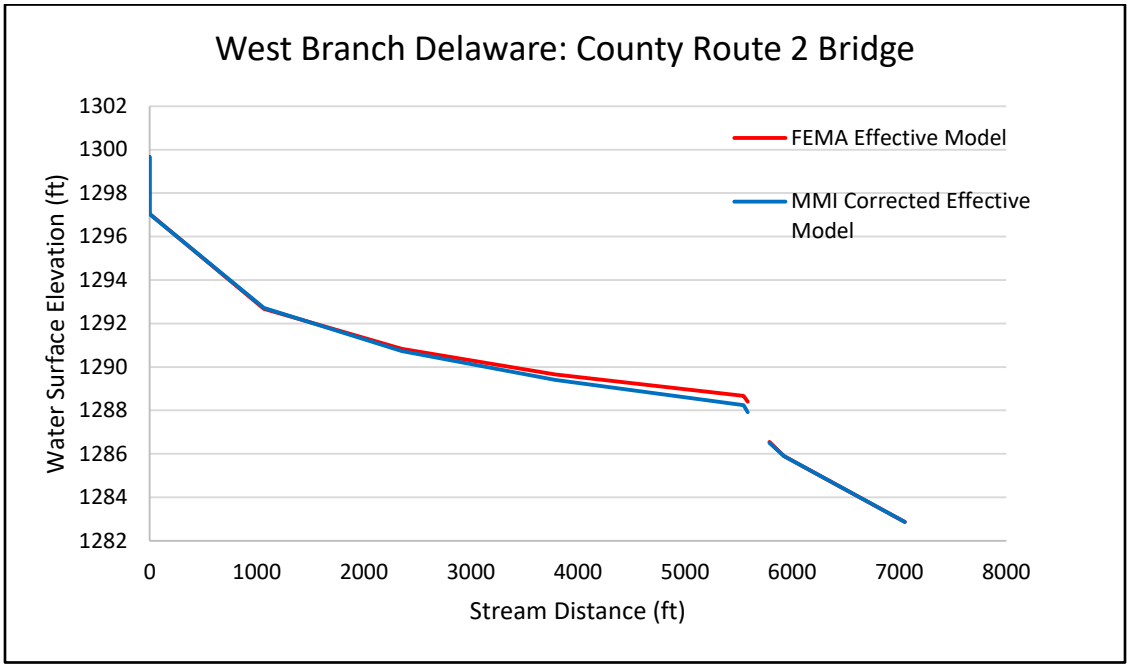


Figure 4-1: Water Surface Elevations of FEMA Effective and MMI Corrected Effective Model

In summary, addition of the flood relief culverts in the County Route 2 bridge did not result in significant mitigation benefits. At one property adjacent to the West Branch of the Delaware River, the culverts prevented the associated home from flooding during the 500-year storm. However, this structure remained free from flooding at smaller events.

An analysis of at-risk structures/facilities was carried out using baseline hydraulic modeling, FEMA mapping, and *ArcGIS*. The analysis examined whether structures were inundated at the 10-, 50-, 100-, and 500-year event as well as the expected depth of flooding. The examination concluded that 40 residential or commercial structures and eight municipal facilities had the potential to be flooded at discharges up to the 500-year event. The municipal facilities are identified below:

- Delancey Pump/Chlorine Station
- Delancey Well Head
- Stormwater Pump Station
- Sanitary Sewer Pump Station
- Launt Hollow Well Head
- Launt Hollow Upper Pump Station
- Launt Hollow Lower Pump Station
- Waste Water Treatment Plant

4.3 Flood Mitigation Analyses

Additional hydraulic analyses were conducted to explore possibilities for reducing flood depths within the project area. Analyses were carried out along three lines of inquiry. The first line of inquiry assessed whether bridges in the project area exacerbated flooding. Next, bridges on Bagley Brook, Launt Hollow,

and Chambers Hollow, which cross major routes, were modeled under partially obstructed conditions. The purpose was to investigate the effect of partially blocked bridges/culverts on flooding depth. Finally, hydraulic modeling was carried out to examine the possibility of preventing the West Branch of the Delaware River from overtopping County Route 2 on the north side of the river.

Modeling of in-channel alterations to reduce flood levels was not conducted as much of the land adjacent to watercourses in the project area consists of productive farmland. Additionally, the West Branch of the Delaware River is a low-gradient river that is well connected to a broad floodplain. As the river is already able to easily access its floodplain area, mitigation alternatives based on floodplain enhancement are unlikely to result in significant reductions in water surface elevations. Also, there are relatively few structures at risk from inundation, and the expected benefit from in-channel restorations is not significant.

4.3.1 Bridge Analysis

A bridge analysis was undertaken to examine whether the bridges were undersized and contributed significantly to flood. This was done by removing bridges from the model. The water surface elevations were then compared to water surface elevations from the MMI corrected effective model. Overall, the bridges were not undersized and did not significantly increase flood surface elevations. In most cases, bridges raised water surface elevations no more than a foot. Furthermore, except for the West Branch of the Delaware River, significant increases in water surface elevations caused by bridges seldom persisted far upstream (see Figures 4-2 through 4-7).

Along the West Branch of the Delaware River, bridge removal was modeled at the County Route 2, Basin Clove Road, and County Route 26 bridges. At the location of the County Route 2 bridge, removal of the structure resulted in water surface elevations that were approximately 1 foot lower than existing conditions for the 100- and 500-year events. Reductions in water surface levels persisted for a distance of about 1,800 feet upstream (Figure 4-2). Decreases in water surface elevations at Basin Clove Road were less than half a foot at the largest discharges and only persisted 115 feet upstream (Figure 4-3). Removal of bridges at County Route 26 also had little impact on water surface elevations. For the 100- and 500-year discharges, removal of the bridges only decreased water surface elevations by about half a foot and did not result in flood mitigation at any structures (Figure 4-4). The minor reductions in water surface levels that occurred at these structures did not result in mitigation benefits for any properties.

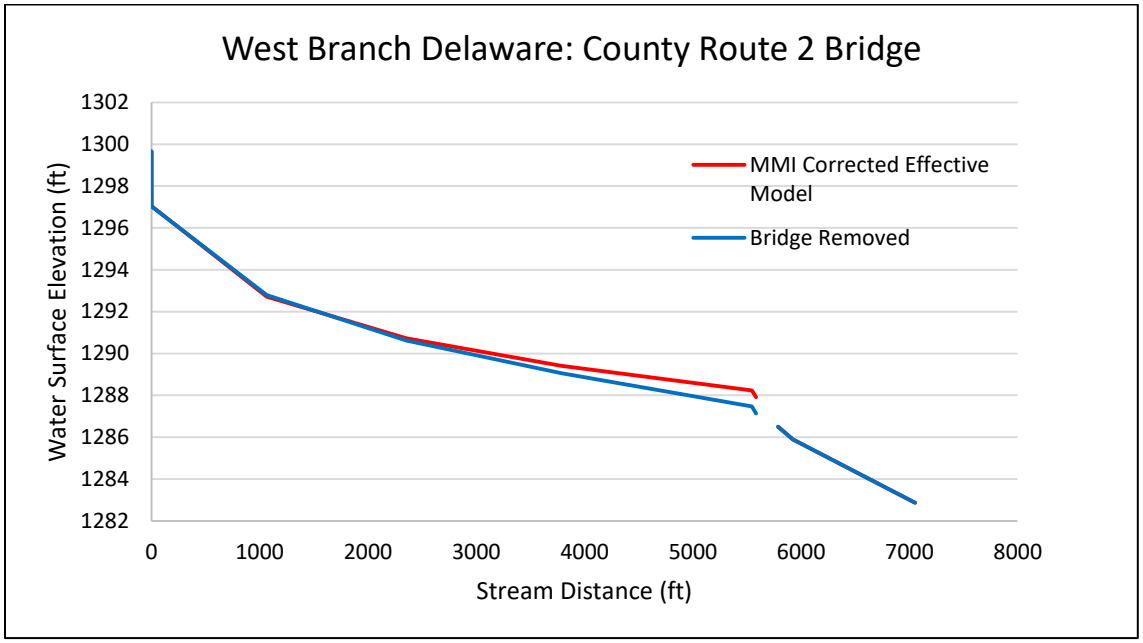


Figure 4-2: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – County Route 2 Bridge

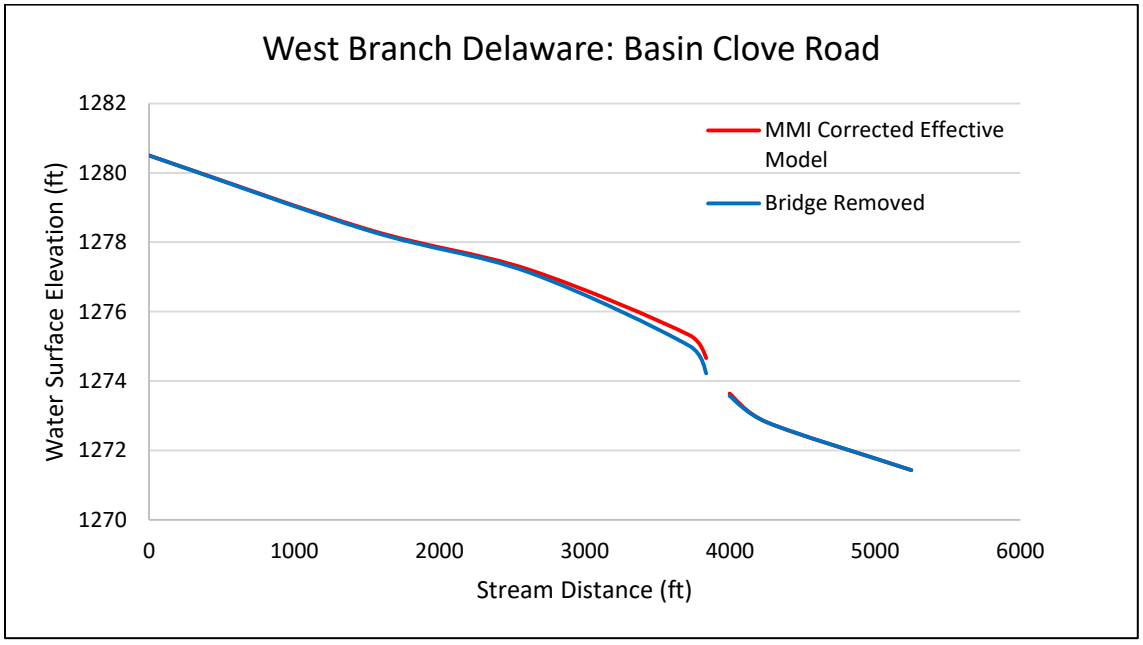


Figure 4-3: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – Basin Clove Road Bridge

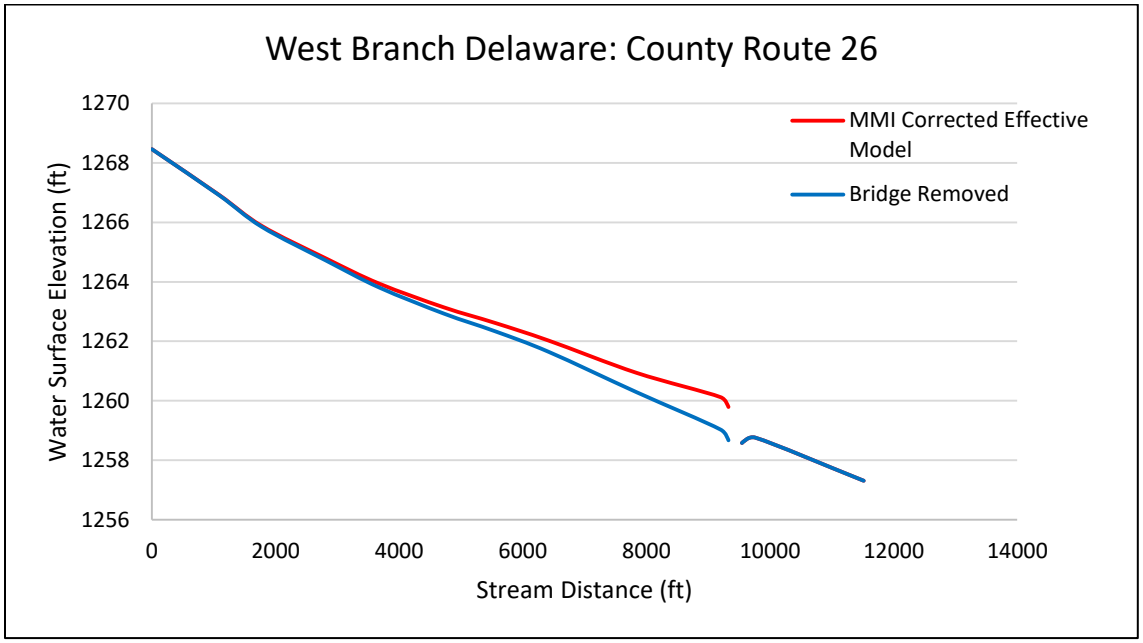


Figure 4-4: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – County Route 26 Bridge

On Bagley Brook, the removal of bridges resulted in modest reductions in water surface elevations. At the County Route 2 bridge, water surface elevations for the 100- and 500-year event decreased by approximately 1 foot when the structure was removed (Figure 4-5). The decrease in water surface elevation only persisted for a distance of 51 feet upstream. As the County Route 2 bridge easily passes the 500-year discharge, it more than adequately handles the largest flood events. The removal of the structure at Back River Road had very little effect on water surface elevations. Water surface elevations for the 100- and 500-year events decreased by about a quarter of a foot and were only seen at the cross section immediately upstream of the bridge (Figure 4-6). These minor reductions in water surface elevation did not result in flood mitigation at any structure.

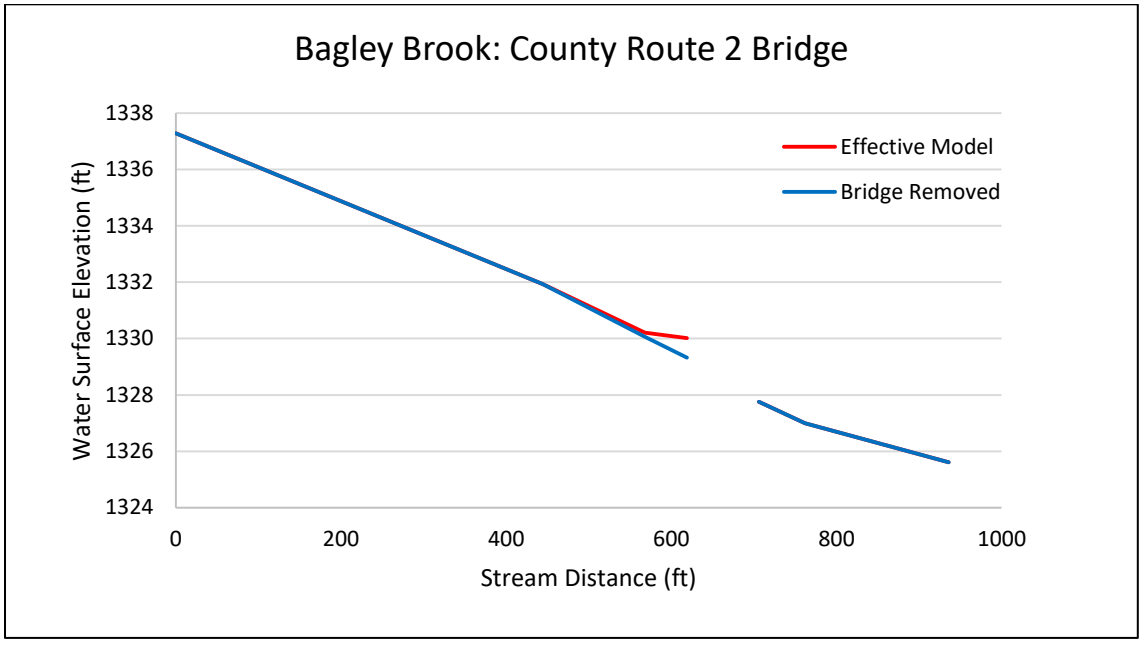


Figure 4-5: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – County Route 2 Bridge

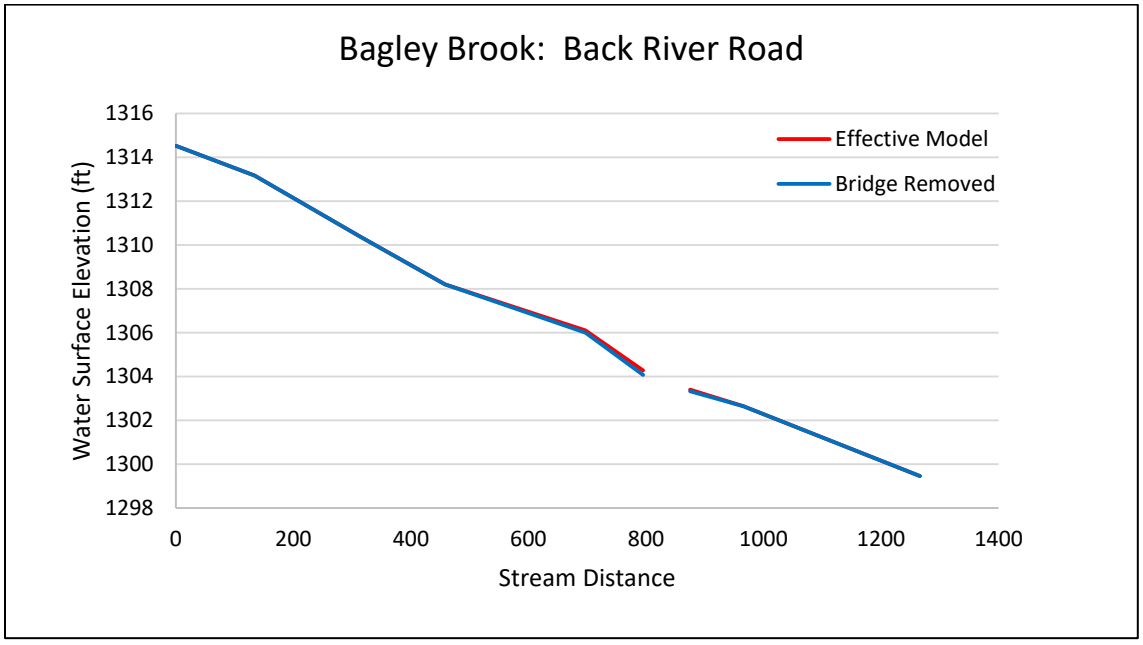


Figure 4-6: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – Back River Bridge

The most significant effects of modeling bridge removals occurred on Launt Hollow at State Highway 10. The reductions in water surface elevations for the 25-, 50-, 100-, and 500-year events were 0.93 feet, 1.27 feet, 1.63 feet, and 2.64 feet, respectively (Figure 4-7). However, this did not result in any appreciable mitigation benefits. The only benefit was for a single home upstream of the bridge. This structure, which was normally inundated by the 500-year event, avoided flooding with removal of the bridge.

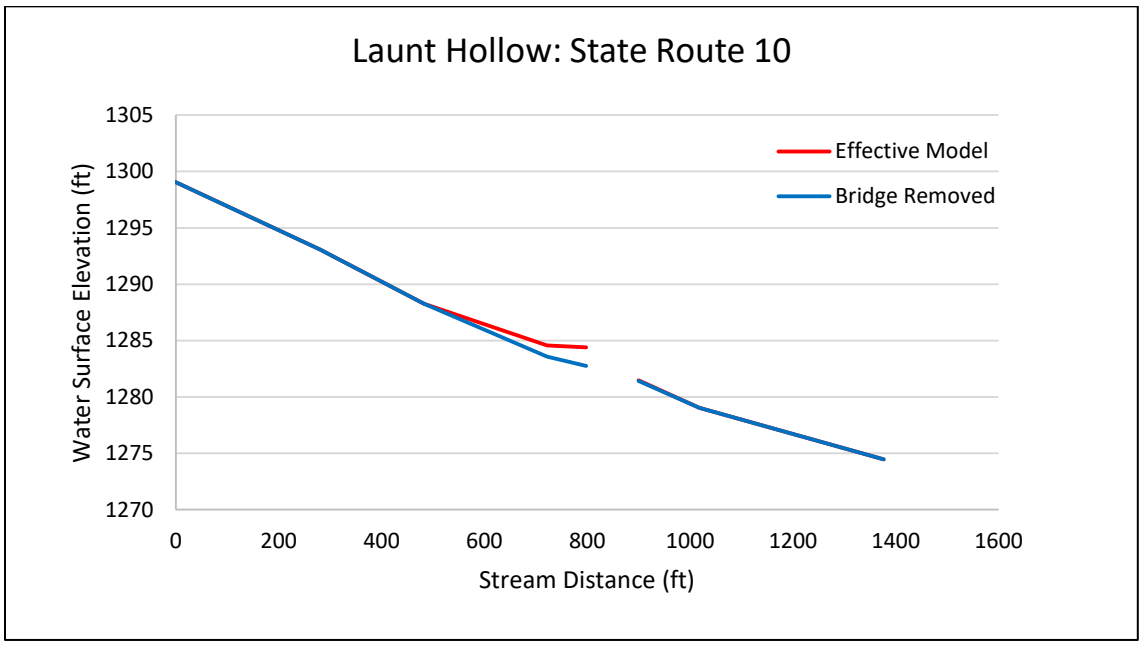


Figure 4-7: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – State Highway 10 Bridge

The removal of structures was modeled on Chambers Hollow at two locations: State Highway 10 and a footbridge crossing the stream between the Delaware County Arc and NYSEG properties. Reduction in water surface elevations at State Highway 10 were 1.23 feet, 1.35 feet, 1.44 feet, 1.52 feet, and 1.82 feet for the 10-, 25-, 50-, 100-, and 500-year events, respectively (Figure 4-8). Although reasonable reductions in water surface elevations were noted, the bridge spanning State Route 10 is able to pass the 500-year discharge, and no structures were found to be at risk from inundation. Water surface elevations at the footbridge decreased by less than half a foot for the 100- and 500-year events (Figure 4-9). Although larger decreases were noted at the smaller events (for example, a 1-foot decrease at the 10-year event), the lower water surface elevations did not mitigate flooding at any structure.

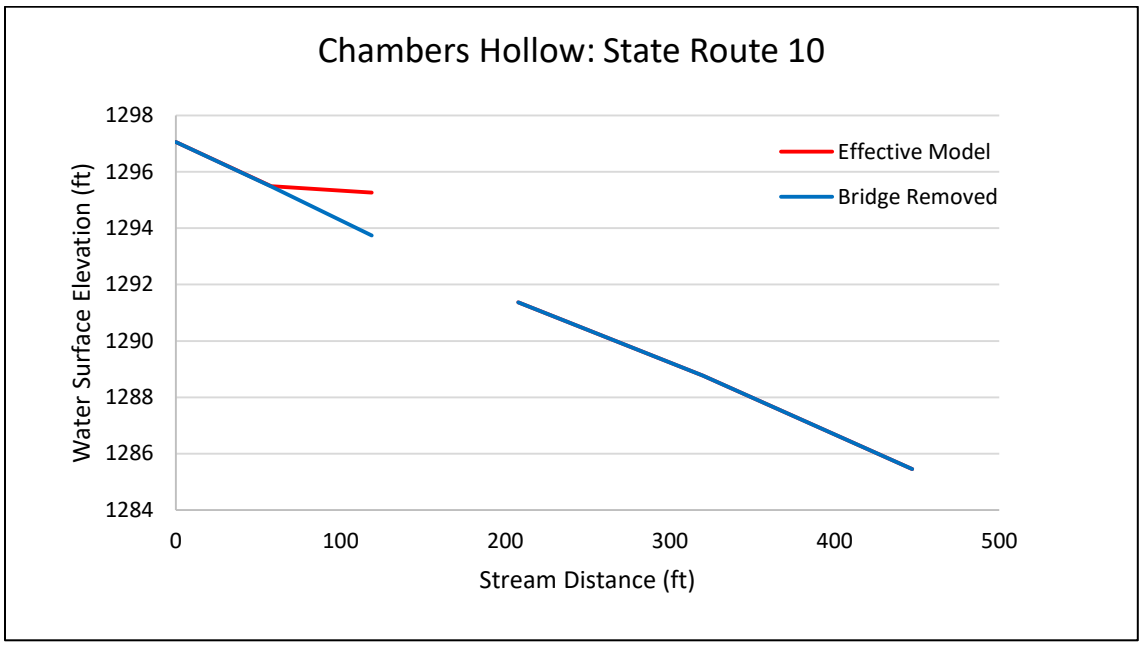


Figure 4-8: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – State Highway 10 Bridge

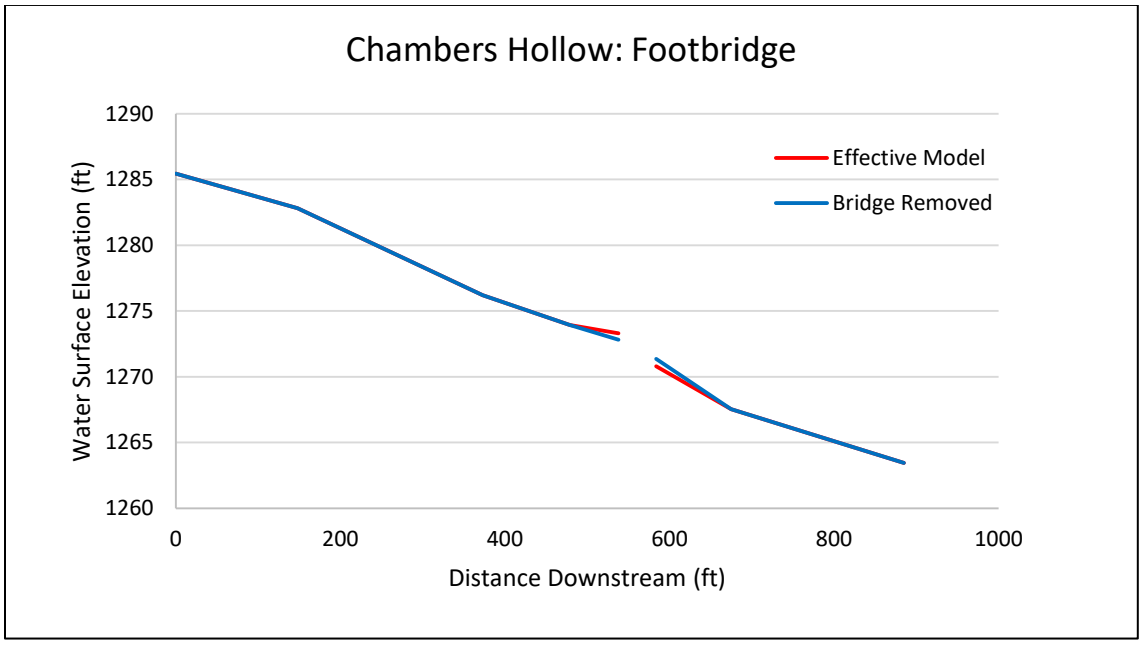


Figure 4-9: Expected Reduction in Water Surface Elevation at the 100-Year Discharge due to Structure Removal – Footbridge

In summary, modeling of bridge removal indicated that the bridges within the project area do not significantly raise water surface elevations or contribute to inundation of structures. Therefore, replacement of existing structures is not recommended.

4.3.2 Hydraulic Modeling of Bridge/Culvert Obstructions

Hydraulic modeling was carried out to assess blockage of bridges and culverts on Bagley Brook, Launt Hollow, and Chambers Hollow. Structures assessed include the Back River Road bridge crossing Bagley Brook and the culverts that pass Chambers Hollow and Launt Hollow under State Highway 10. Culverts and bridges were modeled as 25% and 50% blocked. These simulations were performed to assess the effects of partial blockage on water surface elevations. Additionally, the results may be used to inform maintenance activities such as removing sediment that has aggraded within a structure, diminishing its capacity and increasing risk of inundation.

The Back River Road bridge spanning Bagley Brook has an opening height of 8.33 feet at its upstream end (note: upstream and downstream bridge cross sections have different opening heights). Under baseline conditions, this structure easily passes all flows up to the 500-year discharge. The bridge was modeled as 25% and 50% blocked. To simulate blockage, the bottom and top of the opening were raised/lowered by the same amount. When the bridge is 25% blocked, the opening height is 6.25 feet. Even with this level of obstruction, the bridge was able to pass all flows. At 50% blocked, the opening height is 4.16 feet. When this degree of obstruction occurs, the bridge is able to pass only the 10- and 25-year discharges. The 50-year discharge hits the deck of the bridge while the 100- and 500-year discharges overtop the structure.

The baseline opening height of the structure that passes Launt Hollow under State Route 10 is 5 feet. Unlike the other bridges, this structure was modeled in HEC-RAS as a culvert. As a result, the Depth Blocked function in the Culvert Data Editor was employed to simulate blockage. Baseline modeling indicates that this structure is able to pass all flows up to and including the 100-year discharge. At 25% blocked (3.75 feet opening height), the structure is able to pass the 10-, 25-, and 50-year discharges. Once the structure is 50% blocked, it was not able to pass any of the modeled flows.

The structure that passes Chambers Hollow under State Route 10 was modeled in the same manner as the Back River Road bridge. Under baseline conditions, the opening height is 5.66 feet, and the structure is able to pass all flows. When the opening is 25% blocked, the opening height of the structure is 4.24 feet. Under this condition, the structure easily passes the 10-year discharge. It is also still able to pass the 25-, 50-, and 100-year flows while the 500-year discharge overtops the structure and roadway. Once the structure is 50% blocked, the opening height is reduced to 2.83 feet, and modeling results suggest that it is able to pass the 10- and 25-year discharges but is overtopped by the 50-, 100-, and 500-year events.

Based upon the modeling results, a matrix was developed to trigger a maintenance action in response to blockage of the bridge opening (Table 4.2). Once a percent blockage and corresponding opening height have been reached, the opening of the structure should be cleared to its baseline height to help prevent overtopping during high discharge events. Blockage of the box culvert that carries Covert Hollow under State Highway 10 was not carried out as there is no effective FEMA HEC-RAS model for this stream. However, it is recommended that this culvert be regularly inspected for blockages.

TABLE 4-2
Bridge Blockages that Trigger Maintenance (MXS) Actions

Stream	Baseline - 0% Blocked		25% Blocked		50% Blocked	
	Opening Height (ft)	MXS Action Advised	Opening Height (ft)	MXS Action Advised	Opening Height (ft)	MXS Action Advised
Bagley Brook/ Back River Road	8.33	No	6.25	No	4.16	Yes
Launt Hollow/ State Route 10	5.0	No	3.75	Yes	2.5	Yes
Chambers Hollow/ State Route 10	5.66	No	4.24	No	2.83	Yes

4.3.3 Modeling Overtopping of County Route 2

County Route 2 is one of the most important transportation corridors in the town of Hamden as it links the hamlets of Hamden and Delancey, which are the main population centers. Additionally, during an emergency, it is the main route for crossing the West Branch of the Delaware River during rescue and recovery operations. As a result, it is critical that this road is passable during emergencies. Anecdotal evidence and baseline hydraulic modeling indicate that while the bridge itself is not overtopped County Route 2 between the West Branch of the Delaware River and State Highway 10 is overtopped at flows as low as the 10-year discharge.

Hydraulic modeling using HEC-RAS was carried out to investigate potential solutions for preventing County Route 2 from overtopping. Potential alternatives investigated include the following:

1. Replacing the six flood relief culverts (total capacity = 10.6 ft^2) with two box culverts (total capacity = 150 ft^2)

2. Replacing the six flood relief culverts (total capacity = 10.6 ft^2) with a single box culvert (total capacity = 225 ft^2)

3. Alternative 1 combined with two box culverts (25 ft x 2 ft) installed at the lowest point on County Route 2 between the West Branch of the Delaware River and State Highway 10 (total capacity = 175 ft^2)

None of these alternatives were even marginally effective at reducing overtopping of County Route 2. A review of the MMI corrected effective model found that water surface elevations at the downstream end of the bridge (also referred to as the tailwater) were greater than the elevation of the road (Figure 4-11). In other words, as water surface elevations at the downstream side of the bridge are greater than the road elevation, culverts alone will not work.

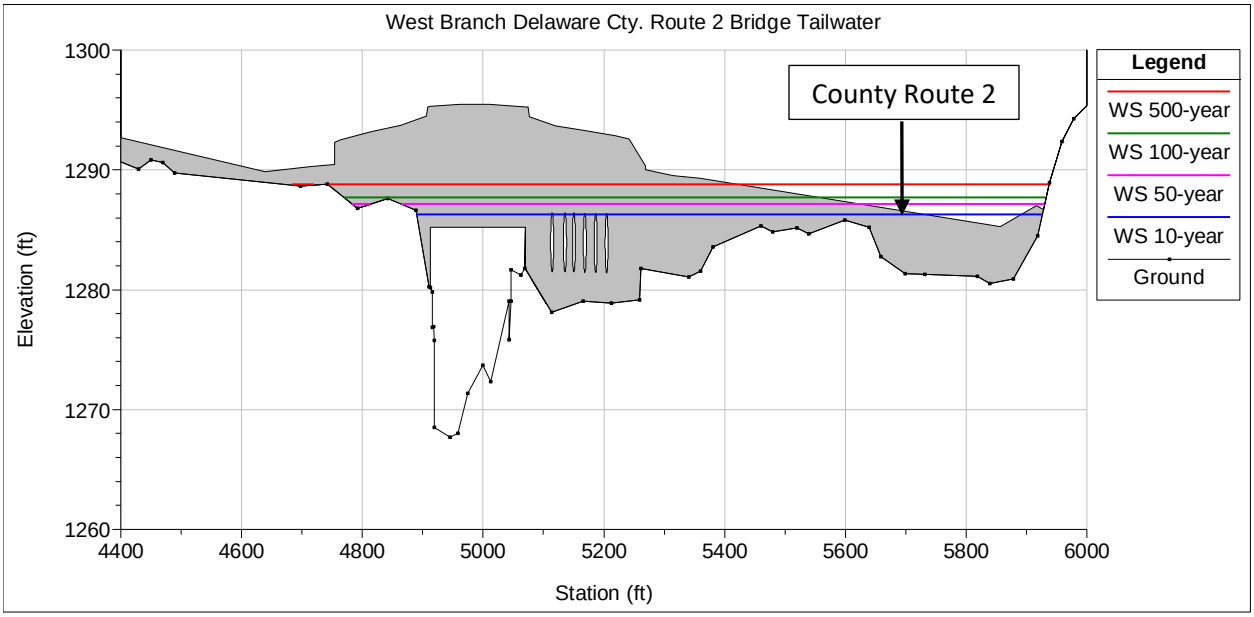


Figure 4-10: Tailwater Elevations at County Route 2 Bridge are Greater than Road Elevation

Reducing inundation of County Route 2 would most likely require lowering the tailwater elevation or raising the road. Raising the elevation of the road is the more feasible option. However, raising the road would increase water surface elevations in the floodway upstream of the bridge. Under NFIP requirements, communities must prohibit activities in the floodway that result in an increase in flood levels.

The only workable solution is replacing the existing bridge and roadway with a structure designed to pass flow along the entire length of the floodplain so that the roadway would not overtop and there would not be an upstream rise in water surface elevation. However, such a solution is prohibitively expensive. The most practical recommendation would be to replace the bridge and roadway with a larger structure spanning the floodplain when the bridge reaches the end of its lifecycle and is due for replacement.

4.3.4 Municipal Infrastructure

Municipal infrastructure was also evaluated for inundation risk. Although it was not possible to perform a benefit-cost analysis (BCA) analysis using the FEMA BCA program, the risk of inundation was assessed using ground elevations derived from digital elevation models (DEMs), field measurements, and HEC-RAS modeling. Vulnerability of flooding to municipal infrastructure was evaluated for the 100-year (Table 4-3) and 500-year (Table 4-4) flood events. It should be noted that some infrastructure are considered to be critical facilities and may require elevation above the elevation of the 500-year flood.

TABLE 4-3
Vulnerability of Municipal Infrastructure to Flooding – 100-Year Flood

Infrastructure	Channel	Elevation of Infrastructure (feet)	100-Year Water Elevation (feet)	Water Depth over Infrastructure (feet)	Flooded?
Delancey Pump/Chlorine Station	West Branch	1,287.4	1,287.9	0.5	YES
Delancey Well Head	West Branch	1,288.3	1,286.8	-1.5	NO
Stormwater Pump Station	West Branch	1,279.1	1,272.8	-6.3	NO
Sanitary Sewer Pump Station	West Branch	1,271.2	1,269.9	-1.3	NO
Launt Hollow Well Head	West Branch	1,276.1	1,267.6	-8.5	NO
Launt Hollow Upper Pump Station	West Branch	1,277.2	1,267.5	-9.7	NO
Launt Hollow Lower Pump Station	West Branch	1,275.1	1,267.5	-7.6	NO
Wastewater Treatment Plant	West Branch	1,268.5	1,266.8	-1.7	NO
Launt Hollow Well Head	Launt Hollow	1,276.1	1,275.3	-0.8	NO
Launt Hollow Upper Pump Station	Launt Hollow	1,277.2	1,278.3	1.1	YES
Launt Hollow Lower Pump Station	Launt Hollow	1,275.1	1,276.3	1.2	YES
Wastewater Treatment Plant	Launt Hollow	1,268.5	1,269.8	1.3	YES

TABLE 4-4
Vulnerability of Municipal Infrastructure to Flooding – 500-Year Flood

Infrastructure	Channel	Elevation of Infrastructure (feet)	500-Year Water Elevation (feet)	Water Depth over Infrastructure (feet)	Flooded?
Delancey Pump/Chlorine Station	West Branch	1,287.4	1,289.8	2.4	YES
Delancey Well Head	West Branch	1,288.3	1,287.5	-0.8	NO
Stormwater Pump Station	West Branch	1,279.1	1,273.6	-5.5	NO
Sanitary Sewer Pump Station	West Branch	1,271.2	1,270.8	-0.4	NO
Launt Hollow Well Head	West Branch	1,276.1	1,268.4	-7.7	NO
Launt Hollow Upper Pump Station	West Branch	1,277.2	1,268.4	-8.8	NO
Launt Hollow Lower Pump Station	West Branch	1,275.1	1,268.4	-6.7	NO
Wastewater Treatment Plant	West Branch	1,268.5	1,267.6	-0.9	NO
Launt Hollow Well Head	Launt Hollow	1,276.1	1,275.7	-0.4	NO
Launt Hollow Upper Pump Station	Launt Hollow	1,277.2	1,279.0	1.8	YES
Launt Hollow Lower Pump Station	Launt Hollow	1,275.1	1,276.7	1.6	YES
Wastewater Treatment Plant	Launt Hollow	1,268.5	1,270.0	1.5	YES

Flooding from the West Branch of the Delaware River only affected the Delancey pump/chlorine station, which was flooded at the 500- and 100-year events. The town reports that the Delancey pump/chlorine station is for back-up water supply only and is rarely utilized. HEC-RAS modeling indicated that the sanitary sewer pump station at Mill Street Spur was not inundated even though it is in the FEMA 100-year floodplain. However, it is most likely surrounded by floodwaters at the 100-year discharge or greater.

The only other municipal infrastructure at risk was located along Launt Hollow. The Launt Hollow well head was not inundated as its top is 2.5 feet above the ground surface. Both pump stations on the left bank were inundated at the 100-year event.

The WWTP is of special concern as it is located in the FEMA 100-year floodplain. An elevation certificate of the facility indicates that the bottom floor elevation is 1,268.5 feet. Based on hydraulic modeling, the WWTP is not inundated by floodwaters from the West Branch of the Delaware River. However, it appears that it is inundated by the 100-year discharge from Launt Hollow.

5.0 BENEFIT-COST ANALYSIS

5.1 Overview of Benefit-Cost Analysis

A BCA is used to validate the cost effectiveness of a proposed hazard mitigation project. A BCA is a method by which the future benefits of a project are estimated and compared to its cost. The end result is a benefit-cost ratio (BCR), which is derived from a project's total net benefits divided by its total project cost. The BCR is a numerical expression of the cost effectiveness of a project. A project is considered to be cost effective by FEMA when the BCR is 1.0 or greater, indicating the benefits of the project are sufficient to justify the costs.

Hydraulic model results, field visits, and FEMA floodplain mapping indicated that relatively few properties in the town of Hamden were at significant risk of inundation. Properties at risk from inundation were typically located in the floodplain of the West Branch of the Delaware River or in close proximity to Launt Hollow or Chambers Hollow.

5.2 Acquisition of Floodprone Properties

Most of the land adjacent to the West Branch of the Delaware River as well as its tributaries in the town of Hamden is productive, high-value agricultural land. Taking this land out of production to construct floodplain benches or other flood mitigation measures is not cost effective, especially given the few structures potentially prone to flooding. Additionally, as the West Branch of the Delaware River is well connected to its broad floodplain, in-channel restorations designed to enhance floodplain connectivity are unlikely to significantly reduce water surface elevations. As a result, the BCA was conducted to evaluate the economic feasibility of acquiring properties so that their respective structure or structures could be removed from the floodplain. Assumptions for the BCA include the following:

- Benefits for acquired/relocated properties were determined as acquisitions.
- Lost revenue was included only for businesses that provided such information.
- Default depth-damage curves were used in the program.
- HEC-RAS modeling provides water surface elevations at distinct cross sections. For any given building located between cross sections, water surface elevations were determined by interpolating between cross sections.
- First floor elevations were estimated using DEM topographic mapping.
- Adjustments to the DEM topography were made for buildings based on direct observations of first floors relative to adjacent grades.
- Building replacement values were based on the assessed values provided by the Delaware County Real Property Tax Services (http://www.co.delaware.ny.us/departments/tax/rolls.htm).
- The full market value of the property was determined by dividing the total assessed value by an adjustment rate of 17.95% (per Tina Mosier, Town of Hamden Assessor).
- The area of structures was estimated using aerial imagery and *ArcGIS*.
- For residential parcels with multiple structures, determination of inundation was based upon the first habitable structure on the property to become flooded.

- For typical commercial parcels with multiple structures, determination of inundation was based upon the first permanent structure on the property to become flooded.
- For agricultural properties, determination of inundation was based upon the first temporary (i.e., greenhouses) or permanent structure to become flooded.

The BCA does not include benefits that could have been generated for avoiding future street cleanup, avoided detours, avoided emergency response, etc.

Separate analyses were carried out for watercourses in the project area. In a few cases, structures may be prone to flooding from both the West Branch of the Delaware River and one of its tributaries. Costs in the BCA include the acquisition of the property based on the assessed value as well as the estimated demolition costs. Benefits were derived from the acquisition and relocation of the home or business from the floodprone area. Within the project area, structures were found to be at risk from the West Branch of the Delaware River, Launt Hollow, and Chambers Hollow. A BCA was not conducted for Bagley Brook as all habitable structures are located outside of the 100-year floodplain. Results of the BCA based on flooding from these watercourses are given in Appendix A of this report.

It is important to note that the LFA/BCA process is a general planning exercise to identify flood risks and possible mitigation efforts. BCR results in this study are dependent on the FEMA HEC-RAS models as well as the best possible information available regarding real property. Therefore, BCR values, especially those that are extremely high or low, should be viewed in the context of proximity to waterbodies, hydraulic modeling, and local topography.

Unusually high BCR values are typically due to areas of low topography. Although water surface elevations may be greater than the ground elevation of low-lying areas, floodwaters may have no actual way of reaching these locations.

Unexpectedly low BCR numbers usually occur for one of two reasons. The first is that structures may be situated on isolated areas of high ground. However, these properties may still incur flood damage as local topography directs floodwaters toward them. The second reason is that structures may be sufficiently elevated above the local ground surface. This situation often occurs with manufactured homes, which are usually elevated about 3 feet above the ground surface. Although floodwaters may not reach the first floor elevation, these homes may actually be surrounded by water impeding access or evacuation. Please refer to Section 6.2.7 for recommendations regarding manufactured homes.

Three properties are located in the FEMA defined floodway. These properties are the following:

- 37784 State Highway 10 (234.-1-45) – Green Thumb Nursery
- 166 County Route 2 (233.-1-23)
- 37032 State Highway 10 (233.-1-11.4) – Mountain Transport

Both 37784 State Highway 10 and 166 County Route 2 have been previously damaged by flooding even though the BCR of 166 County Route 2 is only 0.24. MMI recommends that both of these properties participate in the NYCDEP flood buyout program. 37032 State Highway 10 is also located in the floodway. Hydraulic modeling indicates floodwaters from the 500-year discharge reach two structures on this parcel. However, the buildings are not inundated by the 100-year event as these structures are

located on local high points in the terrain above the base flood elevation. As a result, it is not recommended that this property participate in the NYCDEP flood buyout program.

6.0 FINDINGS AND RECOMMENDATIONS

6.1 Summary of Findings

The hamlets of Hamden and Delancey in the town of Hamden have experienced repeated damages from flooding. Most recently, significant floods have occurred in 2011, 2006, 2005, and 1996. However, compared with many communities in the Catskills, extensive development has not occurred in the floodplains. The reason is that much of the floodplain areas in the town consist of high-value agricultural farmland, especially along the West Branch of the Delaware River. As a result, given the frequency and severity of flooding, there has been relatively little damage to private property and municipal infrastructure. One notable exception is the Green Thumb Nursery, which has experienced repeated flood damage.

There are nine bridges within the study area that cross the various watercourses. Hydraulic modeling indicated that these structures do not substantially contribute to raising water surface elevations or contribute to inundation. In fact, the bridge decks are typically higher than the predicted 100-year water surface elevation.

At the heart of the flood issue in the town of Hamden is development within the floodplain or in proximity to a watercourse. In short, properties or infrastructure located within the floodplain are at risk from inundation during flood events. Fortunately, the bulk of development in the hamlets of Hamden and Delancey has not occurred directly along streams or in floodplains. As a result, modeling and anecdotal evidence indicates that consistent flooding has been limited to a few areas. These areas include the following:

- The lower extent of Mill Street and Mill Street Spur
- Launt Hollow from State Route 10 to the confluence with the West Branch of the Delaware River
- Chambers Hollow from State Route 10 to the confluence with the West Branch of the Delaware River

Flooding does occur in other places along the West Branch of the Delaware River. However, it tends to affect a series of separate properties that are not in close proximity to one another. Given the distance between properties that are regularly flooded, an engineering-based solution would benefit only a few properties at most and would therefore not be cost effective. Additionally, much of the land adjacent to the West Branch of the Delaware River and its tributaries is productive, high-value agricultural land. It is not economically feasible to remove this land from production for a flood mitigation project that would have little benefit. As a result, acquisition of properties or moving properties out of floodprone areas is the most cost effective and practical method for reducing damages caused by flooding.

6.2 Recommendations

MMI has compiled a series of recommendations to improve the resiliency of the town of Hamden during and following flood events.

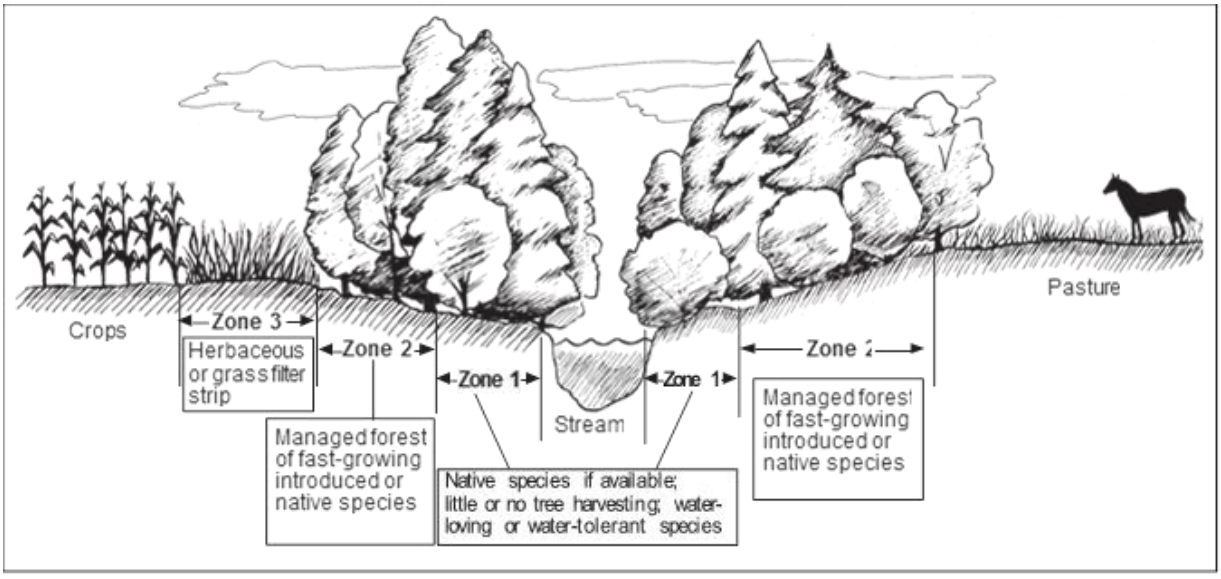
6.2.1 Riparian Buffers

The Natural Resources Conservation Service (NRCS, 2016a) defines a riparian buffer as, "a corridor of trees and/or shrubs planted adjacent to a river, stream, wetland or water body." The benefits of riparian buffers have been well documented and include the following:

- Enhancing the physical stability of the stream channel
- Providing habitat for birds, mammals, and reptiles as well as improving habitat for fish
- Improving water quality

Benefits provided by the buffer are correlated to the width of the buffer and the distance of the buffer from the waterbody.

A riparian buffer consists of three zones. Zone 1 is that area closest to the waterbody. Trees and shrubs in Zone 1 provide habitat for wildlife; contribute vegetation to the waterbody, which benefits aquatic organisms; and creates shading, which lowers water temperature. This zone helps stabilize stream banks and shorelines. Zone 2 begins at the edge of Zone 1 and extends inland. Trees and shrubs in Zone 2 (along with Zone 1) intercept sediment, nutrients, pesticides, and other pollutants in subsurface and surface water flows. A third zone, Zone 3, may be established if periodic and excessive water flows, erosion, and sediment from upslope fields or tracts are anticipated. Zone 3 is generally of herbaceous plants or grass and a diversion or terrace, if needed. This zone provides a "first defense" to assure proper functioning of Zones 1 and 2 (NRCS, 2016b) (Figure 6-1).



(NRCS 2016b)

Figure 6-1: Example of a Riparian Area

The physical benefit of a riparian buffer to a stream has been shown to include increased channel stability, reduced stream bank erosion, and reduced channel migration. Scientific studies have found that intertwining roots within a stream bank can increase stream bank strength, increase resistance to erosion caused by high flows, and provide greater channel stability (Sweeney and Newbold, 2014). One

study found that following major floods bank erosion was 30 times more prevalent on stream bends without forests than those with forests (Beeson and Doyle, 1996). Other studies have also shown that forested stream reaches exhibit slower channel migration and thus provide more stability than deforested channels (Hession, et al., 2003; Allmendinger, et al., 2005). The NRCS (2016a,b) notes that stabilized stream banks also help maintain the geometry of the stream including characteristics such as the meander length and profile.

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

In terms of the vegetation making up the riparian buffer, the NRCS (2016a) recommends utilizing native species, if available, that are as follows:

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

The benefits of riparian buffers to habitat include providing food and cover for wildlife and shade that helps to lower water temperatures. Buffers can also increase habitat diversity in several ways; the addition of large woody debris to a stream provides habitat to a range of species, and a reduction in sedimentation helps prevent silt from covering large rocks or stones and from filling pools in the stream bed, both of which serve as habitat.

In terms of improvements to water quality, buffers have been shown to protect water resources from pollutants in surface runoff such as sediment and nutrients. Vegetated riparian buffers serve to slow water velocity, thus allowing sediment to settle out of the runoff water. The nitrogen and phosphorus attached to the sediment settle out of the surface runoff as well. To a lesser extent, dissolved nitrogen, phosphorus, and other pollutants can be sequestered, degraded, and processed by the riparian buffer.

Many of the agricultural fields along the watercourses within the study area extend very close to the stream channel leaving little to no riparian buffer. During field visits, stream bank instability and erosion were noted in these areas, particularly along the West Branch of the Delaware River. The establishment of riparian buffers is recommended to help prevent the loss of agricultural area due to bank erosion and mitigate agricultural runoff into neighboring waterbodies.

6.2.2 Bank Erosion and Channel Instability

Bank erosion and channel instability are an ongoing problem along the West Branch and its tributaries. In addition to the establishment of riparian buffer described above, the following measures are recommended:

- It is recommended that the town work cooperatively with DCSWCD to conduct a watershed assessment of Bagley Brook to evaluate the problem of channel instability and sediment contribution to the West Branch.

- It is recommended that the town work cooperatively with DCSWCD to conduct stream feature inventory and assess the need for bank stabilization measures along tributaries flowing under Route 10 and entering the West Branch.

6.2.3 Delaware County Fire Training Facility

The Delaware County Fire Training Facility is a critical facility in the town of Hamden. It is particularly important in regard to disaster response including flood events. The facility has at least two vehicle bays/equipment storage buildings that contain vehicles and equipment that would be used in disaster or emergency response scenarios.

Much of the Delaware County Fire Training Facility is located in the 100-year floodplain (Figure 6-1). Due to its location near the confluence of Chambers Hollow and the West Branch of the Delaware River, the facility has the potential to be inundated at flows less than the 100-year event. As a result, access to critical vehicles and equipment may be impaired during flood events. If possible, it is recommended that critical equipment be moved to a location where it could easily be retrieved during a flood event.

If these structures will continue to be utilized for equipment storage, MMI recommends that they be wet floodproofed. Structures that are wet floodproofed do not need to be elevated and are subject to different requirements. Guidance for wet floodproofing includes the following:

- The buildings must have openings to allow floodwaters in and out.
- The building must be constructed of flood-resistant materials below the base flood elevation.
- The building must be adequately anchored to resist floatation, collapse, and lateral movement.
- All electrical and heating utility equipment must be elevated or floodproofed.

For further guidance, see page 5-44 of the NFIP Floodplain Management Requirements.

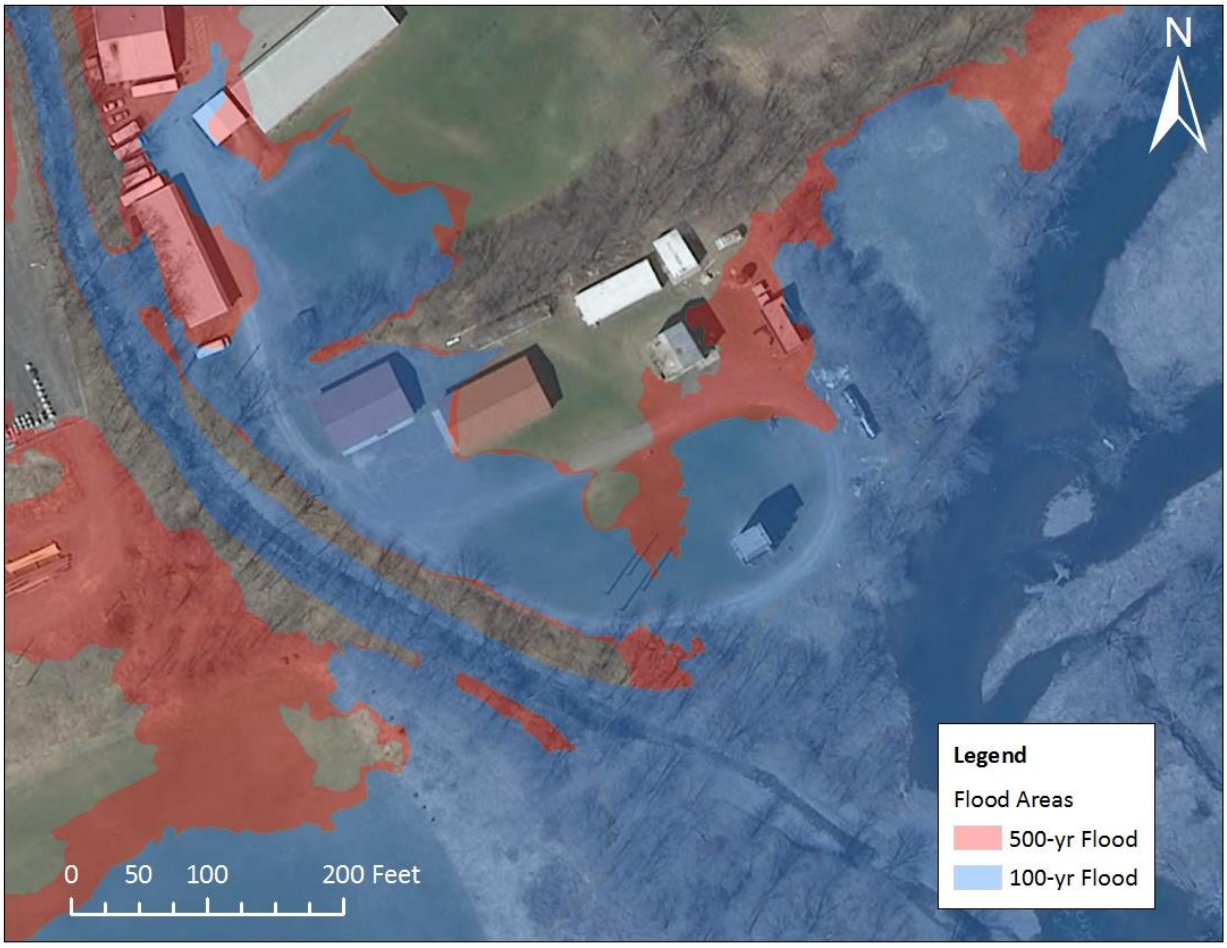


Figure 6-1: Delaware County Fire Training Facility and 500-Year and 100-Year Flood Extents

6.2.4 Emergency Response Equipment Staging

Based on the FEMA FIS and HEC-RAS model, the three bridges over the West Branch of the Delaware River in the town of Hamden are not overtopped by the 100-year flood. However, hydraulic modeling reveals that the approaches to the County Route 2, Basin Clove Road, and County Route 26 bridges over the West Branch of the Delaware River are inundated by the 10-year event. As a result, it may not be possible for emergency responders to access residents on the east side of the West Branch of the Delaware River.

There are approximately 77 homes on the east side of the West Branch of the Delaware River within the extent of the project area. The nearest crossing that is likely to be accessible during major flood events is the Kingston Street bridge in Delhi, which is 6.5 miles north of the County Route 2 bridge. Use of this bridge by emergency responders could result in significant delays. As a result, MMI recommends that emergency response vehicles and equipment are stationed on both sides of the West Branch of the Delaware River.

6.2.5 Road Closures

Flooding of roadways during previous flood events has been reported at several locations including the County Route 2, Basin Clove Road, and County Route 26 bridges over the West Branch of the Delaware River. Approximately 75% of all flood fatalities occur in vehicles. Shallow water flowing across a flooded roadway can be deceptively swift and wash a vehicle off the road. Water over a roadway can conceal a washed out section of roadway or bridge. When a roadway is flooded, travelers should not take the chance of attempting to cross the flooded area. It is not possible to tell if a flooded road is safe to cross just by looking at it. It is recommended that risks associated with the flooding of roadways be reduced by temporarily closing floodprone roads during flooding events. This requires effective signage, road closure barriers, and consideration of alternative routes.

It is also recommended that when these bridges are due for replacement they be evaluated and designed to ensure that flooding does not overtop the approaches to the bridges at these locations.

6.2.6 Water Quality Recommendations

In addition to helping communities identify and mitigate flood hazards, the LFA program mandate includes protecting water quality in the New York City water supply watershed. In order to protect water quality during flood events, MMI recommends the following:

- Propane, oil, and other fuel tanks should be securely anchored.
- Equipment that has the potential to be washed away in a flood (i.e., generators, snowmobiles, ATVs, construction equipment, etc.) should be securely anchored, housed in a shed/garage, or stored outside of the 100-year flood boundary.
- Fueling facilities should be securely anchored and raised or protected with a barrier to prevent contact with floodwaters (i.e., fueling facilities at the Delaware County Arc).
- Equipment at the NYSEG facility along Chambers Hollow (transformers, telephone poles, etc.) should be stored to prevent contact with floodwaters.

6.2.7 Flood/Disaster Notification System

A flood warning/disaster notification system can provide residents with advance notice of a flood event. Such a system would facilitate evacuation and preparation efforts in response to a flood or other natural disaster. Some nearby counties have established reverse 9-1-1 systems, which provide emergency notification. Landlines are automatically registered with the program, and cell phone users can register on the county's website. Residents can choose how to be alerted (phone call, text message, or email). There is also an option to list special needs such as identifying someone using oxygen or a ventilator.

If such a notification system exists within Delaware County, residents of the town of Hamden should be made aware of it. If such a system does not exist, MMI recommends that such a system be established at the county level.

6.2.8 Buyouts and Relocations

In some cases, the best solution to avoiding future flood damages is the acquisition (through a voluntary buyout) of a floodprone home or business and the relocation of its use to another location within the town that is outside of the SFHA. The New York City Funded Flood Buyout Program (described in more detail in the funding recommendations section of this report) is a voluntary program intended to assist property owners who were not eligible for or chose not to participate in the FEMA flood buyout program. Home and business owners in Hamden who have been flooded and have expressed interest in the flood buyout program are encouraged to work with the town, NYCDEP, and CWC.

Two specific properties in Hamden are recommended for buyout. They are the following:

- 37784 State Highway 10 (Green Thumb Nursery)
- 166 County Highway 2 (Bell property)

If these properties were to be acquired and the structures removed, the sites should be considered for floodplain restoration.

6.2.9 Individual Property Flood Protection

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

The Town of Hamden should identify parcels, as part of a community wide pollution protection program, which could benefit from securing or relocating fuel tanks to eliminate a potential source of man-made pollution. Funding can be applied for through the Catskill Watershed Corporation. Additionally, the town should work to identify and remove vacant and abandoned structures and their remaining fuel tanks to prevent future hazards.

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

Elevation of the structure – Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the level of the 100-year flood event. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first floor level or installed from basement joists or similar mechanism at an elevation no less than 1 foot above the base flood elevation.

Construction of property improvements such as barriers, floodwalls, and earthen berms – Such structural projects can be used to prevent shallow flooding. There may be properties within the town

where implementation of such measures will serve to protect structures. Such barriers must not be permitted unless designed by a qualified engineer and shown to comply with NFIP/local floodplain laws.

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

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

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

- Relocate valuable belongings above the 100-year flood elevation to reduce the amount of damage caused during a flood event.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the base flood elevation (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- Elevate the electrical box or relocate it to a higher floor, and elevate electric outlets to at least 12 inches above the high water mark.

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

Maintaining Local Drainages – It is recommended that drainage ditches and catch basins be maintained and cleaned on a regular basis to reduce localized flooding.

6.2.10 Manufactured Homes

The potential risk to manufactured homes, in general, warrants consideration. According to FEMA guidance, manufactured homes located in the 100-year flood zone should, "be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated to or above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse and lateral movement (FEMA, 2009)." FEMA recommends that the best way to meet this requirement is to elevate the bottom of the steel frame to the height of the 100-year water surface elevation. An exception to this guidance is given for lots in existing manufactured home parks. In this

case, homes must be properly elevated no less than 36 inches above grade unless special conditions apply (FEMA, 2009). For specific guidance, refer to FEMA documentation regarding manufactured homes, which may be found online at https://www.fema.gov/media-library-data/20130726-1502-20490-8377/fema_p85.pdf.

6.2.11 Bridge Opening Maintenance

Bridge openings that are even partially blocked have the potential to cause flooding due to backwater effects. Therefore, MMI recommends that bridges on the tributaries to the West Branch of the Delaware River should be periodically inspected to verify that they have not lost capacity. Table 4-2 provides recommendations for when maintenance actions should be taken to clear bridge openings on Bagley Brook, Launt Hollow, and Chambers Hollow. No recommendations were given for the box culvert that carries Covert Hollow under State Highway 10 as there is no effective FEMA HEC-RAS model for this stream. However, this culvert should also be regularly inspected for blockages. Note that these are general guidelines and that it may be warranted to clear bridge openings sooner than the table recommends.

When removal of sediment at bridges is necessary, a methodology should be developed to maintain the proper channel dimensions and slope. This is crucial to avoid destabilizing the physical channel, which could have long-term effects. As a starting point, the following guidelines are recommended:

1. Sediment excavation requires regulatory permits. Prior to initiation of any in-stream activities, NYSDEC should be contacted, and appropriate local, state, and federal permitting should be obtained.

2. Maintain the original channel slope and do not overly deepen or widen the channel. Excavation should not extend beyond the channel's estimated bankfull width unless it is to match an even wider natural channel.

3. Best available practices should be followed to control sedimentation and erosion of the stream bed or bank, which may release fine-grain sediments that cause turbidity.

4. Disposal of excavated sediments should always occur outside of the floodplain. If such materials are placed on the adjacent bank, they will be vulnerable to remobilization and redeposition during the next large storm event.

5. No sediment excavation should be undertaken in areas where aquatic-based rare or endangered species are located.

6.2.12 Measuring Discharge and Stage on the West Branch

The USGS gauges on the West Branch in Walton and upstream of Delhi should be used by town officials, emergency responders, and Hamden residents as an alert system to predict flooding. Real-time gauge information can be accessed at the following sites:

West Branch Delaware River at Walton, New York:
https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=01423000

West Branch Delaware River upstream of Delhi, New York:
https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=01421900

The distance between Hamden and either of these gauges is quite far, making accurate recording of stage and discharge at Hamden difficult. Many of the USGS stream gauges within the New York City water supply watershed are funded through a cooperative agreement between USGS and NYCDEP. It is recommended that the town work with NYCDEP and USGS to explore the possibility of the installation of a stream gauge on the West Branch in Hamden.

6.3 Descriptions of Funding Sources and Resources

Several funding sources may be available to the Commission, the Town of Hamden, and Delaware County and its departments for the implementation of recommendations of this plan.

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

FHM is a funding category in the Stream Management Implementation Program for LFA communities and those participating in the New York Rising Community Reconstruction Program. Municipalities may apply to implement one or more recommendations contained in their LFA and approved by the municipal board. All projects must have modeled off-site flood reduction benefits. Eligible projects include the following:

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

Ineligible projects include construction of flood walls, berms, or levees; stream dredging; routine annual maintenance; or replacement of privately owned bridges, culverts, or roads. Municipalities must apply to the Stream Management Program in their respective county. Contact information is as follows:

M. Graydon Dutcher
Stream Program Coordinator
Delaware County Soil and Water Conservation District
44 West Street, Suite 1
Walton, NY 13856
Ph. 607-865-5223
Fax 607-865-5535
graydon-dutcher@dcswcd.org

NYC Funded Flood Buyout Program

The New York City Funded Flood Buyout Program (NYCFFBO) is a voluntary program intended to assist property owners who were not eligible for or chose not to participate in the FEMA flood buyout

program. It is intended to operate between flood events, not as an immediate response to one. Categories of eligible properties include the following:

1. Properties identified in community LFAs
2. Anchor businesses, critical community facilities, and LFA-identified properties applying to the CWC for relocation assistance
3. Properties needed for a stream project
4. Erosion hazard properties
5. Inundation properties

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

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

Local Flood Hazard Mitigation Implementation Program

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

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

Eligible LFA-derived projects could include the following:

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

Property owners may apply for the following assistance:

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

Sustainable Community Planning Program

This CWC program is for municipalities that have prepared LFAs. It is intended to fund revisions to local zoning codes or zoning maps or to upgrade comprehensive plans in order to identify areas within those municipalities that can serve as new locations for residences and/or businesses to be moved after purchase under the voluntary NYC Funded Flood Buyout Program. Grants of up to $20,000 are available through this program, part of the CWC's Local Technical Assistance Program.

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's NRCS can help communities address watershed impairments that pose imminent threats to lives and property. Most EWP work is for the protection of threatened infrastructure from continued stream erosion. NRCS may pay up to 75% of the construction costs of emergency measures. The remaining costs must come from local sources and can be made in cash or in-kind services. EWP projects must reduce threats to lives and property; be economically, environmentally, and socially defensible; be designed and implemented according to sound technical standards; and conserve natural resources.

FEMA Pre-Disaster Mitigation (PDM) Program

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

FEMA Hazard Mitigation Grant Program (HMGP)

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

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

FEMA Flood Mitigation Assistance (FMA) Program

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

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

- The definitions of repetitive loss and severe repetitive loss properties have been modified.

- Cost-share requirements have changed to allow more federal funds for properties with repetitive flood claims and severe repetitive loss properties.
- There is no longer a limit on in-kind contributions for the nonfederal cost share.

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

NYS Department of State

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

U.S. Army Corps of Engineers (USACE)

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

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

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

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

- Section 206 – Floodplain Management Services: This section of the 1960 Flood Control Act, as amended, authorizes the USACE to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain

resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100% federally funded.

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

Other Potential Sources of Funding

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

New York State Grants – All New York State grants are now announced on the NYS Grants Gateway (a direct link is in the "Links Leaving DEC's Website" section of the right-hand column of this page). The Grants Gateway is designed to allow grant applicants to browse all NYS Agency anticipated and available grant opportunities, providing a one-stop location that streamlines the way grants are administered by the State of New York.

Community Development Block Grant (CDBG) – The Office of Community Renewal administers the CDBG program for the State of New York. The NYS CDBG program provides financial assistance to eligible cities, towns, and villages in order to develop viable communities by providing affordable housing and suitable living environments as well as expanding economic opportunities, principally for persons of low and moderate income. It is possible that the CDBG funding program could be applicable for floodproofing and elevating residential and nonresidential buildings, depending on eligibility of those buildings relative to the program requirements.

Empire State Development – The state's Empire State Development program offers loans, grants, and tax credits as well as other financing and technical assistance to support businesses and encourage their growth. It is possible that the program could be applicable for floodproofing, elevating, or relocating nonresidential buildings, depending on eligibility of those businesses relative to the program requirements.

Private Foundations – Private entities such as foundations are potential funding sources in many communities. The Commission will need to identify the foundations that are potentially appropriate for some of the actions proposed in this report.

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

Land Trust and Conservation Groups – These groups play an important role in the protection of watersheds including forests, open space, and water resources.

NYSDEC "Trees for Tribs" Program – DEC's Trees for Tribs offers low-cost to no-cost native trees and shrubs for streamside restoration. The program also offers free technical assistance that includes plant selection and designing a site planting plan. Native bare root trees and shrubs are provided by the Saratoga State Tree Nursery. The goal of the program is to plant young trees and shrubs along stream corridors to prevent erosion, increase floodwater retention, improve wildlife and stream habitat, and protect water quality. The program emphasizes comprehensive watershed restoration designed to protect "green infrastructure" and serves as the first line of defense against storm and flooding events, protecting property, water quality, and fish and wildlife habitat. The program also promotes best management practices and encourages tributary protection.

As the recommendations of this LFA are implemented, the Commission and Town of Hamden will need to work closely with potential funders to ensure that the best combinations of funds are secured for the modeled alternatives and for the property-specific mitigation such as floodproofing, elevations, and relocations.

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APPENDIX A

BCA RESULTS

The results of the BCA for the West Branch of the Delaware River, Launt Hollow, and Chambers Hollow are given in Tables A-1, A-2, and A-3, respectively. A BCA was not conducted for Bagley Brook as analysis of the hydraulic modeling data indicated that no structures were at even moderate risk of incurring flood damage under present conditions.

TABLE A-1
Estimated Costs, Benefits, and Benefit-Cost Ratio for Acquisitions along the West Branch of the Delaware

Tax ID/SBL	Assessed Property Value ($)	Cost: Assessed Value plus Demo Costs ($)	Benefit ($)	BCR
234.-1-45	119,287	139,287	399,292	2.87
233.-1-23	206,128	226,128	54,524	0.24
234.-1-44	114,880	124,880	34	0.00
234.3-2-1	44,568	54,568	1,484	0.03
234.3-2-2	139,276	159,276	3,666	0.02
234.3-1-2	128,134	148,134	1,225	0.01
234.3-1-1	167,131	187,131	13,686	0.07
254.2-3-18	97,493	117,493	177,248	1.51
254.2-3-14.3	100,000	140,000	89,030	0.64
254.2-3-23	100,279	120,279	27,533	0.23
254.2-3-24	83,565	103,565	11,520	0.11
254.2-3-25	122,563	142,563	0	0.00
254.-1-19	241,426	261,426	17,820	0.07
254.-1-13.2	3,342,618	3,442,618	771,116	0.22
254.-1-12	108,635	128,635	492	0.00
253.-1-10	111,421	131,421	12,340	0.09
253.-1-11	111,421	131,421	46,405	0.35
Total	5,338,826	5,758,825	1,627,415	0.28

TABLE A-2
Estimated Costs, Benefits, and Benefit-Cost Ratio for Acquisitions along Launt Hollow

Tax ID/SBL	Assessed Property Value ($)	Cost: Assessed Value plus Demo Costs ($)	Benefit ($)	BCR
254.-1-16.11	250,696	310,696	123,680	0.40

As shown in the table above, only one parcel was at substantial risk of flooding from Launt Hollow. Upstream of State Highway 10, no structures are located within the 100-year flood boundary. Downstream of the highway, structures on the left bank are not in substantial risk of flooding due to the elevation of the stream bank and neighboring hillslope. Although the first floor elevation of the Delaware Opportunities building is lower than the return interval floodwater surface elevation, the hydraulic model indicates that flows remain in the channel.

TABLE A-3
Estimated Costs, Benefits, and Benefit-Cost Ratio for Acquisitions along Chambers Hollow

Tax ID/SBL	Assessed Property Value ($)	Cost: Assessed Value plus Demo Costs ($)	Benefit ($)	BCR
254.-1-35	2,813,370	2,913,370	144,006	0.05
254.-1-34.1	9,184,830	9,304,830	4,381,796	0.47
254.-1-34.2	1,426,184	1,456,184	9,265,842	6.36
Total	13,424,384	13,674,384	13,791,644	1.01

Along Chambers Hollow, property 254.-1-34.2 (Arc Fire Training Facility) has an extremely high BCR of 6.36. The first floor elevations of the two large buildings on the facility are technically lower than the water surface elevations of the return interval floods. However, the hydraulic model shows that floodwater elevations are less than the elevations of the berms along the banks indicating that large discharges typically remain in the channel. As a result, the BCR should probably be much lower. However, if the berm along the bank was breached or the bank collapsed, the Fire Training Facility would be flooded.

APPENDIX B

***POWERPOINT* PRESENTATIONS AND MEETING MINUTES**

DATE: March 22, 2016
TIME: 6:00pm
MMI #: 5197-08
PROJECT: Hamden LFA

SUBJECT: Flood Advisory Commission Meeting

LOCATION: Hamden Town Hall

A kickoff meeting was held on the evening of March 22, 2016, for the Hamden Local Flood Analysis (LFA) project. In attendance were Mark Carabetta and Vernon Bevan from Milone & MacBroom, Inc. (MMI); Graydon Dutcher and Jessica Rall from Delaware County Soil & Water Conservation District (DCSWCD); Phil Eskeli from New York City Department of Environmental Protection (NYCDEP); Hamden Town Supervisor Wayne Marshfield; Hamden Superintendent of Highways Roger Dibble; and members of the Hamden Flood Advisory Commission (FAC).

The purpose of the meeting was to:

- Review the study area including flood prone areas
- Introduce existing conditions modeling
- Collect information about flooding and flood damages
- Collect information about sediment and debris jams that contribute to flooding
- Discuss potential flood mitigation strategies
- Requests information to be used in Benefit-Cost Analysis
- Discuss schedule, format and goals for public meeting

Mark and Vernon presented slides showing the various focus areas and bridges of interest within the study area. FAC members provided information relating to past flooding and flood-related damages at each area.

The two most recent floods of significance occurred in 1996 and 2006. Using work that DCSWCD has done to calibrate flows in Hamden with upstream and downstream USGS gauges, a determination will be made as to the return interval of both floods.

County Route 2 bridge over West Branch Delaware River – The hydraulic model indicates that while the bridge does not overtop in large floods, the road to the north (river right) overtops. It was noted that the effective FEMA hydraulic model does not include the floodplain culverts, which were put in place when the road was raised in ~2001. The Delaware County DPW has as-built plans, which can be acquired so that the culverts can be added to the hydraulic model.

Basin Clove Road (covered bridge) over West Branch – The bridge was originally built in 1859 and was rebuilt and raised up in 2000. It was noted that bankfull flow events overtop the floodplain upstream of the bridge and flow across the floodplain area river left of the bridge. This results in inundation of Basin Clove Road on the east side of the river.

County Route 26 bridge over West Branch – There is a high bank failure on the left, just upstream of the bridge. There is no record of this bridge overtopping, but in 1999 there was some ice jamming at the bridge and ice was deposited on the floodplain to the right of the bridge. The model indicates that during large floods the road to the right of the bridge overtops. This occurred in the 2006 flood, which led to the portion of town across the West Branch being isolated from the rest of Hamden.

County Route 10 culvert over Chambers Hollow – The box culvert typically passes flood flows (as FEMA model indicates), however in 2006 flood the culvert became partially blocked by several large trees, which entered the stream as a result of extensive bank failures upstream of the project area. Flows overtopped the culvert and ran along the north side of Route 10 and caused flood damage to a residence.

Chambers Hollow near confluence with West Branch – The snowmobile bridge spanning Chambers Hollow adjacent to the fire training facility may be acting as a hydraulic constriction. It is typically closed (barrier has been placed across it) and could potentially be relocated or removed. Previous floods have jumped the right bank of Chambers Hollow and may be influenced by backwater from West Branch. NYSEG experienced flooding in 2006, possibly due to debris jams. Contact there is Dave Simmonds. There is no known history of flooding damage at the garages and bus parking area behind Delaware ARC.

County Route 10 culvert over Launt Hollow – FEMA model indicates that the 100-year flood remains in the channel while the 500-year flood overtops the right bank and causes flooding of one structure and surrounds another. Town occasionally (approximately every three years) removes sediment at the downstream side of this 4-sided box culvert, extending approximately 350 feet downstream. Channel dimensions are provided by DCSWCD. Permit is obtained. It has been about three years since removal took place so it is due to be done soon. In 2007 or 2008 there was a project to reconstruct the channel downstream of the culvert, with installation of a floodplain bench and riparian plantings.

Launt Hollow near confluence with West Branch – Delaware Opportunities and the Hamden WWTP are both located within the floodplain in this area. Neither building was present in the 1996 flood. In 2006, floodwaters came within inches of the first floor of Delaware Opportunities (which is slab on grade) along the rear of the building.

County Route 10 culvert over Covert Hollow – This watercourse was mapped by FEMA using approximate methods and therefore there are no detailed FEMA maps or profiles. However, there is a rough FEMA model, which does not include the culvert. There is no record of this culvert having clogged or overtopped, however a pickup truck was carried through it by floodwaters. It is possible that it has gradually filled with sediment. Measurements can be taken of culvert and it can be fitted into a model. Observation indicate that floodwaters may be jumping out of channel at a point further upstream and therefore all of the flow is not reaching the culvert.

Bagley Brook – In 1996 flood a large deposit of sediment was dropped along Bagley Brook near its confluence with the West Branch, causing the stream to change course. The source of material was a large bank failure upstream of the Back River Road bridge. In 2006, the channel upstream of the Back River Road bridge became clogged with gravel from bank failure and floodwaters ran across Route 2, along Back River Road and across farm fields back to the West Branch. Flow continued

along this course until the channel was unplugged. No problems reported at Route 2 bridge over Bagley Brook. See arrow on map indicating approximate flow path.

Other properties and areas of interest

Mountain Transport, Inc., located near Covert Hollow, had their grounds flooded in 2006 but the structure was not flooded. There is some clarification needed as to whether an elevation certificate would document that they are above the base flood elevation.

Green Thumb greenhouses are located in floodway. Railroad berm way offer some protection. May be subject to backwater from Route 2 bridge.

There are two floodprone homes located along Mill Street (one vacant?). There is a homeowner-constructed berm alongside these homes. Approximate location is drawn on map.

There is a sanitary sewer pump station located on Mill Street close to or in the 100-year floodplain (see map).

There is a town-owned stormwater pump station located just downstream of the covered bridge on river right, in the 100-year floodplain (see map). There are no reported problems with stormwater backcharging into the stormwater system during a flood.

There is a municipal water supply well head located near Launt Hollow (see map). Appears to be in the 100-year floodplain but may be elevated above base flood elevation.

FAC members are going to check whether design plans or elevations exist for Delaware Opportunities, the Hamden WWTP, and the municipal well heads. Contact at Delaware Opportunities is John Eberhardt, Executive Director, at 607-746-1601.

Discussion about approach, timing and format for public meeting. Date: Thursday, May 5, 6pm. FAC will send invites to business owners, effected landowners, ARC, NYSEG, and Delaware Opportunities. MMI will bring large-format maps and collect input on flooding and damages.

Request was made by MMI for information that will later be used for Benefit-Cost Analysis:

- Elevation certificates, if available
- Anything that provides building elevation data such as site plan applications, bridge or road projects (sometimes the corners of buildings are picked up by surveyors), sewer and water system plans, etc.
- For businesses, annual revenue and the amount of time they were shut down after recent floods
- For businesses that are able to provide it, other flood losses such as damaged inventory
- For bridges, flood-related repair costs, lengths and dates of closures and detours

Meeting ended at approximately 8pm.

DATE: May 5, 2016
TIME: 6:00pm
MMI #: 5197-08
PROJECT: Hamden LFA

SUBJECT: Public Meeting

LOCATION: Hamden Town Hall

A public meeting was held on the evening of May 5, 2016, for the Hamden Local Flood Analysis (LFA) project. In attendance were Mark Carabetta and Vernon Bevan from Milone & MacBroom, Inc. (MMI); Graydon Dutcher and Jessica Rall from Delaware County Soil & Water Conservation District (DCSWCD); Phil Eskeli and Nate Hendricks from New York City Department of Environmental Protection (NYCDEP); Hamden Town Supervisor Wayne Marshfield; Hamden Superintendent of Highways Roger Dibble; Hamden Code Enforcer and Floodplain Manager Mark Jacobs; Chairman of the Town of Hamden Flood Commission Richard Smith; additional members of the Hamden Flood Advisory Commission (FAC) and residents from the Town of Hamden.

The purpose of the meeting was to introduce the Local Flood Analysis and Benefit Cost Analysis (BCA) processes to residents of the Town and to solicit information regarding flooding within the Town of Hamden. Information collected this public meeting will be used to supplement and confirm information gathered by MMI during the kickoff meeting with FAC members on March 22.

The meeting was brought to order by Richard Smith. After a brief introduction, he turned the meeting over to Graydon Dutcher. Graydon briefly described the LFA process and gave examples of the type of information that may be useful in moving the project forward.

Mark presented a slide show that outlined the LFA and BCA processes and highlighted the area of concern which are primarily bridges, municipal infrastructure and municipal and private facilities. He also covered LFA data needs and outcomes of the process.

Following the presentation, residents of the town discussed their experiences with flooding in an open forum. In addition to the notes below, information was collected on a series of large format maps.

West Branch of the Delaware – No additional information was collected on property inundation along the West Branch of the Delaware. However, residents did express concern with the state of the river in general. Residents were concerned with the following issues:

- Near the confluence with Bagley Brook, the channel has moved towards County Route 10
- Willows planted along the bank for stabilization are dying
- Accumulation of sediment in the channel, especially upstream of the County Route 2 Bridge

Bagley Brook – In regards to Bagley Brook, most of what was presented supported information passed to MMI during the March 22, Kickoff meeting. At some point in the recent past (date undetermined), the course of Bagley Brook near the confluence changed. Originally, it paralleled the West Branch of the Delaware for a short distance before joining the river. During a flood event

(prior to 1993 based on Google Earth), the stream changed course so that it intersected the West Branch almost perpendicularly. This caused a large gravel bar to form which pushed the West Branch of the Delaware towards County Route 10 (this can be seen in Google Earth).

In 2006, the channel upstream of the Back River Road bridge became clogged with gravel due to a bank failure and floodwaters ran across Route 2, along Back River Road and across farm fields back to the West Branch. Flow continued along this course until the channel was unplugged. No problems reported at Route 2 bridge over Bagley Brook.

Except for flooding in 2006 which was caused by bank failure, Bagley Brook appears to remain in the channel. No other instance of flooding in Delancey were reported.

Covert Hollow – Residents report that Covert Hollow is accumulating gravel which is periodically removed. Accumulation of gravel is occurring primarily at two locations. This first location is at the County Route 10 culvert. The second location occurs about 700 feet downstream of County Route 10 where the stream makes a sharp turn to the right. Although residents report gravel accumulation, there is little account of properties flooding. The only instance of reported flooding occurred when an ice jam clogged the culvert and one or two properties immediately upstream of the County Route 10 experienced some flooding. The culvert does become clogged and overtops quite often.

Launt Hollow – No instances of property inundation were identified along Launt Hollow. At the previous meeting with the Hamden Flood Advisory Committee, it was noted that during the 2006 event, floodwaters came within inches of the first floor of Delaware Opportunities along the rear of the building.

Chambers Hollow – During the 2006 flood, it was reported that water was at the front door of the ARC, but the facility was not actually inundated. It was pointed out that the snowmobile bridge that spans Chambers Hollow in the vicinity of the Fire Training Facility is built upon the abutments of the old railroad line.

Other properties and areas of interest

Mountain Transport, Inc., located near Covert Hollow, had minor flooding on their grounds in the 2006 event. Floodwaters did not come near the building itself. According to the owner, during the 1996 event, floodwaters did not reach the top of the railroad track. Also, the owner of the property at that time put a railroad spike in a telephone pole to mark the upper extent of the floodwaters. The present owner reported that he had his property surveyed for an elevation certificate. However, there is some clarification needed as to whether an elevation certificate would document that they are above the base flood elevation.

Overall, there was little evidence of widespread flooding in the town and residents only identified a few structures that had flooded or were at imminent risk of flooding.

Additional notes were taken on a set of large-format maps. One set of the maps was kept by MMI and another was left with the FAC.

The meeting ended at approximately 8:30 PM.

DATE: August 2, 2016
TIME: 5:30pm
MMI #: 5197-08
PROJECT: Hamden LFA

SUBJECT: Flood Advisory Commission Meeting

LOCATION: Hamden Town Hall

A meeting of the Hamden Flood Commission was held on the evening of August 2, 2016, for the Hamden Local Flood Analysis (LFA) project.

The purpose of the meeting was to:

- Share and discuss preliminary hydraulic modeling results, including:
  - baseline flood elevations at structures and facilities
  - hydraulic analysis of bridges
- Gather additional information on structures, elevations, locations and flood damages
- Discuss flood mitigation scenarios

Mark Carabetta and Vernon Bevan of Milone & MacBroom, Inc. (MMI) presented slides showing the various structures and facilities identified during the previous meetings, and compared the elevations of these structures to base flood elevations. Following is a summary of the discussion:

- Green Thumb Garden Center is flooded by over 5 feet depth during the 100-year flood, and is also in the Floodway.

- The chlorine/pump station is shown to be flooded by less than 1 foot, based on a ground elevation collected at this location. DCSWCD to collect an elevation at this point.

- Municipal Well #1 does not flood during the 100-year flood based on a ground elevation collected at this location. DCSWCD to collect an elevation at the well. This is a secondary, back-up well that only turns on in the event of a spring system failure.

- Mountain Transport is shown to be dry during the 100-year, but is also located within the floodway. This seems unlikely and will be verified.

- The stormwater pump station is shown to be dry during the 100-year flood.

- The sanitary pump station is shown to be dry during the 100-year flood.

- Municipal Well #2 does not flood during the 100-year flood from the West Branch, but is flooded by over a foot from Launt Hollow. This needs to be verified with a more accurate elevation. DCSWCD to collect an elevation at the well. This well system consists of two

wells, which alternate and supplement the spring wells on the mountainside. They are used daily during summer but are not usually used in winter. No flooding has ever been observed at this location.

- The waste water treatment plant does not flood from the West Branch or from Launt Hollow. Elevation of the plant is based on an elevation certificate, which was put in place prior to the development of FIRM maps on Launt Hollow.

- Delaware Opportunities is shown to be inundated by 1.4 feet from the West Branch, and by over 3 feet from Launt Hollow.

- The main building at ARC is dry during flood events on both the West Branch and Chambers Hollow.

- Secondary buildings at ARC are not flooded by the West Branch, but one is flooded by less than one foot from Chambers Hollow. It was pointed out that one of these buildings is a maintenance/storage facility, which may contain chemicals or other potential pollutants if they were to be mobilized in a flood.

- Modeling indicates that both structures at the fire training facility are flooded from Chambers Hollow.

- NY SEG is flooded by 0.2 feet from Chambers Hollow.

Mark and Vernon also presented slides showing the various bridges of interest within the study area, and the results of hydraulic modeling. A summary of the results follow:

- County Route 2 bridge over West Branch Delaware River – The hydraulic model indicates that while the bridge does not overtop in large floods, the road to the north (river right) overtops. This occurred in the 2006 flood, which led to the portion of town across the West Branch being isolated from the rest of Hamden. The effective FEMA hydraulic model did not include floodplain culverts. Delaware County DPW provided as-built plans, and MMI added the culverts to the hydraulic model. The model shows that when the bridge is removed, water surface elevation drops by 1.4 feet at the bridge, by 0.8 feet at the chlorine pump station, and by 0.6 feet at Green Thumb. MMI will investigate whether raising the approach road and/or fitting a larger box culvert would prevent the road from overtopping during a large flood.

- Basin Clove Road (covered bridge) over West Branch – Bankfull flow events overtop the floodplain upstream of the bridge and flow across the floodplain area river left of the bridge. Removal of the bridge from the model resulted in a reduction of 0.4 feet, and no structures benefited.

- County Route 26 bridge over West Branch –The model indicates that during large floods the road to the right of the bridge overtops. This occurred in the 2006 flood, which led to the portion of town across the West Branch being isolated from the rest of Hamden. Removal

of the bridge from the model resulted in a reduction of 1.1 feet, and no structures benefited.

- County Route 2 over Bagley Brook - Removal of the bridge from the model resulted in a reduction of 0.7 feet, and no structures benefited.

- Back River Road over Bagley Brook - Removal of the bridge from the model resulted in a reduction of 0.2 feet, and no structures benefited. It was noted that this bridge is prone to both sediment aggradation and woody debris jams. MMI will model the bridge opening under a partially blocked condition.

- State Route 10 culvert over Launt Hollow – FEMA model indicates that the 100-year flood remains in the channel while the 500-year flood overtops the right bank and causes flooding at a number of structures. Town occasionally (approximately every three years) removes sediment. Removal of the bridge from the model resulted in a reduction of 1.6 feet, extending only a short distance upstream and no structures benefited. MMI will model the opening under a partially blocked condition to determine what effect this has.

- State Route 10 culvert over Chambers Hollow – The box culvert typically passes flood flows (as FEMA model indicates), however in 2006 flood the culvert became partially blocked by several large trees, which entered the stream as a result of extensive bank failures upstream of the project area. Removal of the bridge from the model resulted in a reduction of 1.5 feet, extending a very short distance upstream, and no structures benefited. MMI will model the opening under a partially blocked condition to determine what effect this has on NY SEG and ARC.

- Chambers Hollow bridge near confluence with West Branch – The snowmobile bridge spanning Chambers Hollow adjacent to the fire training facility was assessed. Removal of the bridge from the model resulted in a reduction of 0.5 feet, extending a very short distance upstream, and no structures benefited.

Next Steps:

- DCSWCD to collect elevations at key locations
- MMI to investigate whether raising the approach road and/or fitting a larger box culvert would prevent County Route 2 at West Branch from overtopping during a large flood.
- MMI to model Back River Road bridge opening under a partially blocked condition.
- MMI will model State Route 10 culvert over Launt Hollow under a partially blocked condition to determine what effect this has.
- MMI will model State Route 10 culvert over Chambers Hollow under a partially blocked condition to determine what effect this has on NY SEG and ARC.
- MMI will complete hydraulic assessment at Covert Hollow using approximate methods model.
- MMI will continue its evaluation of residential structures.

DATE: December 12, 2017
TIME: 5:00pm
MMI #: 5197-08
PROJECT: Hamden LFA

SUBJECT: Flood Advisory Commission Meeting

LOCATION: Hamden Town Hall

A meeting of the Hamden Flood Advisory Commission was held on the evening of December 12, 2017, for the Hamden Local Flood Analysis (LFA) project. Attendees of the meeting included personal from Milone and MacBroom, Inc. (MMI), the Town of Hamden Flood Commission, the New York City Department of Environmental Protection, the Catskill Watershed Corporation, the Delaware County Soil and Water Conservation District and the Delaware County Planning Department. The purpose of the meeting was to:

- Share and discuss results of hydraulic modeling and the Benefit Cost Analysis for bridges, facilities and private structures
- Present recommendations for flood resiliency
- Gather additional information for the final report

Mark Carabetta and Vernon Bevan of MMI presented the results of the hydraulic modeling and the Benefit Cost Analysis. The presentation covered the following topics:

- Adequacy of bridges
- Recommendations for bridge maintenance on tributaries to the West Branch of the Delaware
- Vulnerability of municipal infrastructure
- Assessment of channel modifications to provide cost effective flood mitigation benefits
- Riparian Buffers
- A review of potentially at-risk private structures and options for flood mitigation

In summary, hydraulic modeling indicates that bridges in the project area do not significantly contribute to flooding. None of the bridges are overtopped by the 100-year flood. However, approaches to the bridges across the West Branch of the Delaware are overtopped by relatively small events (the 10-year discharge). It was recommended that these bridge/roadways are replaced by improved structures when they reach the end of their life cycles. The FAC emphasized the importance of maintaining a viable and safe connection for emergency equipment to cross the West Branch during major floods. During previous floods, these connections have been lost, with the nearest means to cross the West Branch being Delhi.

Recommendations were also made for maintaining the capacity of bridge openings on tributaries to the West Branch of the Delaware.

Overall, few municipal facilities were subject to flooding. The most notable facility was the Waste Water Treatment Plant. Hydraulic modeling indicated that although this facility was not subject to flooding from the West Branch of the Delaware, a flood risk does occur from Launt Hollow.

Stream Channel modifications to mitigate flooding were not considered viable due to the following reasons:

- The West Branch of the Delaware is already well connected to a broad floodplain
- Most property bordering streams is high-value agricultural land
- Benefit of in-stream modifications is small due to distance between properties

The topic of riparian buffers was introduced. The presentation covered the benefits of riparian buffers as well as recommendations for their establishment.

The final topic discussed was private structures at risk of flooding from the West Branch of the Delaware and its tributaries. Recommendations were provided for individual structures. These recommendations included: elevation of utilities, elevation of the structure, flood proofing, obtaining an elevation certificate and voluntary relocation.

A number of issues or modifications to the report were suggested by members of the Flood Advisory Commission during the meeting. These included:

- Adding a column to the bridge table to show the difference in elevation between the top of the bridge deck and the 100-year water surface elevation
- Verify a hydraulic analysis was run on two properties near the County Route 26 bridge
- Perform a BCA for the replacement of the Cty Route 2 bridge over the West Branch of the Delaware - This will require data from the Town of Hamden
- Include recommendations on performing maintenance at bridge openings (ex. do not over steepen channel, do not destabilize bank, etc.)
- Include recommendations to anchor fuel tanks and equipment
- Include recommendation to establish a flood notification system (reverse 911) or make town residents aware of such a system if it exists
- Verify whether flood by-pass culverts in the Cty Route 2 bridge over the West Branch of the Delaware provide flood mitigation benefits

A major topic addressed during the meeting was how to identify flood prone properties and frame recommendations and BCA results. The discussion centered on how flood prone properties would potentially be identified on a map and whether specific home addresses should be used in the final LFA report. Potential concerns were raised about providing recommendations and benefit/cost ratio scores for individual properties in a public document.

These issues were not fully resolved at the meeting. However, MMI stressed that the recommendations for private structures and results of the BCA can be incorporated into the report in a manner that the Flood Advisory Commission feels would be best for the Town of Hamden and its residents. Representatives from DCSWCD and NYCDEP will investigate and provide feedback to the group.

The Hamden Town Supervisor provided MMI with the town's current flood prevention codes, which will be evaluated by MMI for adequacy relative to flood prevention and protection.

As the LFA report nears completion, MMI has some final data needs:

- Information for the BCA on the Cty Route 2 bridge over the West Branch of the Delaware. The following information will be required:
    - Estimated number of one-way traffic trips per day
    - Historic damages for more than one event
    - Dates of flood events
    - Number of days the road was closed during events
- Guidance from the Flood Advisory Commission on the identification of flood prone properties and the inclusion of recommendations and benefit/cost ratios in the final LFA report.

MMI anticipates that a draft report will be ready for circulation and comments in approximately four to five weeks.

DATE: July 10, 2017
TIME: 5:00pm
MMI #: 5197-08
PROJECT: Hamden LFA

SUBJECT: Flood Advisory Commission Meeting
LOCATION: Hamden Town Hall

A meeting of the Hamden Flood Advisory Commission was held on the evening of July 10, 2017, for the Hamden Local Flood Analysis (LFA) project. Attendees of the meeting included Mark Carabetta from Milone and MacBroom, Inc. (MMI), as well as representatives from the Town of Hamden Flood Commission, the New York City Department of Environmental Protection, the Delaware County Soil and Water Conservation District and the Delaware County Planning Department. The purpose of the meeting was to:

- Review LFA findings
- Review summary of LFA recommendations
- Gather comments and discuss draft LFA report
- Set date for public meeting and town board acceptance/adoption

Mark Carabetta provided a summary of the findings and recommendations contained in the draft LFA report. The presentation is appended.

Following is a summary of the discussion points:

- Suggestion that recommendation be added to report to clean and maintain drainage ditches and catchbasin to reduce localized flooding.
- Clarification that Bell property (166 County Route 2) was damaged in 1996 flood, is now abandoned.
- Suggestion that column be added to table on municipal infrastructure showing the differences between the 100-year flood elevation and the elevation of the structure.
- Suggestion that yellow color be added to table on municipal infrastructure to emphasize structures that are flooded in 100-year event.
- Comment that some infrastructure is considered critical facilities and may require elevation above the 500-year flood.
- Comment that Delancey pump/chlorine station is for back-up water supply only and is rarely utilized.
- Suggestion that LFA report comment on landowner levee. Does it concentrate flows or pose a danger to homes behind levee?
- Comment that there may be an opportunity for floodplain restoration if Bell property were to undergo buyout.
- Suggestion that recommendation be included for DCSWCD conduct watershed assessment of Bagley Brook to evaluate problem of sediment contribution to West Branch.

- Suggestion that recommendation be included for DCSWCD conduct stream feature inventory and assess need for bank stabilization along tributaries flowing under Route 10 and entering West Branch.
- General consensus with how the buyout properties are shown in the draft LFA report (only Green Thumb Nursery and Bell Property are mapped; any other properties and associated BCA results will be included in appended table and not included or specifically called out in LFA report).
- Suggestion to include recommendation to install USGS gauge along West Branch in Hamden.
- Suggestion to include recommendation to install staff gauge on bridge to monitor flood elevations.

Decision was made that all comments on draft report are due to MMI no later than July 24. MMI will then produce and share the final LFA report.

Date of Tuesday, September 12 at 6pm was set for the final public meeting. Board adoption/acceptance will also be sought at that time.

Delaware County Planning will send letters of invitation to landowners. MMI will provide a list of property addresses and parcel numbers of properties that were assessed as part of the LFA.

MILONE & MACBROOM

Kick-Off Meeting

Local Flood Analysis
Hamden, New York

Hamden Flood Commission and Delaware County Soil & Water Conservation District | March 22, 2016

Purpose of Meeting

- Review the study area and flood prone areas
- Introduce existing conditions modeling
- Collect information about flooding and flood damages
- Collect information about sediment and debris jams that contribute to flooding
- Discuss potential flood mitigation strategies
- Requests information to be used in Benefit-Cost Analysis
- Meeting schedule

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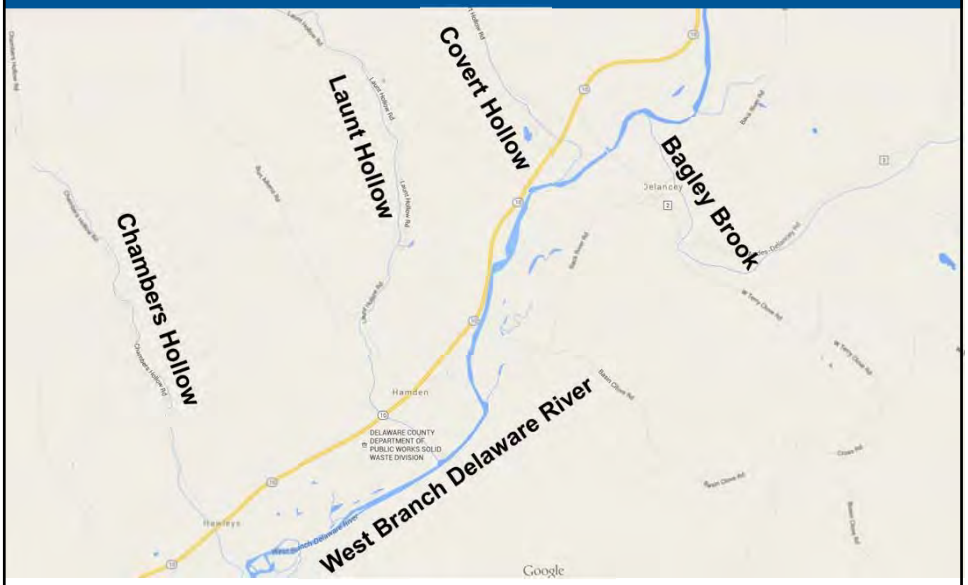
Hamden LFA - Watercourses



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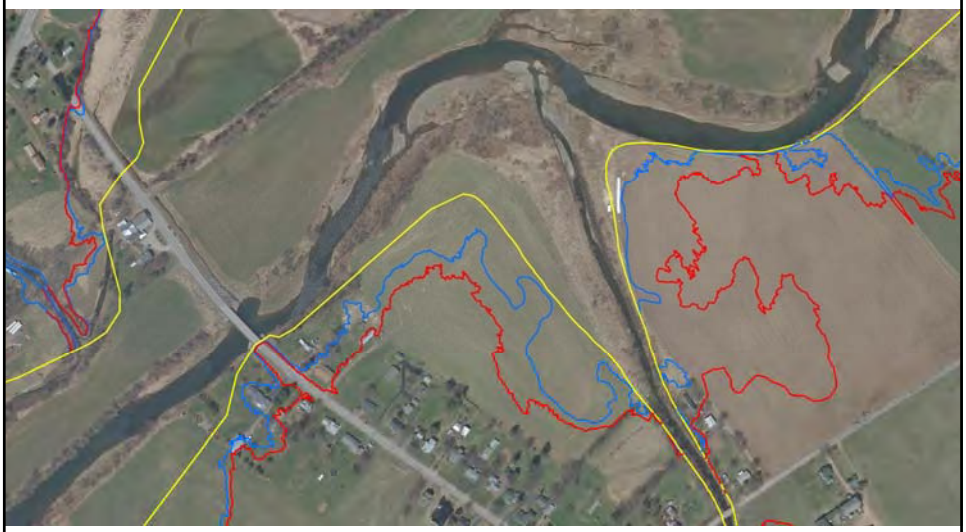
Project Understanding

West Branch Bridges – County Route 2:



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Project Understanding

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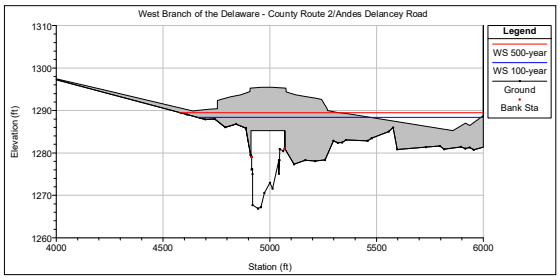

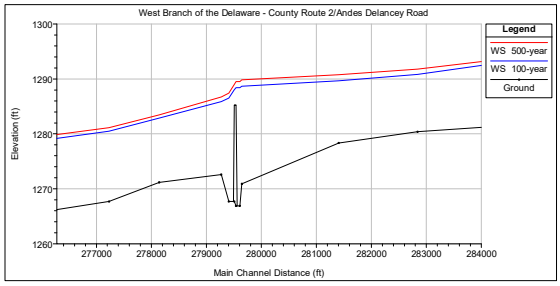

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Project Understanding

West Branch Bridges – Basin Clove Road:

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Project Understanding

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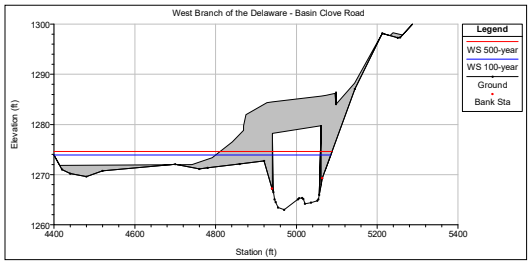

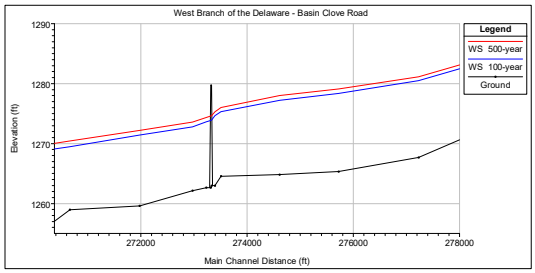

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Project Understanding

West Branch Bridges – Hawleys Downsville Road (County Route 26):

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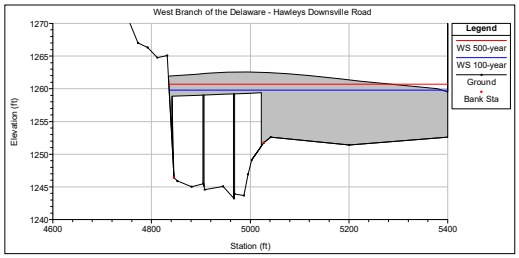
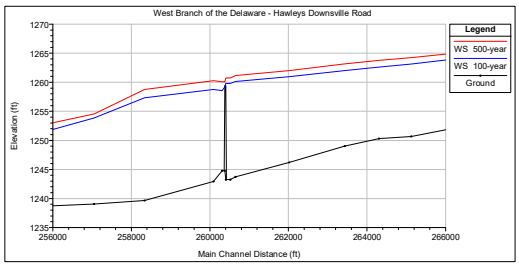
Project Understanding

West Branch Bridges – Hawleys Downsville Road (County Route 26):





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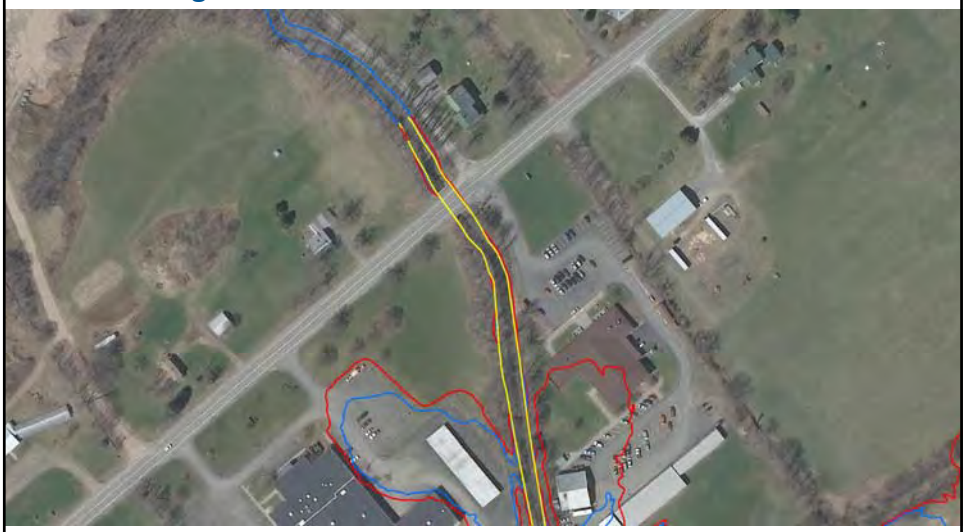
Project Understanding

Route 10 bridge over Chambers Hollow:



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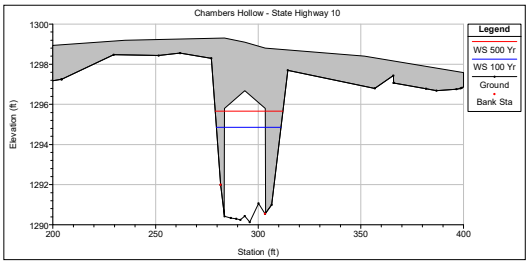
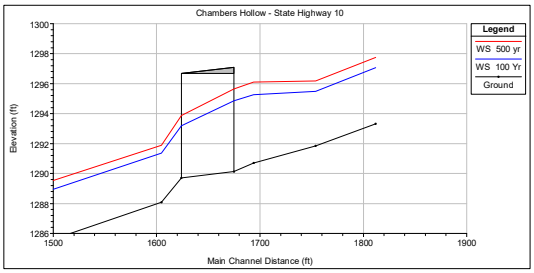
Project Understanding

Route 10 bridge over Chambers Hollow:





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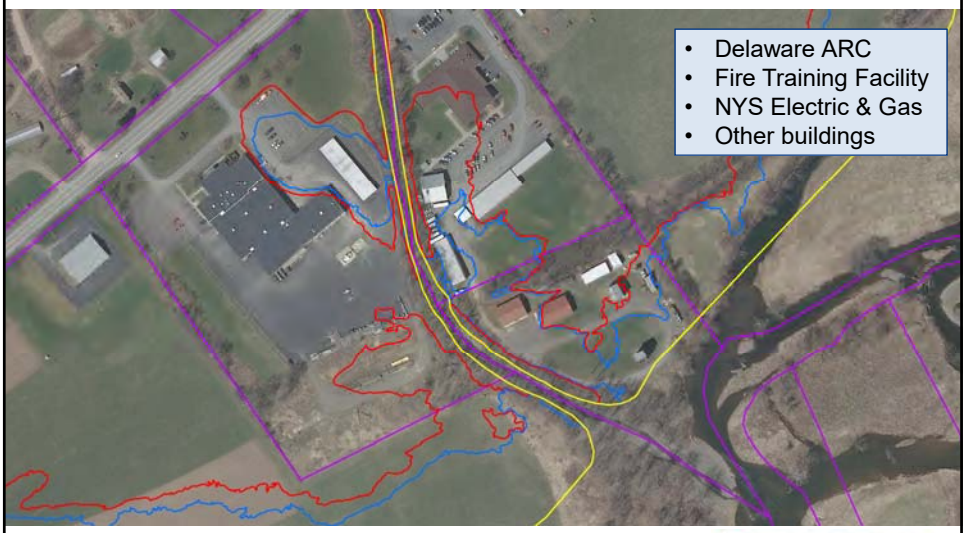
Project Understanding

Chambers Hollow at West Branch:



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Project Understanding

Route 10 bridge over Launt Hollow:

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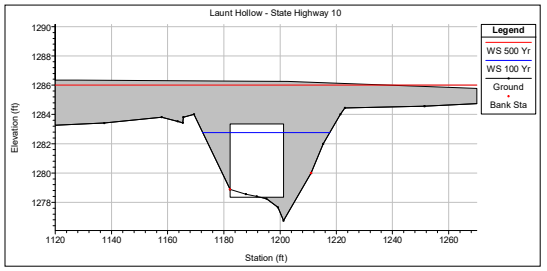
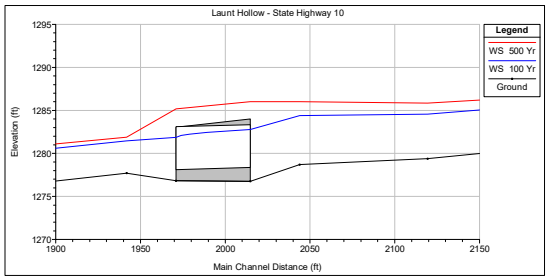
Project Understanding

Route 10 bridge over Launt Hollow:





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Project Understanding

Launt Hollow at West Branch:

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Project Understanding

Route 10 bridge over Covert Hollow:

- No detailed FEMA maps or profiles

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Project Understanding

Bagley Brook at Back River Road:

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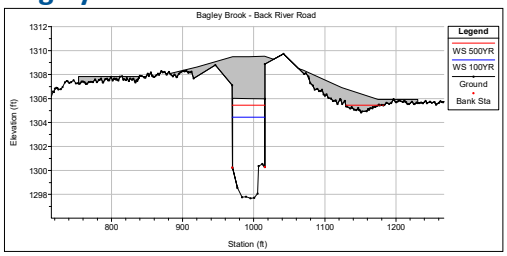
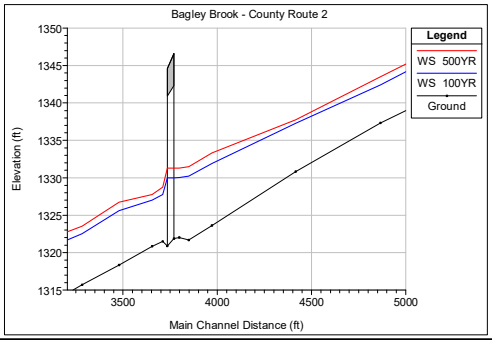
Project Understanding

Bagley Brook at Back River Road:





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Project Understanding

Bagley Brook at County Route 2:

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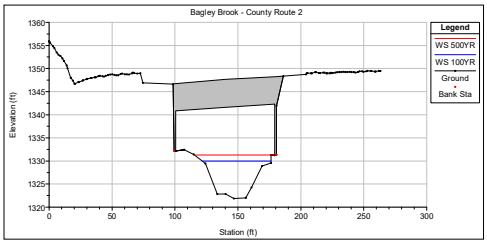
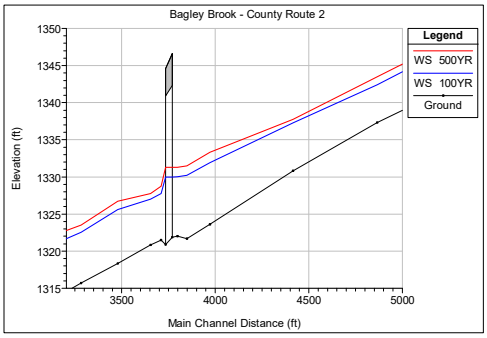
Project Understanding

Bagley Brook at County Route 2:





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LFA Data Needs

- Elevation certificates, if available
- Anything that provides building elevation data such as site plan applications, bridge or road projects (sometimes the corners of buildings are picked up by surveyors), sewer and water system plans, etc.
- For businesses, annual revenue and the amount of time they were shut down after recent floods
- For businesses that are able to provide it, other flood losses such as damaged inventory
- For bridges, flood-related repair costs, lengths and dates of closures and detours

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Flood Committee Meeting

Local Flood Analysis
Hamden, New York

Mark Carabetta, Project Manager
Vernon Bevan, Water Resource Engineer

Hamden Flood Commission | August 02, 2016

Purpose of Meeting

Share and discuss preliminary hydraulic modeling results:

- Baseline flood elevations at structures and facilities
- Analysis of bridges during 100-year flood event

Gather additional information

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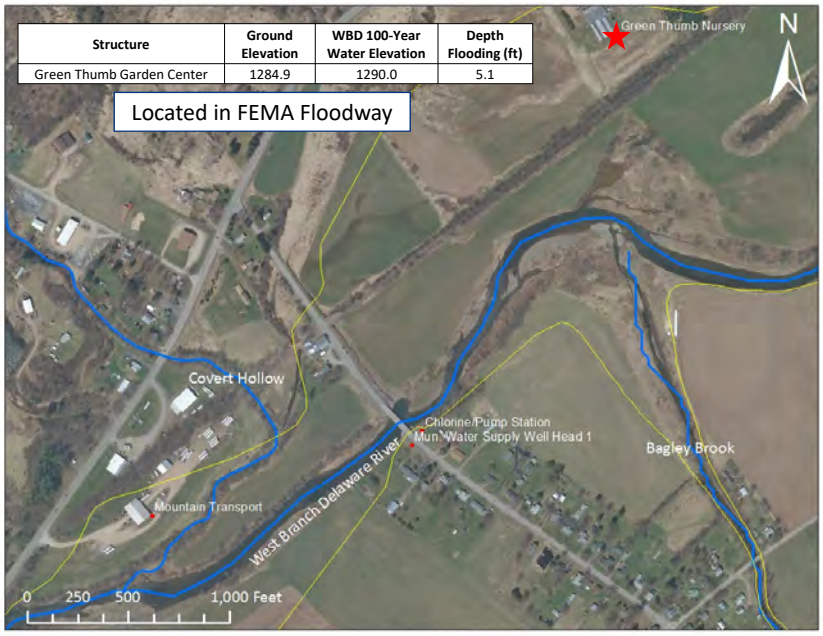
Significant Facilities/Structures Preliminary Baseline Analysis

Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)
Green Thumb Garden Center	1284.9	1290.0	5.1

Located in FEMA Floodway



Significant Facilities/Structures Preliminary Baseline Analysis

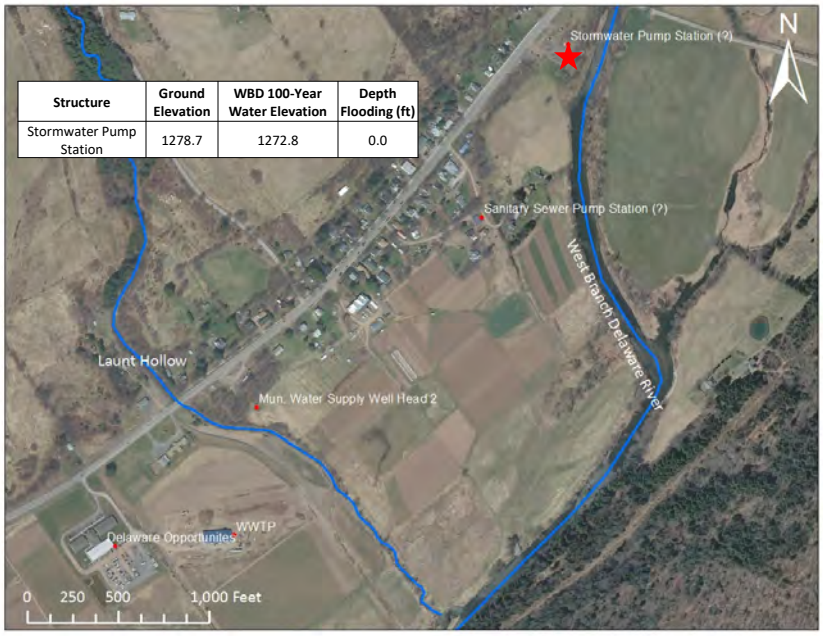
Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)
Chlorine/Pump Station	1287.1	1287.9	0.8

Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)
Mun. Water Supply Well Head 1	1287.6	1287.0	0.0

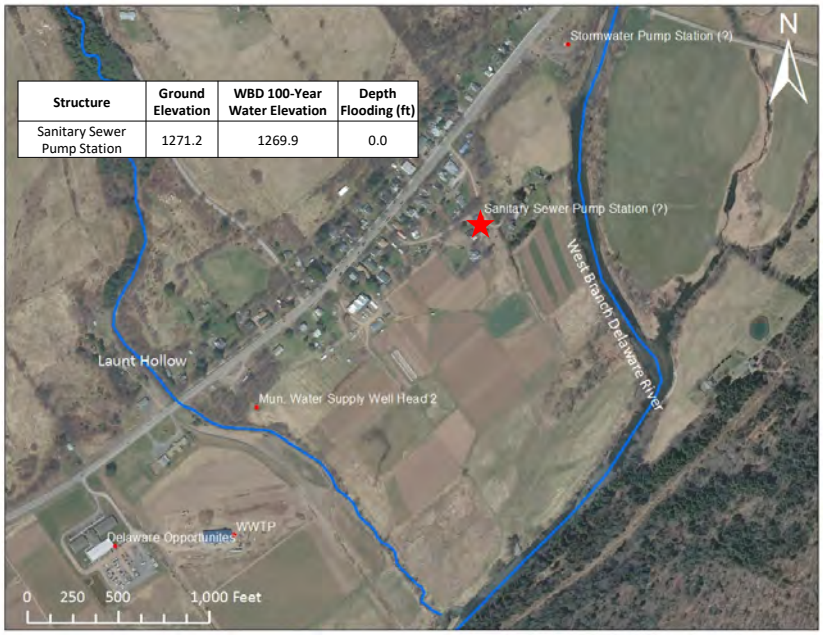
Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)
Stormwater Pump Station	1278.7	1272.8	0.0



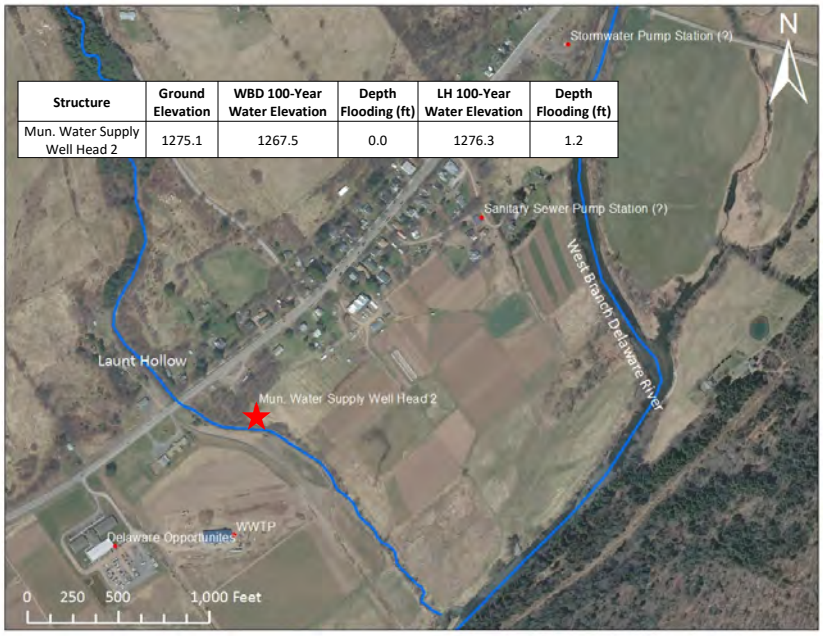
Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)
Sanitary Sewer Pump Station	1271.2	1269.9	0.0



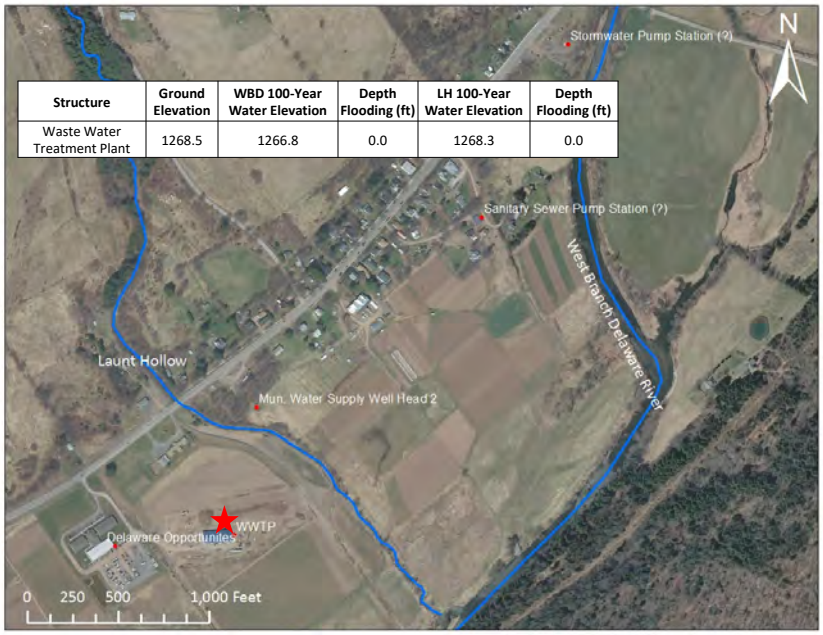
Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)	LH 100-Year Water Elevation	Depth Flooding (ft)
Mun. Water Supply Well Head 2	1275.1	1267.5	0.0	1276.3	1.2



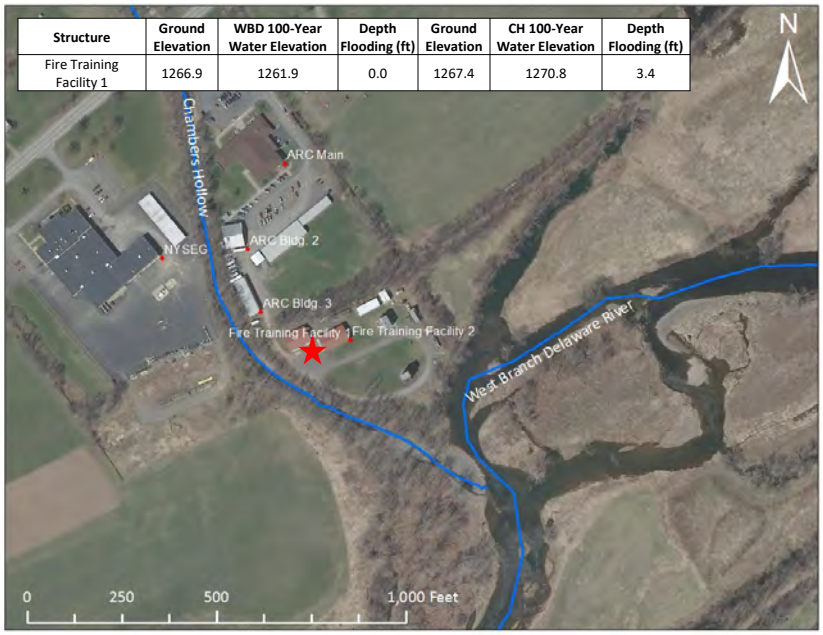
Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)	LH 100-Year Water Elevation	Depth Flooding (ft)
Waste Water Treatment Plant	1268.5	1266.8	0.0	1268.3	0.0



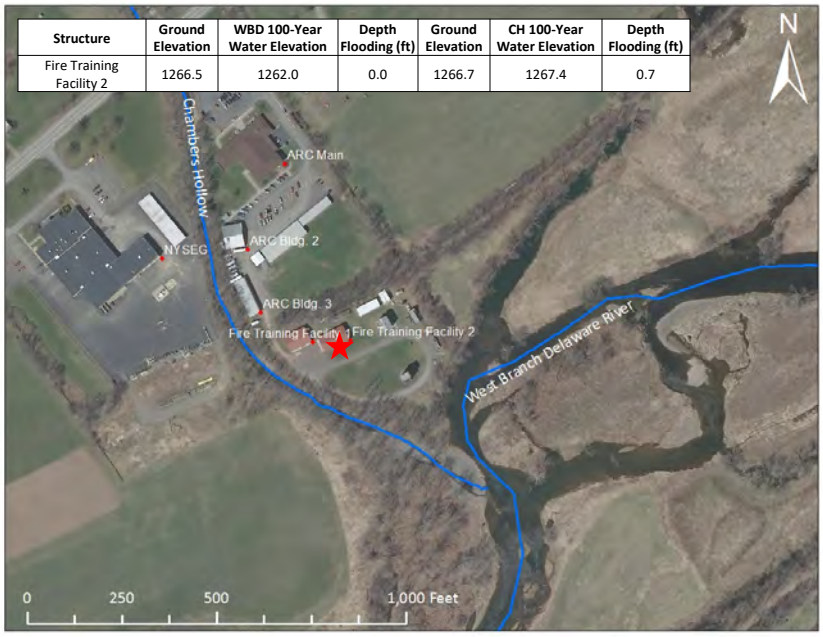
Significant Facilities/Structures Preliminary Baseline Analysis

Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)	Ground Elevation	CH 100-Year Water Elevation	Depth Flooding (ft)
Fire Training Facility 1	1266.9	1261.9	0.0	1267.4	1270.8	3.4

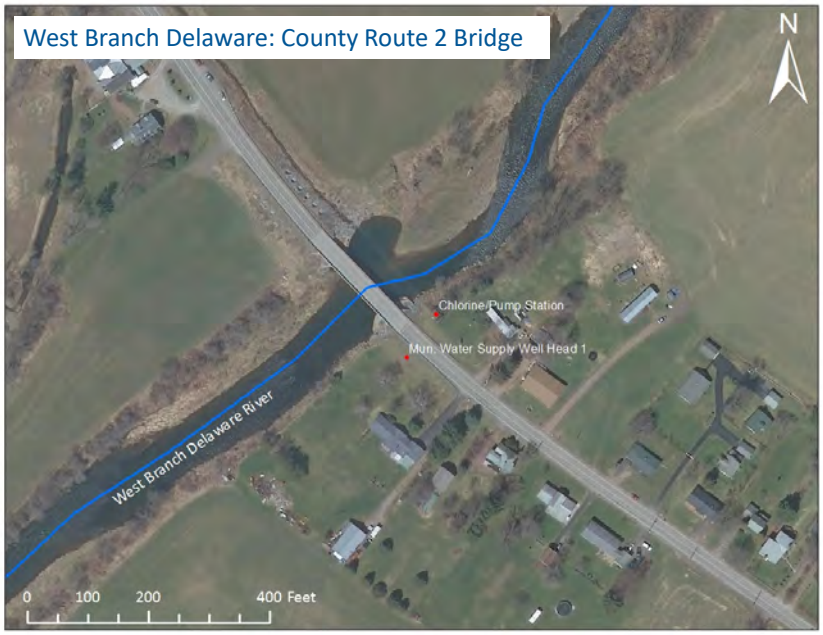


Significant Facilities/Structures Preliminary Baseline Analysis

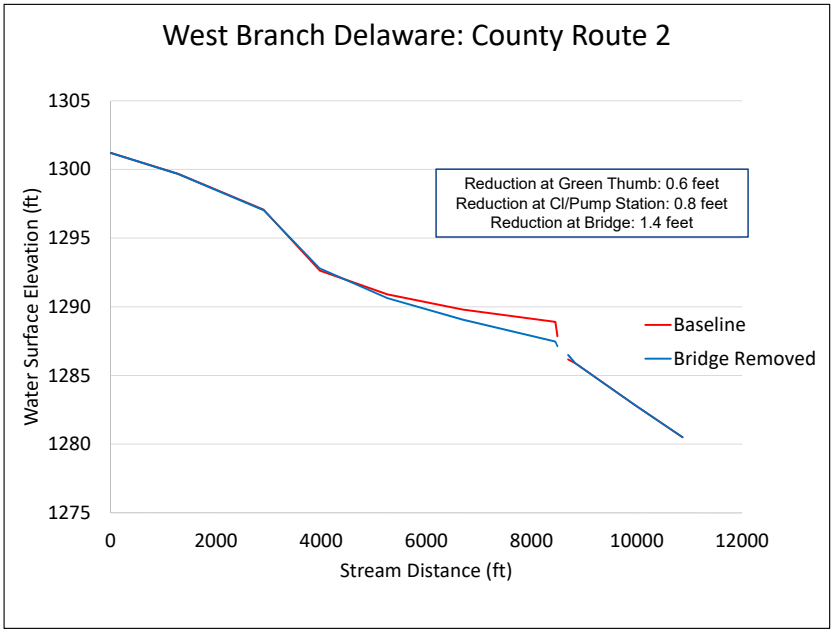
Structure	Ground Elevation	WBD 100-Year Water Elevation	Depth Flooding (ft)	Ground Elevation	CH 100-Year Water Elevation	Depth Flooding (ft)
Fire Training Facility 2	1266.5	1262.0	0.0	1266.7	1267.4	0.7



Bridge Removal Effect on Water Surface Elevations



Bridge Removal Effect on Water Surface Elevations



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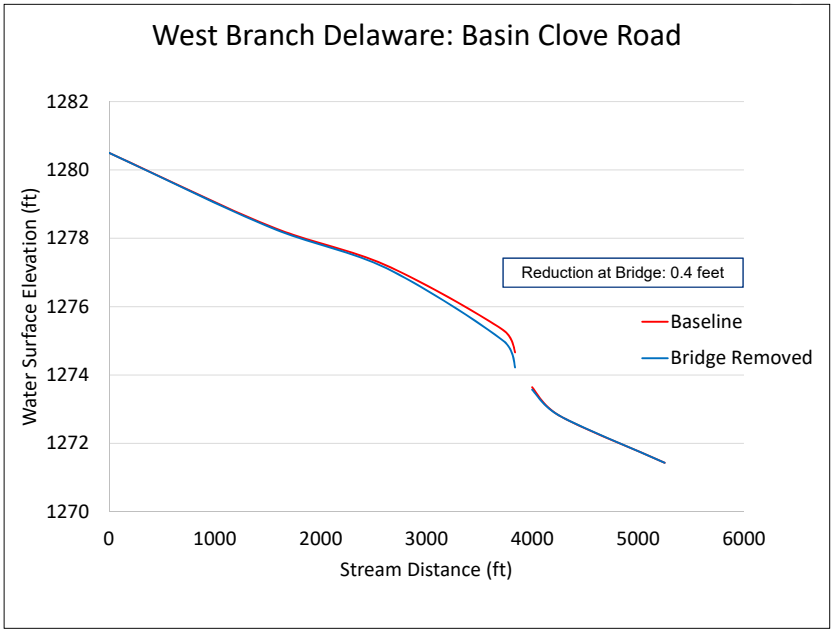

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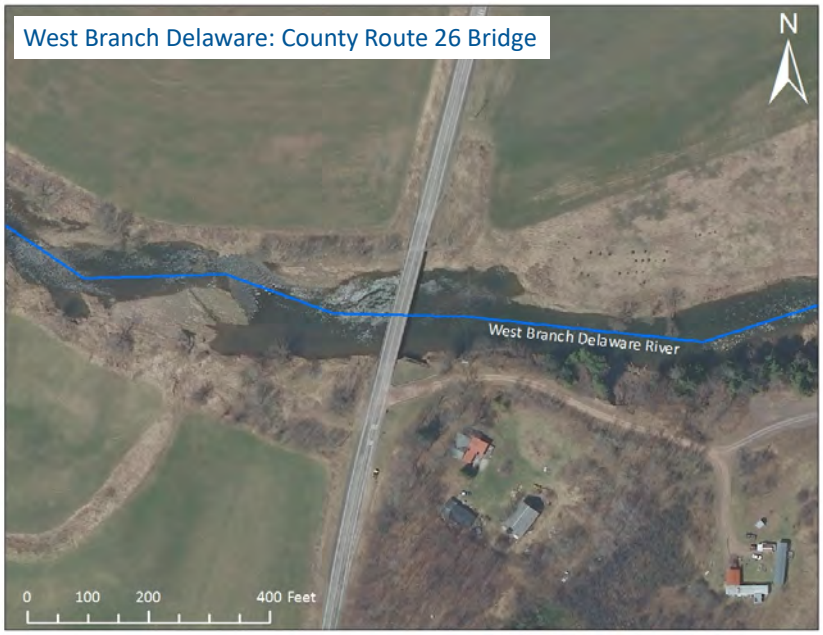
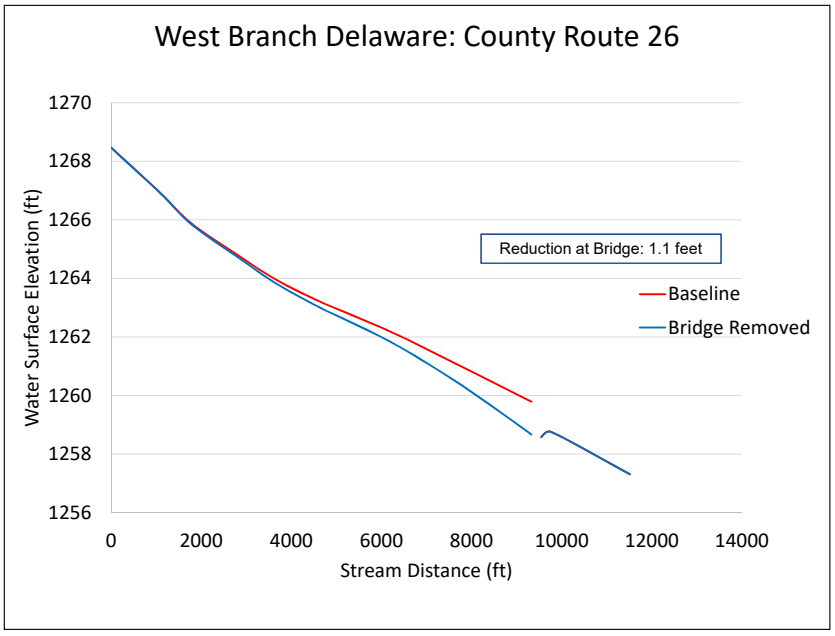


Bridge Removal Effect on Water Surface Elevations



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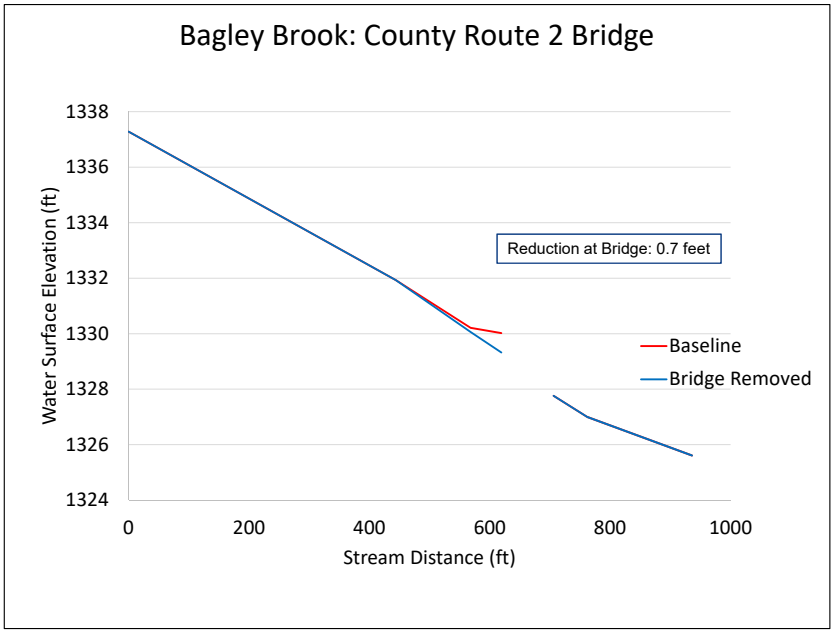

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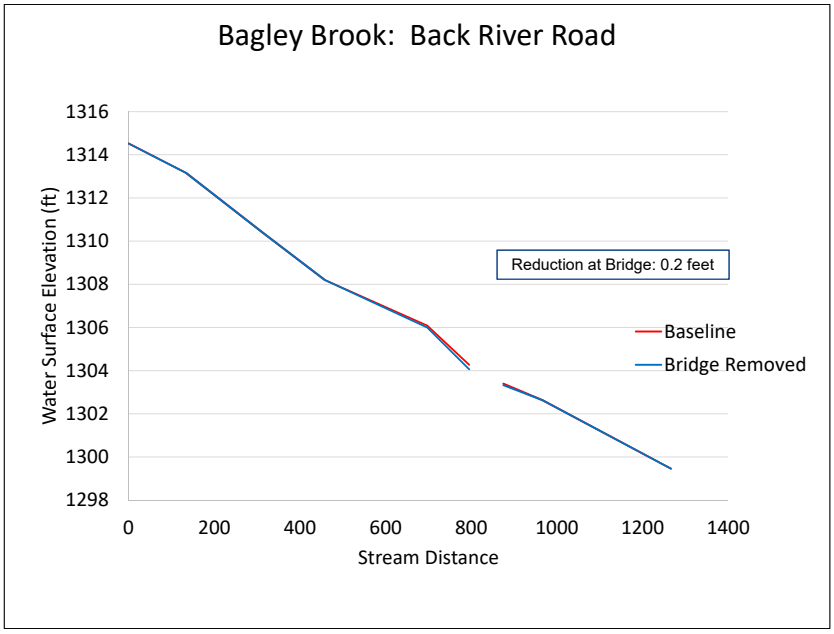

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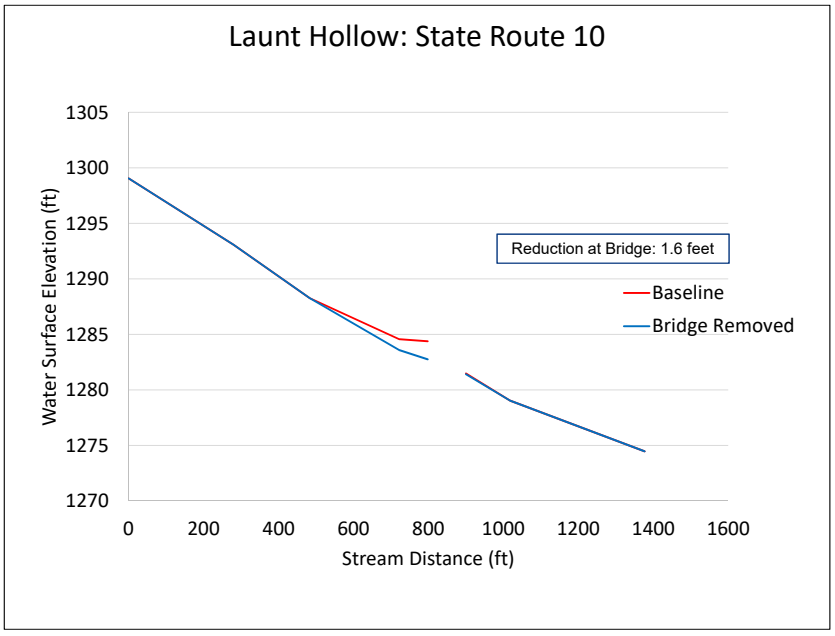

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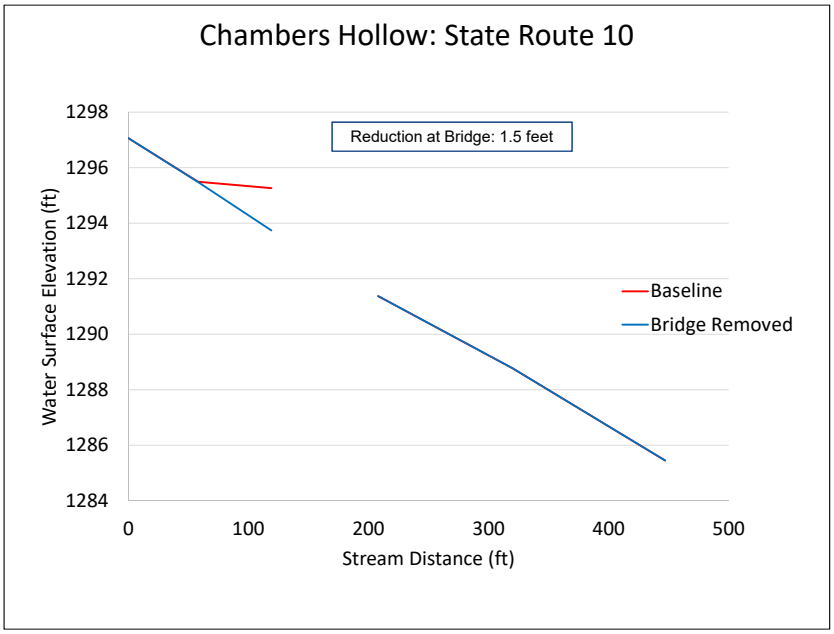

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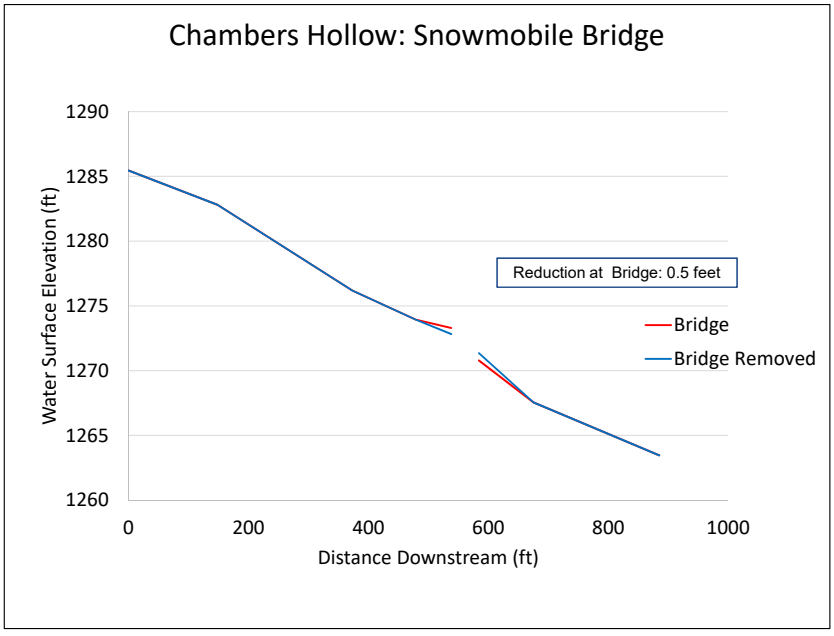

Next Steps

Information gathering

- Locations and elevations of facilities
- Information on water supply, stormwater and wastewater systems

Additional hydraulic modeling and analysis

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Flood Committee Meeting

Local Flood Analysis
Hamden, New York

Mark Carabetta, Project Manager
Vernon Bevan, Water Resource Engineer

Hamden Flood Commission | January 12, 2017

Purpose of Meeting

- Share and discuss results of hydraulic modeling and Benefit Cost Analysis:
  - Bridges
  - Facilities
  - Private Structures
- Gather additional information for final report

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Bridge Adequacy

- Bridges in project area do not significantly contribute to flooding
  - Removal of bridges from hydraulic model did yield significant water surface elevation reductions
  - Reductions, especially on the tributaries, did not persist far upstream
  - Reductions in water surface elevations from bridge removal did not provide mitigation benefits

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Bridge Adequacy

- Bridges structures were not overtopped by 100-year discharge

Stream/River	Bridge Crossing	Bridge Deck Elevation	Predicted 100-Year WSEL
West Branch of the Delaware	County Route 2	1,295.5	1,288.2
West Branch of the Delaware	Basin Clove Road	1,284.5	1,273.9
West Branch of the Delaware	County Route 26	1,262.5	1,259.8
Bagley Brook	County Route 2	1,347.7	1,330.0
Bagley Brook	Back River Road	1,309.5	1,304.4
Covert Hollow	State Highway 10	*	*
Launt Hollow	State Highway 10	1,286.3	1,282.8
Chambers Hollow	State Highway 10	1,299.3	1,294.9
Chambers Hollow	Foot Bridge	1,273.6	1,273.3

*No data available in FEMA 2014 Revised Preliminary FIS or FEMA HECRAS Model
WSEL = Water surface elevation

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Bridge Adequacy

- Flooding of Bridge Approaches on West Branch of Delaware (all during 10-year flood event)
  - County Route 2 – Flooding occurs on western bridge approach
  - Basin Clove Road – Flooding occurs on eastern bridge approach
  - County Route 26 – Flooding occurs on northern bridge approach
- Recommend addressing this when bridges reach end of life cycle and are due for replacement
- Auxiliary emergency services located across West Branch
- Road closure alerts and signage

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Bridge Maintenance

- Assessment of bridge blockage on tributaries and requirement of maintenance (MXS) actions

Stream	Baseline - 0% Blocked		25% Blocked		50% Blocked	
	Opening Height (ft)	MXS Action Advised	Opening Height (ft)	MXS Action Advised	Opening Height (ft)	MXS Action Advised
Bagley Brook/Back River Rd.	8.33	No	6.25	No	4.16	Yes
Launt Hollow/State Route 10	5.0	No	3.75	Yes	2.5	Yes
Chambers Hollow/State Route 10	5.66	No	4.24	Yes	2.83	Yes

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Municipal Facilities

- Few municipal facilities are subject to serious flooding
- Some facilities are at risk of flooding due to West Branch of the Delaware and one of its tributaries

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Municipal Facilities

Infrastructure	Channel	Total Elev. (ft)	500-yr Water Elevation	Flooded?	100-yr Water Elevation	Flooded?
Delancey Pump/Chlorine Station	W. B. Delaware	1,287.44	1,289.83	YES	1287.87	YES
Delancey Well Head	W. B. Delaware	1,288.25	1,287.53	NO	1286.81	NO
Stormwater Pump Station	W. B. Delaware	1,279.08	1,273.60	NO	1272.81	NO
Sanitary Sewer Pump Station	W. B. Delaware	1,271.18	1,270.84	NO	1269.92	NO
Launt Hollow Well Head	W. B. Delaware	1,276.13	1,268.44	NO	1267.63	NO
LH Upper Pump Station	W. B. Delaware	1,277.15	1,268.35	NO	1267.54	NO
LH Lower Pump Station	W. B. Delaware	1,275.12	1,268.35	NO	1267.54	NO
WWTP	W. B. Delaware	1,268.50	1,267.62	NO	1266.84	NO
Launt Hollow Well Head	Launt Hollow	1,276.13	1,275.69	NO	1275.27	NO
LH Upper Pump Station	Launt Hollow	1,277.15	1,278.95	YES	1278.33	YES
LH Lower Pump Station	Launt Hollow	1,275.12	1,276.74	YES	1276.26	YES
WWTP	Launt Hollow	1,268.50	1,270.04	YES	1269.80	YES

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Stream Channel Modifications

- In some cases, in-stream modifications such as floodplain enhancement may reduce inundation
- In-stream modifications not pursued due to low return under existing conditions
  - West Branch of Delaware is already well connected to a broad floodplain
  - Most property bordering streams is productive, high-value agricultural land
  - Benefit of in-stream modifications is small due to distance between flood prone properties

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Riparian Buffers

- Benefits of Riparian Buffers
  - Enhance physical stability of stream channel reducing erosion and loss of land
  - Provides habitat for terrestrial and aquatic wildlife
  - Improves water quality

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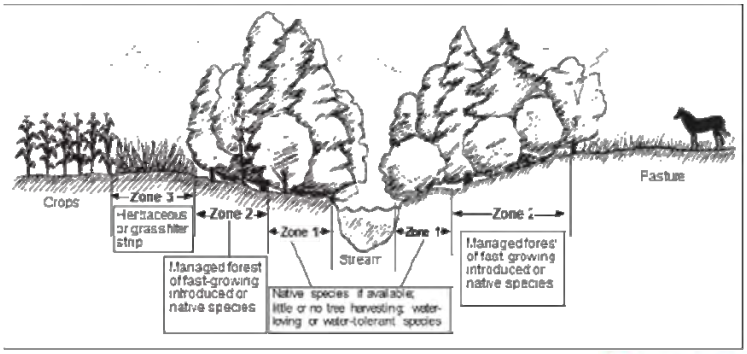
Riparian Buffers

- Riparian Buffer
  - Zone 1 – Native species, with little to no harvesting
  - Zone 2 – Managed, fast-growing species
  - Zone 3 – Herbaceous or grass filter



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Riparian Buffers

- Recommendations for Riparian Buffers
  - NRCS standards for minimum buffer width is 35 feet
  - Use native plant species, if possible
  - Utilize water tolerant species in area adjacent to stream (Zone 1)

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Summary of Recommendations

- Approaches to County Route 2, Basin Clove Road and County Route 26 bridges overtop in 10-year flood.
  - Recommend addressing this when bridges reach end of life cycle and are due for replacement
  - Auxiliary emergency services located across West Branch
  - Road closure alerts and signage
- Follow maintenance recommendations at bridges prone to sediment and debris jamming.
- Delancey Pump/Chlorine Station and upper and lower Launt Hollow pump stations and WWTP may be at risk in the 100-year flood.
  - Recommend floodproofing above the level of the 100-year flood

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Summary of Recommendations (continued)

- Recommend landowners voluntarily work with DCSWCD to establish riparian buffers along West Branch
- Recommendation not storing emergency vehicles and equipment in Fire Training Facility as property may be prone to flooding.
- Creation of extensive floodwalls and levees is not supported by this LFA, nor is extensive sediment removal.
- Provide residents with a range of options for individual property protection, including:
  - Voluntary buy-outs/relocation of frequently-flooded homes/businesses
  - Elevation of electrical panels, appliances, fuel tanks, etc.
  - Individual floodproofing measures, especially for commercial facilities

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Summary of Recommendations (continued)

- Manufactured Homes must meet FEMA elevation and anchoring recommendations even if first floor elevation is adequately above base flood elevation.
- Procedural Recommendations:
  - During and after future floods, record and compile municipal, county, and state costs related to clean-up and recovery in Hamden. This may help improve future BCA determinations.
  - During and after future floods, record high water marks throughout the town.
  - Track and record flood damage over time for anchor businesses and critical facilities.

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Next Steps

Final Report:

- Feedback on Recommendations and Individual Property Matrices
- Need Town of Hamden Flood Damage Prevention Code
- Any Flood Notification Systems or Alerts?

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Flood Committee Meeting

Local Flood Analysis
Hamden, New York

Hamden Flood Committee | July 10, 2017

Purpose of Meeting

- Review of findings
- Summary of recommendations
- Gather comments on draft report
- Set date for public meeting and board acceptance/adoption

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Bridge Adequacy

- Bridges in project area do not significantly contribute to flooding
  - Removal of bridges from hydraulic model did yield water surface elevation reductions
  - Reductions, especially on the tributaries, did not persist far upstream
  - Reductions in water surface elevations from bridge removal did not provide mitigation benefits
- Bridges were not overtopped by 100-year discharge

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Bridge Adequacy

- Flooding of Bridge Approaches on West Branch of Delaware (all during 10-year flood event)
  - County Route 2 – Flooding occurs on western bridge approach
  - Basin Clove Road – Flooding occurs on eastern bridge approach
  - County Route 26 – Flooding occurs on northern bridge approach

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Bridge Maintenance

- Assessment of bridge blockage on tributaries and requirement of maintenance (MXS) actions

Stream	Baseline - 0% Blocked		25% Blocked		50% Blocked	
	Opening Height (ft)	MXS Action Advised	Opening Height (ft)	MXS Action Advised	Opening Height (ft)	MXS Action Advised
Bagley Brook/Back River Rd.	8.33	No	6.25	No	4.16	Yes
Launt Hollow/State Route 10	5.0	No	3.75	Yes	2.5	Yes
Chambers Hollow/State Route 10	5.66	No	4.24	Yes	2.83	Yes

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Municipal Facilities

Infrastructure	Channel	Total Elev. (ft)	100-yr Water Elevation	Flooded?
Delancey Pump/Chlorine Station	W. B. Delaware	1,287.44	1287.87	YES
Delancey Well Head	W. B. Delaware	1,288.25	1286.81	NO
Stormwater Pump Station	W. B. Delaware	1,279.08	1272.81	NO
Sanitary Sewer Pump Station	W. B. Delaware	1,271.18	1269.92	NO
Launt Hollow Well Head	W. B. Delaware	1,276.13	1267.63	NO
LH Upper Pump Station	W. B. Delaware	1,277.15	1267.54	NO
LH Lower Pump Station	W. B. Delaware	1,275.12	1267.54	NO
WWTP	W. B. Delaware	1,268.50	1266.84	NO
Launt Hollow Well Head	Launt Hollow	1,276.13	1275.27	NO
LH Upper Pump Station	Launt Hollow	1,277.15	1278.33	YES
LH Lower Pump Station	Launt Hollow	1,275.12	1276.26	YES
WWTP	Launt Hollow	1,268.50	1269.80	YES

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Stream Channel Modifications

- In some cases, in-stream modifications such as floodplain enhancement may reduce inundation
- In-stream modifications not pursued due to low return under existing conditions
  - West Branch of Delaware is already well connected to a broad floodplain
  - Most property bordering streams is productive, high-value agricultural land
  - Benefit of in-stream modifications is small due to distance between flood prone properties

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Riparian Buffers

- Benefits of Riparian Buffers
  - Enhance physical stability of stream channel reducing erosion and loss of land
  - Provides habitat for terrestrial and aquatic wildlife
  - Improves water quality

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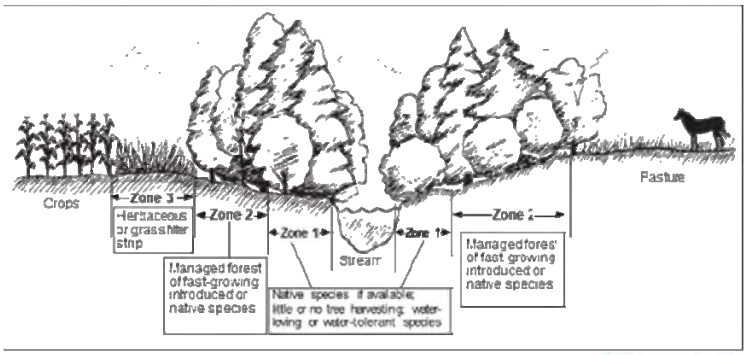
Riparian Buffers

- Riparian Buffer
  - Zone 1 – Native species, with little to no harvesting
  - Zone 2 – Managed, fast-growing species
  - Zone 3 – Herbaceous or grass filter



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Summary of Recommendations

- Approaches to County Route 2, Basin Clove Road and County Route 26 bridges overtop in 10-year flood.
  - Recommend replacement bridges that span floodplain when bridges reach end of life cycle and are due for replacement
  - Auxiliary emergency services located across West Branch
  - Road closure alerts, barriers and signage
- Follow maintenance recommendations at bridges prone to sediment and debris jamming.
- Delancey Pump/Chlorine Station and upper and lower Launt Hollow pump stations and WWTP may be at risk in the 100-year flood.
  - Recommend floodproofing above the level of the 100-year flood

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Summary of Recommendations (continued)

- Recommend landowners voluntarily work with DCSWCD to establish riparian buffers along West Branch
- Recommend not storing emergency vehicles and equipment in Fire Training Facility as property may be prone to flooding.
- Creation of extensive floodwalls and levees is not supported by this LFA, nor is extensive sediment removal.
- Provide residents with a range of options for individual property protection, including:
  - Voluntary buy-outs/relocation of frequently-flooded homes/businesses
  - Elevation of electrical panels, appliances, fuel tanks, etc.
  - Individual floodproofing measures, especially for commercial facilities

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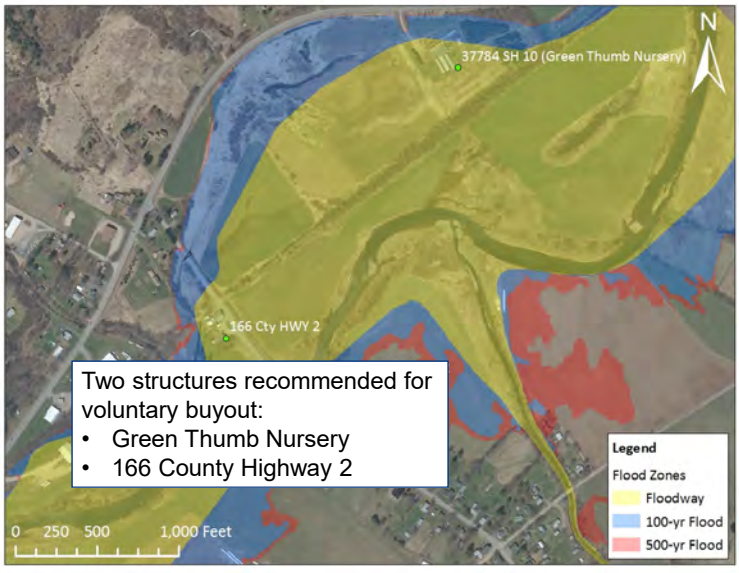
Summary of Recommendations (continued)



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Summary of Recommendations (continued)

- Manufactured Homes must meet FEMA elevation and anchoring recommendations even if first floor elevation is adequately above base flood elevation.
- Procedural Recommendations:
  - During and after future floods, record and compile municipal, county, and state costs related to clean-up and recovery in Hamden. This may help improve future BCA determinations.
  - During and after future floods, record high water marks throughout the town.
  - Track and record flood damage over time for anchor businesses and critical facilities.

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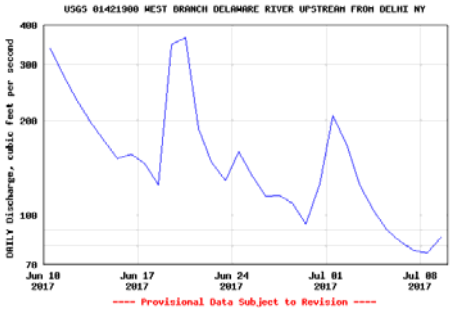
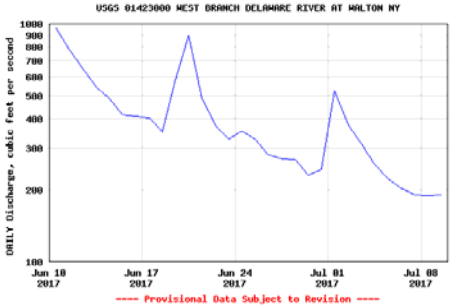
Summary of Recommendations (continued)

- Real time gauge information at Delhi and Hamden can be accessed at https://maps.waterdata.usgs.gov/mapper/index.html





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Summary of Recommendations (continued)

- Use real time gauge information to trigger flood warning alerts

TABLE 3-1
Peak Discharges during Major Flood Events

Date of Discharge Event	Discharge at USGS Gauge in Delhi, NY	Discharge at USGS Gauge in Walton, NY
01/22/59	5,500	15,700
03/05/64	6,330	15,800
12/21/73	6,070	14,700
01/19/96	13,000	25,000
11/09/96	7,000	18,200
04/03/05	5,700	18,200
06/28/06	8,060	28,600
08/28/11	8,860	16,000*

(DCSWCD 2006, USGS 2016)
* Actual Peak Discharge Date was 08/29/2011

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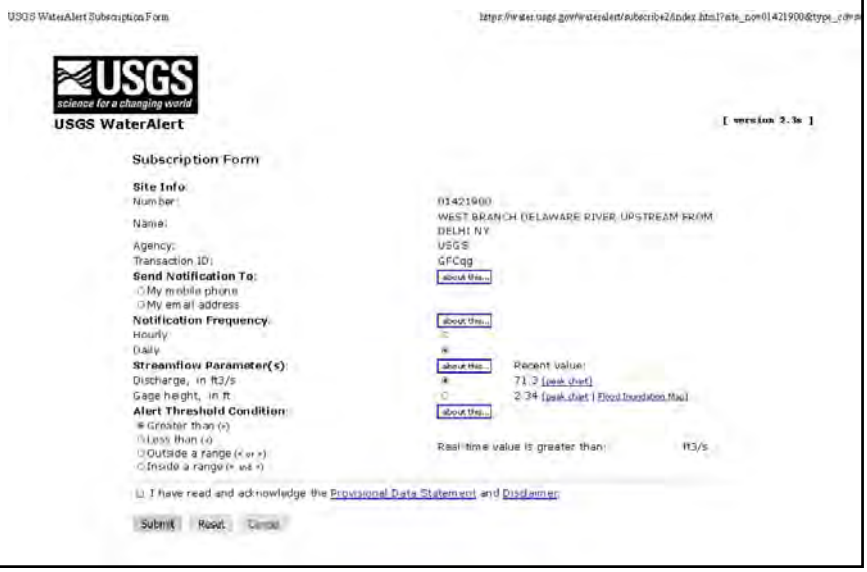
Summary of Recommendations (continued)

- Subscribe for Flood Warning Alerts:



Next Steps

- Produce Final LFA Report
- Public Meeting to Share Recommendations
- Town Board Adoption or Acceptance of Recommendations

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