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Final Report for
Resilient Connecticut 2.0 Phase III Continuation
Resilient Yantic River Corridor

City of Norwich, Towns of Bozrah and Franklin, Connecticut
September 15, 2025

PREPARED FOR:
Connecticut Institute for Resilience and Climate Adaptation

GZA GeoEnvironmental, Inc.
249 Vanderbilt Ave | Norwood, MA 02062
781-278-3700
33 Offices Nationwide
www.gza.com

with support from:
Stantec
Stantec Consulting Services Inc.
475 5th Ave, 12th Fl., New York, NY 10017
212-366-5600

Contents

ACRONYMS

ASCE/SEI	American Society of Civil Engineers / Structural Engineering Institute
BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
CCVI	Climate Change Vulnerability Index
CIRCA	Connecticut Institute for Resilience and Climate Adaptation
CRS	Community Rating System
CSO	Combined Sewer Overflow
CT DEEP	Connecticut Department of Energy and Environmental Protection
CT DEMHS	Connecticut Division of Emergency Management and Homeland Security
CT DOT	Connecticut Department of Transportation

EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
HMP	Hazard Mitigation Plan
HUD	Department of Housing and Urban Development
MPO	Metropolitan Planning Organization
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NDRC	National Disaster Resilience Competition
POCD	City of Norwich Plan of Conservation and Development
ROAR	Resilience Opportunity Area
SECOG	Southeastern Council of Governments
SFHA	Special Flood Hazard Areas
TAC	Technical Advisory Committee
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

ACKNOWLEDGEMENT

Funding support for this project has been provided through the Connecticut Institute for Resilience and Climate Adaptation (CIRCA), as part of 'Resilient Connecticut 2.0.'

FIGURES

EXECUTIVE SUMMARY

Improving resilience for the residents and business owners along the Yantic River Corridor in Southeast Connecticut will help to reduce flood risk and improve the quality of life for the community.

This Resilient Yantic River report and plan (Plan) provides a framework to help the City of Norwich, Southeastern Council of Governments (SECOG, formerly SCCOG), the Connecticut Institute for Resilience & Climate Adaptation (CIRCA), and other key collaborators build resilience to climate change in City of Norwich, Town of Bozrah, and Town of Franklin, with a specific focus on flooding along the Yantic River. The Plan presents an approach to address the effects of climate change and outlines strategies to support decision makers with future resilience improvements. Residents and business owners along the Yantic River in Norwich have worked with a variety of stakeholders to shape the development of forward-looking adaptation strategies tailored to community needs. In this report, the adaptation design strategies are paired with implementable recommendations and specific actions to mitigate the long-term impacts of climate change through increased resilience against river flooding.

Study Area: The Study Area consists of the Yantic River Corridor in Southeast Connecticut from the Fitchville Dam in Bozrah to Uncas Leap in Norwich. The urban river corridor is crossed by CT Route 2 (state highway) and Interstate 395 (Connecticut to Massachusetts). The Study Area is approximately 4 miles long and includes a variety of land uses along the river with business and commercial towards the west of Interstate 395 and pockets of residential to the east of the interstate.

Situated primarily in Norwich, the Study Area contains community assets and critical infrastructure within the corridor that qualify as Resilience Opportunity Areas (ROARs) such as Backus Hospital, Fire Engine Company #1, Norwichtown Commons, Norwich substation, and the Fitchville Dam.

Environmental Risk: Riverine flooding, with its associated losses and repetitive losses, is the primary natural hazard for this project. While other natural hazards pose their own risks, the Study Area experienced a large flood in January 2024, which underscored this project's necessity. Riverine flooding is typically caused by heavy rain, but can also be caused or worsened by dam failures or misoperation, ice jams, snowmelt, runoff on top of frozen ground, or significant increases in impervious surface cover. Resilient Yantic River emerged as a response to increasingly frequent floods, including the January 2024 flood, and is situated within broader statewide efforts to improve resilience against flooding.

Project Approach: The Plan was developed through desktop and best practice research, literature review, community engagement, site visits, and preliminary flood modeling. The project team performed the following scope of work:

- **Reviewed several key documents** including the City of Norwich's Plan of Conservation and Development (2023), City Floodplain Management Ordinance, city planning policy changes, SCCOG Hazard Mitigation and Climate Adaptation Plan (2023), Norwich Annex to the SCCOG HMP (2017), SCCOG Critical Facilities Assessment (2017), Resilient Connecticut PERSISTS framework, and CIRCA's Climate Change Vulnerability Index Viewer.
- **Developed preliminary hydrologic and hydraulic models** to simulate the 1% annual chance (100-year recurrence interval flood) and 0.2% annual chance (500-year recurrence interval flood), which served as a surrogate for future flooding.
- **Conducted multiple rounds of outreach and community engagement** through four Committee meetings and two community events and several focus group meetings.

Plan Recommendations

Much of the project area is within the mapped 1% annual chance (100-year) floodplain as defined in the effective Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) (dated July 2011, undergoing re-study as of September 2025). There is a **222% increase in value of assets at risk** within the 0.2% annual chance (500-year) floodplain versus the 1% annual chance (100-year) floodplain. Flood

magnitudes are anticipated to be more severe in the future: increases in the 100-year flood are expected to be such that the future condition 100-year floodplain may resemble today's 500-year floodplain. These recurring near-term impacts and potential future impacts require bold action. This Plan proposes three conceptual design options and implementable recommendations for adapting to riverine flooding in the Yantic River Study Area. The three alternatives below offer the vision to further initiate action and continue to enhance momentum.

OPTION 1: Channel Widening

The Plan evaluates the benefits of widening an approximately 120-foot section the Yantic River channel between the New London Turnpike and CT Route 2. By widening the channel, the river will have a greater hydraulic capacity to pass floods, decreasing flooding in the vicinity of Norwichtown Commons and the Town Street Corridor.

OPTION 2: Upper Falls Dam Removal

The Plan evaluates how removing the Falls Mill Upper Dam (referenced to as the Upper Falls Dam) would reduce flood risk. By removing the primary spillway, the dam would no longer impound water during floods, leading to reduced peak water levels in the vicinity of the dam. Removal of the dam also can work in tandem with channel widening (Option 1) to absorb the potential for increased downstream flows due to the greater capacity of the upstream channel through the Norwichtown Commons reach. Dam removal also provides a number of tangible ecological and safety benefits including restoration of free-flow and fish / aquatic organisms passage, improved water quality, and elimination of the public safety hazard posed by the apparent poor condition of the dam. Finally, removing the dam eliminates the need for costly repairs, maintenance, ongoing engineering inspections, and emergency action planning.

OPTION 3: Managed Retreat

The Plan proposes **a phased pilot approach** that can build momentum for the development of a broader, comprehensive community-led relocation program of the most flood prone properties in high risk flood zones. Sustained funding, program design, committed program administration, vested stakeholder buy-in, and broad community support will be critical. Additional follow-up planning will be required to more fully develop this alternative.

Reading the Plan

- **Section 1** introduces the plan, overall process, project team, and Study Area.
- **Section 2** characterizes existing conditions and future conditions setting the foundation for engagement and adaptation options.
- **Section 3** provides an overview of the public engagement process for the project, including inputs and results from stakeholder outreach and involvement.
- **Section 4** presents the project's adaptation options and conceptual design considerations.
- **Section 5** details benefit-cost analysis results that can inform continued funding pursuits and efforts towards implementation.

1.0 PROJECT OVERVIEW

The goal of Resilient Yantic River, which is part of the statewide *Resilient Connecticut 2.0* initiative, is to advance the conceptual design of community-driven climate adaptation projects that will improve the physical resilience of the local community and Southeastern Connecticut region to natural hazards along the Yantic River Corridor.

Coordinated by CIRCA, with support from regional councils of governments (COGs) and municipalities, Resilient Connecticut is a statewide initiative to address the impacts of a changing climate. As part of the federally-launched National Disaster Resilience Competition (NDRC) in 2014, Resilient Connecticut provides the state with a planning framework, piloted in the Superstorm Sandy-impacted regions of New Haven and Fairfield Counties, that is now implemented statewide. The initiative focuses on regional resilience and adaptation planning, beginning with engagement and risk assessments that inform municipal to regional scale initiatives.

1.1 Project Goals

Recent regional planning has been advanced by the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) and the Southeastern Council of Governments (SECOG), and supported by state and federal funding. These efforts are in response to a major flood on January 10, 2024 that caused hundreds of Bozrah and Norwich residents to evacuate. Flood waters caused extensive leakage from the Fitchville Dam, damaged structures, closed roadways and prompted emergency rescues. About 5,000 customers lost power when the Bean Hill substation on the banks of the Yantic River was taken offline due to flood risk.

Phase II of the Resilient Connecticut program identified the Yantic River corridor as a Resilience Opportunity Areas (ROAR). In response, the Plan builds the case for three flood adaptation options amidst the challenges of significant flood exposure, upstream dam safety concerns and flood insurance affordability. The Plan provides forward-looking adaptation strategies, with implementable recommendations and actions for governmental leaders, to mitigate the long-term impacts of climate change exacerbated flooding on residents and business owners along the Yantic River Corridor.

1.2 Project Team

The GZA-Stantec team assisted SECOG and CIRCA in Plan development. The GZA-Stantec team consists of experts with many years of experience, specializing in multi-hazard assessment and vulnerability analysis, hazard mitigation design, numerical modeling, regulatory compliance, coastal resiliency, climate change adaptation, education and outreach, structural engineering, transportation systems engineering and analysis, environmental engineering, benefit cost analyses and planning.

1.3 Study Area

The Study Area is located within Southeastern Connecticut, in New London County. The Study Area is primarily within the Villages of Yantic and Norwichtown, and the City of Norwich's municipal boundaries, with extensions into the Towns of Bozrah and Franklin. Stretching along the Yantic River Corridor, the Study Area begins upstream of the Fitchville Pond Dam in Bozrah and ends at Uncas Leap (Yantic Falls) in Norwich, as seen in **Figure 1**. This urban river corridor is crossed by CT Route 2 (state highway) running west-east and Interstate 395 running north-south. The Study Area is approximately 4 miles long and includes a variety of land uses along the river. Business and commercial development, with pockets of residential areas, characterize the corridor.

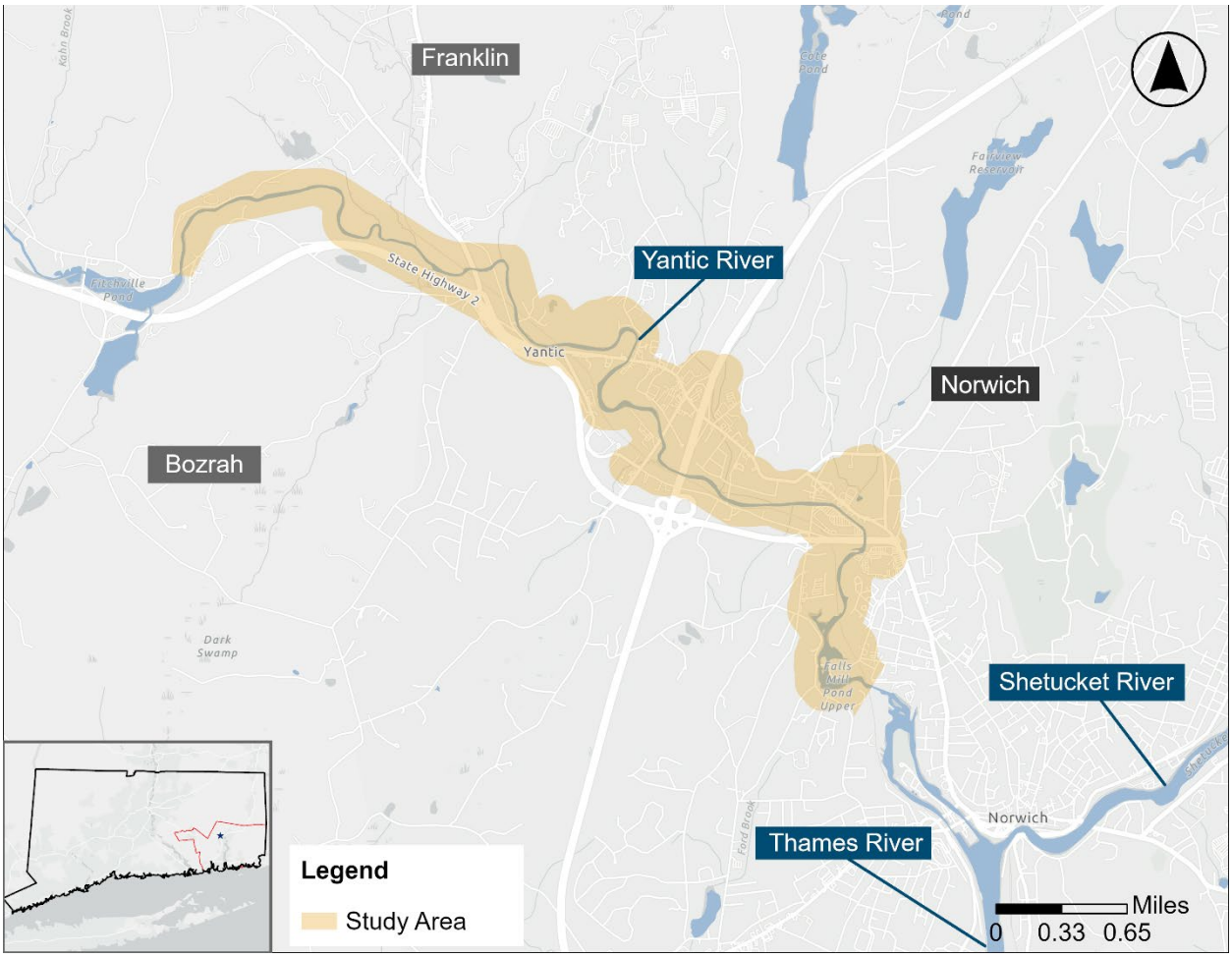

Figure 1. Study Area: Resilient Yantic River Corridor

Within the City of Norwich, the Study Area contains several previously identified Resilience Opportunity Areas (ROARs), which encompass properties like the Norwichtown Commons, Backus Hospital, Yantic Fire Engine Company #1, Norwich substation, and the Fitchville Dam. Additional details about the City of Norwich, Norwichtown, and Village of Yantic can be found in "Section 2.0 Current and Future Conditions" of this report.

1.4 Project Approach

The Resilient Yantic River Plan (the Plan) was developed through desktop and best practice research, literature review, community engagement, site visits, and preliminary flood modeling. The project team performed the following scope of work:

- **Reviewed several key documents** including the City of Norwich's Plan of Conservation and Development (2023), City Floodplain Management Ordinance, city planning policy changes, SCCOG Hazard Mitigation and Climate Adaptation Plan (2023), Norwich Annex to the SCCOG HMP (2017), SCCOG Critical Facilities Assessment (2017), Resilient Connecticut PERSISTS framework, and CIRCA's Climate Change Vulnerability Index Viewer. Key information and findings from these previous studies were reviewed, considered, and incorporated into the Plan, as noted throughout.
- **Developed preliminary hydrologic and hydraulic models** to simulate the 1% annual chance (100-year recurrence interval flood) and 0.2% annual chance (500-year recurrence interval flood), which served as a surrogate for future flooding. The modeling was then used to evaluate

the benefits of different flood mitigation options. See additional description of modeling performed as part of the Plan below.

- **Evaluated adaptation options** on a building and large scale. Several structural and non-structural flood adaptation measures were evaluated. Alternatives were analyzed based on flood protection, feasibility, and public support, with three preferred options being advanced to conceptual design.
- **Outreach**: With support from the Project Team, SECOG and CIRCA conducted multiple rounds of outreach and community engagement, holding four Technical Advisory Committee meetings, two focus groups, and two community events. See Section 3.0.

Preliminary Hydrologic and Hydraulic Analysis

The Project Team performed a preliminary hydrologic and hydraulic analysis to supplement existing flood information, further the Team's understanding of Study Area conditions, and accurately evaluate proposed mitigation alternatives. As of September 2025, the effective FEMA Flood Insurance Study and Flood Insurance Rate Map (FIRM) are undergoing reevaluation by FEMA and the U.S. Geological Survey (USGS). The results of the reevaluation were not available to inform this Plan, which also necessitate the limited modeling performed as part of the planning process.

Preliminary modeling was conducted in order to: supplement limited knowledge of past events due to a short period of record, or inadequate history, and a limited spatial extent for which historic stream gages and measurements were available. Supplemental modeling also supported "What if" testing and scenario planning, as well as design optimization and refinement.

Hydrologic Analysis

This analysis uses peak flood flow data from the effective FEMA Flood Insurance Study[1]. Peak flood flows that are assessed in this Plan are described below, in **Table 1**. Peak flows were converted to hydrographs as needed using the January 2024 observed stream gage data from the USGS gage on the Yantic River at Yantic (No. 01127500).

Table 1: Peak Flood Flows

Recurrence Interval	Peak Flow (cfs)
January 2024	10,900
100-yr	11,530
500-yr	23,655

Note that in the absence of a detailed hydrologic model to simulate future rainfall/ runoff processes, this analysis uses the present day 0.2% annual chance (500-year) peak flood flow as a surrogate for the future 1% annual chance (100-year) peak flood flow.

Hydraulic Analysis

A 2-dimensional hydraulic model (U.S. Army Corps of Engineers (USACE) HEC-RAS v6.6) of the Yantic River was developed to assess the impact of different mitigation actions. The model extends approximately 3.75 miles from upstream of I-395 to the confluence of the Yantic, Shetucket, and Thames Rivers. The model uses publicly available topographic and land cover data. Limited model calibration was performed to approximate similar inundation boundaries observed during the January 2024 flood and those mapped by FEMA for the 1% annual chance floodplain.

Two-dimensional modeling was performed to supplement FEMA 1-dimensional models as 2-dimensional modeling captures flow in both horizontal directions, allowing for a more realistic simulation of overland

[1] FEMA FIS #09011CV005D, Revised August 1, 2023.

flooding, especially in urban areas, floodplains, and regions with varied topography. This enhances spatial detail to assist in identification of vulnerable zones and evaluation of mitigation strategies.

The peak flow hydrographs established above were then routed through the hydraulic model to estimate flood depths and velocities throughout the Study Area. Modeled flood depths are presented in **Appendix B**. Once the existing conditions were successfully represented, the hydraulic model was used to assess different flood mitigation options.

2.0 CURRENT AND FUTURE CONDITIONS

Results from hydrologic and hydraulic modeling indicate that the predicted flood depths and extents in the Study Area are severe, particularly when considering future events. The watershed is relatively large, and the scale of flooding is ***challenging to prevent*** without large-scale, expensive interventions. A more feasible and strategic approach to ***adapt*** to the current flood exposure and to the changing climate will require understanding current and future flood conditions down to a site-specific level.

Norwich developed as a colonial seaport in the 17th century. By the 18th and 19th centuries, Norwich's shipbuilding work and associated industries led the City to rank as one of Connecticut's largest cities. Shipbuilding grew near the head of the Thames River, spurring the development of homes and a broad economic base. The introduction of rail lines in the 19th century further spurred industrial development, with textile mills springing up along the Yantic River. Housing was constructed for mill workers, and grand homes were built on hillsides overlooking the commercial and industrial areas. In the 20th century, local industrial activity and the Norwich economy declined. The primary railroad line between Boston and New York was also relocated away from Norwich and routed through New London, and the nation became less reliant on goods shipped via water. As more goods began to be transported by truck, Norwich continued to lose its geographic advantage, especially after Interstate 95 bypassed the City.[2]

Many of the buildings in the Study Area are more than 50 years old and were constructed before flood maps were available to guide development.[3] Analysis showed that approximately 85% of the buildings in the Study Area were built before 1974, which was before the City began participating in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS) in 1978.[4]

2.1 Site Context

City of Norwich

Founded in 1659, the City of Norwich is an urban community in the north-central region of Connecticut's New London County. The City is approximately 29 square miles in area and consists of several villages, including Taftville, Norwichtown, Occum, Greenville, Thamesville, and Yantic. Yantic is an unincorporated village and former mill town named for the Yantic River, which runs through the village. The Yantic and Shetucket Rivers flow into the Thames River near Downtown Norwich. Norwich is bordered by Bozrah to the west and Franklin to the northwest. Connecticut State Routes 2 and 32 cross through Yantic and connect to Interstate 395 in Norwichtown. Norwich is also located near major rail lines, including the Providence/Worcester line and the New England Central line, which connect the City to Southeastern Connecticut and the rest of New England.[5]

Norwich has had a stable population over the last 70 years, peaking in 1970 (41,739) and reaching its lowest point in 2000 (36,117). Per the 2020 Census, Norwich's population is currently estimated at 40,125, making it the largest municipality in Southeastern Connecticut, and 25th-largest municipality in the State.[6]

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[2] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[3] FEMA (2023). Flood Insurance Study Number 09011CV002D. Version Number 2.6.3.6. map1.msc.fema.gov/mipdata/09011CV002D.pdf?LOC=c4a64168b37f89cb90750b3d00c9bfce

[4] FEMA (2025). Community Status Book Report: Communities Participating in the National Flood Program. https://www.fema.gov/cis/CT.pdf

[5] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[6] U.S. Census Bureau, "Total Population," Decennial Census, Table P1, 2020, https://data.census.gov/table/DECENNIALDHC2020.P1?q=Norwich+city,+Connecticut

Although both Norwich and the Southeastern Connecticut regio are predominately white, Norwich has a more diverse racial and ethnic composition than that of the region and is continuing to diversify, with higher percentages of Hispanic/Latino, Black/African American, and Asian populations than the region as a whole. As of the 2020 Census, white residents comprised 54% of the City population, Hispanic/Latino 19%, Black/African American 11%, and Asian 7%.

Between 2010 and 2020, the Hispanic/Latino population grew by 52%, and the Black/African American population grew by 18%. During the same period, the white population decreased by 17% as shown in **Figure 2**[7]. According to the Norwich Plan of Conservation and Development (POCD), that same period saw a decline in residents younger than age 60, while the population over 60 saw significant growth. Norwich also saw a decrease in older working age adults (40-49), older children (15-19), and young children (<9).

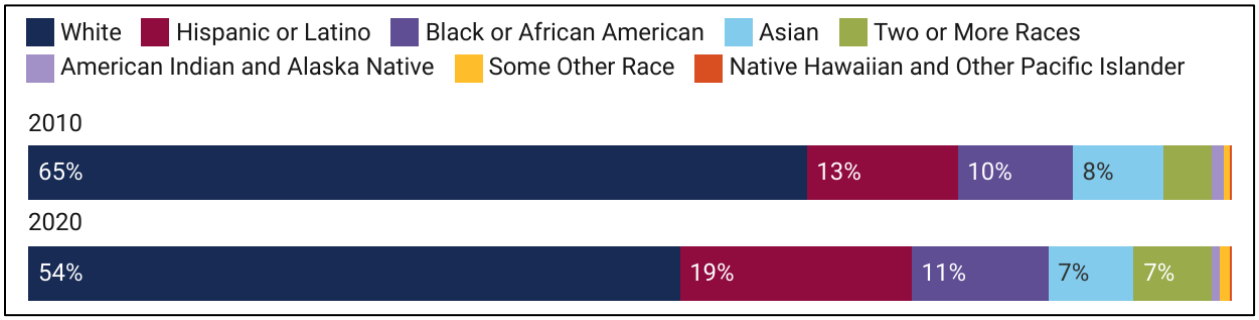

Figure 2. Norwich Racial Demographics in 2010 and 2020[8]
Source: 2010 and 2020 Decennial Census, U.S. Census Bureau

Norwich is governed by a Council/Mayor/Manager form of government. The mayor presides over the City Council. The Council-appointed City Manager serves as the chief executive officer of the City and is directly responsible for the administration of City departments, agencies, and offices. Together, the mayor and the City Council review and approve City business.[9]

Norwich is also a part of SECOG, a federally designated Metropolitan Planning Organization (MPO) and regional Council of Governments[10] with representatives from 22 towns, cities, and boroughs. SECOG was formed to provide a basis for intergovernmental cooperation in dealing with a wide range of issues regarding regional planning, municipal services, and transportation planning.

Zoning

Zoning districts dictate the types of development that are allowed in an area. Norwich's Zoning Ordinance, shown in **Figure 3**, was last updated in 2015 through the City's Comprehensive Plan. 74% of the zoned land is designated for primarily residential use (inclusive of schools, religious institutions, home offices and other uses typically allowed in residential zones). Eighty-seven percent of residential land is zoned for single-family homes, as opposed to districts that allow for higher residential development. There are minimum parking

[7] City of Norwich Plan of Conservation and Development (2023). https://www.norwichct.org/DocumentCenter/View/9214/2023-Plan-of-Conservation-and-Development---Envision-06360
[8] U.S. Census Bureau, "Race," Decennial Census, Table P1, 2020, https://data.census.gov/table/DECENNIALDHC2020.P1?q=Norwich+city,+Connecticut
[9] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf
[10] SECOG. (2025) "About." https://secogct.gov/about

requirements for all residential land.[11] As seen in **Figure 4**, the study area is comprised of residential (single and multi-family), recreational open space, business parks, and other various commercial zoning districts.

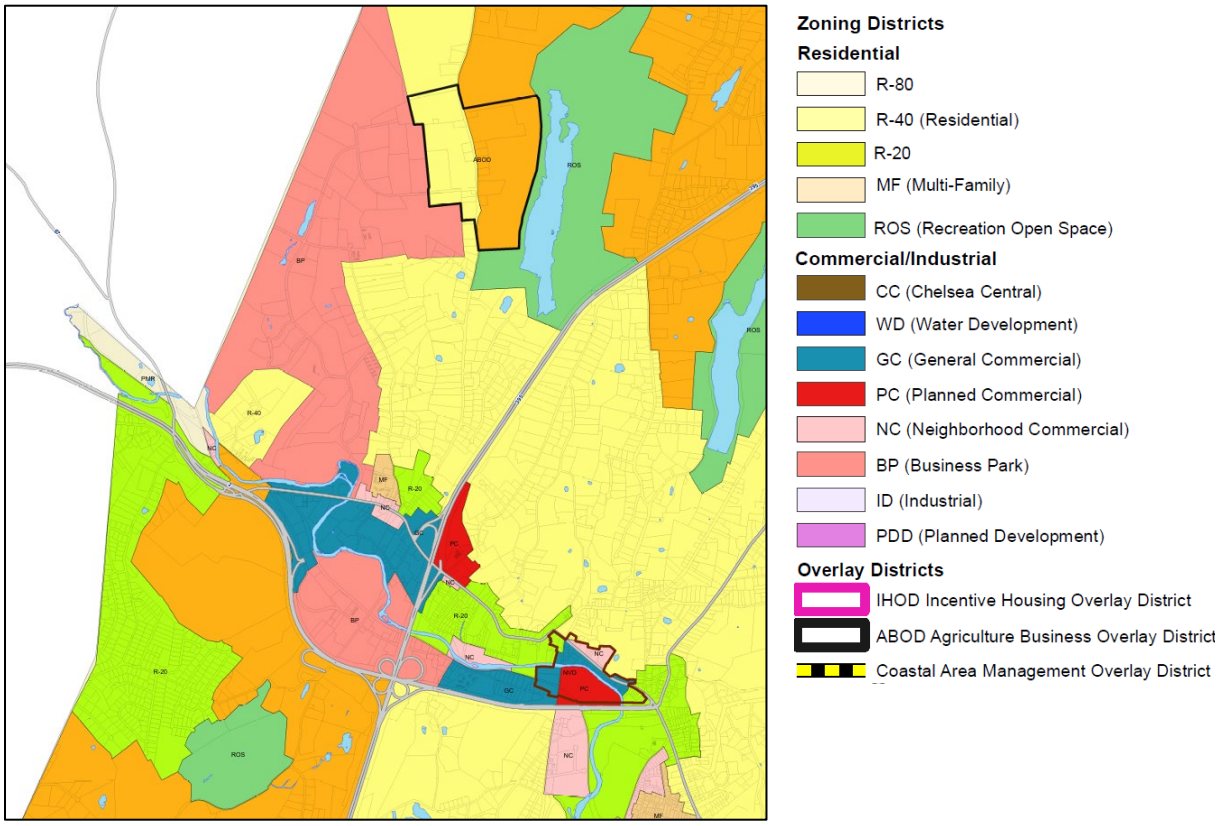

Figure 3. City of Norwich Zoning Map

Source: Norwich City Maps

[11] "National Zoning Atlas." National Zoning Atlas. 2021. https://www.zoningatlas.org/snapshots/?jurisdiction=344.

Land Uses

The City of Norwich Plan of Conservation and Development (POCD) was last updated in 2023 and outlines a long-term vision for the community that will improve quality of life and the economic vitality of the City. The POCD's existing land use map provides a foundation for future analysis and redevelopment efforts.

As shown in Figure 4, as of 2022, residential uses make up the single largest land use category within Norwich, at 54% of the total land area. Open Space/Recreation—which includes public parks, cemeteries, and recreational lands—makes up 11% of land area. A significant portion of Norwich—14%—is dedicated to tax-exempt government and institutional uses. Commercial/Retail/Office at 7% and Industrial at 2% round out the City's existing land uses.

As shown in **Figure 5**, the study area's predominant land uses are industrial, commercial, and residential (mostly single family). The study area also includes some forestland and undeveloped residential and commercial land.

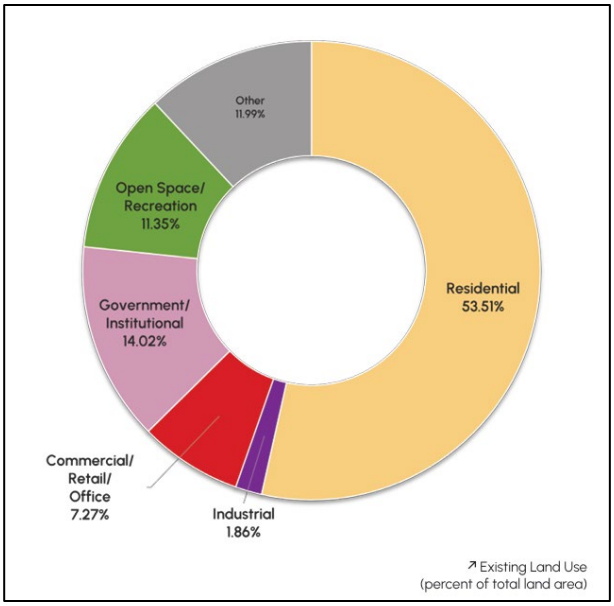

Figure 4. Land Use Distribution for the City of Norwich
Source: City of Norwich Plan of Conservation and Development (2023)

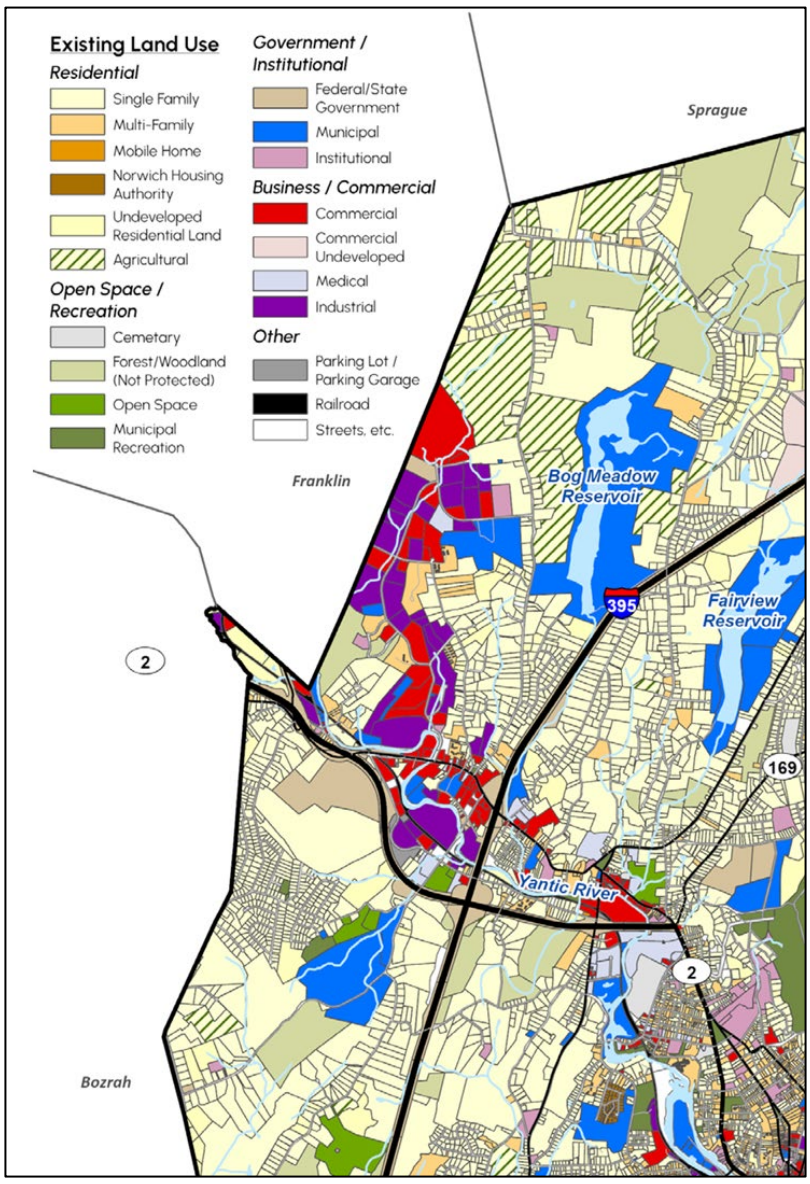

Figure 5. City of Norwich Land Use Map
Source: City of Norwich Plan of Conservation and Development (2023)

Along the Yantic River, land uses are predominantly industrial, commercial, and municipal. Single-family and undeveloped residential land uses are also present.

Residential properties exposed to flood hazards put people in harm's way, while exposed industrial and commercial properties threaten safety for employees, customers, and present risk for business disruptions. Industrial properties also have a high likelihood of hazardous material releases during flood events.

Expected Development Patterns

Norwich's population is expected to grow 30% between 2020 and 2040, per the Norwich POCD. The City's population is increasingly diverse, and the median age has been increasing. Currently, multi-family and rental housing is concentrated in Norwich's downtown area, and along river corridors. More multi-family housing development is planned or underway in the downtown core. While the POCD references Yantic as a neighborhood with potential for infill development or redevelopment of substandard housing, it is not described as a priority target area for residential development.

Directly east of Yantic Village along the Yantic River corridor, Town Street is the commercial heart of Norwichtown. A portion of Town Street that runs along the Yantic River, is recognized as an important commercial corridor, with significant business turnover in recent years. The Norwich POCD notes that 'There is a strong opportunity for redevelopment in this corridor, with potential infrastructure investments creating a stronger sense of place. Policy priorities for Yantic include balancing conservation with development pressures, supporting homeownership and property maintenance programs, investing in infrastructure, and preserving and protecting open spaces.

Several actions within the plan hold relevance for reducing flood risk along riverine corridors. These include the following:

- Creating an Open Space Master Plan;
- Encouraging land protection within natural hazard areas through open space dedications or conservation easements during the development approval process;
- Ensuring coastal resources are protected;
- Ensuring that critical facilities are resilient;
- Reducing flood and erosion risks by reducing vulnerability and consequences;
- Investing in resilient corridors to ensure that people and services are accessible during floods and that development along corridors is resilient over the long term.

Reverting developed land within flood hazard areas back to open space is not specifically addressed, although such strategies would align with goals around reducing flood and erosion risk.

Planning and Zoning Policy Changes: The 2015 Norwich Zoning update includes the development of a restrictive Flood Hazard special overlay district, which imposes additional limitations and permitting requirements on development within FEMA-designated Special Flood Hazard Area Zones A and AE (i.e., the 100-year floodplain).

2.2 Existing Conditions

This section covers the natural environment, flood and stormwater risk, and other climate-related hazards and events relevant to the Study Area.

Natural Environment

The City of Norwich is surrounded by major waterways including the Yantic River, the Shetucket River, and the Thames River. These rivers and their tributaries have formed wetlands that provide rich habitats for local wildlife. Wetlands and endangered species can be found in and around the Study Area, as shown in **Figure 6.**

Endangered species locations are available through the Connecticut Department of Energy and Environmental Protection's (DEEP) Natural Diversity Database, which highlights areas that represent known locations, both historic and extant, of state and federally listed species. The state-listed species are those listed as Endangered, Threatened or Special Concern under the Connecticut Endangered Species Act.[12] The Database does not show the presence of endangered species within the Study Area, beyond a small portion of the Study Area's southeast corner. The presence of endangered species or critical habitat in the Study Area could impact the ability to implement certain flood mitigation projects, or prompt the need for additional studies and permitting.

[12] "Natural Diversity Database." 2020. Ct.gov. 2020. https://deepmaps.ct.gov/datasets/CTDEEP::natural-diversity-database/about.

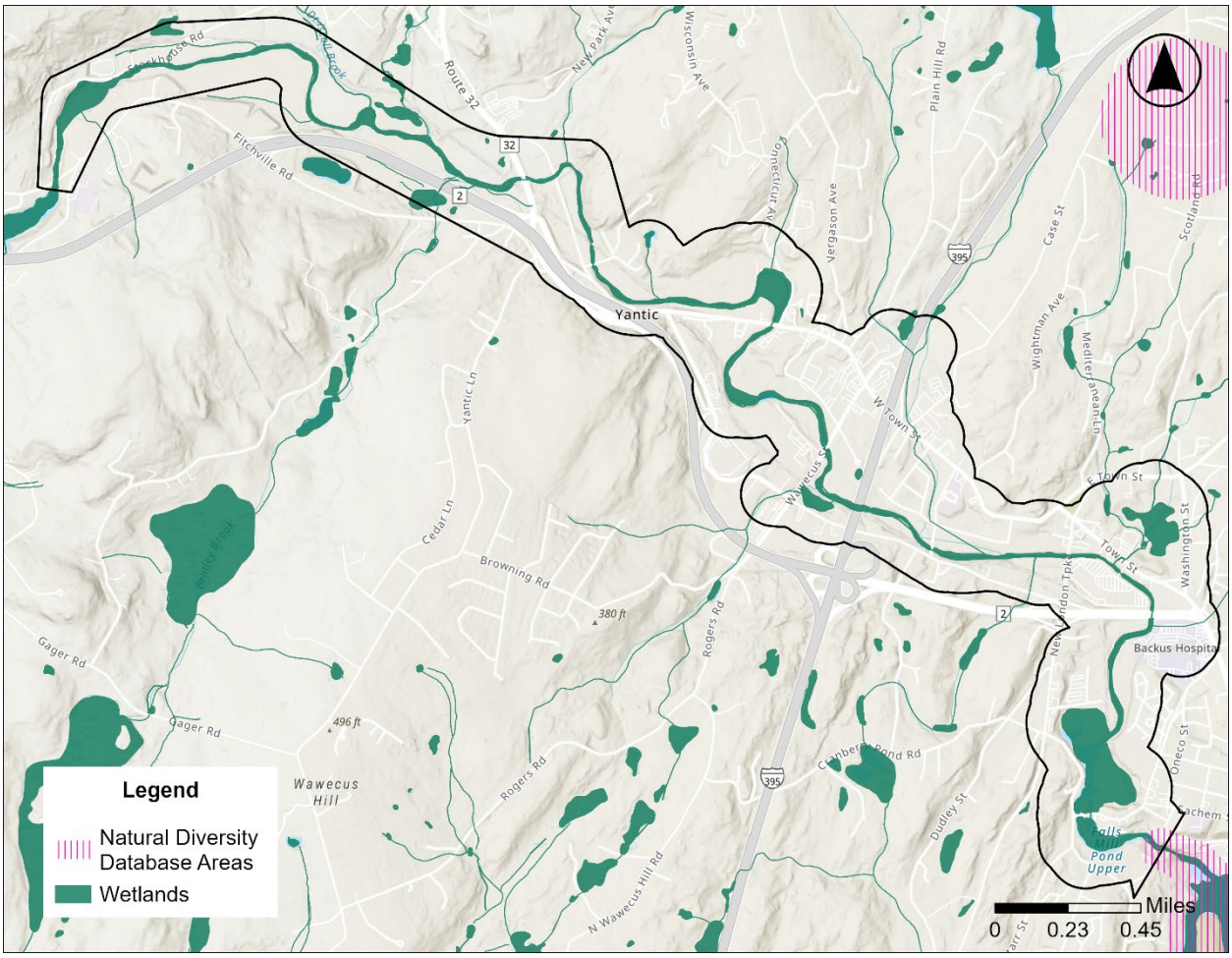

Figure 6. Wetlands and National Diversity Database Areas
Data source: Connecticut National Wetlands Inventory, CT DEEP National Diversity Database

Flood Risk

Riverine flooding is the primary natural hazard in Norwich, along with nuisance flooding and drainage issues. Riverine flooding is typically caused by heavy rainstorms, but can also be caused by dam failures, ice jams, snowmelt, or relatively light rains falling on frozen ground, and significant increases in impervious surfaces.

According to the City's effective Flood Insurance Study (FIS), Norwich's initial flood maps became effective in 1974. The City of Norwich began participating in both the National Flood Insurance Program (NFIP) and the Community Rating System (CRS) in 1978.[13]Many buildings within the Study Area are over 50 years old—consequently, 85% of Study Area structures were constructed before flood maps were available to guide development.[14]

Figure 7 shows the existing 1% annual chance (100-year flood) and 0.2% annual chance (500-year flood) floodplains. The preliminary flood modeling conducted for this study, as described in Section 1.4, will be referred to as the Study Model. There are some differences in the FEMA and the Study Model flood boundaries, both of which are shown in **Figure 7**. Note: the Study Model did not evaluate the flooding of tributary streams to the Yantic River. FEMA flood mapping was used to represent such tributary stream flooding.

[13] FEMA (2025). Community Status Book Report: Communities Participating in the National Flood Program. https://www.fema.gov/cis/CT.pdf
[14] FEMA (2023). Flood Insurance Study Number 09011CV002D. Version Number 2.6.3.6. map1.msc.fema.gov/mipdata/09011CV002D.pdf?LOC=c4a64168b37f89cb90750b3d00c9bfce

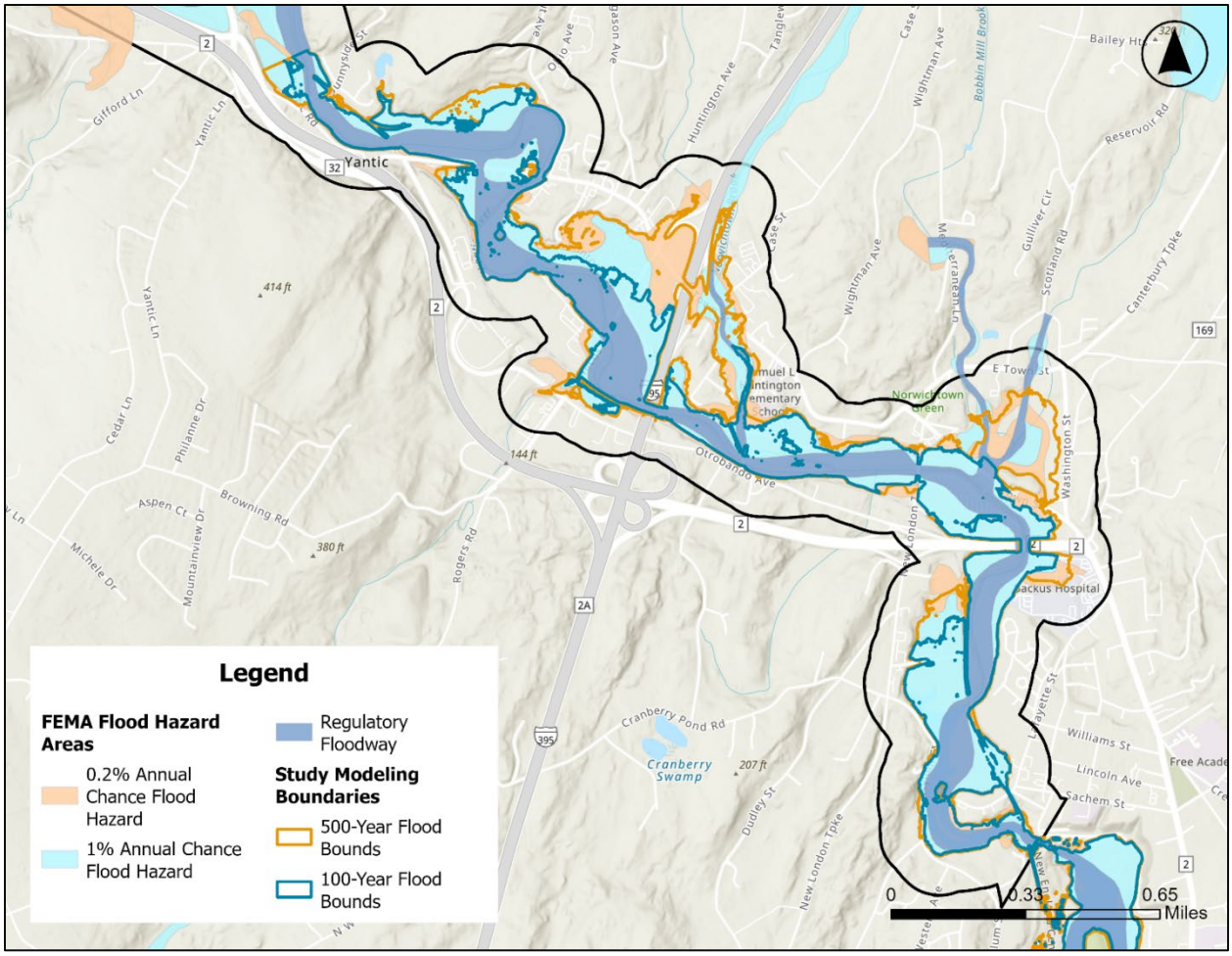

Figure 7. FEMA and Study Model Floodplains
Data source: FEMA, GZA

Figure 8 and **Figure 9** show existing FEMA flood maps of the modeled Study Area, overlayed with the Study Model 1% annual chance (100-year) and 0.2% annual chance (500-year) floodplain boundaries. The outer black line indicates the boundary of the Study Area.

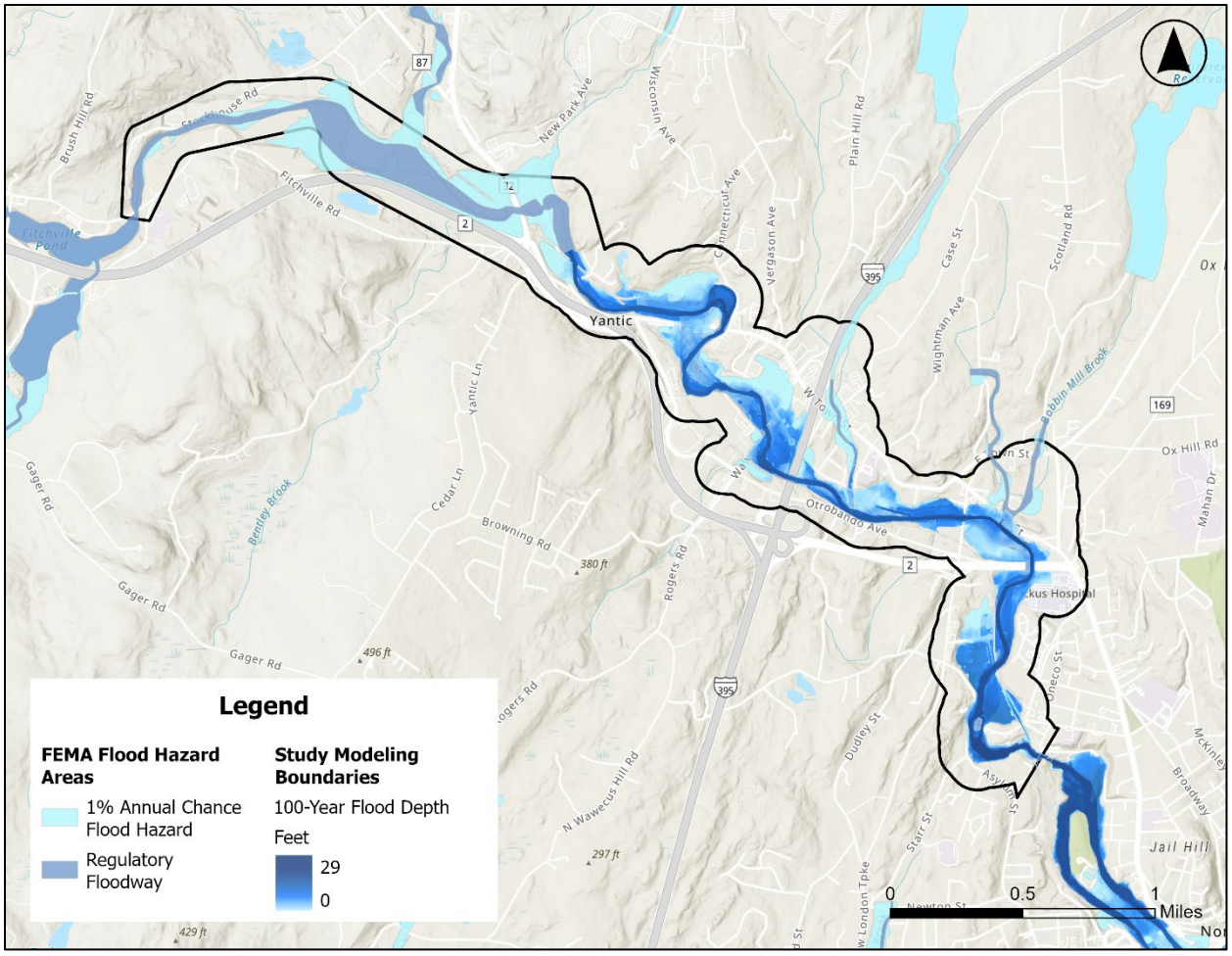

Figure 8: FEMA and Study Model 1% Annual Chance (100-year) Floodplain
Data source: FEMA, GZA

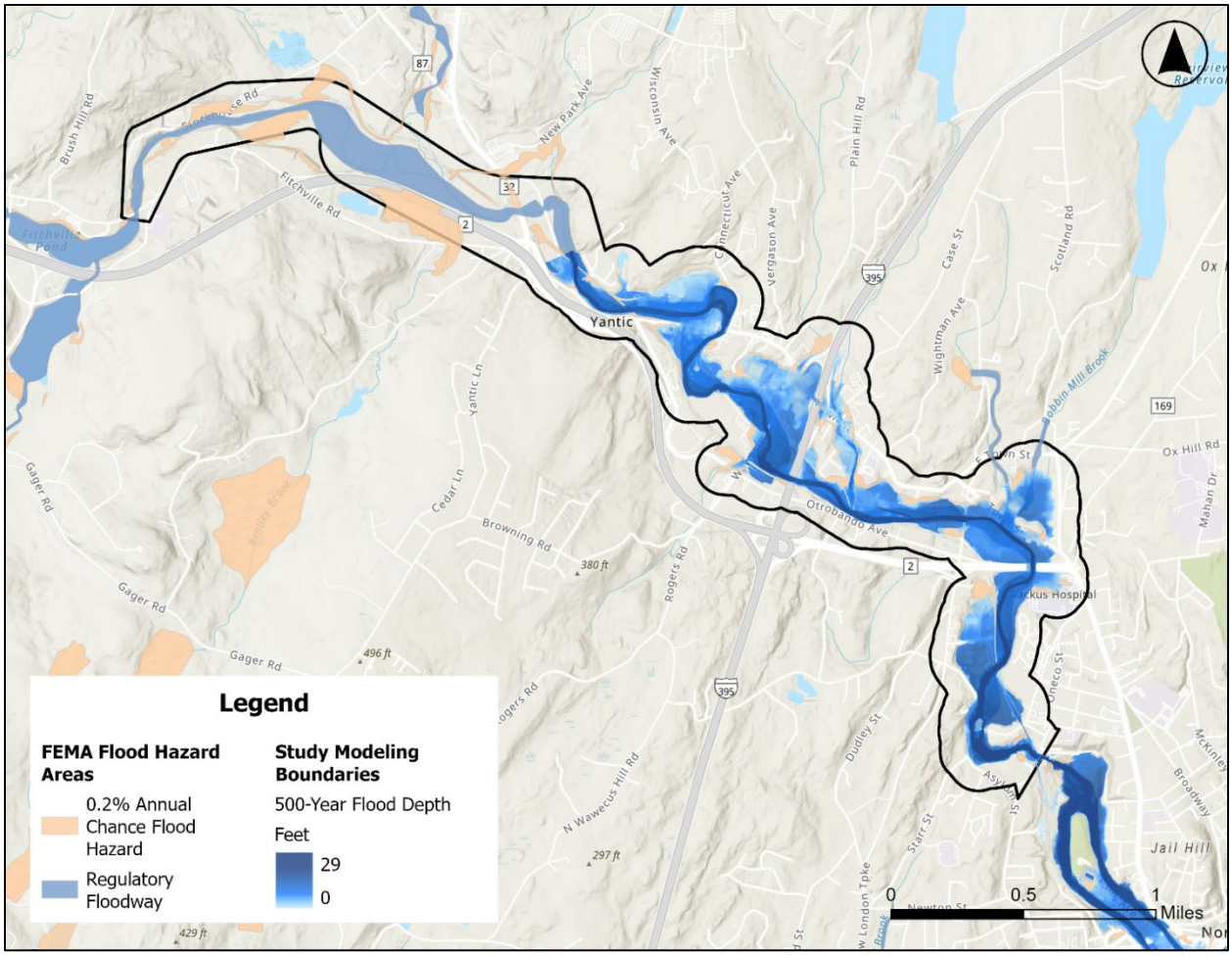

Figure 9: FEMA and Study Model 0.2% Annual Chance (500-year) Floodplain
Data source: FEMA, GZA

For the purposes of this study, the Study Model's current 0.2% annual chance (500-year) flood is used as a proxy for future flood conditions, seen in **Figure 9**. The Study Model 1% annual chance (100-year) flood has peak discharge of 11,530 cubic feet per second and impacts a total of 341.5 acres.

FEMA maximum flood depths are shown below in **Table 2**. These indicate potential considerable risk in the near future. Note the Study Model produces similar results.

Table 2. FEMA Maximum Flood Depths

Asset at Risk	FEMA 100-Year Flood	FEMA 500-Year Flood
Town Street Roadway	1 to 3 ft	up to 8 ft
Norwichtown Commons	2 to 5 ft	6 to 9 ft
Yantic River Plaza	1 to 2 ft	5 to 6 ft
Sturtevant Street Roadway	2 to 3 ft	4 to 6 ft

Historic and Current Day Events

The Great New England Hurricane of 1938 produced the greatest flood of record in Norwich. High water marks of eight feet were recorded at the corner of Bath and Franklin Streets, north of the confluence of the Shetucket and Thames Rivers. According to the Norwich HMP Annex, the USGS gage on the Yantic River recorded an approximately 1% annual chance flood (estimated at 13,500 cfs) during that event.[15]

To date, several flood control projects have been constructed by the U.S. Army Corps of Engineers (USACE) upstream of Norwich on the Shetucket and Quinebaug Rivers, but not the Yantic. The Norwich Local Protection Project, completed in the 1950s and 1960s, aimed to reduce the incidence and severity of flooding in Norwich through channel improvements. In the late 1950's, USACE deepened and widened a 700-foot section of the lower portion of the Shetucket River.[16] Two small reservoirs were constructed by the Soil Conservation Service (known at the time), now the Natural Resources Conservation Service (NRCS), on Spaulding Pond Brook to provide moderate control of upland runoff.[17]

As Yantic is not protected by upstream flood protection projects,[18] Yantic River flooding can be particularly flashy. The Fitchville Pond Dam, a private dam in the Yantic River, was used to provide power to mills in Yantic but is no longer active. The City of Norwich owns the Upper Falls Dam on the Yantic River. The City is considering removal of this dam which is associated with backwater conditions which exacerbate flooding at the Sherman Street bridge.[19] Structure-specific flood risk is addressed in greater detail in Sections 2.3 and 2.4.

The most notable recent flood was the January 2024 flood (8,500 cfs; an approximately 50-year recurrence interval based on GZA's preliminary statistical evaluation). Heavy rainfall and snowmelt led to deep and widespread flooding throughout Yantic, including an uncontrolled release (i.e., leakage; the dam did not breach) at Fitchville Pond Dam. Significant property damage was incurred, an evacuation was ordered, and concerns about Bean Hill substation flood damage resulted in power outages for approximately 5,000 customers.[20] The Edward and Mary Lord Family Health Center basement flooded, resulting in a loss of 58 clinician offices, the Center's food pantry, and extensive removal of flooring, sheetrock, and insulation.[21] In Norwichtown, two residents required rescue from a flooded Domino's Pizza.[22]

The *2023 SCCOG (now SECOG) Hazard Mitigation and Climate Adaptation Plan* and the accompanying *2017 Hazard Mitigation Plan Update Annex for the City of Norwich* note that Connecticut often experiences seasonal flooding. Snowmelt-related flooding occurs in the early spring, frontal systems and tropical storm flooding in the late summer and early autumn, and some flooding occurs at other times of year due to ice jams and dam failures. Additional vulnerabilities reported in the Norwich Annex include silt buildup and flooding of the Canada (aka Sherman Street) Bridge.

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[15] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[16] "Norwich Local Protection Project." 2023. Army.mil. 2023. https://www.nae.usace.army.mil/Missions/Civil-Works/Flood-Risk-Management/Connecticut/Norwich/.

[17] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[18] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[19] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[20] Connecticut Public Radio. "Partial dam break on Yantic River in CT causes evacuation due to potential 'life threatening' floods." Accessed June 6th via https://www.ctpublic.org/news/2024-01-10/partial-dam-break-in-norwich-leads-to-possible-life-threatening-floods.

[21] Pitts, Amanda. "Can't say it won't happen again: Norwich wearily bounces back from January flood." NBC Connecticut. Accessed June 10th via https://www.nbcconnecticut.com/news/local/norwich-wearily-bounces-back-january-flood/3232011/.

[22] Polansky, Rob and Kruczynski, Eliza. "CAUGHT ON CAMERA: People rescued from flooded Domino's in Norwich." Eyewitness News. Accessed June 6th via https://www.wfsb.com/2024/01/10/caught-camera-people-rescued-flooded-dominos-norwich/

Flooding is the most significant hazard across the SECOG planning area. The 2023 HMP reports 75 flash floods and 45 general floods occurring across New London County between 1950 and 2023, causing $806,240 and $6,560,000 in damage over that time period, respectively.

The Norwich Annex details local flooding impacts. Norwich roadways that have been flooded by the Yantic River include the New London Turnpike, Serman Street, and West Main Street. Roadways flooded by Bobbin Mill Brook include Town Street, East Town Street, and Scotland Road. Flooded roadways have also occurred along Spaulding Pond Brook, Ford Brook, Great Plain Brook, and the Mediterranean Lane tributary to the Shetucket River.

Larger flood incidents occurring over the past two decades are detailed in the 2023 SCCOG Hazard Mitigation Plan and the 2017 Norwich Annex, and are shown in **Table 3.**

Table 3. Flood Events in Norwich, CT

Date	Description	Yantic River Flood Height
April 15-16, 2007	A Nor'easter brought widespread and significant river, stream, and urban flooding or low-lying and poor drainage areas throughout Connecticut. Significant river flooding lasted through April 23rd.	1.42 feet above flood stage
February 13, 2008	Heavy rainfall fell on top of 2 to 3 inches of snow, causing several businesses on West Town Street to have 3 to 5 feet of water in their basements.	7 inches above flood stage
December 12, 2008	Major flooding occurred along the Yantic River in Norwichtown and Yantic, with the river above flood stage for nearly 18 hours. Many businesses closed due to flooding.	2.82 feet above flood stage, crest of 11.82 feet
July 2, 2009	Several roads in Norwichtown were flooded due to heavy rain, including a low-lying underpass beneath a railroad bridge on Wawecus Street that was closed for much of the day. Mediterranean Lane was also closed due to flooding. Fire crews were dispatched to assist residents with pumping water out of their basements in areas that typically experience flooding such as Bliss Place off Washington Street.	Not reported
March 29-30, 2010	The City experienced more flooded basements than ever experienced previously, including in areas that never had an issue with flooding. Route 82 had a significant flood near the entrance to KFC and Staples, and over 9,000 sandbags were deployed to protect buildings across the City. Crouch Avenue experienced slumping hillsides due to the sustained heavy rainfall. Sections of West Town Street, New London Turnpike, Wawecus Street, and Mohegan Park Road were closed, as was the "Canada Bridge" on Sherman Street over the Yantic River. The Yantic Fire Engine Company No. 1 sustained flood damage. One employee parking lot was closed at Backus Hospital. Water rescues were performed on Interstate 395 in Norwich. The NCDC listed an estimated $280,000 in property damage to homes and businesses occurred.	Crest of 13.23 feet, 4.23 feet above flood stage
July 25, 2013	The township of Norwich experienced an estimated 5 to 8 inches of rain (localized). Vehicles were stranded, basements flooded, and Sholes Avenue, Pleasant Street, and West Town Street were closed due to flooding, as was Golden Road, and the West Town Street Exit 82 for I-395.	Not reported

Date	Description	Yantic River Flood Height
March 30, 2014	Numerous roads in Norwich were under 2 feet of water as a result. West Town Street under Interstate 395 was closed. A swift-water rescue had to be performed to extract someone from a car.	Crested at 10.10 feet, 1.10 feet above the flood stage
September 21, 2021	Heavy rains pushed the Yantic River to major flood stage with a crest height of 11.71 feet, the seventh highest on record for the river in this location. Power was disrupted, a hotel needed to be evacuated due to basement flooding, and the Mohegan Commons on East Baltic Street was flooded and uninhabitable. An estimated $700,000 in uninsured damages were reported.	Crested at 11.71 feet, 2.71 feet above the flood stage

Norwich has experienced three federal disaster declarations: Superstorm Sandy (#4087), Connecticut Severe Storms and Flooding (#4410), and Tropical Storm Isaias (#4580).

These risks have resulted in significant consequences. Between 1978 and 2023, Norwich experienced 244 repetitive losses, with payments to repetitive loss properties totaling $2,375,676. Within the Study Area, 13 repetitive loss properties were identified: 2 residential, and 11 non-residential. Payments to the repetitive loss properties within Norwich totaled $1,406,235 as of December 2024, with 59% of the total payments to repetitive loss properties occurring between 1978 and 2023. One non-residential structure within Norwich is a severe repetitive loss property, with 6 total loss events. Only two of the 13 repetitive loss properties within Norwich are NFIP-insured.

Floodplain Management Ordinance

Norwich's Floodplain Management Ordinance 3.4 requires 1.5 feet of freeboard—additional height above the base flood elevation (BFE) required by building codes. The ordinance includes additional mitigation-related requirements that apply to existing structures that receive substantial improvements. The ordinance defines structural improvements as any repair, reconstruction, or other improvement taking place during a one-year period at a cumulative cost equal to or greater than 50% of the structure's market value.

Stormwater System

Norwich is one of six communities in Connecticut with combined stormwater and sanitary sewer systems. Most of the sewers built before 1925 were combined sewers, with a single pipe carrying both domestic sanitary sewage and stormwater. During extreme rainfall events, the capacity of the sewer system is overwhelmed resulting in excess combined sewage overflows (CSOs) to nearby rivers, seen in **Figure 10**. The City is involved in a long-term program to reduce CSOs, primarily by implementing sewer separation.[23] The CSOs and stormwater system may create areas of nuisance flooding in the Study Area, but were not included as a primary focus area in this study.

[23] "Stormwater Management Plan." Norwich, CT: City of Norwich, July 2017. https://www.norwichct.org/DocumentCenter/View/3140/2017-Norwich-Stormwater-Management-Plan.

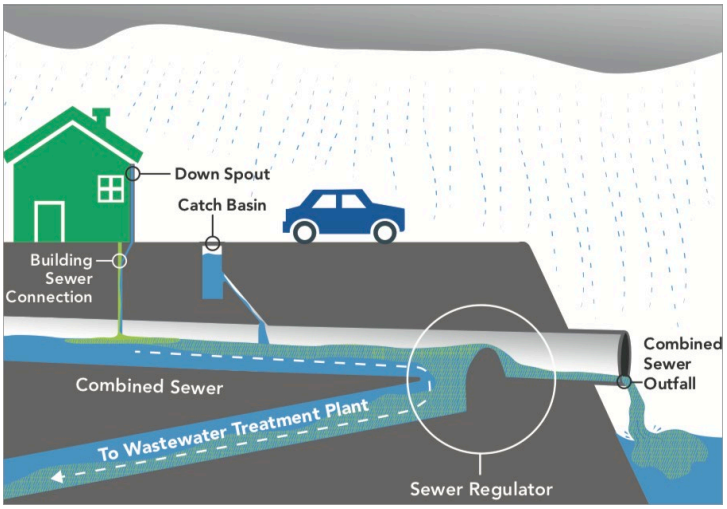


Figure 10. Combined sewer and separated sewer diagram
Image source: New York City Department of Environmental Protection (https://www.nyc.gov/site/dep/water/combined-sewer-overflows.page)

Extreme Heat and Other Climate Change Impacts

While the Norwich HMP Annex to the Local Hazard Mitigation Plan discusses many climate change-related hazards, it does not discuss extreme heat. However, data on relative heat anomalies is available from the Trust for Public Land. As shown in **Figure 11,** areas in the Study Area with heightened temperatures due to urban heat islands include: the Backus Hospital complex and parking lots, as well as the surrounding neighborhoods along Lafayette and Washington Streets; the Norwichtown Commons complex area, including the neighborhoods along Town Street and the New London Turnpike; the area around Samuel L. Huntington Elementary School, including Pleasant Street and Sholes Avenue; the Bean Hill neighborhood along West Town Street; and the industrial area between Otrobando Avenue and Capehart Drive. Efforts to increase vegetation and reduce impervious surfaces may reduce urban heat island effects in these areas. Consideration of heat hazards was beyond the scope of this study.

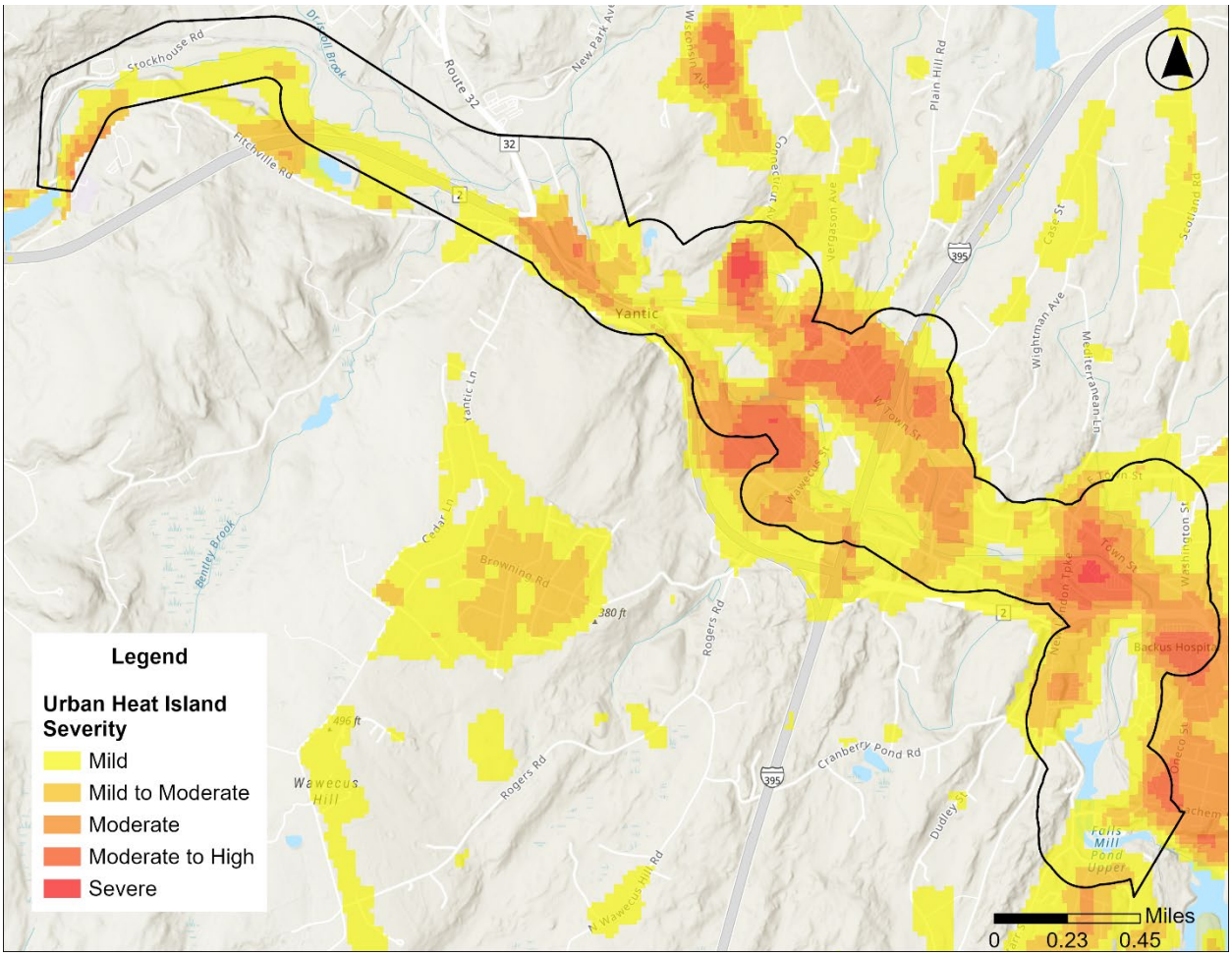


Figure 11. Urban Heat Island Severity
Source: The Trust for Public Land, Descartes Labs, USGS

The Norwich HMP Annex discusses additional climate-change impacted hazards. While hurricanes and tropical storms have the potential to induce coastal flooding and storm surge, backwater effects are unlikely to impact Norwich. Although the Annex expresses some concerns regarding the potential long-term effects of sea level rise and its potential to exacerbate riverine flooding conditions in the future, the Study Area's inland location and elevation make that unlikely.

The Norwich HMP Annex states that erosion along riverbanks is generally not an issue in Norwich, since most of the shorefront is almost fully developed, particularly within industrial areas.[24] While many areas along Yantic River contain erodible surface materials, as shown in **Figure 12**, riverbank stability or erosion concerns were not surfaced in conversations with stakeholders.

[24] Hazard Mitigation Plan Update Annex for the City of Norwich (2017). https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

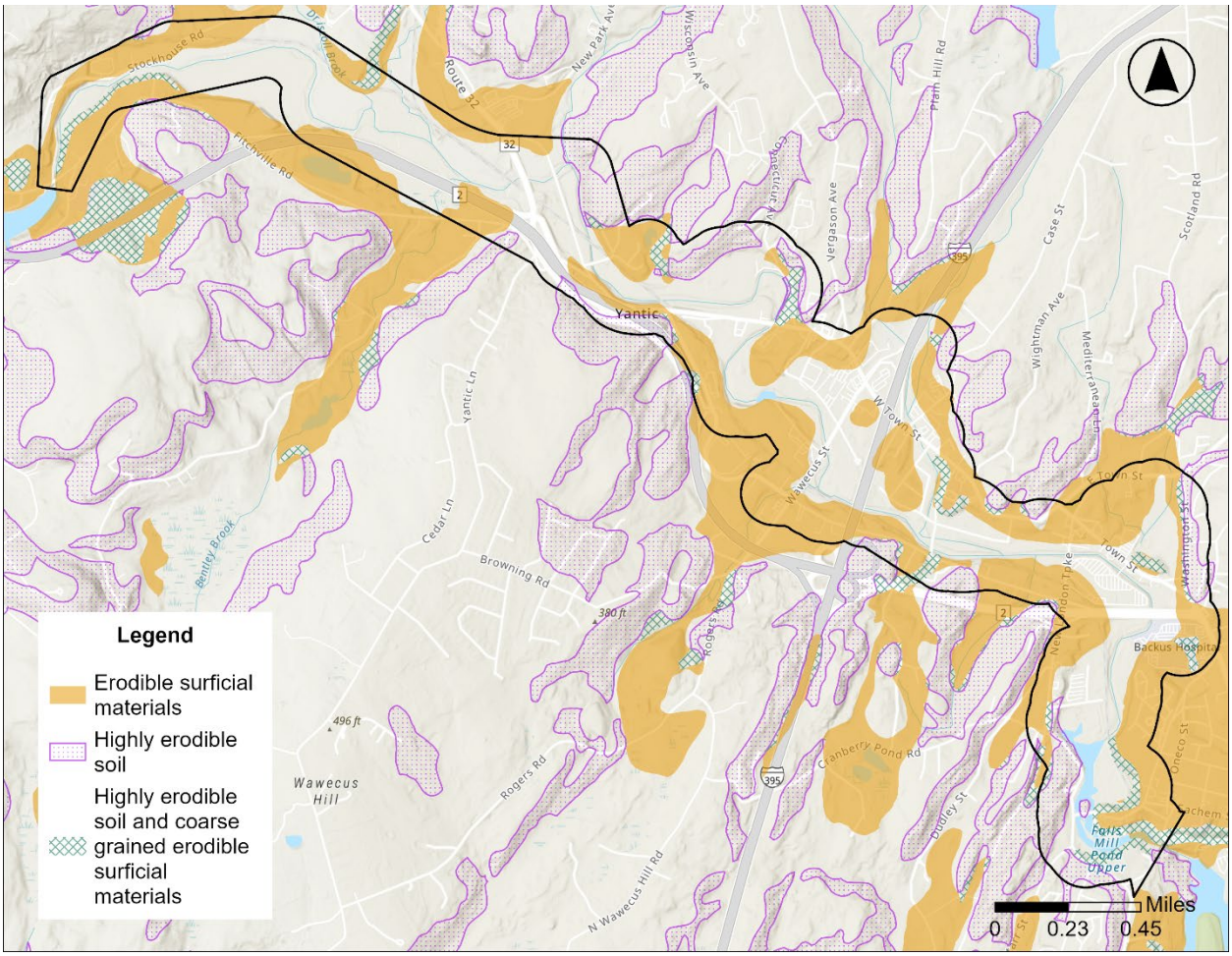


Figure 12: Erosion Susceptibility
Source: Connecticut Erosion Susceptibility, CT DEEP Database

2.3 Existing Flood Conditions Summary

As outlined in Section 2.2 under Flood Risk, the Study Area has a long history of riverine flooding, with several damaging floods in recent years. Resilient Yantic River emerged in response to increasingly frequent flooding in the city.

Flood Vulnerability

The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) has created a Climate Change Vulnerability Index (CCVI) which assesses flood vulnerability using the following formula: Vulnerability = (Sensitivity * Exposure) / Adaptive Capacity. [25] This data, accessible through a web viewer, presents flood vulnerability scores on a scale from 0.0 to 1, with 1 indicating the greatest vulnerability. The CCVI viewer indicates that Yantic's most vulnerable region is Backus Hospital and the surrounding area, including the Norwichtown Commons. Additional vulnerable areas include the area around the Public Works Department, the area around the Bean Hill substation, and the area around Norwich Aesthetic Dentistry on Otrobando Avenue. CCVI viewer results for Yantic's Town Street Corridor are shown in **Figure 13**.

[25] Connecticut Institute for Resilience and Climate Adaptation. 2023. Climate Change Vulnerability Index. https://resilientconnecticut.uconn.edu/ccvi/

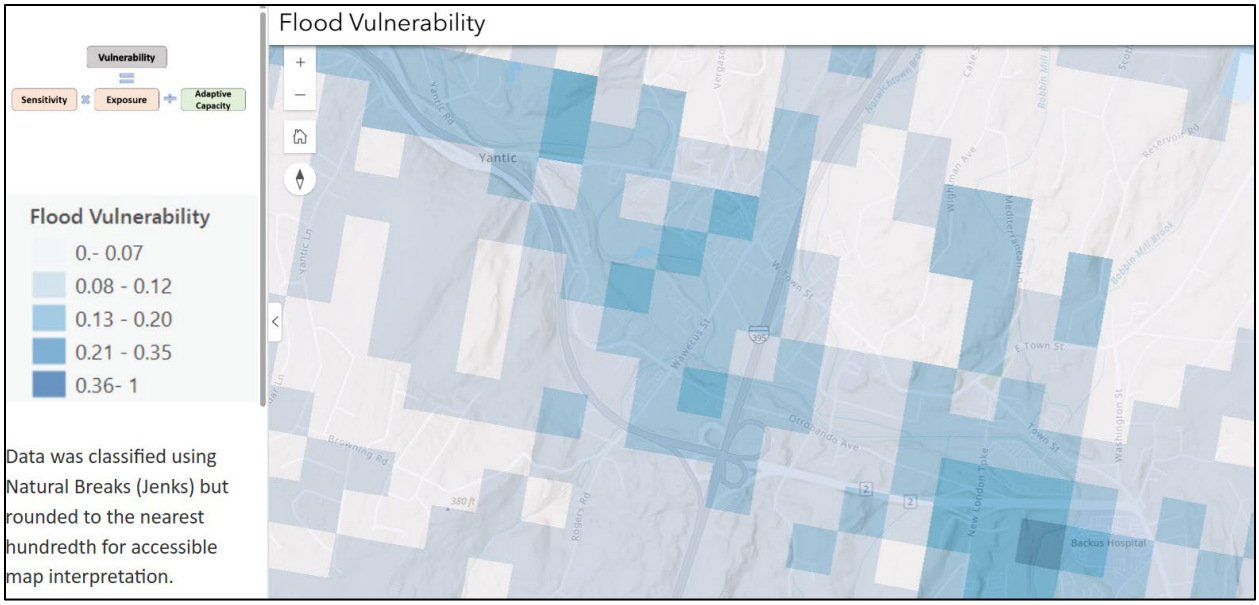


Figure 13. Climate Change Vulnerability Index: Flood Viewer Results – Town Street Corridor
Source: CIRCA Climate Change Vulnerability Index

The Study Model's 1% annual chance (100-year) flood, the existing FEMA flood maps, and local dams, are shown in **Figure 14**. Several dams rated as high and significant hazard by Connecticut's Dam Safety Section of the Inland Water Resources Division are located within the Yantic River watershed.[26]

The dams in the study watershed do not provide significant flood control benefits in their current state, so flood concerns associated with dams are primarily related to dam failure. The privately owned Fitchville Dam, classified as having High Hazard potential by CTDEEP, had an uncontrolled release during the January 2024 flood. Located directly upstream of the Study Area, the release resulted in partial evacuation of the downstream area.[27]

The Bog Meadow Reservoir and Taftville Reservoir Dams are significant hazard dams located to the north of the study site. Downstream dams include the Falls Mill Upper and Lower Dams; the Lower Dam functions as a tidal barrier. Neither tidal fluctuations nor sea level rise impact flooding within the Study Area given the elevations of the area are well above sea level (e.g., the 100-year flood elevation in the vicinity of Norwichtown Commons is 83 to 84 feet).

[26] Connecticut Department of Energy and Environmental Protection (2025). Connecticut Dams – Public Use. (GIS Dataset). https://ctdeep.maps.arcgis.com/home/item.html?id=0d81bba49a084697bd2fb4e231a4de2f
[27] Connecticut Public Radio (2024). "Partial dam break on Yantic River in CT causes evacuation due to potential 'life threatening' floods." https://www.ctpublic.org/news/2024-01-10/partial-dam-break-in-norwich-leads-to-possible-life-threatening-floods

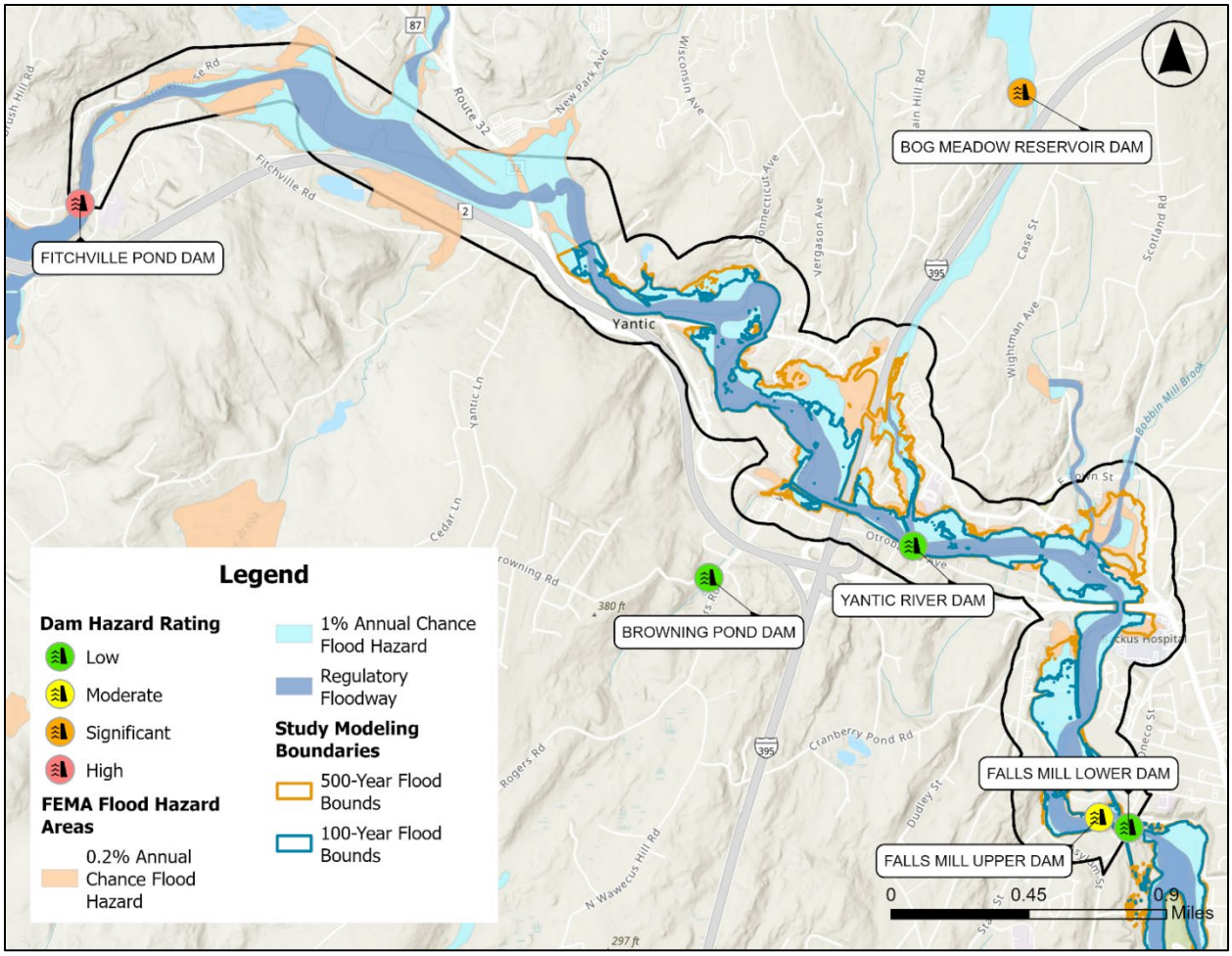


Figure 14: Regional Dams, FEMA and Study Model Floodplains

The Norwich HMP Annex identified the following quantities and values of flood-exposed structures, based on FEMA flood modeling, as shown in **Table 4.**

Table 4. Quantity and Value of Flood-Exposed Structures, Norwich HMP Annex

1% annual chance exposed structures	Total exposed property value	0.2% annual chance exposed structures	Total exposed property value
1,320	$266,674,780	1,546	$317,755,780

Within the Study Model's 1% annual chance (100-year) floodplain, **a total of 93 structures are exposed**. The total assessed value for these structures, and the parcels on which they are located, is **$40.6 million (about 15% of total exposed value)**. Exposed structures within the Study Area are shown in **Figure 15** through **Figure 17**.

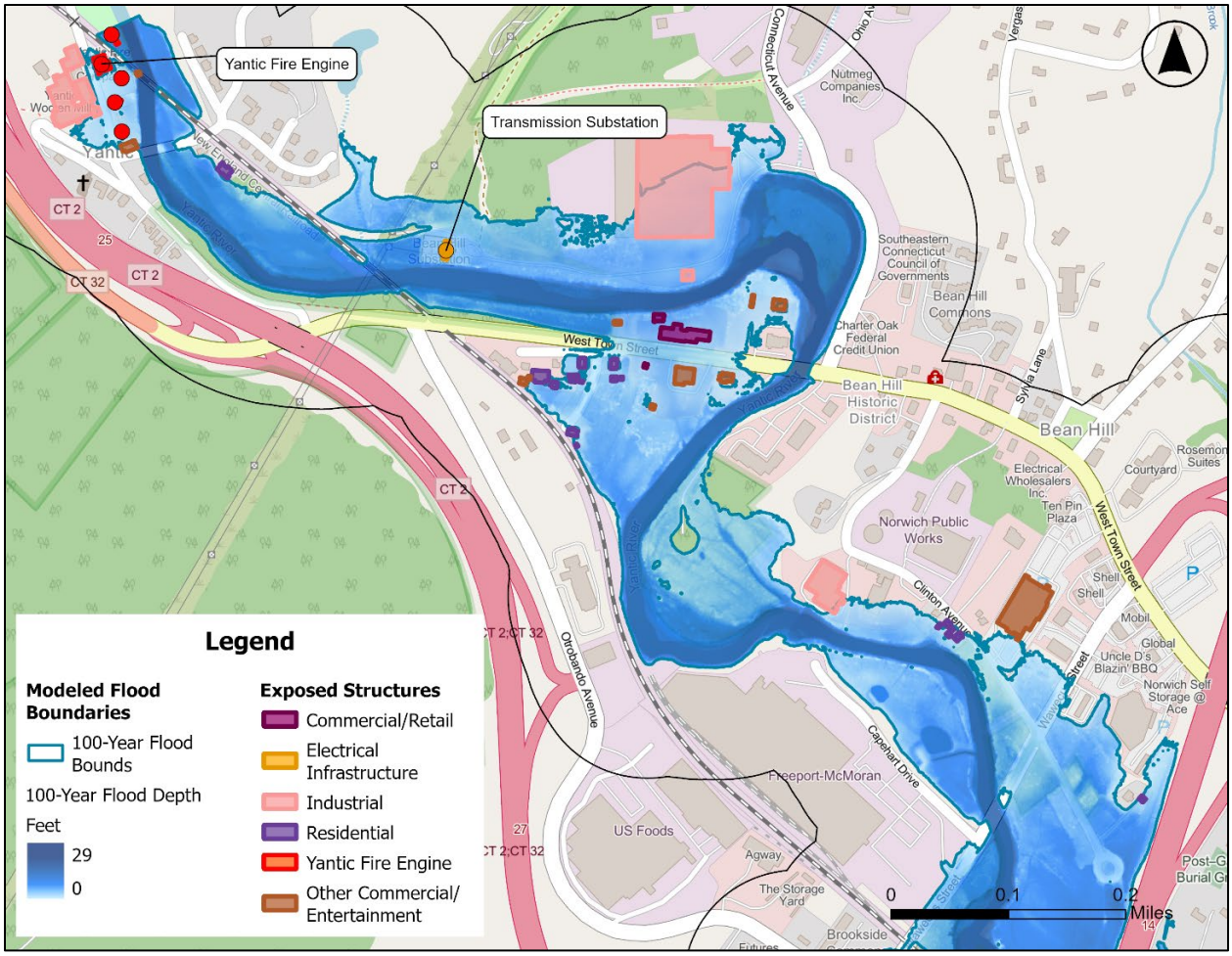


Figure 15: Study Model 1% Annual Chance (100-Year) Flood Risk, Yantic Fire Engine to I-395

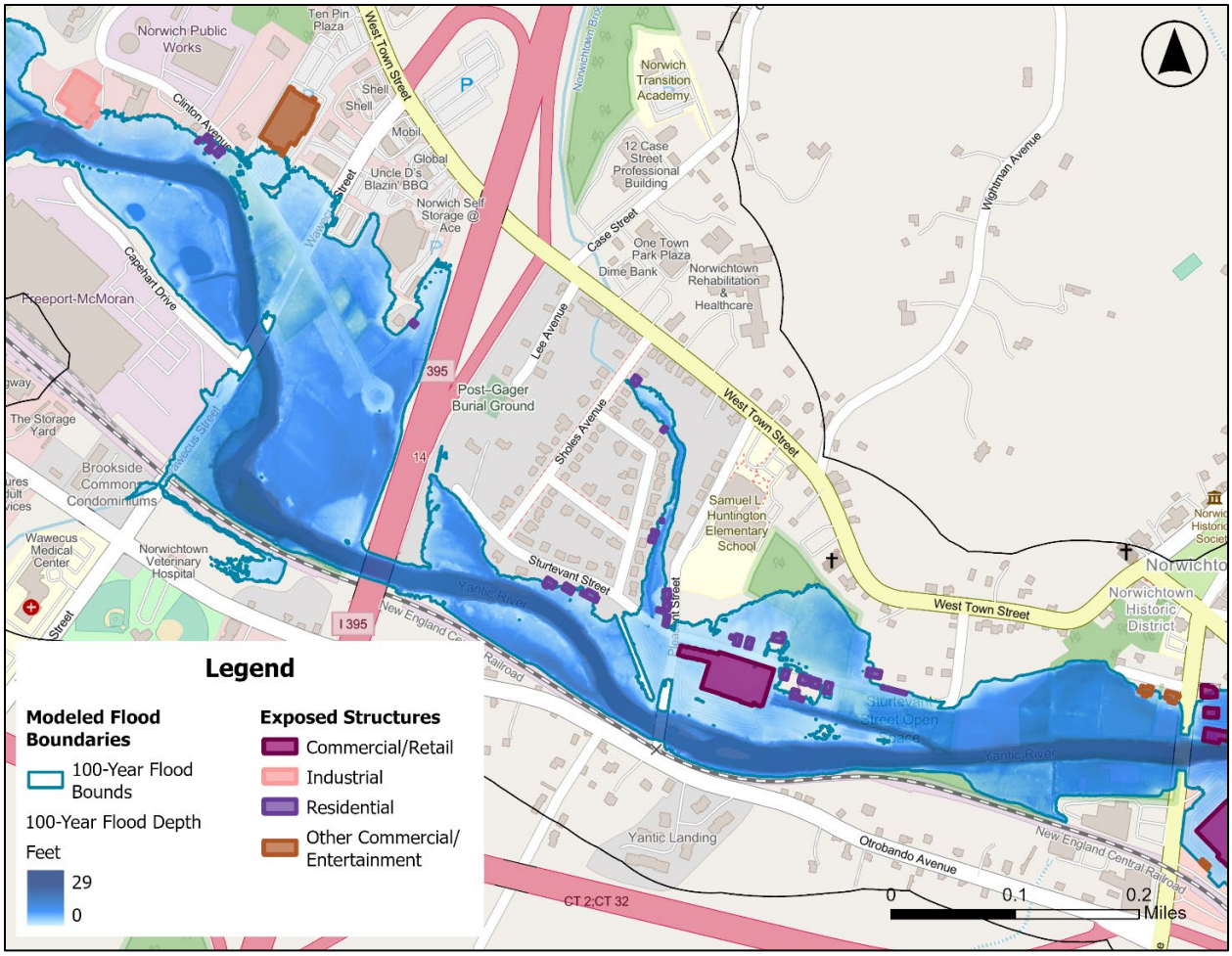


Figure 16: Study Model 1% Annual Chance (100-Year) Flood Risk, I-395 to the New London Turnpike

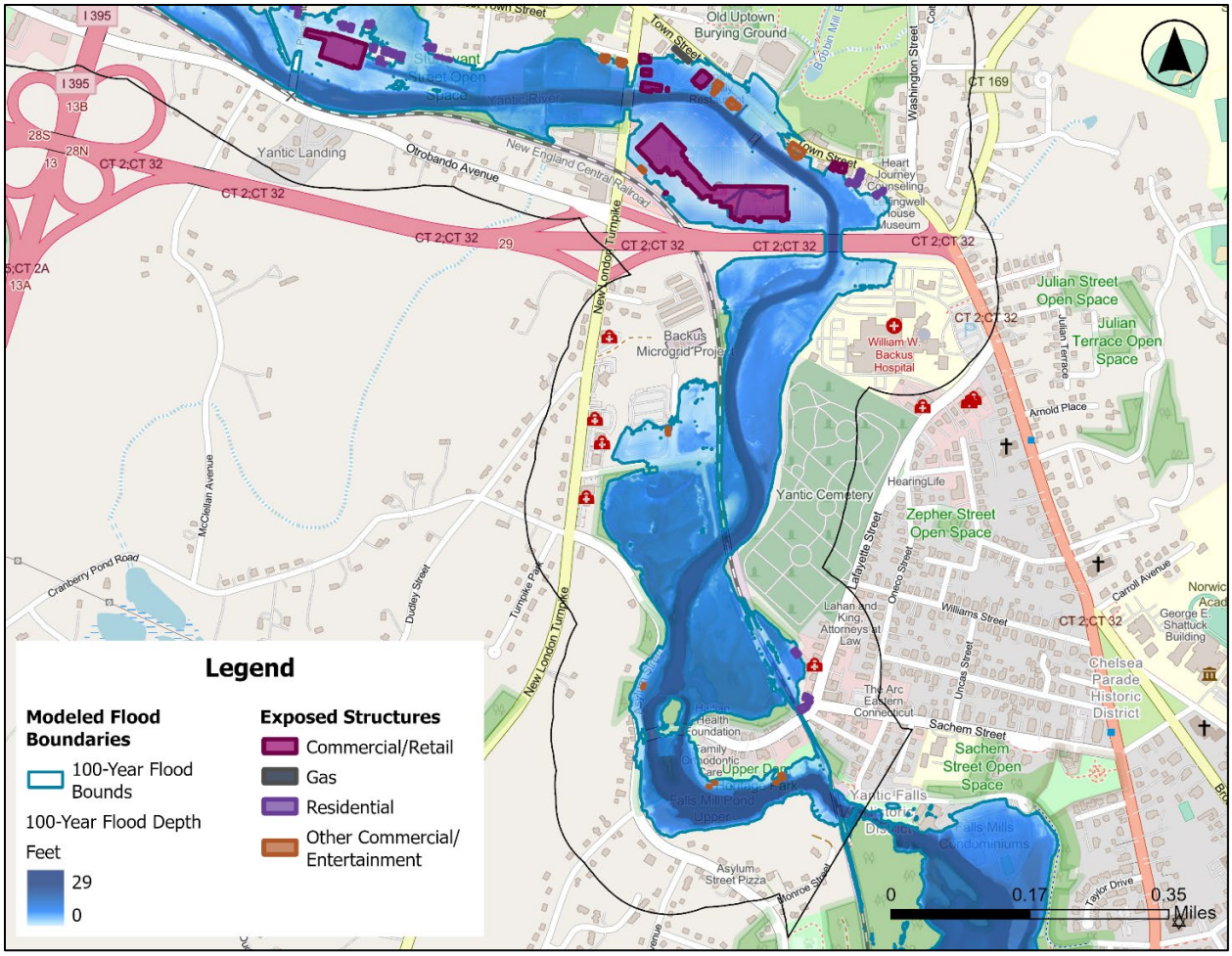


Figure 17: Study Model 1% Annual Chance (100-Year) Flood, Norwichtown Commons to Uncas Leap

Commercial and Industrial Properties

The 2017 Norwich HMP Annex identified the following commercial and industrial properties within the FEMA-identified 1% annual chance (100-year) floodplain and the project Study Area:

- West Town Street: A **gas pipeline facility** owned by the Algonquin Transmission Company.
- Clinton Avenue: A mix of commercial buildings and an old industrial building.
- Yantic Road: A **tavern and several commercial buildings** near the Yantic Fire Engine Company No. 1.
- Pleasant Street & Sturtevant Street: **Yantic River Plaza.**
- Connecticut Avenue: **Plas-Pack Industries, Inc**. experiences flooding, as does an electrical substation nearby.
- Rollins Road: Matlack electrical substation.
- Wawecus Street: The **Phelps-Dodge Industrial Plant** driveway floods, restricting vehicular access to the facility. **Freeport McMoRan** is also flooded by the Yantic River.

Properties within the Study Model's 1% annual chance (100-year) floodplain are shown in **Table 5**.

Table 5: Structures and Uses within the 1% Annual Chance (100-year) Floodplain

Address	Owner	Use
12 New London Tpke	EWK LLC	Com Retl M-94
135 Yantic Rd	Cormier Donald J +	Ind Bldg
140 Yantic Rd	Mill Development Ct LLC	Industrial M-96
140 Yantic Rd	Mill Development Ct LLC	Industrial M-96
16 New London Tpke	16 Nl Tpke LLC	Com Retl M-94
188 West Town St	KB Real Estate LLC	Bowling
2 Lathrop Ave	YT Associates LLC	Prof Bldg M-94
20 New London Tpke	Skymark LLC	Com Retl M-94
20 Town St	NVB Properties LLC	Com Retl M-94
22 Town St	Tam Serena	Com Retl M-94
251-257 West Town St	Cuma LLC	Rest/Clubs M-94
262 West Town St	Megzon Properties LLC	Auto Repr M-95
270 West Town St	Growinbasil LLC	Rest/Clubs M-94
275 West Town St	Central Houston Holding LLC	Com Retl M-94
276 West Town St	FGG Management Group LLC	Com Rel Ld M-00
31 Clinton Ave	BTV Realty of Norwich LLC	Industrial M-96
34 Town St	Transitional Office Buildings LLC	Office Bld M-94
4 Lathrop Ave	Murphy Eloise L L/U +	Sfr Water
42 Town St	TKG Norwichtown Commons LLC	PLAZA W/ANCHR
48 Yantic Flats Rd	Digangi Joseph	Office Bld M-94
50 Pleasant St	Cove Nwch LLC	Com Retl M-94
50 Town St	Chelsea Groton Bank	Bank Bldg
58 Town St	Marasiotis LLC	Rest/Clubs M-94
60 Town St	James Plaza 60 Town LLC	Com Retl M-94
70 Town St	Cnlv Ssnorwhct LLC	Gasmart
Yantic Rd	State Board of Fisheries and Game	State Rec

One documented historic structure, the **Yantic Fire Engine Company No. 1 building**, is located within the 1% annual chance (100-year) floodplain.[28]

Critical Facilities

The Yantic Fire Engine Company No. 1, a volunteer fire department that protects 10 square miles of the City's 27 square miles, floods frequently. The firehouse is located 10.7 feet below the BFE, and utilities are located 12.6 feet below BFE.[29] Consequently, the Fire Department relocates equipment in advance of predicted flooding.[30]

Based on the Study Model, the **Norwich Department of Public Utilities' Bean Hill Substation** is within the 1% annual chance (100-year) floodplain. The Substation connects to an overhead AC transmission line that

[28] City of Norwich. (2017). Hazard Mitigation Plan Update Annex for the City of Norwich. https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

[29] Southeastern Connecticut Council of Governments. (2017). "Municipal Infrastructure Resilience Project – Critical Facilities Assessment: Final Report." Accessed June 6th via https://circa.media.uconn.edu/wp-content/uploads/sites/1618/2017/12/SCCOG-Critical-Facilities-Final-Report.pdf

[30] City of Norwich. (2017). Hazard Mitigation Plan Update Annex for the City of Norwich. https://secogct.gov/wp-content/uploads/2018/07/Norwich-Annex-Approved.pdf

crosses the floodplain. In 2023, Norwich Public Utilities received $650,000 in state funding to support the design of a floodwall around the substation.[31] During the January 2024 flood, the substation was taken offline.

The **gas pipeline monitoring facility** formerly owned by the Algonquin Transmission Company at 279 West Town Street is now owned by the Connecticut State Board of Fisheries and Game and the Connecticut Department of Agriculture. Google StreetView imagery suggests that the structure is in use by a new energy delivery company, Enbridge.

Exposed major roadways include West Town Street, Town Street, Clinton Avenue, and Stuyvesant Street. The intersection of Asylum and Sherman Street, and much of the New England Central Railroad falls within the floodplain as well.

Norwich's HMP Annex notes the additional critical facilities within the FEMA 1% annual chance (100-year) floodplain, as shown in **Table 6.** Many of these locations are outside of the project Study Area but are worth noting in the context of a region that is highly exposed to flooding.

[31] Norwich Public Utilities. (2023) "NPU secures state funding for climate resilience projects." https://www.norwichpublicutilities.com/CivicAlerts.aspx?AID=64

Facility	Address or Location	Emergency Power?	Shelter?	In 1% Annual Chance Floodplain?	In Surge Zones?
Public Works - Fleet Management	Asylum Street				
Water Pollution Control Facility	Falls Avenue	✓		✓	
Health Care Facilities & Senior Living					
Backus Hospital	326 Washington Street	✓			
Norwich Public Schools					
Samuel Huntington Elementary	80 West Town Street				
Thomas W. Mahan Elementary	94 Salem Turnpike				
John M. Moriarty Elementary	20 Lawler Lane	✓	✓		
John B. Stanton Elementary	386 New London Turnpike			✓	
Uncas Elementary	280 Elizabeth Street Extension	✓	✓		
Veterans Memorial Elementary	80 Crouch Avenue				
Wequonnoc Elementary	155 Providence Street				
Kelly Middle	25 Mahan Drive	✓	✓		
Teachers' Memorial Middle	15 Teachers Drive	✓	✓		
Deborah Tennant-Zinewich - Special Education	30 Case Street				
Hickory Street (Special Education)	201 Hickory Street				
Alternate Public Schools					
Integrated Day Charter School	68 Thermos Avenue				
Norwich Technical High School	7 Mahan Drive				
Private Schools					
Wildwood Christian School	35 Wawecus Hill Road				
Montessori Day	218 Dudley Street				
Norwich Free Academy	305 Broadway				
*Building & Maintenance					
Emergency Services					
Fire Department Headquarters - Station 1	10 North Thames Street	✓			
Greeneville Fire Department - Station 2	446 North Main Street	✓			
East Great Plain Volunteer Fire Department	488 New London Turnpike	✓			
Laurel Hill Volunteer Fire Company	509 Laurel Hill Road	✓			
Occum Volunteer Fire Department	44 Taftville-Occum Road	✓		✓	
Taftville Fire Company No. 2 (Volunteer)	134 Providence Street	✓			
Yantic Fire Engine Company No. 1 (Volunteer)	151 Yantic Road	✓		✓	
Police Department	70 Thames Street	✓			
Municipal Facilities					
City Hall / backup EOC / Public Works*	100 Broadway	✓			
Norwich Public Utilities / EOC	173 North Main Street	✓			
Rose City Senior Center	8 Mahan Drive	✓	✓		
Public Works Headquarters	50 Clinton Avenue	✓			

Table 6. Critical Facilities within the FEMA 1% annual chance (100-Year) floodplain
Source: Norwich HMP Annex

Repetitive Loss

Thirteen properties, one of which is a severe repetitive loss property, are located within the Study Area. Nine are in the 1% annual chance (100-year) floodplain, and three are in the 0.2% annual chance (500-year) floodplain. One is outside of, but proximate to, the 0.2% annual chance (500-year) floodplain. These repetitive loss properties have experienced an average of three losses, with an average per-loss payment of $27,563.96. Total payments to these 13 repetitive loss properties amounted to $1,406,235 as of December 2024.

2.4 Future Flood Conditions Summary

Yantic, Connecticut, and the Northeast as a whole are experiencing more frequent and intense extreme precipitation events.[32] These trends are expected to continue, with the 1% annual chance (100-year) and 0.2% annual chance (500-year) storm events occurring more frequently, and with heightened flood levels.[33]

In 2024, the updated Flood Resistant Design and Construction standard (ASCE 24) recommended designing for the annual chance 0.2% annual chance (500-year) flood in response to changing hydrologic conditions.[34] Consequently, the 0.2% annual chance (500-year) flood was used to model future 100-year flooding conditions within the Study Area. The modeled 0.2% annual chance (500-year) flood results in a peak discharge of 23,655 cfs, approximately double the 1% annual chance (100-year) peak discharge of 11,530 cfs. The total area impacted by the 1% annual chance (100-year) flood, inclusive of the Yantic River channel, is about 342 acres, which increases 38% to about 474 acres in the 0.2% annual chance (500-year) flood condition.

Within the Study Area's **0.2% annual chance (500-Year) floodplain** modeled for this project, there are **216 structures**, including **10 repetitive loss properties**, with a **total assessed value for exposed parcels of $130.9 million**.

This compares to a total of **93 structures**, including **6 repetitive loss properties**, within the **1% annual chance (100-year) floodplain** modeled for this project, with a total assessed value for these structures, and the parcels on which they are located, of **$40.6 million**.

With the 500-year floodplain serving as a stand-in for the future flooding conditions, results indicate a **222% increase** in the value of at-risk assets.

[32] National Academies of Sciences, Engineering, and Medicine. 2023. Review of the Draft Fifth National Climate Assessment. Washington, DC: The National Academies Press. https://doi.org/10.17226/26757.
[33] Connecticut Institute for Resilience and Climate Adaptation (CIRCA). (2019). *Connecticut Physical Climate Science Assessment Report*. https://circa.media.uconn.edu/wp-content/uploads/sites/1618/2019/11/CTPCSAR-Aug2019.pdf
[34] ASCE. (2024). *Advancing Flood-resistant Design: The ASCE/SEI Flood Resistant Design and Construction Standards Committee*. Retrieved from https://www.asce.org/communities/institutes-and-technical-groups/structural-engineering-institute/news/advancing-flood-resistant-design-the-asce-sei-flood-resistant-design-and-construction-standards-committee

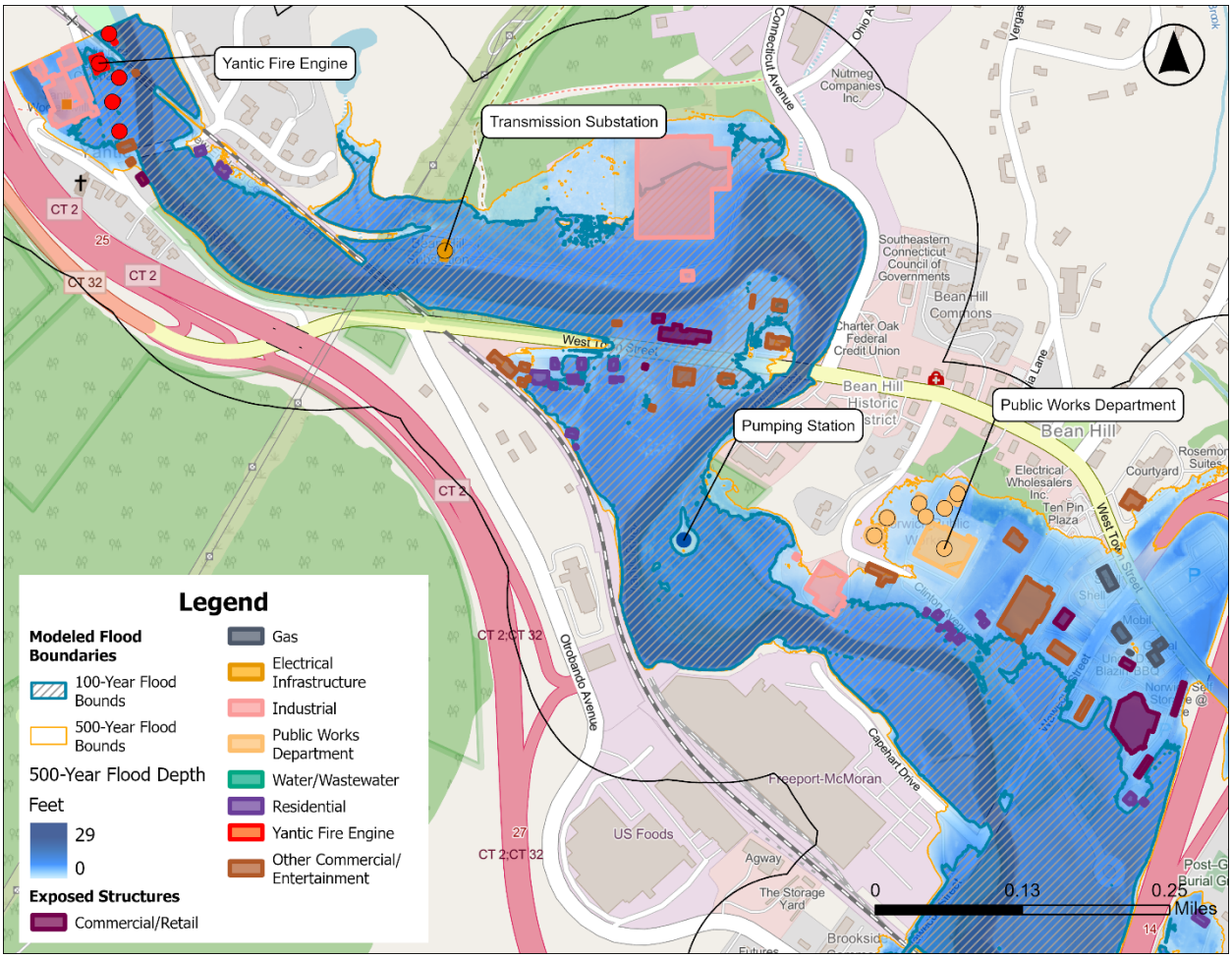


Figure 18: Study Model 0.2% Annual Chance (500-year) Flood Risk, Yantic Fire Engine to I-395

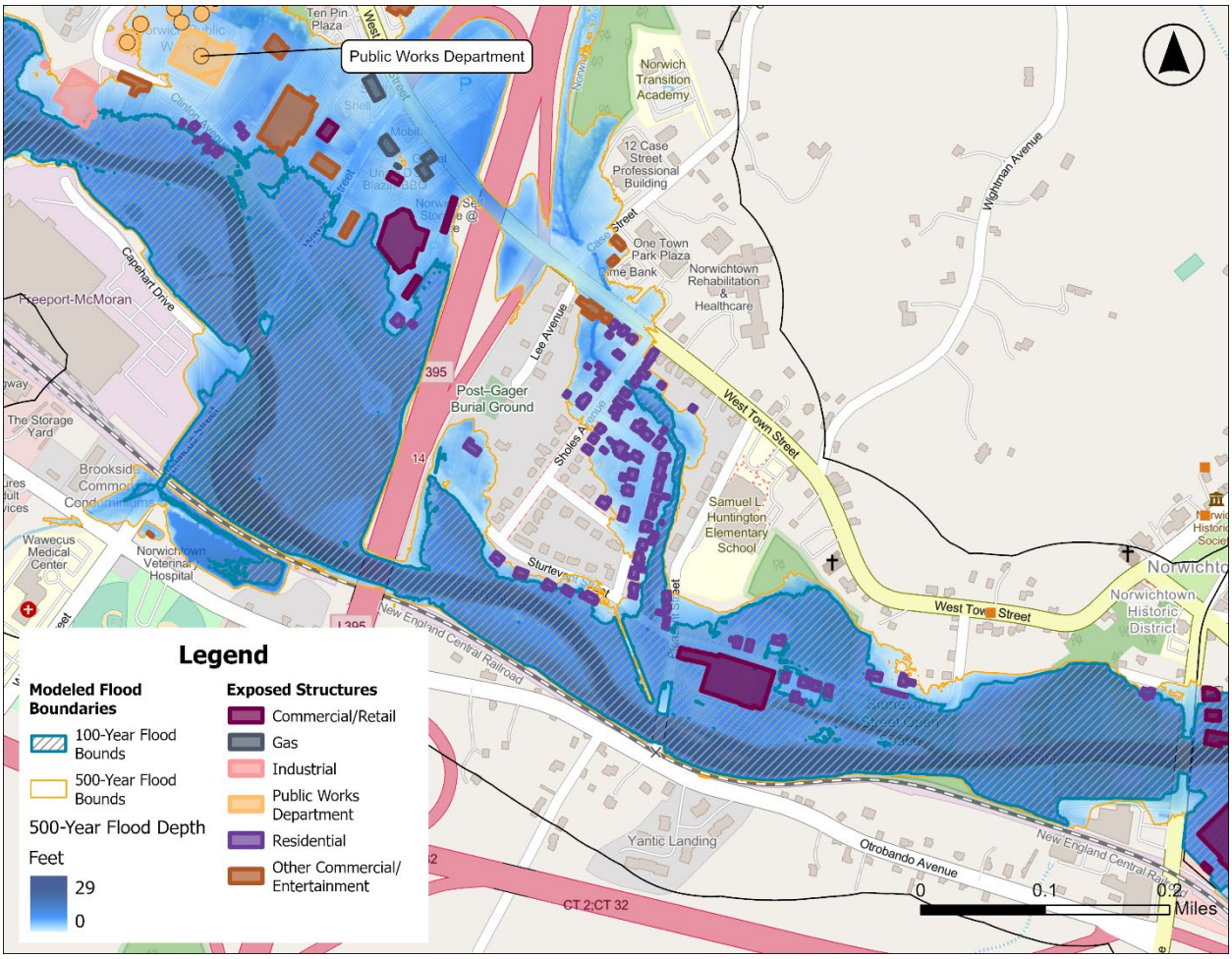


Figure 19: Study Model 0.2% Annual Chance (500-year) Flood Risk, I-395 to the New London Turnpike

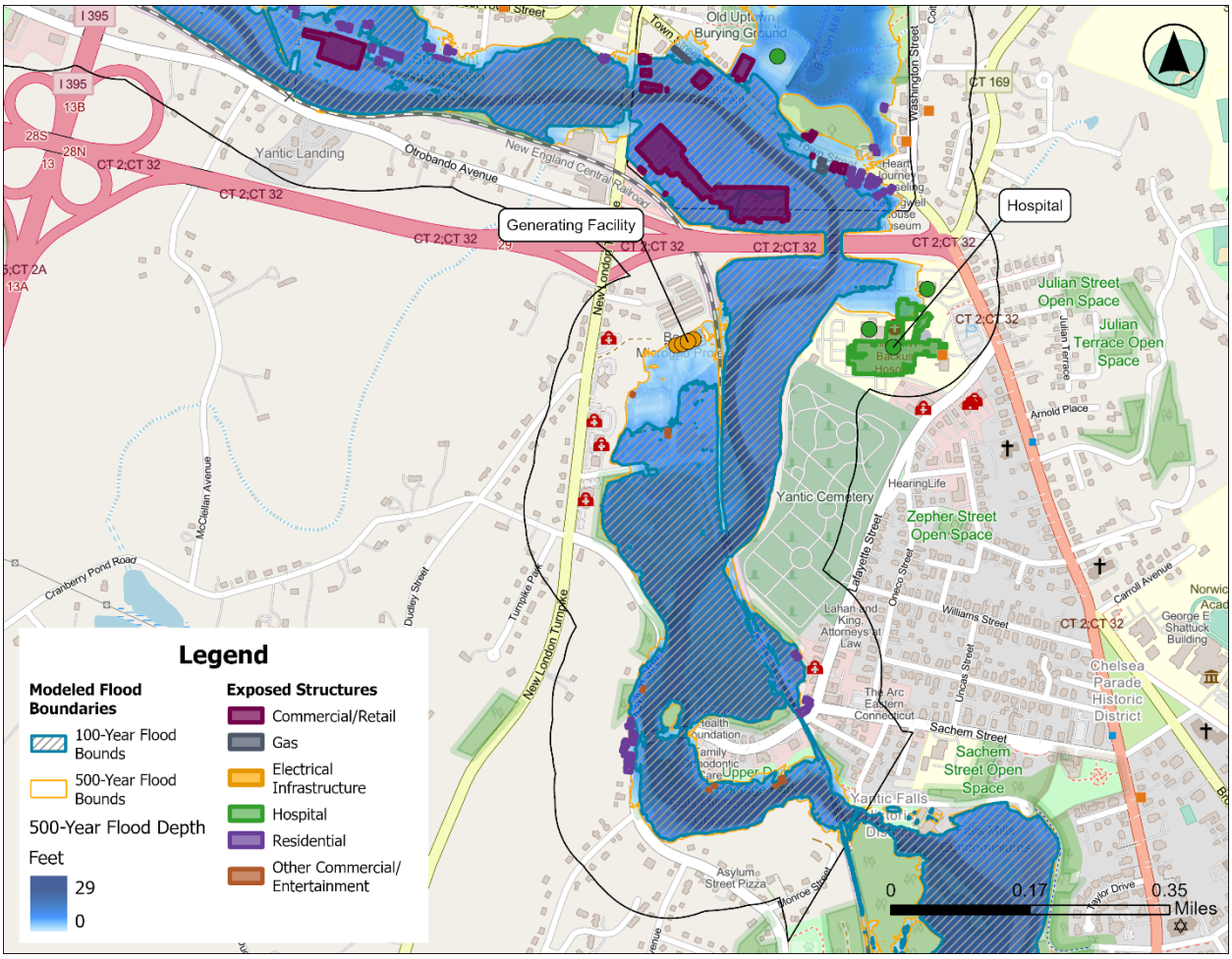


Figure 20: Study Model 0.2% Annual Chance (500-year) Flood, Norwichtown Commons to Uncas' Leap

Greater flood depths are anticipated under the 0.2% annual chance (500-year) flood conditions as compared to the 1% annual chance flood. The region around Yantic Fire Engine Company No. 1 sees flood depth increases up to five feet, seen in **Figure 18**. Further, as shown in **Figure 19**, flooding also expands substantially in the southeast corner of the Bean Hill neighborhood, from the area around the Norwich Department of Public Works to I-395, including the 181 West Town Street Park and Ride lot.

Several distinct areas above the 1% annual chance (100-year) floodplain are newly impacted under 0.2% annual chance (500-year) floodplain conditions. As shown in **Figure 20**, flooding around Bobbin Mill Brook increases substantially, impacting the Edward and Mary Lord Family Healthcare Center, and businesses and residences on Town Street between the Norwichtown Commons entrance and Washington Street. The area around the Norwichtown Commons sees flood depth increases of five to seven feet.

As shown in **Figure 21**, flooding also increases substantially around the Norwichtown Brook, impacting a large quantity of single-family homes along the brook from Sturtevant Street North to West Town Street and Case Street.

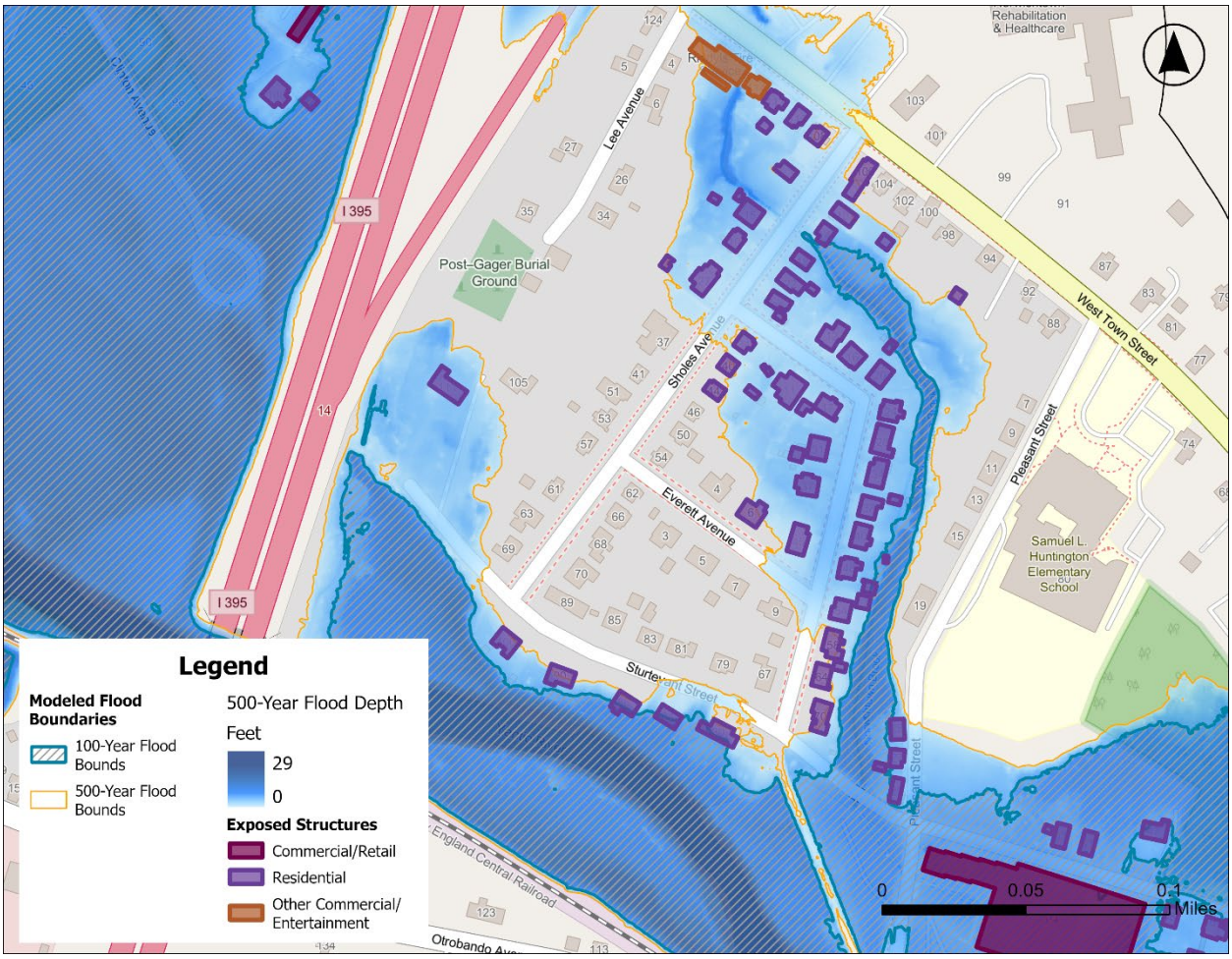


Figure 21: Study Model 0.2% Annual Chance (500-year) Flood, Woodrow Avenue

Historic Assets

There is one location in the National Register of Historic Places within the Study Model 0.2% annual chance (500-year) floodplain. The Yantic Woolen Company Mill is located at 6 Franklin Road, near the Yantic Fire Engine Company. Modeled flood depths within the Mill's footprint peak at approximately eleven and a half feet. Though on the National Register as a historic inn, the Leffingwell House Museum is located barely beyond the mapped boundaries of the 0.2% annual chance (500-year) floodplain.

Commercial and Industrial Properties

Commercial and industrial properties within the Study Model's 0.2% annual chance (500-year) floodplain, but outside of the 1% annual chance (100-year) floodplain include the following. A full list is shown in **Table 7**.

- West Town Street: The Courtyard Norwich Hotel and Prime 82 Restaurant and Bar, the ACE Hardware Store and storage complex, Riddy's Tire Service, various gas stations,
- Yantic Road: the Mill Development LLC's numerous structures on Yantic Road across from the Fire Station, which include the historic Yantic Woolen Mill Complex,
- 31-35 Town Street Shopping Complex: (Town Street's north frontage) Owned by Amity Park LLC, home to Greenleaf Farms, Connection Nail and Spa, Lori's Deli and Bakeshop, and the Goodyear auto shop.

Table 7: Structures and Uses within the 0.2% Annual Chance Floodplain

Location	Owner	Use
108 West Town St	Allyn Jeanne S Tr	Mu Res Typ
11 Wawecus St	Norwich Business Exchange LLC	Com Retl M-94
120 West Town St	Ridenour James D	Auto Repr M-95
125 Yantic Rd	Yantic Village LLC	Comm Bldg M-94
131 Yantic Rd	Welch Joseph J	Post Off
140 Yantic Rd	Mill Development Ct LLC	Industrial M-96
146-148 West Town St	Big Red LLC	Hardware St
15 Town St	Dmo Properties LLC	Store/Shop M-94
15 Wawecus St	Platteborze LLC	Gyms
154-156 West Town St	Alliance Energy LLC	Gasmart
162 West Town St	Savin Gasoline Properties Ii LLC	Gasmart
168 West Town St	Petroleum Marketing Investment Group LLC	Gasmart
174 West Town St	174 West Town Street LLC	Comm Bldg M-94
177 Otrobando Ave	Jtmg Company LLC	Prof Bldg M-94
181 West Town St	Atithi Group Connecticut LLC	Hotels
192 West Town St	192 West Town Street LLC	Store/Shop M-96
2 Town St	Society Of The Founders Of Norwich	Non-Profit M-01
20 Wawecus St	Shackett Jeffrey + Shackett Christopher Co-Trustees	Car Wash
24-26 Town St	Monitha LLC	Gasmart
251-257 West Town St	Cuma LLC	Rest/Clubs M-94
30-32 Town St	Time For Wine LLC	Com Retl M-94
31 Clinton Ave	Btv Realty Of Norwich LLC	Industrial M-96
31-35 Town St	Amity Park LLC	Com Retl M-94
33 New London Tpke	No Reply LLC	Store/Shop M-96
400 Washington St	Lowthorpe Association Inc	Res Develo Mdl-00
41-47 Town St	United Community And	Charitable M-94
43 Clinton Ave	Harts Greenhouse Of Norwich LLC	Com Grn Hs M-96
44 Yantic Flats Rd	44 Yantic Flats LLC	Mu Res Typ
45-57 Town St	United Community And	Com Retl M-94
48 Yantic Flats Rd	Digangi Joseph	Office Bld M-94
5 Case St	5 Case Street LLC	Prof Bldg M-94
58 Yantic Flats Rd	Liu & He Realty LLC	Store/Shop Mdl-96
71 Town Street	Fleet Bank National Association	Bank Bldg

Critical Facilities

As shown in **Figure 22**, Norwich's Department of Public Works (DPW) offices and garage are in the 0.2% annual chance (500-year) floodplain of the Yantic River, on the periphery of the 1% annual chance (100-year) floodplain, and are susceptible to flood damage. The DPW structures are 2.8 feet above the BFE and sandbags for major floods are stored at this location.

The nearby Norwich City Pumping Station (242 West Town Street), home to the Norwichtown Well, is inundated under the 0.2% annual chance (500-year) flood model, and fully surrounded under the 100-year flood model. In February 2025, Norwich began soliciting proposals for installing a PFAS treatment system at the Pumping Station. While not within the Study Area, Norwich's Sewer Treatment Plant and related structures are within the 0.2% annual chance (500-year) floodplain.

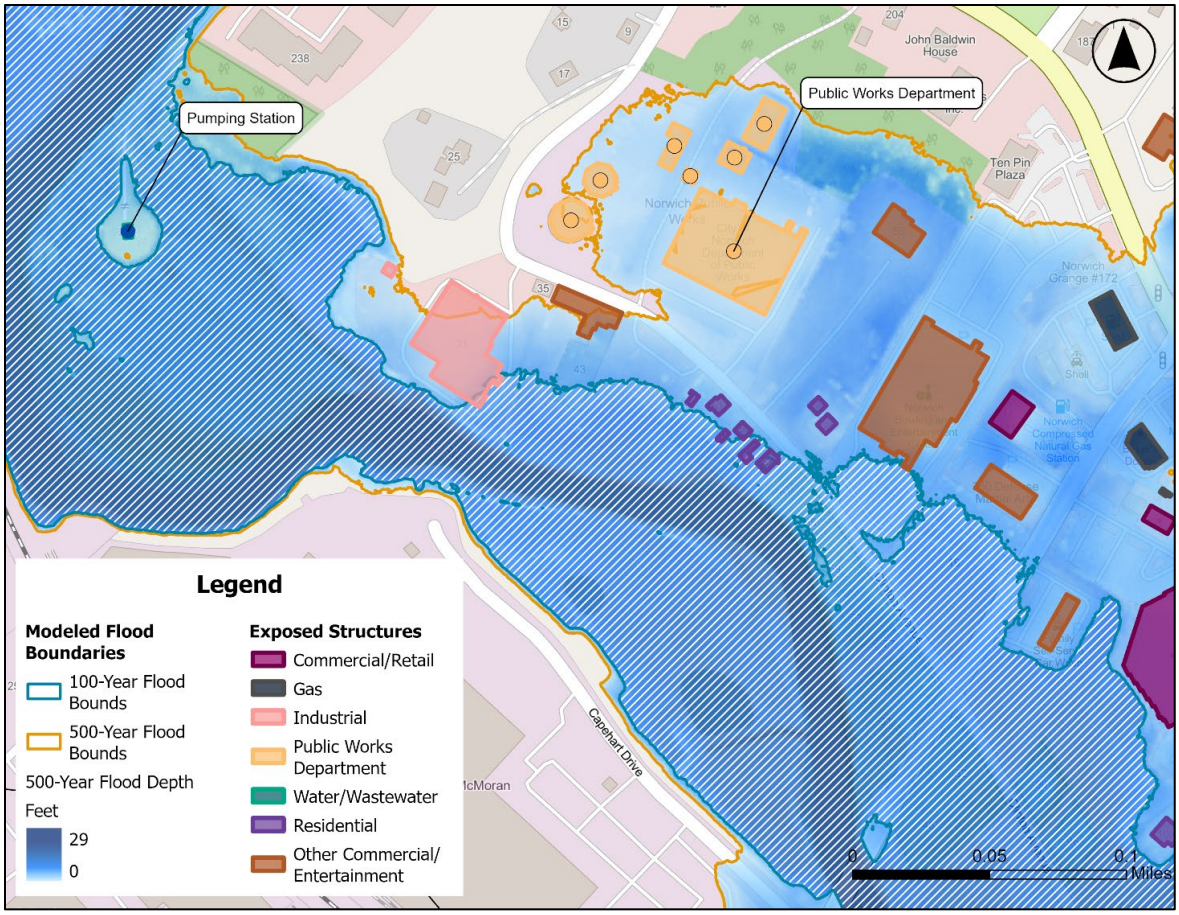


Figure 22: At-Risk Critical Infrastructure: Pumping Station and Public Works Department

As shown in **Figure 23**, Backus Hospital owns a petroleum-powered electrical generating plant, the Backus Microgrid Project, within the 0.2% annual chance (500-year) floodplain (9 Farms Springs Road), adjacent to the New England Central Railroad. As the POCD notes that Backus Hospital is Norwich's largest employer, maintaining access and functionality of the hospital is not only essential for public health and life safety, but also for economic vitality. The Edward and Mary Lord Family Healthcare Center at 47 Town Street is also within the 0.2% annual chance (500-year) floodplain, as shown in **Figure 20**. Inundation is associated with both the Yantic River and its tributary, the Bobbin Mill Brook.

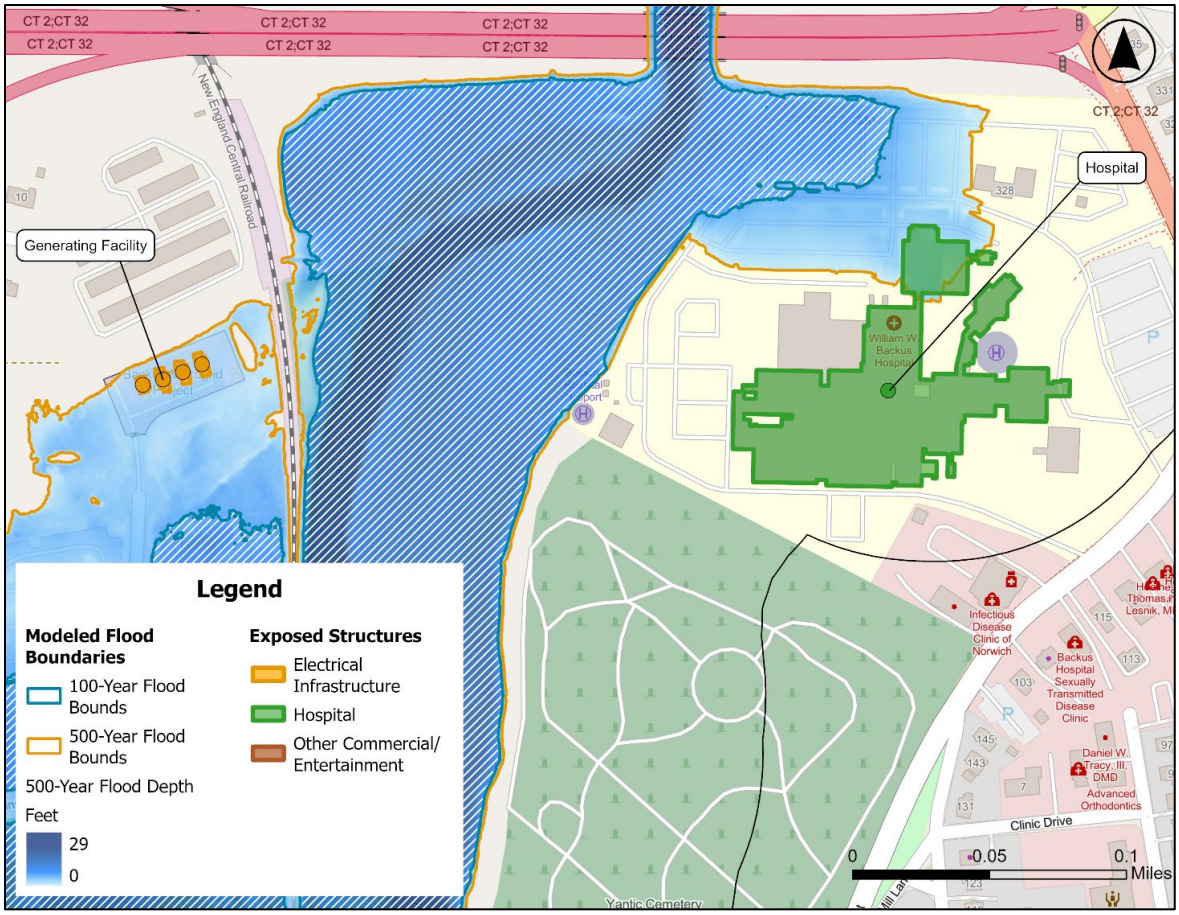


Figure 23: At-Risk Critical Infrastructure: Backus Hospital and Generating Station

Several gasoline stations are within the 0.2% annual chance (500-year) floodplain, including the Norwich Compressed Natural Gas Station at 168R West Town Street, the Mobil Gas Station at 162 West Town Street, and the Stop and Shop gas station at 70 Town Street.

Expansions of roadway impacts generally involve expanding flood areas along already impacted roadways. Several small roadways are newly impacted, including Woodrow Avenue, Butts Lane, and New Wharf Avenue.

3.0 ADAPTATION OPTIONS AND CONCEPTUAL DESIGNS

Residents and business owners along the Yantic River are already dealing with frequent flooding. Unfortunately, the Yantic River is expected to flood more often and more severely going forward, putting lives, properties, and livelihoods at greater risk. Widescale action will be expensive. However, creating a vision for priority areas and resilient corridors drives opportunity for strategic action.

The Plan provides three adaptation options informed by the Resilient Connecticut PERSISTS decision support criteria as well as stakeholder engagement. Trade-offs and areas of conformance with local plan and policies are also presented.

3.1 Priority Areas and Resilient Corridors

Discussions with the community, SECOG, and CIRCA identified the Town Street corridor as a logical resilient corridor for focused development of flood mitigation alternatives. This corridor suffered flood damage during the January 2024 flooding, as shown in **Figure 24**, and hosts numerous businesses that are key to the fabric of the community, including an important grocery store and health care facilities. Running parallel to CT Route 2 within the Study Area, Town Street's closure is anticipated to create an insurmountable obstacle for emergency vehicles to traverse the area. However, Town Street is the main local road connecting several important emergency services. This includes the Backus Hospital, the fire station, and other healthcare facilities, including urgent care facilities and specialty medical providers.

Figure 24. Flood impacts from January 2013
Source: The Norwich Bulletin (https://www.norwichbulletin.com/picture-gallery/news/local/2013/06/29/flooding-in-eastern-connecticut/363734007/)

3.2 Flood Mitigation Options for Buildings

Numerous buildings in the Study Area are subject to flooding. This includes portions of Norwichtown Commons and Backus Hospital. **Table 8** provides a summary of potential mitigation alternatives that might be employed at buildings. Many of these are applicable to multi-story buildings or residential buildings but may not be appropriate or practical for large one-story retail buildings.

As these types of measures need to be tailored to the site-specific constraints of an individual building and are likely to be funded by individual property owners, they were not a major focus area for the development of conceptual design.

Table 8. Flood mitigation options for buildings, structures

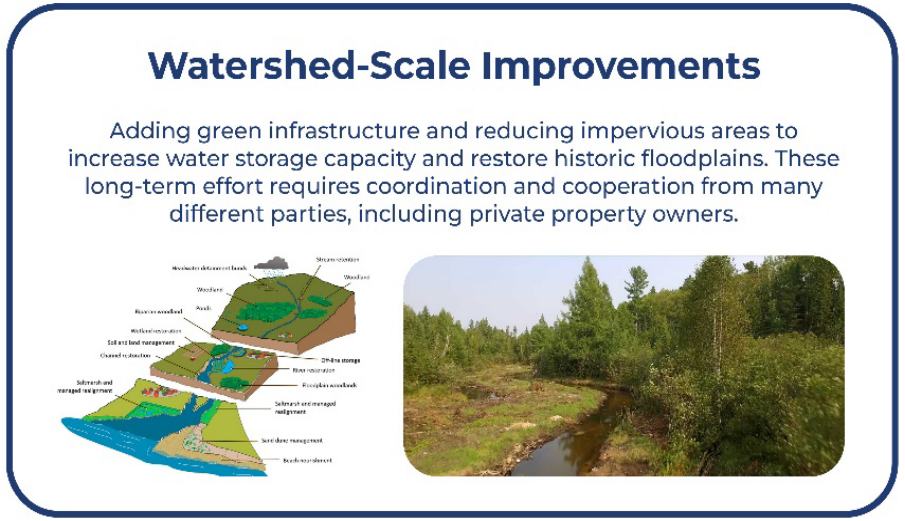
Mitigation Alternative	Applicability	Funding Source
Basement sump pumps Unlikely to mitigate flooding for major floods but helps reduce flood duration and mitigate minor flooding.	Residential or Non-residential Properties	Private owners
Relocate critical equipment above flood levels Elevation on blocks or relocation (e.g., to the roof) helps a structure be usable again faster and reduces losses due to flooding	Residential or Non-residential Properties	Private owners, federal grants
Wet floodproofing measures for unoccupied ground floors Measures that allow floodwaters to enter and exit an area designed and constructed to resist damages from flooding. Floodproofed areas are usable only for parking, storage, and access.	Residential or Non-residential Properties	Private owners, state/federal grants
Dry floodproofing measures Measures to make a structure watertight (i.e., sealants temporary or permanent flood shields, etc) so that floodwaters cannot enter. Some options may require active human intervention, prior to an anticipated event. Best suited for limited areas of shallow (<3ft) water depths and slow-moving water.	Non-Residential Properties	Private owners, state/federal grants
Raise/elevate buildings Raising the structure above the base flood elevation, with consideration for additional freeboard to account for future conditions. (Can often be cost-prohibitive for single-story commercial structures.)	Residential Properties (generally)	Private owners, state/federal grants
Managed retreat Relocating to areas without significant flood exposure. Existing structures are demolished and land is maintained for very limited use (often temporary use or given back to nature).	Residential or Non-residential Properties	City, state, federal

3.3 Large Scale Flood Mitigation Options

In addition to the building related flood mitigation options, several large scale projects were evaluated. Mitigation options involved a mix of both structural and non-structural approaches.

Upper Watershed Storage

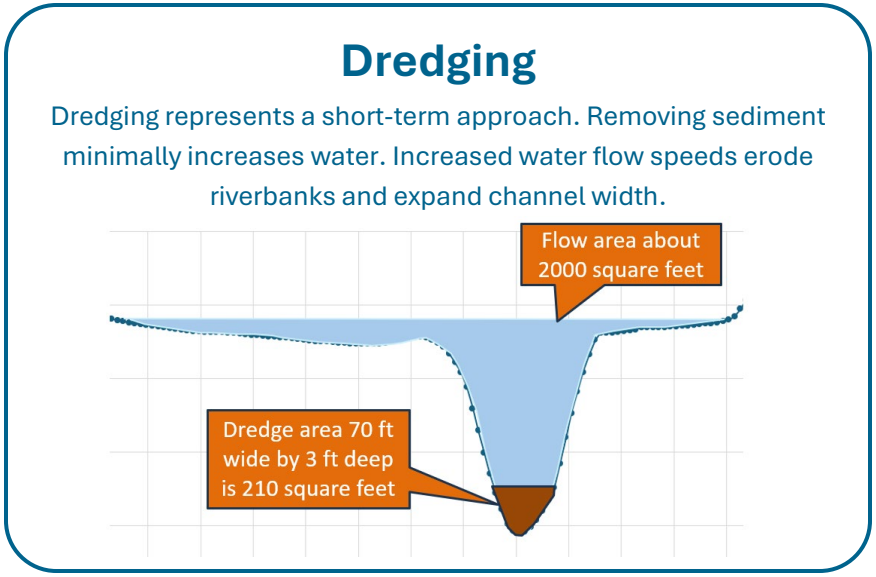
GZA performed a screening level assessment of upper watershed storage in the Yantic River Basin. The assessment included 30 parcels identified by the project's Technical Advisory Committee, located within the Towns of Bozrah and Franklin and the City of Norwich. Storage potential was evaluated using parcel area, and elevation within and outside of the 1% annual chance (100-year) floodplain. To provide an indication of how much upstream storage may be able to reduce downstream flood flows, available storage was compared to the January 2024 flood event. As only 90 acre-ft of additional storage was identified in the 30 parcels, and the volume of the January 2024 flood was approximately 11,000 acre-ft, this option was not advanced. Refer to **Appendix C** for the Flood Storage Analysis Memorandum prepared by GZA for additional details.



In addition, the possibility of using existing upstream dams as flood storage was something that was brought forward by the public during stakeholder engagement. Since most of the significant dams are privately owned and control relatively small portions of the watershed, this alternative was not considered to be viable in a short- or medium-term time frame. Additionally, none of the dams are currently used for flood control purposes, meaning that significant and likely costly modifications would likely be required for the dams to provide that benefit. These modifications may also run counter to the purpose of the dams, since flood control dams generally operate with limited normal pool storage that might limit their use recreationally.

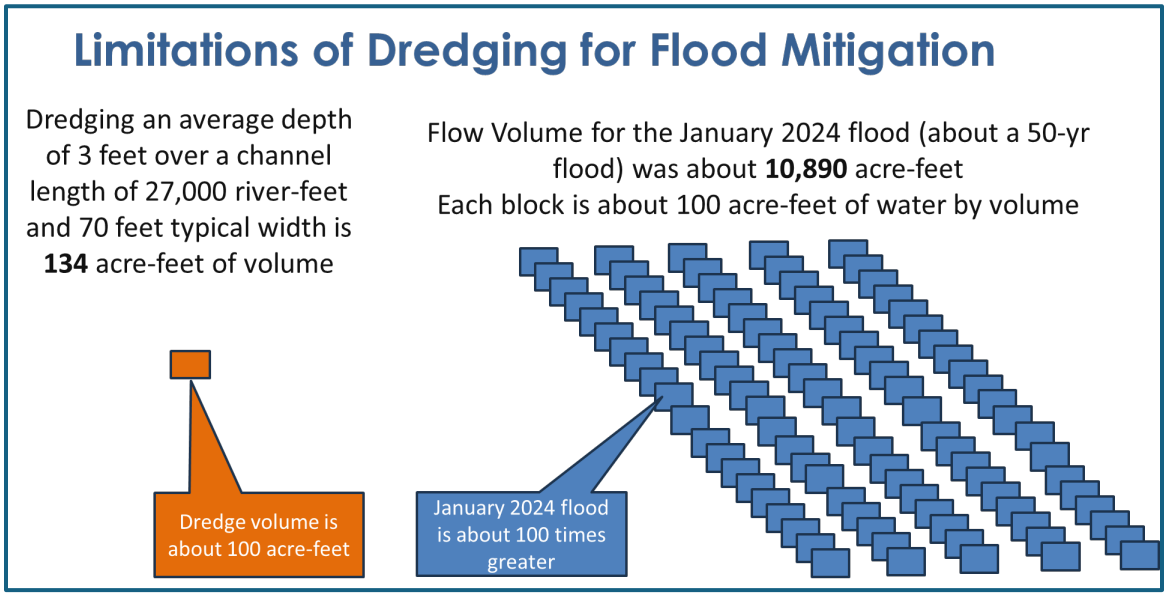
Dredging

Dredging involves removing deposited sediment from the river channel. Sediment typically accumulates in areas of decreased velocities, such as upstream of dams. Dredging can increase river channel capacity by adding flow area. While effective for accommodating 'normal' flow conditions, dredging only increases flow capacity within the channel, and does not impact flow outside of the channel in the floodplains. Similar to the upper watershed storage evaluation, GZA compared the additional volume from dredging to the January 2024 flood event. Dredging an average depth of 3 feet over a river channel length of 27,000 feet and 70 feet typical width would add 134 acre-ft of volume. Compared to the 11,000 acre-ft flood volume in January 2024, dredging would not provide effective flood mitigation.



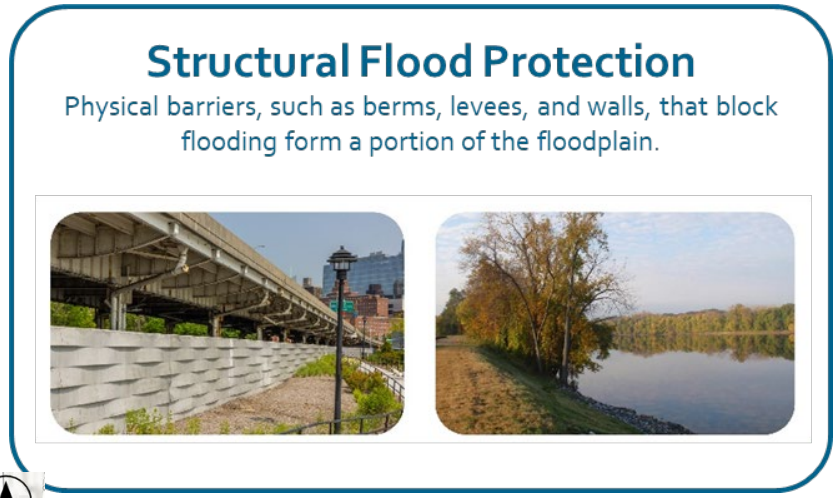
Additional disadvantages for the dredging alternative include:

- Dredging does not address the root cause of sedimentation build-up
- Dredging provides relatively short-term benefits since sediment is very likely to accumulate again
- Permitting may be cumbersome since dredging would disrupt the stream bottom, which is considered a potentially important ecological resource area
- Grant funding is not likely to be available for dredging projects.



Structural Flood Protection

Structural flood protection, such as a berm or flood wall provides a physical barrier that blocks flooding from the floodplain. This Plan evaluated a flood barrier on the left bank of the Yantic River between the New London Turnpike and CT Route 2 with the goal of protecting the Town Street corridor. GZA evaluated both a flood wall along the existing bank and a vegetated berm offset from the River between the bank and Town Street. Although both structures proved effective in keeping Town Street out of the flooding, this option was not favorable with the TAC, since the structure would need to be up to 11 feet high to protect against the 0.2% annual chance (500-year) flood, and would require buyout of the properties between the Yantic River and Town Street.



Additionally, the majority of structures between Town Street and the Yantic River would need to be acquired to have space to construct structural flood protection in this area. As shown in **Figure 25** (left), five properties would need acquired to construct a five-foot high floodwall and seven structures would need acquired to construct a ten-foot high floodwall. In order to construct a berm with stable slopes, a total of 20 structures would need to be acquired to make space for construction.

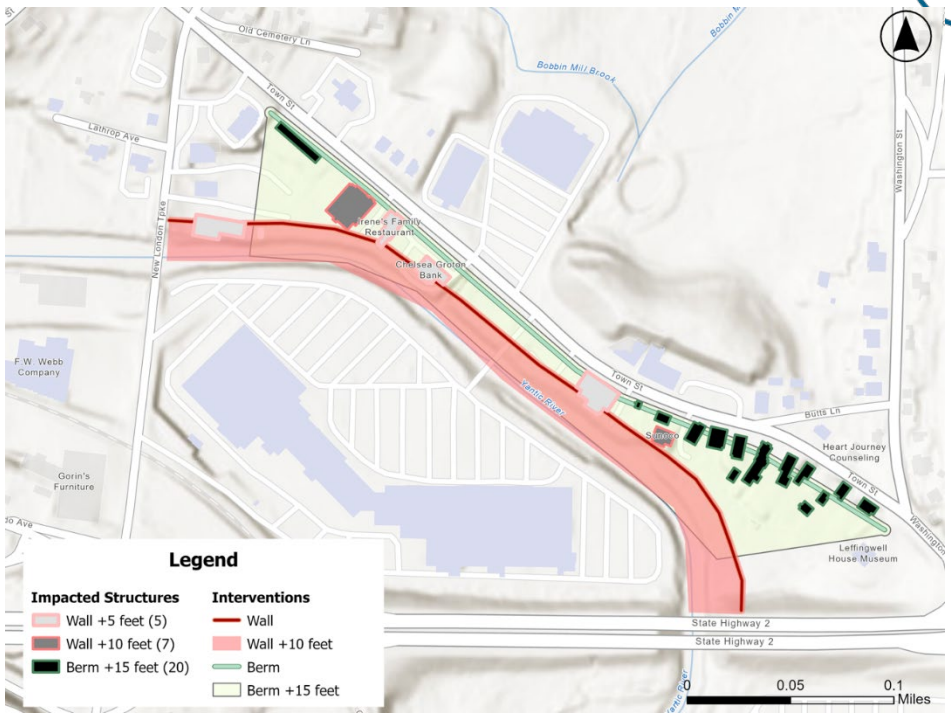


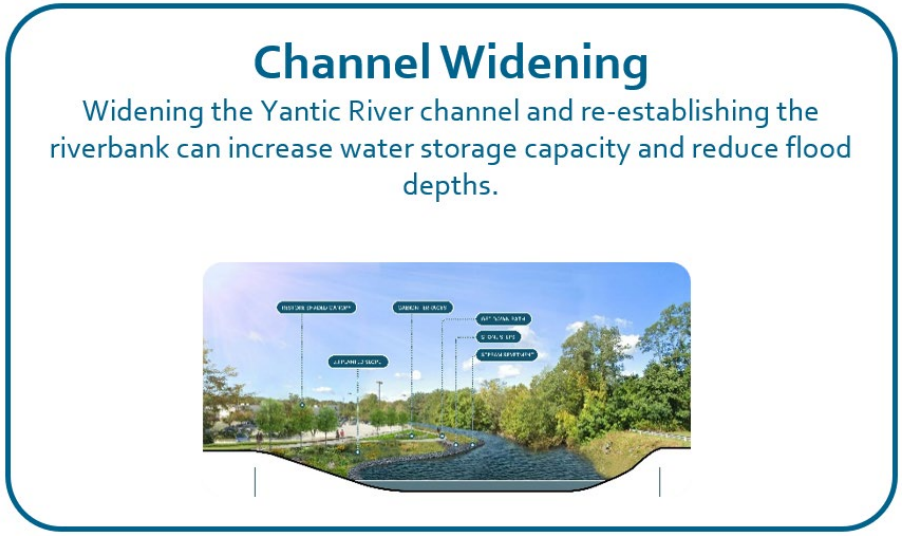
Figure 3.3: Impacted Buildings from Structural Flood Protection

Bridge Widening

Bridges and culverts often act as hydraulic controls, since the structure opening is smaller than the river channel. Increasing structure openings, such as bridges or culverts, can reduce flow impediments. GZA reviewed the FEMA flood profile in the vicinity of the CT Route 2 bridge, and there appeared to be some flow restriction at the bridge, with the headwater being greater than the tailwater. GZA modeled a proposed bridge with a width matching the existing river channel, so there would be no flow constriction. While this did reduce flood depths in the area between the New London Turnpike and CT Route 2, it did not provide significant impacts. Additionally, since the bridge is owned by CTDOT, modifications or reconstruction of the bridge may be more challenging than if it were City owned. It should be noted, however, that the New London Turnpike is in the process of being replaced, so there may be potential for discussions with the City.

Channel Widening

A similar concept to bridge widening, channel widening increases the hydraulic capacity of the river, which keeps flooding in the channel and out of the floodplains. The concept of channel widening was first suggested by a community member during an outreach event. GZA modeled the impact of widening the Yantic River channel between the New London Turnpike and CT Route 2, and found that increasing the hydraulic capacity of the channel provides a significant reduction in flooding in the Norwichtown Commons and Town Street areas.



Dam Removal

Dams act as flood retention structures by storing flow in the impoundment and regulating flow downstream. While dams can reduce water levels downstream, they may increase water levels upstream by restricting the free-flowing river. In addition to potentially reducing flood depths upstream, dam removal projects remove dam safety hazards and provide significant ecological benefits. Falls Mill Upper Dam is located in the Study Area, approximately 5,000 feet downstream of CT Route 2. GZA modeled the removal of the dam and found that water levels are reduced during post-removal conditions.

Managed Retreat

Communities can reduce flood risk to their homes, businesses, and infrastructure by moving to higher ground, out of the way of recurrent flooding. A voluntary relocation program would incentivize property owners to sell their property in the flood hazard area and relocate to higher ground.

3.4 Alternatives Analysis

The flood mitigation options in Section 4.3 were evaluated using the following criteria: flood risk reduction, anticipated cost, solution duration, maintenance, and environmental stewardship. Note that results of the analysis do not necessarily indicate an alternative that was not selected for advancement to concept design is inherently infeasible. Alternatives not selected may require further evaluation or information, require additional outreach to private entities or state agencies, or require a longer timeframe or larger funding sources. The results of the alternatives analysis are presented below in **Table 9**.

Table 9. Alternatives Analysis

Flood Mitigation Option	Flood Risk Reduction	Anticipated Cost	Solution Duration	Maintenance	Environmental Stewardship	Funding Sources
Dam Removal	Low to Medium	Medium	Long	Low	High	State, Federal
Channel Widening	Medium	High	Medium	Low to Medium	Low	State, Federal
Managed Retreat	Very High	Medium to High	Long	Low	High	State, Federal
Structural Flood Protection	High	High	Long	Medium to High	Low	City, State, Federal
Bridge Widening	Medium	Very High	Medium	Medium	Low	State, Federal
Dredging	Low to None	Medium to High	Short to None	High	Very Low	City
Upper Watershed Storage	Low to None	Medium to High	Long	Low	High	City & Town

Based on the alternatives analysis, the top three options are dam removal, channel widening, and managed retreat. A discussion of each option with conceptual designs is presented below.

3.5 Preferred Options and Conceptual Designs

This work is based on the recognition that more intense and frequent flooding along the Yantic River, and elsewhere in the region, is expected in the future. The three adaptation options presented in this section are: widening the river channel, removing the Upper Falls Dam, and managed retreat following channel widening.

Concept 1: Channel Widening

The first concept evaluated widening the Yantic River channel to increase hydraulic capacity. The proposed widening would occur in the vicinity of the Norwichtown Commons between the New London Turnpike and CT Route 2. This 120-foot-long segment of the Yantic River is approximately 90 feet wide, with vegetated side slopes approximately 3H:1V, as shown in **Figure 25**.

Figure 25: Existing Yantic River Channel

The Project Team evaluated widening the southern channel bank by 50 feet towards the Norwichtown Commons. The maximum allowable widening was restricted to due to the vicinity of the northwest corner of the Stop & Shop building to the river. A distance of 20 feet was preserved between the Stop & Shop building and the channel extent to allow access for emergency vehicles, but this distance must be reevaluated and confirmed during future design phases. The proposed layout is presented in **Figure 26**.

Channel widening is expected to reduce the parking area by approximately 40,600 ft^2, eliminating 19% of parking spaces. However, the widened channel can be used as community-oriented waterfront access space during non-flood events, as shown in **Figure 27**.

Note that proposed channel widening does not include adjusting the bridge openings at the New London Turnpike and CT Route 2. With the channel widening, it appears that the CT Route 2 bridge would still act as a minor hydraulic constriction, backing up approximately a foot or so of water into the area. However, given the state ownership of the roadway/ bridge, it would create a more complex and expensive project to widen the bridge. This may be further considered in future phases of this work.


CHANNEL WIDENING: Proposed Strategy
PROJECT LIMIT
TOWN ST
TOWN ST
NEW LONDON TURNPIKE
30'
50'
WIDENING EXISTING RIVERBANK
PROJECT LIMIT
VETERANS OF FOREIGN WARS HWY
2
Existing Riverbank
Proposed Riverbank
100-yr Floodplain After Channel Widening
*GZA Modeled
0 50 100 FEET
N

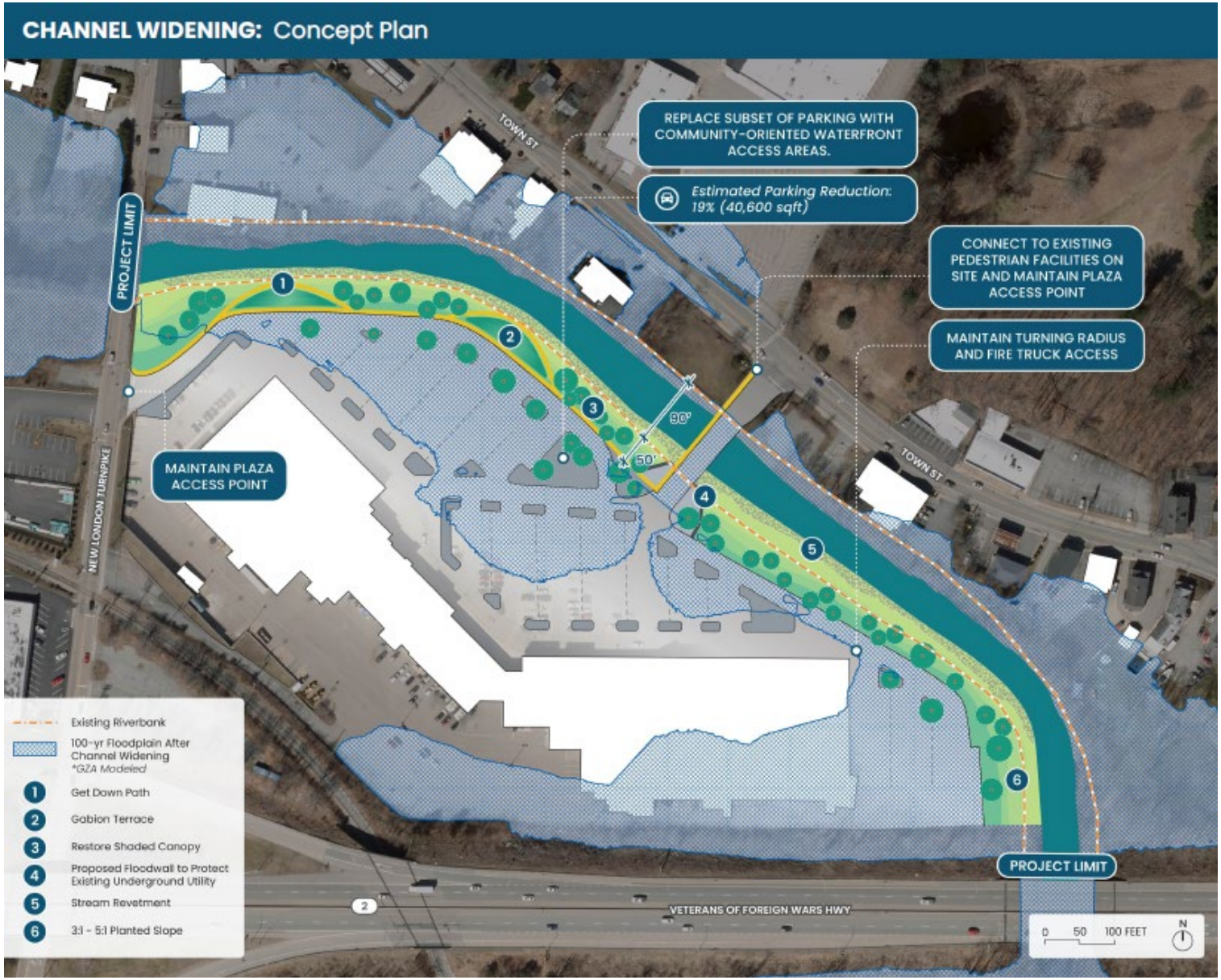


Figure 26: Proposed Channel Widening Layout

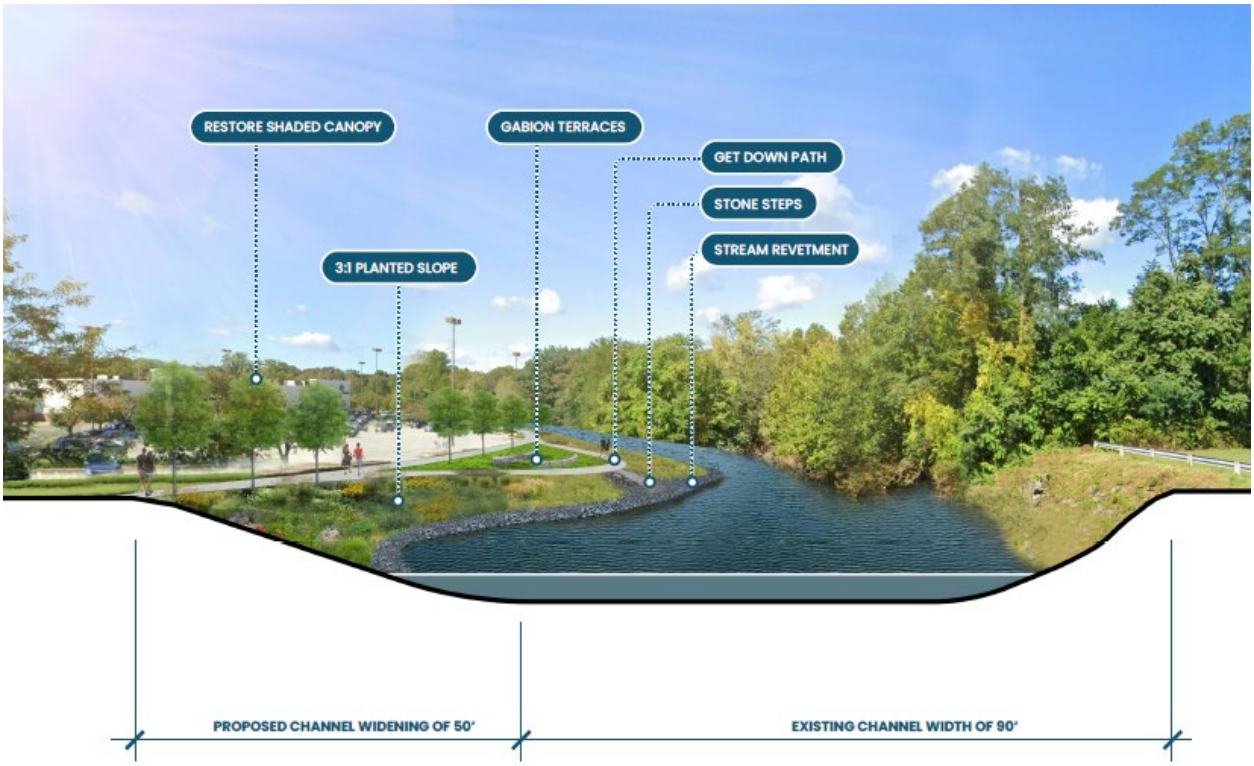


Figure 27: Proposed Channel Widening Section View

The proposed channel widening is expected to decrease flood depths in the Norwichtown Commons and Town Street Corridor by increasing hydraulic capacity in the river. Modeled flood depths for the proposed conditions are shown in **Table 10**.

Table 10: Channel Widening Flood Depths (ft)

Condition	FEMA 100-yr		FEMA 500-yr	
	Norwichtown Commons	Town Street Roadway	Norwichtown Commons	Town Street Roadway
Existing Conditions	2 to 5 ft	1 to 3 ft	6 to 9 ft	Up to 8 ft
Channel Widening	1 to 2 ft	1 ft	5 to 7 ft	Up to 6 ft

The proposed channel widening reduces flood depths in the Norwichtown Commons and significantly reduces the inundation area, with only a portion of the Norwichtown Commons building remaining in the flood area during the 1% annual chance (100-year) flood. Flooding along the Town Street roadway is expected to be reduced to only a minor and shallow flooded area, which could be addressed as needed with a low berm adjacent to the low section of the roadway.

Although flood depths are expected to decrease during the 0.2% annual chance (500-year) flood, there is still expected to be significant flooding in the Norwichtown Commons and Town Street roadway due to the large magnitude of the flood.

Summary: This alternative has potential to reduce the flood depths and, therefore, the flood risk in the area. However, this alternative should not be considered to be a flood protection solution. Proactive planning and action is still required to safeguard lives and property within the area in the event of a large flood because

flooding will still exist. In the future, floods are anticipated to become more severe, which also will reduce the effectiveness of this alternative.

Modeled flood depths for the proposed channel widening are presented in **Appendix B**.

Concept 2: Falls Mill Upper Dam Removal

The second alternative evaluated in depth is the removal of the Falls Mill Upper Dam. The Falls Mill Upper Dam is located approximately 1,300 feet downstream of the Sherman Street crossing, and is owned by the City of Norwich. A masonry dam built in 1910, the structure is approximately 75 feet-long and has a maximum structural height of 10 feet. According to the CTDEEP, the dam is classified as Hazard Class BB: Moderate Hazard Potential. Per Section 22a-409-1 of the Regulations of Connecticut State Agencies, failure of a Hazard Class BB dam may result in damage to normally unoccupied storage structures, paved local roadways, and may result in moderate economic loss. The dam experienced elevated water surface levels during the January 2024 flood, as shown in **Figure 28**.

Figure 28: Falls Mill Upper Dam during January 2024 Flood
(Photo Credit: CT Division of Emergency Management and Homeland Security

GZA visited the dam site on July 31, 2025. A portion of the downstream masonry wall has partially collapsed, and flow is leaking through the bottom of the collapsed section (**Figure 29**). The structure appears to be in poor condition, and presents a dam safety concern for the downstream area.

Figure 29. Falls Mill Upper Dam

For dam removal projects, the following alternatives are typically evaluated alongside dam removal to reinforce that removing the dam is the appropriate decision:

- No action: No action is not a feasible alternative to dam removal because the dam is in apparent poor condition and does not comply with Connecticut Dam Safety regulations. The City of Norwich has reportedly been contemplating removing the dam for some time since it no longer serves a significant purpose.
- Dam repair and rehabilitation: Repairing the dam such that it is in compliance with Connecticut Dam Safety regulations would likely entail the following (at a minimum):
    - Detailed visual inspection and evaluation of the outlet works associated with the former mill on the left side of the dam;
    - Hydrologic and hydraulic analysis to evaluate spillway adequacy;
    - Structural stability analysis to evaluate stability of spillway and abutments;
    - Subsurface explorations to evaluate the foundation conditions for repair alternative development;
    - Design and implementation of dam rehabilitation measures to address:
        - Poor condition of spillway and apparent structural instabilities;
        - Unknown condition of outlet works (abandon or replace);
        - Installation of a reliable low level outlet;
        - Other rehabilitation measures as needed to resolve inadequacies related to spillway capacity and stability.

Based on GZA's experience with similar projects, rehabilitation of the dam would likely resemble complete reconstruction given the dam's apparent poor condition. Such a project would be extensive in scope, requiring large-scale engineering and permitting efforts, and approach or exceed $1,000,000 to accomplish from design

to construction. In addition, ongoing maintenance would be required to keep the dam in satisfactory condition, perform required periodic inspections, and emergency action planning.

The Project Team assessed how removing the dam would reduce flood risk in the Study Area. The hydraulic model described in Section 1 was used to evaluate the impact on flood depths incurred by removing the 75-foot-long masonry spillway structure. **Figure 30** shows the expected water level reduction in the vicinity of the dam post-dam removal during the 1% annual chance (100-year) flood.

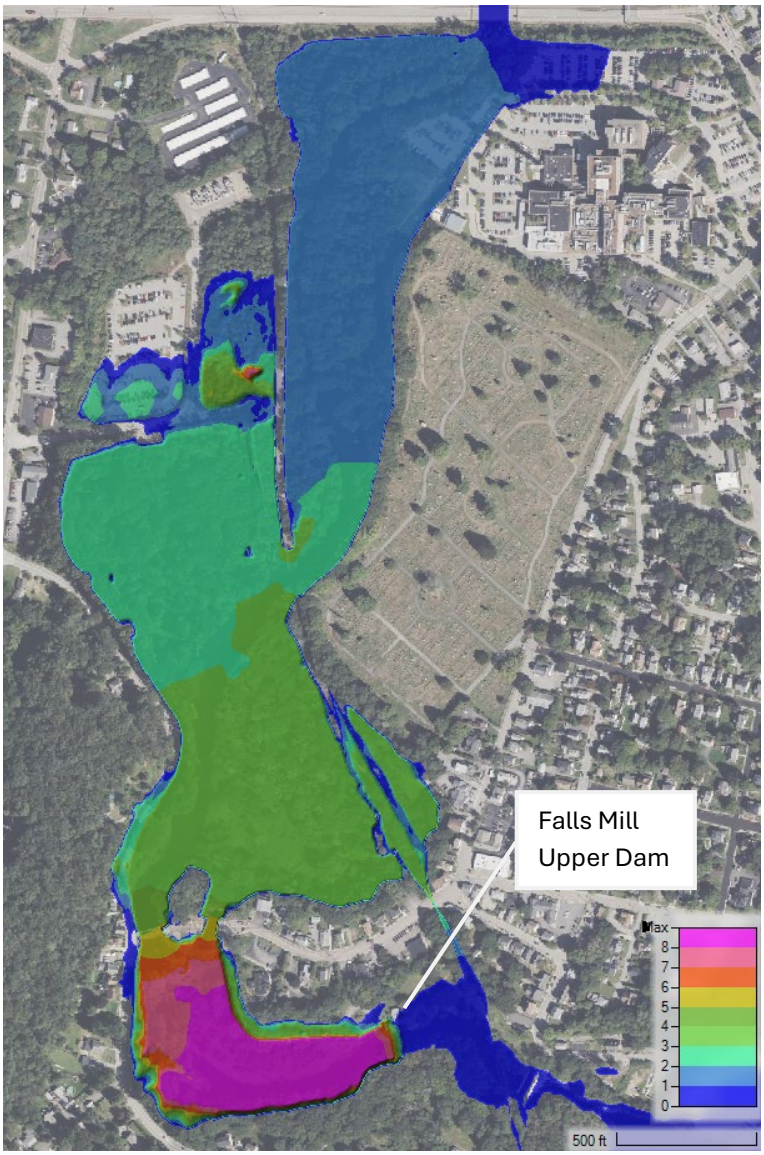


Figure 30: Falls Mill Upper Dam Removal Water Level Reduction 1% annual chance (100-year)

Although the highest magnitude of flood reduction benefits occur between the dam and the Sherman Street crossing, reduction in flooding of up to 1 foot is seen upstream of the dam, extending to CT Route 2 and the Backus Hospital. The flooding encroaching on Asylum Street is eliminated during the 1% annual chance (100-year) flood.

In addition to flood risk reduction, the removal of the Falls Mill Upper Dam provides the following benefits:

Eliminates liability for potential dam failure: given the current poor condition of the dam, there is a possibility of dam failure, which could lead to an uncontrolled release of water downstream. The owner of the dam (City

of Norwich) is liable for an downstream damage caused by a failure of the dam. Removing the dam would eliminate any future liability associated with dam failure.

Eliminates long-term dam safety repair and maintenance costs: if the dam is not removed, repairs must be made to address the current deficiencies. Given the age of the dam, there is potential for more deficiencies in the future. There are additional maintenance costs associated with the dam, including inspections and emergency action planning. Construction costs for dam removal are typically less than a full rehabilitation.

Restoring section of Yantic River to free-flowing conditions is a positive environmental benefit: dams act as an ecological barrier to anadromous fish species. After the dam is removed and the stream channel is restored, much of the impoundment area will be restored as riparian habitat. Fish species currently present downstream of the dam will gain access to new foraging and breeding habitat. In addition to increasing habitat for the fish species, removal of the dam is likely to increase the overall biodiversity of the fishery in the affected section of the river. Increased biodiversity is a positive effect that is commonly observed following dam removal.

The proposed dam removal also includes revitalizing the park area near the dam. The existing mill structure at the left abutment would likely remain, which would be connected to a new river overlook consisting of reclaimed dam materials. In addition, the dam removal project would also revitalize the Yantic Dam Trail (**Figure 33**).

Figure 31: Falls Mill Upper Dam Existing Conditions Layout

Figure 32: Pre-and Post-Dam Removal Concept

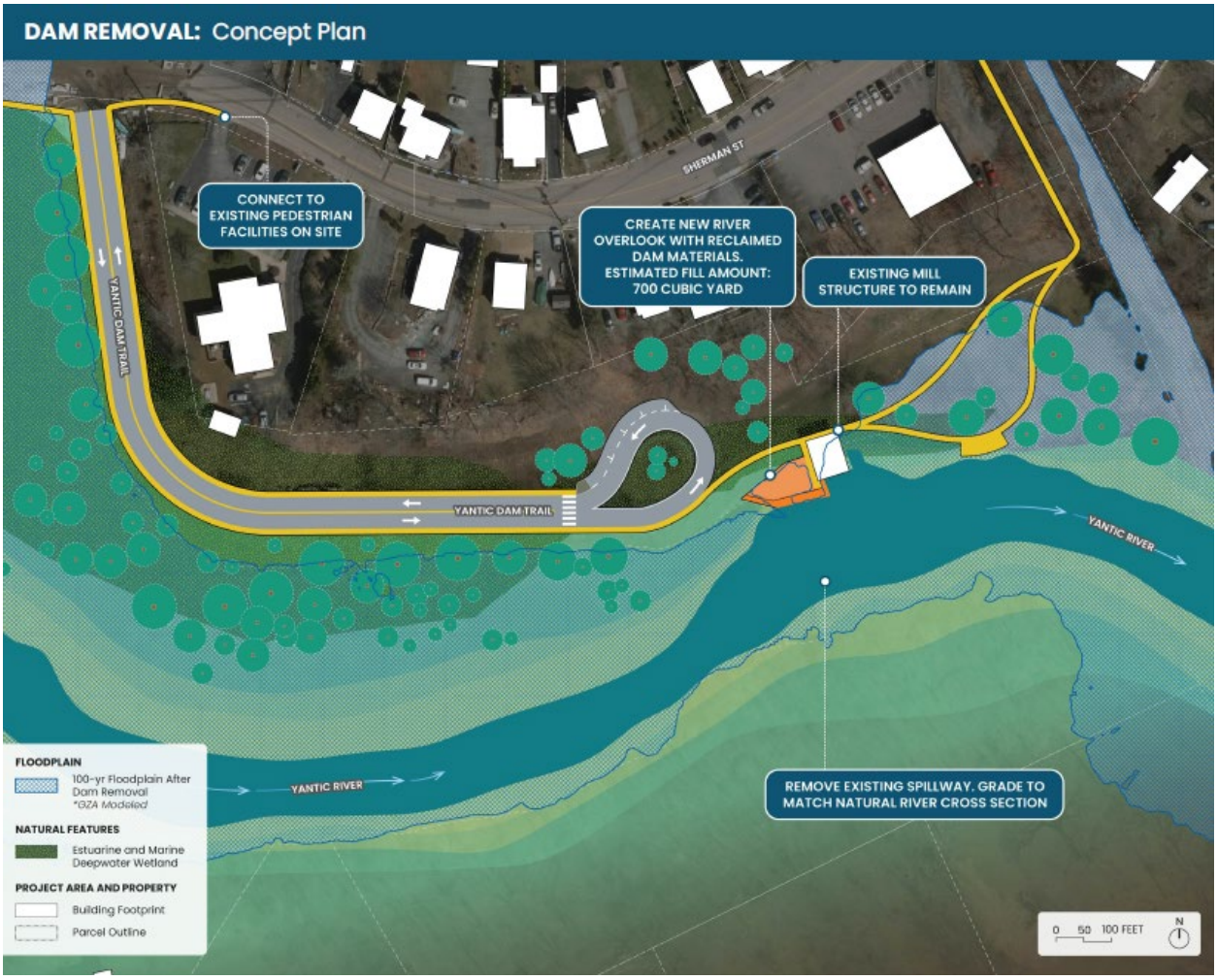


Figure 33: Upper Falls Dam Removal Layout

The next phases for the dam removal option would be to complete a feasibility study, which would consist of evaluating sediment upstream of the dam (identifying the extent of impounded sediment volume,

characterizing the sediment quality, assessing the limits of sediment stabilization and removal), performing preliminary engineering evaluation, and furthering the design of the breached section, local river restoration, and sediment stabilization. Other considerations include permitting, which would include an array of required local, state, and federal permits, and performing additional community outreach with a focus on the abutters of the dam and impoundment. The feasibility study would include an alternatives analysis, which would consider repairing the dam, or taking no action. Project deliverables from the feasibility study would include the final report, existing and proposed conditions drawings, and a benefit-cost analysis (BCA).

A preliminary BCA for the dam removal project is presented in Section 5.2. A BCA for the other dam alternatives (dam repair) was not included in this plan, however, the BCA for a dam repair is expected to be less than one, since there are no flood reduction or ecosystems benefits associated with dam repair.

Concept 3: Managed Retreat

Community-led managed retreat is a proactive, planning approach to move people and property out of areas with severe flood exposure.[35] It is a voluntary alternative and the details should be further developed with the community.

Managed retreat represents an approach, process, and set of policy decisions intended to remove current development and discourage future development or redevelopment in high risk regions, primarily through property buyouts administered by local, state, or federal governments. Buyout properties are restored to open, green space, in perpetuity. In certain circumstances, temporary program or use may take place. A high level overview of the managed retreat process is shown in **Figure 34**.

Figure 34. General steps in a community-led managed retreat process

Data Source: The Nature Conservancy and University of Delaware, "Floodplain Buyouts: Challenges, Practices, and Lessons Learned" (August 2021)

Depending on the scale of the effort, a program can be accompanied by broader policy and land use regulations, relocation assistance, and a plan for receiving the people and businesses who decide to move. Considerations for the scale of intervention are noted in **Table 11**.

Table 11. Relocation approach by scale

Scale	**Relocation Approach**
Regional (multiple jurisdictions)	Comprehensive **approach to mitigate broad scale risk** from hazards, often flooding or fires. Considers development and long-term planning for at-risk communities and receiving communities.
Municipal (single jurisdiction)	Broad **land use regulation (or policy strategy)** to minimize risk by shifting development patterns across a city or within single municipal boundary.
Neighborhood (single jurisdiction)	Narrowed to a smaller impacted area (even a single parcel). The process encompasses two main elements: an acquisition or **buyout** and **relocation**.

[35] Administered at the state, county, or local level, managed retreat, community-led relocation, or managed retreat, refers to a process where a government purchases or "buyouts" a property or set of properties (generally at pre-storm fair market value) from willing sellers, demolishes existing structures on the property, and prohibits future development (i.e., through deed restrictions or a conservation easement).

	A **real estate transaction**, where a government purchases property (may not always include relocation assistance) from a willing seller, demolished existing structures, and prohibits future development. It is supported by some **policy incentives** to move people to safer grounds.

Historical Examples

There is a long history of moving to higher ground across the United States:

- Earliest origins in riverine floodplain management along the Ohio, Missouri, and Mississippi Rivers, often led by NGOs such as the Red Cross.
- In the 1960s, the U.S. National Flood Insurance Program began to incentivize relocation by offering funding for voluntary property buyouts following federally declared disasters.
- Managed retreat emerged in the mid-20th century as a response to repeated flooding in vulnerable areas, such as farmlands and areas behind dams.
- While contemporary programs are mostly implemented after disasters, this practice has begun to shift toward proactive approaches as pre-disaster mitigation.

Managed retreat has been implemented in Connecticut. Making landfall as a Category 3 Hurricane on Long Island New York on September 21, the Great New England Hurricane of 1938 left widespread damage across the New England coast.[36] One of the most destructive events along this coastline, the Great New England Hurricane killed 682 people, destroyed more than 57,000 homes and caused property losses of well over $306 million (around $4.7 billion in 2024).[37]

[36] "Hurricane 1938 Aftermath". *The PBS Network*. Retrieved October 10, 2021

[37] Scotti, R. A. "Sudden Sea – The Great Hurricane of 1938". Boston: Little, Brown & Co., 2003. Archived from the original on January 2, 2007. Retrieved November 30, 2007.

Figure 35. Impacts from the Great Hurricane of 1938 on Ocean Beach (New London, CT)
Source: University of Connecticut, Center for Land Use Education and Research

After the Great Hurricane, 200 damaged New London buildings, which had served as private beachside residences and businesses as seen in **Figure 35**,[38] were removed and replaced with Ocean Beach Park. Established in 1940, this public amenity included a municipal beach, boardwalk and other recreational amenities. A historic depiction of the park can be seen in **Figure 36.**

[38] Ebbin, Syma A., "Recounting the Hurricane of 1938: local memories of a regional disaster" (2008). Wrack Lines. 44.

Figure 36. Aerial view depiction of Ocean Beach Park; Source: University of Connecticut, Center for Land Use Education and Research

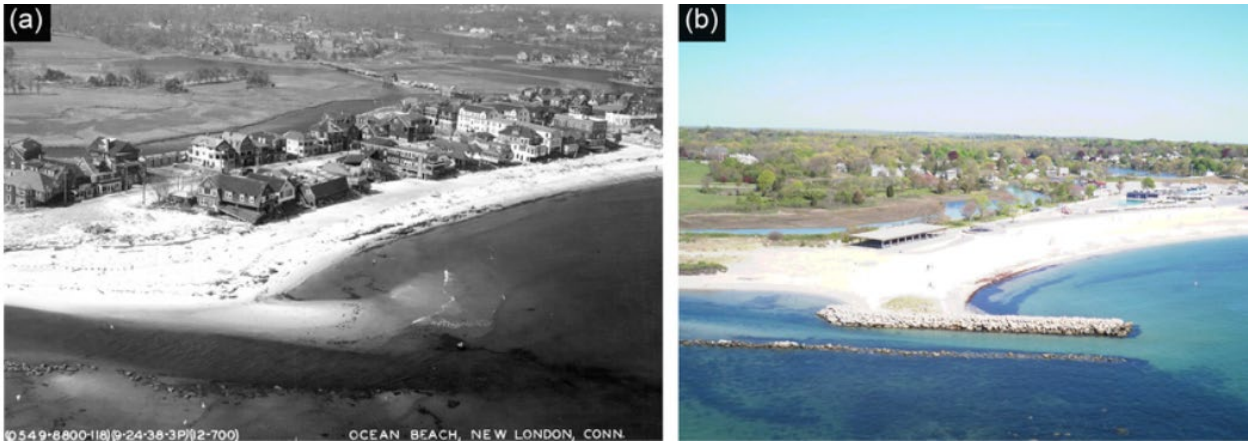


Figure 37. Before and after images of Ocean Beach Park, following the Great Hurricane of 1938

Source: Coastal Land Use Management Methodologies under Pressure from Climate Change and Population Growth; photo (b) taken in 2012.

Contemporary examples of managed retreat show how this practice can contribute to community revitalization. One such example is the City of Meriden and the State of Connecticut's acquisition of a flood-exposed industrial hub showing signs of abandonment and underutilization. While Meriden was a vibrant manufacturing center in the 1800s, by the mid-1900s a dramatic decline in the city's manufacturing base had left behind old, underutilized, contaminated buildings.[39] The City received $14 million in state and federal funds for various clean up and flood control measures at the 14-acre site of Meriden Green. Photos and depictions of the site are seen in **Figure 38** and **Figure 39**.

[39] EPA Region 1. "R1 Success Story: Meriden Green, Meriden, Conn." July 2023. https://www.epa.gov/brownfields/r1-success-story-meriden-green-meriden-conn

Figure 38. Master Plan of Meriden Green
Source: MacBroom, James and Arigoni, Mark. (2017) "Green Guardian." *The Magazine of the American Society of Civil Engineers*. https://www.civilengineering-digital.com/civilengineering/june_2017/MobilePagedArticle.action?articleId=1121361

Figure 39. Photos and depictions of the Meriden Green, following acquisition and redevelopment
Source: MacBroom, James and Arigoni, Mark. (2017) "Green Guardian." *The Magazine of the American Society of Civil Engineers*. https://www.civilengineering-digital.com/civilengineering/june_2017/MobilePagedArticle.action?articleId=1121361

Site clearance and restoration progressed over a decade, with a design process focusing on reducing flood risk and strengthening Meriden's downtown. The overall development timeline (same source as Figure 40) below provides insight into how a similar processes could unfold in Norwich.

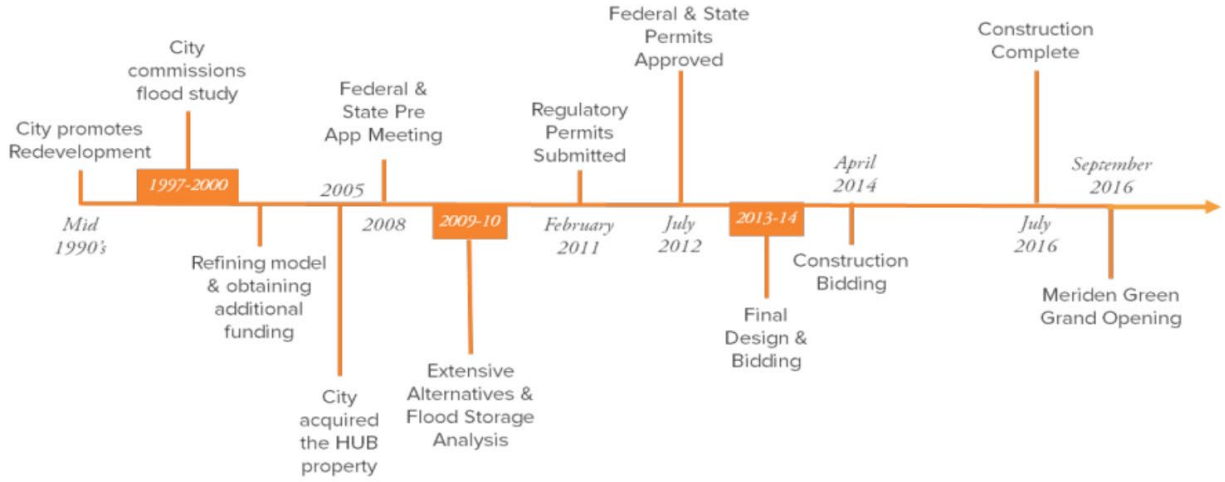


Figure 40. Managed Retreat Example Project Timeline

Elements of Managed Retreat

The Decision: While managed retreat is an effective way to reduce flood exposure, it's a deeply personal decision made by potential program participants. Residents and business owners, whether owners or renters, feel strong attachments to place and community, which relocation can threaten to disrupt. Heading into a new circumstance is challenging, costly, and time-consuming—even when financial and administrative assistance is provided. Buyout program administrators must be respectful of and responsive to that reality, no matter how prepared program participants may be. Local and regional governments considering implementing buyout programs should anticipate encountering heightened emotions.

Successful relocation programs are characterized by:

- Intensive community collaboration to assess interest, develop a shared vision for post-buyout land uses, and understand participant needs;
- Pre-disaster assessments of community need and risk identification;
- Voluntary buyout terms that are fair, transparent, and well-funded;
- Relocation plans that ensure affordability and opportunity, helping advance community goals;
- Equity, inclusion, and a shared vision;
- Utilization of existing tools and resources, including referencing support tools from FEMA, HUD, established relocation programs, academic institutions, and non-profit organizations, such as Buy-In.

Tradeoffs: A one-size fits all strategy does not work. Program details must align with the municipality's vision around growth, community needs, and regulatory and financial constraints. There are pros and cons to be considered when developing and administering a relocation program. Though not exhaustive, key tradeoffs are listed in **Table 12**.

Table 12. Tradeoffs for relocation

Benefits	Challenges
Risk reduction and public safety (local government and property owner).	Equity and justice concerns and general **community resistance.**
Cost reduction • Reduced municipal losses • Property owner cost savings (from damage, insurance premiums, or repetitive loss).	Financial implications • Reduced tax and other revenue (if relocation occurs outside of the original municipality). • Moving costs for property owner (if relocation assistance does not cover) • Delays and funding gaps can leave property owners in limbo.
Reduction in municipal service demand • Less dependence on emergency response services. • Less demand (and maintenance) for municipal infrastructure, resources, and services.	Program administration • Legal hurdles such as clearing property titles and coordination property appraisal for fair market valuation. • Can be a lengthy and complicated process. • Coordination across jurisdictions, navigating needs of diverse stakeholders.
Environmental restoration • Opportunity for sustainable planning. • Enhanced public access to shorelines, waterways. • Creation of new public space. • Creation of new habitat, green space.	Lack of desirable relocation sites/receiving communities or **relocation assistance** (financial or otherwise).

Steps for assessing interest: Assessing interest in retreat and relocation is the typical first step in a holistic, voluntary relocation process that aims to understand who, where, and how residents are impacted; their interest in relocation; and the support they'd need to move. It is important to understand who is impacted, their risk-reduction preferences, and the barriers or needs that inhibit relocation. It is important to convey that voluntary acquisition is being explored because, while the City has considered multiple options for reducing flood risk along the Yantic River, no one option studied significantly reduces or eliminates modeled flood risk along the river corridor.

An example of survey questions, which could be circulated online or used in door-to-door engagement, is included below, and demonstrates key community information needed to proceed with developing a buyout program. Any survey should be accompanied by in-depth education and outreach.

- What is your role in the community—property owner or renter, resident or business owner?
- How have you been impacted by flooding?
- Do you have flood insurance?
- How would you feel about moving to an area with lower flood risk through a relocation program?
- What is driving your response (whether for relocation or not)?

Based on the information gathered, prioritization criteria should be developed that guides the design of the program. For instance, the 32 parcels identified for voluntary acquisition and demolition under the Preliminary Concept have a wide range of ownership and uses, and a wide range of estimated acquisition costs. Prioritization criteria could guide the process and provide a transparent roadmap for interested parties.

Steps for administering a program: Local, county, and state government can administer programs if they have funding and capacity. However, more commonly, programs are administered via the federal government. Common elements are noted in **Figure 41**. Given the occurrence of the January 2024 flooding event, which resulted in a presidentially-declared emergency (Federal Register, 2024), taking a proactive approach to reducing flood risk before the next disaster occurrence is recommended.

Disaster declaration by state and then federal government (can be declared before the event, but usually a declaration occurs during an on-going disaster or within a few weeks)
Notice of funding (30 days) sent from state to local governments
Notice of intent or pre-applications submitted by local governments to state (1-2 months)
Formal applications submitted to state (6-18 months after event)
State review (3-4 months); Applications submitted to federal agency after review
Federal agency review (6 months-2 years)
Federal funding approval (funds released within 30 days after approval)
Home value appraisals (1-6 months; longer if disputed)
Environmental assessments / Historical preservation assessments / Asbestos abatement (1-3 months) (may occur as part of the application or at the same time as home appraisals)
Offer made to homeowners
Waiting period (3-4 months) to protect homeowners (18 months if renters are involved) (not all states) (90 day notice for residents to vacate)
Closing (if offer accepted, 1-3 months)
Demolition (within 90 days unless an extension has been approved)

Figure 41. Standard timeline elements for federally funded program for homeowners
Source: The Nature Conservancy and University of Delaware, "Floodplain Buyouts: Challenges, Practices, and Lessons Learned" (August 2021)

While this may be the end of federal responsibilities, depending on the program administrator, goals, and details, demolition may not be the final step. Other aspects include care and maintenance of the at-risk property, relocation assistance, and coordination with receiving site/community.

Funding sources: Common funding sources include:

- Federal: FEMA, HUD, USDA, SBA
- state budgets
- water conservancy or flood control districts
- water quality programs
- stormwater management fees
- government bond (e.g. resiliency/adaptation bond)
- environmental trust funds
- private partnerships

A more comprehensive discussion of potential funding sources is described in Section 6.

Recommendation: Establish a Managed Retreat Pilot

The City of Norwich and relevant stakeholders have an opportunity to build a more proactive approach to mitigate flooding for business owners and residents. Relocating out of harm's way could align with the City's vision for the future, supporting downtown development, expanding access to recreational space, and reducing flood exposure. A Managed Retreat program could support:

- Investment in infill housing development in nearby low-risk neighborhoods, providing safter local housing opportunities;
- Restoration of river access and establishing new places for recreation;

- Reduction of the burden on the emergency service providers and public works departments.

Key stakeholders should develop a comprehensive Managed Retreat program to address future impacts from flooding. However, the City could begin with a pilot approach at the highest-risk priority areas, such as the Norwichtown Commons and surrounds. This voluntary option gives residents, businesses, property owners, and renters the opportunity to safely and economically move out of harm's way, while staying in the community.

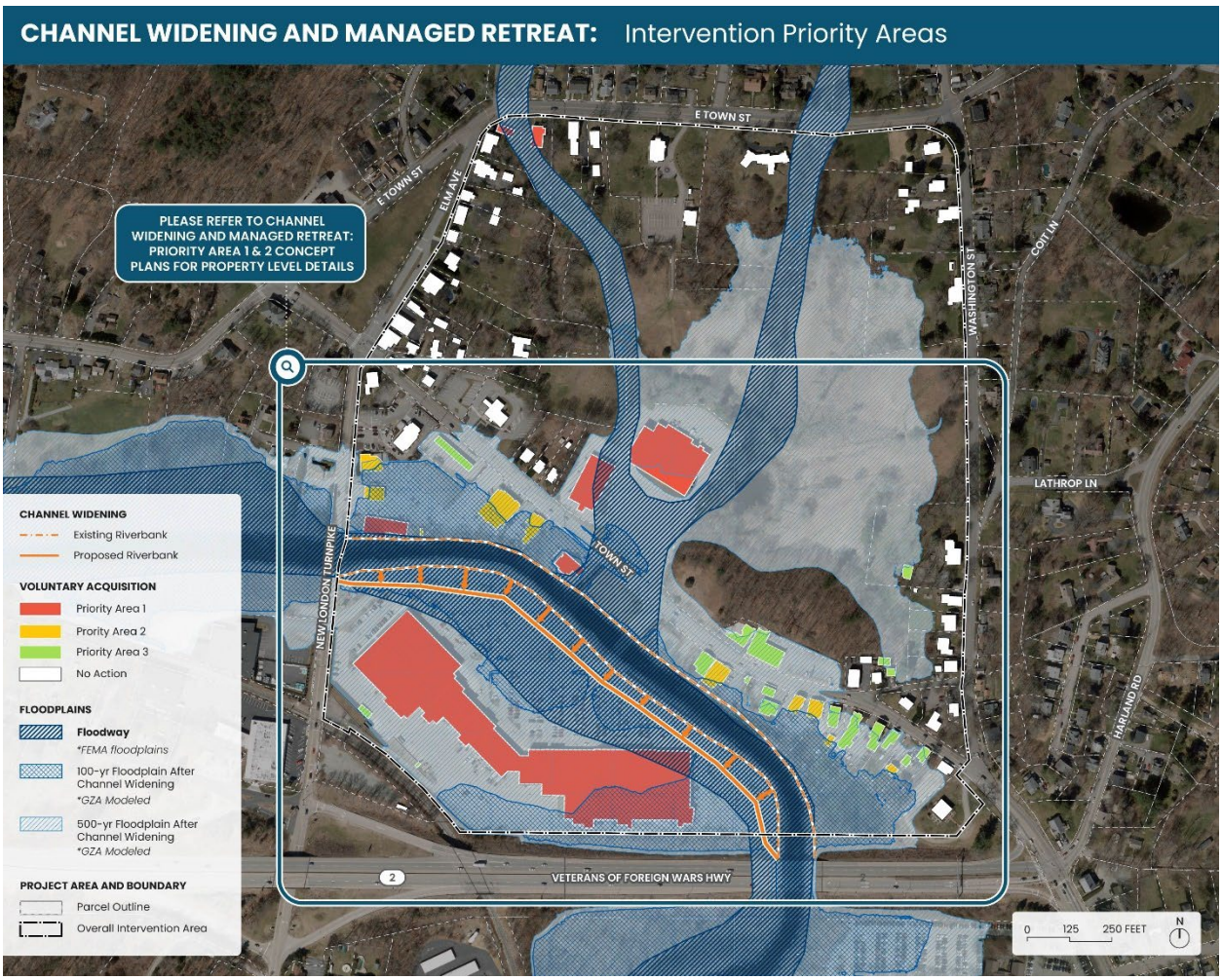
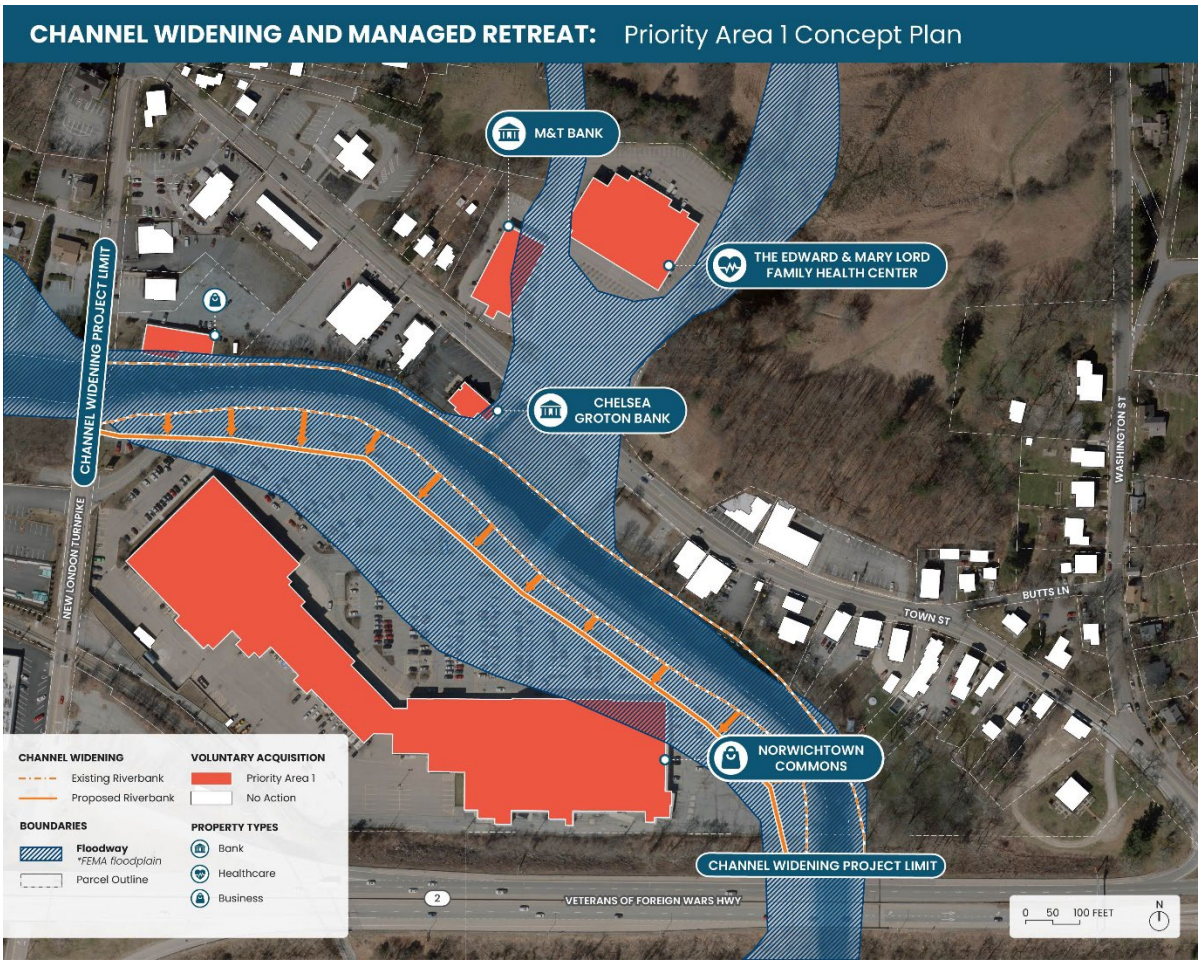


Figure 42. Proposed Managed Retreat Pilot approach

The proposed relocation option assumed completion of the channel widening option as the starting point, between New London Turnpike and CT-2. The approach is proposed below:

- **Priority Area 1:** Structures within the floodway: Seven parcels contain structures within the floodway, with Total Project Costs for removing those structures amounting to $44 million. Nearly 80% of those costs (approximately $35 million) are associated with the Norwichtown Commons holdings. About 12% of those costs are associated with the Edward and Mary Lord Family Health Center. Additional structures within the floodway include one bank, two commercial/retail establishments, and two residences.

- **Priority Area 2:** Structures within the 100-year (1% annual chance) floodplain: Nine parcels contain structures within the 100-year (1% annual chance) floodplain, with Total Project Costs for removing those structures amounting to approximately $3.6 million. 76% of these costs stem from the six commercial/retail structures, with average Project Costs per structure estimated at approximately $460,000. Two residential structures and one restaurant compose the remainder.
- **Priority Area 3:** Structures within the 500-year (0.2% annual chance) floodplain. Twelve additional parcels contain structures within the 500-year (0.2% annual chance) floodplain, with Total Project Costs for removing these structures amounting to approximately $5 million. About 57% of costs are associated with gas stations and auto repair facilities. Approximately 28% of costs are associated with residential structures, with average Project Costs for each of these six structures estimated at $228,000.



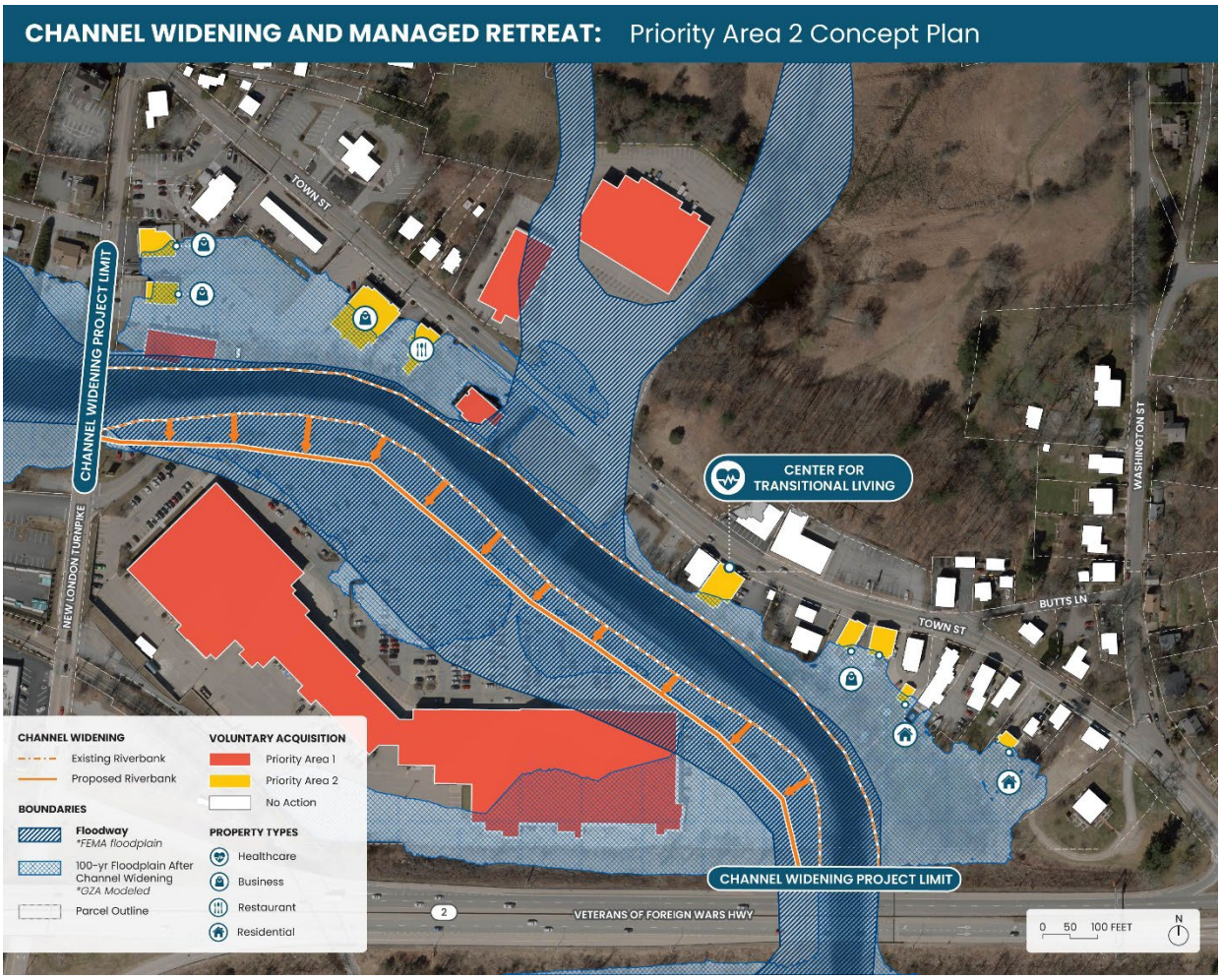


Figure 43. Managed retreat priority areas.

While large-scale managed retreat may not be feasible today given a variety of current constraints, there is an opportunity to be proactive with interventions that will address community flood concerns in the near future, and set the foundation for the community to reach their longer-term vision. Remember that relocation can be a long process. To pilot it, these steps should be considered:

1. **Align key leaders on managed retreat as an opportunity.** Identify important government leaders, align on objectives and garner their support.
2. **Assess interest and community vision.** Deep engagement, consistent coordination and trust must be the centerpiece of the work.
3. **Leverage the results of this report and broad effort, to put project sponsors in a better position to secure funding.** Work to identify key champions and actors prior to securing funding. Establishing a core team to push this work forward will serve the community when funding is awarded.
4. **Identify the "buyout" terms that make sense for the business community and interested parties.** Make sure to engage directly with the interested property owners to understand their needs. Conduct a transparent property assessment and set fair, transparent terms.
5. **Create a project administration plan.** Identify a team who can administer the effort from start to finish, and build a plan with the property owner in mind. Remember that this is a government service, treat it as comprehensively as any other development process. Customer service, timeliness, and replicable process will be important. A broader plan may consider three phases:

   a. Before a hazard event – To assess at risk sites, develop priority criteria, coordinate with potential applicants, and continue community outreach.
   b. During the transaction – To manage the real estate transaction, fund disbursement, and relocation services.
   c. After the transaction – To manage the at-risk site once the move is completed.

6. **Identify relocation terms and areas to receive displaced residents and businesses that make sense for the broader community and interested parties.** This should be rooted in understanding the needs of the city or community, and recognize that this can change as demand or funds rise. Additionally, if it aligns with pilot goals and project capacity, assess the receiving site to consider if it should be part of a broader land use, zoning, or development efforts.
7. **Identify what agency will manage at-risk properties, once and owner moves.** Consider the public safety aspects, demolition plan, and maintenance aspects.

4.0 PRELIMINARY BENEFIT-COST ANALYSIS

Each of the preferred flood mitigation options was evaluated using preliminary benefit-cost analysis (BCA). The FEMA BCA Toolkit v6.0 was used to score each of the projects based on the concept designs and publicly available information. A benefit-cost ratio (BCR) of 1.0 or greater is often considered to be a cost-effective project.

4.1 Concept 1: Channel Widening

Methodology

This analysis considers the mitigation action of widening the channel of the Yantic River between the New London Turnpike and CT Route 2. Analysis of the mitigation action is based on professional expected damages due to the limited availability of historical damages data. The professional expected damages option is used when a hazard event has not occurred, but if the event were to occur, the data shows how much damage would be likely (i.e. 100-yr flood). Analysis of benefits included a comparison of avoided damages (i.e., existing conditions damages less proposed conditions damages with a widened channel).

Analysis

Project Configuration

GZA selected 'Non-Residential Building' for the property structure type since the Norwichtown Commons and surrounding businesses are the most impacted type of structure. The hazard type is 'Riverine Flood' and GZA evaluated the 1% annual chance (100-year) flood consistent with most grant application criteria. Of the mitigation action types provided in the toolkit, 'Floodwater Diversion and Storage' was judged to best fit the channel widening concept. As previously stated, the damage and frequency relationship is based on 'Professional Expected Damages', as hydraulic modeling data was utilized in support of this analysis.

Preliminary Cost Estimation

GZA used the default value of 7.0% for the discount rate. The standard value of 25 years was selected for the useful life of a non-residential building project type. GZA preliminarily estimated the project cost to be approximately $1,800,000. A cost breakdown is included in **Table 13**.

Table 13: Channel Widening Cost Estimate

Item	Cost
Channel Widening	$1,000,000
Construction subtotal	$1,000,000
Engineering Design (30%)	$300,000
Contingency (50%)	$500,000
Total	$1,800,000

Professional Expected Damages Before Mitigation

GZA assessed the expected damages before mitigation by evaluating the impact of the 1% annual chance (100-year) flood, using the hydraulic modeling described earlier. GZA used FEMA Hazus Version 7.0 software to estimate economic loss associated with flooding. A value of $98,434,000 was used in the BCA as the cost associated with the 1% annual chance (100-year) flood based on this estimation. Hazus does not evaluate population at risk (PAR), so no costs associated with potential injury or loss of life was included in the analysis. Economic losses are associated with building loss, contents loss, inventory loss, relocation cost, income loss, rental income loss, wage loss, and direct output loss.

Professional Expected Damages After Mitigation

The damages after mitigation are limited to the losses due to the1% annual chance (100-year) flood in the Study Area, with the reduced inundation area from the channel widening. GZA used Hazus to evaluate losses in the Study Area associated with the effective FEMA 100-year flood inundation area. A value of $80,560,000 was used in the BCA for expected damages after mitigation.

Standard Benefits- Ecosystem Services

The channel widening project is not expected to provide any standard benefits to the ecosystem.

Results

The BCR is calculated by comparing the total project cost to the calculated annualized damages, which are converted to net present value using the default discount rate (7%). The BCR generated for the proposed channel widening using the BCA Toolkit and based on the assumption as stated in this memo is 1.16. With a ratio greater than one, the project is considered cost-effective. It should also be noted that while life loss is not included in the BCA (i.e., human life is not quantified by a dollar value), the project reduces the extents of flooding and depth of flooding, which would be anticipated to reduce the risk of life loss.

4.2 Concept 2: Upper Falls Dam Removal

Methodology

This analysis considers the mitigation action of removing the Upper Falls Dam in Norwich, CT. Analysis of the dam property and dam removal is based on professional expected damages due to the limited availability of historical damages data. Analysis of impacts included a comparison of damages due to a failure of the existing dam and proposed conditions without the dam.

Analysis

Project Configuration

GZA selected 'Other' for the property structure type since other available categories were not appropriate for a dam structure. The hazard type is 'Riverine Flood' since dam failure is assumed to occur during the 1% annual chance (100-year) flood event. The mitigation action type associated with the dam removal is 'Floodplain and Stream Restoration'. As previously stated, the damage and frequency relationship is based on 'Professional Expected Damages', as hydraulic modeling data was utilized in support of this analysis.

Cost Estimation

GZA used the default value of 7.0% for the discount rate. The standard value of 30 years was selected for the useful life of a floodplain and stream restoration project type. GZA estimates the initial project cost to be approximately $810,000. A cost breakdown is included in **Table 14**.

Table 14: Falls Mill Upper Dam Removal Cost Estimate

Item	Cost
Mobilization	$50,000
Water Control	$50,000
Erosion Control	$50,000
Spillway Removal	$150,000
Left Abutment Stabilization	$100,000
Site Restoration	$50,000
Construction subtotal	$450,000

Item	Cost
Engineering Design (30%)	$135,000
Contingency (50%)	$225,000
Total	$810,000

Note that a contingency of 50% was used due to the unknown condition of the sediment upstream of the dam. Annual maintenance costs are estimated to be approximately $5,000 for invasive species control.

Professional Expected Damages Before Mitigation

GZA assessed the expected damages before mitigation by evaluating the impact of dam failure. The impact of dam failure was assessed during the 1% annual chance (100-year) flood, using the hydraulic modeling described in Section 1. GZA utilized the FEMA Hazus Version 7.0 software to estimate economic loss due to dam failure. Hazus uses flood depth grids to estimate potential damages, economic losses, and social impacts from flood. A value of $101,337,000 was used in the BCA as the cost for dam failure based on this estimation. Hazus does not evaluate population at risk (PAR), so no costs associated with potential injury or loss of life was included in the analysis. Economic losses are associated with building loss, contents loss, inventory loss, relocation cost, income loss, rental income loss, wage loss, and direct output loss.

Professional Expected Damages After Mitigation

The damages after mitigation are limited to the losses due to the 1% annual chance (100-year) flood in the Study Area, as there would no longer be the potential for dam failure. GZA used Hazus to evaluate losses in the Study Area associated with the effective FEMA 100-year flood inundation area. A value of $93,850,000 was used in the BCA for expected damages after mitigation.

Standard Benefits- Ecosystem Services

The standard benefits include benefits to the ecosystem related to inland wetland areas created by the project. GZA modeled base flows in the system for existing and proposed conditions. The proposed conditions will convert a portion of the open water into vegetated wetland. The dam removal will contribute to the addition of 5.1 acres of inland wetlands.

Results

The BCR generated for the proposed removal of the Falls Mill Upper Dam using the BCA Toolkit and based on the assumption as stated in this memo is 1.66. With a ratio greater than one, the project is considered cost-effective.

4.3 Concept 3: Managed Retreat

Methodology

This analysis considers the mitigation action of building acquisition between the New London Turnpike, CT Route 2, and Town Street. The specific structures considered in the BCA are described above in Section 4.5. This analysis considers two of the three phases of the proposed acquisition. Analysis of the properties is based on professional expected damages due to the limited availability of historical damages data. Analysis of impacts included a comparison of damages during existing conditions and proposed conditions with acquisition.

Analysis

Project Configuration

GZA selected 'Non-Residential Building' for the property structure type since the majority of buildings considered for acquisition are non-residential. The hazard type is 'Riverine Flood' and GZA evaluated the 1%

annual chance (100-year) flood. The mitigation action type is 'Acquisition'. As previously stated, the damage and frequency relationship is based on 'Professional Expected Damages', as hydraulic modeling data was utilized in support of this analysis.

Cost Estimation

GZA used the default value of 7.0% for the discount rate. The standard value of 100 years was selected for the useful life of an acquisition project type. GZA estimates the project cost associated with structures within the 1% annual chance (100-year) floodplain as noted in the cost breakdown below (**Table 15**).

Table 15: Acquisition Cost Estimate

Item	Cost
Phase 1: Floodway	$44,604,420
Phase 2: 100-year	$3,648,575
Total	$48,252,995

Professional Expected Damages Before Mitigation

GZA assessed the expected damages before mitigation by evaluating the impact of the 1% annual chance (100-year) flood, using the hydraulic modeling described in Section 1. GZA utilized the FEMA Hazus Version 7.0 software to estimate economic loss associated with flooding. A value of $98,434,000 was used in the BCA as the cost associated with the 1% annual chance (100-year) flood based on this estimation. Hazus does not evaluate population at risk (PAR), so no costs associated with potential injury or loss of life was included in the analysis. Economic losses are associated with building loss, contents loss, inventory loss, relocation cost, income loss, rental income loss, wage loss, and direct output loss.

Professional Expected Damages After Mitigation

The damages after mitigation are limited to the losses due to the 1% annual chance (100-year) flood in the Study Area, with the reduction of damage to acquired properties. GZA used Hazus to evaluate losses in the Study Area associated with the effective FEMA 100-year flood inundation area. A value of $70,976,000 was used in the BCA for expected damages after mitigation.

Standard Benefits- Ecosystem Services

The standard benefits include benefits to the ecosystem related to urban green open space areas created by the project. GZA proposes that the former parcel housing the Norwichtown commons be transformed into urban green open space. This would contribute to the addition of 15.6 acres of urban green open space.

Results

The BCR generated for the proposed property acquisition using the BCA Toolkit and based on the assumption as stated in this memo is 0.15. With a ratio less than one, the project is not considered cost-effective. However, as noted above, the BCR does not consider the improvements to life safety gained by relocation of the population at risk. Permanent relocation of the population at risk would be a substantial improvement to public safety. Additionally, over a longer period of time the BCR would improve since development would be relocated from the area of highest risk. Additional benefits would accrue with every instance of flooding.

BCA Summary

A summary of the results of the BCA including benefits, costs, and BCRs is shown in **Table 16**.

Table 16: BCA Summary

Concept	Cost	BCR
Concept 1: Channel Widening	$1,800,000	1.16
Concept 2: Upper Falls Dam Removal	$810,000	1.66
Concept 3: Managed Retreat	$48,252,995	0.15

5.0 STAKEHOLDER ENGAGEMENT

Local long-time business owners indicated that annual premiums for flood insurance are cost prohibitive and coverage is limited. It is less expensive for them to be self-insured and make storm recovery repairs themselves. With growing intensity from storms, this is not a business practice owners prefer to sustain. In addition to contributing their local knowledge and lived expertise, community voices were central to the Plan's proposed adaptation options.

5.1 Engagement at a Glance

Several key topic areas emerged from active engagement over the course of the project. Attendees provided a variety of historical information related to local infrastructure assets, town development, and historical events. Much of the conversations included perspective on critical bridges, dams, flood control systems and storage, and the current policy environment (particularly regarding insurance and stricter environmental regulations that limit dredge material use). There was expressed interest in evaluating multiple adaptation strategies, including upstream flood storage, river widening and dredging, managed retreat, and building-level flood protections.

In advance of the first public meeting, SECOG staff canvassed the Town Street commercial corridor to both advertise the meeting and have conversations with local business owners. The first public meeting was held in May 2025 in Norwich. Members of the Planning Team provided a presentation to the public to describe the current and future flood conditions and discuss potential flood mitigation options. Posters were used to solicit feedback from the public.

Figure 44. Community engagement photos from the May 2025 event
Source: Project team; Jeremy Chen of NBC CT, May 22, 2025; Vallery Maravi of Fox61 May 22, 2025

The second public meeting was held in September 2025 in Norwich. Members of the Planning Team presented the Preferred Concepts and solicited feedback. Due to low turnout the presentation was recorded to be posted to the SECOG website.

Technical Advisory Committee

The Technical Advisory Committee (TAC) helped steer recommendations and provide local knowledge and feedback. The TAC was composed of members from:

- **Backus Hospital** (Genevieve Boas, Donna Handley)
- **Town of Bozrah** (Glenn Pianka)
- **CIRCA** (Mary Buchanan, Nicole Govert, John Truscinski)
- **Town of Franklin** (Alden Miner)
- **The Nature Conservancy** (Emily Hadzopulos)
- **City of Norwich** (Brian Long, Peter Nystrom, Danna Rhodes, John Salamone, Dan Daniska)
- **Norwich Community Development Corporation** (Mary Riley)
- **Norwich Public Utilities** (Eric McDermott, Alisa Morrison)
- **SECOG** (Emily Bigl, Amanada Kennedy, Helen Zincavage)
- **United Community & Family Services** (Pam Kinder)
- **USDA** (Anna Hernberg, Jim Lyons)
- **The Office of U.S. Senator Richard Blumenthal**
- **The Office of U.S. Senator Chris Murphy**

The TAC met four times throughout the project. Additionally, two focus group meetings were held, one with the municipal community and one with the business community. SECOG conducted direct outreach to business owners.

5.2 What We Heard

Business owners reported that flooding continues to cause significant financial burden. Flood insurance premiums are prohibitively expensive and provide only limited coverage, leading some businesses to self-insure and repair damages independently after each flood. Rebuilding after flood events is costly, and relocation is generally not seen as financially feasible without further planning.

Infrastructure concerns were a major theme. The bridge near 60 Town Street often becomes clogged with debris during floods, while the New London Turnpike bridge area is prone to flooding when ice and debris accumulate at the abutment. Several residents stressed the need for the City to be more proactive in maintaining stormwater systems before major storm events. There were broad questions raised about how many structures were damaged in the 2024 flood and how many of those are identified in FEMA's Flood Insurance Rate Maps (FIRM).

Several participants highlighted that dredging performed in the 1980s was effective in reducing flood damages for over a decade. Further, community members emphasized the importance of dredging to provide short-term flood relief while longer-term flood mitigation projects are developed. Business owners also noted that development along the edge of the Stop & Shop shopping center narrowed the river channel, though parking lot space exists that could allow for river widening. A participant recommended evaluating lakes and dams such as Gardner Lake, Lake Williams, and Fitchville Pond in more detail. There were some suggestions about expanding the Study Area to consider upstream flood storage capacity.

Local government officials supported the preferred concepts overall, but had several key concerns. High funding needs was a major concern for each of the concepts. The need for coordination and support between neighboring towns on flood risk reduction strategies was also expressed. There were also concerns about the complexity of channel widening and managed retreat around commercial areas related to property ownership and tax base concerns.

For Further Study

Participants identified multiple areas for further study, including the Norwichtown Commons and Sherman Street, New London Turnpike, and West Town Street. Although dredging was recognized as only a temporary measure, some residents expressed frustration that stricter environmental regulations now limit its use.

Several community members also expressed support for dam removal projects that would both reduce flood risk and create new recreational or park spaces.

There was clear interest in evaluating various flood mitigation strategies, including broad regional efforts like expanding water storage, dam removal, river widening, managed retreat, and structural or building-level flood protections.

6.0 CONCLUSION

Potential Funding Sources

Various funding sources have been identified to balance the implementation and planning costs of the proposed adaptation options. Note that the following funding information is subject to change as these programs are modified, paused, and ended, and as new programs and regulations are implemented. It is important to recognize that there is likely no single source that will cover the entirety of proposed option costs. Most funding sources include a cost share that is often borne by the locality receiving funds. Funding these types of projects will require strategy, cooperation, and consistent coordination across various funders and stakeholders.

Federal Funding

As a central source, the Bipartisan Infrastructure Law (BIL) is a five-year (covering fiscal years 2022-2026) federal infrastructure funding program that includes $23.3 billion in funds for Natural Disaster Mitigation and Prevention. BIL provides direct funding to states and grants for municipalities and not-for-profit organizations. Depending on the funding program, the grants may pay for 75% or more of the costs for eligible climate resilience projects. This legislation created a once in a generation level of federal funding assistance, but the legislation ends September 30, 2026. If not expanded or renewed, projects funded through fiscal year 2026 can be completed through fiscal year 2029.

One of the BIL-funded programs, Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT), aims to improve the resilience of surface transportation systems to natural hazards, such as flooding. PROTECT opportunities fall into two categories: formula program funds, which are allocated to states, and discretionary funds, for which states, MPOs, and local governments can apply directly. Formula funds are disbursed to state DOTs over a five-year period and are non-competitive. States may use these funds towards improving state transportation systems or may pass down funds to local and regional entities. Discretionary grants are competitive and typically require benefit-cost analysis and detailed project proposals. Cost-sharing under PROTECT for project funds can be reduced if a state or MPO has a Resilience Improvement Plan (RIP) in place.

Eligible activities under PROTECT include:

- Planning and technical capacity building;
- Resilience improvements to existing infrastructure;
- Strengthening evacuation routes;
- Enhancing at-risk coastal infrastructure.

The PROTECT program is currently considered “archived” as of February 2025. While no new Notice of Funding Opportunity (NOFO) has been posted since the FY2024-2026, the program is part of a multi-year federal investment strategy. The Federal Highway Administration (FHWA) continues to implement BIL programs, including PROTECT, and has expressed commitment to resilience and climate adaptation efforts.

The City has expressed intentions to replace the bridge on Norwichtown Turnpike near the Domino's Pizza building, where channel widening is proposed. The difference in project cost to design for flood resilience has the potential to be eligible under PROTECT and should be considered, with regard to project timing to future NOFO opportunities.

Additional examples of commonly pursued federal grant funding programs from specific agencies for flood mitigation and climate adaptation projects identified in this Plan include[40]:

- Bureau of Reclamation, Department of Interior
- Environmental Protection Agency (EPA)
- Department of Transportation (DOT)
- Federal Emergency Management Agency (FEMA)
- Department of Housing and Urban Development (HUD)
- National Oceanic and Atmospheric Administration (NOAA)
- U.S. Army Corps of Engineers (USACE)
- U.S. Department of Agriculture (USDA)
- U.S. Economic Development Administration (USEDA)
- U.S. Fish and Wildlife Service (FWS)
- U.S. Small Business Administration (SBA)

Though not exhaustive, individual federal funding programs are listed below, categorized by the relevant flood mitigation option. Certain sources may be used from multiple proposed flood mitigation options. It should be noted that the funding sources below may require certain planning or policies be in place in order to be eligible to apply for project funding. For example, communities must have an adopted , FEMA-approved hazard mitigation plan in order to be eligible for project grants under the Hazard Mitigation Grant Program.

Table 17. Common federal funding sources for proposed flood mitigation options

Flood Mitigation Option	Common Funding Source
Dam Removal	EPA - Section 319
	FEMA - Rehabilitation of High Hazard Potential Dams
	NOAA - Fisheries Community-Based Restoration
	NOAA - Transformational Habitat Restoration and Coastal Resilience Grant
	USACE - Aquatic Ecosystem Restoration Program (Section 206)
	USACE - Corps Water Infrastructure Financing Program
	USDA NRCS - Watershed Rehabilitation Program
	U.S. Forest Service Dam Removal Program
	USFWS - National Fish Passage Program
Channel Widening	Bureau of Reclamation - WaterSMART Env Water Resources Program
	Bureau of Reclamation - WaterSMART Cooperative Watershed Management Program
	DOT - National Culvert Replacement
	DOT - Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation Grant
	EDA – Disaster Supplemental Grant Program
	EPA - Clean Water State Revolving Fund
	EPA - Water Infrastructure Finance and Innovation Act
	EPA - Climate Pollution Reduction Grants
	FEMA - Hazard Mitigation Grant Program
	FEMA - Flood Mitigation Assistance
	FEMA - Building Resilient Infrastructure and Communities
	NOAA - Regional Coastal Resilience Fund
	NOAA - Transformational Habitat Restoration and Coastal Resilience Grant

[40] GZA has previously summarized federal grant programs at https://service.gza.com/infrastructure with specific updates on programs available to municipalities in Connecticut.

Flood Mitigation Option	Common Funding Source
	USACE - Section 1135
	USDA - Environmental Quality Incentives Program [for Private property owners]
	USDA - Regional Conservation Partnership Program
	Bureau of Reclamation - WaterSMART Env Water Resources Program
	Bureau of Reclamation - WaterSMART Cooperative Watershed Management Program
Managed Retreat	DOT BUILD Grant
	DOT - Transportation Alternatives Set Aside Program
	EDA – Disaster Supplemental Grant Program
	EPA - Clean Water State Revolving Fund
	EPA - Regional Wetland Program Development Grants
	EPA - Climate Pollution Reduction Grants
	FEMA - Hazard Mitigation Grant Program
	FEMA - Building Resilient Infrastructure and Communities
	FEMA - Flood Mitigation Assistance
	HUD – Community Develop Block Grant
	HUD – Community Develop Block Grant-Disaster Recovery
	NOAA - Regional Coastal Resilience Fund
	NOAA - Coastal Zone Enhancement Grants (Section 309)
	NOAA - Coastal Zone Management grants (Section 306/306a)
	USDA NRCS Conservation Easement and Restoration Funding Programs
	USDA - Emergency Watershed Floodplain Protection Easement
	USFWS - National Coastal Wetlands Conservation Grant
	U.S. Small Business Admin Disaster Loan [for Private property owners]

It is important to note that accepting federal funding for flood mitigation projects may increase the performance standards required for a project in order to comply with higher state or local floodplain management standards. Such standards may include using a 1% annual chance event with SLR and freeboard considerations (e.g., 1 to 3 feet), or using a 0.2% annual chance event with SLR and freeboard considerations (e.g., up to 2 feet). Depending on the project, the requirements of the state, as applied through the permit review process, may require even more robust performance standards.

State Funding

Connecticut also has increased its available state grant funding for resilience projects due in part to the federal funding the State will receive for spending through September 30, 2026. There are several state-wide funding sources for the proposed flood mitigation options as well. A list of individual programs is presented below.

Table 18. Common state-wide funding sources for proposed flood mitigation options

Flood Mitigation Option	Common Funding Source
Dam Removal	National Fish and Wildlife Foundation – Northeast Forest and Rivers Fund
	Long Island Sound Community Impact Fund
Channel Widening	Connecticut Wetland In-Lieu Fee Program
	Long Island Sound Futures Fund
	Long Island Sound Community Impact Fund
	National Fish and Wildlife Foundation – Northeast Forest and Rivers Fund
	State Flood and Erosion Control Board (Norwich)
	CT DEEP - Urban Green and Community Gardens Grant
	CT DECD - Urban Act Grant

Flood Mitigation Option	Common Funding Source
	CT Green Infrastructure Bank – Environmental Infrastructure[41]
Managed Retreat	CIRCA - Climate and Equity Grant
	CT DEEP - Open Space and Watershed Land Acquisition Grant Program
	CT DEMHMS - Emergency Management Performance Grant
	State Flood and Erosion Control Board (Norwich)

There are also legislation to track and monitor that are relevant to specific municipal funding sources as well. For example:

- Public Act No. 19-77, **An Act Authorizing Municipal Climate Change and Coastal Resiliency Reserve Funds**, effective July 1, 2019 enables municipalities to create a Climate Change and Coastal Resiliency Reserve Fund, that the Town can use any or all of such reserve, "*...to pay for municipal property losses, capital projects and studies related to mitigating hazards and vulnerabilities of climate change including, but not limited to, land acquisition*."

- P.A. 21-115 **An Act Concerning Climate Change Adaptation**, allows municipalities to create a *stormwater authority*. This Act indicates the purposes of such authority shall be to (among other aspects) develop a stormwater management program (including, but not limited to):
    - For construction and post-construction site stormwater runoff control, including control detention and prevention of runoff from development sites
    - For the control and abatement of stormwater pollution from existing land uses and the detection and elimination of connections to the stormwater system which threaten public health, welfare, or the environment

Other Funding Sources

Other non-governmental funding sources could include The Nature Conservancy's Climate Resilience Fund, National Geographic Society's Extreme Weather and Natural Hazards Solutions Grant, and The Funder's Networks' Partners for Places, Jobs and Inclusive Infrastructure Initiative, water quality or water conservancy programs, flood districts, public-private partnerships.

Toward Implementation

Concept 1: Channel Widening

A more detailed hydraulic assessment of the proposed widened reach of the Yantic River would be necessary to advance this concept. Specific impacts to abutting properties and downstream properties and infrastructure need to be evaluated to satisfy the FEMA no rise criteria. The detailed assessment would build on the preliminary evaluation performed for this project, and evaluate different alternatives for channel widening such as dimensions and bank stabilization.

Concept 2: Falls Mill Upper Dam Removal

The next phases for the dam removal option would be to complete a feasibility study, which would consist of evaluating sediment upstream of the dam (identifying the extent of impounded sediment volume, characterizing the sediment quality, assessing the limits of sediment stabilization and removal), performing preliminary engineering evaluation, and furthering the design of the breached section, local river restoration, and sediment stabilization. Other considerations include permitting, which would consist of an array of

[41] The Connecticut Green Bank (www.ctgreenbank.com) indicated at its January 17, 2024, Winter Quarterly Webinar plans to expand the Smart-E Loan Program again in 2024 to add additional flood resiliency measures for homeowners in G.G.S. 22-6. Developments are ongoing.

required local, state, and federal permits, and performing additional community outreach with a focus on the abutters of the dam and impoundment.

Concept 3: Managed Retreat

The next steps toward implementing managed retreat would be to establish a pilot program. Goals of the pilot program should include: alignment of key leaders on managed retreat, assessment of interest and community vision, leverage the results of this report to put project sponsors in a better position to secure funding, identification of the "buyout" terms, and creation of a project administration plan. This voluntary option gives Yantic residents, businesses, property owners, and renters the opportunity to safely and economically move out of harm's way, while staying in the community.

Appendix A- Limitations

USE OF REPORT

1. GeoEnvironmental, Inc. (GZA) prepared this Report on behalf of, and for the exclusive use of the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) for the stated purpose(s) and location(s) identified in the Report. Use of this Report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Report and/or proposal and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this Report may be found at the subject location(s).
3. The interpretations and conclusions presented in the Report were based solely upon the services described therein, and not on scientific tasks or procedures beyond the scope of the described services. The work described in this Report was carried out in accordance with the agreed upon Terms and Conditions of Engagement.
4. GZA's elevation, hydrologic, and hydraulic evaluation was performed in accordance with generally accepted practices of qualified professionals performing the same type of services at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. The findings are dependent on numerous assumptions and uncertainties inherent in the assessment process. The findings of the evaluation are not an absolute characterization of actual risks, but rather serve to highlight potential sources of risk at the site(s).
5. The study included review of flood elevations developed for the current climate.
6. Unless specifically stated otherwise, the evaluations performed by GZA and associated results and conclusions are based upon evaluation of historic data, trends, references, and guidance with respect to the current climate and sea level conditions. Future climate change may result in alterations to inputs which influence flooding at the site (*e.g.*, rainfall totals, storm intensities, mean sea level, *etc*.). Such changes may have implications on the estimated flood elevations, flood frequencies and/or other parameters contained in this Report.

RELIANCE ON INFORMATION FROM OTHERS

7. In conducting our work, GZA has relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy

or completeness of that information. Any inconsistencies in this information which we have noted are discussed in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

8. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations with codes and regulations by other parties are beyond our control.

COST ESTIMATES

9. Unless otherwise stated, our cost estimates are for comparative, or general planning purposes. These estimates may involve approximate quantity evaluations and may not be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over the labor and material costs required to plan and execute the anticipated work, our estimates were made using our experience and readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

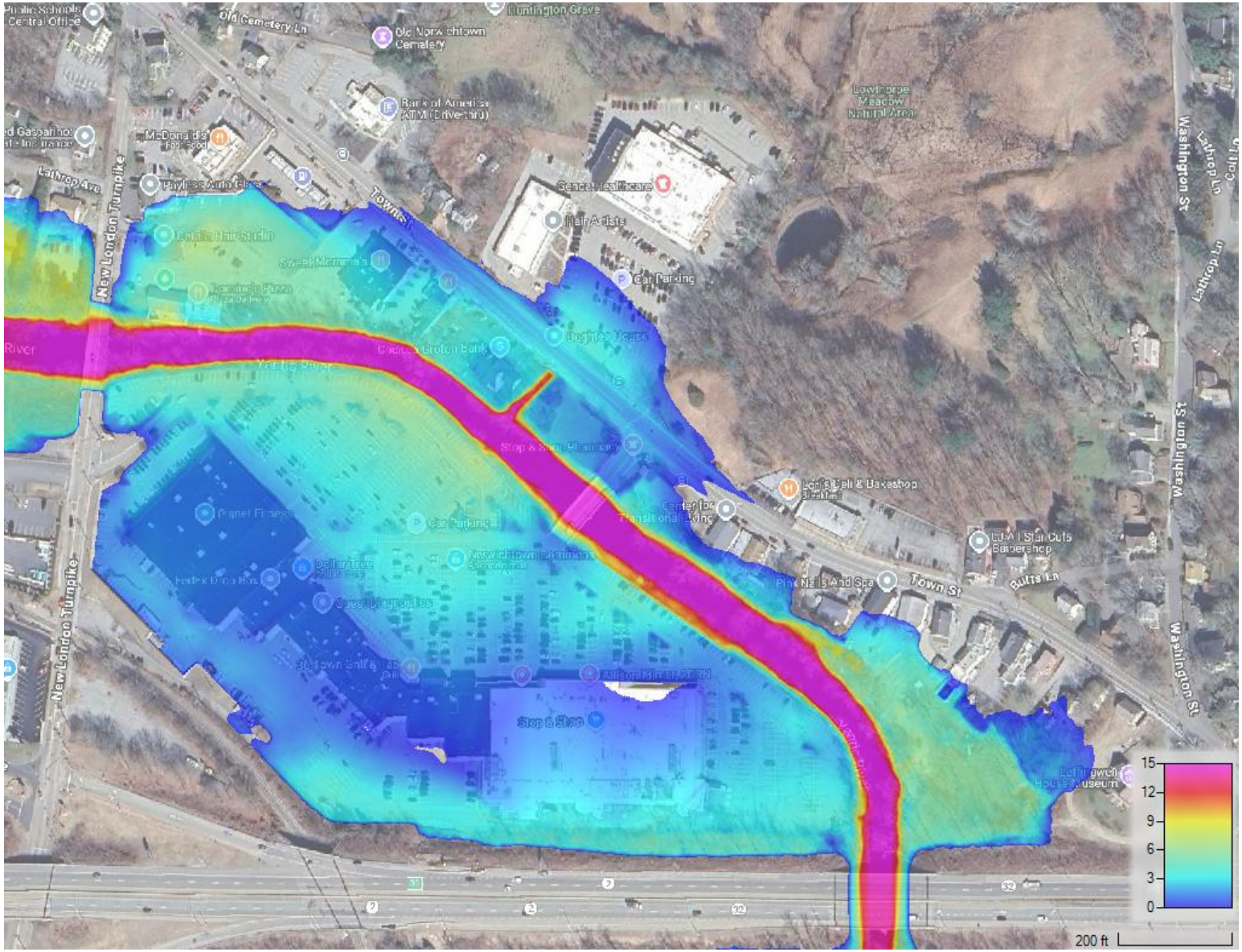
ADDITIONAL INFORMATION

10. In the event that the Client or others authorized to use this Report obtain information on conditions at the site(s) not contained in this Report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the opinions stated in this Report.

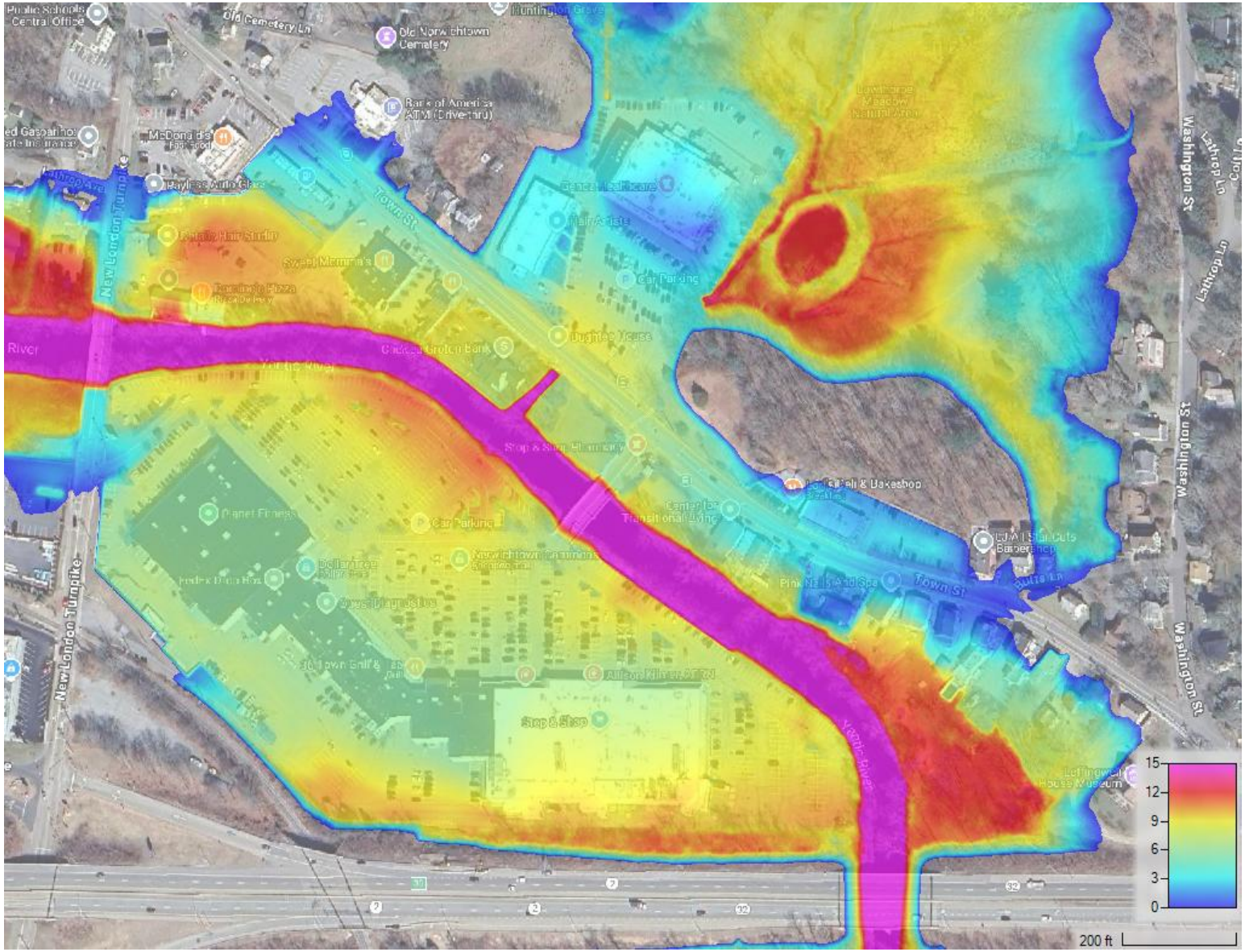
ADDITIONAL SERVICES

11. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

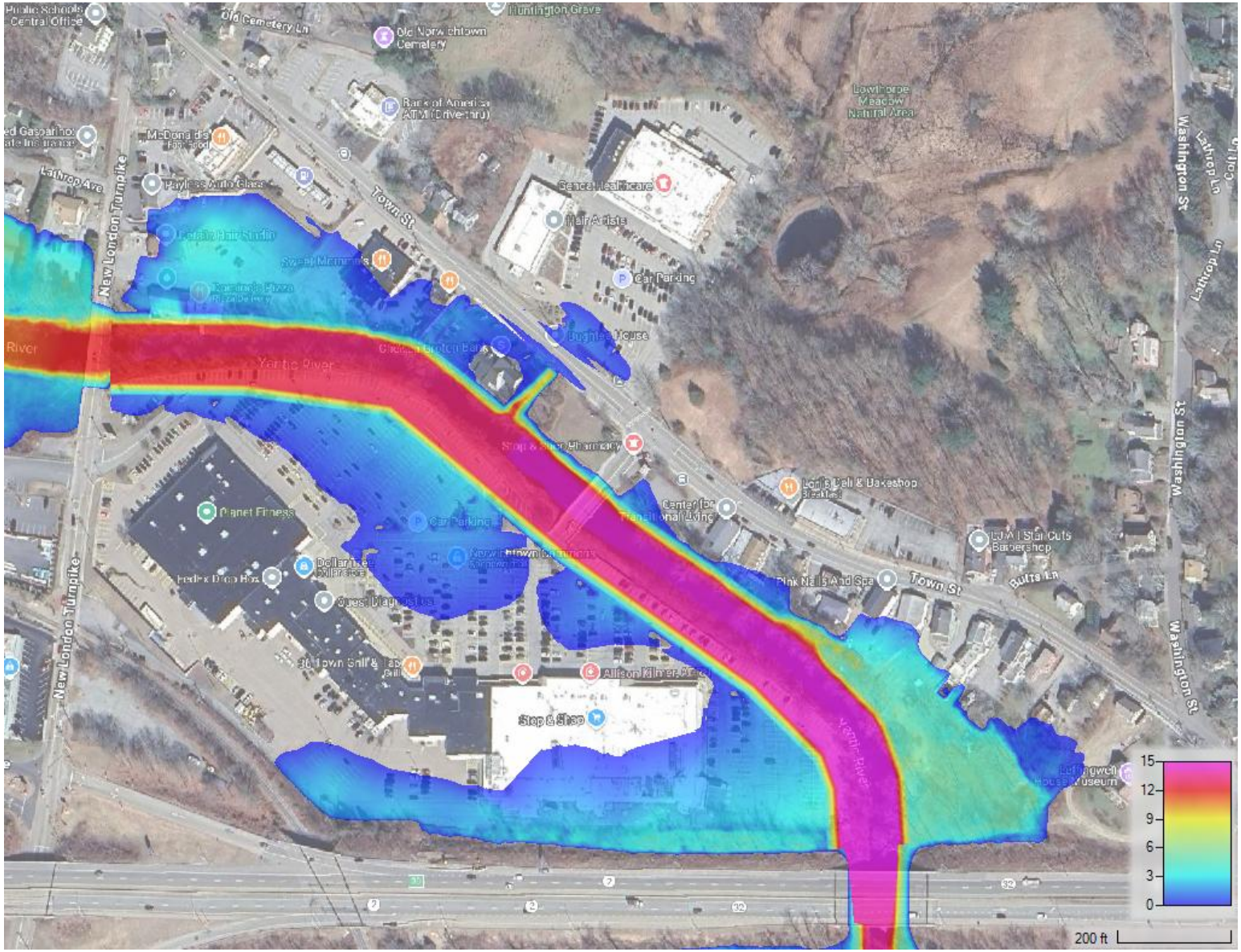
Appendix B- Flood Modeling Results



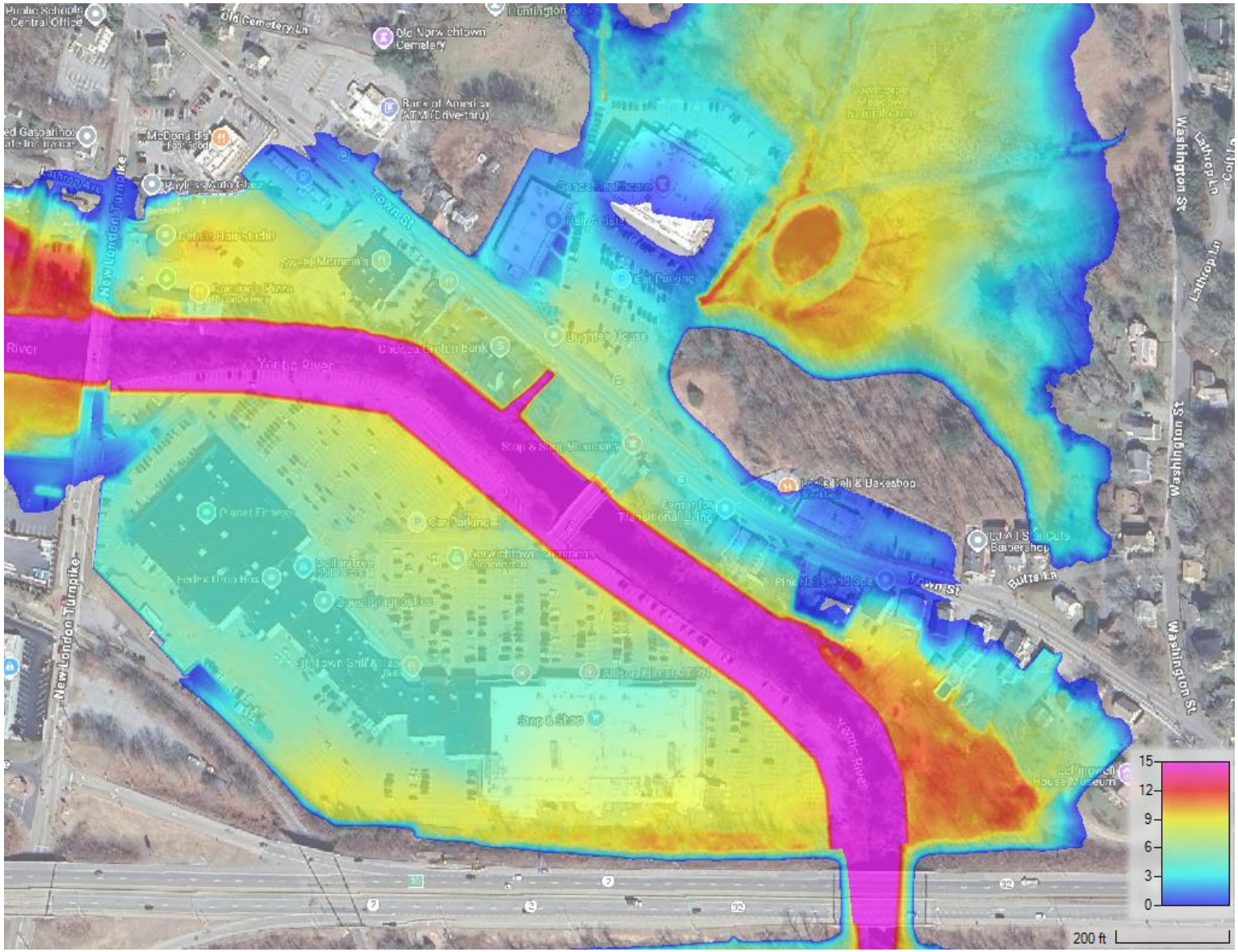
Existing Conditions 1% Annual Chance (100-yr) Flood Depths



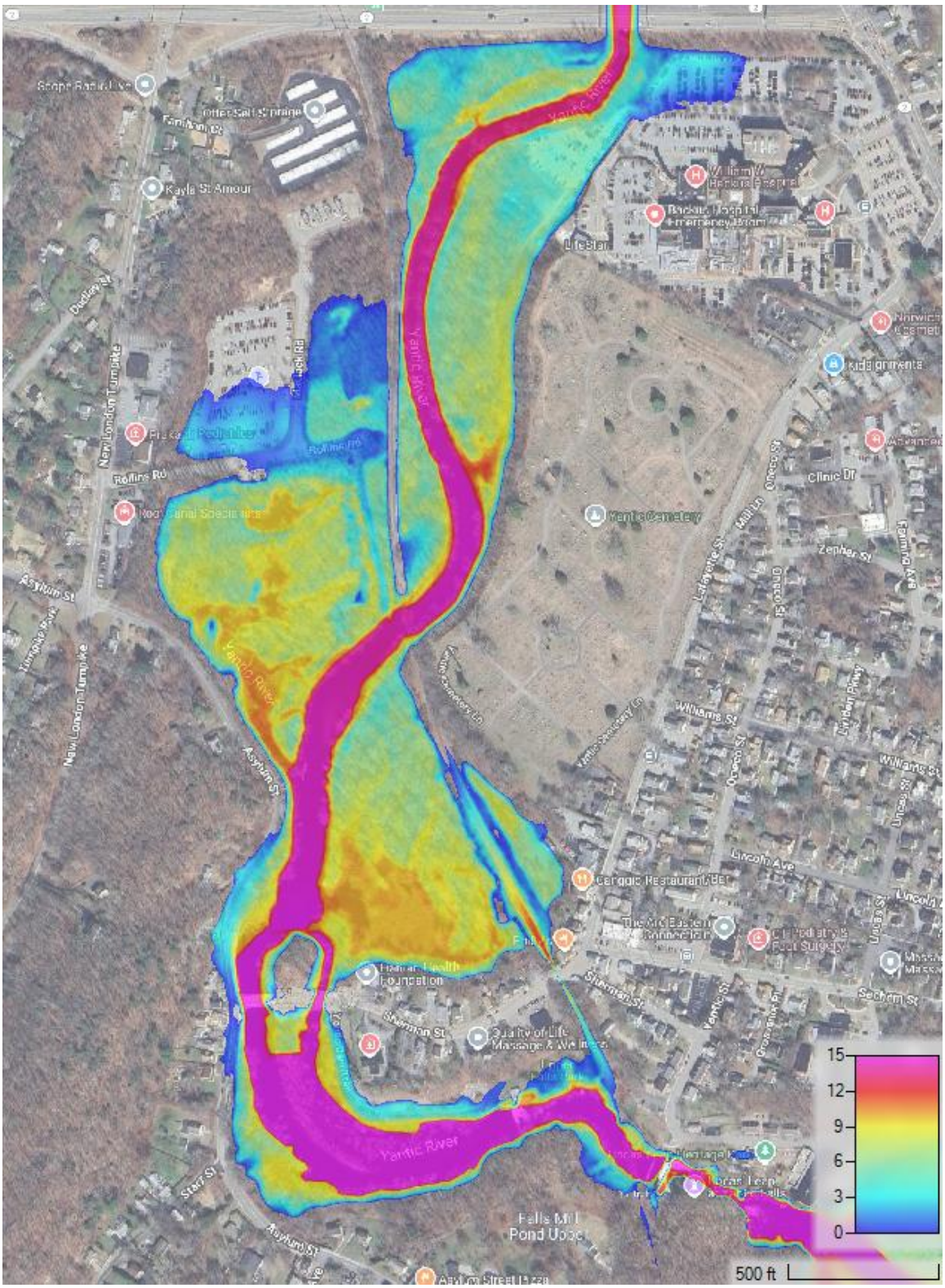
Existing Conditions 0.2% Annual Chance (500-yr) Flood Depths



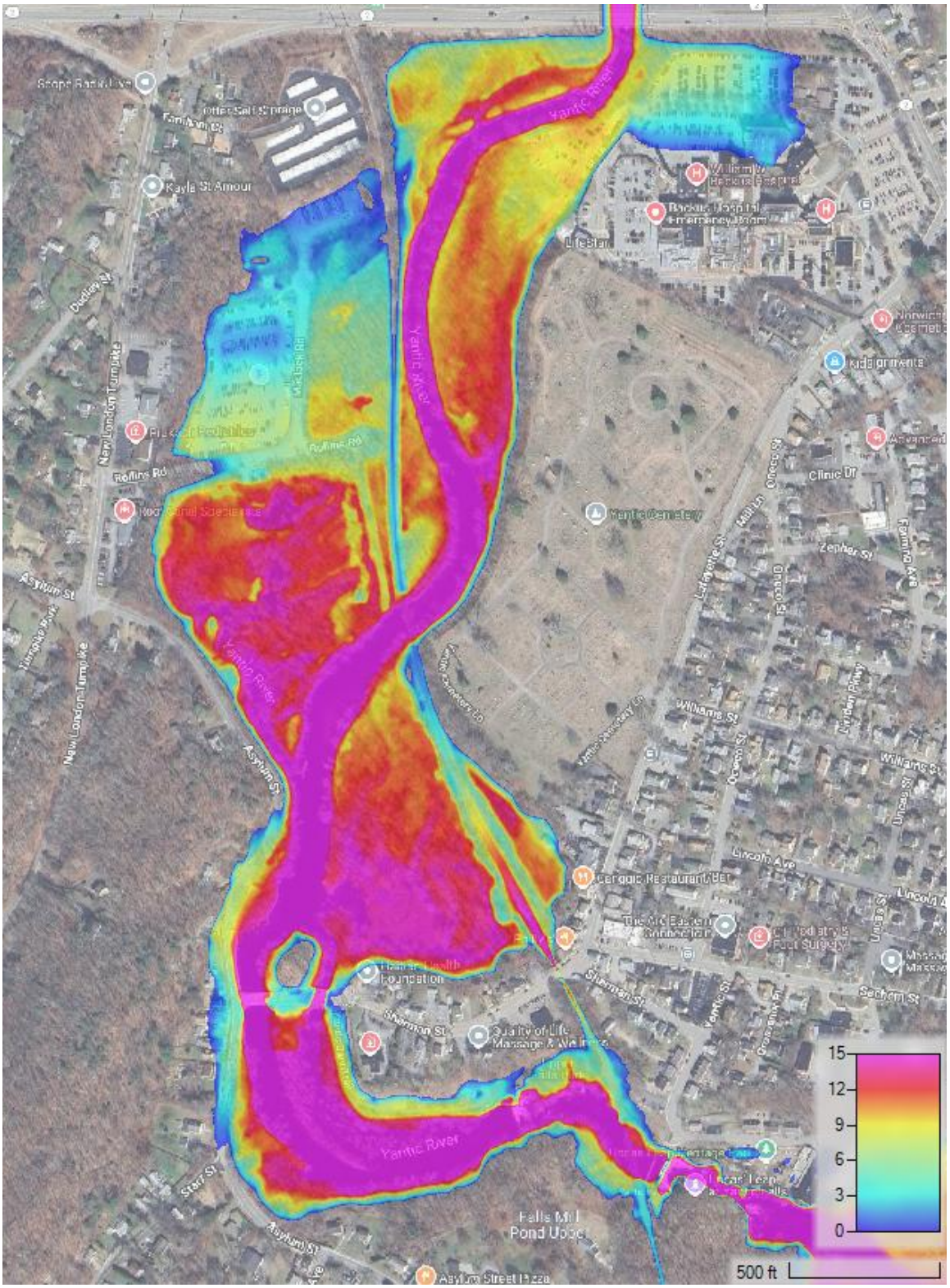
Option 1- Channel Widening 1% Annual Chance (100-yr) Flood Depths



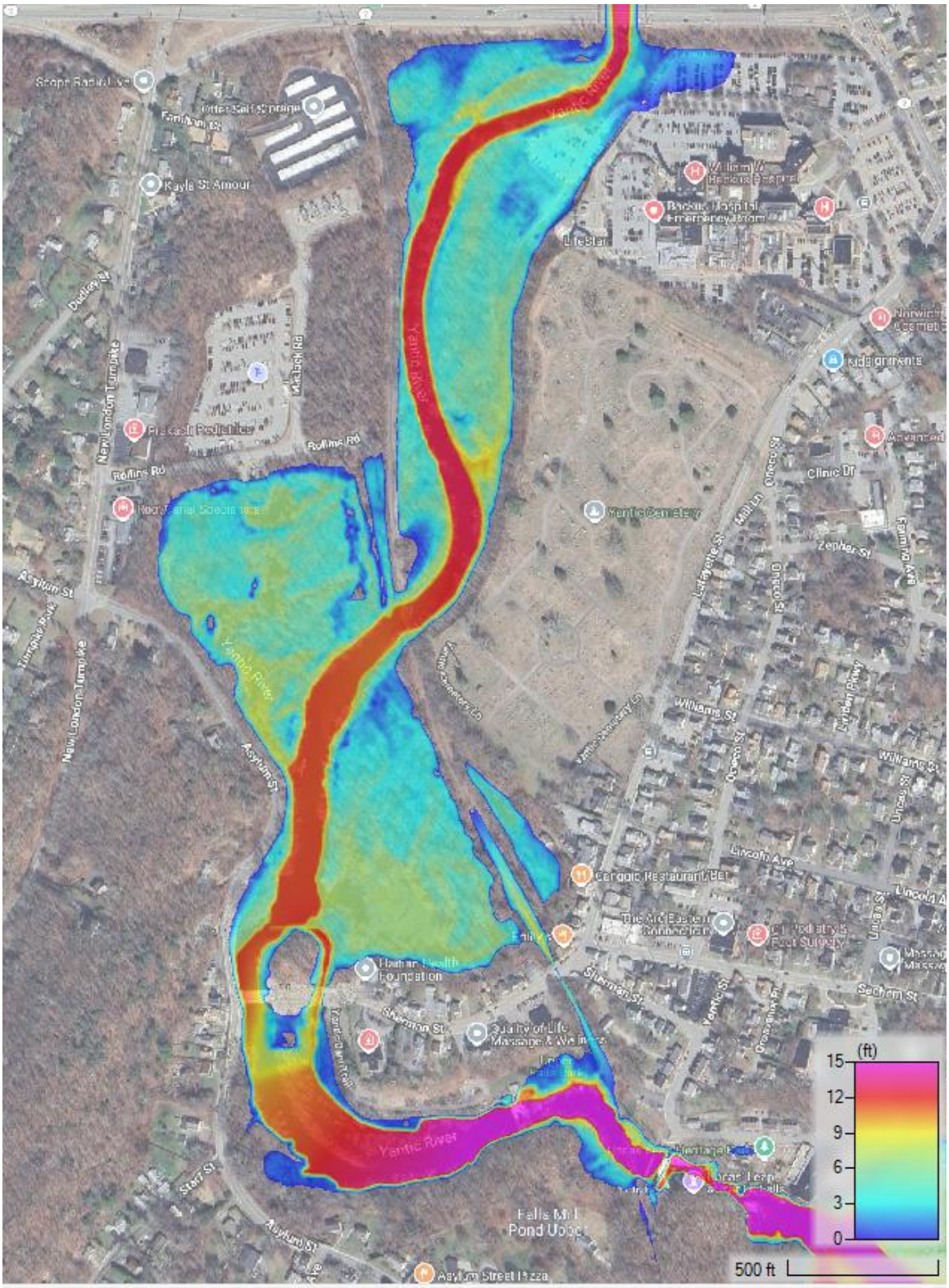
Option 1- Channel Widening 0.2% Annual Chance (500-yr) Flood Depths



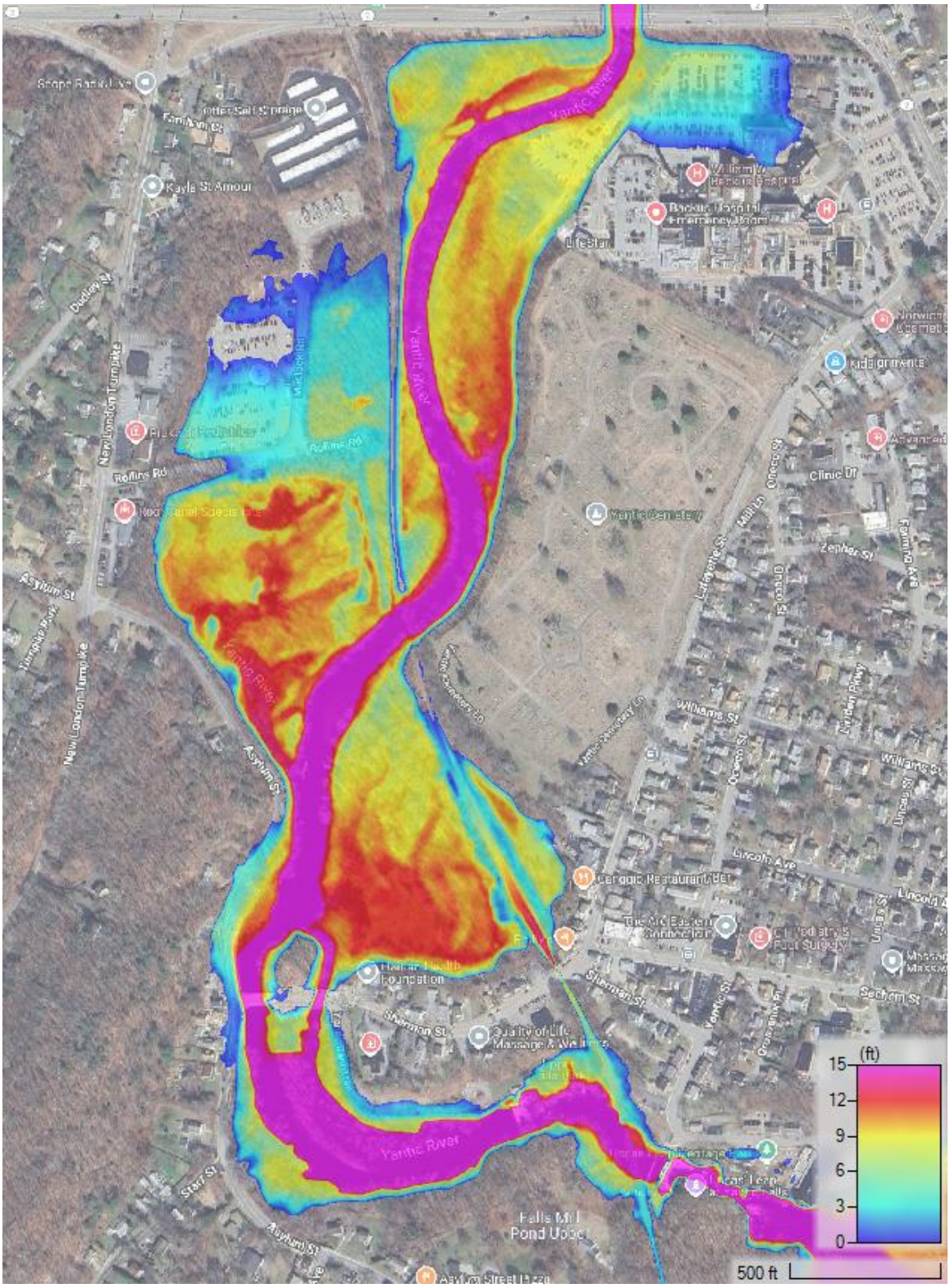
Existing Conditions 1% Annual Chance (100-yr) Flood Depths



Existing Conditions 0.2% Annual Chance (500-yr) Flood Depths



Option 2- Falls Mill Upper Dam Removal 1% Annual Chance (100-yr) Flood Depths



Option 2- Falls Mill Upper Dam Removal 0.2% Annual Chance (500-yr) Flood Depths

Appendix C- Upper Watershed Storage Assessment

Known for excellence.
Built on trust.

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

M E M O R A N D U M

To: Connecticut Institute for Resilience and Climate Adaptation (John Truscinski)
Southeastern Connecticut Council of Governments (Helen Zincavage)

From: GZA GeoEnvironmental, Inc. (David M. Leone, Alex Roper)

Date: April 7, 2025

File No.: 01.0177671.00

Re: Resilient Yantic: Upper Watershed Storage Assessment

The following summarizes GZA GeoEnvironmental Inc.'s (GZA) screening level assessment of upper watershed storage in the Yantic River basin. GZA evaluated 30 parcels identified by SECOG, located approximately 3.5 miles upstream of the commercial district and Backus Hospital focus areas. The parcels are located within the Towns of Bozrah and Franklin and the City of Norwich, with both state and private ownership.

GZA used parcel area, ground elevation within the 1% annual exceedance probability (AEP) floodplain, ground elevation outside of the 1% AEP floodplain, and area outside of the 1% AEP floodplain as screening criteria. Parcels were categorized into three categories, as having: feasible flood storage area, infeasible flood storage area, or potential for preservation of existing floodplain storage:

- Feasible

If the elevation difference was less than five feet, the parcel was deemed feasible, and the additional flood storage potential was estimated based on elevation and area of the parcel. GZA identified ten parcels as having feasible flood storage potential, with approximately 90 acre-feet of additional storage potential with grading and excavation.

- Infeasible

If the elevation difference between the area within the floodplain and area outside the floodplain was greater than five feet, then the parcel was deemed infeasible. For floodwaters to be able to be stored on such properties, earthwork would be required to reduce the land elevation to something below the flood elevation. As a result, GZA judged the amount of grading required to be the prohibitive factor in the feasibility of flood storage. According to Connecticut Department of Transportation 2024 Estimating Guidelines, the unit cost of earth excavation ranges between $17 to $81 per cubic yard. This equates to approximately $27,500 to $130,000 per acre-foot.

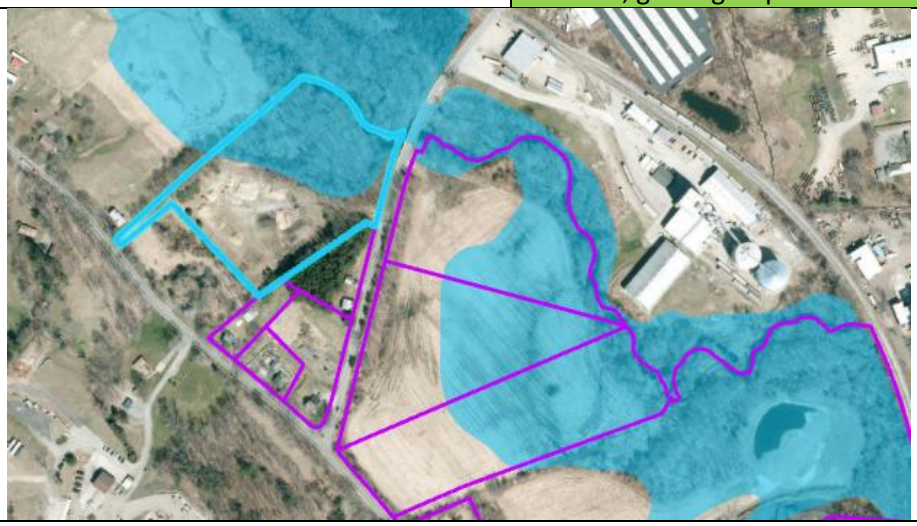
- Preservation of Existing Floodplain Storage:

If the parcel is already entirely within the 1% AEP floodplain, it is categorized as having potential to preserve existing floodplain storage, as no new storage is available, and preservation of the area would inhibit future development of impervious area.

To provide an indication of how much upstream storage may be able to reduce downstream flood flows, GZA estimated the volume of the January 2024, 2-day flood. The 2024 event had a volume of approximately 11,000 acre-feet. The maximum discharge associated with this event (about 8,500 cfs) is slightly less than that of the 2% AEP (50-yr recurrence interval) flow. The additional storage volume is less than 1% of the 2% AEP flood volume. Therefore, the evaluated parcels are not anticipated to have significant flood storage impacts for large magnitude floods.

The following tables and graphics depict the analyses by parcel.

Parcel Location	Murphy Rd, Franklin, CT
Parcel Owner	COLEMAN PATRICK
Parcel Area (acres)	6.3
Approx. ground El. within Floodplain (ft, NAVD88)	141
Approx. ground El. outside of Floodplain (ft, NAVD88)	144
Area outside of 1% AEP Floodplain (acres)	3.3
Approx. flood storage volume (acre-ft)	9.9
Conclusion	Feasible; grading required



Parcel Location	58 Murphy Rd, Franklin, CT
Parcel Owner	ADAMS JEAN & LAMBERT JOHN
Parcel Area (acres)	0.91
Approx. ground El. within Floodplain (ft, NAVD88)	136
Approx. ground El. outside of Floodplain (ft, NAVD88)	153
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

Parcel Location	77 Lebanon Rd, Franklin, CT
Parcel Owner	CHARRON HOLLY
Parcel Area (acres)	0.58
Approx. ground El. within Floodplain (ft, NAVD88)	136
Approx. ground El. outside of Floodplain (ft, NAVD88)	160
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

Parcel Location	75 Lebanon Rd, Franklin, CT
Parcel Owner	CHIEKA BRENDA
Parcel Area (acres)	0.54
Approx. ground El. within Floodplain (ft, NAVD88)	136
Approx. ground El. outside of Floodplain (ft, NAVD88)	165
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

Parcel Location	71 Lebanon Rd, Franklin, CT
Parcel Owner	SEAGER ANDREW E
Parcel Area (acres)	1.4
Approx. ground El. within Floodplain (ft, NAVD88)	136
Approx. ground El. outside of Floodplain (ft, NAVD88)	157
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

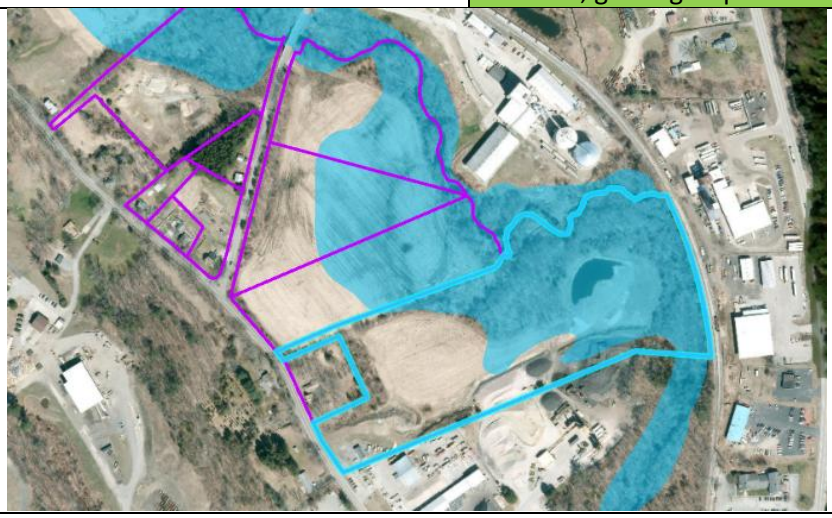
Parcel Location	Murphy Rd, Franklin, CT
Parcel Owner	FRANKLIN BUSINESS PARK LLC
Parcel Area (acres)	5.7
Approx. ground El. within Floodplain (ft, NAVD88)	135
Approx. ground El. outside of Floodplain (ft, NAVD88)	136
Area outside of 1% AEP Floodplain (acres)	2.2
Approx. flood storage volume (acre-ft)	2.2
Conclusion	Feasible; grading required

Parcel Location	Murphy Rd, Franklin, CT
Parcel Owner	FRANKLIN BUSINESS PARK LLC
Parcel Area (acres)	5.3
Approx. ground El. within Floodplain (ft, NAVD88)	135
Approx. ground El. outside of Floodplain (ft, NAVD88)	136
Area outside of 1% AEP Floodplain (acres)	2.7
Approx. flood storage volume (acre-ft)	2.7
Conclusion	Feasible; grading required

Parcel Location	Lebanon Rd, Franklin, CT
Parcel Owner	FRANKLIN BUSINESS PARK LLC
Parcel Area (acres)	5.8
Approx. ground El. within Floodplain (ft, NAVD88)	135
Approx. ground El. outside of Floodplain (ft, NAVD88)	142
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

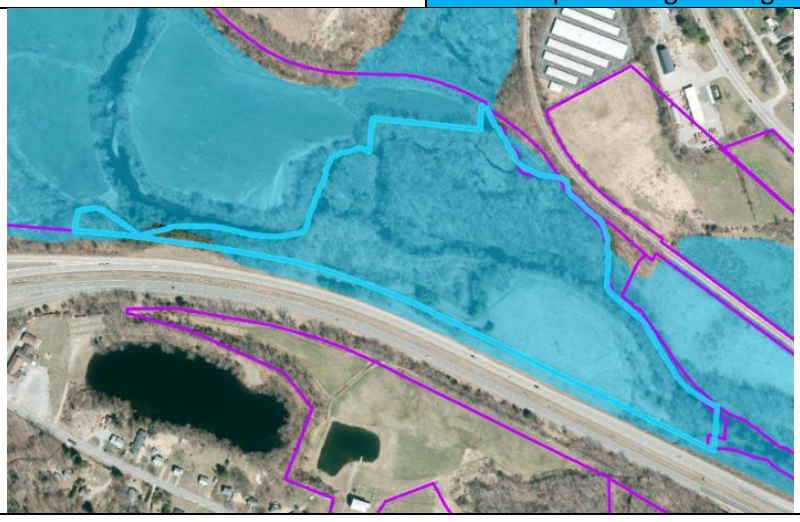
Parcel Location	61 Lebanon Rd, Franklin, CT
Parcel Owner	CRANEY MARY R L/U & THOMAS A & MICHAEL J
Parcel Area (acres)	1.3
Approx. ground El. within Floodplain (ft, NAVD88)	135
Approx. ground El. outside of Floodplain (ft, NAVD88)	145
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

Parcel Location	Unknown
Parcel Owner	Unknown
Parcel Area (acres)	18.1
Approx. ground El. within Floodplain (ft, NAVD88)	130
Approx. ground El. outside of Floodplain (ft, NAVD88)	132
Area outside of 1% AEP Floodplain (acres)	5.6
Approx. flood storage volume (acre-ft)	11.2
Conclusion	Feasible; grading required

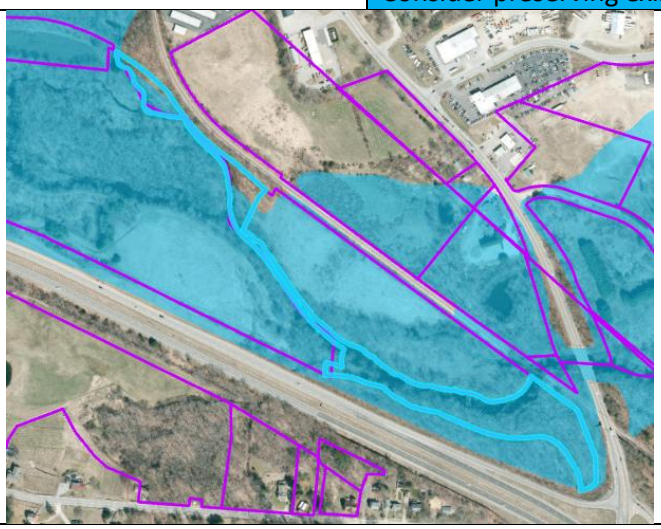


Parcel Location	133 Fitchville Rd, Bozrah CT
Parcel Owner	A & J LLC
Parcel Area (acres)	70.3
Approx. ground El. within Floodplain (ft, NAVD88)	122
Approx. ground El. outside of Floodplain (ft, NAVD88)	125
Area outside of 1% AEP Floodplain (acres)	10.5
Approx. flood storage volume (acre-ft)	31.5
Conclusion	Feasible; grading required

Parcel Location	Fitchville Rd, Bozrah, CT
Parcel Owner	STRONG WARREN
Parcel Area (acres)	24.2
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

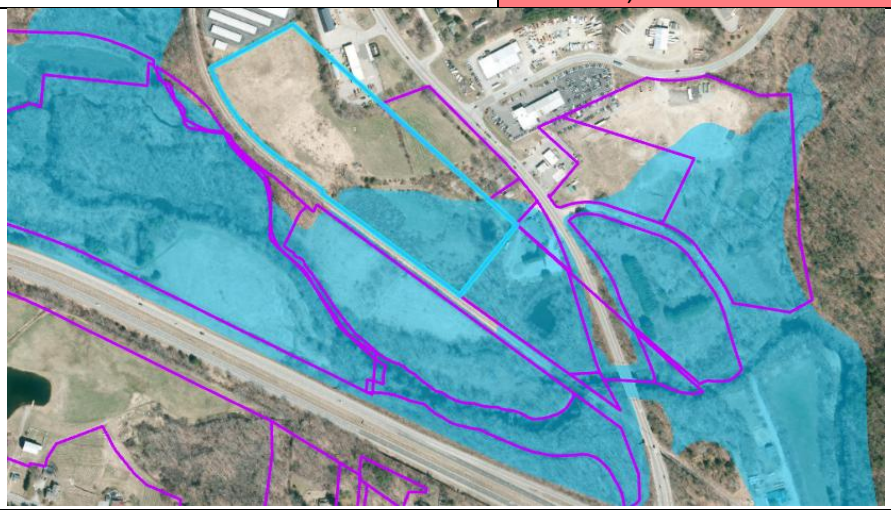


Parcel Location	244 Yantic Rd, Norwich, CT
Parcel Owner	MILL DEVELOPMENT CT LLC
Parcel Area (acres)	5.5
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

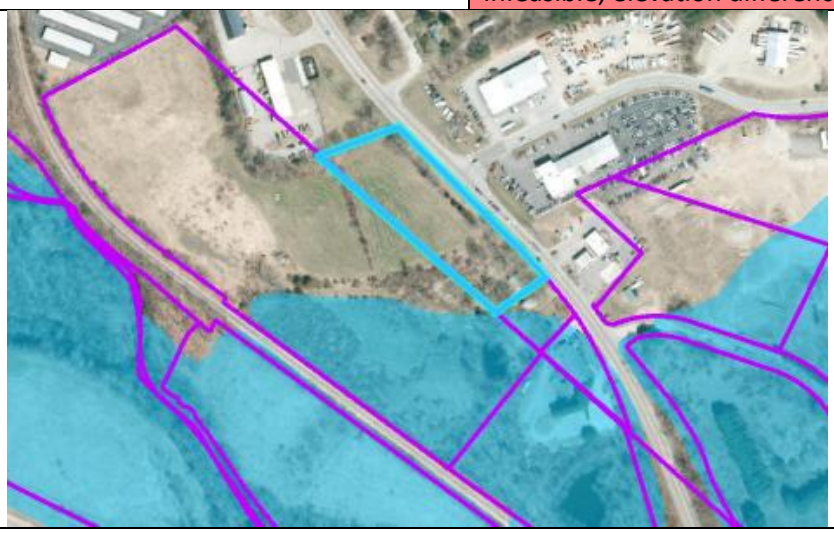


Parcel Location	224 Yantic Rd, Norwich, CT
Parcel Owner	18 ROUTE 32 LLC
Parcel Area (acres)	8.9
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

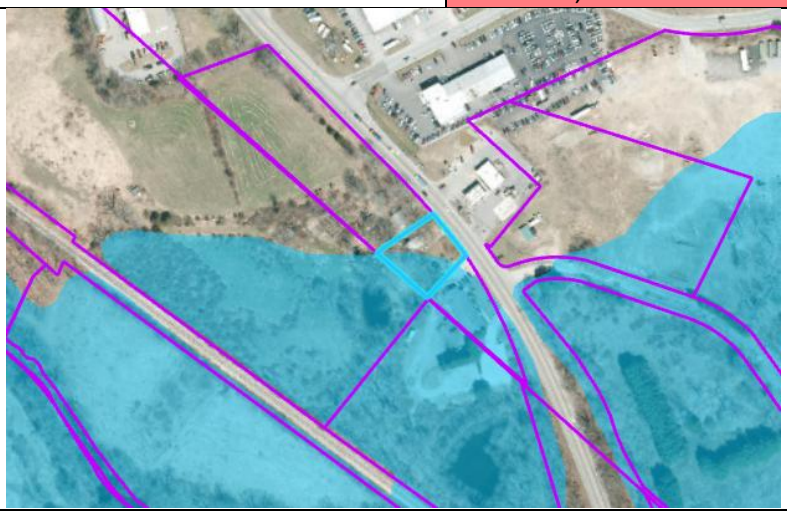
Parcel Location	240 Yantic Rd, Norwich, CT
Parcel Owner	18 ROUTE 32 LLC
Parcel Area (acres)	13.3
Approx. ground El. within Floodplain (ft, NAVD88)	118
Approx. ground El. outside of Floodplain (ft, NAVD88)	128
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft



Parcel Location	18 Route 32, Franklin, CT
Parcel Owner	18 ROUTE 32 LLC
Parcel Area (acres)	2.4
Approx. ground El. within Floodplain (ft, NAVD88)	118
Approx. ground El. outside of Floodplain (ft, NAVD88)	130
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

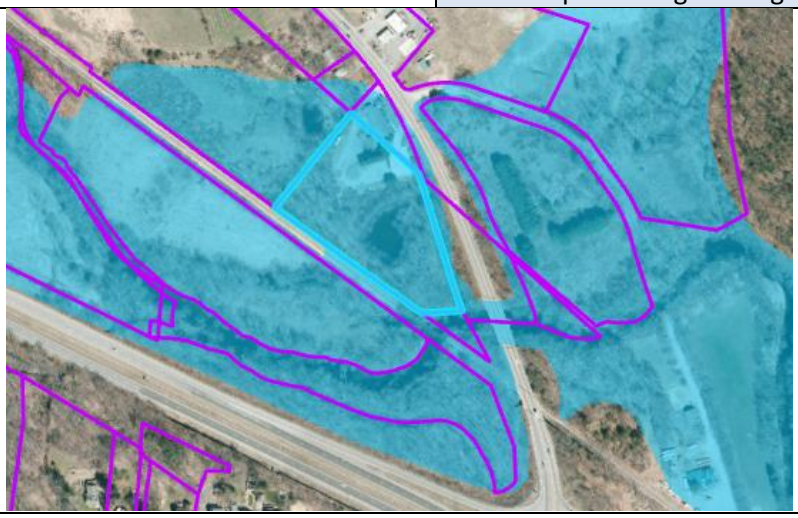


Parcel Location	14 Route 32, Franklin, CT
Parcel Owner	SINKO LINDA L & SEMMELROCK KAREN T
Parcel Area (acres)	0.45
Approx. ground El. within Floodplain (ft, NAVD88)	108
Approx. ground El. outside of Floodplain (ft, NAVD88)	118
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

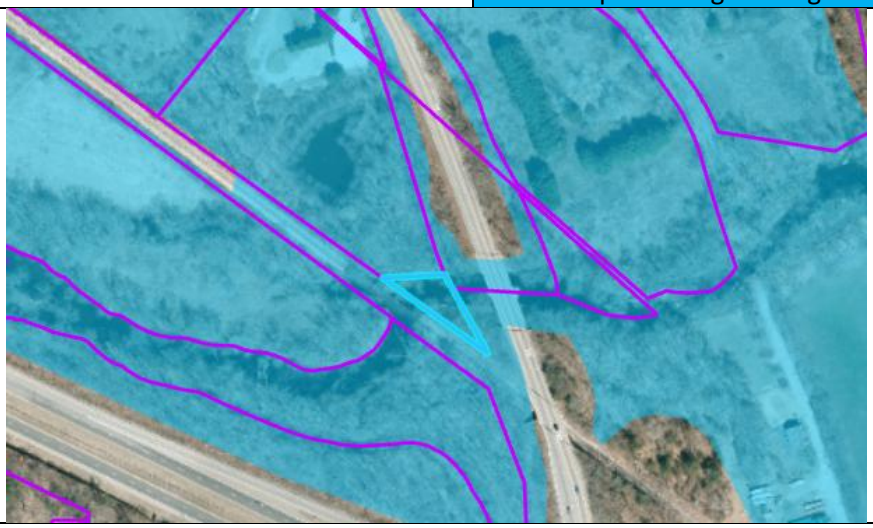


Parcel Location	10 Route 32, Franklin, CT
Parcel Owner	BELLAVANCE & GATES LLC
Parcel Area (acres)	0.52
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

Parcel Location	230 Yantic Rd, Norwich, CT
Parcel Owner	BELLAVANCE & GATES LLC
Parcel Area (acres)	4.2
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

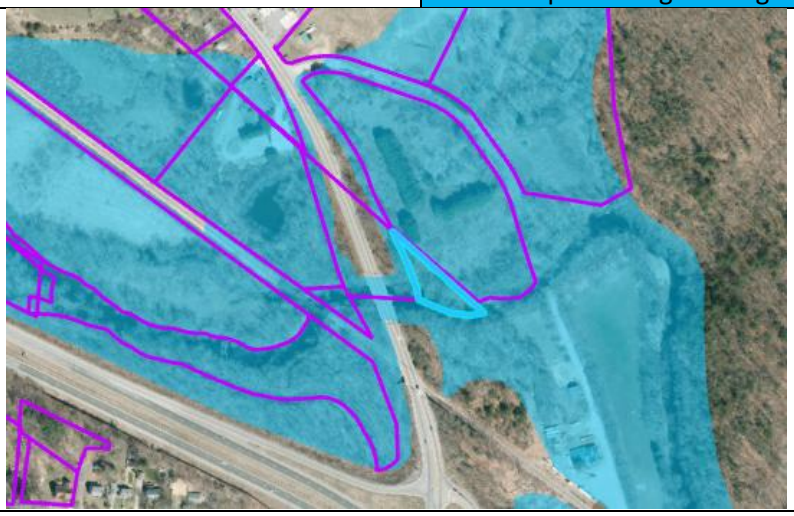


Parcel Location	Yantic Rd, Norwich, CT
Parcel Owner	CONNECTICUT STATE OF
Parcel Area (acres)	0.24
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

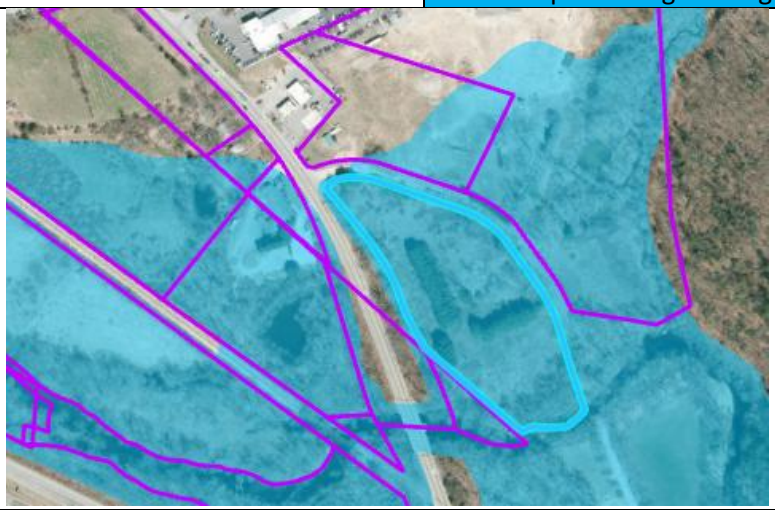


Parcel Location	Yantic Rd, Norwich, CT
Parcel Owner	CONNECTICUT STATE OF
Parcel Area (acres)	1.6
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; roadway within parcel

Parcel Location	200 Yantic Rd, Norwich, CT
Parcel Owner	CONNECTICUT STATE OF
Parcel Area (acres)	0.49
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage

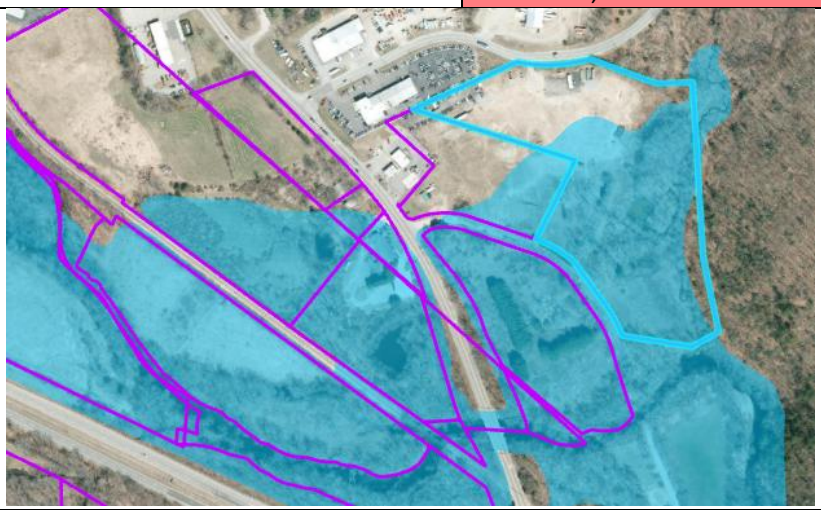


Parcel Location	15 Old Route 32, Franklin, CT
Parcel Owner	CONNECTICUT STATE OF
Parcel Area (acres)	5.5
Approx. ground El. within Floodplain (ft, NAVD88)	N/A
Approx. ground El. outside of Floodplain (ft, NAVD88)	N/A
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Consider preserving existing floodplain storage



Parcel Location	8 Old Route 32, Franklin, CT
Parcel Owner	PIOTRKOWSKI SAMMY
Parcel Area (acres)	3.7
Approx. ground El. within Floodplain (ft, NAVD88)	115
Approx. ground El. outside of Floodplain (ft, NAVD88)	122
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

Parcel Location	23 New Park Ave, Franklin, CT
Parcel Owner	ADELMAN FAMILY IRREVOCABLE
Parcel Area (acres)	11.8
Approx. ground El. within Floodplain (ft, NAVD88)	117
Approx. ground El. outside of Floodplain (ft, NAVD88)	123
Area outside of 1% AEP Floodplain (acres)	N/A
Approx. flood storage volume (acre-ft)	N/A
Conclusion	Infeasible; elevation difference > 5ft

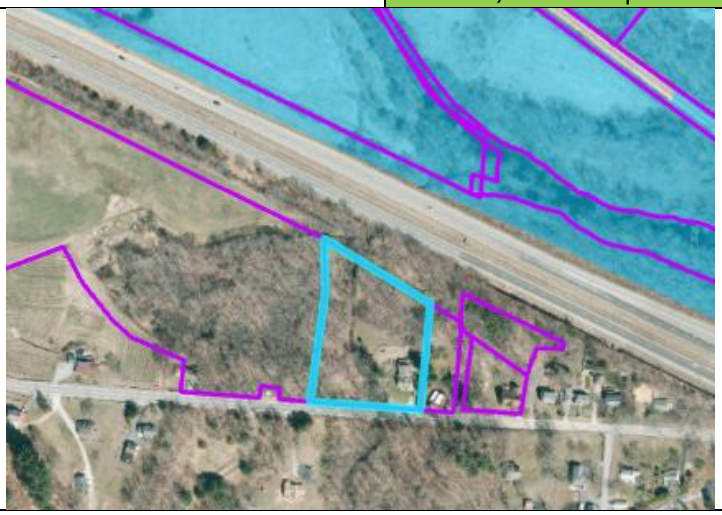


Parcel Location	50 Fitchville Rd, Norwich, CT
Parcel Owner	DESROSIERS BARRY AMANDA M
Parcel Area (acres)	0.6
Approx. ground El. within Floodplain (ft, NAVD88)	114
Approx. ground El. outside of Floodplain (ft, NAVD88)	112
Area outside of 1% AEP Floodplain (acres)	0.6
Approx. flood storage volume (acre-ft)	1.2
Conclusion	Feasible; would require connection under CT Rt 2

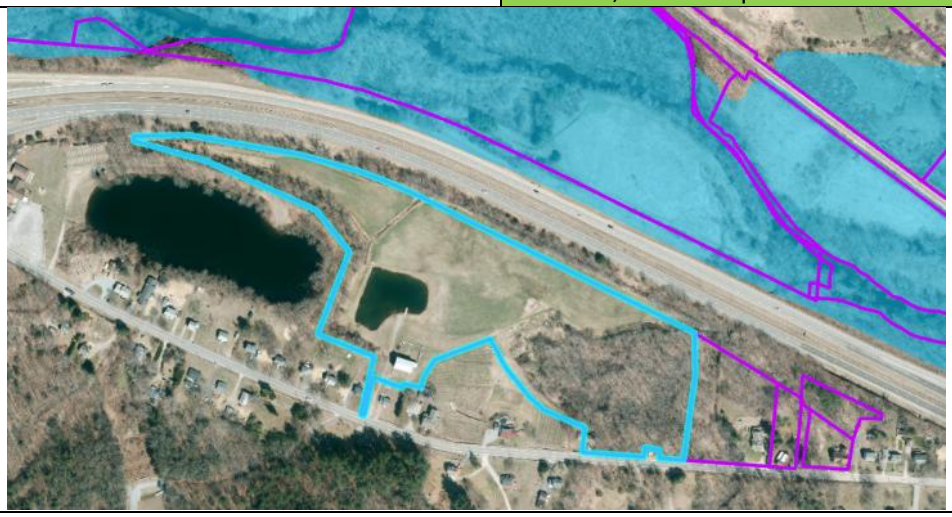
Parcel Location	52 Fitchville Rd, Norwich, CT
Parcel Owner	LEM ENTERPRISES LLC
Parcel Area (acres)	0.56
Approx. ground El. within Floodplain (ft, NAVD88)	114
Approx. ground El. outside of Floodplain (ft, NAVD88)	113
Area outside of 1% AEP Floodplain (acres)	0.56
Approx. flood storage volume (acre-ft)	0.56
Conclusion	Feasible; would require connection under CT Rt 2

Parcel Location	61 Fitchville Rd, Norwich, CT
Parcel Owner	SWINDELL STEPHANIE
Parcel Area (acres)	0.55
Approx. ground El. within Floodplain (ft, NAVD88)	114
Approx. ground El. outside of Floodplain (ft, NAVD88)	113
Area outside of 1% AEP Floodplain (acres)	0.55
Approx. flood storage volume (acre-ft)	0.55
Conclusion	Feasible; would require connection under CT Rt 2

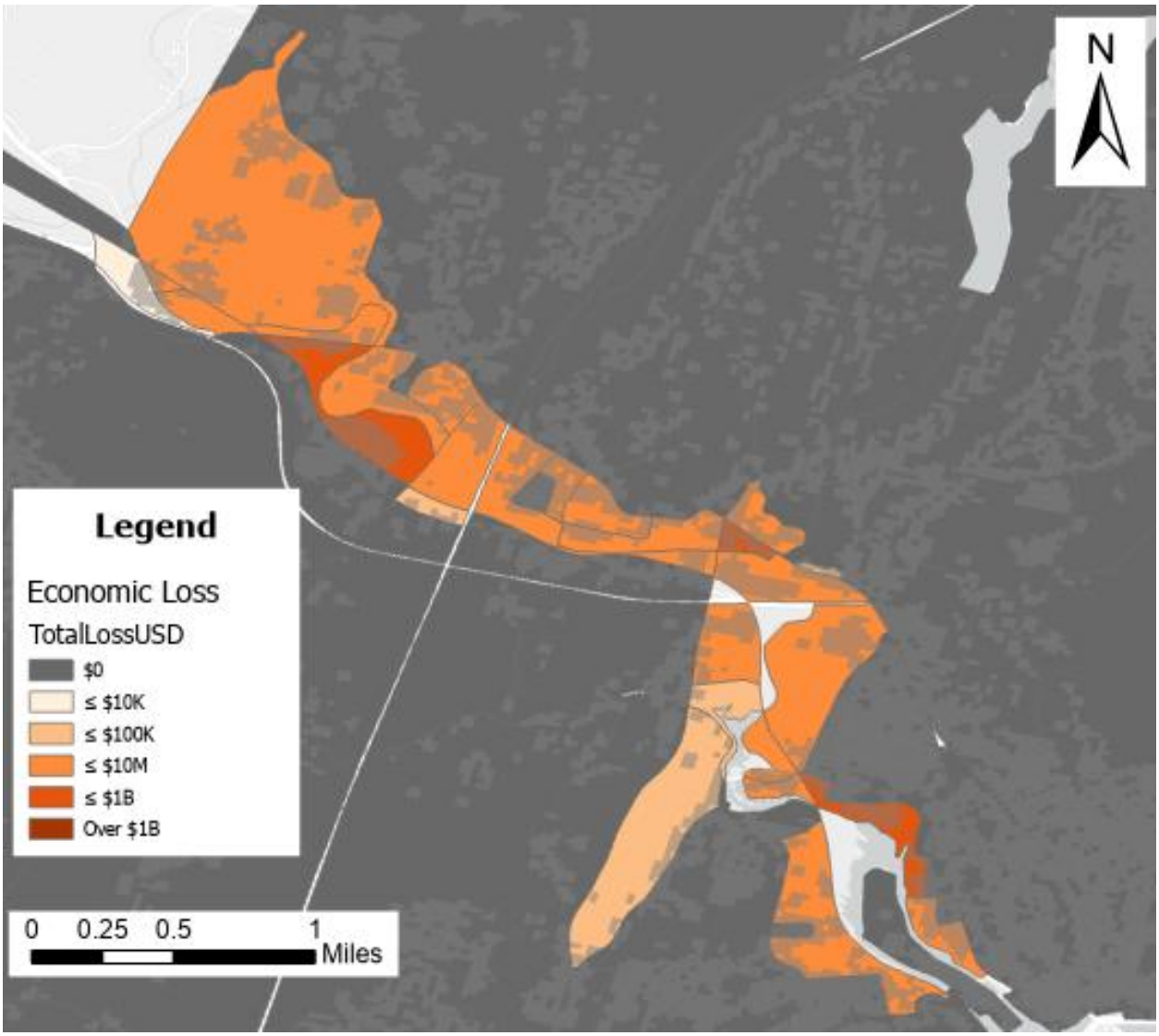
Parcel Location	65 Fitchville Rd, Bozrah, CT
Parcel Owner	DUBICKI MARK A & LISA M
Parcel Area (acres)	2.5
Approx. ground El. within Floodplain (ft, NAVD88)	114
Approx. ground El. outside of Floodplain (ft, NAVD88)	111
Area outside of 1% AEP Floodplain (acres)	2.5
Approx. flood storage volume (acre-ft)	7.5
Conclusion	Feasible; would require connection under CT Rt 2



Parcel Location	Fitchville Rd, Bozrah, CT
Parcel Owner	STRONG WARREN
Parcel Area (acres)	17.2
Approx. ground El. within Floodplain (ft, NAVD88)	114
Approx. ground El. outside of Floodplain (ft, NAVD88)	111
Area outside of 1% AEP Floodplain (acres)	7.6
Approx. flood storage volume (acre-ft)	22.8
Conclusion	Feasible; would require connection under CT Rt 2



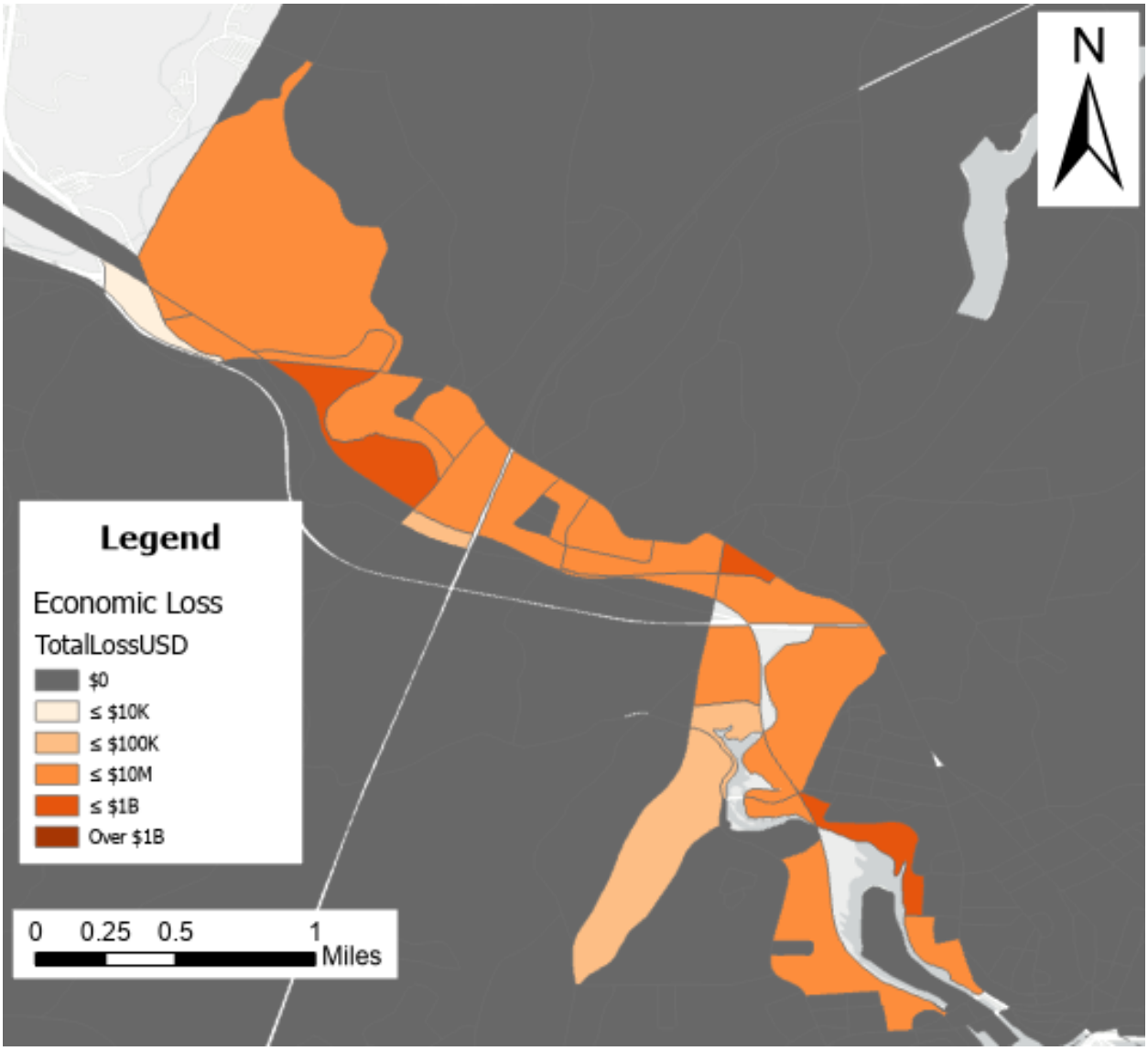
Appendix D- BCA Results



Existing Conditions Hazus Results: Professional Expected Damages Before Mitigation

Census Block	Total Loss	Building Loss	Contents Loss	Inventory Loss	Relocation Cost	Income Loss	Rental Income Loss	Wage Loss
090116962003001	5,654,000	572,000	1,423,000	447,000	383,000	1,156,000	320,000	1,353,000
090116962003002	4,357,000	225,000	1,111,000	21,000	181,000	1,441,000	145,000	1,233,000
090116962003003	180,000	40,000	92,000	14,000	5,000	8,000	1,000	20,000
090116962003004	4,862,000	251,000	903,000	12,000	165,000	126,000	67,000	3,338,000
090116962003006	4,159,000	188,000	674,000	134,000	193,000	499,000	104,000	2,367,000
090116962003012	1,336,000	155,000	436,000	100,000	50,000	241,000	34,000	320,000
090116962003013	1,620,000	5,000	48,000	2,000	70,000	322,000	38,000	1,135,000
090116962003015	89,000	0	0	0	0	28,000	0	61,000
090116962003017	13,190,000	790,000	2,893,000	3,000	955,000	2,470,000	710,000	5,369,000
090116962004004	3,000	1,000	1,000	0	1,000	0	0	0
090116963001016	148,000	7,000	17,000	0	5,000	80,000	4,000	35,000
090116963001017	19,357,000	2,175,000	6,664,000	785,000	987,000	4,426,000	652,000	3,668,000
090116963001018	8,088,000	597,000	1,944,000	204,000	554,000	1,876,000	323,000	2,590,000
090116963001020	13,000	0	0	0	0	7,000	0	6,000
090116963002010	578,000	199,000	165,000	15,000	16,000	109,000	6,000	68,000
090116963002013	346,000	189,000	85,000	0	52,000	0	20,000	0
090116963002014	2,325,000	90,000	376,000	19,000	207,000	549,000	28,000	1,056,000
090116963002015	6,039,000	392,000	1,138,000	415,000	423,000	786,000	314,000	2,571,000
090116963002016	5,530,000	878,000	1,888,000	940,000	365,000	674,000	279,000	506,000
090116965002004	14,236,000	3,789,000	4,152,000	17,000	866,000	2,884,000	743,000	1,785,000
090116965002007	531,000	34,000	146,000	6,000	3,000	130,000	2,000	210,000
090116965003001	4,823,000	734,000	1,482,000	26,000	315,000	678,000	26,000	1,562,000
090116965003015	202,000	16,000	74,000	0	0	33,000	0	79,000
090116966003001	130,000	2,000	6,000	0	0	45,000	0	77,000
090116966003003	21,000	0	1,000	0	0	6,000	0	14,000
090116966003010	12,000	1,000	1,000	0	1,000	1,000	0	8,000
090116967013002	187,000	0	0	0	0	4,000	0	183,000
090116968001008	418,000	133,000	182,000	0	1,000	30,000	0	72,000
Total	**98,434,000**	**11,463,000**	**25,902,000**	**3,160,000**	**5,798,000**	**18,609,000**	**3,816,000**	**29,686,000**

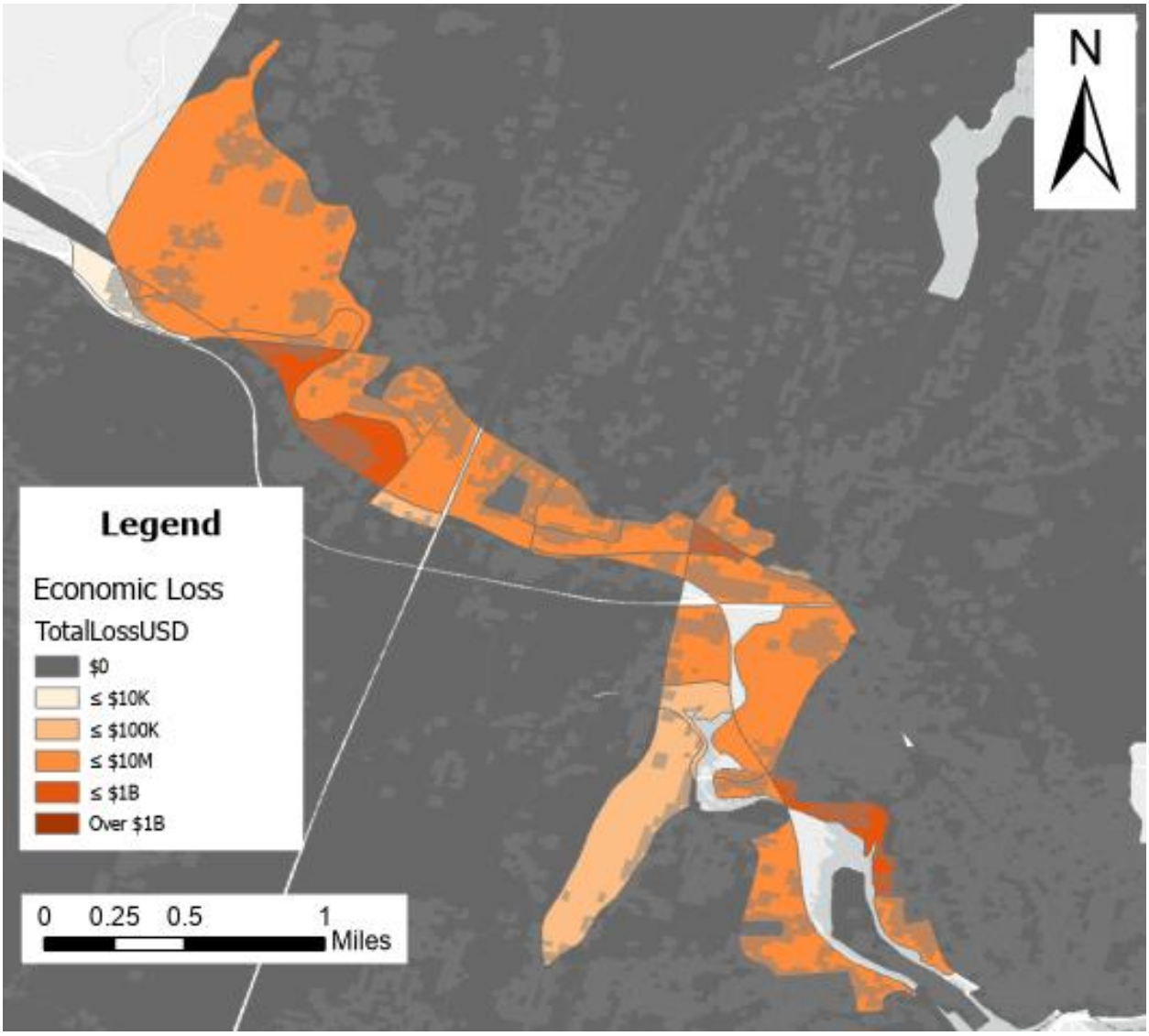
Existing Conditions Hazus Results: Professional Expected Damages Before Mitigation



Option #1- Channel Widening Hazus Results: Professional Expected Damages After Mitigation

Census Block	Total Loss	Building Loss	Contents Loss	Inventory Loss	Relocation Cost	Income Loss	Rental Income Loss	Wage Loss
90116962003001	5,654,000	572,000	1,423,000	447,000	383,000	1,156,000	320,000	1,353,000
90116962003002	4,357,000	225,000	1,111,000	21,000	181,000	1,441,000	145,000	1,233,000
90116962003003	180,000	40,000	92,000	14,000	5,000	8,000	1,000	20,000
90116962003004	4,862,000	251,000	903,000	12,000	165,000	126,000	67,000	3,338,000
90116962003006	4,134,000	184,000	669,000	133,000	193,000	495,000	103,000	2,357,000
90116962003012	1,313,000	154,000	428,000	98,000	49,000	238,000	33,000	313,000
90116962003013	1,587,000	5,000	46,000	1,000	70,000	316,000	37,000	1,112,000
90116962003015	72,000	0	0	0	0	22,000	0	50,000
90116962003017	13,189,000	790,000	2,892,000	3,000	955,000	2,470,000	710,000	5,369,000
90116962004004	3,000	1,000	1,000	0	1,000	0	0	0
90116963001017	12,596,000	1,277,000	3,632,000	418,000	716,000	3,330,000	472,000	2,751,000
90116963001018	2,979,000	258,000	791,000	84,000	126,000	693,000	70,000	957,000
90116963002010	537,000	184,000	152,000	14,000	15,000	102,000	5,000	65,000
90116963002013	295,000	162,000	71,000	0	46,000	0	16,000	0
90116963002014	1,181,000	26,000	120,000	4,000	109,000	312,000	13,000	597,000
90116963002015	3,449,000	151,000	447,000	160,000	219,000	542,000	160,000	1,770,000
90116963002016	3,625,000	511,000	1,085,000	564,000	302,000	527,000	227,000	409,000
90116965002004	14,221,000	3,786,000	4,149,000	17,000	861,000	2,884,000	740,000	1,784,000
90116965002007	530,000	34,000	145,000	6,000	3,000	130,000	2,000	210,000
90116965003001	4,823,000	734,000	1,482,000	26,000	315,000	678,000	26,000	1,562,000
90116965003015	201,000	16,000	73,000	0	0	33,000	0	79,000
90116966003001	130,000	2,000	6,000	0	0	45,000	0	77,000
90116966003003	21,000	0	1,000	0	0	6,000	0	14,000
90116966003010	12,000	1,000	1,000	0	1,000	1,000	0	8,000
90116967013002	191,000	0	0	0	0	4,000	0	187,000
90116968001008	418,000	133,000	182,000	0	1,000	30,000	0	72,000
Total	**80,560,000**	**9,497,000**	**19,902,000**	**2,022,000**	**4,716,000**	**15,589,000**	**3,147,000**	**25,687,000**

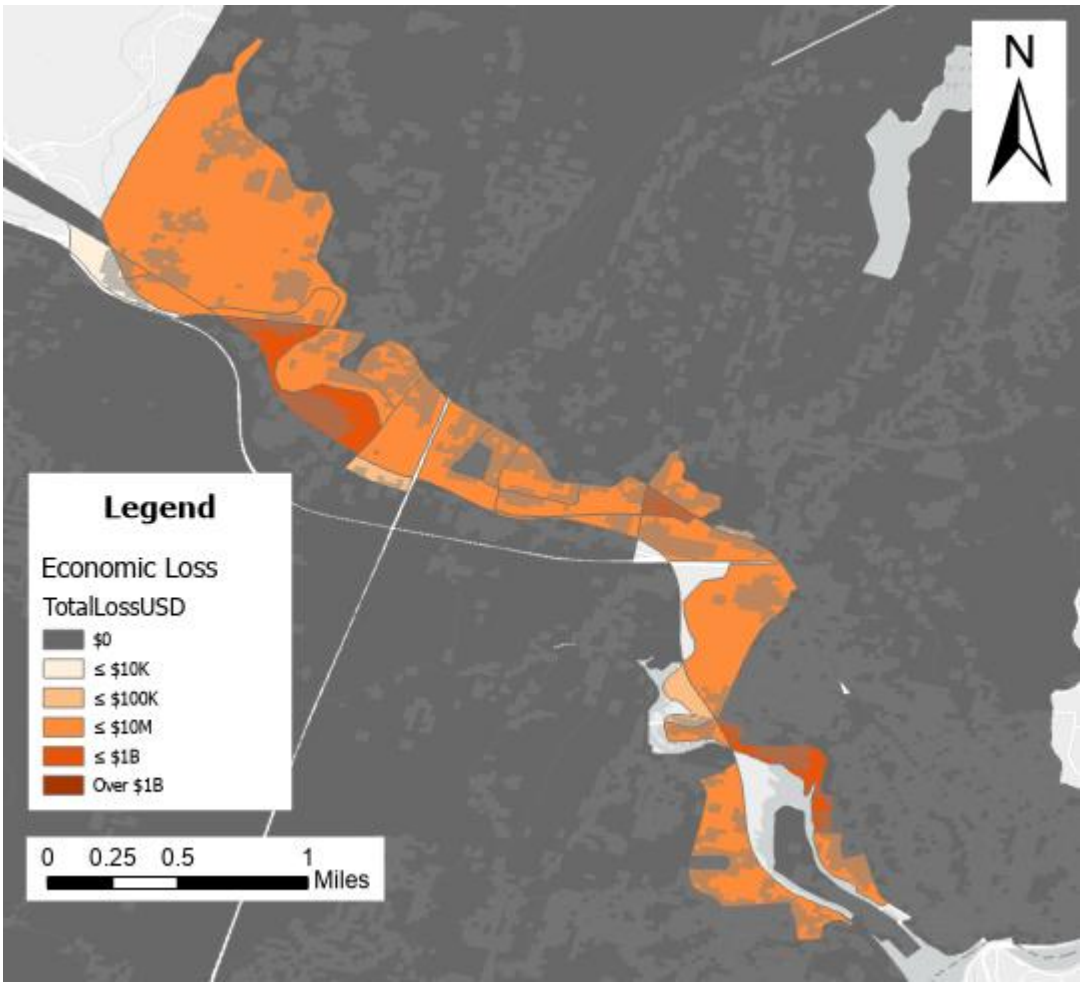
Option #1- Channel Widening Hazus Results: Professional Expected Damages After Mitigation



100-yr Dam Failure Hazus Results: Professional Expected Damages Before Mitigation

Census Block	Total Loss	Building Loss	Contents Loss	Inventory Loss	Relocation Cost	Income Loss	Rental Income Loss	Wage Loss
90116962003001	5,654,000	572,000	1,423,000	447,000	383,000	1,156,000	320,000	1,353,000
90116962003002	4,357,000	225,000	1,111,000	21,000	181,000	1,441,000	145,000	1,233,000
90116962003003	180,000	40,000	92,000	14,000	5,000	8,000	1,000	20,000
90116962003004	4,862,000	251,000	903,000	12,000	165,000	126,000	67,000	3,338,000
90116962003006	4,159,000	188,000	674,000	134,000	193,000	499,000	104,000	2,367,000
90116962003012	1,336,000	155,000	436,000	100,000	50,000	241,000	34,000	320,000
90116962003013	1,620,000	5,000	48,000	2,000	70,000	322,000	38,000	1,135,000
90116962003015	89,000	0	0	0	0	28,000	0	61,000
90116962003017	13,190,000	790,000	2,893,000	3,000	955,000	2,470,000	710,000	5,369,000
90116962004004	3,000	1,000	1,000	0	1,000	0	0	0
90116963001016	148,000	7,000	17,000	0	5,000	80,000	4,000	35,000
90116963001017	19,357,000	2,175,000	6,664,000	785,000	987,000	4,426,000	652,000	3,668,000
90116963001018	8,088,000	597,000	1,944,000	204,000	554,000	1,876,000	323,000	2,590,000
90116963001020	13,000	0	0	0	0	7,000	0	6,000
90116963002010	578,000	199,000	165,000	15,000	16,000	109,000	6,000	68,000
90116963002013	346,000	189,000	85,000	0	52,000	0	20,000	0
90116963002014	2,325,000	90,000	376,000	19,000	207,000	549,000	28,000	1,056,000
90116963002015	6,039,000	392,000	1,138,000	415,000	423,000	786,000	314,000	2,571,000
90116963002016	5,530,000	878,000	1,888,000	940,000	365,000	674,000	279,000	506,000
90116965002004	15,646,000	4,340,000	4,621,000	19,000	916,000	3,065,000	789,000	1,896,000
90116965002007	651,000	50,000	208,000	8,000	3,000	146,000	2,000	234,000
90116965003001	4,793,000	729,000	1,460,000	26,000	318,000	677,000	25,000	1,558,000
90116965003015	201,000	16,000	73,000	0	0	33,000	0	79,000
90116966003001	130,000	2,000	6,000	0	0	45,000	0	77,000
90116966003003	21,000	0	1,000	0	0	6,000	0	14,000
90116966003010	11,000	1,000	0	0	1,000	1,000	0	8,000
90116967013002	1,549,000	4,000	5,000	0	35,000	55,000	18,000	1,432,000
90116968001008	461,000	152,000	198,000	0	1,000	32,000	0	78,000
Total	**101,337,000**	**12,048,000**	**26,430,000**	**3,164,000**	**5,886,000**	**18,858,000**	**3,879,000**	**31,072,000**

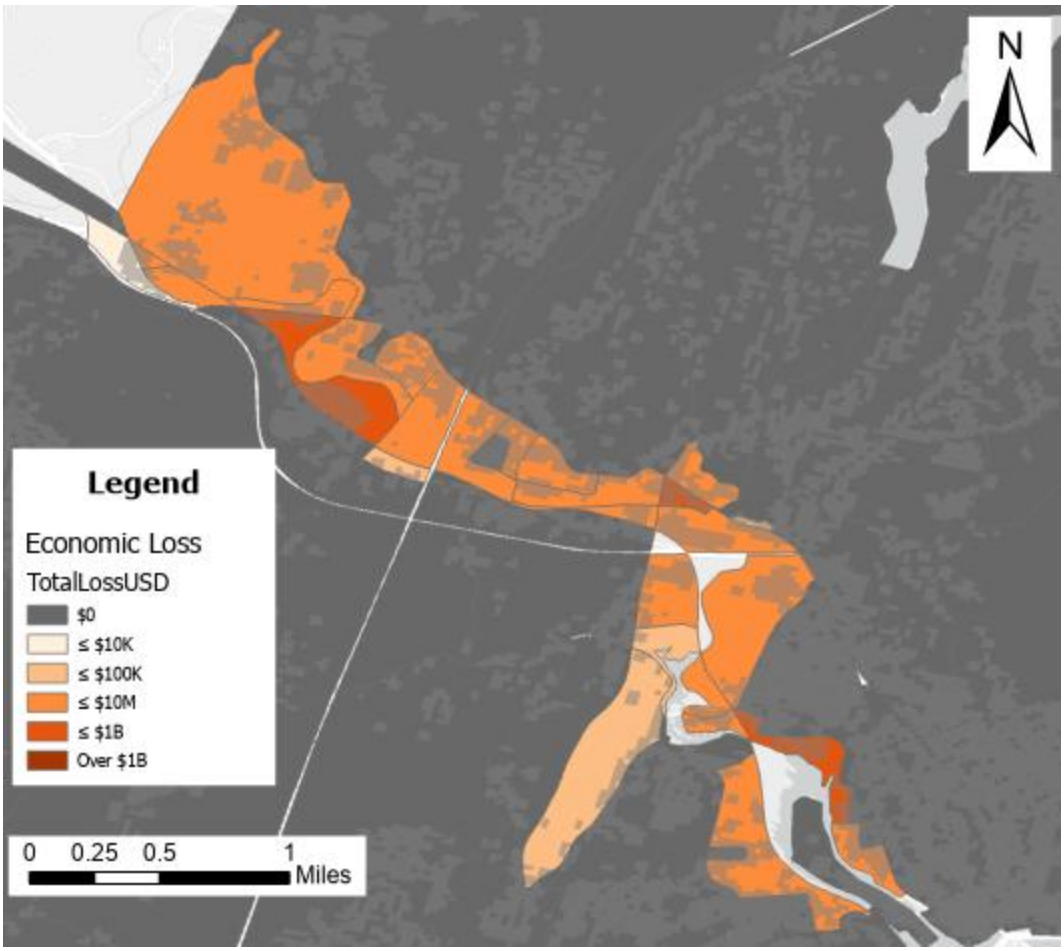
100-yr Dam Failure Hazus Results: Professional Expected Damages Before Mitigation



Option #2- Dam Removal Hazus Results: Professional Expected Damages After Mitigation

Census Block	Total Loss	Building Loss	Contents Loss	Inventory Loss	Relocation Cost	Income Loss	Rental Income Loss	Wage Loss
90116962003001	5,654,000	572,000	1,423,000	447,000	383,000	1,156,000	320,000	1,353,000
90116962003002	4,357,000	225,000	1,111,000	21,000	181,000	1,441,000	145,000	1,233,000
90116962003003	180,000	40,000	92,000	14,000	5,000	8,000	1,000	20,000
90116962003004	4,862,000	251,000	903,000	12,000	165,000	126,000	67,000	3,338,000
90116962003006	4,159,000	188,000	674,000	134,000	193,000	499,000	104,000	2,367,000
90116962003012	1,336,000	155,000	436,000	100,000	50,000	241,000	34,000	320,000
90116962003013	1,622,000	5,000	48,000	2,000	70,000	322,000	38,000	1,137,000
90116962003015	89,000	0	0	0	0	28,000	0	61,000
90116962003017	13,190,000	790,000	2,893,000	3,000	955,000	2,470,000	710,000	5,369,000
90116962004004	3,000	1,000	1,000	0	1,000	0	0	0
90116963001016	152,000	8,000	20,000	0	5,000	80,000	4,000	35,000
90116963001017	19,456,000	2,192,000	6,710,000	791,000	984,000	4,445,000	652,000	3,682,000
90116963001018	6,426,000	478,000	1,506,000	157,000	430,000	1,516,000	249,000	2,090,000
90116963001020	14,000	0	0	0	0	8,000	0	6,000
90116963002010	580,000	199,000	167,000	15,000	16,000	109,000	6,000	68,000
90116963002013	346,000	189,000	85,000	0	52,000	0	20,000	0
90116963002014	2,374,000	91,000	396,000	19,000	210,000	557,000	29,000	1,072,000
90116963002015	6,136,000	403,000	1,163,000	424,000	431,000	795,000	320,000	2,600,000
90116963002016	5,547,000	884,000	1,898,000	944,000	363,000	674,000	278,000	506,000
90116965002004	14,227,000	3,786,000	4,148,000	17,000	867,000	2,882,000	743,000	1,784,000
90116965002007	292,000	21,000	83,000	3,000	0	71,000	0	114,000
90116965003001	2,120,000	125,000	357,000	11,000	210,000	424,000	17,000	976,000
90116965003015	99,000	6,000	32,000	0	0	18,000	0	43,000
90116967013002	211,000	0	0	0	0	5,000	0	206,000
90116968001008	418,000	133,000	182,000	0	1,000	30,000	0	72,000
Total	**93,850,000**	**10,742,000**	**24,328,000**	**3,114,000**	**5,572,000**	**17,905,000**	**3,737,000**	**28,452,000**

Option #2- Dam Removal Hazus Results: Professional Expected Damages After Mitigation



Option #3- Acquisition Hazus Results: Professional Expected Damages After Mitigation

Census Block	Total Loss	Building Loss	Contents Loss	Inventory Loss	Relocation Cost	Income Loss	Rental Income Loss	Wage Loss
90116962003001	5,654,000	572,000	1,423,000	447,000	383,000	1,156,000	320,000	1,353,000
90116962003002	4,357,000	225,000	1,111,000	21,000	181,000	1,441,000	145,000	1,233,000
90116962003003	180,000	40,000	92,000	14,000	5,000	8,000	1,000	20,000
90116962003004	4,862,000	251,000	903,000	12,000	165,000	126,000	67,000	3,338,000
90116962003006	4,159,000	188,000	674,000	134,000	193,000	499,000	104,000	2,367,000
90116962003012	1,336,000	155,000	436,000	100,000	50,000	241,000	34,000	320,000
90116962003013	1,620,000	5,000	48,000	2,000	70,000	322,000	38,000	1,135,000
90116962003015	89,000	0	0	0	0	28,000	0	61,000
90116962003017	13,190,000	790,000	2,893,000	3,000	955,000	2,470,000	710,000	5,369,000
90116962004004	3,000	1,000	1,000	0	1,000	0	0	0
90116963001016	148,000	7,000	17,000	0	5,000	80,000	4,000	35,000
90116963002010	578,000	199,000	165,000	15,000	16,000	109,000	6,000	68,000
90116963002013	346,000	189,000	85,000	0	52,000	0	20,000	0
90116963002014	2,325,000	90,000	376,000	19,000	207,000	549,000	28,000	1,056,000
90116963002015	6,039,000	392,000	1,138,000	415,000	423,000	786,000	314,000	2,571,000
90116963002016	5,530,000	878,000	1,888,000	940,000	365,000	674,000	279,000	506,000
90116965002004	14,236,000	3,789,000	4,152,000	17,000	866,000	2,884,000	743,000	1,785,000
90116965002007	531,000	34,000	146,000	6,000	3,000	130,000	2,000	210,000
90116965003001	4,823,000	734,000	1,482,000	26,000	315,000	678,000	26,000	1,562,000
90116965003015	202,000	16,000	74,000	0	0	33,000	0	79,000
90116966003001	130,000	2,000	6,000	0	0	45,000	0	77,000
90116966003003	21,000	0	1,000	0	0	6,000	0	14,000
90116966003010	12,000	1,000	1,000	0	1,000	1,000	0	8,000
90116967013002	187,000	0	0	0	0	4,000	0	183,000
90116968001008	418,000	133,000	182,000	0	1,000	30,000	0	72,000
Total	**70,976,000**	**8,691,000**	**17,294,000**	**2,171,000**	**4,257,000**	**12,300,000**	**2,841,000**	**23,422,000**

Option #3- Acquisition Hazus Results: Professional Expected Damages After Mitigation