
Local Flood Hazard Analysis

Prepared for

City of Norwich

One City Plaza
Norwich, NY 13815

Revision 0
September 2025

Barton&Loguidice

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City of Norwich, Chenango County

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List of Acronyms

BIL PROTECT	Bipartisan Infrastructure Law Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation
CFA	Consolidated Funding Application
cfs	Cubic feet per second
CDBG-MIT	Community Development Block Grant Mitigation
CRRA	Community Risk and Resiliency Act
DEC	New York State Department of Environmental Conservation
DHSES	New York State Department of Homeland Security and Emergency Services
EFC	NYS Environmental Facilities Corporation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
fps	Feet per second
HEC-RAS	Hydraulic Engineering Center's River Analysis System
HMGF	Hazard Mitigation Grant Program
LIDAR	Light Detection and Ranging
LF	Linear feet
LFHA	Local Flood Hazard Analysis
NAD83	North American Datum (1983)
NAVD88	North American Vertical Datum (1988)
NFIP	National Flood Insurance Program
NYSDEC	New York State Department of Environmental Conservation
PDM	Pre-Disaster Mitigation
Q	Volumetric flow rate (gpm, MGD)
SFHA	Special Flood Hazard Area
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WFPO	Watershed Protection and Flood Prevention Operations
WQIP	Water Quality Improvement Program

EXECUTIVE SUMMARY

A Local Flood Hazard Analysis (LFHA) was completed with funding through the Federal Emergency Management Agency's (FEMA) DR-4480-NY Hazard Mitigation Grant Program (HMGF) with the New York State Department of Homeland Security and Emergency Services (DHS&S) as a subapplicant. The purpose of the LFHA was to analyze the factors affecting flooding risk in the City of Norwich (City) and to develop a risk analysis tool and baseline models for evaluating the effectiveness of various mitigation strategies. Two flood sources, Canasawacta Creek and the Chenango River, flow adjacent to the City and are prone to periodic flooding.

The project team applied the US Army Corps of Engineers' (USACE) hydraulic model HEC-RAS (Hydraulic Engineering Center's River Analysis System) to determine flood inundation limits along the two streams as a function of peak discharge and flood volume. Detailed surveys of portions of the streams' bathymetry and elevation of streambanks were conducted to refine model accuracy. The simulations of water surface elevation were combined with a digital elevation model to delineate areas of inundation. Once the HEC-RAS model was calibrated and verified, the project team applied the model to determine future inundation limits.

A review of the inundation maps was completed to evaluate risk and vulnerability of critical services and historical structures. In doing so, this study provides a resource for use in other long-term planning initiatives, including disaster recovery and emergency response planning, economic development and capital improvement planning, land use, and transportation planning.

Mitigation strategy categories to reduce flooding risk are identified for future engineering analysis and design. Recommended next steps (outside of the scope of this study) include identifying and analyzing potential flood hazard mitigation measures within the study area to mitigate flood risk. A benefit-cost analysis should be completed after measures are evaluated for effectiveness in reducing flood risk. Potential sources of funding for mitigation measure analysis and installation are identified in the LFHA report.

1.0 PURPOSE AND SCOPE OF STUDY

The City of Norwich is susceptible to repeated flooding from the Chenango River and Canasawacta Creek in response to heavy rainfall, snowmelt, and ice jams. A large majority of damage to homes and businesses have been reported in the south end of the City where both flood sources converge. Past flood events have principally impacted basements, causing damage to critical mechanical systems, but have not qualified for first floor flooding assistance. In many cases residents have been displaced from homes and have made necessary repairs out-of-pocket.

Funding to support this engineering study was provided by the Federal Emergency Management Agency's (FEMA) DR-4480-NY Hazard Mitigation Grant Program (HMGp) with the New York State Department of Homeland Security and Emergency Services (DHS&ES) as a subapplicant. The hydraulic model HEC-RAS is the central quantitative tool developed for the LFHA by the project team. The Army Corps of Engineers developed HEC-RAS to perform one- and two-dimensional hydraulic calculations for a full network of natural and constructed channels. The HEC-RAS model predicts water surface elevation in response to streamflow. As part of this project, the project team incorporated recent detailed data for stream channel geometry, bank elevation, and infrastructure into the HEC-RAS model. The study area encompassed the two streams that flow adjacent to the City: Canasawacta Creek and the Chenango River. There was strong agreement between model simulations and the FEMA's November 2010 inundation areas, demonstrating that the calibrated HEC-RAS is a reliable predictive tool of conditions in the study area.

Once calibrated and tested, the HEC-RAS model was applied to simulate the impacts of future streamflow on flooding. The FEMA published a series of flood inundation maps on November 26, 2010, detailing areas of the City that would be flooded during the 50%, 10%, 2%, 1%, and 0.2% AEP inundation events. The inundation maps display the impact of the existing 1% AEP inundation event and the simulated impact of predicted future flow events along the Chenango River and Canasawacta Creek. Prior hydrologic and hydraulic analyses utilized simpler models to map floodplains; this LFHA uses current data and the more sophisticated model developed by FEMA in 2010 as a foundation for predicting flooding extent and frequency. With this important tool, the City can identify public and private infrastructure at greatest risk and evaluate where mitigation is most cost-effective.

Mitigation strategies to reduce flooding risk are identified for future engineering analysis and design. Next steps coming out of the study include identifying and analyzing potential flood hazard mitigation measures within the study area to mitigate flood risk. A benefit-cost analysis should be completed after measures are evaluated for effectiveness in reducing flood risk. Potential sources of funding for mitigation measure analysis and installation are identified in the LFHA report.

The project team presented their findings to the City Common Council and City residents on August 19, 2025. The presentation is attached as **Appendix D**.

2.0 LOCATION DESCRIPTION

2.1. Overview

The City of Norwich is bound by Canasawacta Creek to the west and the Chenango River to the east. The confluence of the two waterways is located at the southern point of the City, which is a common location for flooding. Its geographic location, combined with modern development, contributes significantly to the issue of flooding risk within the City. Key elements of the landscape that affect flooding risk include:

- topography and surficial geology, which affect the degree of runoff and erosion in the watershed
- erodible upstream sub watersheds, from which sediment is transported downstream, filling in stream channels and reducing channel capacity for containing floodwaters
- development and impervious surfaces, which increase surface runoff and reduce groundwater recharge
- geographic location of the city, which is situated between two waterways which converge at the southern end of the city
- geographic location of the city, which is situated in Central New York, where cold weather and precipitation events cause ice jams
- glacial geology forming a U-shaped valley type and typical natural river types when unaltered

2.2. Watershed Description

Canasawacta Creek and the Chenango River are located in the Susquehanna River Basin. The project river reach is located in a low gradient fluvial valley where the surface materials are primarily stratified drift composed of well to moderately sorted medium to coarse sands to pebble gravels. The contributing watershed area for the confluence of Canasawacta Creek and the Chenango River is estimated to be 332 mi² as delineated by StreamStats (Appendix B). The study area and watersheds are presented in Figures 2-1 and 2-2.

Land cover is an important factor to the drainage hydrologic cycle, exerting considerable influence on the chemical, physical, and biological characteristics of waterbodies. Land cover classifies the vegetation (or lack thereof) covering the ground. The predominant land cover within the City is developed land. Existing land cover, as defined by the 2019 USGS National Land Cover Database, is presented in Figure 2-3. Predominant land uses within the City are medium- to high-density residential, and commercial. Predominant land uses outside city limits are forest to the east and west, and a mixture of forest and agriculture to the north and south.

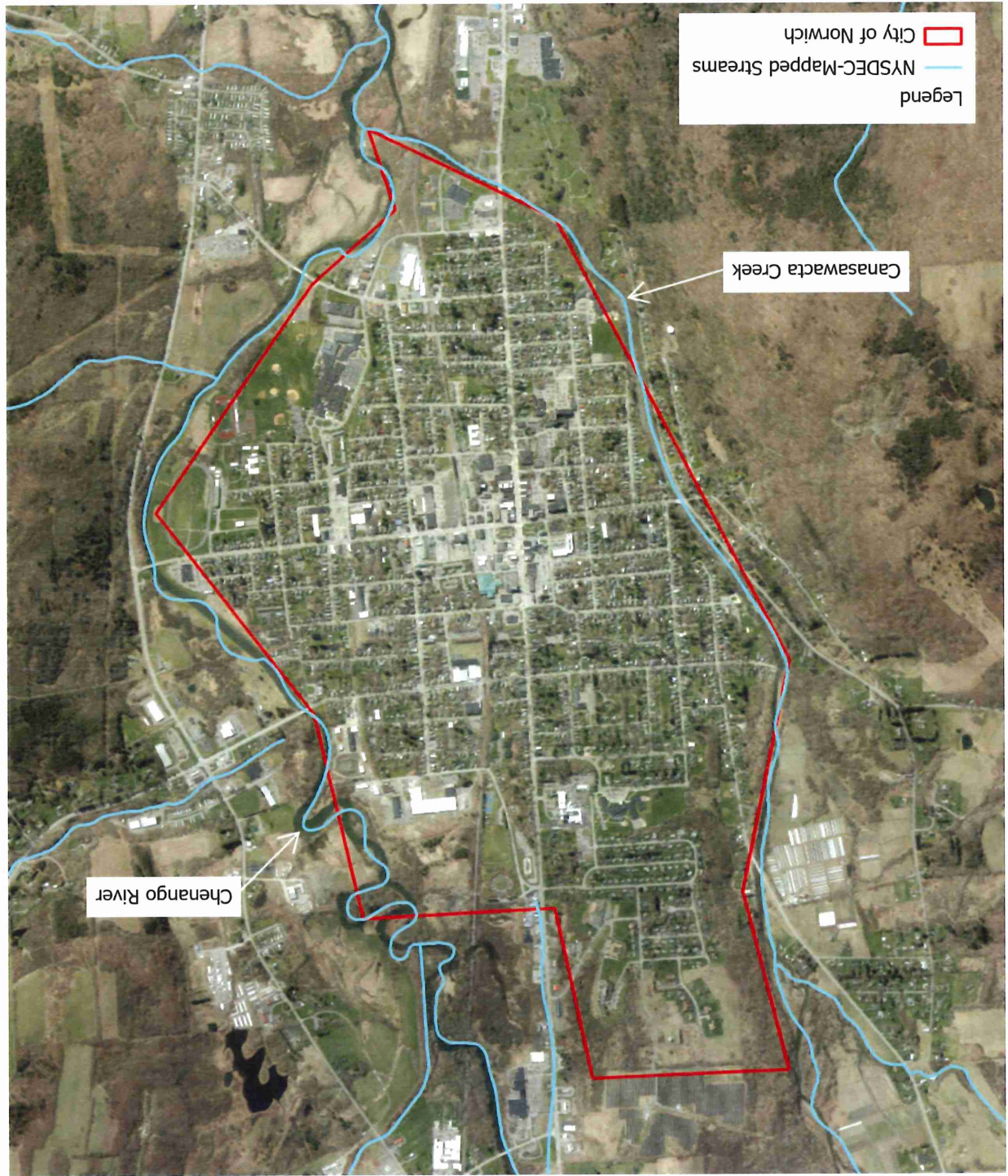
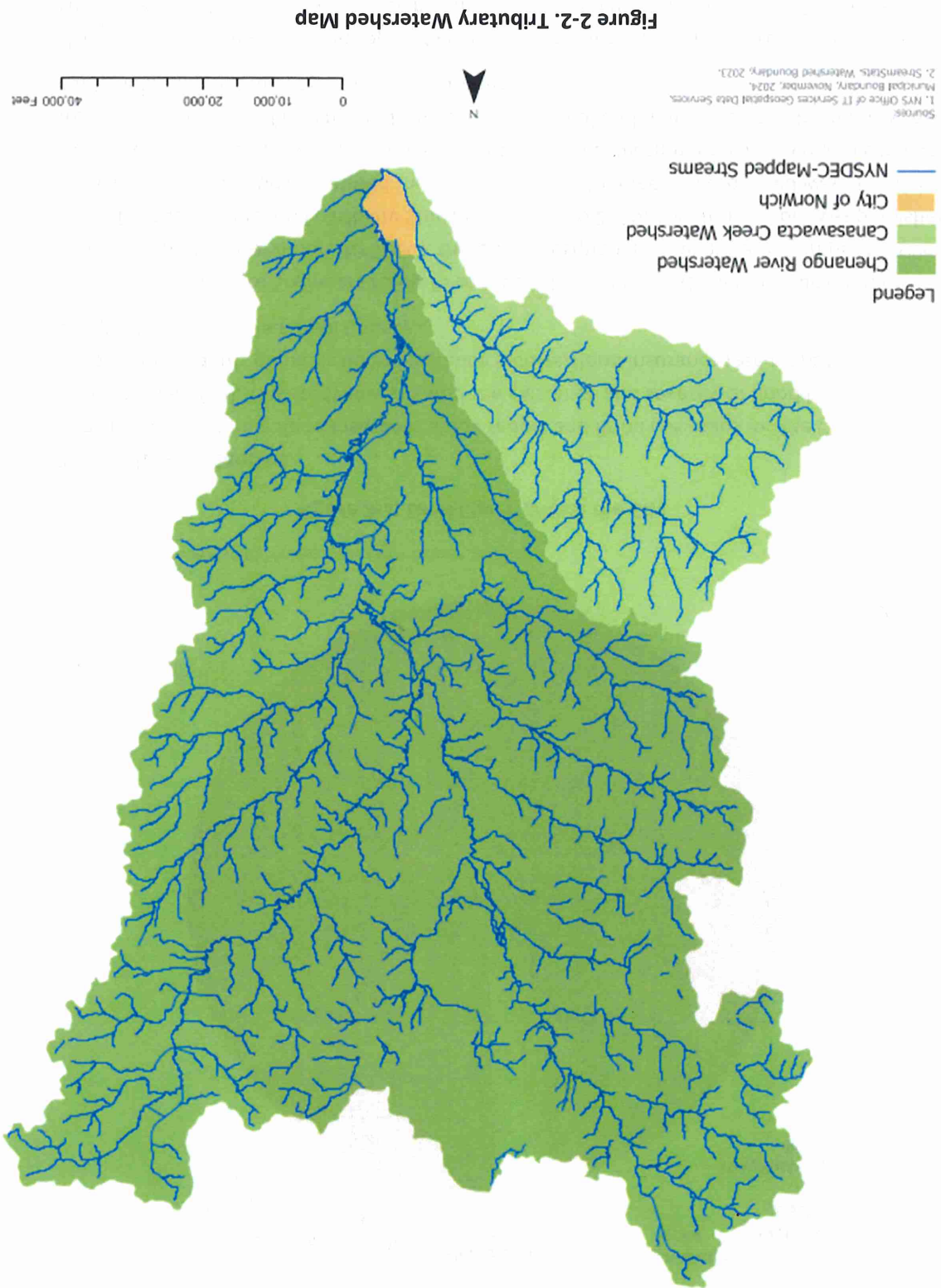
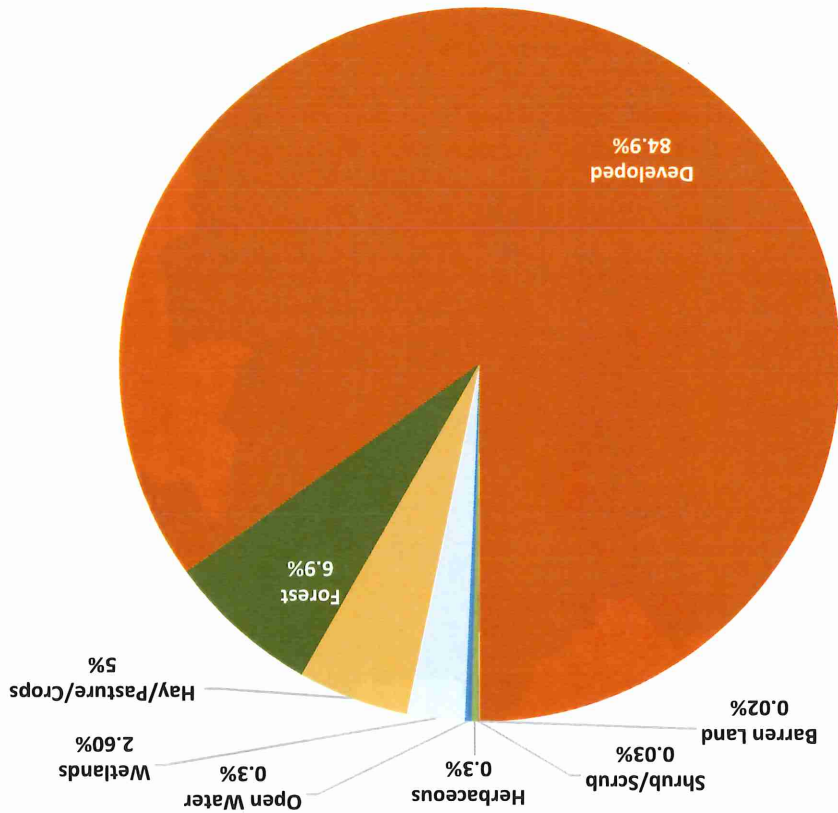


Figure 2-1. Site Map

Sources:
1. ESRI Aerial Imagery, Basemap, May 2025.
2. NYS Office of IT Services Geospatial Data Services.
Municipal Boundary, November, 2024.
3. NYSDEC, Mapped Streams, 2019.





Source: USGS National Land Cover Dataset, 2019.

Figure 2-3. Land Cover Within the City

2.3. Related Studies

The FEMA published a flood insurance study report and flood risk maps for the City of Norwich in November 2010. This study investigated the existence and severity of flood hazards in and revises and updates previous flood insurance studies/flood insurance rate maps for the geographic area of Chenango County.

The US Army Corps of Engineers (USACE) conducted, jointly with the NYS Department of Environmental Conservation (NYSDEC), the Upper Susquehanna River Basin Comprehensive Flood Damage Reduction Feasibility Study from 2009 to 2019. The draft report was published in January 2020. This study identified the current risk for flooding and proposed ways to minimize the impact from flood events, preliminarily determined environmental and economic impact from various levels of flooding, and suggested structural and non-structural alternatives that could help minimize damage to life and property.

Historic flood risk management projects in the City include a channel improvement project completed in 1950. The project is owned and maintained by New York State. The project consisted of the improvement of approximately 2 miles of the Chenango River channel through Norwich from Rexford Street Bridge to and in the vicinity of the mouth of Canasawacta Creek.

The work includes channel straightening and enlargement, riprap protection, and the removal of gravel bars, brush, trees, and other obstructions from the channel, banks, and floodway.

3.0 EXISTING CONDITIONS MODELING AND ANALYSIS

3.1. Approach

The project team conducted a statistical analysis of peak annual streamflow data to establish a baseline understanding of streamflow patterns and variability. The statistical analysis included fitting probability distributions (Log-Pearson Type III) to the peak annual streamflow data to estimate the likelihood of extreme flow events at different return periods. Once the statistical analysis was complete, the hydrologic inputs necessary to model flood events within the study area were synthesized.

3.2. Hydrology

The project team determined peak flows for the model simulations utilizing information from the United States Geological Survey (USGS) gaging stations on Canasawacta Creek and the Chenango River. By relying on measured stream flow rather than precipitation, the analysis minimized uncertainties related to environmental conditions, such as soil moisture, snow cover, storm intensity, storm duration, etc. Focusing on streamflow ensures a more reliable and consistent basis for flood modeling, particularly given the long standing operation of USGS gages in the area.

3.3. Data Availability

Many streamgages have been discontinued or converted to a reduced level of service due to lack of funding, thus limiting the amount of available data. The following table summarizes the available data at the three streamgages used for hydrologic analysis and the time period for which data was available.

Streamgage Name	Streamgage Number	Available Data Start	Available Data End	Years of Record	Type of Data Collected
Canasawacta Creek	01505500	10/01/1945	03/13/1977	32	Maximum Daily Flow (cfs)
Chenango River at Sherburne, NY	01505000	09/17/1986	Present	39	Instantaneous Discharge (measured every 15 minutes) (cfs)
Chenango River at Greene, NY	01507000	10/12/2007	Present	18	Instantaneous Discharge (measured every 15 minutes) (cfs)

The streamgage at Canasawacta Creek has been removed from service and data is limited to 1977. Further, data collected on Canasawacta Creek does not include instantaneous flow values necessary to develop a flood hydrograph.

3.4. Analysis Methods

The project team completed statistical evaluations of data from the gaging stations to determine the flow associated with the exceedance probability. These peak flows, along with observed storm events used for model calibration, were used to help generate time series

hydrographs to model the various events. The flow at the confluence of each tributary to the Chenango River (Johnson Creek and Ransford Creek) were the flow (Qu) at Greene and Sherburne for each storm recurrence event was computed using HEC-SSP. Qu was calculated for each storm recurrence event using the following equation:

$$Q_u^n = Q_g^n \left[\frac{DA_u^n}{DA_g^n} \right]^{exp}$$

Where:

Qu = flow (cfs)

Qg = flow at gaged site (cfs)

DAu = drainage area of ungaged site (sq. miles)

DAg = drainage area of gaged site (sq. miles)

exp = exponent based on drainage area regression

The geometric mean was calculated for ungaged sites between the Qu at Greene and the Qu at Sherburne. The drainage area only equation exponents for each region can be useful in transferring peak-discharge information upstream or downstream from a gaged site according to the ratio of the ungaged area to the gaged site's drainage area, raised to the exponent power [Lumia et al, 2006]. Projected future discharges follow NYSDEC guidance as discussed in the New York State Flood Risk Management Guidance for the Implementation of the Community Risk and Resiliency Act (CRRRA) document titled *Estimating Elevation*. Projected future riverine flows are adjusted by a factor of 120-percent.

3.5. Peak Flood Flows

The average and peak discharges predicted for the project site using the hydrologic methods described in Section 3.4 are summarized in **Tables 3-1 and 3-2**.

Table 3-1. 100-Year Recurrence Base Flood Discharges			
Location	Drainage Area (sq. mi)	Calculated Discharge (cfs)	Projected Future Discharge (cfs)
Canasawata Creek (entire basin)	61.9	8,700	10,440
Chenango R. Upstream of Confluence with Canasawata Ck	313	14,831	17,797
Chenango R. Upstream of Route 320	324	15,216	18,260
Chenango R. at Ransford Creek	332	15,495	18,594
Chenango R. at Johnson Creek	394	17,597	21,116

Table 3-2. 500-Year Recurrence Base Flood Discharges			
Location	Drainage Area (sq. mi)	Calculated Discharge (cfs)	Projected Future Discharge (cfs)
Canasawacta Creek (entire basin)	61.9	10,043	12,051
Chenango R. Upstream of Confluence with Canasawacta Ck	332	19,955	23,946
Chenango R. Upstream of Route 320	313	19,118	22,941
Chenango R. at Ransford Creek	324	19,604	23,525
Chenango R. at Johnson Creek	394	22,600	27,120

3.6.

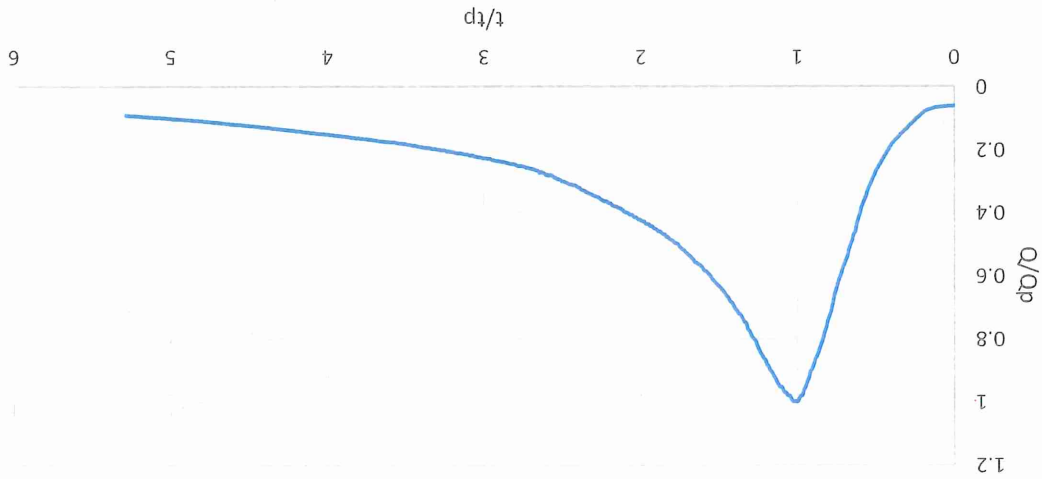
Flood Hydrograph Development

Flood hydrographs were developed using the unit hydrograph method, a hydrological technique that estimates runoff response from a watershed to a standardized unit of rainfall. A unit hydrograph represents the runoff generated by a single unit (like one inch) of rainfall occurring uniformly across the entire watershed over a specific duration. This method allows for analysis of how a watershed responds to a specific rainfall event by providing a standardized response curve. The unit hydrograph can be used to estimate peak flows for future events by applying the unit hydrograph ratio to any peak flood value.

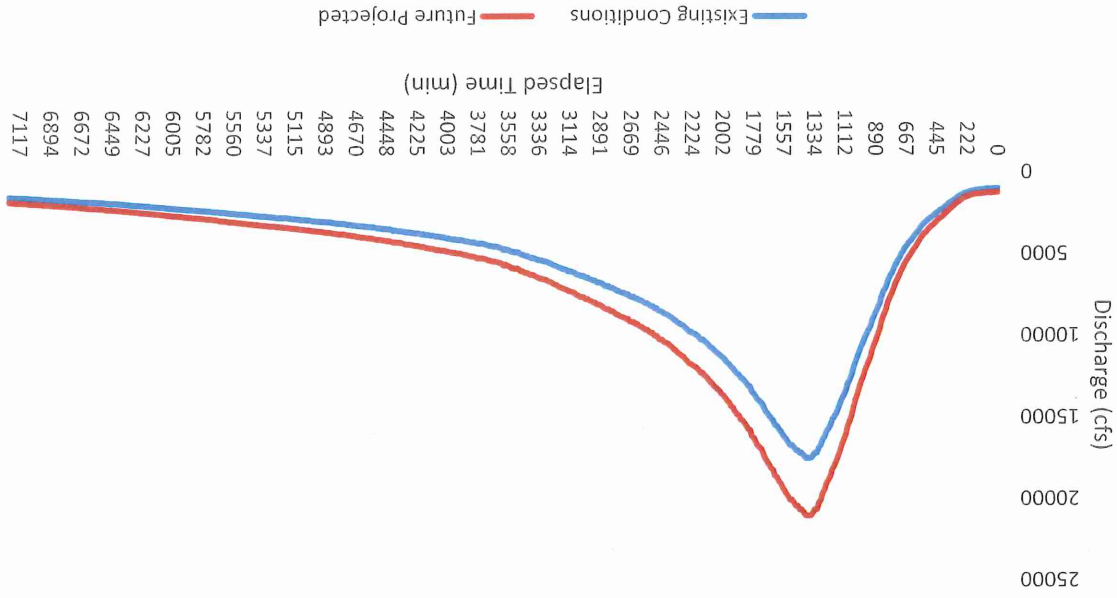
Stream flow data was collected from Canasawacta Creek, Chenango River at Sherburne, and Chenango River at Greene. Five storm events were isolated based on streamgauge data. Due to limited data availability and storm data, the September 8, 2011 storm was selected as the model calibration storm due to its longer duration and regional significance, representing a realistic worst-case scenario.

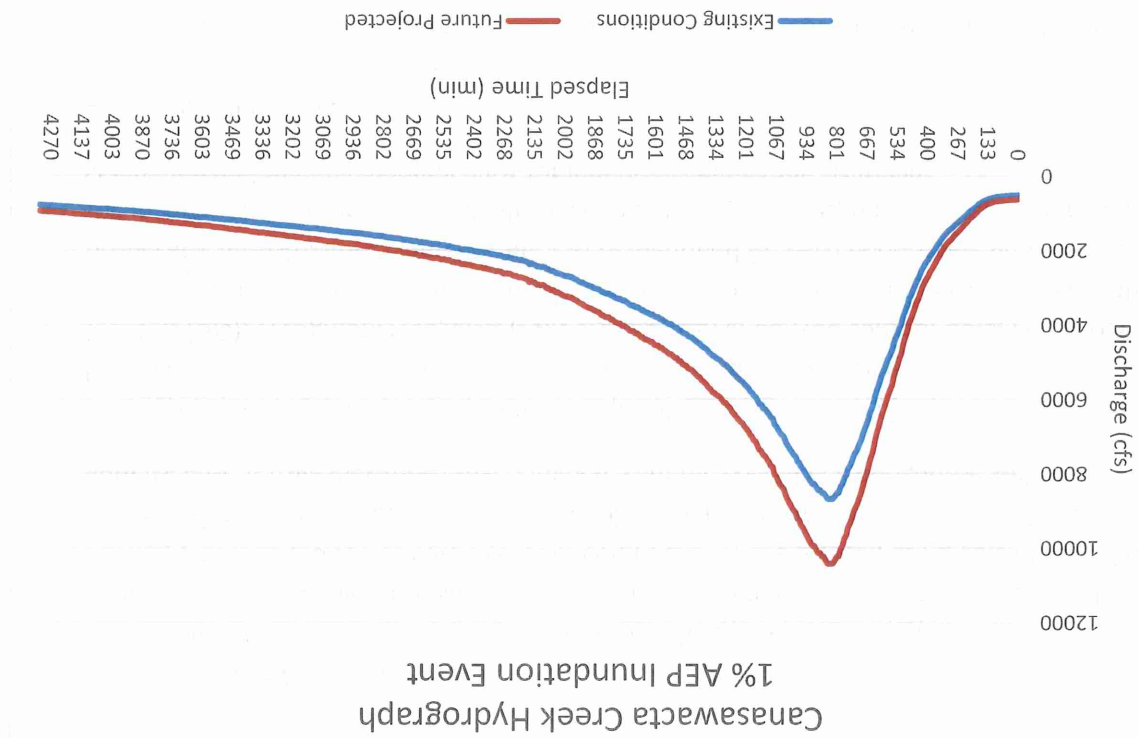
Streamflow response of the watershed to flood scenarios can be predicted by applying the derived hydrograph to observed streamflow data. The dimensionless unit hydrograph from Chenango River gage used to develop design flood hydrographs for the model is shown below. The hydrographs were adjusted to a 5-day duration for Chenango River and a 3-day duration for Canasawacta Creek.

Dimensionless Unit Hydrograph for Chenango River (9/2011)



Chenango River Hydrograph 1% AEP Inundation Event





4.0

HYDRAULIC ANALYSIS

4.1.

Analysis Methods

Evaluation of flooding risk within the City of Norwich required use of a detailed model capable of accurately projecting water surface elevation as a function of stream discharge. HEC-RAS (v6.4.1) was selected to evaluate hydraulic conditions for the project, using data obtained from site topographic surveys augmented with publicly available data sources. The 2019 FEMA LiDAR data used for terrain elevations was obtained from the NYS GIS Clearinghouse website.

For each scenario, the model projected flood profiles, water surface (flood) elevations and lateral flood extents (inundation widths) within the project area. Using Geographic Information Systems (GIS), topographic mapping (supported by LiDAR-derived contour data) and aerial imagery overlays to depict inundation zones, at-risk structural elements (including residential properties, infrastructure elements, etc.) were identified for each flood stage modeled. Defining the inundation limits and affected infrastructure elements corresponding to each modeled flood stage provided the fundamental basis for identifying mitigation strategies.

4.2.

Model Inputs

4.2.1.

Geometric Data

Detailed surveys of portions of Canasawacta Creek's bathymetry and elevation of streambanks were conducted to refine model accuracy. Survey data was collected up- and downstream of existing and previously existing structures and at the confluence of Canasawacta Creek and the Chenango River. For areas where there was no detailed survey, digital elevation model data was used to extract geometry for overbank terrain. Changes to the Canasawacta Creek model include the removal of the dam at Kurt Beyer Park, the removal of the bridge at Red Mill Road, and the replacement of the Plymouth Street Bridge on new alignment. Reach cross section data was obtained at the dam and bridge removal sites and at the foot bridge at Kurt Beyer Park.

4.2.2.

Roughness and Energy Loss Coefficients

Canasawacta Creek Manning's n
Channel: 0.040 – 0.050 (increased to improve low flow stability early in model)
Overbank Left: 0.010 – 0.100 (0.080 typical, not adjusted)
Overbank Right: 0.070 – 0.100 (0.080 typical, not adjusted)

Chenango River Manning's n

Channel: 0.033 – 0.120 (not adjusted)
Overbank Left: 0.035 – 0.120 (not adjusted)
Overbank Right: 0.045 – 0.120 (not adjusted)

Note that some Chenango River cross sections include relic and secondary channels that may be reflected in FEMA's selection of overbank roughness coefficients. B&L retained the original values for the LFHA analysis.

B&L also retained the original Contraction and Expansion coefficients from the original FEMA HEC-RAS and HEC-2 models, which ranged from 0.1 to 0.3 and 0.3 to 0.5, respectively.

4.2.3. Boundary Conditions The boundary locations of the model were adjusted from the 2010 FEMA studies to buffer the corporate limits of the City of Norwich. Upstream boundary conditions are represented by an inflow hydrograph and boundary energy slope based on the prevailing channel slope. Similarly, a normal depth boundary condition was assumed at the downstream model extent on the Chenango River based on prevailing channel conditions. Lateral inflow hydrographs were added to the Chenango River channel to represent the location of major stream inflows within the study limits.

4.2.4. Ineffective Flow Areas B&L started model development with the original ineffective flow areas from the 2010 FEMA models for the Chenango River and Canasawacta Creek. Vertical and lateral adjustments were made to reflect updated geometry on Canasawacta Creek where appropriate. In some cases, ineffective flow areas were added to floodplains to improve model stability at the transition between channel and overbank flows conditions. The areas added were intended to prevent miscalculation of active flow areas and velocities that often trigger instability between adjacent cross sections.

4.2.5. Flood Flow Design flows and hydrologic inputs rely on the values provided in Section 3.0 of this LHA report. Future flow conditions were obtained in HEC-RAS by adding a flow multiplier (scale factor) of 1.2 in the HEC-RAS model, rather than creating separate input hydrographs. The resulting model hydrograph is equivalent.

4.3. Model Scenario Results

B&L developed hydraulic model scenarios for the 1% AEP flood (100-year recurrence) for the Chenango River, Canasawacta Creek, and a combination of both sources. Each scenario was duplicated to capture projected future flows, for a total of six model scenarios. All model scenarios represent existing conditions and do not take into any future projects, flood mitigation measures, or channel improvements. Four inundation maps are included as illustration. **Figure 4-1** shows the existing and projected 1% AEP inundation zones if only the Chenango River is flooded. **Figures 4-2 and 4-3** show the existing and projected 1% AEP inundation zones if only Canasawacta Creek is flooded and if both reaches are flooded simultaneously, respectively. **Figure 4-4** shows the LHA inundation zone outside of the 2010 FEMA 1% AEP inundation zone.

4.4. Summary of Results

The model results generally align with the FEMA mapped Special Flood Hazard Areas (SFHAs) along the Chenango River. However, geometry changes of the inundation area along Canasawacta Creek clearly reflect the differences between the LHA mapped inundation limits

when compared to FEMA's current boundaries. The 2D elements in the LFHA model better represent the extent and flow path of floodwaters as they leave Canasawacta Creek, especially the conveyance along roadways and city streets. While the extents of flooding north of Main Street are reduced, it becomes clear that additional risk to areas not presently mapped in SFHAs exists. Areas near the confluence of the two flood sources are impacted more drastically than depicted by the separate FEMA models reflected on the FIRMs. A summary of parcels affected by each flood scenario is summarized in **Table 4-1** below. B&L expects that the conveyance of flood volume from the upstream extent of Canasawacta Creek contributes to the expansion of the flood inundation limits in that area. Further, motorists may be impacted more severely by extreme flood events than previously anticipated as most major roadways are expected to flood as a result of the combined 1% AEP flood event.

Table 4-1. Number of Parcels Affected				
Scenario	Chenango 1% AEP Flood Event	Canasawacta 1% AEP Flood Event	Combined 1% AEP Flood Event	
FEMA	916*			
LFHA Existing	536	935	1,325	
LFHA Projected**	613	1,280	1,598	

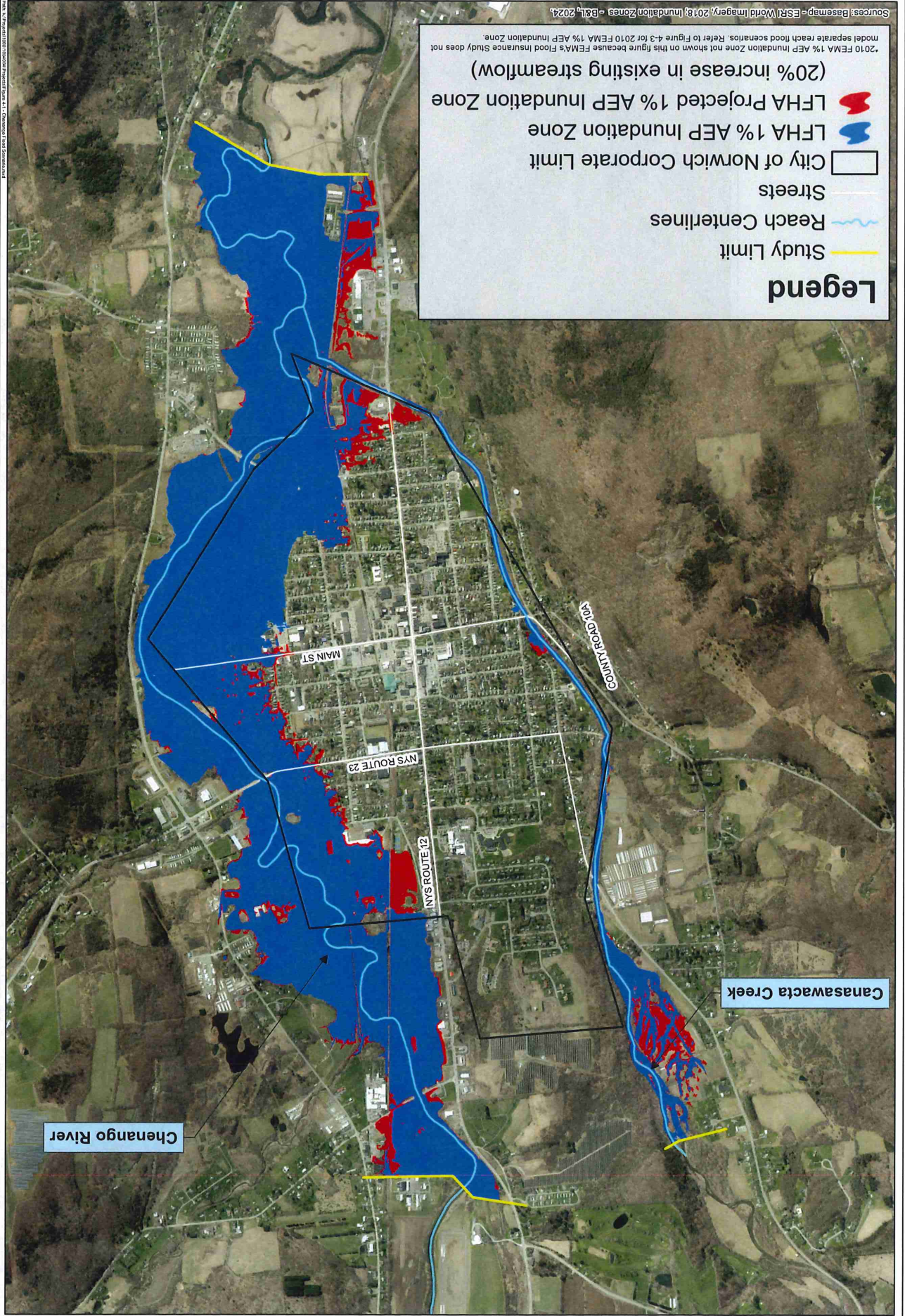
* FEMA's 2010 Flood Insurance Study does not differentiate between different reach flood scenarios and does not model future flooding

**Projected future riverine flows are adjusted by a factor of 120-percent.



2010 FEMA 1% AEP Inundation Zone not shown on this figure because FEMA's Flood Insurance Study does not model separate reach flood scenarios. Refer to Figure 4-3 for 2010 FEMA 1% AEP Inundation Zone.
(20% increase in existing streamflow)

- LFHA Projected 1% AEP Inundation Zone
- LFHA 1% AEP Inundation Zone
- City of Norwich Corporate Limit
- Streets
- Reach Centerlines
- Study Limit



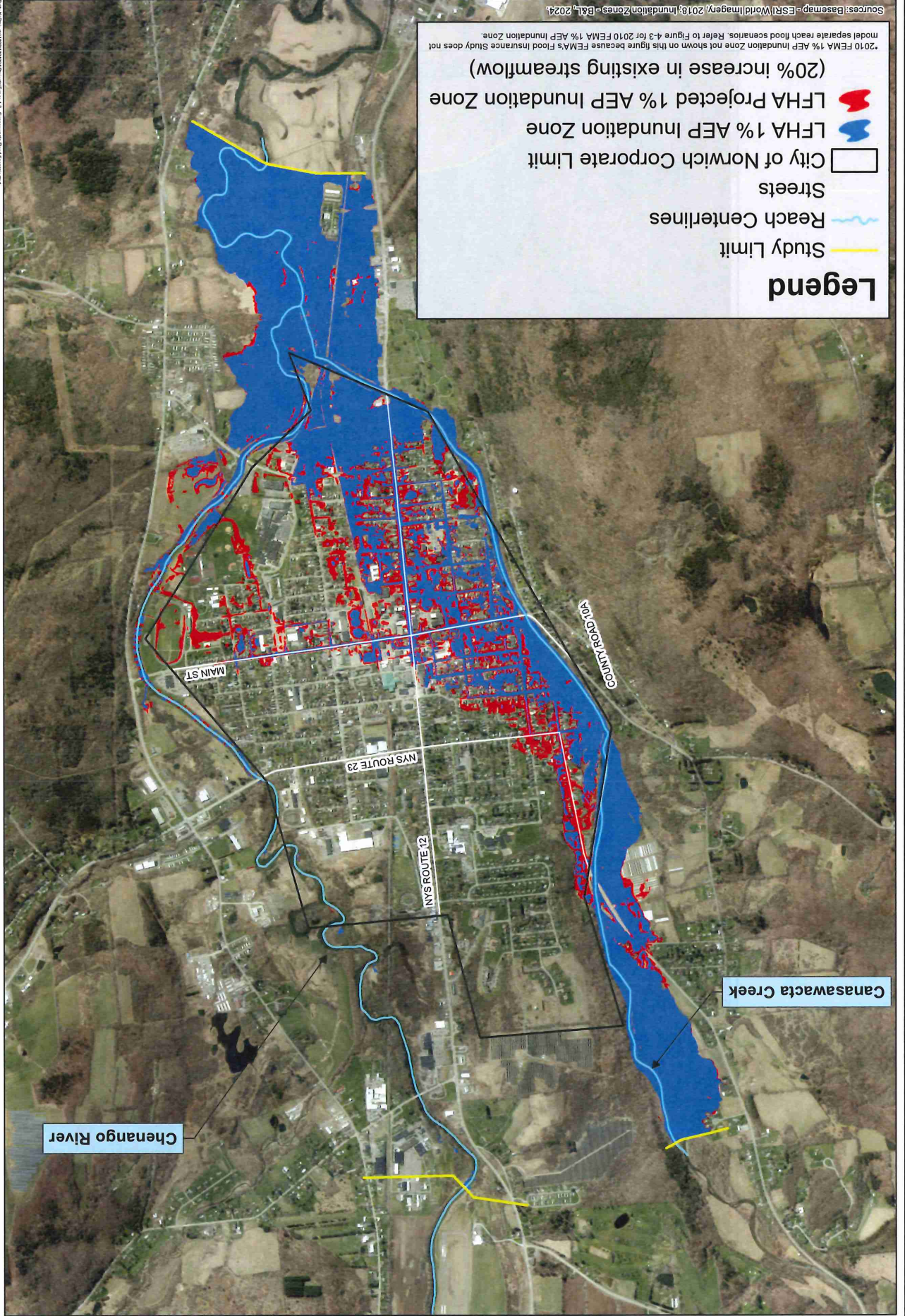
Sources: Base map - ESRI World Imagery, 2018; Inundation Zones - B&L, 2024.



Sources: Base map - ESRI World Imagery, 2018; Inundation Zones - B&L, 2024.

*2010 FEMA 1% AEP Inundation Zone not shown on this figure because FEMA's Flood Insurance Study does not model separate reach flood scenarios. Refer to Figure 4-3 for 2010 FEMA 1% AEP Inundation Zone.

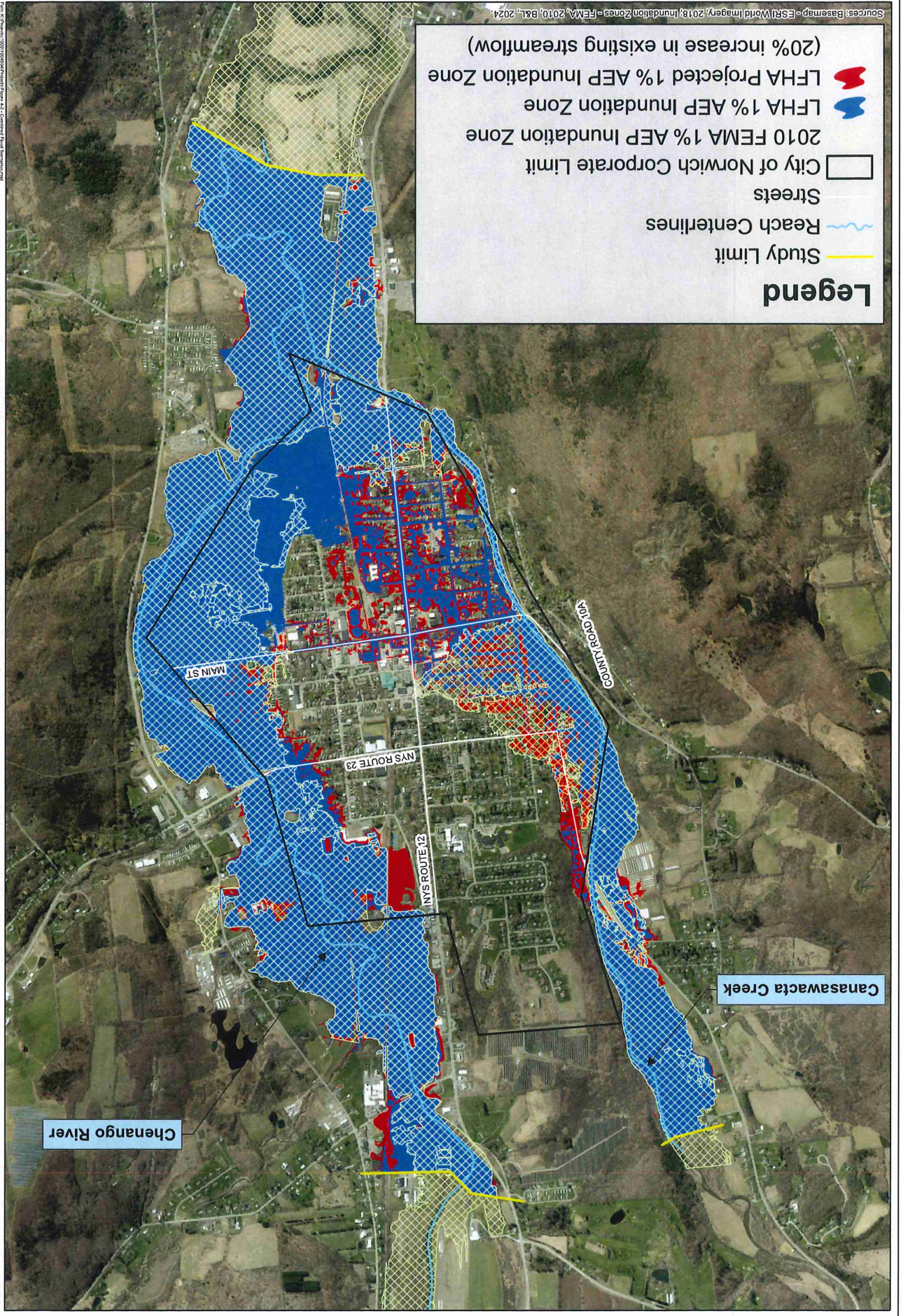
- Legend**
- Study Limit
 - Reach Centerlines
 - Streets
 - City of Norwich Corporate Limit
 - LFHA 1% AEP Inundation Zone
 - LFHA Projected 1% AEP Inundation Zone (20% increase in existing streamflow)





(20% increase in existing streamflow)

- Legend**
- City of Norwich Corporate Limit
 - 2010 FEMA 1% AEP Inundation Zone
 - LFHA 1% AEP Inundation Zone
 - LFHA Projected 1% AEP Inundation Zone
 - Study Limit
 - Reach Centerlines
 - Streets



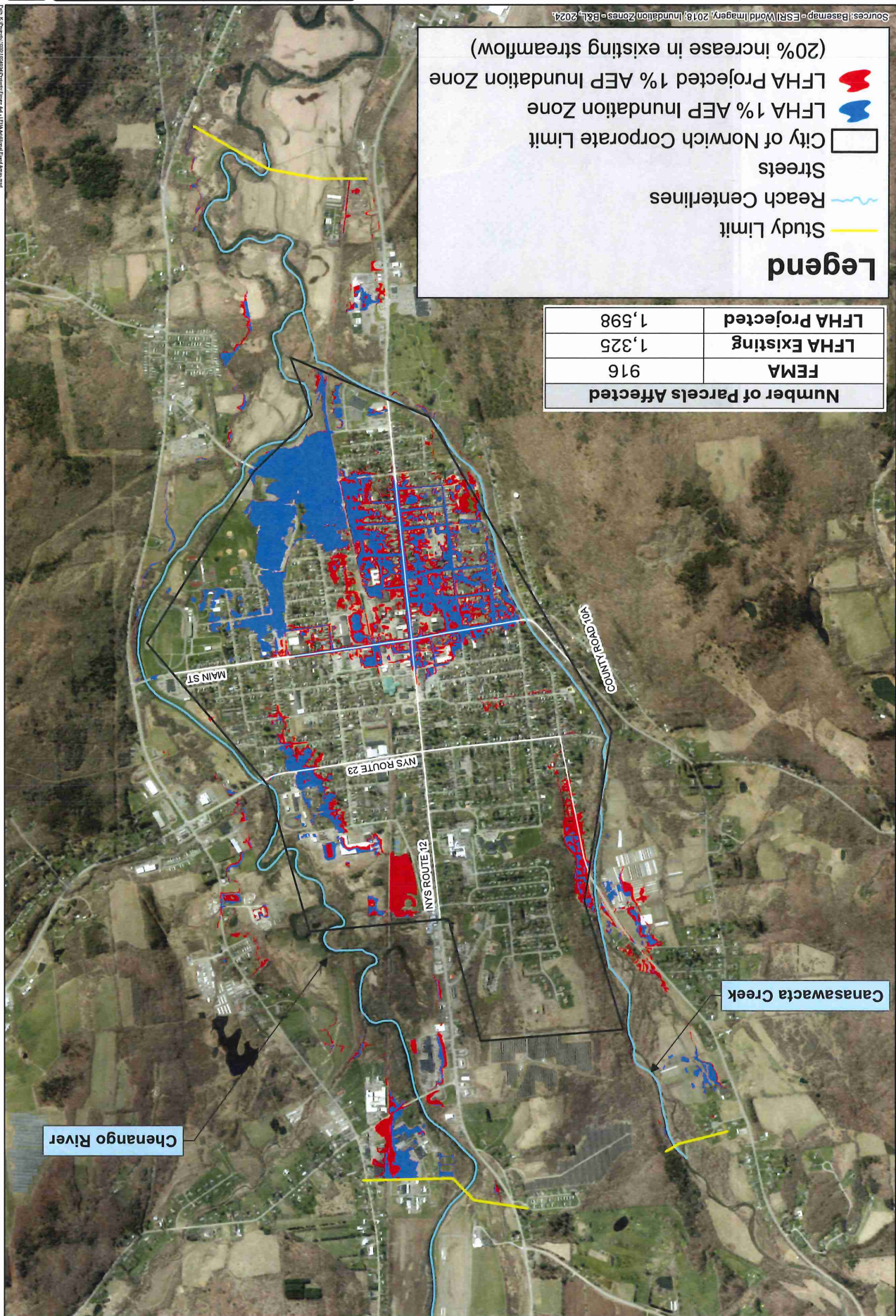


Sources: Baseemap - ESRI World Imagery, 2018; Inundation Zones - B&L, 2024.

Legend

- Study Limit
- Reach Centerlines
- Streets
- City of Norwich Corporate Limit
- LFHA 1% AEP Inundation Zone
- LFHA Projected 1% AEP Inundation Zone
- (20% increase in existing streamflow)

Number of Parcels Affected	
FEMA	916
LFHA Existing	1,325
LFHA Projected	1,598



5.0 FLOOD RISK ANALYSIS

5.1. Comparison to Effective Flood Insurance Rate Maps

The model results generally align with the FEMA mapped Special Flood Hazard Areas (SFHAs) along the Chenango River. However, geometry changes along Canasawacta Creek are clearly reflected by the differences between the LFHA mapped inundation limits when compared to FEMA's current boundaries. The 2D elements in the LFHA model better represent the extent and flow path of floodwaters as they leave Canasawacta Creek, especially the conveyance along roadways and city streets. While the extents north of Main Street are reduced, it becomes clear that additional risk to areas not presently mapped in SFHAs exists. Areas near the confluence of the two flood sources are impacted more drastically than depicted by the separate FEMA models reflected on the FIRMs. B&L expects that conveyance of flood volume from the upstream extent of Canasawacta Creek contributes to the expansion of the flood inundation limits in that area. Further, motorists may be impacted more severely by extreme flood events than previously anticipated as most major roadways are expected to flood as a result of the combined 1% AEP flood event.

5.2. Critical Services

Critical services within the City of Norwich include a hospital, police station, firehouse, highway department garage, and wastewater treatment plant. The UHS Chenango Memorial Hospital is located in the northcentral part of the City. Due to its location between the reaches and elevation, the hospital is not located within the existing and projected inundation zones. The Norwich Police Station and firehouse are located centrally within the City. Due to their location and elevation, both the police station and firehouse are expected to flood during the existing and projected 1% AEP inundation event.

Due to its proximity to the Chenango River and relatively low elevation, the highway department garage is expected to flood during the existing and projected 1% AEP flood. The wastewater treatment plant is located at the southern end of the City, just south of the confluence of the Chenango River and Canasawacta Creek. Due to its relatively higher elevation compared to the surrounding floodplain, the wastewater treatment plant is partially located within the existing and projected flood zones. Access to the wastewater treatment plant will be limited due to flooding of the access road to the plant. Critical services are illustrated in **Figure 5-1**.

5.3. Transportation and Evacuation

Motorists may be impacted more severely by extreme flood events than previously anticipated as most major roadways are expected to flood as a result of the combined 1% AEP flood event. Roads in the southern end of the city are expected to flood, while the central and northcentral roads are not expected to flood due to their higher elevations.

5.4. Historic Structures

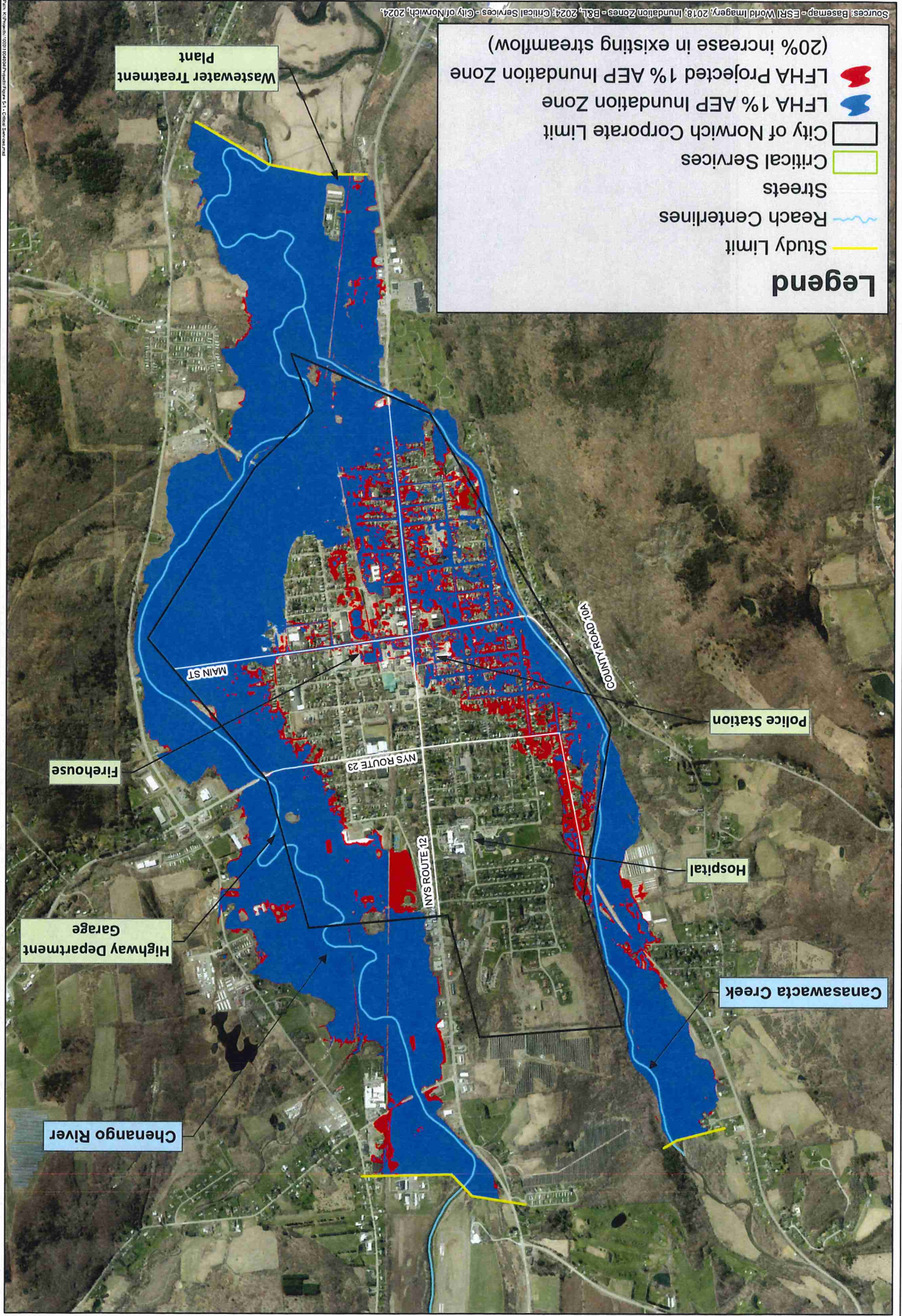
Historic structures, as listed by the National Register, within the City of Norwich include the United States Post Office – Norwich, Eaton Family Home, Emmanuel Episcopal Church Complex,

Methodist-Episcopal Church of Norwich, Norwich Pharmacal Company Warehouse. Historic districts within the City include the North Broad Street Historic District and the Chenango County Courthouse District.

All historic structures and districts are located centrally within the City. The Methodist Episcopal Church of Norwich and the North Broad Street Historic District are outside of the inundation area. The Emmanuel Episcopal Church Complex, Eaton Family Home, Norwich Pharmacal Company Warehouse, United States Post Office, and Chenango County Courthouse District are expected to flood during the existing and projected 1% AEP inundation event. Historic structures are illustrated in **Figure 5-2**.



- Legend**
- Study Limit
 - Reach Centerlines
 - Streets
 - Critical Services
 - City of Norwich Corporate Limit
 - LFHA 1% AEP Inundation Zone
 - LFHA Projected 1% AEP Inundation Zone (20% increase in existing streamflow)



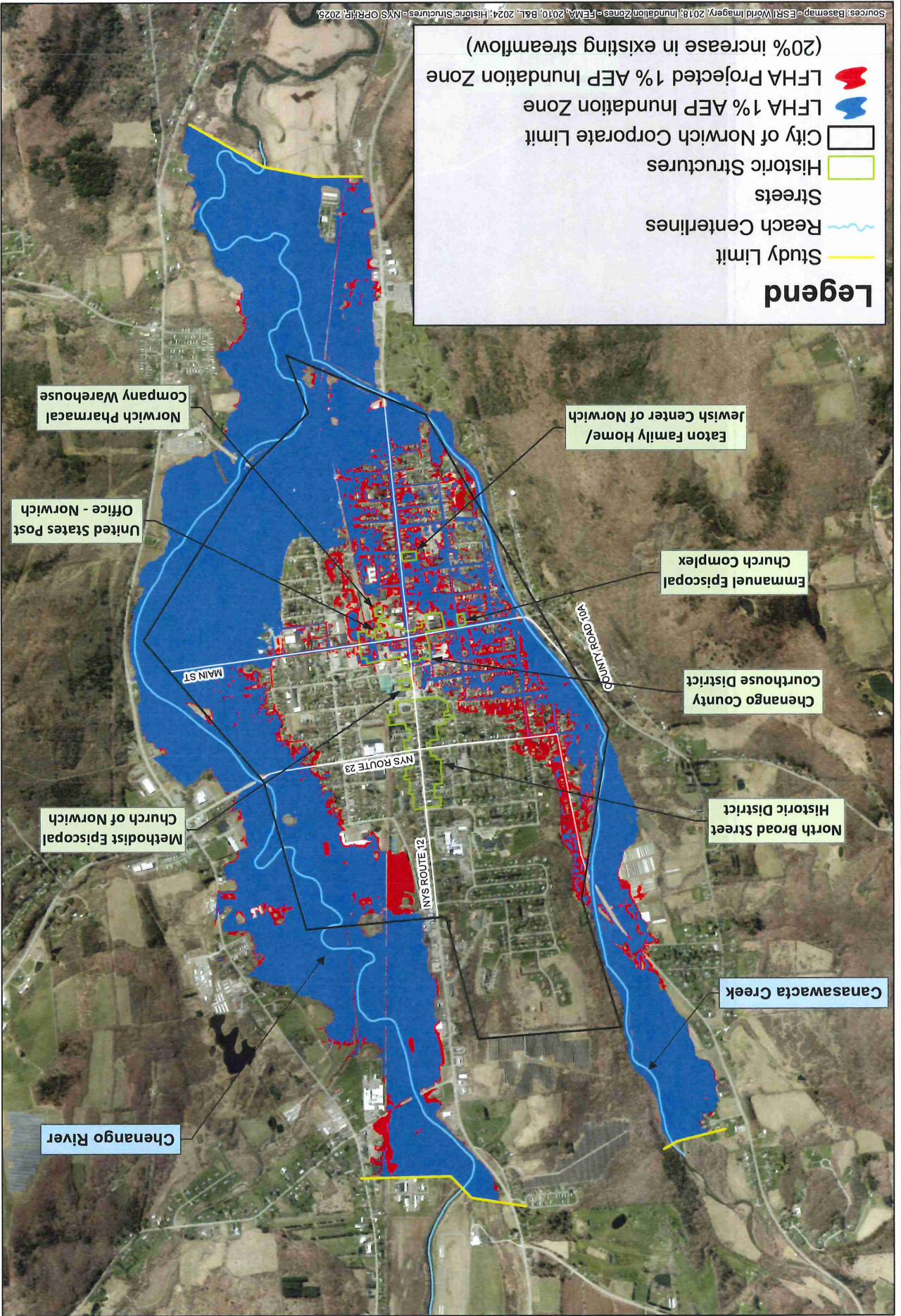
Sources: Basemap-ESRI/World Imagery, 2018; Inundation Zones-B&L, 2024; Critical Services-City of Norwich, 2024.



Sources: BaseMap-ESRI World Imagery, 2018; Inundation Zones-FEMA, 2010; B&L, 2024; Historic Structures-NYS OPRHR, 2025.

Legend

- Study Limit
- Reach Centerlines
- Streets
- Historic Structures
- City of Norwich Corporate Limit
- LFHA 1% AEP Inundation Zone
- LFHA Projected 1% AEP Inundation Zone
- (20% increase in existing streamflow)



6.0 FLOOD HAZARD MITIGATION

6.1 Mitigation Strategies

As demonstrated by the model projections and confirmed by history, the City of Norwich is susceptible to flooding during high streamflow events. The project team defined recurrence intervals using streamflow, which is not always equivalent to the recurrence interval of storm events (that is, a 100-year storm event may not result in a 100-year streamflow event). Antecedent conditions such as soil moisture and snow cover coupled with spatial variability in rainfall intensity, location, and duration makes predicting flooding as a function of storm events extremely complicated. It is far more reliable to evaluate flooding risk based on the exceedance probability of streamflow, as FEMA does through their Flood Insurance Studies (see, for example FEMA 2010). In Norwich, the presence of long-established USGS gages on both of the streams greatly increases the statistical accuracy of predicted streamflow recurrence intervals and exceedance probabilities.

Although identification and evaluation of specific mitigation strategies were outside of the scope of this LFHA, various types of mitigation strategies are characterized in **Table 6-1** below.

Table 6-1. Mitigation Strategies	
Category	Description
Alteration of Channel Cross Section	Actions that provide additional cross-sectional area to carry floodwater, including dredging, channel widening, and vertical height increase.
Alteration of Existing Structures	Actions that use or modify structures to mitigate flood hazard such as retrofit of bridge abutments and culverts, or use of check valves at storm sewer outfalls.
Natural Resource Protection	Actions that minimize loss of, or preserve/restore the function of natural systems and associated ecosystem services (such as streambank protection and stabilization) redesign of roadside ditches, attenuation of peak flows through regional detention)
Reservoir Routing	Actions that modify the operation of existing dams and reservoirs in the watersheds for flood control purposes.
Sediment Control	Actions that would decrease sediment loads at their sources in the watershed, impede the downstream transport of sediment loads, and/or reduce the rate of deposition of sediment in the study area

In January 2020, the USACE published a report documenting the findings of the Upper Susquehanna River Basin Comprehensive Flood Damage Reduction Feasibility Study, conducted jointly with the NYSDEC. The study used a watershed planning approach to evaluate flood risk and investigate feasibility of structural and non-structural flood reduction measures in the identified focus areas. **Table 6-2** below is a modified version of Table 23: Initial Array of Alternatives for the City of Norwich from the USACE's feasibility study report, highlighting only the alternatives considered feasible based on the USACE's judgment. A separate in-depth analysis is needed to assess the benefits of different flood mitigation strategies.

Table 6-2. Array of Alternatives for the City of Norwich				
Alternatives Considered for Focus Risk Area:	Norwich	Preliminary Federal Interest	Engineering Judgement	Acceptability of Potential Impacts
Clearing, snagging, and shoal removal Federal channel along Chenango River and Canasawacta Creek in Norwich	Non-structural measures in Norwich including a combination of elevating structures, acquisitions, and floodproofing of structures	No Potential	Feasible	High Impacts Likely; More Analysis Needed
		Potential	Feasible	Low Impacts Likely; Acceptable

A preliminary hydraulic model was run to determine if inundation limits will be affected by dredging. The model was run with a 30-foot width by 0- to 4-foot depth (depending on the cross section) dredge to achieve a consistent slope between Broad Street and the Chenango River. The results lowered water surface elevations up to 4" and the benefits carried upstream of Broad Street, diminishing as they went upstream. **Figure 6-1** depicts the inundation limits if some dredging were to occur, which looks similar to the Combined 1% AEP Flood Inundation Map (Figure 4-3) with only minor reductions in flood limits. Further in-depth analysis is required to thoroughly assess the potential benefits and constraints of dredging.

Non-physical mitigation strategies include updating local flood ordinances to reduce the risk and impact of flooding on people, property, and the environment. The City of Norwich adopted Chapter 273 – Flood Damage Prevention to promote public health, safety, and general welfare, and to minimize public and private losses due to flood conditions within the City. FEMA's National Flood Insurance Program (NFIP) Community Rating System Coordinator's Manual provides guidance to communities that want to design or improve their floodplain management programs. Section 430 provides guidance on developing higher regulation standards that provide more protection to new development, redevelopment, and existing development. Section 430 of the Coordinator's Manual is attached as **Appendix C**.

6.2. Critical Locations

Critical locations for flood mitigation strategies include areas that would protect critical services from flooding (highway department garage, firehouse, police station, and wastewater treatment plant). Additional critical locations include the eastern and southern end of the City where the Chenango River would flood many households during an inundation event.

6.3. Next Steps

Next steps include evaluating upstream measures and measures within the City for their effectiveness in reducing flood risk. The model should be applied to determine how various interventions would reduce the extent of inundation. A benefit-cost analysis (BCA) should be completed to compare the costs of implementing the recommendations with the benefit of avoided damages. This analysis shall use standard procedures and algorithms developed by the FEMA to calculate damages. In addition to flood mitigation projects, institutional controls such as modifications to planning and zoning regulations are needed to improve resilience to changing climate and to manage risks.

In addition to evaluation of potential future flood mitigation projects, next steps should include a homeowner-level evaluation of exterior and interior flood proofing measures, as described in Section 7.0.

6.4. Available Funding Sources

The community will incur costs for planning, design, construction, permitting, and implementation of the various recommended alternatives. Funding assistance from non-local partners, including state and federal agencies, could improve the associated benefit-cost ratios. This section provides a brief overview of programs and agencies that could potentially support the City's efforts in reducing the risk of flood damage.

Funding assistance for implementation of potential mitigation actions may be available from several NYS and federal grant programs in place to assist communities with preparing for and mitigating the impacts of climate change and flooding. A summary table is provided below:

Table 6-3. Potential Funding Sources			
Grant Program	Funding Agency	Description	Applicability
Water Quality Improvement Program (WQIP)	NYSDEC	The WQIP program is a competitive, statewide reimbursement grant program open to local governments and not-for-profit corporations to implement projects that directly improve water quality or habitat, promote flood risk reduction, restoration, and enhanced flood water source. This funding is for and climate resiliency, or protect a drinking water source. This funding is for construction/implementation projects, not projects that are exclusively for planning.	Green infrastructure projects to address combined sewer overflows, reduce a pollutant impacting a waterbody or address a regional water quality issue; provide resiliency to impacts from climate change; or reduce localized flooding; or projects to install green infrastructure practices designed to capture and remove the pollutant contributing to water quality impairment. Projects to replant vegetation within the riparian zone of waterbodies to filter nutrients and sediment, prevent streambank/shoreline erosion, reduce thermal impacts to waterbodies, and increase flood resiliency.
Climate Smart Communities	NYSDEC	The Climate Smart Communities Program offers matching grants (50% cost sharing) up to \$2 million in state assistance payments toward the cost of any climate adaptation or mitigation projects. Project categories include supporting implementation projects related to the reduction of greenhouse gas emissions and climate change adaptation and planning and assessment projects aligned with Climate Smart Communities certification actions.	Projects can include creating a plan to relocate municipal facilities and/or residential/commercial facilities out of the floodplain, adopting zoning regulations, and establishing a buyout program. Must include public outreach.

Table 6-3. Potential Funding Sources

Grant Program	Funding Agency	Description	Applicability
Resilient Watersheds Grant Program	NYSDEC NYSEFC	The RWG program aims to implement projects that build community resilience to extreme weather events, promote flood risk and ice jam reductions and/or restoration, enhance flood and climate resilience, and implement natural and nature-based feature construction or ecologically sustainable projects while supporting healthy riparian habitats. This funding is for the construction and/or implementation of projects, not projects exclusively for planning and/or design. A NYSDEC-approved flood study must be completed by the time funding is awarded. 10% of the cost must be locally matched, and funds are disbursed as costs are incurred. Grant applications are submitted each June through the Consolidated Funding Application (CFA).	- floodplain restoration, creation, and/or reconnection to a stream - wetland creation and/or restoration - berm removal, dam removal, stream culvert replacement and right-sizing - culvert, bridges, and appurtenant structures removal - streambank, stream channel, or shoreline restoration and/or stabilization and establishment of riparian buffers - stream daylighting
Green Innovation Grant Program	NYSEFC	Supports projects across New York State that utilize unique EPA-designated green stormwater infrastructure design and create cutting-edge green technologies. Competitive grants are awarded to projects that implement one or more of the following green practices: green stormwater infrastructure, energy efficiency, water efficiency and environmental innovation.	Only the green practices constructed that exceed the requirements of the SPDES General Permit for Stormwater Discharges from Construction Activity are eligible for funding.
Local Waterfront Revitalization Program	NYSDOS	Funds projects that address local and regional (coastal or inland) waterway issues, improve water quality and natural areas, guide development to areas with adequate infrastructure and services away from sensitive resources, promote public waterfront access, and provide for redevelopment of underutilized waterfronts. Projects should address restoration and flood risk reduction.	Activities that preserve, restore, or enhance natural landscapes that protect water quality and catalyze waterfront revitalization, reduce localized flooding or increase resilience to flood/precipitation impacts, and/or make public facilities more accessible/resilient to severe weather
Hazard Mitigation Grant Program (HMGP)	NYSDHSES (FEMA)	The HMGP provides funding to states, local communities, tribes and territories in response to disaster declarations to reduce or eliminate the risk of repetitive flood damage to buildings insured under the National Flood Insurance Program (NFIP).	Mitigation projects can include planning and enforcement activities (developing and adopting HMPs, acquisition of hazard prone homes and businesses, post-disaster code enforcement), flood protection, retrofitting, and construction activities.

Table 6-3. Potential Funding Sources			
Grant Program	Funding Agency	Description	Applicability
Flood Mitigation Assistance – Swift Current	NYS DSHSES (FEMA)	The purpose of FEMA Swift Current is to reduce or eliminate flood risk to NFIP-participating communities and repetitively flood damaged structures insured by the NFIP following a flood-related disaster event, and to enhance community flood resilience with NFIP-participating communities. The program does so by providing for mitigation opportunities immediately after a flood disaster with the aim of delivering mitigation outcomes as quickly as possible. This differs from the existing FMA grant opportunity, which operates on an annual grant cycle and funds a broader range of flood mitigation activities through a nationally competitive selection process. FMA Swift Current aims to streamline funding following a federal disaster declaration using flood insurance claims-based eligibility criteria, shorter application periods, and narrowing project type eligibility to only include individual flood mitigation projects involving properties that are Severe Repetitive Loss, Repetitive Loss and Substantially Damaged.	Funding is only available to property owners that have a current flood insurance policy under the NFIP and a history of repetitive or substantial damage from flooding. Swift Current funds individual Flood Mitigation Projects for FFMA and/or NFIP-defined Repetitive Loss (RL), Severe Repetitive Loss (SRL), or properties deemed Substantially Damaged after the applicant's disaster declaration incident period start date. Eligible Individual Flood Mitigation Projects include property acquisition and structure demolition/relocation, structure elevations, dry floodproofing of historic residential structures, non-residential structures, non-structural retrofitting of existing structures and facilities, mitigation reconstruction, and structural retrofitting of existing structures
NYS Hazard Mitigation Revolving Loan Fund	NYS DSHSES (FEMA)	The Federal Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Act became law on January 1, 2021. The STORM Act authorizes FEMA to provide capitalization grants to states, eligible federally recognized tribes, territories, and the District of Columbia, who may award low interest loans directly to local communities. These revolving loan funds provide hazard mitigation assistance for local governments to reduce risks from natural hazards and disasters. The Safeguarding Tomorrow RLF program is part of FEMA's Hazard Mitigation Assistance grant portfolio to support mitigation projects at the local government level and increase resilience to natural hazards and climate change. Funding from FEMA's Safeguarding Tomorrow RLF supports New York's Hazard Mitigation Revolving Loan Fund (HM RLF). Loan funds can be leveraged differently than other funding opportunities to meet unique funding needs.	Eligible projects include construction or modification of natural or built infrastructure to increase resilience, building code adoption and enforcement, local zoning and land use planning changes encouraging low-impact development or watershed-level planning, and developing local hazard mitigation plans.

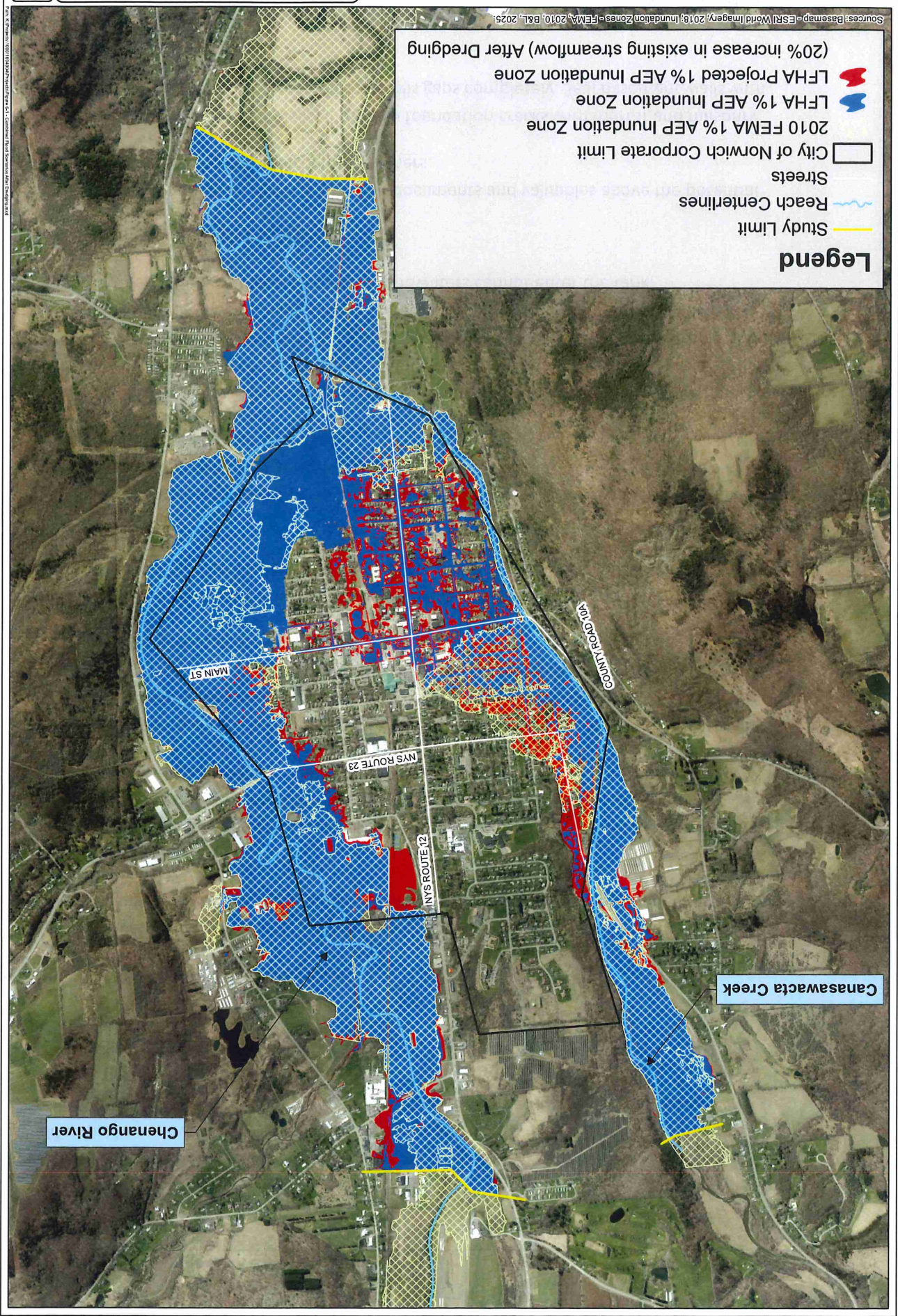
Table 6-3. Potential Funding Sources

Grant Program	Funding Agency	Description	Applicability
Pre-Disaster Mitigation (PDM) Grant Program	NYS DSHSES (FEMA)	The PDM Grant Program makes federal funds available to state, local, tribal, and territorial governments to plan for and implement sustainable cost-effective measures designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters.	All applicants and subapplicants must have a FEMA-approved Hazard Mitigation Plan by the application deadline and at the time of the obligation of funds, unless the subapplicant is applying for a planning subgrant. The Chenango County Hazard Mitigation Plan (HMP) was first adopted in 2015 and updated in 2021, making the City eligible to apply for PDM funds to implement the plan's recommendations.
Community Development Block Grant (CDBG-MIT)	USHUD	The CDBG-MIT program provides funds to eligible grantees to use this assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks and reduce future losses.	Mitigation activities are defined as activities that: increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering and hardship by lessening the impact of future disasters.
Watershed and Flood Prevention Operations (WFPO) Program	USDA NRCS	The WFPO Program aims to provide technical and financial assistance to plan and implement authorized watershed project plans for the purpose of watershed protection, flood mitigation, water quality improvements, and agricultural water management. The program provides 100% of construction and engineering costs for flood damage reduction projects and up to 100% of costs for flood control projects.	Eligible authorized project plans for the purpose of flood prevention, watershed protection, public recreation, public fish and wildlife, agricultural water management, municipal and industrial water supply, and water quality management.
Bipartisan Infrastructure Law PROTECT (BIL PROTECT) Program	DOT	The BIL PROTECT Program provides project funding to help make surface transportation more resilient to natural hazards, including climate change, sea level rise, flooding, extreme weather events, and other natural disasters through support of planning activities, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure.	Eligible activities include planning activities, resilience improvements, community resilience and evacuation route activities, and at-risk coastal infrastructure activities.



Legend

- Study Limit
- Reach Centerlines
- Streets
- City of Norwich Corporate Limit
- 2010 FEMA 1% AEP Inundation Zone
- LFHA 1% AEP Inundation Zone
- LFHA Projected 1% AEP Inundation Zone (20% increase in existing streamflow) After Dredging



Sources: Basemap - ESRI World Imagery, 2018; Inundation Zones - FEMA, 2010; B&L, 2025.

7.0 HOMEOWNER FLOOD PROTECTION MEASURES

While the potential mitigation strategies outlined above may assist with reducing localized flooding concerns, additional homeowner flood protection measures should also be considered to manage flooding, particularly as the result of groundwater. The following homeowner flood protection recommendations were developed by FEMA

(https://www.fema.gov/sites/default/files/documents/fema_protect-your-home-from-flooding-brochure_2020.pdf).

Exterior Homeowner Flood Protection Measures

- Maintain proper water runoff and drainage. Routinely clean and maintain gutters, downspouts, and splash pads. Ensure drainage ditches and storm drains are clear of debris and are functioning properly.
- Improve lot grading. If necessary, consider building up any sunken areas around the foundation, digging small depressions to properly channel water (while avoiding adverse impacts to abutters), and grade properties to slopes away from structures.
- Reduce impervious surfaces. Where adequate separation to groundwater is available, retaining and creating natural green space around properties can help reduce stormwater runoff. Consider options such as rain gardens, vegetated swales, or pervious pavements, which allow more water to be absorbed by the ground.

- Install a rain barrel. Rain barrels are typically connected to gutter downspouts and collect the runoff from roofs. The stored water can be used for non-potable uses such as watering the lawn and gardens.

- Elevate utilities and service equipment. Raise and anchor air conditioning condensers, heat pumps, water meters and other service equipment onto pedestals or platforms that are at least 1 foot above the potential flood elevation.

- Anchor outdoor fuel tanks. Attach outdoor fuel tanks to a large concrete slab that weighs enough to resist the force of floodwaters or install ground anchors that are connected across the top of the tank with metal straps. If located in an identified high-risk zone, fuel tanks should also be elevated to or above the regulatory flood elevation. If not feasible then all filling and ventilation tubes should be elevated so that floodwaters cannot enter the tank.

Interior Homeowner Flood Protection Measures

- Protect valuable possessions. Move important documents and valuables above the potential flood elevation and/or inside watertight containers.
- Seal foundations and basement walls. Close any foundation cracks with mortar and masonry caulk or hydraulic cement, which expands and fills gaps completely. Seal basement walls with

waterproofing compounds to avoid seepage. Make sure any floor drains are clear of obstructions.

- Install flood vents. Flood vents are small permanent openings that allow floodwater to flow freely through an enclosure such as a crawlspace or garage. Properly positioned and installed flood vents protect homes during floods by preventing water pressure buildup that can destroy walls and foundations. Flood openings may be required for lower enclosures of homes being built in high-risk flood zones, but they can also be installed in existing homes. Once installed, make sure your flood vents are kept free of debris and will allow the free flow of floodwater.

- Install a sump pump. Sump pumps, which pump groundwater away from a structure, can prevent or minimize basement seepage and flooding. They draw in the groundwater from around a structure and direct it away from the structure through drainage pipes. Water powered or battery-backup systems are recommended in case of electrical power failure.
- Prevent sewer backups. Install drain plugs for all basement floor drains to prevent sewer backups. Another recommended option, regardless of the potential flood elevation, is to install sewer backflow valves for all pipes entering the building. These devices, which allow water to flow only one direction, prevent floodwater and wastewater from backing up into toilets, sinks, and other drains. A qualified, licensed plumber should install all measures.

- Use flood-resistant building materials. Examples include tile, vinyl, rubber, lime plaster, cement board, concrete, or pressure-treated and decay-resistant wood.
- Raise electrical system components. Increase the height of electric service panels (fuse and circuit breaker boxes) and all outlets, switches, and wiring to at least 1 foot above the potential flood elevation. A licensed electrician should make these modifications.

- Protect utilities and service equipment. Move the main parts of heating, ventilation, and air conditioning (HVAC) systems to a higher floor. Consider raising other major appliances. If relocation or elevation is not possible, service equipment can be protected using low floodwalls and shields.
- Anchor indoor fuel tanks. Anchor fuel tanks by attaching them to a large concrete slab that weighs enough to resist the force of floodwaters.

- Install a flood alert system. A variety of flood sensors and other early warning devices can alert the risk of imminent flooding so preventative or protective actions can be taken.

8.0 REFERENCES

- Ahearn, E. A. (2004). *Regression Equations for Estimating Flood Flows for the 2-, 10-, 25-, 50-, 100-, and 500-Year Recurrence Intervals in Connecticut*. U.S. Department of the Interior, U.S. Geological Survey. Reston: U.S. Geological Survey.
- Federal Emergency Management Agency (FEMA), 2010. Flood Insurance Study, Chenango County, New York.
- Federal Emergency Management Agency (FEMA), 2017. National Flood Insurance Program Community Rating System – Coordinator's Manual.
- Federal Emergency Management Agency (FEMA), 2020. Protect Your Home from Flooding: Low-cost projects you can do yourself. Available from: https://www.fema.gov/sites/default/files/documents/fema_protect-your-home-from-flooding-brochure_2020.pdf
- Lumia, Richard, Freehafer, D.A., and Smith, M.J., (2006). Magnitude and frequency of floods in New York: U.S. Geological Survey Scientific Investigations Report 2006-5112, 152 p.
- New York State Department of Environmental Conservation (NYSDEC), 2020. New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act-Estimating Guideline Elevations.
- New York State Department of Environmental Conservation (NYSDEC), 2025. Norwich Flood Damage Reduction Project. Available from: https://extapps.dec.ny.gov/docs/water_pdf/fcprprlnorwich.pdf
- U.S. Army Corps of Engineers, 2020. Upper Susquehanna River Basin, New York. Comprehensive Flood Damage Reduction Feasibility Study Completion Report.

APPENDIX A Flood Maps

APPENDIX B

StreamStats Report

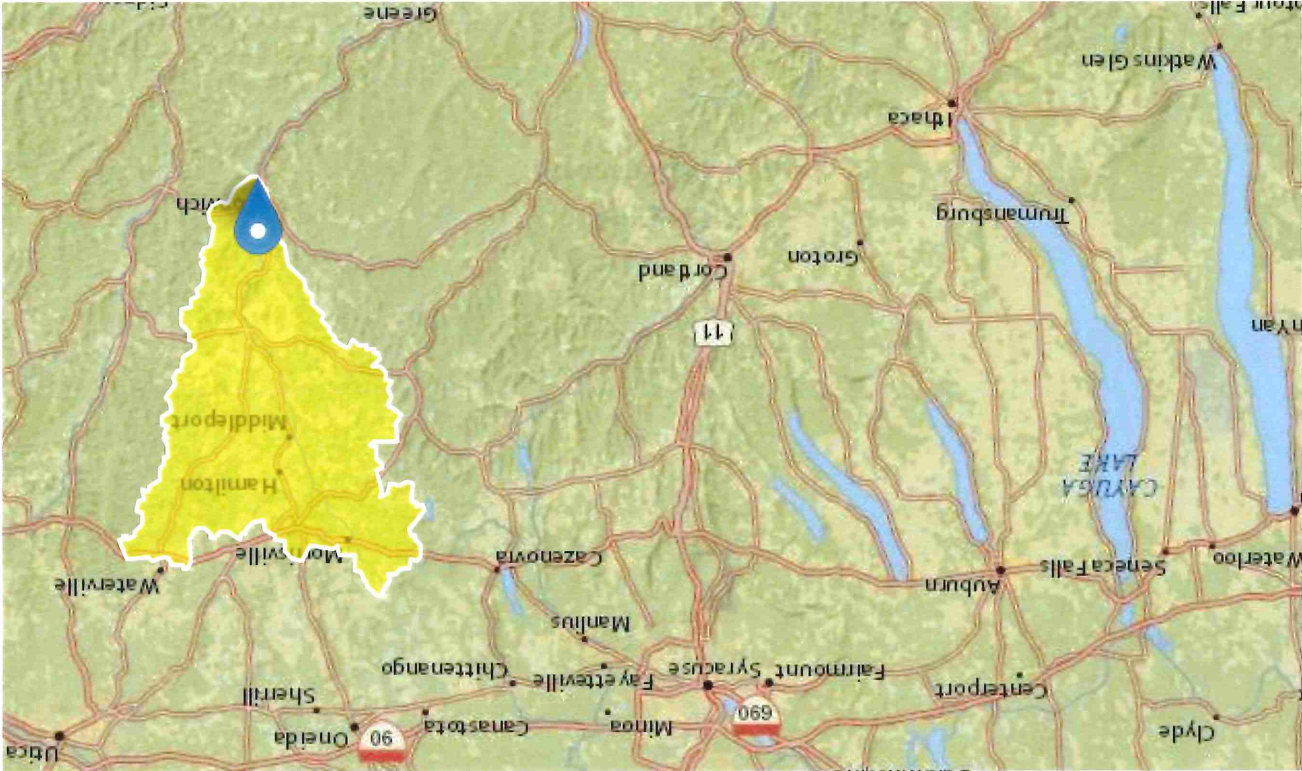
StreamStats Report - Chenango River at Canasawacta Confluence

Region ID: NY

Workspace ID: NY20240603135612165000

Clicked Point (Latitude, Longitude): 42.51746, -75.51633

Time: 2024-06-03 09:56:32 -0400



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	456012.3	meters
CENTROIDY	Basin centroid vertical (y) location in state plane units	4735282.7	meters
CSL1085LO	10-85 slope of lower half of main channel in feet per mile.	3.53	feet per mi
DRNAREA	Area that drains to a point on a stream	332	square miles

Parameter	Code	Parameter Description	Value	Unit
JULAVPRE		Mean July Precipitation	3.76	inches
JUNAVPRE		Mean June Precipitation	4.19	inches
JUNMAXTMP		Maximum June Temperature, in degrees F	74.8	degrees F
LENGTH		Length along the main channel from the measuring location extended to the basin divide	46.2	miles
MAR		Mean annual runoff for the period of record	21.1	inches
MAYAVPRE		Mean May Precipitation	3.87	inches
PRJUNAUG00		Basin average mean precip for June to August from PRISM 1971-2000	11.5	inches
SLOPERATIO		Ratio of main channel slope to basin slope as defined in SIR 2006-5112	0.0127	dimensionless
SSURGOA		Percentage of area of Hydrologic Soil Type A from SSURGO	7.61	percent
SSURGOB		Percentage of area of Hydrologic Soil Type B from SSURGO	19.3	percent
STORAGE		Percentage of area of storage (lakes ponds reservoirs wetlands)	2.39	percent

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [2006 Full Region 4]

Parameter	Code	Parameter Name	Value	Units	Min	Max
DRNAREA		Drainage Area	332	square miles	0.61	3941
SLOPERATIO		Slope Ratio NY	0.0127	dimensionless	0.006	0.438
STORAGE		Percent Storage	2.39	percent	0	7.75
MAR		Mean Annual Runoff in	21.1	inches	19.84	26.09

Peak-Flow Statistics Flow Report [2006 Full Region 4]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEP: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEP	Equip. Yrs.
80-percent AEP flood	3710	ft³/s	29.4	29.4	3.1
66.7-percent AEP flood	4370	ft³/s	28.8	28.8	2.6
50-percent AEP flood	5170	ft³/s	27.9	27.9	2.5
20-percent AEP flood	7160	ft³/s	24.7	24.7	4.2
10-percent AEP flood	8450	ft³/s	23.1	23.1	6.5
4-percent AEP flood	10100	ft³/s	22	22	9.9
2-percent AEP flood	11300	ft³/s	21.6	21.6	12.6
1-percent AEP flood	12500	ft³/s	21.6	21.6	15
0.5-percent AEP flood	13600	ft³/s	21.7	21.7	17.1
0.2-percent AEP flood	15100	ft³/s	22.4	22.4	19.4

Peak-Flow Statistics Citations

Lumia, Richard, Freehater, D.A., and Smith, M.J.,2006, Magnitude and Frequency of Floods in New York: U.S. Geological Survey Scientific Investigations Report 2006-5112, 152 p. (<http://pubs.usgs.gov/sir/2006/5112/>)

➤ Flow-Duration Statistics

Flow-Duration Statistics Parameters [Statewide duration flows excl LongIs 2014 5220]

Parameter	Code	Parameter Name	Value	Units	Min	Max
DRNAREA		Drainage Area	332	square miles	3.14	4780
JUNAVPRE		Mean June Precipitation	4.19	inches	3.59	5.33
CENTROIDX		CENTROIDX	456012.3	meters	166000	658000
CENTROIDY		CENTROIDY	4735282.7	meters	4560000	4920000

Parameter	Code	Parameter Name	Value	Units	Min	Max
CSL1085LO		10-85 slope of lower half of main channel	3.53	feet per	1.56	152
LENGTH		Main Channel Length	46.2	miles	0.88	305
MAR		Mean Annual Runoff in	21.1	inches	11.6	37.4
SSURGOB		SSURGO Percent	19.3	percent	1.14	65.7
		Hydrologic Soil Type B				
JULAVPRE		Mean July Precipitation	3.76	inches	3.2	5.26
MAYAVPRE		Mean May Precipitation	3.87	inches	3.15	5.68
PRJUNNAUG00		Basin average mean precip for June to August	11.5	inches	10.5	15.5
JUNMAXTMP		Maximum June	74.8	degrees F	68.8	78.8
SSURGOA		SSURGO Percent	7.61	percent	0.62	51.2
		Hydrologic Soil Type A				
EL1200		Percentage of Basin Above	82.4	percent	0	100
		1200 ft				

Flow-Duration Statistics Flow Report [Statewide duration flows excl Longsl 2014 5220]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEP: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEP
0.01 Percent Duration	13300	ft^3/s	23
1 Percent Duration	3730	ft^3/s	14
5 Percent Duration	1800	ft^3/s	8.8
10 Percent Duration	1170	ft^3/s	7.3
15 Percent Duration	914	ft^3/s	6.6
20 Percent Duration	735	ft^3/s	7
25 Percent Duration	617	ft^3/s	7.2
35 Percent Duration	446	ft^3/s	8.7
50 Percent Duration	267	ft^3/s	11

StatisticValueUnitASEp

65 Percent Duration	158	ft ³ /s	14
75 Percent Duration	103	ft ³ /s	22
80 Percent Duration	85.1	ft ³ /s	26
85 Percent Duration	69.2	ft ³ /s	31
90 Percent Duration	55.2	ft ³ /s	38
95 Percent Duration	41.8	ft ³ /s	49
99 Percent Duration	27.2	ft ³ /s	92
99.99 Percent Duration	8.07	ft ³ /s	93

Flow-Duration Statistics Citations

Gazoorian, C.L., 2015, Estimation of unaltered daily mean streamflow at ungaged streams of New York, excluding Long Island, water years 1961–2010: U.S. Geological Survey Scientific Investigations Report 2014–5220, 29 p. (<https://pubs.usgs.gov/sir/2014/5220/>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [98.0 Percent (324 square miles) Bankfull Region 5 SIR2009 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	332	square miles	0.7	332

Bankfull Statistics Parameters [2.0 Percent (8.11 square miles) Bankfull Region 7 SIR2009 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	332	square miles	1.07	349

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	332	square miles	0.07722	940.1535

Bankfull Statistics Parameters [Appalachian Plateaus P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	332	square miles	0.081081	536.995602

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	332	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [98.0 Percent (324 square miles) Bankfull Region 5
SIR2009 5144]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEP: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIL	PIU
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Bankfull Area	1280	ft^2	452	3630
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Bankfull Depth	7.15	ft	2.58	19.8
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Bankfull Streamflow	6520	ft^3/s	908	46800
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Bankfull Width	183	ft	63.4	528
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Bankfull Statistics Flow Report [2.0 Percent (8.11 square miles) Bankfull Region 7
SIR2009 5144]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEP: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIL	PIU
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Bankfull Area	717	ft^2	211	2430
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Bankfull Depth	4.67	ft	1.29	16.9
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Bankfull Streamflow	3150	ft^3/s	290	34200
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Bankfull Width	154	ft	44.1	537
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Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
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Bieger_D_channel_width	169	ft
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Bieger_D_channel_depth	5.93	ft
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Statistic	Value	Unit
Bieger_D_channel_cross_sectional_area	1030	ft^2
Bankfull Statistics Flow Report [Appalachian Plateaus P Bieger 2015]		

Statistic	Value	Unit
Bieger_P_channel_width	191	ft
Bieger_P_channel_depth	6.05	ft
Bieger_P_channel_cross_sectional_area	1140	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	95.6	ft
Bieger_USA_channel_depth	4.15	ft
Bieger_USA_channel_cross_sectional_area	393	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bankfull Area	1270	ft^2
Bankfull Depth	7.1	ft
Bankfull Streamflow	6450	ft^3/s
Bankfull Width	182	ft
Bieger_D_channel_width	169	ft
Bieger_D_channel_depth	5.93	ft
Bieger_D_channel_cross_sectional_area	1030	ft^2

Bieger_P_channel_width	191	ft
Bieger_P_channel_depth	6.05	ft
Bieger_P_channel_cross_sectional_area	1140	ft^2
Bieger_USA_channel_width	95.6	ft
Bieger_USA_channel_depth	4.15	ft
Bieger_USA_channel_cross_sectional_area	393	ft^2

Bankfull Statistics Citations

Mulvihill, C.I., Baldigo, B.P., Miller, S.J., and Dekoskie, Douglas, 2009, Bankfull Discharge and Channel Characteristics of Streams in New York State: U.S. Geological Survey Scientific Investigations Report 2009-5144, 51 p. (<http://pubs.usgs.gov/sir/2009/5144/>)
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➤ Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 4]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	332	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 4]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	152000	ft³/s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D. 1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)

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Application Version: 4.20.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

APPENDIX C
FEMA NFIP Coordinator's Manual – Section 430

430 HIGHER REGULATORY STANDARDS

The OBJECTIVE of this activity is to credit regulations to protect existing and future development and natural floodplain functions that exceed the minimum criteria of the National Flood Insurance Program (NFIP).

431 Background

Although the NFIP minimum standards provide a great deal of flood protection, damage can still result for many reasons:

- Estimates of flood heights are subject to various errors;
- Changes in weather patterns may alter flood-heights;
- Buildings may be damaged by floods that exceed the predicted 100-year flood;
- Urbanization and other changes in the watershed can increase the flood hazard and flood frequency;
- Filling and other development in the floodplain can reduce storage and conveyance capacity, increasing flood hazards; and
- Filling and construction practices can damage or destroy valuable natural floodplain functions.

For these reasons, and the fact that local situations vary, many communities adopt development standards that are higher than or supplement the minimum NFIP criteria. This activity provides credit for those regulatory standards.

431.a. Activity Description

Under this activity, numerous higher regulatory approaches are credited that provide more protection to new development, redevelopment, and existing development. Examples of higher standards and the benefits that they can provide include

- Prohibiting fill and other ground-altering measures can protect existing development and habitat, improve water quality, and maintain the flood attenuating benefits of natural areas (credited under DL1a);
- Requiring compensatory storage preserves areas of the floodplain that can store flood water and minimizes increases in flood heights due to development (credited under DL1b);
- Requiring the lowest floors of residences to be higher than the base flood elevation protects buildings from higher floods (credited under FRB);
- Protecting foundations reduces damage that results from scour and settling (credited under FDN);

Current NFIP standards for regulation of development in riverine areas require that new residential buildings in the Special Flood Hazard Area (SFHA) have their lowest floor at or above the base flood elevation. Non-residential buildings may be floodproofed to the base flood elevation. NFIP coastal rules require that new buildings be above the base flood elevation and, in V (velocity) Zones, be built on engineered piles or columns. If an existing building is improved or reconstructed and the value of the project exceeds 50% of the building's value, the building must be brought up to the same standards applied to new construction.

- Requiring full compliance with floodplain management regulations when proposed improvements or repairs are less than 50% of a building's value brings more nonconforming buildings up to current flood protection standards (credited under CSI and LSI);

- Protecting critical facilities to higher levels reduces damage to those facilities and improves the community's ability to respond to the needs of citizens during a disaster (credited under PCF);
- Adopting and enforcing a building code improves the quality of construction of new buildings and provides more staff support for floodplain management regulations (credited under BC);
- Standards for protecting buildings from local drainage problems reduce flood losses and flood insurance claims, especially outside the floodplain (credited under LDP);
- Requiring new manufactured housing in existing manufactured housing parks to meet the same level of protection as is required for other new buildings reduces flood losses and flood insurance claims (credited under MHP);

A community should not amend its ordinances solely to earn Community Rating System (CRS) credit points, nor should it necessarily adopt the examples used in the *CRS Coordinator's Manual*. Ordinance language should be carefully written to support the community's own goals and the purposes of its regulatory program. All such language should be reviewed by the community's legal counsel before it is adopted.

- Requiring new construction in the coastal A Zone to meet the same standards as V-Zone buildings protects it from a known breaking wave hazard (credited under CAZ);
- Adopting and enforcing construction rules tailored to special flood-related hazards, such as riverine erosion and alluvial fan flooding, provides protection in ways that the NFIP's national minimum criteria do not (credited under SHR);
- Adopting and enforcing regulations addressing tsunami hazards protects people and structures from the impacts of a tsunami (credited under TSR);
- Adopting and enforcing regulations addressing long-term coastal erosion can reduce the loss of structures caused by the erosion of beaches, dunes, and bluffs (credited under CER); and
- Having Certified Floodplain Managers (CFM®) and high-quality administrative procedures and inspections can reduce errors and minimize problems during construction (credited under RA).

The element OHS (other higher standards), provides credit for regulations not listed in this or other activities. As noted in Section 113.d, communities are invited and encouraged to submit other regulatory provisions that are not part of the NFIP's minimum criteria and/or alternative approaches to the credits listed here.

431.b. Activity Credit Criteria

For all the elements except RA (regulations administration, Section 431.q), the community must provide a legally enforceable regulation. In most cases, this will be in the form of an ordinance adopted by the community's governing body and incorporated into its municipal code.

(1) Regulations adopted by a county, regional agency, or state that are enforced within the community can be credited. Their implementation is verified in the same manner as a community regulation and it is expected that the community will assist in the verification.

(2) Regulations must have the force of law and meet the requirements of Section 231.b.

(3) If the legal authority for the regulatory language is not clear, the ISO/CRS Specialist may request a letter from the community's legal counsel that confirms that he/she will defend the regulation in court if it is challenged.

(4) For CRS credit, the regulatory language must be adopted and in full force at the time CRS credit is requested, e.g., at the verification visit.

(5) If the community approves Conditional Letters or Letters of Map Revision based on Fill (CLOMR-Fs or LOMR-Fs) by signing a "Community Acknowledgment Form" (MT-1 Form 3), the credit will be adjusted or prorated.

(6) Credit for any element is prorated if the sampling done during verification finds instances in which the element is not fully implemented. It does not matter why it is not fully implemented. For example, if a review of Elevation Certificates finds that some new buildings did not have the required freeboard because of legally issued variances, the credit is prorated.

See also Section 231 on documentation of regulations for CRS credit.

431.c. Activity Impact Adjustment

Impact adjustment ratios are part of the calculations for all elements in Activity 430 except BC, LDP, MHP, SMS, and RA. They are explained in Sections 402–403.

Impact Adjustment Maps

An impact adjustment map must be prepared when

- (1) The areas qualifying for Activity 430 credit need to be determined for the impact adjustment ratio, or
- (2) The regulations are enforced outside the Special Flood Hazard Area (SFHA) (so that the impact adjustment ratio can be greater than 1.0).

When preparing an impact adjustment map, note that

- (1) The areas affected by the regulation(s) must be marked on an impact adjustment map. Marking each area with the appropriate acronym is a convenient shorthand. Section 402 has additional information about determining impact adjustments for areas.

- (2) Areas to be credited for a higher regulatory standard must not include areas preserved as open space (OSP) in Activity 420 (Open Space Preservation). Therefore, OSP credited areas must be shown on the impact adjustment map used for Activity 430. There is no Activity 430 credit for higher standards for fill or buildings in areas where fill and buildings are not allowed (i.e., areas preserved as open space). This is explained in Section 402.c.

- (3) An impact adjustment map does not need to be prepared when a regulatory standard is enforced throughout the entire SFHA and there is no creditable open space. The impact adjustment ratio in that case is 1.0. However, the community must be certain that a regulation is enforced throughout the regulatory floodplain. For example, the ordinance may say that all new buildings must be built to a freeboard level, but that rule may only apply in flood zones where a base flood elevation is provided. In such cases, an impact adjustment map would be needed to delineate and calculate the areas affected by the freeboard standard.

- (4) An impact adjustment map does not need to be prepared when a regulatory standard is enforced throughout the entire SFHA, but the map must show those areas for which the community is requesting or receiving credit for preserving open space (OSP) under Activity 420 (Open Space Preservation). If the only adjustment to the impact of an element is for OSP, the impact adjustment ratio for the 430 element is the complement of the impact adjustment for OSP.

Example 431.c-1.

A community has 22% of its SFHA preserved as open space.
 $OSP = 0.22$. The community enforces its freeboard requirement throughout the rest of the SFHA.

$$FFRB = 1 - r_{OSP} = 1 - 0.22 = 0.78$$

There is no need for a separate impact adjustment map for Activity 430 in this instance.

- (5) If less than 10% of the community's SFHA is affected by the regulations or if the community does not prepare an impact adjustment map, an impact adjustment ratio of 0.1 can be used (up to 0.5 for CAZ).

- (6) When regulations are enforced outside the SFHA, the impact adjustment ratio can be greater than 1.0, the community will receive more points than the maximum listed for the element. The maximum ratio for this is 1.5 (i.e., the area regulated is 50% (or more) larger than the SFHA) less the impact adjustment in Activity 420 for OSP.

The maximum total impact adjustment for any element in 430 combined with the impact adjustment for 420 OSP cannot exceed 1.5.

Sections 402–403 provide guidance on impact adjustments and impact adjustment maps. Additional criteria and clarifications may be included under each activity's impact adjustment section.

431.d. Activity Documentation Provided by the Community

Most elements in this activity have the same documentation needs at the verification visit:

- (1) The state or local law or ordinance language that adopts the regulatory standard that is being enforced in the community. See also Sections 231.b and 231.c on documenting regulatory language.

- (2) The impact adjustment map. See Section 431.c.

- (3) [For credit for regulating flood-prone areas outside the SFHA] Documentation that shows that regulations are in effect outside the SFHA (i.e., the regulatory floodplain).
- (4) Development plans and/or permit records that document how the regulation has been applied.

The ISO/CRS Specialist may visit a sample of sites in the field to verify that the land has been developed and/or buildings have been constructed in accordance with the approved plans.

Some elements have additional or different documentation requirements, as noted in the separate documentation sections, below.

432 Elements

432.a. Development Limitations (DL)

The maximum credit for this element is 1,330 points.

This element has three parts, crediting different aspects of the regulation of floodplain development:

- (1) Prohibition of fill (DL1) (maximum credit: 280 points). The use of fill to elevate buildings has advantages that make it desirable for developers and homeowners. However, there are problems with using fill: it reduces floodplain storage capacity, can deflect waves onto neighboring property, and it has an adverse impact on native vegetation, wetlands, drainage, and water quality.
- The benefits of using fill accrue to the developer and to the property owner. Conversely, the problems accrue to neighbors, taxpayers, the community, the NFIP, or the environment. Because filling is not a desirable floodplain management activity, this element credits communities that prohibit fill.

One method to offset the impacts of the use of fill is to require compensatory storage, but compensatory storage does not compensate for the adverse impact on other natural floodplain functions. Therefore, it is worth approximately half the credit. This credit is for regulations that require new developments to provide compensatory storage at hydrologically equivalent sites up to a ratio of 1.5 to 1.

- (2) Prohibition of buildings (DL2) (maximum credit: 1,000 points). If the regulations prohibit only certain types of buildings, such as residences, the points can be prorated.
- (a) Prohibition of all buildings (DL2a): Full credit for DL2 is for prohibiting all buildings and LOMR-Fs.
- (b) Prohibition of all buildings (DL2b): Partial credit is provided if the community allows LOMR-Fs.

- (3) Prohibition of outdoor storage of materials (DL3) (maximum credit: 50 points). Credit can be received under three sub-elements:

- (a) Prohibition of all materials (DL3a): Full credit for DL3 is for prohibiting outdoor storage of all materials in the SFHA.

- (b) Prohibition of hazardous materials (DL3b): Partial credit is provided if only hazardous materials are prohibited (indoors or outdoors).

- (c) Storage of hazardous materials (DL3c): Credit is provided if hazardous materials are allowed to be stored indoors in the floodplain, but must be elevated above the base flood elevation.

If all three items (DL1, DL2, and DL3) are included in the community's regulations and there are still vacant areas in the regulatory floodplain, those areas would be effectively preserved as open space. The community should submit those areas for the higher credit for OSP in Activity 420 (Open Space Preservation). See Section 422.a(3)(c).

These regulations have their full impact in undeveloped areas. Therefore, the impact adjustment map must identify areas credited for open space preservation (OSP) and areas that are undeveloped, i.e., where there are no buildings on the parcels or the area is zoned for conservation or agriculture with a minimum lot size of 10 acres or larger.

Credit Criteria for DL

- (1) Prohibition of fill (DL1):

- (a) Prohibition of all fill (DL1a): This credit is for prohibiting all filling in the regulatory floodplain.

This includes the community's NOT approving Conditional Letters or Letters of Map Revision based on Fill (CLOMR-F or LOMR-F). If a CLOMR-F or LOMR-F is issued for a property in the community, then DL1 credit will be denied. This applies to CLOMRs and LOMRs that include filling as part of the reason for requesting a map change.

Minor filling may be allowed where needed to protect or restore natural floodplain functions, such as a part of a channel restoration project.

The following regulatory approaches do not warrant credit for DL1:

- Regulations that prohibit loss of storage only if it adversely affects flood heights on other properties. This credit is for prohibiting all filling, particularly because of its adverse effect on natural floodplain functions.
- Subdivision regulations that do not apply to all new development.
- Regulations that apply to buildings or private development, but not to bridges, highways, parking lots, and other floodplain uses.
- The standard NFIP language that prohibits increases in flood heights in floodways. That standard does not prohibit fill—it allows filling that can be shown by an engineering study not to increase flood levels. It reads

Prohibit encroachments, including fill, new construction, substantial improvements and other developments unless certification (with supporting technical data) by a registered professional engineer is provided demonstrating that encroachments shall not result in any increase in flood levels during occurrence of the base flood discharge; . . .

(b) Compensatory storage (DL1b): This credit is for regulations that require new development to provide compensatory storage at hydraulically equivalent sites up to a ratio of 1.5:1. Credit is not provided for

- Compensatory storage requirements in floodways only or in V Zones only, or
- Stormwater management regulations that require a developer to compensate for any increase in runoff created by the development. This is credited under Activity 450.

(2) Prohibition of buildings (DL2): Full credit for DL2 is for prohibiting all new buildings in the SFHA.

This includes not approving CLOMR-Fs or LOMR-Fs. When a CLOMR-F or LOMR-F is applied for, the community is required by the Federal Emergency Management Agency (FEMA) to sign a Community Acknowledgment Form that states, in part, “the completed or proposed project meets or is designed to meet all of the community floodplain management requirements . . .” If a CLOMR-F or LOMR-F is issued for a property in the community, then DL2 credit will be adjusted. This applies to CLOMRs and LOMRs that include filling as part of the reason for requesting a map change. If the regulations only prohibit certain types of buildings, such as residences, the points will be prorated. If buildings are prohibited in parts of the SFHA, such as the floodway, the impact adjustment will adjust the points. Prohibiting critical facilities is credited in Section 432.f, Protection of critical facilities, not under DL2.

(3) Prohibitions on storage of materials (DL3) has no additional criteria.

Credit Points for DL

(1) DL1 = EITHER:

- (a) 280 points, for regulations that prohibit fill within floodplains, including construction of buildings on fill,

OR

- (b) 130 points x the ratio of compensation, for regulations that require new development to provide compensatory storage at hydraulically equivalent sites up to a maximum of 195 for a ratio of 1.5:1 or greater

Example 432.a-1.

A community requires that for each cubic foot of fill placed in the regulatory floodplain, the builder must remove a cubic foot of fill from a hydraulically equivalent location. The compensation ratio is 1:1, so $DL1b = 130 \times 1 = 130$.

Gulf Beach County requires that for each cubic foot of fill placed in the regulatory floodplain, the builder must remove 1.25 cubic feet of fill from a hydraulically equivalent location. The compensation ratio is 1.25:1, so $DL1b = 130 \times 1.25 = 162.50$.

- (2) DL2 = 1,000 points, for regulations that prohibit buildings within the regulatory floodplain and when CLOMR-Fs and LOMR-Fs are neither recognized nor approved by the community,

OR

DL2 = 100 points, for regulations that prohibit buildings within the regulatory floodplain and when the community approves CLOMR-Fs and LOMR-Fs

If the regulations only prohibit certain types of buildings, such as residences, the points will be prorated.

(3) DL3 = one of the following:

- (a) 50 points, for regulations that prohibit outdoor storage of materials within the regulatory floodplain,

OR

- (b) 20 points, for regulations that prohibit storage of hazardous materials anywhere in the floodplain,

OR

- (c) 10 points, for regulations that require hazardous materials to be stored indoors, above the base flood elevation

DL3 credit is not cumulative. If the regulations govern storage of only certain kinds of materials, the points will be prorated.

Impact Adjustment for DL

DL credit is adjusted based on the ratio of the area affected by the DL regulation to the area of the SFHA. See Section 431.c on calculating an impact adjustment. The following additional criteria apply:

- (1) The areas affected by the DL regulation(s) must be marked on an impact adjustment map that meets the criteria in Section 431.c. In addition to showing areas credited under OSP, the impact adjustment map must also show developed and undeveloped areas. “Undeveloped” means that there are no buildings on the parcels or that the area is zoned for conservation or agriculture with a minimum lot size of 10 acres (these areas may also qualify for LZ credit).

- (2) Areas credited for DL credit must exclude areas credited for OSP. However, if the DL regulations are sufficient, vacant areas may qualify for OSP and the community should receive the higher points under OSP (see Section 422.a(3)(c)).

- (3) Only undeveloped areas are eligible for DL1a and DL2 credit, unless the regulations clearly state that they apply to developed areas. For example, if DL2 regulations are enforced in areas already developed and a building is substantially damaged, it cannot be replaced and the site must be cleared and kept vacant. Note that if a DL2 regulation prohibits all new buildings except farm structures, the value for DL2 can be prorated and the credit can be applied to areas with farm structures.

- (4) DL1b, compensatory storage, and DL3, prohibitions on storage of materials, can be credited in developed areas.

$$rDL\# = \frac{aDL\#}{aSFHA}, \text{ where}$$

$aDL\#$ = the size of the area(s) that qualify for DL# credit
 ($aDL1a$ is the size of the area that qualifies for DL1a credit, etc.), and

$aSFHA$ = the size of the community's SFHA

$$cDL = (DL1 \times rDL1) + (DL2 \times rDL2) + (DL3 \times rDL3)$$

Documentation for DL Provided by the Community

- (1) The activity documentation requirements listed in Section 431.d must be met.

432.b. Freeboard (FRB)

The maximum credit for this element is 500 points.

The NFIP requires that the lowest floor of residential structures be elevated to or above the base flood elevation and that non-residential structures be elevated or floodproofed to or above the base flood elevation. Attached garages and utilities (including electrical, heating, ductwork, ventilating, plumbing, and air conditioning equipment) must also be protected to the base flood elevation (44 *Code of Federal Regulations (CFR)* §60.3(a)(3)). This can be done by elevating them or using flood-resistant materials during construction.

A freeboard requirement adds height above the base flood elevation to provide an extra margin of protection to account for waves, debris, miscalculations, changing weather patterns, or lack of data. A freeboard requirement of one foot means that the level of protection for the lowest floor (or lowest horizontal structural member in V Zones), machinery and equipment, etc. is one foot above the base flood elevation.

Credit Criteria for FRB

- (1) Lowest floor, utilities, and garages: For FRB credit, freeboard must be applied to the elevation of the lowest floor (or lowest horizontal structural member in V Zones) of the building or to the elevation to which a non-residential building is dry floodproofed, and to all components of the building, including all utilities, ductwork, and attached garages. All portions of the building below the freeboard level must be constructed using flood-damage-resistant materials. If the garage floor is below the freeboard level, the garage must meet the opening and wet floodproofing requirements for enclosures.

Two references on these requirements are *Protecting Building Utilities from Flood Damage*, FEMA-348, and *Flood Damage-Resistant Materials Requirements*, Technical Bulletin 2 (2008).

- (2) The amount of freeboard is measured according to the following criteria:

- (a) In A Zones, freeboard is measured from the top of the lowest floor. In V Zones, it is measured from the bottom of the lowest horizontal structural member. If the ordinance uses "lowest horizontal structural member" or similar language instead of "lowest floor" in areas outside of the V Zone or coastal A Zones where CAZ credit applies, 1 foot is added to the amount of freeboard credited. For example, if the community's ordinance requires that buildings in the A Zones be elevated so the bottom of the floor joists is at least 1.0 feet above the base flood elevation, the ordinance is scored as requiring 2.0 feet of freeboard.

- (b) For the purpose of calculating CRS credit for freeboard, the 500-year flood elevation is considered to be one foot higher than the base flood elevation, unless the community demonstrates that it is higher. For example, if the community's ordinance requires that the building be protected to at least the 500-year flood elevation, the ordinance is scored as requiring 1.0 feet of freeboard.

(c) In AO Zones, base flood depths are provided instead of base flood elevations. Where depths are not provided, the NFIP regulations require new buildings to be elevated 2 feet above the highest adjacent grade. Some communities misinterpret this requirement as two feet of freeboard. Elevating 2 feet above the highest adjacent grade in an AO Zone where no base flood depth is provided is a minimum requirement of the NFIP and is not eligible for credit.

However, in AO Zones with depth numbers, the NFIP requires elevation above that depth. Going higher than the specified depth warrants FFB credit, which is scored the same as in an AE Zone.

(d) "Stem wall" construction involves constructing the foundation walls above grade, filling the interior area, and pouring a slab over the fill. From the outside, the building looks as though it is elevated on a crawlspace, but openings are not required. Such buildings are categorized as Diagram 1.b in the FEMA Elevation Certificate. This construction practice does not prohibit fill, but it limits the amount of fill to the building footprint. If the regulations prohibit fill for new buildings, but allow for stem wall construction, the credit is the average of the values in the "No filling restrictions" and "Compensatory storage required" columns in the table in the Credit Points section, below.

(e) If the ordinance uses the encroached elevation using FEMA's standard allowable maximum rise of one foot, add 0.5 feet to the amount of freeboard. Detailed riverine flood studies that produce a floodway provide a flood elevation based upon the floodway encroachment. In a Flood Insurance Study, these elevations are listed in the "With Floodway" column in the Floodway Data Table. They are generally higher than the "Without Floodway" or "Regulatory" flood elevations. For example, if the community's ordinance requires that the building be protected to at least one foot above this encroached elevation, the ordinance is scored as requiring 1.5 feet of freeboard.

(f) Many communities have focused on elevating the top of the lowest floor, but have allowed utilities (especially ductwork) to hang below the floor joists, where it can be primarily a concern for buildings on crawlspace. Buildings on slab foundations, on pilings, and in V Zones typically have the utility facilities waterproofed or elevated to a sufficient height.

To receive full credit for this element, electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) must be elevated or waterproofed to the base flood elevation plus freeboard. If the community requires that electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) be elevated or made of flood-resistant materials above the base flood elevation, but does not require these facilities to be elevated or protected to the freeboard level, then the value for freeboard in the table is considered to be 75% of the elevation requirement. If utilities and ductwork are not required to be elevated, floodproofed, or otherwise protected to the base flood elevation, there is no credit for FFB.

Credit Points for FRB

FRB = as shown below, based on the required freeboard

Freeboard	No filling restrictions	Compensatory storage required	Fill prohibited
1 foot	100	110	120
2 feet	225	250	280
3 feet	375	440	500

(1) More points are provided if the community prohibits buildings on fill (e.g., they must be constructed on piers, pilings, or flow-through crawlspaces) or requires compensatory storage if filling is used.

(2) The values for freeboard levels not shown are interpolated from the credit points table. For example, the value for 1.5 feet of freeboard where compensatory storage is required is the average of the values for 1.0 foot and 2.0 feet: $(110 + 250) \div 2 = 180$ points.

(3) If a community has more than three feet of freeboard, the regulations will be reviewed for special credit higher than the points shown in the credit points table, above. The community will need to provide additional information to warrant the higher credit, such as a demonstrated expectation of new growth in the area.

(4) Other adjustments to the scoring are explained in the section on credit criteria, above.

Impact Adjustment for FRB

FRB credit is adjusted based on the ratio of the area affected by the freeboard requirement to the area of the SFHA. See Section 431.c on calculating an impact adjustment. The following additional criteria apply.

(1) Areas requested for FRB credit must exclude areas credited for OSP or DL2.

(2) There are instances in which a community may have different freeboard requirements in different areas, such as

- The community does not require freeboard where there are no base flood elevations, such as in approximate A Zones and AO Zones;
 - Freeboard is only required for elevated buildings (non-residential buildings may be floodproofed to the base flood elevation without freeboard);
 - Manufactured homes have a different elevation requirement; or
 - There is higher freeboard in a V Zone or a floodplain subject to deeper flooding.
- In these cases, the formulae should use FRB#1, FRB#2, etc. to calculate the appropriate values for the different areas.

$$rFRB = \frac{aFRB}{aSFHA}, \text{ where}$$

aFRB = the size of the area(s) that qualifies for FRB credit, and

aSFHA = the size of the community's SFHA

Example 432.b-1.

South Scottsdale is a fictitious community used for CRS examples (see Figure 430-1). The City requires that all new buildings and substantial improvements be elevated two feet above the base flood elevation. To minimize floodplain encroachments, the City also requires that all new buildings be constructed either (1) without fill on flow-through foundations, such as piers or crawlspaces with sufficient openings, or (2) on slab foundations with compensatory storage required for any filling.

$$FRB = 250$$

These regulations apply throughout the SFHA. In the approximate A Zones of Tributaries A and B, buildings must be elevated two feet above the base flood elevation calculated by the permit applicant (which is credited in Activity 410 (Flood Hazard Mapping)).

These regulations only have an impact where new buildings and substantial improvements can be constructed. As noted in Section 431.c(4), areas set aside from development as preserved open space are excluded from the impact adjustment calculations.

aFRB = the size of the area(s) that qualify for FRB credit, i.e., the SFHA not credited for OSP under Activity 420 (Open Space Preservation)

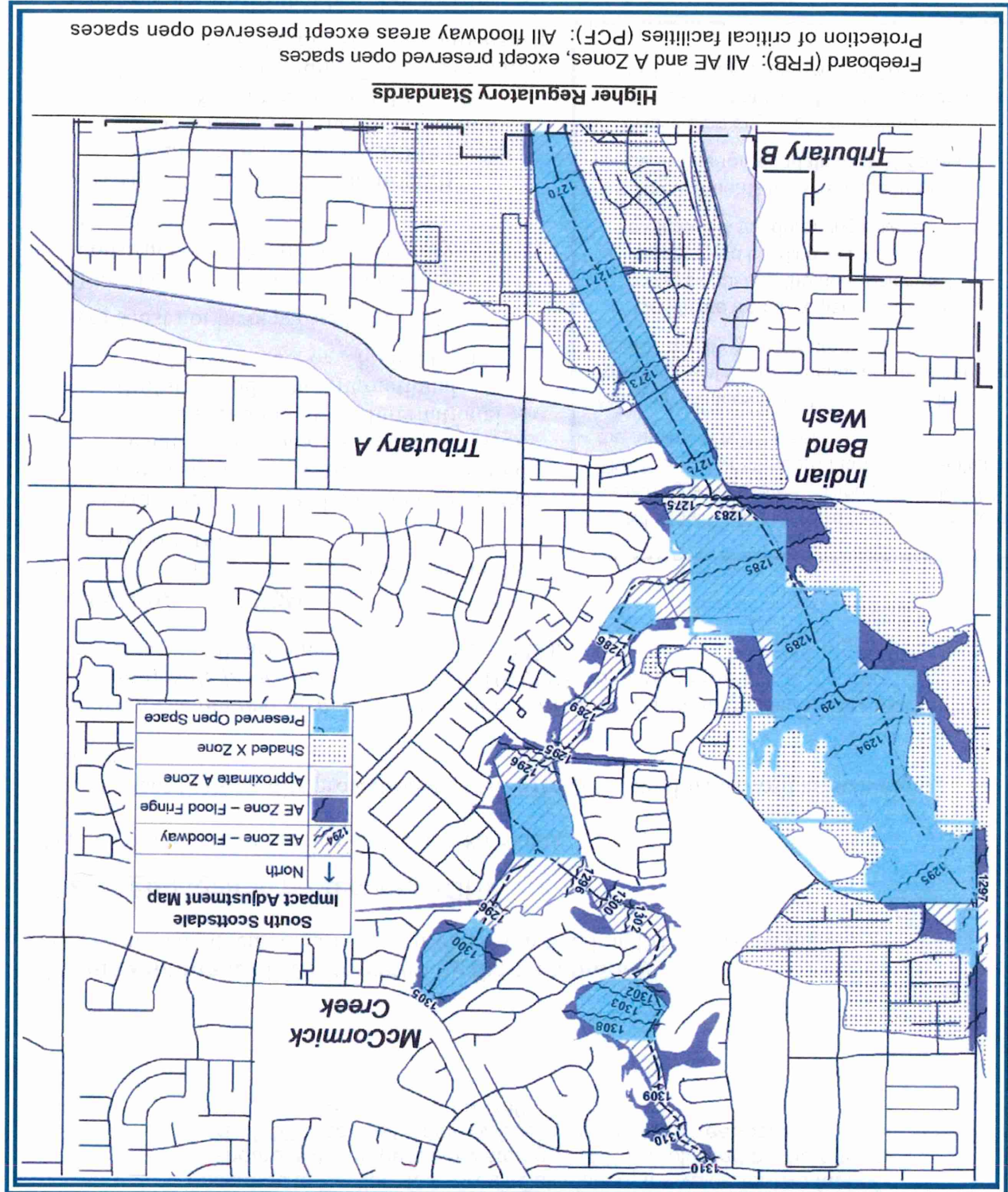
$$aSFHA = 504.40$$

$$aOSP = 242.90$$

$$aFRB = aSFHA - aOSP = 504.40 - 242.90 = 261.50$$

$$rFRB = \frac{aFRB}{aSFHA} = \frac{261.50}{504.40} = 0.52$$

Figure 430-1. South Scottsdale's impact adjustment map for Activity 430.



According to Section 433, Credit Calculation, the value for two feet of freeboard with compensatory storage (250) is multiplied by the ratio for cFRB, 0.52. The total credit for South Scottsdale's freeboard requirement, cFRB, is 52% of 250.

Documentation for FRB Provided by the Community

- (1) The activity documentation requirements in Section 431.d must be met.

432.c. Foundation protection (FDN)

The maximum credit for this element is 80 points.

The element FDN credits protection against differential settling as well as scour and erosion.

See also *Ensuring that Structures Built on Fill in or near Flood Hazard Areas are Reasonably Safe from Flooding*, FIA-TB-10, 2001 (also available at www.fema.gov/library/viewRecord.do?id=1723).

Credit Criteria for FDN

- (1) For FDN1 credit, ALL new buildings in the regulatory floodplain

- (a) Must be constructed on foundations that are designed and sealed by a registered design professional as complying with the requirements of the International Building Code, the International Residential Code, or ASCE 24, and
- (b) Must not be constructed on fill.
- (2) For FDN2 credit, ALL new buildings constructed on fill in the regulatory floodplain

- (a) Must be constructed on properly designed and compacted fill (e.g., fill that meets the criteria of (1) Section 1803.5.8 and Section 1804.4 of the International Building Code, (2) Section 2.4 of ASCE 24, or (3) their equivalent);
- (b) Must be on fill that has appropriate protection from erosion and scour; and

- (c) Must meet a compensatory storage requirement (for the building and fill) that meets the credit criteria of Section 432.a., Development Limitations (DL1b).

FDN1 requires foundations to be "designed and sealed by a registered design professional." This is a higher standard than that specified in the minimum NFIP criteria. Many ordinances have language like the following, which are minimum NFIP criteria and DO NOT qualify for FDN credit:

"Certificate from a registered design professional that the non-residential floodproofed building will meet the ordinance's floodproofing criteria"

"Requirements for an engineering certificate for foundations in V Zones"

"Having an engineer certify opening standards that differ from the one square inch per one square foot of floor area."

- (3) For FDN3 credit, all new buildings built on fill in the regulatory floodplain
- (a) Must be constructed on properly designed and compacted fill (e.g., fill that meets the criteria of (1) Section 1803.5.8 and Section 1804.4 of the International Building Code, (2) Section 2.4 of ASCE 24, or (3) their equivalent), and
- (b) Must be on fill that has appropriate protection from erosion and scour.

Credit Points for FDN

FDN = one of the following. These points are not cumulative.

- (a) FDN1 = 80 points, for engineered foundations and no buildings on fill
- OR
- (b) FDN2 = 60 points, for buildings on compacted fill, protected from erosion and scour, with compensatory storage
- OR
- (c) FDN3 = 35 points, for buildings on compacted fill, protected from erosion and scour, but no compensatory storage

Impact Adjustment for FDN

FDN credit is adjusted based on the ratio of the area affected by the foundation protection regulation to the area of the SFHA. See Section 431.c on calculating an impact adjustment. The following additional criteria apply:

- (1) Areas delineated for FDN credit must exclude areas credited for OSP or DL2.
- (2) There is no credit for FDN in V Zones because the NFIP requires all new buildings in V Zones to have engineered foundations (44 *CFR* §60.3(e)(4)) and prohibits fill from being used for structural support (see §60.3(e)(6)). Therefore, V Zones must be excluded from aFDN unless the community has higher foundation protection standards than those in §60.3(e).

$$rFDN = \frac{aFDN}{aSFHA}, \text{ where}$$

aFDN = the size of the area(s) that qualify for FDN credit, and

aSFHA = the size of the community's SFHA

Documentation for FDN Provided by the Community

(1) The activity documentation requirements in Section 431.d must be met.

432.d. Cumulative substantial improvements (CSI)

The maximum credit for this element is 90 points.

The NFIP allows improvements valued at up to 50% of the building's pre-improvement value to be permitted without meeting the flood protection requirements for buildings located in the SFHA. Over the years, a community may issue a succession of permits for different repairs or improvements to the same structure. This can greatly increase the overall flood damage potential to that building as well as the insurance liability to FEMA. CSI provides credit to a community that ensures that the total value of all improvements or repairs permitted OVER TIME does not exceed 50% of the value of the structure. When the total value does exceed 50%, the original building must be protected according to the ordinance requirements for new buildings.

Under some circumstances the NFIP flood insurance policy may pay a portion of the cost of bringing a substantially flood-damaged building into compliance with the community's floodplain management ordinance. If the community has a more restrictive definition of substantial damage, the provision may still apply. More information on Increased Cost of Compliance coverage can be found at www.CRSresources.org/400.

If a community does not regulate for cumulative substantial improvements, it may still receive credit for regulation of additions. Additions within the footprint of the original building would have to be to a floor above the base flood elevation. Additions outside the footprint of the original building would have to be elevated (non-residential structures could be floodproofed) above the base flood elevation.

Credit Points for CSI

Up to 90 points are provided for tracking improvements cumulatively.

CSI = the total of the following points, not to exceed 90 points

(1) EITHER:

(a) 40 points, if the regulations require that improvements, modifications, and additions to existing buildings are counted cumulatively for at least 10 years

OR

(b) 20 points, if the regulations require that improvements, modifications, and additions to existing buildings are counted cumulatively for at least 5 years

(2) EITHER:

(a) 40 points, if the regulations require that reconstruction and repairs to damaged buildings are counted