

Hartford and East Hartford, CT Section 216 Levee Rehabilitation Flood Risk Management Feasibility Study

Draft Feasibility Report & Draft Environmental Assessment



April 2026



**US Army Corps
of Engineers**
New England District



HARTFORD AND EAST HARTFORD SECTION 216 LEVEE REHABILITATION FLOOD RISK MANAGEMENT FEASIBILITY STUDY

DRAFT FEASIBILITY STUDY EXECUTIVE SUMMARY

STUDY INFORMATION

The U.S. Army Corps of Engineers (USACE), New England District is conducting a feasibility study for the Hartford and East Hartford, Section 216 Levee Rehabilitation, Flood Risk Management (FRM) Feasibility Study and prepared the attached Integrated Feasibility Report and Environmental Assessment (IFR/EA). This IFR/EA documents the study process and identifies a Tentatively Selected Plan (TSP).

The city of Hartford and the town of East Hartford are the non-federal sponsors (NFSs) for this feasibility study. On January 3, 2023, the USACE and the two NFSs executed a Feasibility Cost Study Agreement (FCSA). The feasibility study was performed with a project cost share of 50 percent Federal funding and 50 percent contributed by the NFSs.

The period of analysis for the study is a 50-year period, from 2030 through 2079. For evaluation purposes, project implementation was estimated to begin in the year 2030 and is expected to last 5 years. The base year is considered the year the alternatives have been implemented and begin to accrue benefits. Therefore, the base year for this project is assumed to be 2035.

The total estimated value of structures and the content within structures located within the area defended by the two FRM systems is approximately \$2.0 Billion.

PROBLEM

The Hartford and East Hartford Flood Risk Management (FRM) systems, approximately 80 years in age, are facing a growing risk of catastrophic failure. Key components of these USACE-built systems have reached the end of their service life, a problem stemming from system-wide aging infrastructure rather than a lack of maintenance. The city of Hartford and town of East Hartford have partnered with the New England District under Section 216 of the Flood Control Act of 1970 (Public Law 91-611) to analyze the systems with the goal of addressing end of service life issues that exceed the capability of the local sponsors.

Problems associated with the existing conditions of the Hartford and East Hartford FRM systems include flooding that could impact people and property within the area protected by the systems. With the change in physical and economic condition associated with system features lasting beyond their expected service lives, there is a flood risk to the

population and structures in Hartford and East Hartford. Specific problems that will be addressed by this feasibility study include:

1. Risk to property related to flooding events in the city of Hartford and town of East Hartford over the period of analysis (50 years) due to inadequate, out of date, failing features of the FRM systems.
2. Risk to public health, safety, and critical infrastructure related to flooding events in areas of the city of Hartford and town of East Hartford defended by the FRM systems over the period of analysis (50 years).

PLANNING OBJECTIVES

The overarching objective is to find an effective and environmentally acceptable solution to ensure the sustainability and resiliency of these FRM systems, which reduces the risk of damage to residences, businesses, and critical infrastructure, life safety to vulnerable communities and negative impacts to the local communities and the region. Specific objectives are to:

1. Reduce current risks to property and safety of residents in the study area for the 50-year period of analysis.
2. Address major performance deficiencies caused by degradation or exceedance of service life to restore the design level of flood risk management through the 50-year period of analysis.

PLANS CONSIDERED

The focused array of alternatives is provided in the table below. The array consists of four plans, including the No Action Alternative. No Locally Preferred Plan has been identified.

The Focused Array of Alternatives

Alternative 1 – No Action Alternative
No Measures
Alternative 2a– Reconstruction Plan with Pump Stations Rehabs
<ul style="list-style-type: none"> • Pump Station Rehabilitation <ul style="list-style-type: none"> North Meadows Pump Station (<i>Hartford</i>) South Meadows Pump Station (<i>Hartford</i>) Meadow Hill Pump Station (<i>East Hartford</i>) • Replace Sluice Gates on the Park River System (<i>Hartford</i>) • Toe Drain Replacement - Segments #4, #5 & #6 (<i>East Hartford</i>)
Alternative 3 – Risk Driver Plan
<ul style="list-style-type: none"> • Dutch Point Floodwall Joint Displacement Repair (<i>Hartford</i>) • Filter Blanket at Main Street Closure Structure - Seepage Risk (<i>East Hartford</i>) • Toe Drain Replacement – Segment #2 – Seepage Risk (<i>East Hartford</i>)
Alternative 4a – Combined Plan
Alternative 2a + Alternative 3

To select the TSP, a comprehensive benefits analysis was completed on the focused array of alternatives, including National Economic Development (NED), Regional Economic Development (RED), Other Social Effects (OSE) and Environmental Quality (EQ). The results of the comprehensive benefits analysis are compiled in the array provided below. Alternative 4a provided the most RED, OSE and EQ benefits and was determined to be the TSP.

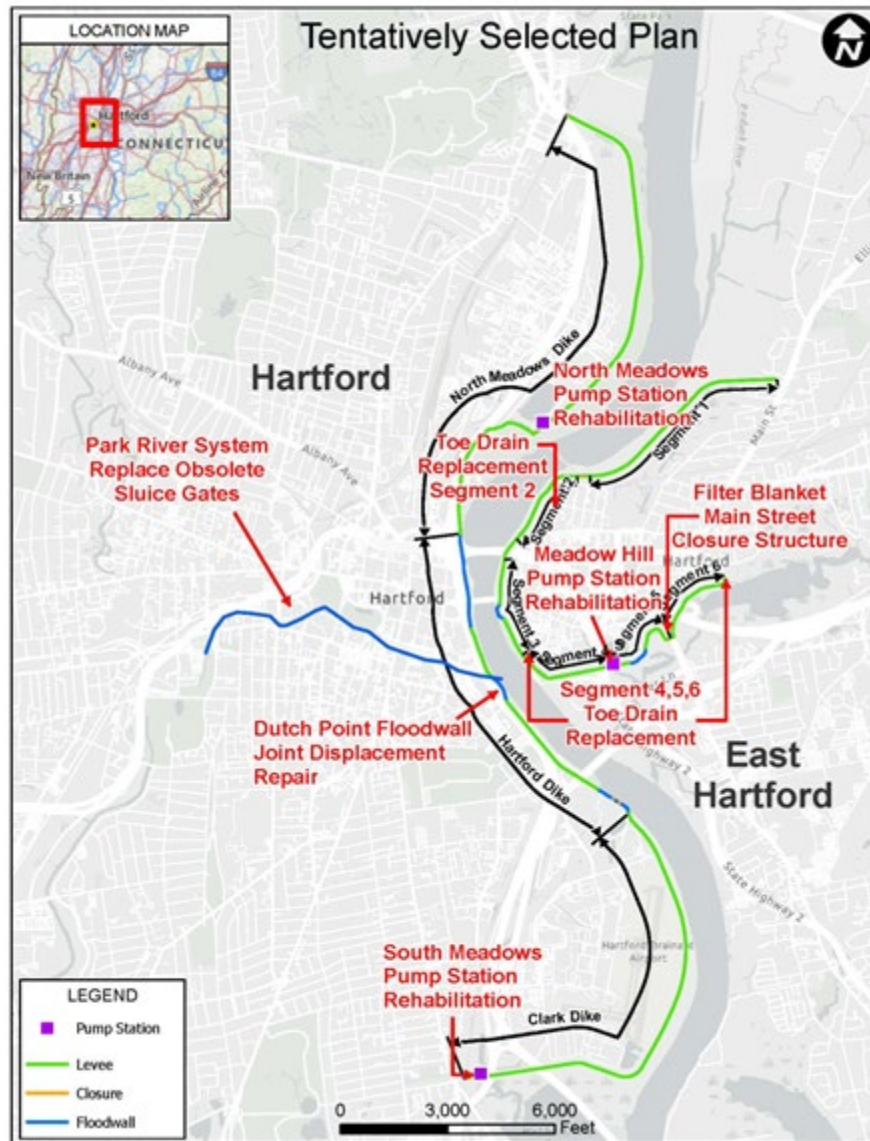
TENTATIVELY SELECTED PLAN

The elements of the TSP are provided in the table below, while the figure shows the location of each.

The Tentatively Selected Plan

Alternative 4a – Combined Plan with Pump Station Rehabilitation

- Pump Station Rehabilitation
 - North Meadows Pump Station (*Hartford*)
 - South Meadows Pump Station (*Hartford*)
 - Meadow Hill Pump Station (*East Hartford*)
- Replace Obsolete Sluice Gates on the Park River System (*Hartford*)
- Toe Drain Replacement - Segments #4, #5 & #6 (*East Hartford*)
- Dutch Point Floodwall Joint Displacement Repair (*Hartford*)
- Filter Blanket at Main Street Closure Structure - Seepage Risk (*East Hartford*)
- Toe Drain Replacement – Segment #2 – Seepage Risk (*East Hartford*)



Locations of Measures Included in the Tentatively Selected Plan

PROJECT IMPACTS

Based on evaluation of environmental resources and project effects, there are no significant or specific environmental considerations necessary for project implementation. There are historic properties and archeological resources located in the two towns within the project area. Because USACE cannot fully determine the project's effect on historic properties prior to finalization of this feasibility study, a programmatic agreement (36 CFR 800.14(b)(1)(iii)) has been prepared in accordance with Section 106 of the National Historic Preservation Act and implementing regulations 36 CFR 800. The programmatic agreement allows the USACE to complete the necessary historic, architectural and archaeological surveys (if needed) during the follow-on Pre-Construction, Engineering and Design phase of the project, once the measures and identified properties have been confirmed.

Summary of Reasonably Foreseeable Effects of the Tentatively Selected Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air quality	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Aquatic resources/wetlands	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Fish and wildlife habitat	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Hazardous, toxic, & radioactive waste	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Historic properties & cultural resources	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hydrology	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Infrastructure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Land use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public Health & Safety	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Socioeconomics	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soils	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Threatened/Endangered species/critical habitat	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water quality	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

PROJECT SCHEDULE

The detailed cost estimate assumed a construction completion date of January 2033 which is within the range of uncertainty associated with the administration's budget and Congressional appropriation process. The latest timeframes are subject to change based on availability of funding in an efficient manner.

Estimated Design and Construction Schedule

Action	Estimated Start Date
Integrated Final Feasibility Report/EA to Higher Authority for Approval	September 2026
Sign Chief's Report and Chief's Report submitted to ASA (CW)	December 2026
ASA (CW) Integrated Final Feasibility Report/EA Approval	February 2027
ASA (CW) submits report to OMB	February 2027
Final Report to Congress	April 2027
Pre-Construction, Engineering and Design phase	January 2028

BENEFITS AND COST

The total investment cost estimate of Alternative 4a is \$100,632,000. Total project first costs of the plan were calculated using September 2025 price levels at a federal discount rate of 3.25% for 2026. Information about the economic costs of the TSP is provided below.

Economic Summary of the Tentatively Selected Plan

Federal discount rate FY2026 = 3.25%, OCT 2025 Price Levels, 50-Year Period of Analysis, Costs in \$1,000	
Project First Costs	
Construction Contract Cost	\$46,077
Preconstruction Engineering & Design (PED)	\$25,803
Contingency (40%)	\$28,752
Project First Costs Total	\$100,632
Interest During Construction (IDC)	\$2,918
Total Investment Cost	\$103,550
Capital Recovery Factor	0.04073
Total Average Annual Cost	\$4,218
Average Annual Benefits	\$1,824
Net Benefits	-\$2,394
Benefit-Cost Ratio (BCR)	0.43

The total project cost will be divided between the two non-federal sponsors (the city of Hartford and the town of East Hartford) into two separable projects.

Current Project First Cost Divided between the Two Non-Federal Sponsors

Project Component	Estimated Project First Costs
East Hartford FRM System	\$38.4 Million
Hartford FRM System	\$62.2 Million
Total Project	\$101 Million

The final feasibility report will include a revised cost estimate based on a higher level of design maturity.

DRAFT FINDING OF NO SIGNIFICANT IMPACT

HARTFORD AND EAST HARTFORD SECTION 216 LEVEE REHABILITATION FLOOD RISK MANAGEMENT FEASIBILITY STUDY

The U.S. Army Corps of Engineers, New England District (USACE), has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. § 4321 *et seq.*), as amended. The draft Integrated Feasibility Report and Environmental Assessment (IFR/EA) for the Hartford and East Hartford, Section 216 Levee Rehabilitation, Flood Risk Management Feasibility Study addresses the feasibility and federal role in rehabilitating the aging Flood Risk Management (FRM) systems in Hartford and East Hartford, Connecticut.

The EA, incorporated herein by reference, evaluated six alternatives including the No Action Alternative, the Reconstruction Plan with Pump Stations Rehabilitation Alternative 2A, the Reconstruction Plan with Pump Stations Replacement Alternative 2B, the Risk Driver Plan Alternative 3, the Combined Plan with Pump Station Rehabilitation Alternative 4A, and the Replacement Plan with Pump Station Replacement 4B. All alternatives involve the repair or rehabilitation of the FRM system infrastructure. Under the No Action Alternative, USACE would not rehabilitate the FRM systems and the risk of failure of the FRM systems would remain. Alternatives 2A and 2B both address the Hartford and East Hartford levees, but Alternative 2A includes the rehabilitation of the pump stations while Alternative 2B involves full replacement of the pump stations. Alternatives 4A and 4B are two plans that combine Alternative 3 with either Alternative 2A (i.e., Alternative 4A) or Alternative 2B (i.e., Alternative 4B) and differ based on either rehabilitating or replacing the pump stations. Alternatives 2B and 4B were removed from further analysis due to high implementation cost, constructability challenges, and real estate complexity.

The Proposed Action (Alternative 4A) involves architectural, electrical, structural, and mechanical improvements for two pump stations in Hartford (North Meadows and South Meadows) and one pump station in East Hartford (Meadow Hills); installation of mini-piles for the Dutch Point floodwall in Hartford; replacement of sluice gates on the Park River system in Hartford; installation of a filter blanket at the Main Street closure structure in East Hartford; and replacement of toe drain segments #2, #4, #5, #6 in East Hartford. The recommended plan is the Total Net Benefits Plan.

For all alternatives, the reasonably foreseeable effects were evaluated as appropriate. A summary assessment of the reasonably foreseeable effects of the Proposed Action is listed in **Table 1**:

Table 1: Summary of Potential Effects of the Recommended Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air quality	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Aquatic resources/wetlands	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Fish and wildlife habitat	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Hazardous, toxic, & radioactive waste	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Historic properties & cultural resources	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hydrology	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Infrastructure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Land use	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Public Health & Safety	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Recreation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Socioeconomics	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soils	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Threatened/Endangered species/critical habitat	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Water quality	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts. No compensatory mitigation is required as part of the recommended plan. Public review of the draft EA will begin on DATE. All comments submitted during the public review period will be considered in the Final EA.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the USACE determined that historic properties may be adversely affected by the recommended plan. USACE and the Connecticut Historic Preservation Office, entered into a Programmatic Agreement, dated DATE OF AGREEMENT. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts on historic properties.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, USACE determined that the recommended plan may affect, but is not likely to adversely affect, the federally proposed endangered tricolored bat (*Perimyotis subflavus*) and the federally proposed threatened monarch butterfly (*Danaus plexippus*). USACE has made the determination that the proposed action will not jeopardize the continued existence of the tricolored bat or the monarch butterfly, and conference with USFWS is not required. USACE has also determined that there will be no effect on the federally listed Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), the shortnose sturgeon (*Acipenser*

brevirostrum), or designated critical habitat for the New York Bight distinct population segments of Atlantic sturgeon. No other designated critical habitat occurs within the action area.

Technical, environmental, economic, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the review by other federal, state and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the recommended plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Pursuant to Section 176(c) of the Clean Air Act, an air quality analysis was performed for the Proposed Action. The estimated emissions for the proposed project will not exceed *de minimis* threshold levels and therefore, a conformity determination is not required.

I certify that the resulting EA represents the following: USACE's good-faith effort to prioritize documentation of the most important considerations and factors required by NEPA within the congressionally mandated page limits and timeline; that this prioritization reflects the USACE's expert judgment; the document is substantially complete; that any considerations addressed briefly or left unaddressed were, in the USACE's judgment, comparatively not of a substantive nature that meaningfully informed the consideration of environmental effects and the resulting decision on how to proceed; and that in the USACE's judgment the analysis contained therein is adequate to inform and reasonably explain the USACE's final decision regarding the proposed federal action.

Date

Justin R. Pabis, P.E.
Colonel, U.S. Army Corps of Engineers
District Commander

**HARTFORD AND EAST HARTFORD
SECTION 216 LEVEE REHABILITATION
FLOOD RISK MANAGEMENT
FEASIBILITY STUDY**

**DRAFT FEASIBILITY REPORT & ENVIRONMENTAL
ASSESSMENT**

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1.0 STUDY INFORMATION AND BACKGROUND

1.1 STUDY OVERVIEW

This Feasibility Study, authorized by the Flood Control Act of 1970 (Public Law 91-611), was developed by the U.S. Army Corps of Engineers (USACE) New England District in partnership with the city of Hartford and the town of East Hartford. The study investigates two separate Flood Risk Management (FRM) systems on the Connecticut River: one on the western bank, which is owned, managed and operated by Hartford and the other on the adjacent eastern bank owned, managed and operated by East Hartford. This cooperative effort was formally initiated through a Feasibility Cost Share Agreement signed by all parties on January 3, 2023. Following the execution of the agreement, this study effort assessed the potential for federal involvement in rehabilitating the aging facilities of both systems.

Please note that throughout this report the terms “FRM system”, “levee system” and “levee embankment” or “levee” are used. In this feasibility report, the terms are not interchangeable and have different meanings. The phrase “FRM system” refers to the entire integrated system, including the pump stations, sluice gates, levee embankments and floodwalls, etc. The terms “levee system” is the system of structures built to protect an area from riverine flooding, includes earthen embankments, flood walls and closures. While “levee embankment” and “levee” only refers to the earthen embankments that are included in each system.

Furthermore, the official name of some of the project features include the term “dike” for example, the Clark Dike. While these specific project features were originally named “dikes,” by definition, they are levee embankments. When referring to the name of the project feature the word “dike” will be retained as a proper name, but when describing the type of flood protection feature type they will be referred to as “levee embankment” or “levee.”

1.2 STUDY AUTHORITY

The authority to conduct feasibility studies examining the reconstruction of structural flood risk management projects and separable elements constructed by USACE is Section 216 of the Flood Control Act of 1970 (Public Law 91-611) which states:

The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significant changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.

This study authority, as well as USACE policy contained in the *Memorandum for Commanders: Reconstruction of USACE Structural Flood Damage Reduction Projects*

for which Non-Federal Interests are Responsible for Operations, Maintenance, Repair, Rehabilitation and Replacement dated August 16, 2005, are the primary source guidance for analysis conducted for this study. Copies of supporting guidance can be found in **Appendix 1-D: References & Supporting Guidance**.

1.3 STUDY PURPOSE AND NEED*

This study provides a crucial opportunity to analyze the vulnerabilities of the current FRM systems and to develop a plan for a modern, reliable flood protection system. A robust FRM system is not only essential for public safety but also for the financial well-being of residents, businesses and communities who depend on the FRM systems. The purpose of this study is to assess the feasibility and federal role in rehabilitating the aging FRM systems in Hartford and East Hartford, with the primary goal of finding feasible ways to improve these systems to reduce risks to life and safety, minimize property damage, and increase the overall resiliency of the communities they protect. The purpose and need satisfies the Flood Risk Management authority of USACE.

The historic floods of 1936 and 1938 profoundly impacted Hartford and East Hartford, leaving a lasting mark on the community and its environment. The Great New England Flood of March 1936 was the result of a severe winter with heavy snowfall, followed by two successive storm systems that brought heavy rain. This combination of rapid snowmelt and rainfall caused the Connecticut River to rise to a record-breaking 37.6 feet in Hartford, a record that remains to this day. The flood inundated 20% of downtown Hartford, turning Bushnell Park into a lake and forcing residents to navigate the streets by boat. The community suffered immensely, with thousands left homeless, and the city lost power and telephone communications. The environmental impact was also severe, with massive blocks of ice scouring the river valley, destroying bridges, and altering the landscape. The floodwaters left behind up to three feet of mud and debris, ruining agricultural land and requiring an extensive cleanup effort.

Two years later, in September 1938, the region was struck again, this time by the "Great New England Hurricane." This event was a devastating combination of a hurricane, flood, and tidal surge. Heavy rains had already saturated the ground and swollen the rivers for days before the hurricane made landfall. The hurricane then dumped an additional 6 to 17 inches of rain across the Connecticut River Valley. In Hartford, the Connecticut River crested at 35.4 feet, the second-highest level on record, once again flooding parts of the city. The community impact was catastrophic, causing 600 deaths across New England and extensive damage to homes, businesses, and infrastructure. In East Hartford, the dikes built after the 1936 flood were instrumental in protecting large portions of the town, but areas outside this system still experienced significant flooding. Environmentally, the hurricane uprooted an estimated 2 billion trees in the region, flattened tobacco barns in the valley, and caused rivers to change their courses, permanently altering the landscape.

These two floods prompted the construction of the comprehensive FRM systems that currently protect Hartford and East Hartford from future disasters and are the subjects of this feasibility study.

A failure of the FRM systems protecting Hartford and East Hartford would be a disaster of catastrophic proportions, far exceeding the historic floods of 1936 and 1938 that led to their construction. A levee breach would unleash a torrent of water into densely populated urban and industrial areas. Such an event would be comparable to the Great Flood of 1993, which saw record rainfall that led to the failure of over 1,000 levees along the Mississippi and Missouri Rivers. That event destroyed 10,000 homes, caused 50 deaths, and resulted in damages exceeding \$15 billion. A similar failure in Hartford would cause immense loss of property and potentially loss of life, with devastating economic consequences for the entire region. For East Hartford alone, it's estimated that approximately 10,000 people live and work behind the levee (daytime population as estimated by the USACE National Structure Inventory 2023), and a breach could cause loss of life and destroy homes, businesses, and critical infrastructure, leading to staggering economic losses.

Compounding the disaster, the Hartford and East Hartford FRM systems rely on a series of pump stations for interior drainage. These pumps are critical for removing the rainwater that accumulates behind the levees. Should these pump stations fail due to a power outage or mechanical breakdown during a major storm, the protected areas would flood from within, even if the main river levees hold. This internal flooding presents a secondary but equally severe threat, capable of inundating neighborhoods and critical infrastructure with stormwater that has nowhere to go.

Flooding poses significant threats to both communities and the environment. Severe flooding can cause damage to property and critical infrastructure like roads, railways, and communication systems which can lead to severe economic costs. These economic burdens can include direct property damage, rising insurance premiums, and the risk of displacement. Flooding also has significant impacts to public health and the natural environment. Floodwater can become contaminated with various pollutants, and runoff from heavy rainfall can wash pollutants into waterways, degrading water quality and posing a threat to public health and natural environments. Flood risk is projected to grow, with a higher likelihood of severe storms and increased precipitation. The ongoing threat of flooding remains a critical issue for the safety and well-being of communities at risk of flooding.

The impacts of flooding in the Hartford and East Hartford area extend far beyond immediate water damage, and could cripple critical regional infrastructure, stifle economic growth, and impose severe financial burdens on the community. A failure of the FRM systems would jeopardize essential services, including the Hartford Pollution Control Facility, which serves eight communities and processes a significant portion of New England's sludge. This facility can process up to 200 million gallons daily. Its failure would cause a devastating environmental and public health disaster. The flooding of a wastewater treatment facility, such as the ones located behind the Hartford and East Hartford levees, would trigger a severe public health and environmental crisis. When a treatment plant is inundated, it fails, releasing massive quantities of untreated or partially treated sewage, industrial waste, and other hazardous materials directly into the floodwaters. This toxic slurry would contaminate the entire flooded area, exposing

residents to a dangerous mix of bacteria, viruses, and chemicals, creating conditions ripe for the outbreak of waterborne diseases. The cleanup of this hazardous material from buildings, streets, and soil would be a monumental, expensive, and lengthy undertaking.

The region's strategic importance is amplified by its role as a critical transportation nexus, home to the I-84/I-91 interchange, major rail lines, and the Hartford-Brainard Regional Airport. The inundation of this vital hub would trigger severe economic consequences, paralyzing the essential transportation arteries that are foundational to the commerce and connectivity of the entire Northeast.

The majority of the study area is identified as economically disadvantaged. These communities bear a disproportionately heavy burden from the impacts of flooding, a reality driven by a combination of geographic, financial, and social vulnerabilities. These neighborhoods are frequently situated in low-lying, flood-prone areas where land values are lower, often adjacent to industrial zones that can release toxic materials during a flood. Residents typically live in older, less resilient housing and are more likely to be renters without flood insurance, leaving them with few resources to recover from property loss. The inability to afford evacuation costs, such as transportation and lodging, can trap families in harm's way. In the aftermath, recovery is a steep uphill battle; navigating complex government aid programs, combating mold and other health hazards, and finding affordable temporary housing can be insurmountable challenges for those with limited savings and unstable employment, often leading to long-term displacement and the fracturing of vital community support networks.

The impact on the Connecticut River's ecosystem would be equally severe. The sudden discharge of contaminated floodwater and raw sewage from a compromised treatment plant would introduce pollutants into the riverine system. This influx of pollutants and nutrient loading from sewage could trigger algal blooms downstream, including in local wetlands, depleting the water's oxygen and creating "dead zones" incapable of supporting aquatic life. The disaster would cause irreparable harm to the river's ecosystem, with effects potentially occurring miles downstream. The force of a major breach could also physically alter the river's channel and adjacent landscape, compounding the long-term ecological damage.

The significance of such a failure cannot be overstated. It would represent a cascading disaster, combining catastrophic flooding, loss of life and immense property damage, and a severe, long-lasting environmental contamination event. The rebuilding process would be extraordinarily difficult, involving not just the reconstruction of physical infrastructure but also extensive environmental remediation and a profound social and economic recovery effort for the affected communities.

Despite their 80-year age, these FRM systems have been remarkably effective, protecting the greater Hartford region from significant riverine flooding. According to the New England District Project Benefits Report Tool, from 2006 to 2026, the systems generated a combined \$691.8 million in flood prevention benefits (\$466.5 million for Hartford and \$225.3 million for East Hartford), equating to average annual benefits of \$32 million and

\$15 million, respectively. However, this legacy of protection is now at a critical juncture. Having reached the end of their service life, the aging systems face a significant risk of catastrophic failure, transforming the very infrastructure that has provided decades of security into a considerable threat to public health, safety, and property.

A robust FRM system is essential to ensuring the continued public safety and financial well-being of the residents, businesses, and communities in Hartford and East Hartford. Both municipalities rely on the optimal performance of these systems for protection against annual riverine flooding, and this dependence is not expected to diminish in the future.

1.4 STUDY SCOPE

The scope of this study includes the areas defended by the FRM systems. These areas, primarily zoned for commercial and industrial uses, are densely developed urban communities which include public, commercial, residential, and industrial properties. A small number of residential properties are located within the study area. Structures within the defended areas have a combined estimated property value of \$2 billion. By enhancing these aging systems, USACE can ensure the long-term security of the public, commercial, residential, and industrial properties that form the foundation of these communities.

1.5 NON-FEDERAL SPONSOR

The city of Hartford and the town of East Hartford are the Non-Federal Sponsors (NFS) for this feasibility study.

1.6 STUDY LOCATION

The study area includes the FRM Systems located in Hartford and East Hartford, Connecticut and the areas defended by these systems, (**Figure 1**). The East Hartford system defends about 760 acres from flooding of the Connecticut and Hockanum Rivers. The Hartford system was constructed to provide flood protection for 3000 acres from the Connecticut River, Park River, North and South Branches of the Park River, Gully Brook, and Folly Brook.

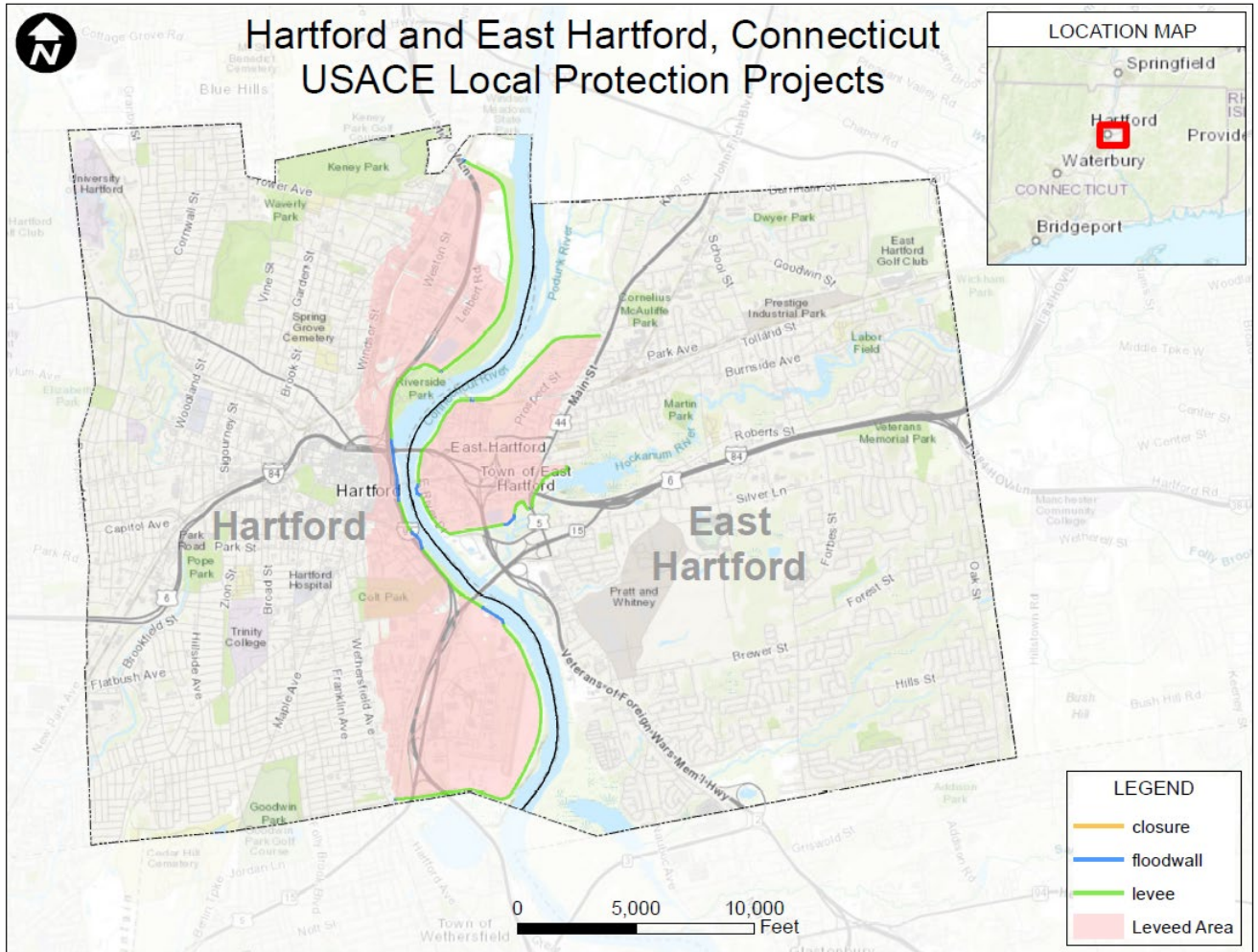


Figure 1: The Areas Defended by the Hartford and East Hartford Flood Risk Management Systems

Hartford and East Hartford are located in the Connecticut River Basin, which is the largest river system in New England and is designated as one of only 14 American Heritage Rivers. The watershed (**Figure 2**), which is long and narrow, extends approximately 280 miles from the headwaters in Quebec, Canada, south through parts of New Hampshire, Vermont, Massachusetts, and Connecticut, before emptying into Long Island Sound.

Characterized by hilly, forested uplands, the basin is framed by the Green Mountains and Berkshires to the west and the White Mountains to the east. It has a total drainage area of 11,250 square miles. The cities of Hartford and East Hartford are situated within this watershed, approximately 45 miles from the Connecticut River's mouth. The lower 60-mile reach of the river is tidally influenced.

The Connecticut River's vast watershed spans approximately 11,000 square miles, connects 148 tributaries, and is home to 2.3 million residents across 400 communities



Figure 2: The Connecticut River Watershed

*The star indicates the location of the study area

(American Rivers, 2020). The land is predominantly forested (77%), with smaller portions dedicated to agriculture (9%), development (7%), and wetlands (7%) (Clay, et al., 2006). Unique among large New England rivers, its mouth is free of a major port or urban center. Instead, it features tidal wetlands recognized as "Wetlands of International Importance."

The study area is located in the Middle Connecticut River region, which stretches between Amherst, Massachusetts and Middletown, Connecticut. This region is densely populated, with approximately 2 million residents. Tidal influence reaches from the river's mouth to 58 miles (93 km) north at the Enfield Rapids in Windsor Locks, CT, which includes the study area.

The study area is located in Connecticut Congressional District CT-01 represented by John B. Larson (D) of the 118th U.S. Congress; and Senators Richard Blumenthal (D) and Chris Murphy (D).

1.7 PROJECT LOCATIONS

1.7.1 Hartford, Connecticut

Hartford is the capital city of Connecticut, located in Hartford County in the north-central part of the state (**Figure 3**). It sits on the Connecticut River, approximately 19 miles northwest of the river's mouth at Long Island Sound. The coordinates of the city are 41.76° N, 72.67° W. The city's total area is 18.05 square miles, of which 17.38 square miles is land. Hartford is the core city of the Greater Hartford metropolitan area (Hartford-East Hartford-Middletown, CT), which has a population of over 1.21 million residents as reported by the 2020 census.

As of the 2020 census, the population of Hartford was 121,054, making it the fourth largest city in Connecticut. The city has a diverse demographic profile. In 2023, the racial and ethnic makeup was approximately 33.8% Black or African American (Non-Hispanic), 18.3% other races (Hispanic), 15.9% White (Non-Hispanic), and 10.5% White (Hispanic). A significant portion of the population, 44.8%, identifies as Hispanic or Latino, with a large concentration of residents of Puerto Rican origin.

Hartford's strategic location is supported by significant critical infrastructure. The city is a major transportation crossroads, with the intersection of Interstates 84 and 91 providing direct access to Boston and New York City. Rail service is provided by Amtrak, with Hartford Union Station servicing regional trains. The Hartford-Brainard Regional Airport is located within the study area, while Bradley International Airport is located just 15 minutes north of downtown. The city's energy needs are met by major utility providers like Connecticut Light and Power, Eversource and Connecticut Natural Gas.

Economically, Hartford has historically been a major center for the insurance industry, earning it the nickname "Insurance Capital of the World." Many insurance companies are headquartered in the city, and it is a hub for medical care, research, and education. The median household income in 2023 was approximately \$45,300, and the poverty rate was 25.5%. In contrast, the Greater Hartford metropolitan area is one of the most productive economic regions in the country, with a per capita income that ranks among the highest nationally.

Hartford also holds significant educational and cultural importance in Connecticut and the greater Northeast region. The city is home to several institutions of higher education, including Trinity College, the University of Hartford, and the University of Connecticut's School of Law and downtown campus. Hartford is one of the oldest cities in America and is rich in history. The city is the birthplace or residence of notable figures such as Mark Twain, Harriet Beecher Stowe, John Pierpont (J.P.) Morgan, and Frederick Law Olmsted. The city includes numerous landmarks such as the Mark Twain House and the Wadsworth Atheneum, the country's second-oldest public art museum.

The Hartford FRM System is vital for protecting the city's commercial, institutional, and residential areas from flooding along the Connecticut River. This infrastructure is essential for the region's economy and public safety. The project's protected area includes approximately 3,000 acres of highly developed public, commercial, residential and industrial land, which includes the areas in the North Meadows, Downtown, Sheldon-Charter Oak, and South Meadows neighborhoods.



Figure 3: Downtown Hartford, Connecticut

1.7.2 East Hartford, Connecticut

East Hartford (**Error! Reference source not found.**) is a town in Hartford County, Connecticut, situated on the eastern bank of the Connecticut River, directly opposite the state capital of Hartford. The town was originally part of Hartford but became an independent town in 1783. Known as the crossroads of New England, East Hartford is equidistant from Boston and New York City and is situated with easy access to interstate highways, airports, railroads and other modes of transportation.

The town is approximately the same size as Hartford at 18.7 square miles (sq mi) (48.5 km²) but has a smaller population and is less congested. As of the 2020 US Census, East Hartford has a population of 51,045 and a density of 2,837 people/sq mi (1,095.4/km²) (USCB, 2021). This figure represents a stabilization after a period of decline from its peak population of 57,583 in 1970, a trend historically tied to the operational shifts of its primary employer, Pratt & Whitney.

The town is characterized by a diverse demographic profile. As of 2021, residents of color constituted 70% of the population. The racial makeup was approximately 32.6% non-Hispanic White, 24.8% Black or African American, and 38.2% Hispanic or Latino. The

median household income was approximately \$66,943, with a poverty rate of about 14.7% as of 2023.

The town's economy and critical infrastructure are strongly linked to the aerospace industry. The largest employer is the aerospace manufacturer Pratt & Whitney, a subsidiary of Raytheon Corporation, which employs around 8,000 people. Other significant employers include Goodwin University and Coca-Cola Bottling Company.

Critical infrastructure includes major transportation arteries such as Interstate 84 and U.S. Route 6, utility services provided by Eversource Energy and Connecticut Natural Gas, and water management by the Metropolitan District Commission. Additionally, Pratt & Whitney Stadium at Rentschler Field is a major piece of public infrastructure, serving as a venue for sports and entertainment.

The East Hartford FRM system is located along the east bank of the Connecticut River and the north bank of the Hockanum River in East Hartford, CT and is intended to reduce flood risk to 760 acres of the town of East Hartford, CT. The defended areas are predominantly commercial and industrial, hosting businesses and critical infrastructure that are the economic lifeblood for the local community and the greater Hartford region. There are relatively few residential structures located within the study area.



Figure 4: East Hartford, Connecticut

1.8 NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS

This report was prepared pursuant to the National Environmental Policy Act (NEPA) of 1969 and the Department of Defense (DoD) NEPA Implementing Procedures, June 30, 2025 (90 Federal Register 27857).

NEPA requires federal agencies to integrate environmental review into their planning and decision-making process. To support this requirement, this draft feasibility report includes

an environmental assessment (EA). An EA briefly provides sufficient evidence and analysis for determining the impacts of the proposed action and whether to prepare a finding of no significant impact (FONSI) or a more intensive environmental impact statement if significant impacts are identified.

Per the DoD NEPA Implementing Procedures dated June 30, 2025, the final EA must include the following elements:

- A statement of the purpose and need for the proposed agency action based on the DoD's statutory authority.
- Proposed action and the alternatives to the extent required by NEPA § 102(2)(H), 42 U.S.C. § 4332(2)(H)
- The reasonably foreseeable effects of the proposed agency action and alternatives considered

Sections of the report that are required to fulfill the requirements of NEPA are marked with an asterisk (*) in the headings.

1.9 APPLICATION OF SECTION 216 POLICY AND USACE GUIDANCE

The scope of this feasibility study was principally defined by two governing documents:

- The Flood Control Act of 1970 (Section 216): This legislation provides the foundational authority for the analysis.
- USACE Memorandum, *"Reconstruction of USACE Structural Flood Damage Reduction Projects for which Non-Federal Interests are Responsible for Operations, Maintenance, Repair, Rehabilitation and Replacement"* (August 16, 2005): This memorandum offers specific guidance on implementation.

The policies outlined in these documents were integrated into the study's objectives and used as criteria for screening project measures.

A key stipulation from the USACE 2005 memorandum is that if a project's reconstruction does not alter its original scope or function, the evaluation must focus on the incremental justification of its individual features. This involves comparing the "with-reconstruction" and "without-reconstruction" scenarios for each feature to determine if the work is justified. Hydrology and Hydraulics (H&H) modeling was conducted to support the incremental justification of components of the tentatively selected plan (TSP). The modeling and analysis are described later in this report (**Section 3.0: Modeling and Analysis**).

For further detail the USACE 2005 memorandum is located in **Appendix 1-D: References & Supporting Guidance**, and an in-depth analysis of the policy interpretation is available in **Appendix 1-E: Plan Formulation**.

1.10 AUTHORIZED PROJECT OVERVIEW

The reach of the Connecticut River which runs through the study area is subject to seasonal flood threats from the Connecticut River Valley watershed and tributary drainage areas. High-water events have been observed year-round but typically occur during the spring (associated with snowmelt) and the fall (associated with hurricane-related storms). To combat the impacts of this flooding, both Hartford and East Hartford have constructed FRM systems.

Typical FRM systems are comprised of a number of features. These include:

Earthen Levees: Earthen embankments have the primary purpose of furnishing flood risk reduction from seasonal high water loading periods lasting from days to weeks.

Concrete Floodwalls: A floodwall is an engineered structure made of reinforced concrete. Floodwalls for both FRM systems included in this study consist of T, I, and L-walls.

Traffic/Pedestrian Closures: A closure structure is a gap in the levee system that remains open for pedestrian, rail, or vehicular traffic but can be closed in the event of high water. Closure structure storage vaults are typically integrated with the closure abutments and are located on the landside of the levee system, providing secure storage for the removable closure parts.

Interior Drainage Structures: Drainage structures function by allowing interior runoff to exit during normal river stages, by gravity flow through a system of collector sewers, gated manholes, diversion channels, and drainage pipes generally equipped with flap gates on concrete headwalls.

Pump Stations: Pump stations are used to move interior drainage water from the interior side (leveed area) of a FRM system to the riverside. During flood stages, storm water and sanitary sewage is removed from the protected area by the pumping stations.

1.10.1 Hartford Flood Risk Management System

Hartford's FRM project can be divided into two separate but integrated systems – the Main Stem Connecticut River or original FRM system and the Park River system (**Figure 5**). Together these systems protect portions of metropolitan Hartford from floods from the Connecticut River, Park River, North and South Branches of the Park River, Gully Brook, and Folly Brook.



Figure 5: The Hartford Flood Risk Management System

The main stem FRM system was constructed following the damages resulting from the 1936 flood. In the spring of 1936, heavy rains combined with melting snow to flood many rivers in New England. Hartford was hard hit as the Connecticut River rose to 38 feet above flood stage (**Figure 6**). The main stem system runs along the entire eastern boundary of the city of Hartford, Connecticut on the west bank of the Connecticut River. It extends from high ground near the Hartford-Windsor town limit south to high ground below the Hartford-Wethersfield boundary.

The Park River conduit system was constructed to discharge all flows, up to design flows of 32,000 cubic feet per second (cfs), from the Park River Basin to the Connecticut River without damage to the area protected by the Connecticut River Right Bank - Hartford, CT system along the west bank of the Connecticut River and the conduit.

The original flood protection project for Hartford was authorized after the historic flood of 1936. The provisions that authorized its construction are included in the Emergency Relief Appropriation Acts of June 22, 1936, June 29, 1937, and June 21, 1938, and the Flood Control Act approved June 28, 1938 (House Document No. 455, 75th Congress, Second Session). The authorizations were modified by the Flood Control Act of August 18, 1941 (House Document No. 653, 76th Congress, Third Session). Additional elements of the FRM system were authorized in subsequent legislation. These included:

- Gully Brook Conduit - Flood Control Act of October 26, 1942 (Public No. 759, 77th Congress, Second Session)
- Folly Brook Dike and Conduit - Flood Control Act of 1950 (Public Law 516, 81st Congress, 2nd Session).
- Park River Flood Protection Project – Flood Control Act of 1968 (Public Law 90-483, 90th Congress dated August 13, 1968).

The original USACE design flood for the Hartford Levee is documented in the 1937 Flood Control Connecticut River Valley Report of Survey and Comprehensive Plan (Comprehensive Plan) and the 1941 Connecticut River Flood Control Project Final Report on Construction (Final Report). According to the 1941 Final Report, the design flood for the Hartford Levee was based on the “maximum predicted flood reduced by the 20 reservoirs of the Comprehensive Plan.” According to the plan, the elevations to which all proposed dikes were designed was based upon the greatest predicted flood, as modified by the Comprehensive Plan of 20 reservoirs, plus a design freeboard of approximately three feet. However, note that only 16 of the 20 proposed reservoirs were ultimately constructed.

The city of Hartford completed their own flood studies and desired greater protection than what was proposed by USACE. The levee grades proposed by the city of Hartford were based on a flood 25% greater than the maximum flood of record (1936 flood) and are about six feet higher than what was proposed by USACE. The peak flow of the 1936 flood event was approximately 290,000 cfs. A flood 25% greater would have a peak discharge of approximately 360,000 cfs. The final Hartford levee system design grades are based on a Connecticut River peak discharge of 360,000 cfs along with approximately three feet of freeboard.

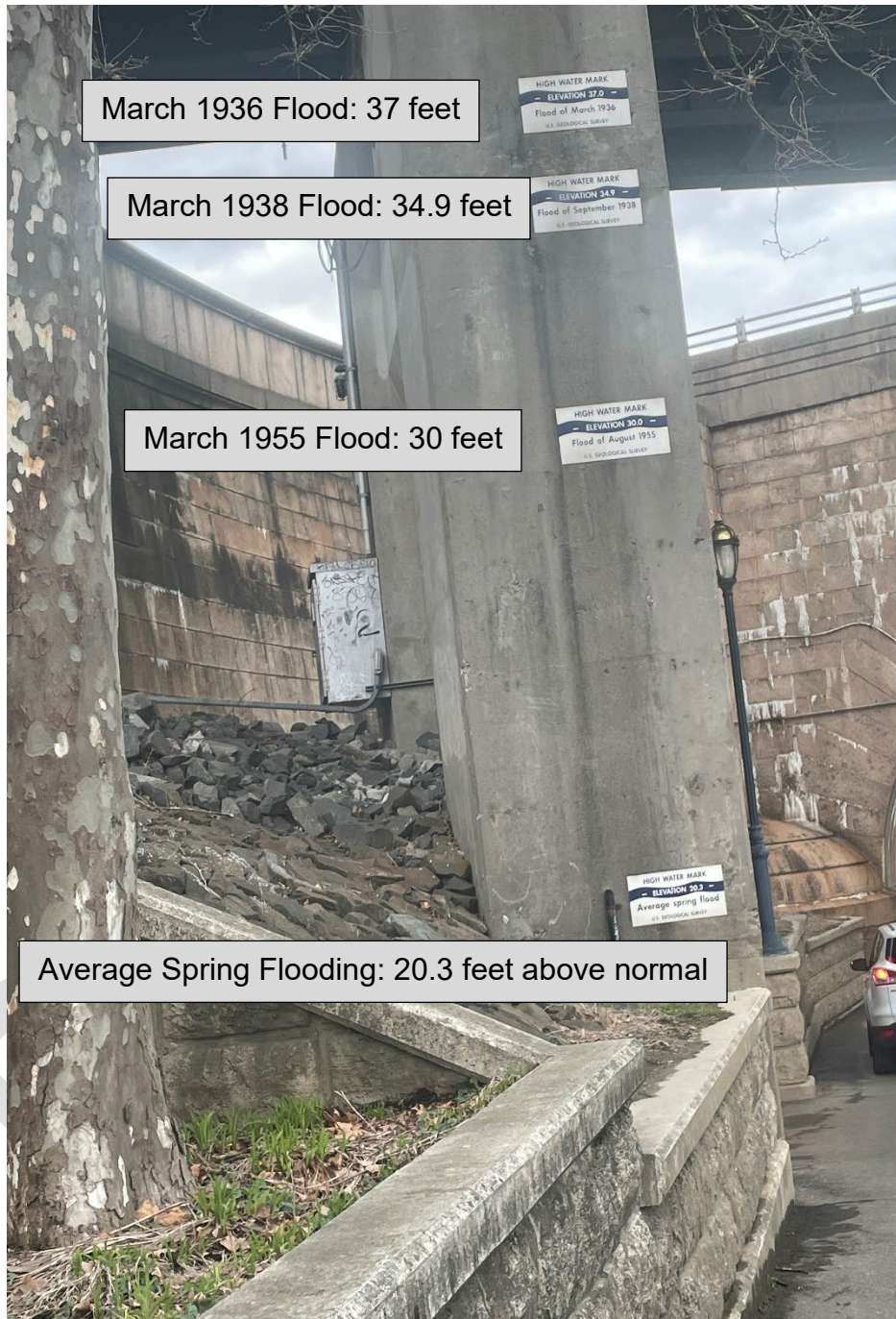


Figure 6: Plaques on a Bridge Pillar in Hartford's Riverside Park Indicate the High-Water Marks for the 1936, 1938, and 1955 Floods

Construction of the main stem FRM system began by the USACE on March 24, 1938, and was completed on August 24, 1944 (**Table 1**). Construction was divided into 3 sections: North Meadows Dike, Riverfront Dike, South Meadows Dike (Clark Dike). Construction of the Park River system was authorized by the Flood Control Act of 1968

(Public Law 90-483, 90th Congress dated August 13, 1968). Construction began in June 1976 and was completed in 1981.

Table 1: Construction History of the Hartford Flood Risk Management System

Location	Project	Years Constructed
Connecticut & Park Rivers and Gully Brook	Levees, Walls, conduits, and pumping stations	1938 to 1944
Folly Brook - Hartford	Levees, channel improvement	1956 to 1958
Folly Brook - Wethersfield	Channel Improvement	1977 to 1979
Park River Extension - Hartford	Conduit, auxiliary conduit and pumping stations	1979 to 1981

Together, the Hartford Main Stem and Park River FRM Systems were designed to provide flood protection from the Connecticut River, Park River, North and South Branches of the Park River, Gully Brook, and Folly Brook. The system provides flood protection to approximately 3,000 acres of highly developed public, commercial, residential, and industrial land in Hartford, including the Hartford-Brainard Airport, a power plant, and hundreds of commercial properties.

The completed Hartford Main Stem FRM Project consists of about six miles (34,000 feet) of earthen levees, about 0.8 miles (4,400) feet of concrete floodwalls, five closure structures, three pumping stations, one conduit, and appurtenant drainage facilities. While the Park River protection consists of a 16,800-foot-long twin-rectangular reinforced concrete conduit, a short section (660 linear feet) of concrete flood wall at the North Park River inlet structure, a 9,200-foot-long circular concrete lined Auxiliary conduit, and the Gully Brook pressure conduit. Three of the six pump stations in Hartford are located on the Park River System. The principal features of the project are included in **Table 2**.

Table 2: Components of the Hartford Main Stem and Park River Flood Risk Management Systems

Components	Hartford FRM System	Park River FRM System
Earthen Levee	34,000 (linear feet)	0
Concrete Floodwall	4,400 (linear feet)	660 (linear feet)
Pump Stations	3	3
Storage Ponds	2	0
Stoplog Closure Structures	5	0
Conduits/Channels	1	3

Levees & Floodwalls: The levees and floodwalls extend from high ground near the Hartford-Windsor town line south to high ground just below the Hartford-Wethersfield boundary line. See **Section 4.0** below for details on the existing system.

The levees for the protection of the city of Hartford are constructed of free-draining river sand with a thick layer of dense impervious earth on the river side, extending down to a steel sheet pile cutoff to help prevent water seeping through and under the levee. At the land side toe of the levee, a drain is provided to control any seepage that may occur. Both sides of the levee are covered with topsoil to prevent erosion and on the river side where scour from the Connecticut River may occur, riprap is also provided. The flood walls are of the reinforced concrete cantilever type, consisting of a vertical wall, or stem, connected to base featuring a shear key and a steel sheet piling cutoff wall. Drains are provided on the landside of the wall to collect seepage water. (O&M Manual, 2009)

Pump Stations: During higher river flows interior drainage is evacuated from the protected area by the six pumping stations: the North Meadows Pump Station, South Meadows and Keney Lane Pump Stations on the Main Stem FRM system, with the Bushnell, Pope, and Armory Pump Stations constructed on the Park River FRM system.

According to discussions with the city of Hartford representatives, the South Meadows and North Meadows pump stations are operated more frequently than the other stations due to their lower trigger elevations for closing their river gates. In general, the South Meadows and North Meadows pump stations are operated when the Connecticut River is above elevation 5 feet - North American Vertical Datum of 1988 (NAVD88) and their storage pond is full. Based on the stage duration curve, elevation 5 ft-NAVD88 corresponds to 30% time exceeded. The Kenney Lane and Bushnell pump stations are operated less frequently due to their higher trigger elevations for closing the river gates that corresponds to less than 7% time exceeded. According to the City of Hartford, Bushnell and Kenney Lane pump stations are operated for flood fighting a few times every year. The City of Hartford indicated that Armory and Pope pump stations have never been operated for flood fighting.

Representatives from the town of East Hartford also provided information on the frequency of use of each pump station. The Meadow Hill pump station is operated more frequently than the other stations due to its lower trigger elevation for closing the river gate. In general, Meadow Hill pump station is operated when the Connecticut River is above elevation 5 ft-NAVD88 and its storage pond is full. Based on the stage duration curve, elevation 5 ft-NAVD88 corresponds to 30% time exceeded. The Pitkin and Cherry Street pump stations are operated less frequently due to their higher trigger elevations for closing their river gates that corresponds to less than 6% time exceeded. According to operations logs accessed during a site visit in 2023, there are “dry” years when these two pump stations are not operated, but there are “wet” years when they are operated in multiple occasions.

Storage Ponds: The Hartford Main Stem FRM system includes two storage ponds. North Meadows pump station contains a storage pond, which covers approximately 16 acres, located west of the levee . The pond maintains a pool elevation between 3.2 and 7.2 ft-NAVD88) during pump station operation. South Meadows has a small storage basin adjacent to the pump station to the north. The pond has a capacity of approximately 13.5

acre-feet, covering roughly 4.5 acres, and it maintains an elevation between 2.2 and 4.2 feet-NAVD88 while the pump station is in operation.

Closure Structures: There are five openings in the system to permit highway and railroad passage during non-flood periods, closure structures associated with rail and roadway crossings are closed when floodwaters threaten the protected area.

Conduits and Channels: The conduits (listed below), which convey flow from the drainage area to the river during non-flood flow conditions, become pressurized during river flood flows. This is due to backflow of the Connecticut River into these conduits during periods of high river level.

- Park River conduit, measures over 10,000 feet long and passes beneath Bushnell Park in the central part of the city, ending at the Connecticut River.
- The Park River auxiliary conduit is located about 1,100 feet south of the first conduit. This auxiliary conduit, 9,200 feet long and lying approximately 200 feet below ground surface, allows the Park River to be completely diverted under the city of Hartford directly to the Connecticut River. Two pumping stations support the auxiliary conduit.
- The third conduit is the 3,100-foot Gully Brook conduit, which ties into the first Park River conduit.
- The fourth is the 2,200-foot Folly Brook conduit, which ties into the conduit located at the lower end of Folly Brook in Wethersfield.

The conduits are included in **Figure 5**. More detail is shown in **Figure 7** and **Figure 8**.



Figure 7: Gully Brook, North and South Branch Park River, Park River, and Auxiliary Conduits in the Northern Hartford Flood Risk Management System

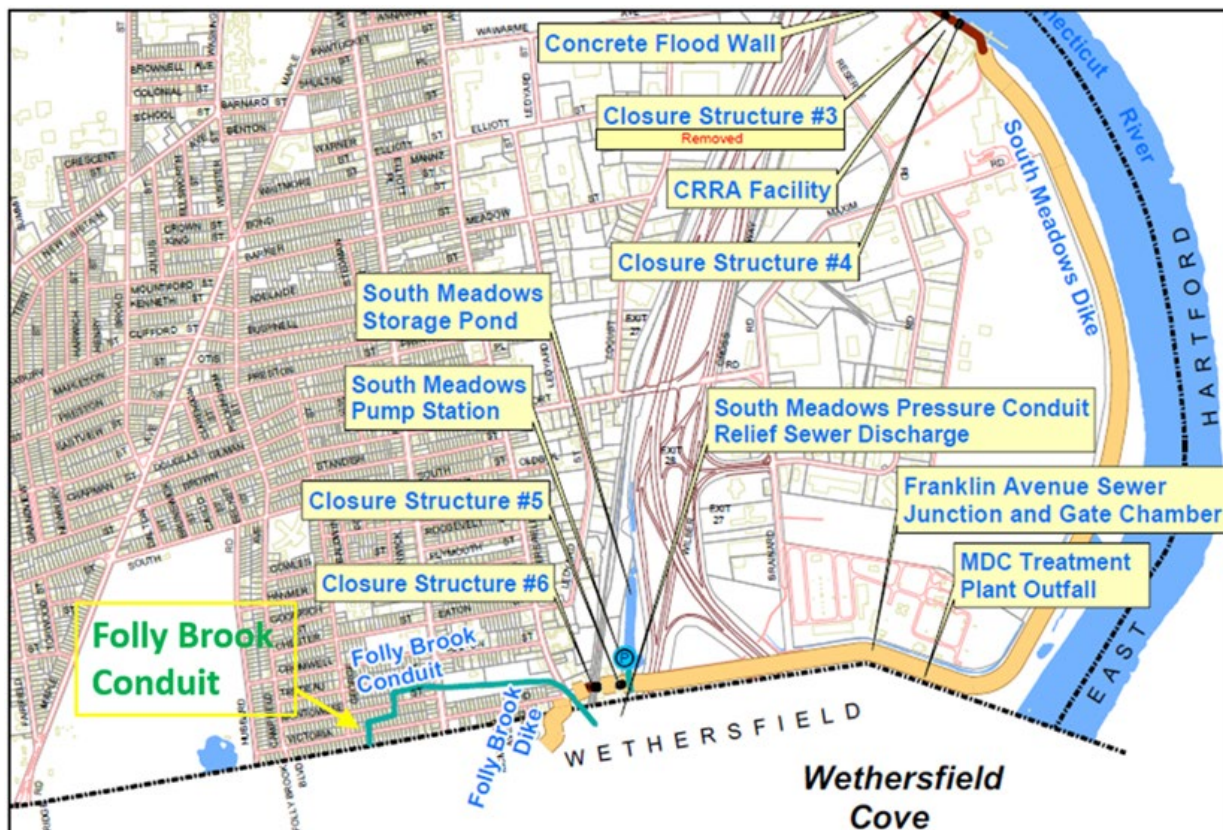


Figure 8: Folly Brook Conduit in the Southern Hartford Flood Risk Management System

1.10.2 East Hartford Flood Risk Management System

The East Hartford FRM system is located along the east bank of the Connecticut River and the north bank of the Hockanum River in East Hartford (**Figure 9**). The FRM system was constructed by USACE in response to devastating floods that occurred in 1936 and 1938. The record flood was in March 1936, with a peak flow of 313,000 cfs that includes upstream breach flows. The peak flow of the March 1936 flood without the upstream breach flows was estimated at 290,000 cfs.

The original USACE design flood for the East Hartford Levee is documented in the 1937 Flood Control Connecticut River Valley Report of Survey and Comprehensive Plan (Comprehensive Plan) and the 1941 Connecticut River Flood Control Project Final Report on Construction (Final Report). According to the 1941 Final Report, the design flood for the East Hartford Levee was based on the “maximum predicted flood reduced by the 20 reservoirs of the Comprehensive Plan” with a peak flow of 318,000 cfs, which is approximately 10% greater than the March 1936 peak flow without the upstream breach flows. According to the plan, the elevations to which all proposed dikes were designed was based upon the greatest predicted flood, as modified by the Comprehensive Plan of twenty reservoirs, plus a design freeboard of approximately three feet. However, note that only 16 of the 20 proposed reservoirs were ultimately constructed.



Figure 9: The East Hartford Flood Risk Management System

The system was authorized by the Congress on June 28, 1938, through the Flood Control Act of 1938 as modified by Public Law 859, 76th Congress, approved October 15, 1940 and by the Flood Control Act of 1941. Construction of the FRM system occurred between December 1938 and July 1943 (\$2.4 million - 1943 dollars). Upon completion the project was transferred from USACE to the town of East Hartford. Some elements of the system are more than 80 years old.

The system provides flood risk management for approximately 760 acres of mixed residential, commercial, and industrial properties from flooding of the Connecticut and Hockanum Rivers. The north end of the project starts at high ground at Greene Terrace, from here the levee passes Connecticut Southern Railroad Bridge, Bulkeley Bridge, Founders Bridge, continues along East River Drive and south of Hartland Street where the levee proceeds east along the floodplain on the north side of the Hockanum River, past Interstate 84, and terminating at Brewer Lane. Although it is directly across the river, the East Hartford FRM system design height is more than 6 feet lower than the Hartford FRM System. At the time of construction, the city of Hartford requested and paid for a higher level of protection.

The East Hartford FRM project includes levee embankment, concrete floodwall, two stop-log closure structures, three pump stations with appurtenant drainage structures and facilities, and a storage pond (**Table 3**).

Table 3: Components of the East Hartford Flood Risk Management System

Components	East Hartford FRM System
Earthen Levee	19,300 (linear feet)
Concrete Floodwall	1,400 (linear feet)
Pump Stations	3
Storage Ponds	1
Stoplog Closure Structures	2
Conduits/Channels	1

Levees & Floodwalls: The East Hartford FRM project includes about 19,300 linear feet of earthen levee and 1,400 linear feet of concrete floodwall along the Connecticut and Hockanum Rivers. The levee associated with the FRM system consists of an embankment with a clean sand core and waterside clay blanket. Toe drains were installed along the landside toe. In general, slopes are covered with grass with the exception of riprap along the waterside slope in three locations. At one location, the riprap has been partially covered by the construction of East River Drive over the levee.

Typical levee embankment dimensions shown on the record drawings include:

- Maximum Height of Embankment: 28 feet
- Crest Width: 10 feet

- Riverside Slope: 2.5H:1V to 3H:1V (height-to-vertical feet)
- Landside Slope: 2H:1V to 3H:1V

Elevations-range reported in the current 2010 Operations and Maintenance (O&M) Manual are:

- Elevation (EI) 43.2 National Geodetic Vertical Datum of 1929 (NGVD29) (EI 42.4 NAVD88) to
- EI 38.9 NGVD29 (EI 38.1 NAVD88)

There are two floodwall sections along the system. The first floodwall is at the Riverpoint Condominium Complex. This wall is a T-wall section with a crest elevation of about EI 38.4 NGVD29 (EI 37.6 NAVD88). The second floodwall is located at the Metropolitan District Commission (MDC) Wastewater Treatment Plant (WWTP). This wall is an I-wall section with a crest elevation of about 38.2 feet NAVD88.

Pump Stations: There are three pumping stations that discharge storm rainfall from behind the levee into the Connecticut River. These are located at Meadow Hill, Cherry Street, and Pitkin Street.

Storage Ponds: The 5-acre storage pond at Meadow Hill is on the south side of the project. The pond provides storage for those times when the inflow to the Meadow Hill pumping station is greater than the pumping capacity. Storage allows the inflow to be managed without damage to the protected area.

Closure Structures: There are two stoplog structures, one each at the railroad and Main Street.

Conduits & Channels: An interior channel has been constructed within the protected area behind the levee. The channel flows roughly parallel to the Connecticut River for about three miles. Runoff water flows under normal “sunny day” conditions into the Meadow Hill Storage Pond. It’s then passed into the Hockanum River, near its confluence with the Connecticut River.

1.10.3 Authorized Project Operations and Maintenance

The city of Hartford and the town of East Hartford maintain and operate their respective FRM systems. 33 Code of Federal Regulations (CFR), 208.10, prescribes the regulations covering O&M of flood damage reduction for structures and facilities. In general, Section 208.10 provides that structures and facilities constructed by the United States for local flood protection will be continuously maintained in such a manner and operated at such times, and for such periods as may be necessary, to obtain maximum benefits. Section 208.10 also sets the guidelines for the O&M of said facilities, including: levees, floodwalls, drainage structures, closure structures, pumping plants, channels and floodways, and miscellaneous other facilities.

Proper O&M requires that the NFS and its designated agents have a thorough understanding of the FRM systems' infrastructure, the preventative maintenance required during normal river stages, and the operational procedures during flood emergencies. In addition, NFS's employees exercise the pumps for short periods of time every month to make sure they are still functioning.

The original O&M manuals provide instructions on the operation and maintenance of the FRM systems. The manuals were prepared by USACE for use by the town of East Hartford and the city of Hartford, which are responsible for the O&M of the FRM systems in perpetuity after project completion. The O&M manuals for each system are listed below.

- Operations & Maintenance Manual for Hartford Local Protection Project, Connecticut and Park Rivers (Original 1946 and 1981 (Park River System), Revised 2009)
- Operational and Maintenance Manual, for Flood Protection System *Connecticut River Flood Control East Hartford, Connecticut (Original 1946, Revised 2010) (USACE 1946 & 2010)*

Both Hartford and East Hartford are committed to ensuring emergency operations fully incorporate FRM safety operations and have detailed standard operating procedures regarding the FRM systems. Both entities have developed plans to address emergency situations.

In 2017, the town of East Hartford prepared an Emergency Action Plan (EAP). The purpose of the EAP is to reduce risk of human life loss and injury and minimize property damage during an emergency event at the East Hartford FRM System. The EAP compiled relevant information about emergency response regarding the FRM system from two primary documents: the existing Emergency Operation Plan and the existing O&M manual for the FRM system, which are both periodically updated by the Town. The EAP describes the history of the system, the emergency action plan process including communications and flood fighting, inundation areas, maintenance, and roles and responsibilities. The EAP was last updated in 2023.

Hartford's comprehensive approach to safety is managed through three primary pillars: the Municipal Emergency Operations Plan, which coordinates city-wide agency responses to all hazards; the Hazard Mitigation and Climate Adaptation Plan, which focuses on long-term risk reduction and infrastructure resilience; and the Hartford Flood Control Emergency Plan, a specialized protocol for the FRM system and river management. The Hartford Flood Control Emergency Plan was developed through a collaborative effort between the city's engineering consultants and USACE to ensure the aging FRM system meets modern safety standards. This plan was specifically designed to satisfy FEMA accreditation requirements and includes a hypothetical breach analysis to guide evacuation strategies. It utilizes a structured monitoring system with clear triggers, such as Phase IA Monitoring when the river reaches 12 feet and increasing to Phase II Emergency Operations if levels exceed 24 feet. These protocols, maintained by

the Greater Hartford Flood Commission, provide the technical and operational framework necessary to protect the city's 3,000 acres of developed land from Connecticut River flooding.

The Non-Federal Sponsors' adherence to O&M requirements is reviewed and documented by the New England District Levee Safety Program through routine and periodic inspections. The purpose of an FRM system periodic inspection is to identify deficiencies that pose hazards to human life or property. USACE performs formal periodic inspections of the system every five years, and performs a site visit annually to discuss and assess the performance of the system. In addition to USACE inspections, the non-Federal sponsors are required to inspect their systems bi-annually and submit those reports to USACE. The list below only includes the most recently completed inspection reports. All inspection reports are archived at the New England District, USACE and/or with the respective municipalities (City of Hartford, Town of East Hartford).

- FY23 Formal Inspection Report of the Connecticut River Left Bank & Hockanum River Right Bank Flood Risk Mitigation System (FRMS) in East Hartford, Connecticut (2024)
- FY24 Site Visit Summary Report for the Connecticut River Left Bank & Hockanum River Right Bank Flood Risk Mitigation System (FRMS) in East Hartford, Connecticut (2024)
- FY23 Site Visit Summary Report for the Connecticut River Right Bank Flood Risk Mitigation System (FRMS) in Hartford, Connecticut (2023)
- FY23 Routine Inspection Report for the North and South Branch Park River, Park River Conduit System in Hartford, Connecticut (2023)
- Floodwall and Closure Structure Displacement Monitoring Report, Hartford Flood Control System, Hartford, Connecticut (2024)
- East Hartford Flood Control System, Floodwall Monitoring Summary Report, 2024 Site Measurement, East Hartford, Connecticut (2024)

In 2009, both the city of Hartford and the town of East Hartford FRM Systems were accredited by the Federal Emergency Management Act (FEMA) National Flood Insurance Program. Accreditation of a flood control system lasts for 10 years and leads to the recognition and incorporation of the FRM system in FEMA's Flood Insurance Rate Maps. To be accredited, the system must provide flood protection from the 1% annual chance flood and comply with the requirements in 44 CFR 65.10.

Under Public Law 84-99, USACE can provide both emergency technical and direct assistance in response to flood and coastal storms and gives USACE the authority to supplement local efforts to repair flood control projects damaged by a flood. If a system fails to maintain federal levee standards (e.g. failed inspection) the FRM system becomes ineligible for Public Law 84-99 assistance. Project owners are able to temporarily remain eligible for assistance while system repairs and improvements are conducted through the System-Wide Improvement Framework (SWIF). The SWIF program requires the project owners to submit a plan outlining how the deficiencies will be addressed and a timeline

for completion and annual letters summarizing the activities over the past year that were performed in accordance with the SWIF.

The Hartford FRM system was rated as “Unacceptable” by USACE during the routine inspection on June 3, 2013. The city of Hartford voluntarily entered into the SWIF program through the submittal of a Letter of Intent, which was accepted by USACE on August 11, 2015. The proposed SWIF outlined the actions that the City planned to undertake beginning in early 2019 through June 30, 2025. The SWIF demonstrated the City’s commitment to restoring the Hartford FRM Systems to attain compliance with USACE operations and maintenance standards. A system-wide approach optimizes flood risk reduction by correcting deficiencies in a way that provides the largest flood risk reduction in the most efficient and economical manner.

The NFSs do an excellent job of maintaining the projects and responding to items identified in both periodic and routine inspections, as well as completion of numerous repairs that exceed normal O&M. Individual components rated as unacceptable in inspections are consistently corrected by the NFS prior to the next inspection. At no point have the FRM systems lost FEMA accreditation.

1.11 RELEVANT STUDIES, REPORTS AND EXISTING PROJECTS

1.11.1 Studies & Reports

Hundreds of documents, including operations manuals, monitoring studies, and repair logs, have been produced for the two FRM systems since initial construction was started during the 1930s. Due to resource limitations, a full literature review was not documented within this Feasibility Report. However, **Appendix 1-E: Plan Formulation** summarizes key reports related to the authorized projects. The complete collection of historical reports is maintained in the New England District archives.

1.11.2 Existing Flood Risk Management Projects

Flow in the Connecticut River is altered by a combination of hydropower dams on the mainstem and flood control and hydropower dams on its tributaries. The watershed has one of the highest densities of dams per unit area in the United States, with 65 major dams serving various purposes, including flood risk management, hydropower, water supply, and recreation. Cumulatively, these dams significantly affect the river's natural processes by altering its channel shape, geomorphology, water levels, and sediment transport.

Within this system, USACE New England District, operates a network of 14 dams specifically for flood control, regulating a drainage area of 1,570 sq mi and have 526,630 acre-feet of storage available for flood control (**Figure 10**). These dams, located in Connecticut (8), Massachusetts (4), and New Hampshire (2), are managed to protect life and property by reducing the damage seen in major historical floods (**totals**. Twenty smaller Soil Conservation Service (now National Resources Conservation Service) dams influence discharges off approximately 77 sq mi of the watershed and have a total storage capacity of 25,700 acre-feet. There are 23 non-Federal reservoirs or lake

systems existing in the basin having usable storage capacities of 7,000 acre-feet or more. These dams are largely for hydroelectric power generation, but a few are for impounding water supply, and they have no flood control storage allocation.

Table 4). In addition, there are two dams constructed by USACE and handed over post-construction to the State of Connecticut to be owned, operated and maintained for flood risk management purposes, adding a further 21 sq mi and 11,000 acre-feet to the FRM

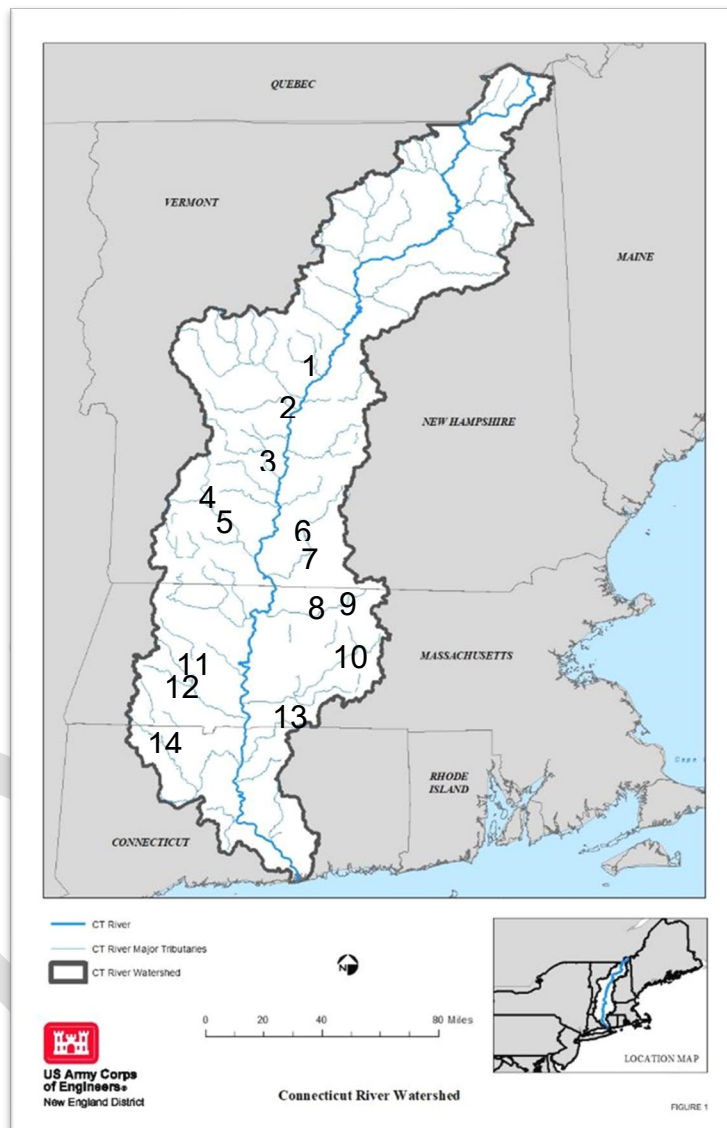


Figure 10: Federally Operated Flood Risk Management Dams Located in the Connecticut River Watershed

(Numbers on the figure correspond with

totals. Twenty smaller Soil Conservation Service (now National Resources Conservation Service) dams influence discharges off approximately 77 sq mi of the watershed and have a total storage capacity of 25,700 acre-feet. There are 23 non-Federal reservoirs or lake systems existing in the basin having usable storage capacities of 7,000 acre-feet

or more. These dams are largely for hydroelectric power generation, but a few are for impounding water supply, and they have no flood control storage allocation.

Table 4)

totals. Twenty smaller Soil Conservation Service (now National Resources Conservation Service) dams influence discharges off approximately 77 sq mi of the watershed and have a total storage capacity of 25,700 acre-feet. There are 23 non-Federal reservoirs or lake systems existing in the basin having usable storage capacities of 7,000 acre-feet or more. These dams are largely for hydroelectric power generation, but a few are for impounding water supply, and they have no flood control storage allocation.

Table 4: Federally Operated Flood Risk Management Dams Located in the Connecticut River Watershed

	Dam	River	State	Location	Built	Primary Towns Protected
1	Union Village Dam	Ompompanoosuc River	VT	East Thetford	1950	Union Village Section of Thetford, Norwich, White River Junction and Wilder Village Sections of Hartford, Hanover and West Lebanon.
2	North Hartland Dam	Ottauquechee River	VT	Hartland	1961	Hartford, Windsor, Weathersfield, Springfield, Rockingham, Plainsfield, Cornish, Claremont, Charlestown, and Walpole
3	North Springfield Dam	Black River	VT	North Springfield	1960	Springfield and other communities downstream
4	Ball Mountain Dam	West River	VT	Jamaica	1961	Downstream communities in West River Valley: Jamaica, Townshend, and Dummerston
5	Townshend Dam	West River	VT	Townshend	1961	Townshend, Dummerston, Newfane, Brookline, and Brattleboro
6	Surry Mountain Dam	Ashuelot River	NH	Surry	1941	Keene, Swanzey, Winchester, Hinsdale and other communities along the Ashuelot River
7	Otter Brook Dam	Otter Brook	NH	Keene	1956	Keene, Swanzey, Winchester, and other communities along the Ashuelot River
8	Tully Lake Dam	Tully River - East Branch	MA	Royalston	1949	Athol, Orange and other communities along the Mill River
9	Birch Hill Dam	Millers River	MA	Royalston	1942	Athol, Orange and other communities along the Mill River
10	Barre Falls Dam	Ware River	MA	Barre	1958	Ware, Chicopee and other communities along the Connecticut River
11	Knightville Dam	Westfield River	MA	Huntington	1941	Huntington, Westfield, West Springfield, and other communities along the Westfield River
12	Littleville Lake Dam	Westfield River - Middle Branch	MA	Huntington	1965	Huntington, Westfield, West Springfield, and other communities along the Westfield River
13	Conant Brook Dam	Conant Brook	MA	Monson	1966	Monson and communities along the Quaboag River
14	Colebrook Dam	Colebrook River	CT	Winstead	1969	Communities along main stem and West Branch of the Farmington River

2.0 EXISTING CONDITIONS AND FUTURE WITHOUT PROJECT CONDITIONS

The existing condition is a baseline from which all of the future conditions are built and is made up of the natural and physical environment, as well as the relationship of people with the environment. These existing conditions include relevant factors such as climate, wildlife resources, and socioeconomic conditions that could influence or be impacted by the potential project alternatives. The future without project condition (FWOP), also known as the No Action Alternative (NAA), is the anticipated future for a given resource during the period of analysis if no federal action is implemented. The FWOP serves as the baseline against which all action alternatives effects are measured.

This section discusses resources expected to have reasonably foreseeable effects resulting from the proposed alternatives. Details on both the existing conditions and future without project are detailed in the following sections. The period of analysis for projecting the future without project condition is 50 years, which is the standard in most USACE planning studies and aligns with Engineer Regulation (ER) 1105-2-103. The 50-year period begins in 2030 and runs through 2080.

2.1 NATURAL ENVIRONMENT

The natural environment is defined as resources that are biotic or biological in nature, such as flora and fauna. This section includes a discussion on the existing conditions and future without project conditions for wildlife, special status species, and other biological resources within the study areas.

2.1.1 Wetlands

The Clean Water Act regulations define wetlands as areas that are “inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (33 CFR 328.3(c)(1)). The U.S. Fish and Wildlife Service (USFWS) maintains the National Wetlands Inventory, which is a wetlands database across the United States. The USFWS’s Wetlands Mapper was used to determine the type and extent of wetlands in the project areas (USFWS, n.d.).

The city of Hartford and the town of East Hartford are situated across from each other on the Connecticut River. Along the banks of the Connecticut River on the Hartford side exists approximately 300 acres of wetlands, situated between the Route 291 bridge to the north, the Route 3 bridge to the south, and about 1 mile inland. On the opposite bank of the Connecticut within the same parameters are more than 500 acres of wetlands in East Hartford.

Due to the heavy urbanization of Hartford and East Hartford, most of these wetlands are small and isolated or associated with the riparian area of the Connecticut River. However,

there are four large wetland complexes within the limits of Hartford and East Hartford. Along the Connecticut River, north of Interstate 84 in East Hartford, is a wetland conglomeration about 200 acres in size, categorized by mix of forested and emergent vegetation. A second wetland complex in East Hartford is associated with the Hockanum River and is a mix of forested and emergent wetlands approximately 150 acres in size. Just above State Highway 3 are two other large wetlands: about 100 acres of primarily forested wetlands around Wethersfield Cove just south of Hartford, and over 200 acres of forested wetlands around Keeney Cove in East Hartford. Wetlands found within the study area are presented in **Figure 11** and **Figure 12**.

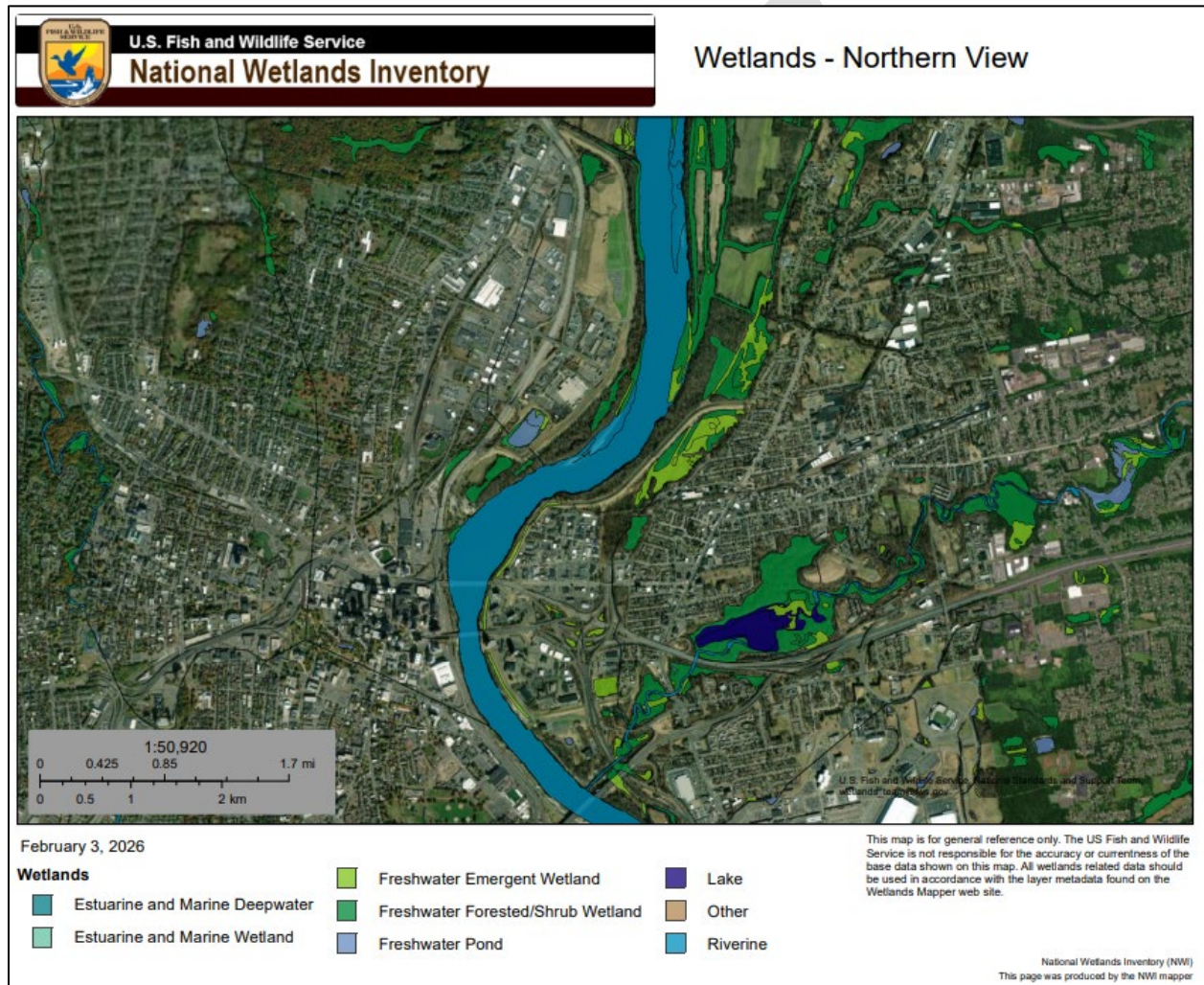


Figure 11: Wetlands Located in the Northern Part of the Study Area (USFWS, n.d.)

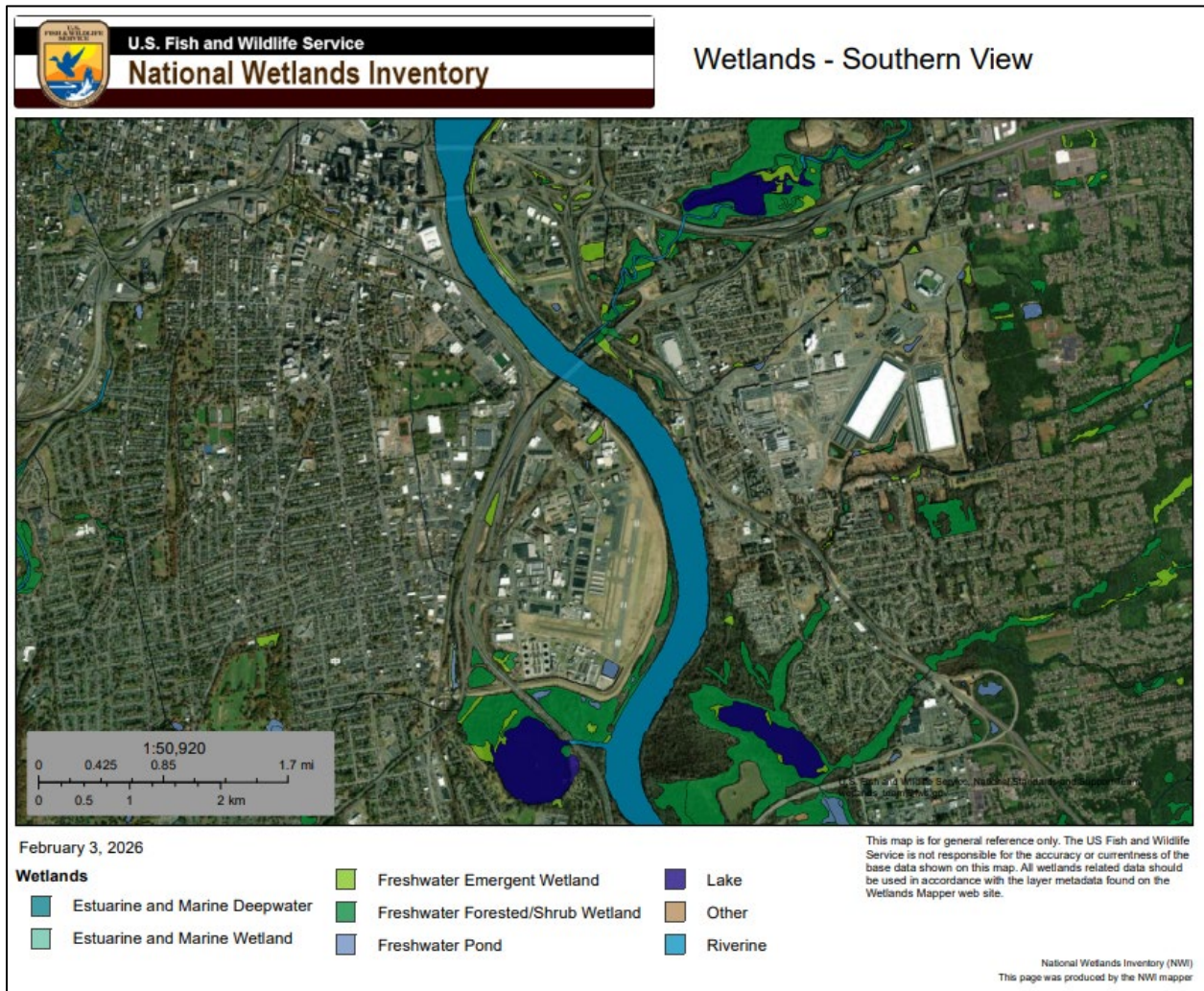


Figure 12: Wetlands Located in the Southern Part of the Study Area (USFWS, n.d.)

2.1.2 Vegetative Resources

The Greater Hartford region sits within the Connecticut Valley Level IV ecoregion designated by the US Environmental Protection Agency (USEPA) (USEPA, 2025b; Griffith et al., 2009). Dominant forest-types in this region are central (e.g., oak (*Quercus* spp.), maple (*Acer* spp.), hickory (*Carya* spp.)) and transition hardwoods (e.g., sugar maple (*Acer saccharum*), birch (*Betula* spp.), ash (*Fraxinus* spp.)). In the floodplains of this ecoregion, species include silver maple (*Acer saccharinum*) and cottonwood (*Populus deltoides*), while drier elevated areas contain pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*). The U.S. Department of Agriculture's Plant Hardiness Zone Map places both Hartford and East Hartford between 6b and 7a, with lowest average annual temperatures between 5 to -5 degrees Fahrenheit.

The city of Hartford is a densely populated urban area with limited natural terrestrial habitats. However, the city has a Forestry Division that maintains and improves the urban forest (City of Hartford, n.d.). Trees approved for the urban forest include various hickories

(*Carya* spp.), oaks (*Quercus* spp.), and lindens (*Tilia* spp.), along with individual species such as horse chestnut (*Aesculus hippocatanum*) and zelkova (*Zelkova serrata*). According to a 2020 report, the current tree canopy covers 25% of the city, consisting of approximately 568,000 trees, of which ~10% make up half of the total canopy (City of Hartford, 2020). Dense areas of vegetation occur within Riverside Park, Bushnell Park, and in narrow areas along the Connecticut River and the South Branch of the Park River. The town of East Hartford is primarily suburban, with denser areas of vegetation and tree cover situated along the Connecticut and Hockanum rivers. The town's Tree Warden and Beautification Commission maintain and improve the urban canopy.

Invasive species in Connecticut are found in aquatic and terrestrial habitats. There is limited information on the occurrence of non-aquatic invasives, however, common species in Connecticut include Norway maple (*Acer platanoides*), tree of heaven (*Ailanthus altissima*), and Japanese barberry (*Berberis thunbergii*) (UCONN, 2024). These species may occur along roadsides and within recreational parks. Two common aquatic invasives in Connecticut are water chestnut (*Trapa natans*) and Northern hydrilla (*Hydrilla verticillata*). The Aquatic Invasive Species mapping tool, developed by the Connecticut Agricultural Experiment Station's Office of Aquatic Invasive Species, identified water chestnut in the North Meadows retention pond, in Wethersfield Cove, and in the Hockanum River (OASIS, n.d.). Hydrilla was identified throughout the project area, with notable patches along Riverside Park, along South Meadows, and within Wethersfield Cove and Keeney Cove. No information on invasive species management by Hartford or East Hartford was found; however, the Office of Aquatic Invasive Species surveys and manages for aquatic invasive species.

2.1.3 Fish & Wildlife Resources

The study area, characterized by its urban environment, is home to a variety of terrestrial wildlife species that are well-adapted to living alongside humans. These include common species such as raccoons (*Procyon lotor*), eastern grey squirrels (*Sciurus carolinensis*), and other small mammals. In addition, mammals like white-tailed deer (*Odocoileus virginianus*), coyotes (*Canis latrans*), big brown bats (*Eptesicus fuscus*), and red foxes (*Vulpes vulpes*) are also present in Connecticut and may be found in the project area (CTDEEP, 2025a). Reptiles and amphibians in the region include the common snapping turtle (*Chelydras serpentina*), the common garter snake (*Thamnophis sirtalis*), and the eastern red-backed salamander (*Plethodon cinereus*) (CTDEEP, 2025b). Freshwater fish species thrive in the Connecticut and Hockanum Rivers, as well as in the numerous wetlands throughout the Greater Hartford area. Common species include largemouth bass (*Micropterus nigricans*), rainbow trout (*Oncorhynchus mykiss*), yellow perch (*Perca flavescens*), and bluegill (*Lepomis macrochirus*) (CTDEEP, 2024a).

Connecticut is also home to over 450 species of birds, with frequent visitors such as the mourning dove (*Zenaida macroura*), tree swallow (*Tachycineta bicolor*), and red-winged blackbird (*Agelaius phoeniceus*) (National Audubon Society, n.d.; eBird, 2025). Migratory birds in the study areas identified by the USFWS's automated Information for Planning and Consultation (IPaC) online tool are listed in **Table 5** below (USFWS, 2025). Birds that are of Conservation Concern (BCC) by the USFWS are denoted with an "**". Bird species

considered for the BCC include nongame birds, game birds without a hunting season, subsistence-hunted nongame birds in Alaska, and Endangered Species Act (ESA) candidate, proposed, and recently de-listed species. The overall goal of the BCC designation is to accurately identify the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent the USFWS’s highest conservation priorities (USFWS, 2021a). The fish and wildlife resources listed above are shared by both Hartford and East Hartford. Of the migratory bird species in **Table 5**, only the golden eagle (*Aquila chrysaetos*), king rail (*Rallus elegans*), and ruddy turnstone (*Arenaria interpres morinella*) have been identified as occurring exclusively in Hartford. However, given the similar biological conditions between Hartford and East Hartford, it is likely that these species may also be found in East Hartford.

Table 5: Migratory Birds Potentially Found in the Project Areas (USFWS, 2021a)

Common Name	Scientific Name
Bald eagle	<i>Haliaeetus leucocephalus</i>
Black-billed cuckoo*	<i>Coccyzus erythrophthalmus</i>
Blue-winged warbler*	<i>Vermivora cyanoptera</i>
Bobolink*	<i>Dolichonyx oryzivorus</i>
Canada warbler*	<i>Cardellina canadensis</i>
Chimney swift*	<i>Chaetura pelagica</i>
Eastern whip-poor-will*	<i>Antrostomus vociferus</i>
Golden eagle	<i>Aquila chrysaetos</i>
Grasshopper sparrow*	<i>Ammodramus savannarum perpallidus</i>
Hudsonian godwit*	<i>Limosa haemastica</i>
Kentucky warbler*	<i>Geothlypis formosa</i>
King rail*	<i>Rallus elegans</i>
Least tern*	<i>Sternula antillarum antillarum</i>
Lesser yellowlegs*	<i>Tringa flavipes</i>
Long-eared owl*	<i>Asio otus</i>
Pectoral sandpiper*	<i>Calidris melanotos</i>
Prairie warbler*	<i>Setophaga discolor</i>
Red-headed woodpecker*	<i>Melanerpes erythrocephalus</i>
Ruddy turnstone*	<i>Arenaria interpres morinella</i>
Rusty blackbird*	<i>Euphagus carolinus</i>
Scarlet tanager*	<i>Piranga olivacea</i>
Semipalmated sandpiper*	<i>Calidris pusilla</i>
Short-billed dowitcher*	<i>Limnodromus griseus</i>

Common Name	Scientific Name
Willet*	<i>Tringa semipalmata</i>
Wood thrush*	<i>Hylocichla mustelina</i>

*Birds of Conservation Concern (BCC).

There are also several invasive animal species found in Connecticut, consisting of insects and invertebrates (CTDEEP, 2022). The four insect species are the emerald ash borer (*Agilus planipennis*), Asian long-horned beetle (*Anoplophora glabripennis*), spotted lanternfly (*Lycorma delicatula*), and spongy moth (*Lymantria dispar*). The emerald ash borer, native to eastern Asia, is an iridescent green beetle that feeds on ash trees almost exclusively, decimating ash trees quickly. The Asian long-horned beetle, native to China and Korea, is a shiny black beetle with white spots that kills maple and other hardwood trees. The spotted lanternfly, red and white winged with black spots, is a newer invasive pest, first detected in the U.S. in 2014 and native to China, India, and Vietnam. The wide range of host plants makes this insect especially concerning. The spongy moth, detected in Connecticut in 1905, feeds on a variety of plants and becomes a significant problem when there's an outbreak of caterpillars. The invertebrates include three species in the Megascolecidae family: the rustic jumping worm (*Amyntas agrestis*), the compact jumping worm (*Amyntas tokioensis*), and the large jumping worm (*Metaphire hilgendorfi*). The jumping worms are native to East Asia, primarily Japan, and are prevalent throughout the eastern and southern United States. The widespread nature of jumping worms makes it a difficult species to manage.

2.1.4 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) on all actions, or proposed actions, permitted, funded, or undertaken by the agency, that may adversely affect Essential Fish Habitat (EFH) for federally managed species. EFH describes waters and substrates necessary for fish for spawning, breeding, feeding, or growth to maturity. EFH for 15 federally managed species is present at the project area within the Connecticut River, as identified by the NMFS EFH Mapper (NOAA Fisheries, 2021) (**Table 6**). The summer flounder (*Paralichthys dentatus*) submerged aquatic vegetation habitat area of particular concern (HAPC) also occurs in the project area. A HAPC is a subset of EFH that is susceptible to human-induced degradation, especially if the habitat is ecologically important or located in an environmentally stressed area. (NOAA Fisheries, 2025).

Table 6: Essential Fish Habitat Present in the Project Area

Common Name (Scientific Name)	Life Stages Present
Atlantic salmon (<i>Salmo salar</i>)	All life stages
Atlantic butterfish (<i>Peprilus triacanthus</i>)	All life stages

Common Name (Scientific Name)	Life Stages Present
Black seabass (<i>Centropristis striata</i>)	Juvenile
Summer flounder (<i>Paralichthys dentatus</i>)	Juvenile, adult
Winter flounder (<i>Pseudopleuronectes americanus</i>)	All life stages
Windowpane flounder (<i>Scophthalmus aquosus</i>)	All life stages
Scup (<i>Stenotomus chrysops</i>)	All life stages
Bluefish (<i>Pomatomus saltatrix</i>)	Juvenile, adult
Atlantic mackerel (<i>Scomber scombrus</i>)	All life stages
Longfin inshore squid (<i>Doryteuthis pealeii</i>)	Eggs, juvenile, adult
Winter skate (<i>Leucoraja ocellata</i>)	Juvenile, adult
Little skate (<i>Leucoraja erinacea</i>)	Juvenile, adult
Red hake (<i>Urophycis chuss</i>)	All life stages
Pollock (<i>Pollachius pollachius</i>)	Juvenile, adult
Atlantic herring (<i>Clupea harengus</i>)	Juvenile, adult

2.1.5 Threatened & Endangered Species

Lists of threatened, endangered, and species of special concern are maintained by the USFWS and the State of Connecticut. Under the ESA of 1973 (16 U.S.C. § 1531 et seq), endangered species are defined as any species in danger of extinction throughout all or portions of its range. A threatened species is any species likely to become endangered in the foreseeable future. The ESA defines critical habitat of the threatened and endangered species as a geographic area occupied by the species that contain the physical or biological features that are essential to the conservation of a particular species and that may need special management or protection.

An official list of federally protected species was obtained on November 10, 2025, using the USFWS IPaC online tool (USFWS, 2025). The project areas in both Hartford and East Hartford are located within the range of the proposed endangered tricolored bat (TCB) (*Perimyotis subflavus*) and the proposed threatened monarch butterfly (*Danaus plexippus*). The IPaC tool did not identify any designated critical habitats for these species in the project areas.

Tricolored bat: The TCB was listed as a federally proposed endangered species under the ESA on September 14, 2022. This bat species is found across much of the eastern and central U.S. and in Canada, Guatemala, Honduras, and Mexico. The species' range includes 40 U.S. states. This insectivorous bat is found in forested habitats where they roost primarily in leaves or needles of live or recently dead trees. These bats are flexible in selecting roost sites, choosing roost trees that provide cavities and crevices. In the winter, they hibernate typically in caves, abandoned mines, and road-associated culverts.

White-nose syndrome, a fungal disease known to affect bats, is currently the predominant threat to this species, followed by wind energy related mortality (USFWS, 2021b). White-nose syndrome has caused an estimated decline of more than 90 percent of the species across its range (USFWS, 2024a).

Monarch butterfly: The monarch butterfly was listed as a federally proposed threatened species under the ESA on December 12, 2024. The monarch butterfly lives and migrates throughout North America, divided into eastern and western populations, but can also occur in Australia, New Zealand, and portions of the Iberian Peninsula. The eastern North American population is the largest as it encompasses about 70 percent of the region's range. Monarch butterflies rely solely on the milkweed plant (*Asclepias* spp.) for egg laying and metamorphosis but can feed on many flowering plants during breeding and migration to overwinter in Mexico (USFWS, 2024b). The eastern population has a 56-74 percent probability of becoming extinct within 60 years. The western population has a 99 percent probability of becoming extinct in 60 years. Threats to the monarch butterfly include loss of habitat for breeding, migration, and overwintering; exposure to insecticide; and effects of climate change. Critical habitat of 4,395 acres is also proposed for monarch butterflies in California. No critical habitat is proposed in New England.

Marine Species: Endangered or threatened marine and anadromous (migratory) species under the ESA are managed by the National Oceanic and Atmospheric Administration (NOAA) Fisheries. Within the Connecticut River, the NOAA fisheries Section 7 online mapper identified endangered shortnose sturgeon (*Acipenser brevirostrum*), all distinct population segments of the endangered/threatened Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the adult stage, all life stages of the endangered New York Bight distinct population segments for the Atlantic sturgeon and designated critical habitat for the New York Bight distinct population segments of Atlantic sturgeon (NOAA, 2023).

State-listed Species: In Connecticut, animal or plant species of conservation concern may be listed as threatened (T), endangered (E), or special concern (SC), under the authority of the Connecticut Endangered Species Act of 1989 (Conn. Gen. Stat. § 26-303). The Connecticut Natural Diversity Data Base online tool was used to assess the potential presence of state-protected species within the study area (CTDEEP, 2025c). In Hartford, the study area was found to contain suitable habitat for 24 protected animal and plant species, as well as one mitigation area designated for managed habitat (**Table 7**). In East Hartford, suitable habitat was identified for 12 protected species (**Table 8**). Species occurring in both Hartford and East Hartford are denoted with an asterisk (*). For more information on these state-listed species, see **APPENDIX 1-A: Environmental Documentation**.

Table 7: State Listed Species Potentially Found in the Hartford Study Area (CTDEEP, 2025c)

Common/Scientific Name	Status	Common/Scientific Name	Status
Mudpuppy (<i>Necturus maculosus</i>) *	SC	Northern arrowhead (<i>Sagittaria cuneata</i>)	E
Bald eagle (<i>Haliaeetus leucocephalus</i>)	T	Pygmyweed (<i>Crassula aquatica</i>) *	E
Eastern meadowlark (<i>Sturnella magna</i>)	T	Davis' sedge (<i>Carex davisii</i>)	T
Peregrine falcon (<i>Falco peregrinus</i>) *	T	Short-awned meadow foxtail (<i>Alopecurus aequalis</i>) *	T
Bobolink (<i>Dolichonyx oryzivorus</i>)	SC	Cattail sedge (<i>Carex typhina</i>)	SC
Savannah sparrow (<i>Passerculus sandwichensis</i>)	SC	Bristly buttercup (<i>Ranunculus pensylvanicus</i>)	SC
Yellow lampmussel (<i>Lampsilis cariosa</i>) *	E	Wiegand's wild rye (<i>Elymus wiegandii</i>)	SC
Riverine clubtail (<i>Stylurus amnicola</i>)	T	Hoary plantain (<i>Plantago virginica</i>)	SC
Midland clubtail (<i>Gomphus fraternus</i>) *	T	Georgia bulrush (<i>Scirpus georgianus</i>)	SC
Cobra clubtail (<i>Gomphus vastus</i>) *	SC	Shortnose sturgeon (<i>Acipenser brevirostrum</i>) *	E
Tidewater mucket (<i>Leptodea ochracea</i>) *	SC	Atlantic sturgeon (<i>Acipenser oxyrinchus oxyrinchus</i>) *	E
Eastern pondmussel (<i>Ligumia nasuta</i>)	SC	Blueback herring (<i>Alosa aestivalis</i>) *	SC

* Species with an asterisk are shared between Hartford and East Hartford

Table 8: State Listed Species Potentially Found in the East Hartford Study Area (CTDEEP, 2025c)

Common/Scientific Name	Status	Common/Scientific Name	Status
Mudpuppy (<i>Necturus maculosus</i>) *	SC	Tidewater mucket (<i>Leptodea ochracea</i>) *	SC
Northern leopard frog (<i>Rana pipiens</i>)	SC	Pygmyweed (<i>Crassula aquatica</i>) *	E
Peregrine falcon (<i>Falco peregrinus</i>) *	T	Short-awned meadow foxtail (<i>Alopecurus aequalis</i>) *	T
Yellow lampmussel (<i>Lampsilis cariosa</i>) *	E	Shortnose sturgeon (<i>Acipenser brevirostrum</i>) *	E
Midland clubtail (<i>Gomphus fraternus</i>) *	T	Atlantic sturgeon (<i>Acipenser oxyrinchus oxyrinchus</i>) *	E

Common/Scientific Name	Status	Common/Scientific Name	Status
Cobra clubtail (<i>Gomphus vastus</i>) *	SC	Blueback herring (<i>Alosa aestivalis</i>) *	SC

* Species with an asterisk are shared between Hartford and East Hartford.

2.1.6 Future Without Project Conditions

The natural environmental resources and factors described in this section are expected to continue to be inundated by more frequent extreme flood events. Flooding may temporarily impact sensitive resources, such as wetlands and EFH, potentially exposing them more frequently to urban polluted runoff when capacity of the flood risk management system is decreased. Exposure to polluted floodwaters is the primary impact to vegetation, EFH, fish and wildlife, and T&E species. Pollutants common during flooding, described further in **Section 2.2.4**, include urban litter, wastewater from combined sewer overflows, fertilizer/pesticide chemicals, and oil. Excess nutrients and synthetic chemicals would negatively impact natural resources temporarily during the span of flooding. Hartford and East Hartford are expected to experience flood events similar to and greater than what has currently been observed.

2.2 PHYSICAL ENVIRONMENT

The physical environment is defined as resources that are abiotic (non-living) in nature, such as the inorganic, chemical, and geographical aspects that support life. This section includes a discussion on the existing conditions and future without project conditions within the study areas for resources such as air quality, topography, and climate.

2.2.1 Climate & Air Quality

Climatic regions are described by the Köppen-Geiger climate classification system and are represented by three letters, according to their main climate group and precipitation and temperature subgroups. Most of Connecticut is classified as a humid subtropical climate (Köppen classification Dfa) (WBG, n.d.). A humid subtropical climate can be broadly described as having four distinct seasons with large seasonal temperature differences, with hot, humid summers, and moderately cold, snowy winters. The hottest months are June, July, and August, while the colder months are December, January, and February. The Northeast region of the United States experiences extreme heat, flooding, droughts, and poor air quality, as well as an increase in extreme precipitation events and more severe and long-lasting heatwaves (Crimmins et al., 2023).

The NOAA's Centers for Environmental Information (NCEI) provides summaries of climate data for locations across the United States. At the Hartford Brainard Field weather station, the average annual rainfall is 42.83 inches, and the average daily temperature is 52°F, based on the 1991–2020 climate normal period. **Figure 13** presents the average monthly temperature and precipitation patterns recorded at this station (NCEI, 2025). Given East Hartford's close proximity to Hartford, these climate-patterns are considered representative of average conditions in East Hartford as well.

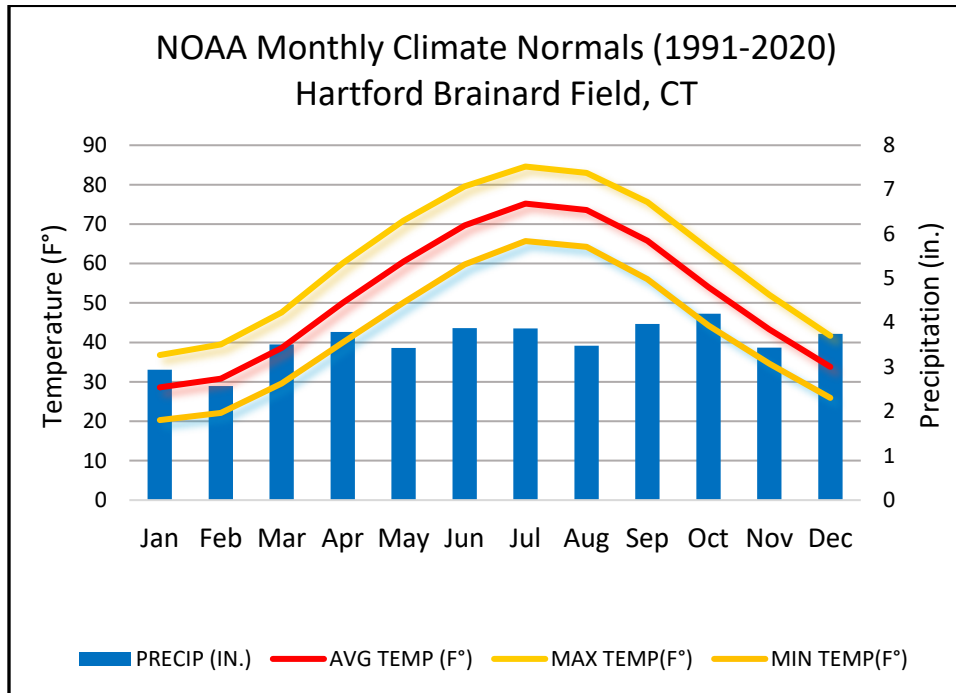


Figure 13: Average Monthly Climate Normal for the Hartford Brainard Field (NCEI, 2025)

The Clean Air Act (CAA) establishes the framework for modern air pollution control and delegates primary responsibility for regulating air quality to the States, with oversight by the USEPA. The USEPA develops rules and regulations to preserve and improve air quality as minimum requirements of the CAA, and delegates specific responsibilities to state and local agencies. Seven specific pollutants (called criteria pollutants) have been identified to be of concern with respect to the health and welfare of the public. The criteria pollutants are carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), particulate matter 10 micrometers or less in aerodynamic diameter (PM₁₀), particulate matter 2.5 micrometers or less in aerodynamic diameter (PM_{2.5}), and lead (Pb). The USEPA has established the National Ambient Air Quality Standards (NAAQS) for these pollutants. Attainment zones are areas where the NAAQS have been met. The USEPA publishes Air Quality Statistics report each year that compares data on these criteria pollutants to the national standards. Non-attainment statistics for each pollutant are categorized in order from marginal, moderate, serious, severe, and extreme. In 2024, Hartford County, which contains the city of Hartford and the town of East Hartford, was listed as being in “serious” non-attainment for the 8-hour ozone standard and in maintenance for the carbon monoxide standard (USEPA, 2026). The USEPA has approved a State Implementation Plan for attaining NAAQS for these pollutants. Hartford County is in attainment of all other criteria pollutants.

2.2.2 Topography, Geology, & Soils

The Connecticut Valley ecoregion is primarily characterized by level and gently rolling hills, with some areas featuring higher hills (USEPA, n.d.; Griffith et al., 2009). Spanning

approximately 1,459 sq mi, the region has elevations ranging from 10 to 1,106 feet above sea level and local relief between 200 and 800 feet. It is marked by the presence of small lakes, ponds, and reservoirs, formed by low to moderate gradient streams and larger rivers.

With respect to geology, the Hartford and East Hartford FRM systems are located in the Central Lowlands of the Connecticut physiographic province, also known as the Hartford Basin. This basin was formed during a failed continental rift during the Mesozoic Era (~200 million years ago), which allowed for surficial lava flows resulting in the interbedded sedimentary and igneous bedrock seen today (Hubert, 1992).

The dominant bedrock geology of the area consists of sedimentary rock formations, including arkose, siltstone, sandstone, shale, and conglomerate (Rogers, 1985). There are also tilted basalt layers that have given rise to distinctive ridges, such as the Holyoke basalt, which forms a prominent north-south ridge stretching from southern Connecticut to central Massachusetts.

The region's surficial geology is largely made up of thick deposits of outwash, alluvial, and lacustrine sediments. Often underlying these sediments are glacial till deposits formed by large continental ice sheets, which covered New England most recently during the Pleistocene Wisconsinan glaciation. During ice sheet retreat (~12,000 to 15,000 years ago), Glacial Lake Hitchcock formed and spanned from Rocky Hill, CT, northward to Burke, VT. Once the Rocky Hill debris dam on the south end of the lake was compromised ~14,000 years ago, Glacial Lake Hitchcock drained, and the Connecticut River was formed (USACE, 2019).

Hartford and East Hartford are located across the Connecticut River from each other, in one of the flatter sections of the Connecticut Valley. Hartford lies between the Connecticut River to the east and the Park River to the west, while East Hartford is additionally bisected by the Hockanum River, which flows through the town and into the Connecticut River. The Connecticut Valley contains rich soils that have attracted human settlement for use of cropland and pasture. However, soils in the project area are impacted by heavy urbanization and industrialization, particularly in the city of Hartford. Soils of Hartford County are primarily sandy soils derived from glacial outwash, such as the Hartford series, Enfield series, and sandy loam.

2.2.3 Hydrology

2.2.3.1 Surface Water and Floodplains

The dominant feature of the hydrologic system in the Greater Hartford region is the Connecticut River. Hartford and East Hartford share the following hydrologic unit codes (HUCs) used by the United States Geologic Survey (USGS) (USGS, 2021):

- 01 (HUC 2: Region) – New England Region
- 0108 (HUC 4: Sub-region) – Connecticut
- 010802 (HUC 6: Basin) – Lower Connecticut
- 01080205 (HUC 8: Sub Basin) – Lower Connecticut

Hartford and East Hartford differ slightly at HUC 10 “Watershed” and HUC 12 “Sub-Watershed”. At HUC 10, Hartford lies within the Connecticut River-Scantic River to Mattabesset River (0108020507) and Park River (0108020505) watersheds. At HUC 12, Hartford contains the Connecticut mainstem-Scantic River to Hockanum River (010802050505), Park River-South Branch and mainstem (010802050502), and Connecticut mainstem-Hockanum River to Hog Brook (010802050506) sub-watersheds.

In East Hartford, HUC 10 includes the Hockanum River (0108020505) and Connecticut River-Scantic River to Mattabesset River (0108020507) watersheds. At HUC 12, East Hartford contains the Hockanum River-Tankerhoosen River to mouth (010802050505), Connecticut mainstem-Scantic River to Hockanum River (010802050505), Connecticut mainstem-Hockanum River to Hog Brook (010802050506), Salmon Brook (010802050503), and Podunk River (010802050502) sub-watersheds.

Because the landscape around the Connecticut River is relatively flat, both Hartford and East Hartford are prone to poor drainage. Following the major floods of 1936 and 1938, USACE constructed an FRM system to reduce flood risk. The surface water hydrology in both communities has since been heavily altered by urban development. Modifications such as storm-sewer construction and the paving of formerly pervious surfaces have increased both the rate and volume of surface runoff within the project area. In addition, USACE buried the main branch of the Park River beneath the city of Hartford, allowing it to discharge into the Connecticut River while minimizing future flood risk. FEMA has designated a majority of the project area in both Hartford and East Hartford as Zone X (areas with reduced flood risk due to the FRM system from 1% annual chance flood) or Zone AE (areas of 1% annual chance flood (100-year flood zone)).

2.2.3.2 Past Flood Events

Storms within the Connecticut River Basin consist of extratropical continental storms which move across the area under the influence of the prevailing westerlies, thunderstorms produced by local convective activity or by more general frontal activity, extratropical maritime storms which move northward along the Atlantic coast, and maritime storms of tropical origin. Flooding can occur in New England during any time of the year, as a result of either excessive precipitation, snowmelt, or a combination of the two. The maximum flood of record on the Connecticut River at the project location occurred in March 1936 and was the result of intense rainfall accompanied by excessive snowmelt. The largest flooding events experienced within the study area are listed below:

- 1936 Flood: The 1936 flood stands as one of the most devastating events in Hartford's history. During this flood, the Connecticut River crested at over 20 feet above flood stage, causing catastrophic damage by submerging homes, businesses, and critical infrastructure. **Figure 14** provides an aerial perspective of the flooding, with the Colt's Patent Fire Arms Manufacturing Company complex centered in the image. In the background, the Bulkeley Bridge is seen spanning the Connecticut River, connecting the city of

Hartford on the left with East Hartford on the right. The Travelers Tower is also visible on the far left of the Hartford skyline.



Figure 14: An Aerial View of the Connecticut River at Hartford during the Flood of 1936, Featuring the Colt Firearms Factory at Center
(Source: USACE)

- 1938 Hurricane: Just two years later, the infamous 1938 hurricane brought another round of severe flooding to Hartford. The heavy rainfall, combined with some storm surge effects, overwhelmed the city, causing further destruction and loss of life.
- 1955 Floods: The back-to-back floods of August and October 1955, caused by hurricanes Connie and Diane, respectively, brought further devastation to the region. These events led to significant infrastructure improvements and flood control measures.
- Recent Floods: While major floods have become less frequent due to flood control measures, Hartford still experiences periodic flooding, particularly during heavy rainfall events and spring thaws.

2.2.4 Water Quality

Natural waters in the Greater Hartford region are largely freshwater, as the Connecticut River, which empties into Long Island Sound, becomes less saline around the town of Chester, which is about 30 miles downstream of Hartford and East Hartford (CTDEEP, 2008). The river is tidal as far as Windsor Locks, which is about 60 miles from the mouth

of the river and 8 miles north of the project areas. The river bottom of the Connecticut River is mainly mud and has vegetative cover less than 30% (USFWS, n.d.). The Park River in Hartford and the Hockanum River in East Hartford are tributaries to the Connecticut River. The portion of the Park River within the Hartford project area is buried underground and exits into the Connecticut River from a large conduit. The Hockanum River meanders through various wetlands before discharging into the Connecticut River.

Water quality in Connecticut is managed through established water quality standards based on classified uses of each water body. The Connecticut River is a class B waterbody, suitable for recreation, healthy aquatic habitat, and fishing, with allowable discharges of treated wastewater, but may be subject to periodic contamination from municipal combined sewer overflows and urban runoff during heavy rains. According to the Connecticut Department of Energy and Environmental Protection (CTDEEP) 2024 Integrated Water Quality Report, the Connecticut River is listed as being impaired in one use category and the Park River is impaired in one use category. The Hockanum River is listed as being impaired in two use categories (CTDEEP, 2024b). These impairments are within the USEPA Category 5 classification, the highest classification that requires a Total Maximum Daily Load cleanup plan. A summary of information for this data from the 2024 Integrated Report is presented in **Error! Reference source not found.** This information is published in the *2024 Integrated Water Quality Report Appendix B1* (CTDEEP, 2024b).

Table 9: List of Impaired Rivers in the Project Area

Waterbody	Impaired Designated Use	Impairment Cause	Category
Connecticut River	Fish Consumption	Polychlorinated Biphenyls	5
	Fish Consumption	Perfluorooctane Sulfonate	5
Park River (North and South Branches)	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	5
Hockanum River	Fish Consumption	Perfluorooctane Sulfonate	5
	Habitat for Fish, Other Aquatic Life and Wildlife	Cause Unknown	5

The Connecticut River is also subject to combined sewer overflows (CSOs): the discharge of raw sewage and stormwater into nearby streams due to the carrying capacity of the single combined pipe being exceeded during intense or long-duration precipitation events. Modern communities have upgraded to systems that separate stormwater and wastewater, but both Hartford and East Hartford still utilize the combined system, although efforts to separate the system are underway. The MDC, a non-profit municipal corporation chartered by the Connecticut General Assembly, manages drinking water and wastewater collection and treatment. In compliance with the USEPA’s CSO Control Policy

and a consent order from CTDEEP, the MDC is following a Long-Term Control Plan to eventually eliminate the combined sewer and stormwater system (MDC, 2018; Save the Sound, 2024).

According to the EPA's National Combined Sewer Overflow Inventory, there are about 16 combined sewer outfalls within the project areas: four that discharge from Hartford into the Connecticut River, nine that discharge to the Park River conduit, two that discharge to Folly Brook and empties into Wethersfield Cove, and one that discharges into the North Meadows storage pond (EPA, 2025a). No outfalls currently discharge from East Hartford into Connecticut River or the Hockanum River. There are still about 38 combined sewer outfalls in the Greater Hartford area that the MDC manages and which ultimately discharge pollutants and wastewater into the Connecticut River. Eight of Hartford's combined outfalls, some located outside of the project area, flow into Wethersfield Cove via the Folly Brook conduit, a popular recreational area for swimming and boating (Hartford Courant, 2025).

Waters can stay impacted up to two hours after a rain event and associated CSO discharge ends (CTDEEP, 2021). The pollutants of CSO discharges can have physical, biological, and chemical attributes (Perry et al., 2024). Physical attributes can include increased turbidity, changes in pH of water, and litter. Litter from wastewater is usually comprised of synthetic particles from sanitary products, while stormwater litter comes from common urban debris such as tire particles and their resulting microplastics. Biological attributes can include parasites and microorganisms such as bacteria and viruses. *Escherichia coli* (*E. coli*) is an indicator microorganism that is used during water quality assessments because of its link to fecal contamination in water. Chemical attributes, specifically from wastewater, are often attributed to industrial and household products such as tributyltin (used in textiles and detergents) and Triclosan (used in shampoos, cosmetics, toothpastes). Chemical attributes of stormwater are related to oil, pesticide and fertilizer contaminants, chemicals, and road salt (during the winter season). The resulting cocktail of pollutants can also cause nutrient pollution. For example, an excess of nitrogen and phosphorus fuels rapid growth of aquatic plants, particularly algae, which then die and are decomposed by bacteria. This decomposition process consumes the dissolved oxygen and leads to fish kills due to reduced oxygen in the water, known as hypoxia.

In 2023, the MDC reported 90 days of combined sewer overflow, for a total estimated flow of 1,596,193,922 gallons (CTDEEP, 2026). During a water quality study of the Connecticut River, completed by the Connecticut River Conservancy in 2025, *E. coli* samples were taken and compared to thresholds for safe recreation developed by the EPA (O'Donnell, 2024). During sampling of *E. coli* in 2023 in wet weather, samples taken in East Hartford show that the river was near or at the primary contact recreation threshold twice, and at or above the secondary contact threshold twice. Samples taken in Windsor Meadows, located just north of Hartford, show that the river was at or above the primary contact threshold three times, and above the secondary contact threshold once. Samples taken during dry events did not meet or exceed the threshold levels. Generally, the Connecticut River is safe for recreation during dry events and sometimes safe for

recreation during wet weather events. However, CTDEEP notifies the public during CSO discharges to help the public avoid recreating in waterbodies that may be affected.

2.2.5 Future Without Project Conditions

Each resource in the physical environment was analyzed for the FWOP condition. In the FWOP, the conditions of climate, air quality, topography, and geology are not expected to differ from the existing conditions. The project sites in Hartford and East Hartford are heavily developed and are therefore limited in future development of impervious surfaces and resulting run-off. The Connecticut River already experiences periodic negative impacts to water quality due to combined sewer overflows and runoff, which may be experienced more frequently in the FWOP. A Long-Term Control Plan to reduce the separate the combined sewer systems would continue to be followed, reducing the existing water quality contamination into the future. However, potential for levee breach or interior flooding could worsen water quality, potentially introducing new pollutants to the river system. Soils may be impacted by future flooding, due to the potential for contaminants accumulating in sediments over the long term. Accumulation of pollutants in rivers can affect bottom dwelling aquatic species, or if resuspended during turbid conditions can temporarily affect recreation.

2.3 BUILT ENVIRONMENT

The built environment refers to man-made resources and infrastructure and is defined as the urban landscape, social structures, and human-made settings within the project areas. This section includes a discussion on the existing conditions and future without project conditions on resources such as historic properties, recreation, and land use.

2.3.1 Hazardous, Toxic, & Radioactive Waste

The presence of Hazardous, Toxic, and Radioactive Waste (HTRW) in the study area is likely given the project's location in an urbanized area with historically heavy industrial use. In order to complete a feasibility level HTRW evaluation for the proposed project, a records review was conducted in alignment with ER 1165-2-132: *HTRW Guidance for Civil Works Projects* (USACE, 1992), and in general accordance with portions of American Society for Testing and Materials (ASTM) E1527-21: *Standard Practice for Environmental Site Assessment: Phase 1 Environmental Site Assessment Process* (ASTM International, 2021). The evaluation involved a direct review of Federal and State databases to identify known, high-priority sites, including those on the USEPA's National Priorities List (NPL) and sites regulated by the State of Connecticut. No environmental sampling of soil or groundwater was performed as part of this evaluation.

Regulatory database summary reports were acquired from Environmental Data Resources, Inc. (EDR) in June 2023 with updates acquired in December 2025 and January 2026. These reports consolidate standard federal, state, local, and tribal environmental record sources based on ASTM E1527-21 recommended minimum search distances from the site (ASTM International, 2021). The reports provided by EDR were generated for four target properties along the FRM systems, with each report generating a one-mile search radius around the selected property. Properties within this radius were

screened for existing environmental database listings, which allowed for coverage of all relevant properties in Hartford and East Hartford (**APPENDIX 2-J: Hazardous, Toxic and Radioactive Waste Analysis**).

Results of the HTRW analysis indicate that the project area is impacted by a variety of known and potential sources of contamination stemming from industrial and commercial activity in Hartford and East Hartford. Sites of potential HTRW concern were cross-referenced with the Project Delivery Team's (PDT) proposed measures throughout the planning process, which lead to the exclusion of measures within known contaminated areas, such as the former Materials Innovation and Recycling Authority (MIRA) waste to energy site located in Hartford (CSWS, 2022).

The remaining measures were carried forward for further evaluation. The remaining sites were then screened for their potential to impact project construction activities based on 1) the presence of suspected soil and/or groundwater contamination, 2) mobility within the soil-groundwater-air matrix, and 3) potential for construction to disturb contaminated media. Given the limitations of this desktop review and the lack of confirmatory sampling during Feasibility Phase, caution is advised during all intrusive work, and characterization of soil and groundwater is recommended prior to construction. Special management and disposal of soil and groundwater may be required in some areas. **APPENDIX 2-J: Hazardous, Toxic and Radioactive Waste Analysis** details the findings of the HTRW evaluation conducted for this study.

2.3.2 Public Health & Safety

Hartford and East Hartford are situated behind FRM systems that protect the communities from flooding of the Connecticut River. In addition to the Connecticut River, the FRM system in Hartford manages flooding of the Park River, Gully Brook, and Folly Brook, while the East Hartford system manages flooding of the Hockanum River. These Hartford Main Stem and the East Hartford FRM systems were constructed more than 80 years ago, while construction of the Park River System was completed in the early 1980s. These FRM systems were intended to protect the public and community resources during significant flood events. The levied areas contain commercial, industrial, residential, and public infrastructure, businesses, and recreational areas that are frequently visited.

Public safety resources for the city of Hartford include the Hartford Fire Department, the Hartford Police Department, the Health and Human Services Department, and the Emergency Services and Telecommunications. Public safety resources for East Hartford include the East Hartford Fire Department, the East Hartford Police Department, and the Health and Human Services Department. Both the Hartford and East Hartford Fire Departments have Emergency Management divisions responsible for planning and directing disaster response.

2.3.3 Cultural Resources

"Cultural resources" is an umbrella term for many heritage-related resources, including prehistoric and historic archaeological sites, buildings, structures, districts, or certain

objects. Cultural resources are discussed in terms of archaeological resources, architectural resources, or resources of traditional cultural significance. Several federal laws and regulations have been established to manage cultural resources, including the National Historic Preservation Act (NHPA) of 1966, NEPA of 1969, the Archeological and Historic Preservation Act of 1974, the American Indian Religious Freedom Act of 1978, the Archeological Resource Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1990. In addition, DoDI 4710.02, *Department of Defense Interactions with Federally Recognized Tribes* (2006), governs Department of Defense interactions with federally recognized tribes and Executive Order (EO) 13175, *Consultation and Coordination with Indian Governments* (2000), charges federal departments and agencies with regular and meaningful consultation with Native American tribal officials in the development of policies that have tribal implications. For more information, refer to the USACE Tribal Policy Principles located on the USACE Tribal Nations Program website.

The National Register of Historic Places (NRHP) is administered by the National Park Service (NPS) and is the official list of the properties in the United States that are significant in terms of prehistory, history, architecture, or engineering. Generally, resources must be more than 50 years old to be considered eligible for the NRHP. To meet the evaluation criteria for NRHP eligibility, a property needs to be significant under one or more NRHP evaluation criteria (36 CFR 60.4) and retain historic integrity expressive of the significance. More recent structures might be NRHP-eligible if they are of exceptional importance or if they have the potential to gain significance in the future per special NRHP considerations. Additional information regarding the regulations, recent publications, and current guidance is available online at the NPS NRHP homepage.

As a federal agency, USACE has certain responsibilities for the identification, protection, and preservation of cultural resources that may be located within the Area of Potential Effect (APE) associated with any proposed undertaking. Current statutes and regulations governing the identification, protection, and preservation of these resources include the NHPA, NEPA, EO 11593, and the regulations implementing Section 106 of the NHPA (36 CFR 800, Protection of Historic Properties, August 2004). The NHPA and its implementing regulations require federal decision makers to consider historic properties in their evaluation of effects associated with an undertaking. Under the NHPA, historic property means any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the NRHP maintained by the Secretary of the Interior (NPS).

2.3.3.1 Historic Properties

According to the Connecticut State Historic Preservation Office (CTSHPO) Cultural Resources Information System (ConnCRIS) database, several historic properties, districts, and archaeological sites have been identified in the study area (CTSHPO, 2025). A Phase IA cultural resources investigation was completed for this study and identified more than 3,000 previously recorded aboveground historic properties and 53 recorded historic districts. Of the 3,000 historic properties, 51 are individually NRHP or State Register-listed, 32 of which are part of the Colt Industrial District in Hartford. A total of 925

previously evaluated historic properties have been determined eligible for listing and contribute to recorded historic districts throughout the study area, the majority of which are located in the city of Hartford and are part of the Frog Hollow Historic District and the Prospect Avenue Historic District. Most of the recorded historic properties in the study area are residential and date to the late-eighteenth and early-nineteenth centuries. A map of all historic properties in the study area is provided in **Figure 15**.

Of the 53 total historic districts in the study area, 49 are located in the city of Hartford and four are located in the town of East Hartford. One district, the Colt Industrial Historic District in Hartford, is also a National Historic Landmark. Two of the Hartford districts, the George Keller Historic District and the Ridgefield Street Historic District, are designated Local Historic Districts and have not been NRHP-listed. Four other Hartford districts have been listed on the State Register, but not the NRHP. A map of all historic districts in the study area is provided in **Figure 16**. More information on known or recorded cultural resources in the study area is provided in **APPENDIX 1-H: Cultural Resource Report and Background Study**.

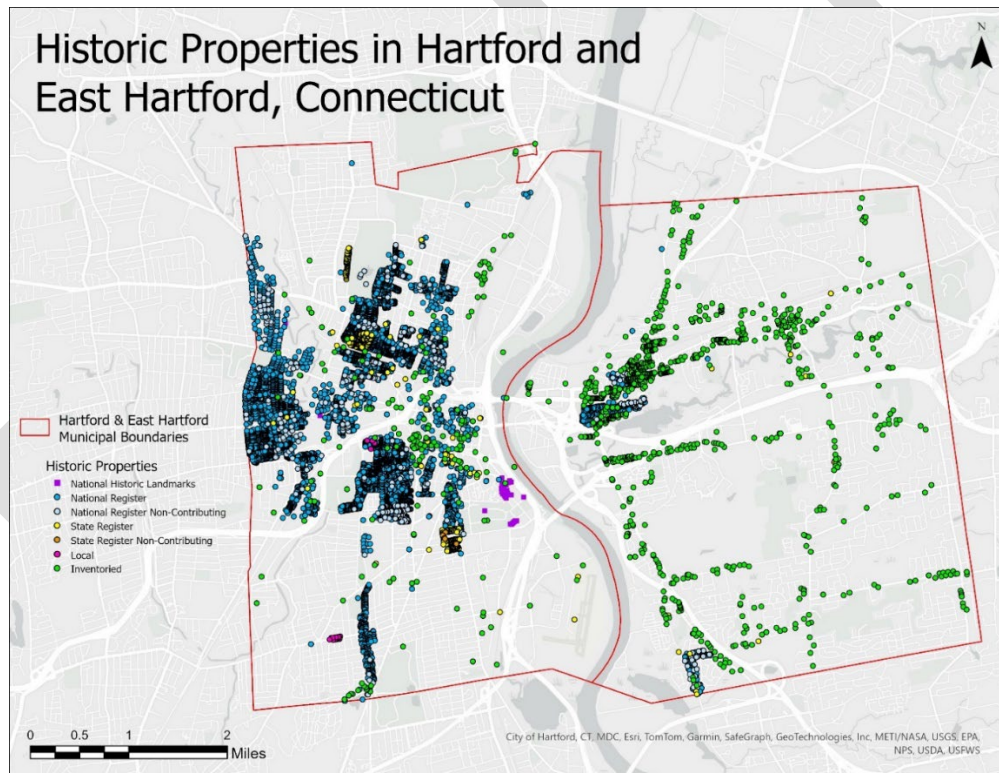


Figure 15: Historic Properties in the Study Area

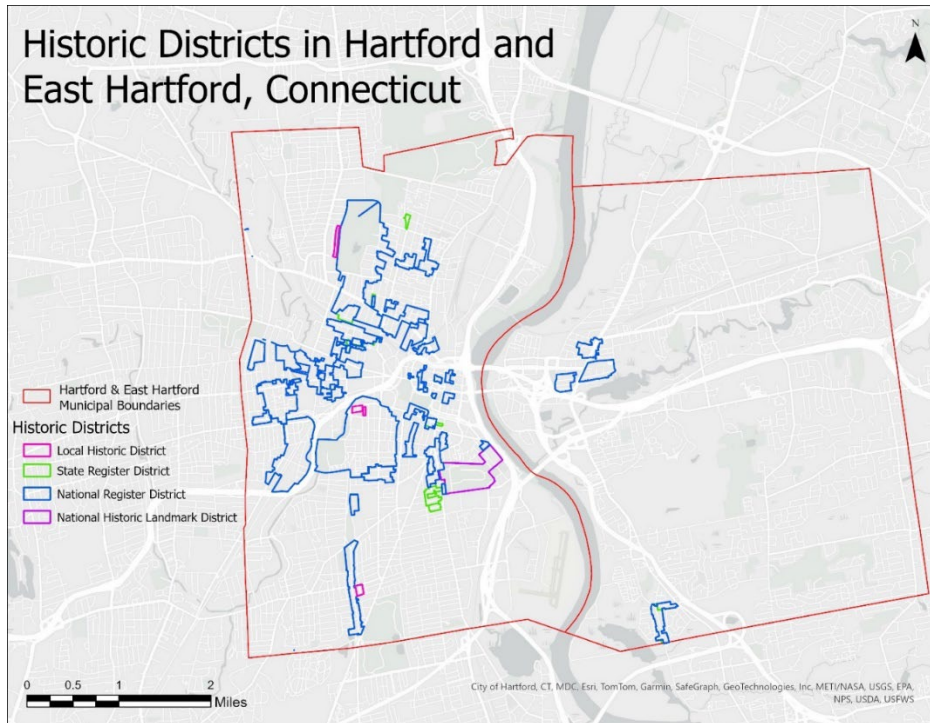


Figure 16: Historic Districts in the Study Area

2.3.3.2 Archaeological Resources

In accordance with Section 106 of the NHPA, the Phase IA cultural resources investigation identified 40 archaeological sites within the study area (see **APPENDIX 1-H: Cultural Resource Report and Background Study** for further information). A total of 31 sites are located in the town of East Hartford and the other nine sites are located in the city of Hartford. The sites span both historic and prehistoric periods and consist of but are not limited to cemeteries, dwellings, and industrial works sites. The NRHP status of each site is currently unavailable but will need to be consulted once plans are established to determine the level of impact and potential for adverse effects. Due to the sensitive nature of archaeological sites, no locational data is reproduced here.

2.3.4 Recreation & Aesthetics

Recreational facilities are defined as those amenities that provide for relaxation, rest, exercise, activity, enjoyment, education, or opportunities for leisure and community support that enrich the quality of life. These include, but are not limited to, parks, trails, boat ramps, athletic fields, and playgrounds. Recreational areas may include any type of activity in which residents or visitors may participate, such as hiking, bike riding, boating, fishing, swimming, picnicking, playground use, or participation in sports. The project areas intersect with several recreational hubs that connect Hartford and East Hartford both with each other and with the Connecticut River through the Riverfront Recapture park system (Riverfront Recapture, n.d.(a)).

Riverfront Recreation: Hartford and East Hartford share the Founders Bridge Walkway and Charter Oak Bridge, allowing pedestrians and cyclists to connect with several recreation areas on either side of the Connecticut River. Along the river, south of Downtown Hartford and outside of the levied project area, is the Charter Oak Landing. The park encompasses 27 acres and contains a boat launch, access for fishing, a playground, picnic tables, charcoal grills, paved paths, and restrooms. The park is also home to nesting eagles (Riverfront Recapture, n.d.(b)). The Charter Oak Bridge connects Charter Oak Landing to the southern end of the Great River Park in East Hartford. The Great River Park also sits alongside the Connecticut River, just outside of the levied project area, and covers about 22 acres. It contains a boat launch, picnic areas, fishing access, art sculpture installations, playgrounds, a fitness station, paved paths, and a 350-seat amphitheater for performances (Riverfront Recapture, n.d.(c)). Intersecting through Great River Park is the East Hartford Riverwalk. The 1.5-mile Riverwalk connects to the Founders Bridge Walkway in the north and the Hockanum River Linear Trail in the south. The East Hartford Riverwalk is also a section of the approximately 3,000-mile-long East Coast Greenway, a shared-use trail that connects 15 states from Florida to Maine (East Coast Greenway, n.d.; Town of East Hartford, n.d.).

Above Downtown Hartford in North Meadows, situated along the Connecticut River and outside of the levied project area, is Riverside Park. The park is a 75-acre recreational space that offers a boat launch, access for fishing, a playground, a sand volleyball court, cricket and football fields, paved and unpaved trails, art sculpture installations, picnic tables, charcoal grills, and restrooms. The northern end of Riverside Park connects with North Meadows Bird Sanctuary, a nature preserve that is currently not open to the public but is a soon-to-be tourist attraction (HBID, n.d.). In Downtown Hartford there is the recreational hub of Mortensen Riverfront Plaza, a nearly 0.5-acre park with a stage and a grassy terrace with seating for 2,500 people. The park includes performance facilities, public boat cruises, access to fishing, art sculpture installations, and paved paths (Riverfront Recapture, n.d.(d)). Several other natural areas along the river exist near the project areas, with the Wethersfield Cove Park and Folley Brook Natural Area just below South Meadows in the town of Wethersfield, and across the river with Kenney Cove in East Hartford. In addition to these riverfront parks, the Connecticut River is also a recreational resource. The river is about 410 miles and provides recreation opportunities such as swimming, boating, and fishing.

Inland Recreation: Within the project area in Hartford, there are two public parks. The 37-acre Bushnell Park is located in Downtown Hartford and is a major centerpiece, featuring a historic carousel and is the site of numerous major events. Colt Park, just south of Downtown Hartford, is 114 acres and contains a playground, swimming pool, splash pads, sports fields, and Dillion Stadium. Colt Park is listed on the NRHP. In the East Hartford project area, there is Center Park, a 2.2-acre natural park that sits in a residential area just above Interstate 84.

Aesthetics: Visual resources are the natural and man-made features that comprise the visual qualities of a given area, or “viewshed.” These features form the overall impression that an observer receives of an area or its landscape character. Topography, water,

vegetation, man-made features, and the degree of panoramic view available are examples of visual characteristics of an area.

Aesthetically, Hartford and East Hartford are known for their proximity to the Connecticut River, a scenic characteristic of the area and a popular recreational feature. The river also contributes to a variety of wildlife habitats that host many different species. Natural resources along the Connecticut River, such as Riverside Park, are popular for wildlife viewing.

Hartford and East Hartford also derive their aesthetic values from historic resources. In Hartford, there are several historical features and buildings, many of which are part of the historic Colt Industrial District. There are 49 historic districts in Hartford and four in East Hartford.

2.3.5 Noise

The project areas in Hartford and East Hartford are primarily urban. Major intersections of highway (i.e., I-84 and I-91 in Hartford, and I-84 and Route 2 in East Hartford), carry large amounts of traffic through the project areas. Noise levels typical of populated, urban environments are influenced by vehicular traffic, public transit, rail network, construction, aircraft, watercraft, industrial, and commercial activities. The influence of each of these sources of noise on ambient levels depends on the proximity to transportation corridors and developed areas. The decibel (dB) is the unit used to measure the intensity of the sound. Decibels are measured on a logarithmic scale, and they correspond to how a human's ear interprets sound pressure. A "weighted" scale (dBA) is used to account for the frequency range with respect to how people respond to sound. Typical noise levels associated with urban environments and freeways range between 70-90 dBA (A-weighted decibels) (CHC, n.d.; Yale, n.d.). Other common, but infrequent, urban noises include car horns or ambulance sirens, at around 110-120 dBA.

2.3.6 Land Use

Hartford is a highly developed city characterized by a mix of public, commercial, residential, and industrial land uses. The project area encompasses approximately 3,000 acres, a substantial portion of which is dedicated to industrial and commercial activity. Much of the area is dominated by impervious surfaces, with limited areas of developed open space, bare land, and scattered patches of forest and wetlands. With the exception of Downtown Hartford, a narrow corridor of mixed forest and interspersed wetlands separates developed areas from the Connecticut River. **Figure 17** illustrates the land use within one part, the South Meadows neighborhood, of the study area. Larger open spaces occur near Hartford–Brainard Airport in South Meadows, within Colt Park just south of Downtown Hartford, and in Riverside Park and the Bird Sanctuary in North Meadows. The extensive impervious cover reflects the concentration of properties and businesses, major roadways and highways, and Hartford's dense city center.

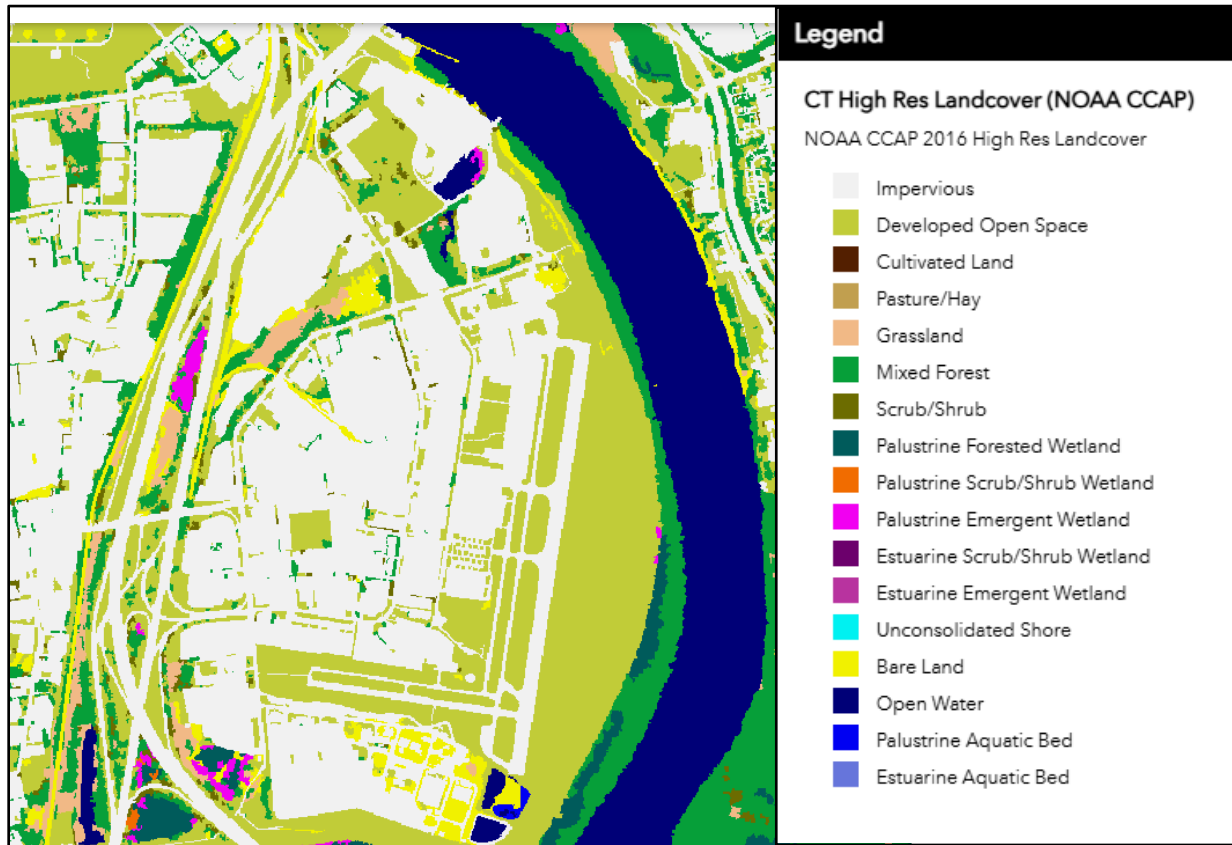


Figure 17: Land Use in the South Meadows Neighborhood of Hartford, CT (UCONN, n.d.)

East Hartford also contains extensive development, though at a lower density than Hartford, with larger areas of undisturbed natural land (**Figure 18**). The approximately 760-acre project area is primarily characterized by impervious surfaces. The convergence of I-84 and Route 2 occurs within the project area, crossing small, fragmented sections of wetlands and forested land. The project area contains public, commercial, residential, and industrial properties. A corridor of mixed forest, interspersed wetlands, and bare land separates the developed areas from the Connecticut River.



Figure 18: Land Use in the East Hartford Study Area (UCONN, n.d.)

2.3.7 Transportation

Hartford and East Hartford share a variety of transportation infrastructure, such as major highways, public transit, and railways. The Hartford project area contains three major highway intersections: convergences of Interstate 84 (I-84) and Interstate 91 (I-91), CT Route 44 and I-84, U.S. Route 2 and I-91, and U.S. Route 5/CT Route 15 and I-91. I-84, Route 2, and Route 5/Route 15 are carried over the Connecticut River by the Bulkeley Bridge, Founders Bridge, and Charter Oak Bridge, respectively, and into East Hartford. I-84 and Route 2 converge within the East Hartford project area.

Hartford and East Hartford share a public transit system that encompasses local and regional buses and trains, operating through CT *transit* and the Greater Hartford Transit District (GHTD). CT *transit* is the brand name for services operated by private bus companies under contract to the Connecticut Department of Transportation (CTDOT). CT *transit* offers about 80 different bus routes in the greater Hartford area in a variety of services, including local, long-distance, shuttle, and CT *fastrak*. The GHTD owns and operates the Hartford Union Station, which is utilized by both public and private transportation companies such as Greyhound Lines and Amtrak. The GHTD also offers

the Paratransit Service in compliance with the Americans with Disabilities Act, which provides equal access to public transportation for individuals with disabilities.

Additionally, CT *rail* (CT) owns the Hartford Line commuter rail, operated jointly with TransitAmerica Services and Alternate Concepts (TASI/ACI) and Amtrak. East Hartford does not receive public railway service (e.g., CT *rail*, Amtrak). A summary of services for public transportation can be found in **Table 10**.

Table 10: Public Transportation in the Greater Hartford Area

Owners/ Operators	Services	Description
CT <i>transit</i>	Local bus	Local bus routes make frequent stops, linking neighborhoods and urban centers
CT <i>transit</i>	Flyer bus	Flyer bus routes provide faster service than other local routes, but offer limited stops
CT <i>transit</i>	Bus rapid transit (CT <i>fastrak</i>)	CT <i>fastrak</i> routes provide limited stops and faster service than local routes, but require pre-paid fare
CT <i>transit</i>	Express bus	Express bus routes provide long-distance service between cities and suburbs
CT <i>transit</i>	Connector bus	Connector bus routes provide peak-hour weekday service between rail stations and central business areas
CT <i>transit</i>	Shuttle	Shuttle bus routes are short distance, operating primarily within downtown Hartford
CT <i>rail</i> , TASI/ACI, Amtrak	Hartford Line	A commuter rail service
GHTD	Paratransit	A bus service for disabled individuals that operates within a ¾ mile radius surrounding the fixed route service
GHTD, Amtrak	Amtrak	A national rail service offering four services, including Hartford Line, that stop in Hartford

Although CT *rail* does not service East Hartford, there are 20 CT *transit* bus routes that serve or drive through the East Hartford project area. About 43 CT *transit* bus routes serve or drive through the Hartford project area, with a majority of the routes originating at Union Station in Downtown Hartford. A list of these bus routes can be found in Transportation Section of **APPENDIX 1-F: Comprehensive Benefits Analysis**. Shared between Hartford and East Hartford is also a freight rail: the Connecticut Southern Railroad, Incorporated, headquartered in Hartford.

2.3.8 Critical Infrastructure

Within the study areas in Hartford and East Hartford, a diverse array of critical infrastructure supports the region's population and economy. This infrastructure spans utilities, public safety, government services, healthcare, and education.

The region's water and sanitary sewer systems are managed by MDC, a non-profit municipal corporation serving numerous municipalities in the greater Hartford area, including Hartford and East Hartford. Two Water Pollution Control Facilities (WPCF), also known as wastewater treatment plants (WWTPs), are located within the study area—one in Hartford and one in East Hartford—which are connected by a complex system of sewer lines. The main offices of the MDC are also located in the South Meadows neighborhood of Hartford.

Electrical and natural gas services are also critical components of the region's infrastructure. The main offices of Connecticut Natural Gas, which serves central Connecticut, are situated in East Hartford. The electric utility company, Eversource, has a facility on Sheldon Street in Hartford. Additionally, the Hartford Steam Company, located on Columbus Boulevard, provides distinct heating and cooling systems to many of the city's government and historic buildings. Its downtown system, which is within the study area, serves 47 buildings, including City Hall, the Hartford Civic Center Coliseum, and a senior citizens residential tower.

In East Hartford, fire protection and emergency medical services are provided by the municipally owned Fire Department of East Hartford, which operates out of five stations. One of these, Fire Station One on Main Street, is located within the study area. The Hartford study area, by contrast, does not contain any fire stations, though it is served by a private ambulance service. No police department facilities are located within either study area.

Both local and state government offices are located within the study areas. In East Hartford, the Town Hall on Main Street contains the town clerk's office, the building inspector, probate court, and town council chambers. In Hartford, two state government high-rise towers on Columbus Boulevard house numerous agencies, including the Department of Revenue Services, the Office of Tourism, the State Board of Pharmacy, and the Office of Early Childhood. The Hartford Probate Court is located separately on Talcott Street.

The Greater Hartford area is a major healthcare hub. Within the East Hartford study area, the largest medical facility is the University of Connecticut (UConn) Health Medical Services. Other smaller facilities located within the area include private doctor and dentist offices, a hospice, a dialysis clinic, and a nuclear pharmacy.

Educational institutions are also protected by the FRM systems. In East Hartford, these include offices for Albertus Magnus College and the Arizona College of Nursing. The Hartford study area contains the Capitol Region Education Council (CREC) Central Office, the CREC Greater Hartford Academy of the Arts High School, and the Sports and

Medical Sciences Academy magnet school. A private flight school is also located at the Hartford-Brainard Airport.

Other significant facilities located within the study area include the Barbara Bailey Kennelly Post Office Building and the Hartford Correctional Center in Hartford's North Meadows neighborhood.

The study areas include critical infrastructure facilities that have regional significance. Descriptions of these facilities are included below.

Hartford Water Pollution Control Facility (Hartford): The Hartford WPCF, operated by the MDC, is the largest wastewater treatment plant in Connecticut and plays a crucial role in the region's public health and environmental well-being. The facility began operation in 1938 and can treat up to 200 million gallons of wastewater per day. It serves the member towns of Bloomfield, East Hartford, Hartford, Newington, Rocky Hill, West Hartford, Wethersfield, and Windsor, and also provides limited sewer services to Manchester, Glastonbury, and South Windsor.

The Hartford WPCF is a cornerstone of the MDC's efforts to protect the Connecticut River, into which it discharges treated effluent. The facility's significance extends to the health of Long Island Sound, as the Connecticut River is a major source of freshwater to the Sound. Upgrades at the Hartford WPCF, such as those for nitrogen removal, have been driven by the need to improve the water quality of both the Connecticut River and Long Island Sound. The facility utilizes a multi-step treatment process, including primary and secondary treatment, to remove pollutants from wastewater.

A key part of the process is disinfection, particularly from May to September, using ultraviolet light to ensure the water is safe for recreational activities like boating and fishing in the Connecticut River. In addition to its primary function, the Hartford WPCF has a sustainable energy component; it incinerates solids removed from the wastewater and uses the generated heat to produce nearly 40% of the facility's electricity needs. This "green" process helps to lower operating costs while benefiting the environment. The MDC's Clean Water Project, a massive wastewater infrastructure upgrade, further underscores the facility's regional importance by dramatically reducing combined sewer overflows and contributing to a cleaner, healthier Connecticut River, which in turn boosts the local economy and quality of life.

The Hartford WPCF functions as a crucial regional hub for sludge processing. While the Hartford facility provides full secondary treatment for the wastewater generated within its direct service area, it also receives and processes sludge from the MDC's three satellite plants in East Hartford, Rocky Hill, and Poquonock (Windsor). Furthermore, the Hartford WPCF accepts sludge from other non-District sources, including other municipalities from outside of Connecticut.

Connecticut Natural Gas (East Hartford): The Connecticut Natural Gas facility in East Hartford serves as a crucial operational and distribution hub for the region's energy

infrastructure. As a subsidiary of Avangrid, this operations center is responsible for the delivery of natural gas to customers throughout the Greater Hartford area and surrounding communities. The facility is a significant local employer, with hundreds of staff, including customer relations representatives who handle inquiries regarding billing, service, and other consumer needs.

CTtransit Bus Facility: The CTtransit bus facility in Hartford, located at 100 Leibert Road, is the operational heart of the state's largest public transportation division, making it a linchpin for regional mobility. As the headquarters for CTtransit's Hartford division, this facility manages a complex network of over 43 local routes, 5 limited-stop "flyer" routes, and 18 express routes that serve 27 towns throughout Hartford County. This extensive reach connects the capital city with surrounding communities like Bloomfield, East Hartford, Manchester, and West Hartford, providing essential transportation for thousands of daily commuters for work, education, and healthcare. The facility is not only a hub for buses and drivers but also the nerve center for planning and coordinating services, including the innovative CTfastrak bus rapid transit system, which has a dedicated roadway to enhance speed and reliability. Furthermore, the facility supports crucial connector services, such as the Bradley Flyer to the airport and shuttles to downtown attractions, reinforcing its role in integrating the region's various economic and social centers. The recent relocation of the customer service office to Hartford's Union Station further solidifies the facility's connection to the broader regional transit network, which includes rail services.

The Eversource Facility (Hartford): The Eversource facility in Hartford is a cornerstone of the regional energy infrastructure, serving as a critical hub for delivering electricity and natural gas to approximately 1.8 million customers across Connecticut. As New England's largest energy provider, its Hartford operations are integral to the company's broader service to 4.6 million customers throughout Connecticut, Massachusetts, and New Hampshire. The facility is central to the company's grid modernization efforts, which are essential for accommodating the increasing complexity of the power grid due to the integration of solar power, battery storage, and electric vehicles. Furthermore, the Hartford-based operations play a key role in major infrastructure projects, such as the Greater Springfield Reliability Project and the New England East-West Solution, which enhance the reliability of the power grid across the entire region. The company's Hartford presence also supports statewide initiatives like the Energy Storage Solutions program and the Residential Renewable Energy Solutions Program, which are designed to create a more resilient and decarbonized electric grid for all of Connecticut.

2.3.9 Future Without Project Conditions

Each resource in the social environment was analyzed for the FWOP condition. In the FWOP, the conditions of noise and land use are not expected to differ from the existing conditions. Further degradation of the FRM systems in the FWOP may result in the system not performing as intended during significant flood events, resulting in more widespread flooding or longer periods of flooding. Uncontrolled flooding can mobilize debris and pollutants and create access difficulties for municipal emergency services, impacting public safety and health. Uncontrolled and more frequent flooding is also

expected to impact recreation. Riverfront and inland parks in both municipalities would be cut off or inundated as a result of future flooding. There would likely be a short-term decrease in visitors to recreational areas during flooding, which may extend for longer periods of time if pollutants are left behind. Flood inundation of local streets, highway ramps, and major roads could cut off bus routes, preventing riders in both communities from using public transportation. Flooding could also impact the freight rail lines in both communities, resulting in service interruptions.

Continued and increased flooding in the project areas over time could have indirect, potentially significant adverse impacts on cultural resources such as historic properties, districts, and archaeological sites that are located in flood-prone areas. Depending on the frequency and severity of these events, future flooding could alter the character-defining historic architectural features of structures throughout East Hartford and Hartford, resulting in substantial alteration of a historic property's viewshed, acoustic environment, or other environmental component, specific elements that likely contribute to the significance of a historic property. Overall, the greatest impact to cultural resources would be expected to result from fluvial flooding from the Connecticut River during substantial storm events. Erosion from fluvial flooding could also significantly impact archaeological resources over time through erosion or other flood-related disturbances.

Flooding poses a severe threat to the critical regional and local utility hubs, including the Metropolitan District Commission's WPTF (a.k.a. WWTP), Connecticut Natural Gas, and the Hartford Steam Company. The WWTP in particular could expose humans and the natural environment to untreated wastewater during a levee breach or interior drainage flooding. More widespread flooding could endanger essential services for the local communities of Hartford and East Hartford but could also have far reaching impacts on the region, as some services found in the study service the greater Hartford region. Furthermore, failure of the services would jeopardize public safety, education, and healthcare infrastructure, including East Hartford's Fire Station One, local magnet schools, and UCONN Health, potentially causing long-term economic instability and reducing the region's capacity to respond to emergencies.

2.4 ECONOMIC ENVIRONMENT

The economic environment refers to monetary resources, economic infrastructure, and resiliency. This section includes a discussion on the existing conditions and future without project conditions of socioeconomics, demographics, unemployment, and infrastructure resiliency.

2.4.1 Socioeconomics & Demographics

According to the American Community Survey, the population of Hartford County as of 2021 was 898,636. Of this total, the racial and ethnic breakdown for the Hartford, CT Urban Area is as follows: 58% of the population is white, 12% is black or African-American, 19% is Hispanic or Latino, and 6% is Asian. Persons 65 years and over make up 15% of the population in the Hartford, CT Urban Area, and persons under 18 make up 22% of the population.

2.4.2 Economy & Unemployment

In the Hartford, CT Urban Area, 91.1% of residents 25 years of age or older are high school graduates, and 40% of that same group have a bachelor's degree or higher. This compares to the statewide Connecticut figures of 90.5% for high school graduates or higher and 38.9% for those with a bachelor's degree or higher. In the city of Hartford, 85.7% of households have a broadband internet subscription. Based on Census Bureau criteria, 10.9% of Hartford County was in poverty in 2021, compared with 8.4% statewide in the same year.

65.8% of the population 16 years and older in Hartford County is in the civilian labor force, compared to 66.5% in the entire state of Connecticut. The unemployment rate for the Hartford-West Hartford-East Hartford, CT Metro Area was 3.9% as of August 2025. The statewide unemployment rate for Connecticut in September 2025 was 3.8%.

2.4.3 Structure Inventory

Structure inventories for the Hartford and East Hartford areas were developed as inputs into the HEC-FDA 2.0 modelling software, in order to calculate NED benefits resulting from reduction in physical flood damages to structures and contents in the study area. Structure data for the study area was collected from the National Structure Inventory (NSI) database in order to develop the structure data required as inputs for HEC-FDA. This data was refined using Google StreetView and Assessor data from the Hartford and East Hartford assessors' offices, to accurately reflect the number and types of structures that currently exist in the study area. RSMeans square footage data processed the refined structure attributes, to provide Depreciated Replacement Values for all structures, as required by ER 1105-2-100.

2.4.4 Infrastructure and Installation Resilience

Although Hartford and East Hartford are 45 miles upstream on the Connecticut River from Long Island Sound, a daily tidal influence of typically 1 to 2 feet is still apparent. The tidal influence is small in comparison to the effects of inland storms, and review of the water levels **APPENDIX 2-H: Infrastructure and Installation Resilience** indicated that these were mutually independent (extremely limited correlation). Although sea level is expected to rise, it is unlikely to create any issues at the pump stations through 2100. Inland storm drainage is noted to have been reducing over the 20th and early 21st centuries, although the Comprehensive Hydrological Assessment Tool indicates rising flows in the basin through 2100.

Observed and projected increases in rainfall do not directly lead to increases in streamflow. There is uncertainty related to how the municipalities will develop, especially in East Hartford, and this concern will affect any calculation of the population at risk.

There is no clear pattern concerning changes in streamflows, and any changes in relative sea-level are unlikely to affect the pump stations' operations.

The resilience analysis reviewed vulnerability assessment results from the USACE Civil Works Vulnerability Assessment Tool and detected no obvious change in risk ranking, relative to the other rated hydrologic units in the continental US, Alaska and Hawaii, through 2100.

2.4.5 Future Without Project Conditions

Over the next 50 years, the assumption is the overall condition of the levee embankments and floodwalls in the system will remain relatively the same. However, expected decreases in pump station reliability will result in increased interior flooding and increases to O&M costs. The sponsor has stated that the associated increases to O&M costs will be above their current and projected funding capabilities, and result in maintenance delays.

The city of Hartford and the town of East Hartford will continue with responsibilities as described in the project O&M manual. As funding is identified, they will continue to address long-term degradation and out-of-date components at pump stations and other features in the Hartford and East Hartford FRM systems.. However, the full condition of pump station components cannot be determined through routine inspections, and failures of system components (especially at pump stations) often occur while they are in operation. Given the long turnaround on replacement parts, some pump stations could have multiple pumps inoperable during future flood seasons. Additional discussion on forecasted pump station reliability including degradation contained in Section 3.2 and Appendix G.

Both nonfederal sponsors currently have an EAP, and evacuation plan with warning systems in place.

The majority of the interior drainage area in Hartford and East Hartford has been developed, limiting the possibility of future significant increase in impervious surfaces and resulting run-off. In addition, future population and land use may experience minor to moderate changes in the project area; however, the future hydrologic condition will likely be held constant due to the regulations on development that the municipalities have in place.

The MDC is currently constructing a waterway protection project (tunnel) whose purpose is to capture, store, and attenuate CSO discharges during storm events. This project consists of boring a 20-foot diameter, 4-mile long tunnel under the City of Hartford which will act similarly to a detention basin for combined sewage and floodwater storage. The tunnel construction is scheduled to be completed within the next few years and is one part of MDC's initiatives to reduce sewer overflows. Since the project is expected to be constructed and operational for the entire period of analysis, it is being considered in both the FWOP and FWP conditions.

The Hartford and East Hartford Flood Protection Systems remain eligible to participate in the USACE Rehabilitation Program under Public Law 84-99 (Section 5 of the Flood Control Act of 1941) (Public Law 84-99). If the FRM system is damaged or destroyed

during a flood event, USACE may be able to provide financial assistance to rehabilitate the FRM system. Also under Public Law 84-99, USACE may provide emergency operations through direct assistance (i.e. sandbags and portable pumps) as well as technical assistance (i.e. inundation mapping, flood modeling, and historical data) during a flood event. Actions completed under the RP or as an emergency operation would have a limited effect on system features that are degraded or exceeded their expected service life unless that feature was directly damaged or destroyed by a flood event. Given the level of uncertainty that a future rehabilitation action would occur under PL 84-99, the FWOP condition does not assume any reconstruction of system features under the RP.

3.0 MODELING AND ANALYSIS

Modeling is a critical tool for assessing the potential benefits of a project, and in the case of the FRM systems, it was used to predict and quantify the advantages of rehabilitation. The PDT employed a two-pronged approach during the feasibility phase, using both H&H modeling and a Mechanical Reliability Analysis to gain a comprehensive understanding of the system's performance and potential failure points. The H&H modeling was employed to predict and visualize potential flooding scenarios that would occur if components of the FRM systems either failed or functioned at a lower capacity. By simulating water flow and inundation levels, this analysis identified the specific consequences of a system breach. Concurrently, the Mechanical Reliability Analysis assessed the likelihood of failure for individual system components, such as pumps and gates, providing a clear understanding of the system's vulnerabilities and most at-risk elements.

The insights gathered from these two modeling efforts were then synthesized to calculate the benefits of rehabilitating the FRM systems. By comparing the predicted flood damages in a failure scenario against the reduced damages expected with an upgraded and more reliable system, the PDT could quantify the value of the project. This "benefit" is essentially the reduction in risk and avoidance of potential economic and social costs associated with flooding. This data-driven approach ensures that rehabilitation efforts are strategically focused on the most critical components, thereby maximizing the return on investment by effectively mitigating the highest risks of system failure.

3.1 HYDROLOGY AND HYDRAULICS MODELING

The H&H modeling completed for the feasibility phase falls into two distinct categories: interior drainage and levee breach. Interior drainage flooding occurs when rainfall or other water (like snowmelt) collects behind a levee system—on the protected side—and cannot drain away fast enough. While levees are built to protect communities from river flooding or storm surges by blocking water from the outside, they also create a barrier that prevents natural drainage from the inside going out. If water builds up behind the levee system due to heavy rain or blocked drainage systems, it can cause flooding within the leveed area. While levees protect from external threats, interior drainage is a critical part of comprehensive flood risk management within levee-protected zones.

The second source of flooding damage results from levee failure. A levee embankment can fail in several ways, and when it does, the results are potentially catastrophic flooding.

The most common failure modes include overtopping, where floodwater simply rises higher than the levee's crest and pours over the top, eroding the landside slope until it collapses. Another cause is erosion from the force of the water, which can wear away the levee's surface or weaken its base. Internal erosion, or "piping," is a particularly dangerous failure where water seeps through or under the levee, carrying away soil particles and creating underground channels. This can cause the levee's foundation and/or the levee itself to become unstable, leading to a sudden and rapid breach. When a breach occurs, a powerful, fast-moving wall of water is unleashed, inundating the area the levee was built to protect. In many cases, this flooding can be deep and persistent, causing extensive property damage, displacing residents, and putting lives at risk.

A summary of H&H modeling undertaken during the feasibility phase is provided in this section. Detailed information regarding the modeling effort can be found in **Appendix 2-B1: Hydraulics & Hydrology, Levee Breach** and **Appendix 2-B2: Hydraulics & Hydrology, Interior Drainage**.

3.1.1 Interior Drainage Analysis

The purpose of this section is to document the H&H analyses of the interior drainage areas of the North Meadows, South Meadows, Bushnell and Kenney Lane pump stations in Hartford; and Meadow Hill, Cherry Street and Pitkin pump stations in East Hartford. The analysis included the development of synthetic flood hydrographs associated with frequency rainfall events routed through the as built and projected future pump station conditions using established pump and storage pond capacities. Resulting interior ponding elevations for each station were established to document risk associated for both the existing condition and future with project scenarios.

The Armory and Pope pump stations in Hartford were screened out from the hydrologic and hydraulic analysis as part of the planning process based on operations information provided the city of Hartford, which indicated that these two pump stations have never been operated for flood fighting.

Three pump station capacities were modeled including the 100%, 50%, and 10% capacities. Note that during the initial scoping phase of this feasibility study, increasing the pumping capacity of the pump stations was considered. However, this measure was screened out after an initial evaluation of the pump stations original designs. It was determined the pump stations were oversized (i.e., have more installed capacity than required by design) and the installation of larger pumps would not be justified.

3.1.1.2 Modeling Approach

After consulting with the USACE Flood Risk Management-Planning Center of Expertise, a specific modeling strategy was selected for the pump station's interior drainage analysis. While a detailed stormwater model was initially considered, it was not feasible due to missing data, specifically the lack of pipe invert elevations.

Instead, a "lumped" modeling approach was adopted using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). This method combined the Soil Conservation Service (SCS) curve number and unit hydrograph methods, which are ideal for urban areas where limited data prevents model calibration. To ensure a conservative (safer) estimate, the analysis assumed that peak floodwaters would be level across the entire affected area. The only exception was the Cherry Street Pumping Station, where a more detailed 2D routing was performed in Hydrologic Engineering Center's River Analysis System (HEC-RAS) for its two distinct impact zones. This chosen approach offered several key advantages:

- Efficiency: It was a much faster and less labor-intensive modeling method.
- Data Availability: The analysis relied on existing data, avoiding the need for costly and time-consuming field surveys to gather pipe information.
- Conservative Design: By modeling only overland flow, the approach provides a conservative basis for sizing the pump stations, as it doesn't account for the limited capacity of the pipe system which would otherwise slow water inflow.

3.1.1.2 Modeling Assumptions

Modeling of flooding resulting from interior drainage included the following assumptions and limitations:

- Initial drainage areas for the pump stations were obtained from previous modeling studies and were modified (In consultation with the Hartford MDC) to direct overland flow based on the layout of underground storm sewer networks.
- All runoff was conservatively assumed to reach the pump stations and not detained in surrounding low-lying areas within the pump stations watershed. Portions of the northern drainage area of South Meadows Pump Station were assumed to be stored in a smaller retention pond within Colt Park and routed to the primary storage pond at the station.
- Storage ponds located at the North Meadows, South Meadows and Meadow Hill Pump Stations were assumed to be dredged to their original design capacity.
- Underground storm sewer information was not included in the analyses, except for the South Meadows Pump Station, which included routing through two major conduits.
- Pump stations were modeled using their original design capacities, not current measured outputs. This approach simulates performance as if the stations were fully rehabilitated to their design specifications.
- Based on a correlation analysis, interior rainfall events were treated as statistically independent from the Connecticut River's tailwater conditions for the same storm frequencies.
- A direct correlation was assumed between the frequency of an interior rainfall event and the resulting runoff (e.g., a 2-year storm was assumed to produce a 2-year runoff).

- Peak flood elevations were conservatively assumed to be level across the impacted area without routing. The only exception was the Cherry Street Pumping Station, where inflow hydrographs for two separate areas were routed using HEC-RAS 2D.

3.1.1.3 Model Development

This section outlines the methodology used to develop the model used to assess the interior drainage areas for the Hartford and East Hartford pump stations. The primary goal of this analysis was to assess potential flooding impacts resulting from pump degradation by simulating an independent, maximum-depth storm event.

The analysis was conducted using the Hydrologic Engineering Center's Hydrologic Modeling System (version 4.11) (HEC-HMS v4.11). The core of the model combined the SCS Curve Number method to calculate basin losses and the SCS Unit Hydrograph method to transform excess precipitation into runoff. This approach was selected to maintain consistency with previous studies and for its proven ability to produce conservative results in urban areas where calibration is not feasible.

Key modeling parameters are detailed below:

Runoff Transformation: The SCS Unit Hydrograph method was used with a standard Peak Rate Factor of 484. Basin lag time was calculated as 60% of the time of concentration.

Basin Losses: Runoff coefficients were determined using the SCS Curve Number method. Curve numbers were generated in ArcPro (v3.3) by processing soil data from the 2023 gSSURGO database with the 2021 National Land Cover Dataset (USGS, 2021b).

Precipitation Data: The model utilized a synthetic 12-hour frequency storm. Annual maximum precipitation depths were obtained from the NOAA Atlas-14 dataset for a single representative location covering all pump stations.

The initial drainage boundaries for each pump station were obtained from existing FEMA accreditation reports. The drainage areas were then refined by cross-referencing them with current storm sewer system maps and high-resolution 2016¹ topographic lidar data to ensure accuracy.

For the Keney Lane & Bushnell Pump Stations, analysis revealed that major rainfall events could potentially draw runoff from a drainage area larger than the one originally designed for. However, operational data from the pumps for 2024 and early 2025 showed that their activation frequency was inconsistent with runoff from this larger area.

¹ Hydro-flattened bare earth digital elevation model (DEM) derived from the classified LiDAR data for the 2016 Connecticut LiDAR project. Acquire detailed surface elevation data for use in conservation planning, design, research, floodplain mapping, dam safety assessments, and hydrologic modeling. LAS and bare earth DEM data products are suitable for 1 foot contour generation.

Therefore, based on this operational data and verification against current topography, the original design drainage areas were used for these two stations.

The analysis for the South Meadows Pump Station determined that local storage features, specifically at Colt Park and a nearby swale surrounding the airport and water treatment plant, significantly attenuate (reduce) flows into the station's storage pond. To account for this effect, this analysis adopted a methodology similar to a 1981 study, subdividing the total drainage area. The area was divided into five distinct sub-basins, which allowed for the modeling of localized storage at Colt Park and the airport swale.

For the South Meadows Pump Station, the storage capacity of the localized overland area within Colt Park was calculated using the 2016 terrain data and storage-volume tools within HEC-RAS.

The Muskingum-Cunge method was used to route flows from the Colt Park storage area to the South Meadows storage pond. This routing was based on the physical properties of the two largest storm sewer pipes and used index flows representative of frequent storm events.

The intention of the hydrologic analysis for Hartford and East Hartford was to assess an individual, independent storm of maximum depth in order to assess flooding impacts due to pump degradation. The analysis utilized synthetic frequency storms with 12-hour durations utilizing annual maximum precipitation depths obtained from NOAA Atlas 14 to achieve this goal. A single representative location was chosen for all pump stations in Hartford and East Hartford. The precipitation depths used for this analysis are included below in **Table 11**.

Table 11: NOAA Atlas-14 AMS Precipitation Depths in Inches

Precipitation Depths (in) for Annual Exceedance Probability (1/year)								
Duration	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500
5-min	0.37	0.51	0.61	0.75	0.85	0.96	1.08	1.24
10-min	0.52	0.72	0.87	1.06	1.20	1.36	1.52	1.76
15-min	0.61	0.84	1.02	1.25	1.42	1.60	1.79	2.08
30-min	0.83	1.14	1.37	1.68	1.92	2.16	2.42	2.80
60-min	1.04	1.43	1.73	2.12	2.41	2.72	3.05	3.54
2-hr	1.34	1.84	2.22	2.71	3.08	3.47	3.92	4.59
3-hr	1.55	2.12	2.55	3.12	3.54	3.99	4.52	5.32
6-hr	1.94	2.66	3.21	3.94	4.47	5.04	5.73	6.79
12-hr	2.36	3.28	3.98	4.91	5.58	6.31	7.20	8.59

A summary of the basin inputs for the hydrologic model is included in **Table 12**.

Table 12: Hartford/East Hartford Hydrologic Model Basin Parameters

City	Pump Station	Pump Station Sub Basin	Drainage Area (sq.mi.)	Curve Number (CN)	Time of Concentration (hours)	SCS Lag Time (minutes)
Hartford	North Meadows	North Meadows	2.1	88.4	1.7	62
	South Meadows	South Meadows (1A)	0.5	88.3	1.0	35
		South Meadows (1B)	0.5	90.2	0.6	23
		South Meadows (2)	0.5	89	1.3	45
		South Meadows (3)	0.7	88.2	1.9	68
		South Meadows (4)	0.2	87.7	1.	38
		Bushnell	Bushnell	0.4	90	1.8
	Keney Lane	Keney Lane	0.41	90.4	1.1	0.6
	East Hartford	Meadow Hill	Meadow Hill	1.26	83	3.4
Cherry Street		Cherry Street	0.0222	88.6	0.3	0.2
Pitkin Street		Pitkin Street	0.0625	89.3	0.3	0.2

3.1.1.4 Hydraulic Model Development for the Pump Stations

With the exception of the Cherry Street pump station, the hydraulic modeling of the pump stations was incorporated into the hydrologic modeling (HEC-HMS model) where the rainfall/runoff was developed. For the Cherry Street pump station, the hydraulic modeling of the pump station and the resultant flooding were modeled in HEC-RAS 2D. Details of hydraulic model used in HEC-HMS and HEC-RAS are detailed in the following sections

Storage Volume and Pump Capacity: Elevation-storage curves were developed for each pump station. For the North Meadows, South Meadows, and Meadow Hill stations, only detention pond and overland storage were considered, while sewer storage was disregarded. At South Meadows, which has a small adjacent pond, the storage curve also incorporated several connected low-lying areas. The other four pump stations lack storage ponds, so their storage was based on previously calculated stormwater capacity from FEMA certifications, verified and updated with overland storage derived from current drainage area topography.

To assess the impact of equipment degradation, the performance of the overall station, rather than individual pump, was the focus. Station capacity was modeled as a single curve based on the combined design capacity of all installed pumps (**Table 13**). This total capacity was then evaluated at full (100%), 50%, and 10% levels to simulate various operational states.

Table 13: Pump Station Inventory

City	Pump Station	Pump Configuration
Hartford	North Meadows	(4) 36-inch pumps, (1) 16-inch pump
	South Meadows	(6) 36-inch pumps
	Bushnell	(3) 30-inch pumps, (1) 16-inch pump
	Keney Lane	(3) 36-inch pumps, (1) 16-inch pump
East Hartford	Meadow Hill	(4) 30-inch pumps
	Cherry Street	(2) 16-inch pumps
	Pitkin Street	(2) 20-inch pumps

Tailwater Conditions and Pump Operations: The pump stations typically drain water from behind the levees via gravity until high stages on the Connecticut River trigger the closure of the conduit, initiating pumping operations. To model this, a stage-duration curve for the river was developed using daily stage data from 2006 to 2023 at the USGS gage at Bulkley Bridge (**Figure 19**). This curve was simplified into three "index stages" representing high-river, low-river, and gravity-flow conditions.

The North Meadows, South Meadows, and Meadow Hill pump stations can use gravity to pass runoff approximately 70% of the time, while the other four pump stations are able to use gravity flow more than 90% of the time in a year. Therefore, Bushnell, Keney Lane, Pitkin, and Cherry Street pump stations are operated less frequently than the North Meadows, South Meadows, and Meadow Hill pump stations.

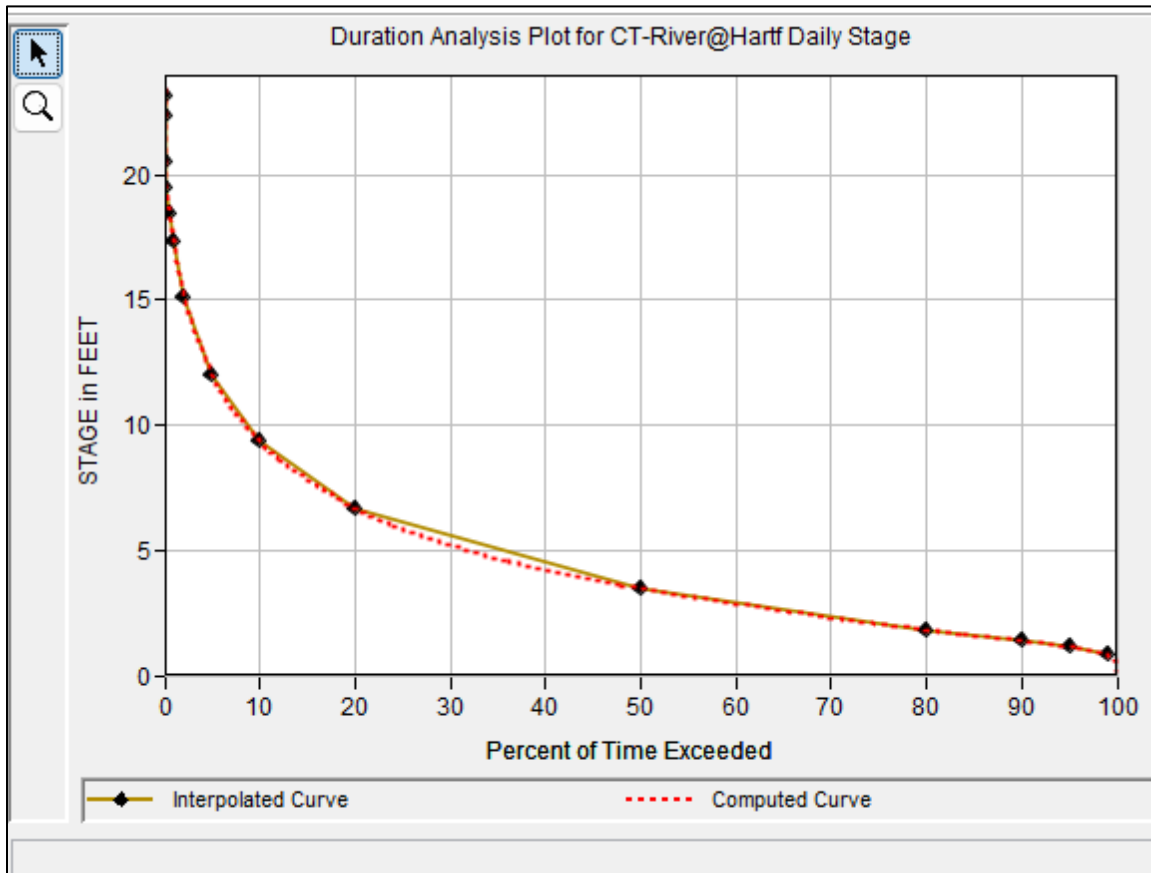


Figure 19: A Stage-Duration Curve from the Connecticut River Recorded by the US Geological Service Gage 01190070 at the Bulkley Bridge

The index stages were then translated from the gage to each pump station's outfall using constant flows in the Semi-Quantitative Risk Assessment (SQRA) HEC-RAS model. A special translation was required for the Bushnell pump station, which discharges into the Park River Conduit. For this location, the Connecticut River index stage was first translated to the Park River's outlet and then projected upstream to the Bushnell outfall, accounting for estimated flows within the Park River. Operational rules for each pump, such as gate closure triggers and intake elevations, obtained from O&M manuals and design documents, were also incorporated into the model. Pump operation details are listed in **Table 14**.

Table 14: Pump Stations Operation Details

Pump Station	Gravity Gate Closure Elevation in River at Pump Station (feet-NAVD88)	Pump On Elevation (feet-NAVD88)	Pump Off Elevation (feet-NAVD88)
North Meadows	5.2	6.2	3.2
South Meadows	5.0	4.2	2.2

Pump Station	Gravity Gate Closure Elevation in River at Pump Station (feet-NAVD88)	Pump On Elevation (feet-NAVD88)	Pump Off Elevation (feet-NAVD88)
Bushnell*	14.7	14.2	9.2
Keney Lane	10.7	10.7	7.7
Meadow Hill	5.2	5.2	2.2
Cherry Street	12.2	17.7	10.7
Pitkin Street	11.2	10.7	2.4

* Bushnell PS elevation is based on elevation in Park River

Simulation and Coincident Frequency Analysis: Simulations combining the various pump capacities, tailwater elevations, and precipitation events were run in HEC-HMS using a level pool routing approach, which assumes a constant water surface elevation across an impacted area. For the Cherry Street pump station analysis in HEC-RAS 2D, inflow hydrographs from HEC-HMS were used to generate more precise peak water surface elevations across two distinct damage reaches **Figure 20**.

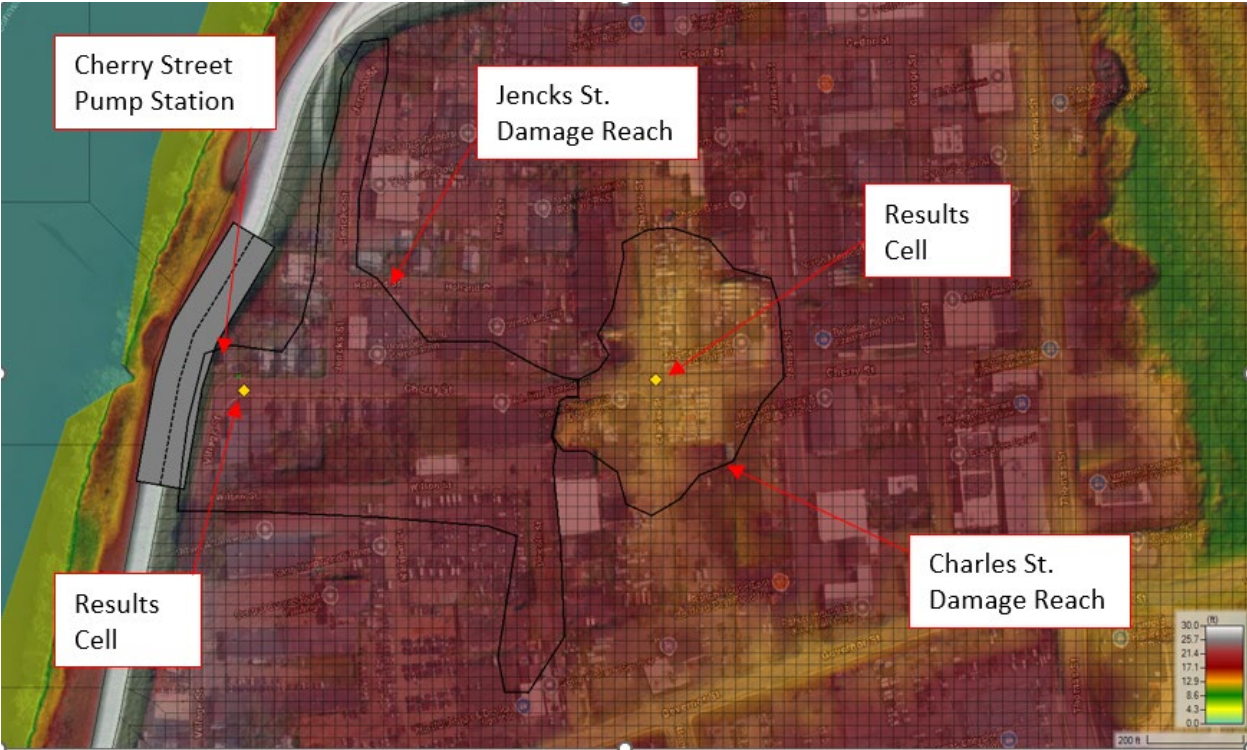


Figure 20: Cherry Street Pump Station Damage Reaches

A correlation analysis confirmed that daily precipitation and river stage data are statistically independent (r-value of 0.057), validating the use of the total probability theorem. The resulting curves combine the probability of specific rainfall frequencies (from NOAA Atlas-14) with the probability of the river exceeding a certain stage (from the

stage-duration curve) to provide a comprehensive risk assessment for each pump capacity scenario.

The final step was to develop coincident frequency curves for each pump station. This analysis determines the total probability of interior ponding elevation based on the combined, independent probabilities of two input variables: interior rainfall events and exterior river stage (**Figure 21**).

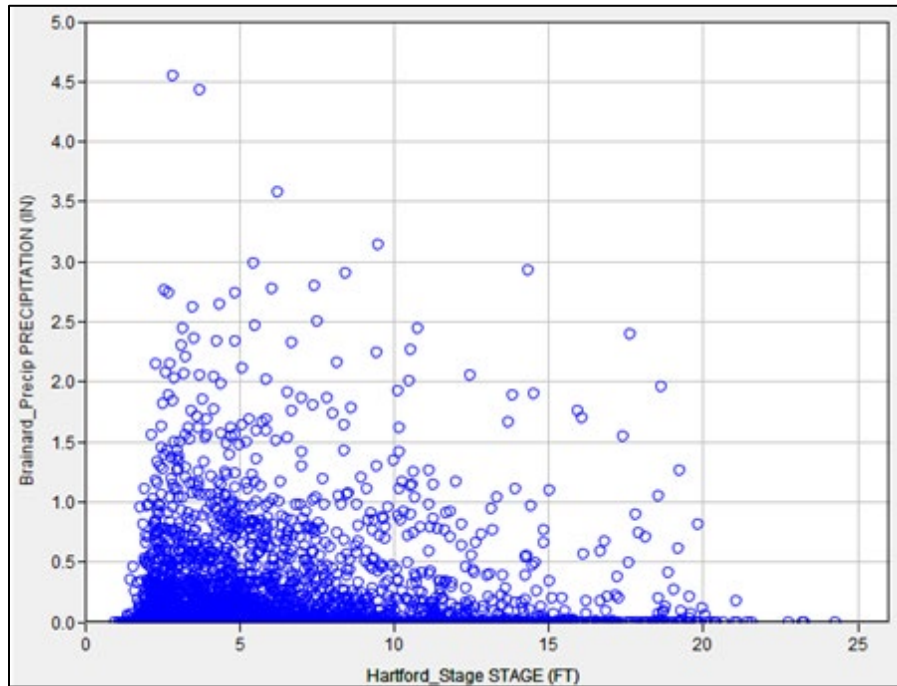


Figure 21: Correlation Plot between Connecticut River Stage and Interior Rainfall at Brainard Field.

To assess the combined flood risk from interior rainfall and exterior river stages, a coincident frequency analysis was performed using the Hydrologic Engineering Center's Statistical Software Package (HEC-SSP), version 2.3. The analysis produced response curves that predict interior ponding elevations by integrating the probabilities of these two independent events using the total probability theorem. The probability for interior rainfall events was derived from the intensity-duration-frequency relationships in NOAA Atlas 14. The probability for exterior river stages was calculated from a stage-duration curve developed using daily data from the USGS gage at Bulkeley Bridge from 2006 to 2023 and transferred to the outfall for each pump station.

The results of the coincident frequency analyses for three capacities (10%, 50% and 100% capacity) for each pump station are provided below in **Table 15** through **Table 22**. An example of a computed coincident frequency curve is shown in **Figure 24** for the Meadow Hill pump station at 100% capacity. Inundation maps for each frequency storm and each pump station capacity condition are included in Attachment B in **APPENDIX 2-B2: Hydraulics & Hydrology, Interior drainage**

An example of an inundation map is shown in **Figure 22** for the Meadow Hill pump station, 100% Capacity, 500-Year (0.002 Annual Exceedance Probability [AEP]) storm event.

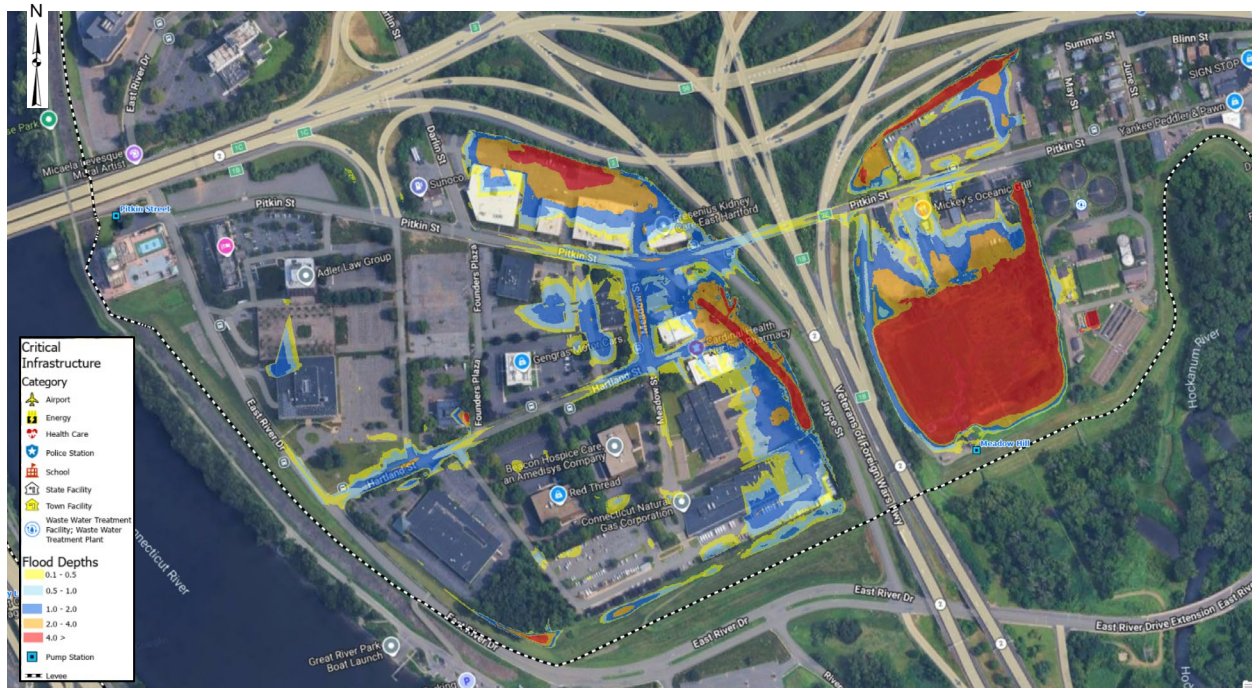


Figure 22: Interior Drainage Flooding Map Developed for the Meadow Hill Pump Station at 100% Capacity during a 500-Year (0.002 AEP) Storm Event

North Meadows Pump Station (Hartford): The analysis shows a direct link between the pump station's operational capacity and the flood level at which buildings are impacted. At full (100%) pumping capacity, building flooding only occurs during major events like the 0.01 AEP (100-year) flood or larger; smaller floods primarily affect roads and parking lots. However, as the station's performance degrades, this threshold drops significantly. With capacity reduced to 50%, buildings are impacted by the 0.02 AEP (50-year) flood. At just 10% capacity, even a 0.04 AEP (25-year) flood can cause building damage. This demonstrates that any reduction in the North Meadows Pump Station's large design capacity (440 cfs) dramatically increases the flood risk to buildings in the area.

Table 15: North Meadows Coincident Frequency Maximum, Interior Elevation

Coincident Frequency Results for North Meadows Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	6.6	7.2	7.2
0.2	8.2	9.1	11.2

Coincident Frequency Results for North Meadows Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.1	9.7	11.1	13.0
0.04	11.8	13.3	14.7
0.02	13.2	14.4	15.5
0.01	14.2	15.2	16.0
0.005	14.9	15.7	16.5
0.002	15.5	16.4	17.1
* AEP: Annual Exceedance Probability			

South Meadows Pump Station (Hartford): The analysis shows that the South Meadows pump station's performance is critical to protecting local buildings from flooding. At full (100%) pumping capacity, building damage is contained within the water pollution control facility run by the MDC and only occurs during a 0.02 AEP (50-year) flood or larger. However, as the station's capacity degrades, the risk escalates significantly. At 50% capacity, the flooding of building begins with a more frequent 0.04 AEP (25-year) flood and extends beyond the WWTF. At a critical 10% capacity, the impact is severe: some buildings are affected by events as common as a 0.2 AEP (5-year) flood, while major storms impact a significant number of commercial buildings. This dramatic increase in risk is a direct result of the station's massive 700 cfs design capacity—the largest in this study—meaning any loss of performance has widespread consequences.

Table 16: South Meadows Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for South Meadows Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	4.3	5.2	5.2
0.2	5.9	6.6	9.1
0.1	6.9	7.8	9.9
0.04	8.1	9.3	11.1
0.02	8.9	10.1	12.0
0.01	9.7	10.8	12.8
0.005	10.3	11.5	13.6
0.002	10.8	12.5	14.8
* AEP: Annual Exceedance Probability			

Bushnell Pump Station (Hartford): The flood risk to commercial buildings in the area is directly tied to the Bushnell pump station's performance. At full (100%) capacity, flooding impacts up to nine buildings (near Whitehead Highway and the Ann Uccello/Jewell Street area) during a 0.01 AEP (100-year) event or larger. As the station's performance degrades, these same areas become vulnerable to more frequent storms. At 50% capacity, impacts begin at the 0.02 AEP (50-year) level. At a critical 10% capacity, flooding starts with just a 0.04 AEP (25-year) event. Furthermore, at this lowest capacity, a 100-year flood expands the impact zone, affecting up to six additional buildings near Trumbull and Asylum Streets. The impacts of the degradation of the Bushnell pump station discharge capacity are limited by the small number of structures impacted. However, the impacts of the degradation of the Bushnell pump station discharge capacity are greater than the impacts caused by the Keney Lane pump station.

Table 17: Bushnell Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for Bushnell Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	10.4	10.4	10.4
0.2	12.8	12.8	12.8
0.1	14.6	15.9	15.9
0.04	18.6	24.5	26.5
0.02	22.4	25.3	27.2
0.01	25.1	26.4	28.1
0.005	26.1	27.2	28.9
0.002	27	28.0	29.8
* AEP: Annual Exceedance Probability			

Keney Lane Pump Station (Hartford): The performance of the Keney Lane pump station determines when key infrastructure is flooded. At full (100%) capacity, a commercial building on Windsor Street, the Tilcon concrete plant, and the Grove Street underpass are impacted by a 0.01 AEP (100-year) flood or larger. As the station's capacity degrades, these same locations are affected by more common storms. The flood threshold drops to a 0.02 AEP (50-year) event at 50% capacity, and to a 0.04 AEP (25-year) event at a critical 10% capacity. At this lowest capacity level, a major 100-year storm also floods an additional building and area along Mark Street. Despite this clear increase in risk, the overall impact from the Keney Lane station's degradation is considered limited because it only affects a small number of structures.

Table 18: Keney Lane Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for Keney Lane Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	7.8	7.8	7.8
0.2	10.0	10.3	10.7
0.1	11.6	12.5	15.0
0.04	14.6	16.4	21.0
0.02	16.9	19.2	22.0
0.01	18.7	20.6	22.8
0.005	20.0	21.3	23.5
0.002	20.9	22.3	24.1
* AEP: Annual Exceedance Probability			

Meadow Hill Pump Station (East Hartford): The pump station's operating capacity directly determines the flood level at which buildings and roadways are impacted. At full (100%) capacity, building damage only occurs during rare events like the 0.005 AEP (200-year) flood. As the capacity decreases to 50%, impacts begin at the more frequent 0.01 AEP (100-year) level. At the most critical 10% capacity, buildings become vulnerable to events as common as the 0.04 AEP (25-year) flood. The severity of the flooding increases significantly with the water depth. A pond elevation of 16-17 feet NAVD affects about five buildings, but if the water rises to 19.9 feet NAVD, the number jumps to approximately 20 commercial buildings, along with roadways and the town's wastewater treatment facility. Modeling suggests that a large number of structures could be impacted by the station's degradation during large storm events.

Table 19: Meadow Hill Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for Meadow Hill Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	5.1	5.6	6.3
0.2	6.8	7.8	9.8
0.1	8.5	9.8	12.8
0.04	10.8	13.0	16.2
0.02	12.7	15.4	17.5
0.01	14.9	17.0	18.4
0.005	16.4	18.0	19.1
0.002	17.8	19.0	19.9

Coincident Frequency Results for Meadow Hill Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
* AEP: Annual Exceedance Probability			

Pitkin Pump Station (East Hartford): The degradation of the Pitkin pump station primarily impacts the adjacent River Point Condominiums, a 20-story residential building. While its 104 apartments are safe due to their high elevation, the building's lower areas, like the garage, begin to flood during a 0.1 AEP (10-year) event. This flood threshold for the condominiums remains constant regardless of the pump's operating capacity. The main difference between scenarios is the impact on surrounding roadways and commercial parking lots. At 100% capacity, these areas are affected by a 0.01 AEP (100-year) flood. However, when capacity drops to 50% or 10%, the risk increases, and these same areas are impacted by a more frequent 0.04 AEP (25-year) flood. Because the effects are confined to the condominium's lower levels and a few localized commercial areas, the overall impact of the station's degradation is considered limited.

Table 20: Pitkin Street Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for Pitkin Street Pump Station			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	10.0	10.0	10.0
0.2	14.8	15.3	15.3
0.1	16.6	16.9	17.2
0.04	17.3	17.5	17.9
0.02	17.6	17.8	18.3
0.01	17.9	18.1	18.6
0.005	18.2	18.4	19.0
0.002	18.4	18.6	19.4
* AEP: Annual Exceedance Probability			

Cherry Street Pump Station (East Hartford): The flood risk in the Cherry Street area is directly tied to the pump station's performance, with impacts escalating as capacity decreases. At full 100% capacity, a 0.01 AEP (100-year) storm causes only minor roadway flooding, while a larger 0.002 AEP (500-year) storm affects one building with shallow flooding. When the capacity drops to 50%, the risk increases significantly, causing the 100-year storm to impact one building. At this reduced capacity, a 500-year storm adds a potential house to the impact zone and deepens roadway flooding to two feet. The situation becomes more severe at a critical 10% capacity, where a 100-year storm now affects both a building and a house. In this worst-case scenario, a 500-year storm expands the flood zone to include two additional commercial buildings, with maximum flood depths reaching two feet. In summary, the impacts of the station's degradation are considered limited. Even under the most severe conditions, the damage is confined to a maximum of four structures and only occurs during very infrequent, high-magnitude storms.

Table 21: Cherry Street Jencks Street Damage Reach Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for Cherry Street Pump Station Jencks Street Damage Reach			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	20.0	20.0	20.0
0.2	20.0	20.0	20.0
0.1	20.0	20.1	20.1
0.04	20.1	20.2	20.8
0.02	20.2	20.6	21.1
0.01	20.6	21.0	21.3
0.005	20.9	21.2	21.5
0.002	21.1	21.4	21.6
* AEP: Annual Exceedance Probability			

Table 22: Cherry Street Charles Street Damage Reach Coincident Frequency Maximum Interior Elevation

Coincident Frequency Results for Cherry Street Pump Station Charles Street Damage Reach			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.5	14.0	14.0	14.0
0.2	14.0	14.1	14.1

Coincident Frequency Results for Cherry Street Pump Station Charles Street Damage Reach			
AEP*	Max Pond Elevation (feet, NAVD88)		
	100% Capacity	50% Capacity	10% Capacity
0.1	14.0	14.1	14.1
0.04	14.1	14.1	14.2
0.02	14.1	14.2	14.3
0.01	14.1	14.2	14.6
0.005	14.1	14.2	14.9
0.002	14.1	14.4	15.2

* AEP: Annual Exceedance Probability

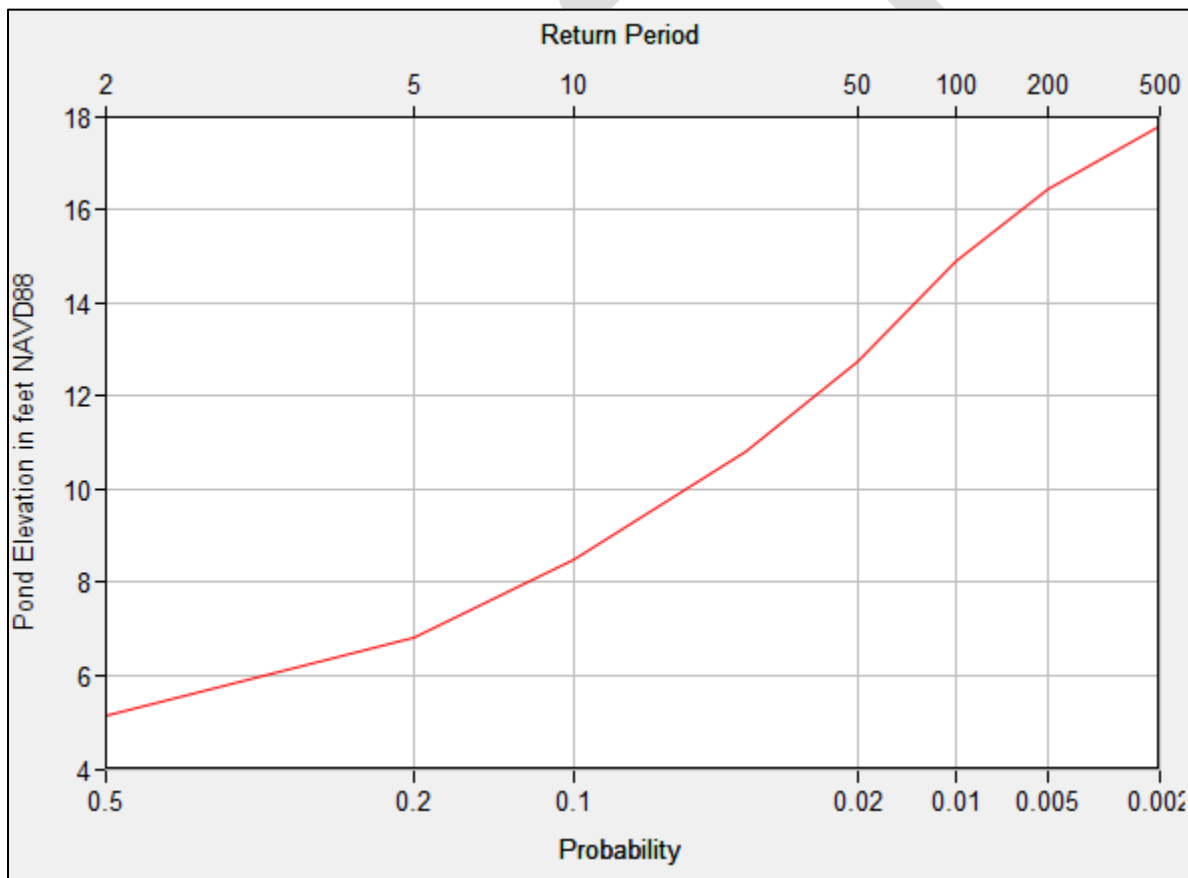


Figure 23: Predicted Flooding Elevation per Storm Event for Meadow Hill Pump Station at 100% Capacity

3.1.1.5 Impacts of Sea Level Change on Interior Drainage Modeling

The potential for sea-level change (SLC) to impact pump station performance was analyzed due to the tidal influence on the Connecticut River. Although Hartford and East Hartford are located approximately 52 river-miles upstream from Long Island Sound, tidal effects extend about eight miles beyond the municipalities, with a typical tidal signal of 1.2 feet (**Figure 24**). An increase in sea level could raise river tailwater conditions, thereby reducing the discharge capacity of the pumps. To account for this, future SLC was first estimated at the mouth of the Connecticut River using the USACE Sea Level Analysis Tool (SLAT). These projections were then routed upstream to Hartford using an existing USACE HEC-RAS model for various river flow conditions (low, typical, and high). The resulting increases in water elevation were used to modify the Connecticut River's stage-duration curve by raising the index elevations that serve as the tailwater conditions in the pump station simulations. Ultimately, these revised water surface elevations were incorporated into the final coincident-frequency analysis to assess pump performance under future sea-level conditions.

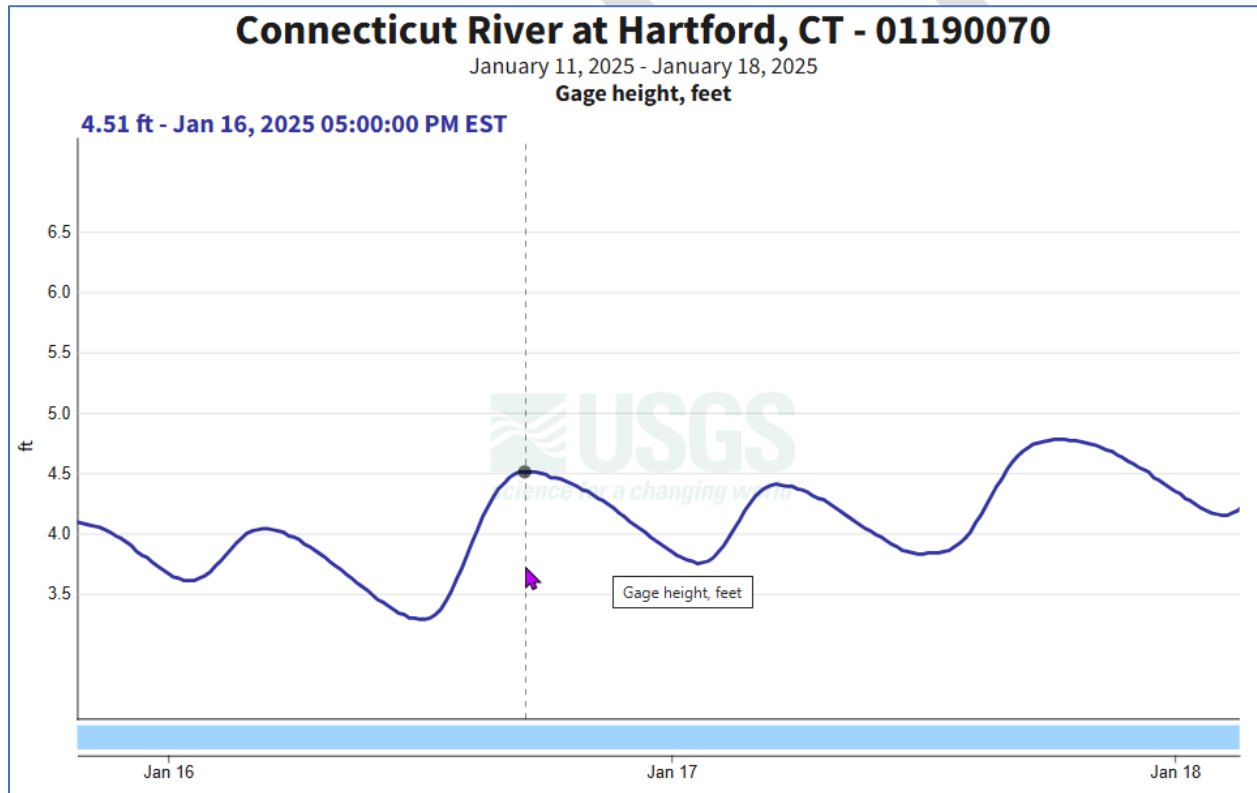


Figure 24: Stage Hydrograph from the Connecticut River at Hartford, CT Recorded at USGS Station 01190070

To assess the impact of future SLC on pump station performance, projections were based on data from the nearest long-term tide station, NOAA's New London Gauge. While this gauge has a historical SLC rate of 2.87 mm/yr over its 86-year record, this analysis used a more recent rate of 4.94 mm/yr, derived from the last 40 years of data (1984–2024), for projections made with the SLAT tool. Projected changes to sea level as predicted by

SLAT for the three USACE SLC models (low, intermediate, and high) are shown in **Figure 25**.

The USACE intermediate SLC curve was selected for the projections because the pump station capacities and resultant pond elevations are not significantly sensitive to the river tailwater that is affected by SLC. The analysis defined a 50-year planning horizon ending in 2080 and a 100-year adaptation horizon ending in 2130, relative to a 2030 base year. Based on this framework, the resultant SLC for the 50-year planning horizon (2080) was estimated to be 1.8 feet at the New London Gauge.

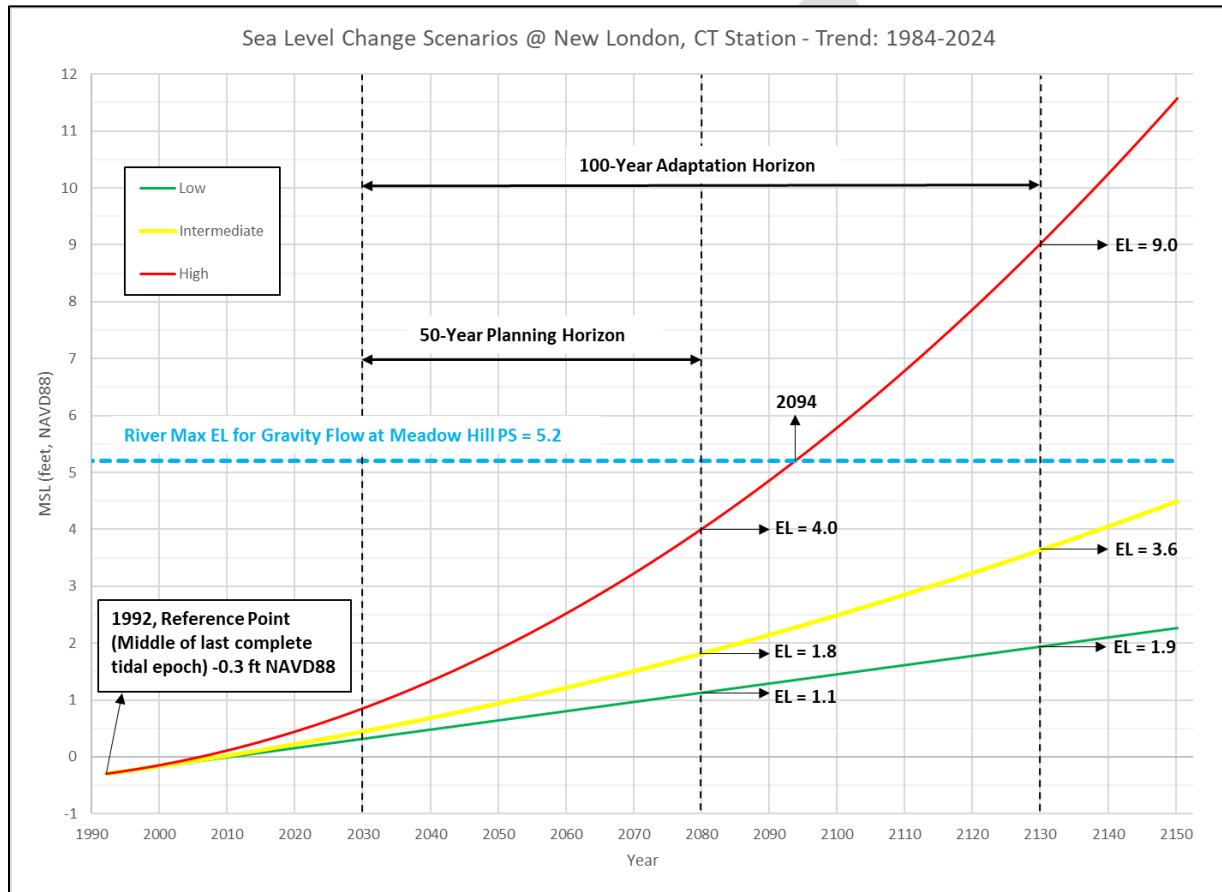


Figure 25: U.S. Army Corps of Engineers Sea Level Change Scenarios Trends from 1984 to 2024 at New London, Connecticut

This projected 1.8-foot rise was then propagated upstream to Hartford using an existing HEC-RAS breach model. Simulations compared present conditions against future conditions by adjusting the model's downstream ocean boundary. For the future scenario, the 1.8-foot SLC was added to the present Mean Sea Level. The results showed that the impact diminishes upstream; the 1.8-foot rise at the coast translated to an increase of only 0.2 to 1.2 feet at the pump station tailwaters, with the smaller impact occurring during higher river flow conditions.

Using these translated water levels, a new stage-duration curve for the year 2080 was developed for the Hartford gauge. As part of the screening analysis of the planning process, four pump stations were screened out from the National Economic Development (NED) analysis including Bushnell, Kenney Lane, Pitkin, and Cherry Street stations. Therefore, the coincident frequency analyses were performed for the North Meadows, South Meadows and Meadow Hill pump stations to account for the higher pump stations tailwater conditions for the year 2080 based on the USACE intermediate curve. The hydrologic and hydraulic models were used to simulate the precipitation events using the tailwater elevations affected by the SLC. A final coincident frequency analysis was then performed for the North Meadows, South Meadows, and Meadow Hill pump stations to account for these future tailwater conditions. The results showed that for significant flood events (i.e., the 25-year return period and greater), the projected increase in water depth was minimal, generally less than one foot. Consequently, it was concluded that sea-level change is not a primary driver for the interior drainage area analyses.

3.1.1.5 Interior Drainage Analysis Conclusions

The results of the coincident frequency analyses performed for the interior drainage of the seven pump stations show that the flood impacts due to the degradation of the pumping discharge capacity are greater for the North Meadows, South Meadows, and Meadow Hill pump stations because their protected areas include more vulnerable structures than the other four pump stations (Keney Lane, Bushnell, Pitkin, and Cherry Street pump stations) that have a limited number of structures vulnerable in their impact areas.

The North Meadows, South Meadows, and Meadow Hill pump stations can use gravity to pass runoff approximately 70% of the time, while the other four pump stations are able to use gravity flow more than 90% of the time in a year. Therefore, Bushnell, Keney Lane, Pitkin, and Cherry Street pump stations are operated less frequently than the North Meadows, South Meadows, and Meadow Hill pump stations.

Sea-level-change is not a driver for the pump stations interior drainage area analyses. Coincident frequency analyses were performed for the North Meadows, South Meadows and Meadow Hill pump stations to account for the higher pump stations tailwater conditions for the year 2080 based on the USACE intermediate curve. The coincident frequency analyses results comparing present to year 2080 show that for the floods that affect structures (i.e., 25-yr return period and larger floods), the depth differences are small (less than one foot).

3.1.2 Levee Breach Analysis

This section documents the levee breach analysis performed for the Hartford and East Hartford FRM Systems. The primary purpose of this analysis was to assess the impacts of potential levee failures on proposed measures within the feasibility study. The modeling effort builds upon the foundation of the 2019 Hartford SQRA and the 2023 East Hartford abbreviated FRM system screening, with breach locations chosen specifically to evaluate risks near the proposed measures.

3.1.2.1 Hydraulic Model Development

Modeling for the breach analysis for Hartford and East Hartford, CT utilized the model developed for 2019 SQRA with some additional improvements; additional details can be found in the 2019 SQRA for the city of Hartford report. The model was updated from HEC-RAS 5.0 to HEC-RAS 6.4.1. Terrain data was updated to new bare-earth light detection and ranging (LiDAR) data collected in 2023 with 2-foot resolution. Minor terrain modifications were made near the Dutch Point flood wall. Model geometry for the Hartford breach analysis used the full geometry from the 2019 SQRA, beginning near the confluence of the Westville River in the North, East Branch Farmington River to the West, and extends to the Long Island Sound at the downstream boundary.

The breach modeling utilized a truncated geometry from the 2019 SQRA that was restricted to the mainstem Connecticut River beginning at the Farmington River confluence in the North and concluding at the Long Island Sound for the downstream boundary. The modeling utilizes 1D unsteady flows for the river channel with 2D meshes for the protected areas behind the levees to capture the dynamic inundations associated with breaches. Modeling within the 2D areas utilized Shallow Water Equations (SWE-ELM) with a Eulerian-Lagrangian approach to solve for advection in order to capture the dynamic nature of levee breaches.

Events for both Hartford and East Hartford utilized the hydrograph for the August 2011 flood event to align with previous modeling efforts, noting that the flood of record is the 1936 flood event. Coincident flows for the Hartford breach modeling were left unchanged from the 2019 SQRA modeling. The truncated modeling for East Hartford used a slightly higher coincident flow of 150 cfs, compared to 100 cfs, for Hockanum River, representing a late Spring flow condition. A review of the daily average flow for the 76.1 sq mi drainage area for the Hockanum River near its confluence with the Connecticut River shows that flow contribution from the basin is relatively minimal. According to the 2017 Flood Insurance Study Report, the Hockanum River is heavily influenced by backwater effects from the Connecticut River, reducing its impact on stages at the project area.

3.1.2.2 Hydrologic Loads

To analyze the impacts of a potential levee breach, a comprehensive suite of hydrologic scenarios was developed for both the Hartford and East Hartford systems. The primary analysis included nine standard loading events based on peak stages at the Levee Crest Level (LCL) and the first toe loading event. This analysis was supplemented with additional scenarios: 62.5% and 92.5% loading for Hartford, and 62.5% and 87.5% for East Hartford. Additionally, several overtopping scenarios were modeled to evaluate specific measures. The Hartford system was assessed with 0.5, 1, 2, and 2.5 feet of overtopping. The East Hartford modeling included 1 and 2 feet of overtopping at its LCL.

Annual Exceedance Probabilities (AEP) or return intervals for each of these hydrologic loads were based on probability function (logarithmic space) from the updated stage-frequency curve for the Hartford USGS gage (developed as part of the 2019 SQRA),

which is shown in **Figure 26**. Summaries of the loading scenarios are provided in **Table 23** and **Table 24**.

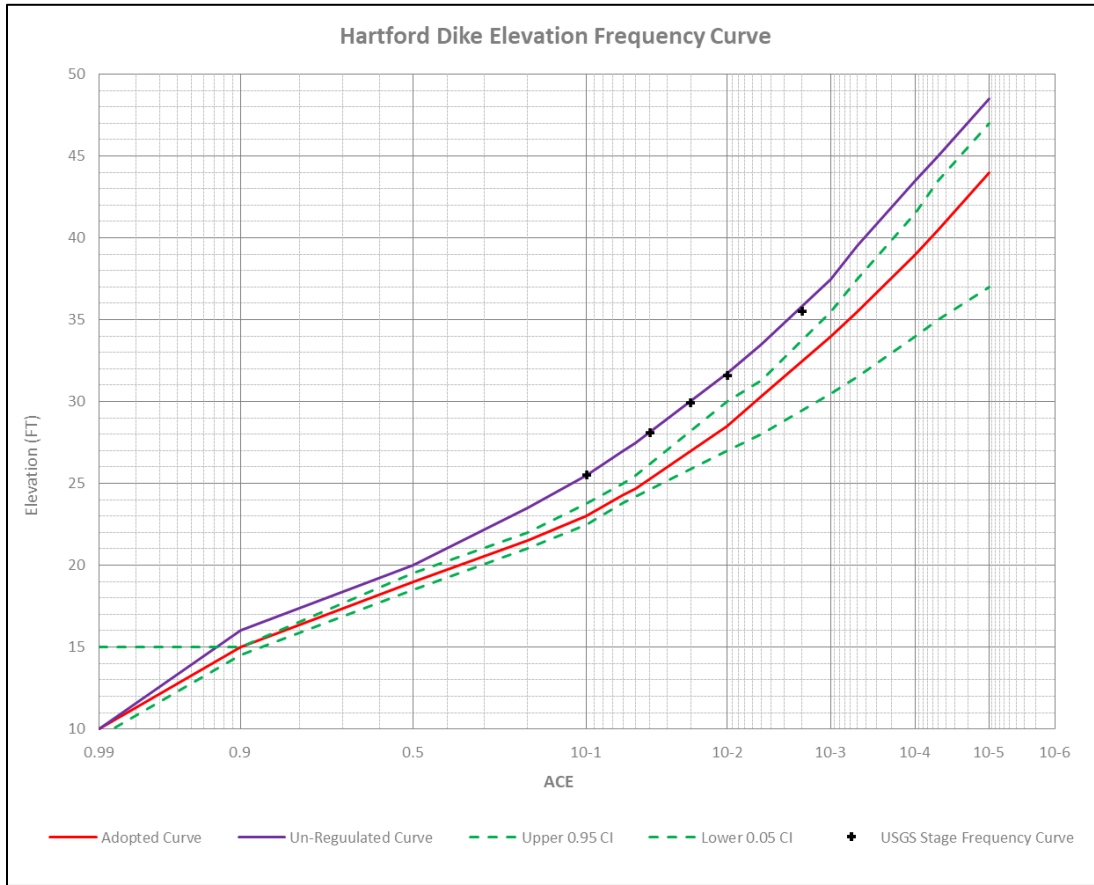


Figure 26: Stage-Frequency Curve for the Connecticut River at Hartford, CT Recorded by USGS Gage 01190070 (2019 SQRA)

Table 23: Hartford Hydrologic Loading Scenarios

Loading Scenario	Water Surface Elevation at LCL (feet-NAVD88)	Annual Exceedance Probability (AEP)	Return Interval (years)	Ratio of Inflow Hydrograph
Toe	16.02	0.99	1	0.29
25%	23.49	0.27	3.7	0.88
50%	30.94	1.5E-02	67	1.43
62.5%	34.68	3.9E-04	251	1.73
75%	38.42	8.7E-05	1,146	2.06
92.5%	43.78	9.6E-05	10,338	2.66
TOL	45.91	2.4E-05	40,556	3.1
0.5 feet OT	46.41	1.6E-05	61,787	3.25
1 feet OT	46.91	1.1E-05	93,284	3.38

Loading Scenario	Water Surface Elevation at LCL (feet-NAVD88)	Annual Exceedance Probability (AEP)	Return Interval (years)	Ratio of Inflow Hydrograph
2 feet OT	47.91	5.3E-06	188,522	3.71
2.5 feet OT	48.41	3.2E-06	309,025	3.9

Table 24: East Hartford Hydrologic Loads

Loading Scenario	Water Surface Elevation at LCL (feet-NAVD88)	Annual Exceedance Probability (AEP)	Return Interval (years)	Ratio of Inflow Hydrograph
Toe	15.9	9.1E-01	1.1	0.5
25.00%	21.6	2.6E-01	3.9	0.8
50.00%	27.3	2.1E-02	47.6	1.2
62.50%	30.1	6.4E-03	156	1.4
75.00%	33.0	1.9E-03	520	1.64
87.50%	35.9	6.3E-04	1,590	1.88
TOL	38.7	1.9E-04	5,131	2.152
1-foot OT	39.7	1.2E-04	8,157	2.27
2-foot OT	40.7	7.1E-05	14,128	2.4

A breach at the LCL was determined to not be needed as breaches at the LCL did not impact potential measures for the TSP. The LCL for the East Hartford Levee System was established at a low point near Cherry St. Pump Station near station 107+00. The 2011 flood event was used as the primary inflow hydrograph along the Connecticut and Farmington Rivers. This event was scaled to achieve the desired loading at the LCL. Steady flows were used along the Hockanum River, and a constant stage of 5 feet NAVD88 was applied to the downstream coastal boundary, consistent with the 2019 SQRA modeling *“this downstream boundary represents a tidal condition between the average annual maximum high tide which is approximately 4.3 feet NAVD88 (5.1 feet NGVD29) and the 10% ACE tidal elevation which is approximately 5.3 feet NAVD88 (6.1 feet NGVD29) based on March 2012 tidal profiles for the New England Coastline from FEMA.”*

3.1.2.3 Selection of Levee Breach Locations

The specific locations for the levee breach modeling in both Hartford and East Hartford were selected collaboratively by the PDT to align with the locations of proposed measures and assess associated risks.

The first Hartford location, at the Interstate 84 and Interstate 91 interchange (BL2), was modeled to simulate a seepage failure through the embankment. Consequently, an overtopping scenario was not considered necessary for this failure mode. The second location modeled in Hartford was at the Dutch Point Flood Wall. After sensitivity analyses

on the failure timing, the PDT defined the breach as a progressive failure, with two monoliths failing instantly, followed by the failure of a third monolith over the course of an hour. A map of these breach locations is provided in **Figure 27**.

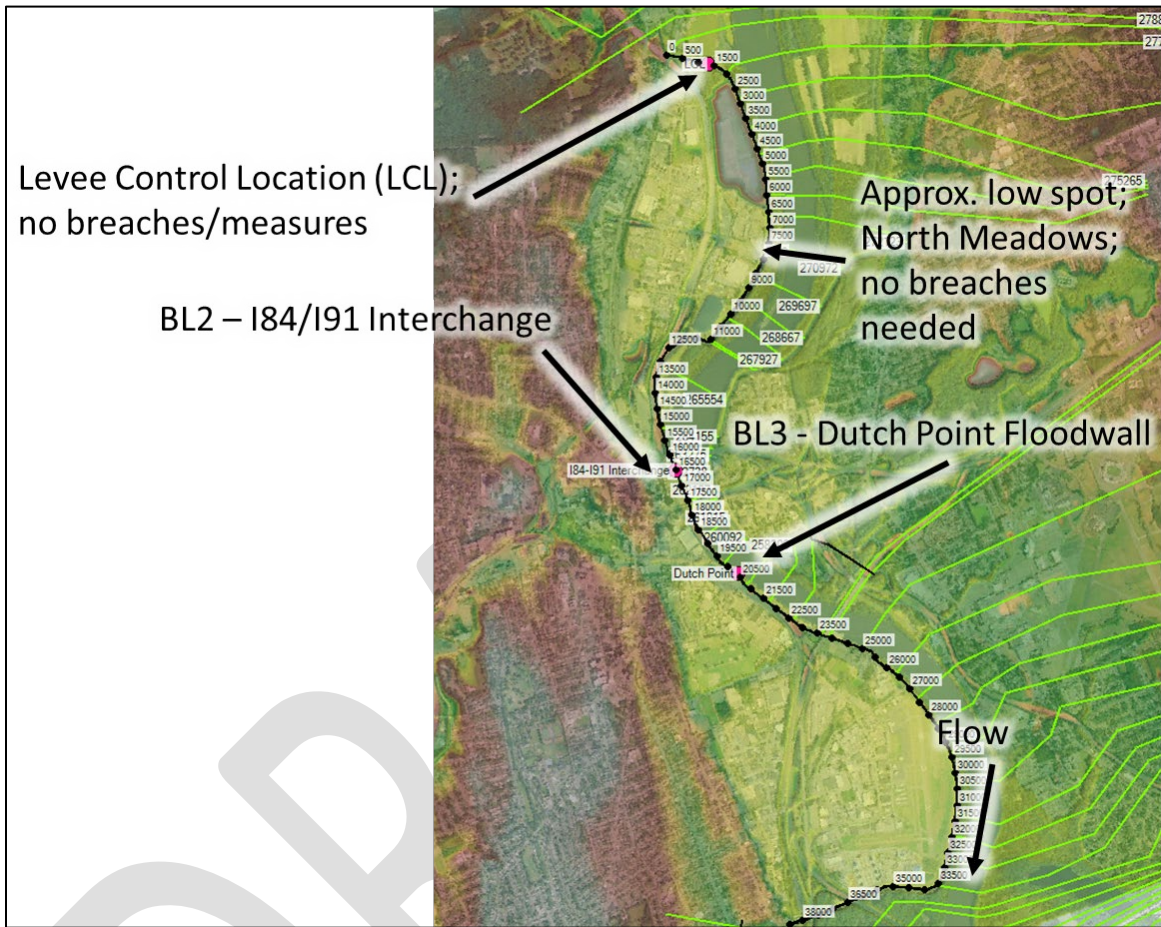


Figure 27: Hartford Levee Breach Locations

Three breach locations were analyzed for the East Hartford system. The first was established at a newly identified LCL for this study. The second breach, located at the crib wall, was designed to model a potential backward erosion piping (BEP) failure. The third location, at the Main Street closure structure, was intended to represent a seepage failure within the embankment during a flood event. These locations are shown on the map in **Figure 28**.

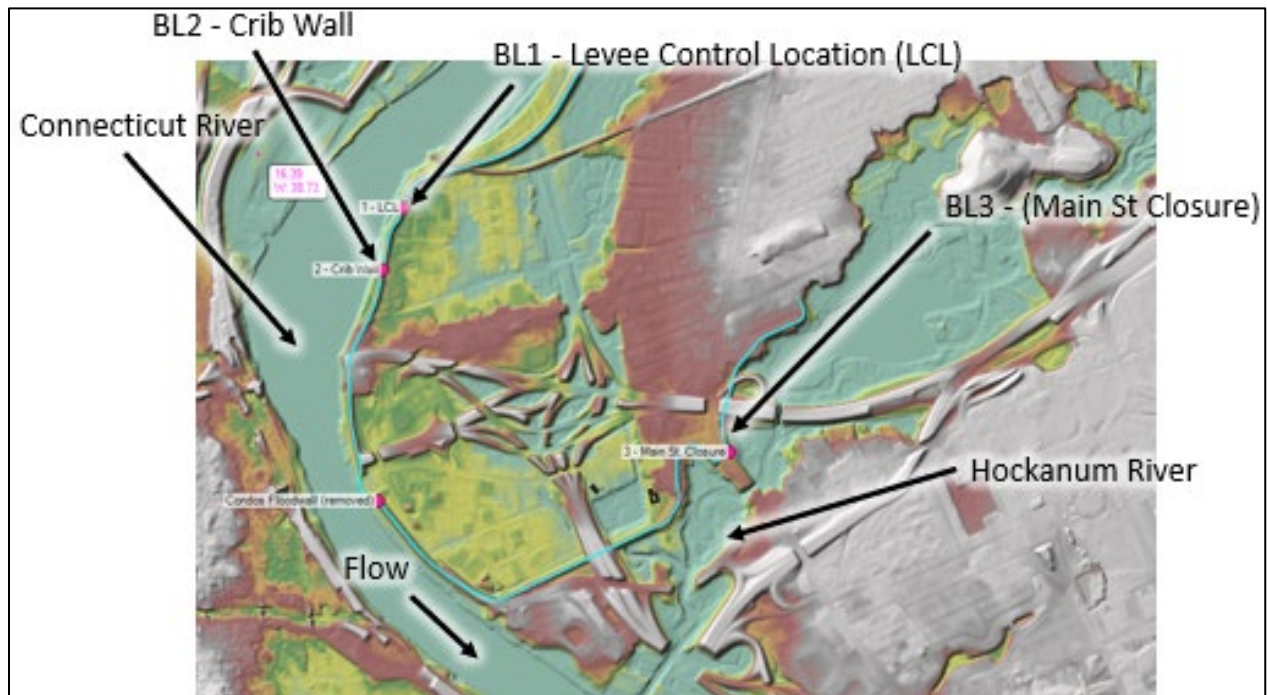


Figure 28: East Hartford Levee Breach Locations

A summary of breach locations is included below in **Table 25**.

Table 25: System Breach Locations

Levee Breach Locations	Short Name	Station	Justification for Selection
Hartford, CT			
Breach Location 2	BL2	Station 0+64M	Location of potential seepage failure in the earthen embankment at the intersection of interstates 84 and 91. PDT determined that overtopping failures were not needed based on the nature of the failure.
Breach Location 3	BL3	38+41M	Location of the Dutch Point flood wall joint displacement potential failure mode identified in the SQRA. A custom breach progression was determined by the PDT involving the failure of two monoliths instantly with a slow failure of a third monolith.
East Hartford, CT			
Breach Location 1 – LCL	BL1	~Station 107+00	Newly identified levee control location. This location was identified as the point in the system with the lowest levee elevations compared to water surface profile.
Breach Location 2	BL2	Station 117+00	Location of BEP seepage failure mode near the crib wall. Measures are proposed by the PDT to reduce risk in this location.

Levee Breach Locations	Short Name	Station	Justification for Selection
Breach Location 3	BL3	Station 215+00	Breach in this location set to represent seepage through the embankment wall.

3.1.2.4 Levee Breach Assumptions

The formation of levee breaches was modeled in HEC-RAS using the simplified physical breach method, which dynamically calculates breach growth based on hydraulic conditions and pre-defined erosion rates. For most scenarios, a standard set of erosion parameters was applied. The maximum potential breach width was set to an unrestrictive value, allowing the erosion rate itself to govern the final size of the breach. A default side slope of 2H:1V was used for these standard breaches. However, two specific locations required customized parameters, which were developed in collaboration with the PDT to reflect unique site conditions and failure modes:

Hartford (BL3 - Dutch Point Flood Wall): This breach was not modeled with standard erosion parameters. Instead, a user-defined failure was scripted to simulate the instantaneous collapse of two 40-foot concrete monoliths, followed by the progressive failure of a third monolith over the subsequent hour. This scenario was an exception to the standard 2H:1V side slopes.

East Hartford (BL3 - Main Street Closure): At this location, the standard erosion rate parameters were reduced by 25%. This adjustment accounts for the presence of the concrete closure structure, which is expected to impede the erosion of the embankment during a breach event.

3.1.2.4 Model Summary And Levee Breach Results

Model results for the non-breach and breach scenarios for the top of levee loading at each location are displayed in **Figure 29** to **Figure 33**.



Figure 29. Projected Flooding at Hartford Breach Location BL2 at the Top of Levee Loading Scenario for Non-Breach (Left) and Breach (Right) Conditions



Figure 30. Projected Flooding at Hartford Breach Location BL3 at the Top of Levee Loading Scenario for Non-Breach (Left) and Breach (Right) Conditions

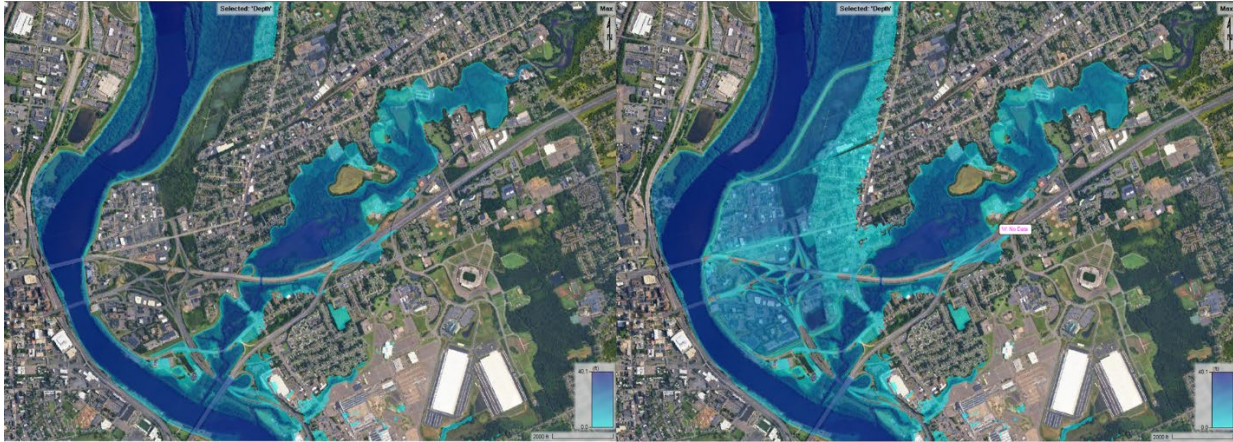


Figure 31. Projected Flooding in East Hartford at the Levee Crest Level Location for the Top of Levee Loading Scenario for Non-Breach (Left) and Breach (Right) Conditions



Figure 32. Projected Flooding at East Hartford Breach Location BL2 for the Top of Levee Loading Scenario for Non-Breach (Left) and Breach (Right) Conditions



Figure 33: Projected Flooding at East Hartford Breach Location BL3 for the Top of Levee Loading Scenario for Non-Breach (Left) and Breach (Right) Conditions

3.2 MECHANICAL RELIABILITY ANALYSIS FOR PUMP STATION CAPACITY

To quantify the future flood risk from the nine aging pump stations in the study area, a three-part analysis was conducted. This approach integrated a mechanical reliability analysis to predict future capacity loss, the previously described H&H modeling to simulate the resulting flood levels, and economic modeling to calculate the financial damages from that flooding. This section provides a summary of the Mechanical Reliability Analysis.

The mechanical reliability analysis began by using failure and maintenance data provided by the NFSs to generate failure models for the critical components of the pump stations which include: the pumps; the diesel motors that drive the pumps and their clutches; the gear boxes that provide power transmission from the diesel motor to the pump; the sluice gates which control the flow into and out of the pump station and their actuators; and the gate valves which control flow into and out of individual pumps. This analysis was based on the available in-situ data, so the failure statistics for these components were tailored to their specific environmental conditions and operating schedules. These failure models define how the probability of failure for these critical components changes over time.

Next, Fault Tree Analysis was performed for each pump station taking into account each specific pump station's design, operating norms, and the age of its components. The failure models developed in the previous step were used to inform the model of the failure probability distribution for each component. This analysis utilized a Monte Carlo simulation to develop curves which determine how the probability of failure of the pump station changes over time. Finally, the capacity of the pump station in each year was calculated by multiplying the reliability of the pump station in that year by its capacity if it was fully reliable.

The prediction of the pump station's capacity in each year from the mechanical reliability analysis was combined H&H modeling which shows how flood risk and inundation changes in the area under different pump station capacities. This combination allows the team to understand how the flood inundation for the area changes over time as the pump station continues to lose capacity. This information is then used in economic modeling to estimate how flood damages change over time with respect to the pump station capacity and the resultant change in flood depths.

Figure 34 shows the results of the mechanical reliability analysis for the study period if reliability trends continue, as in the Future Without Project Condition. No pump station begins the study with 100% capacity due to the age of their components. This aligns with current observations of the capacity of the pump stations, with most having one or more pump arrangements being inoperable at the time that this analysis was completed.

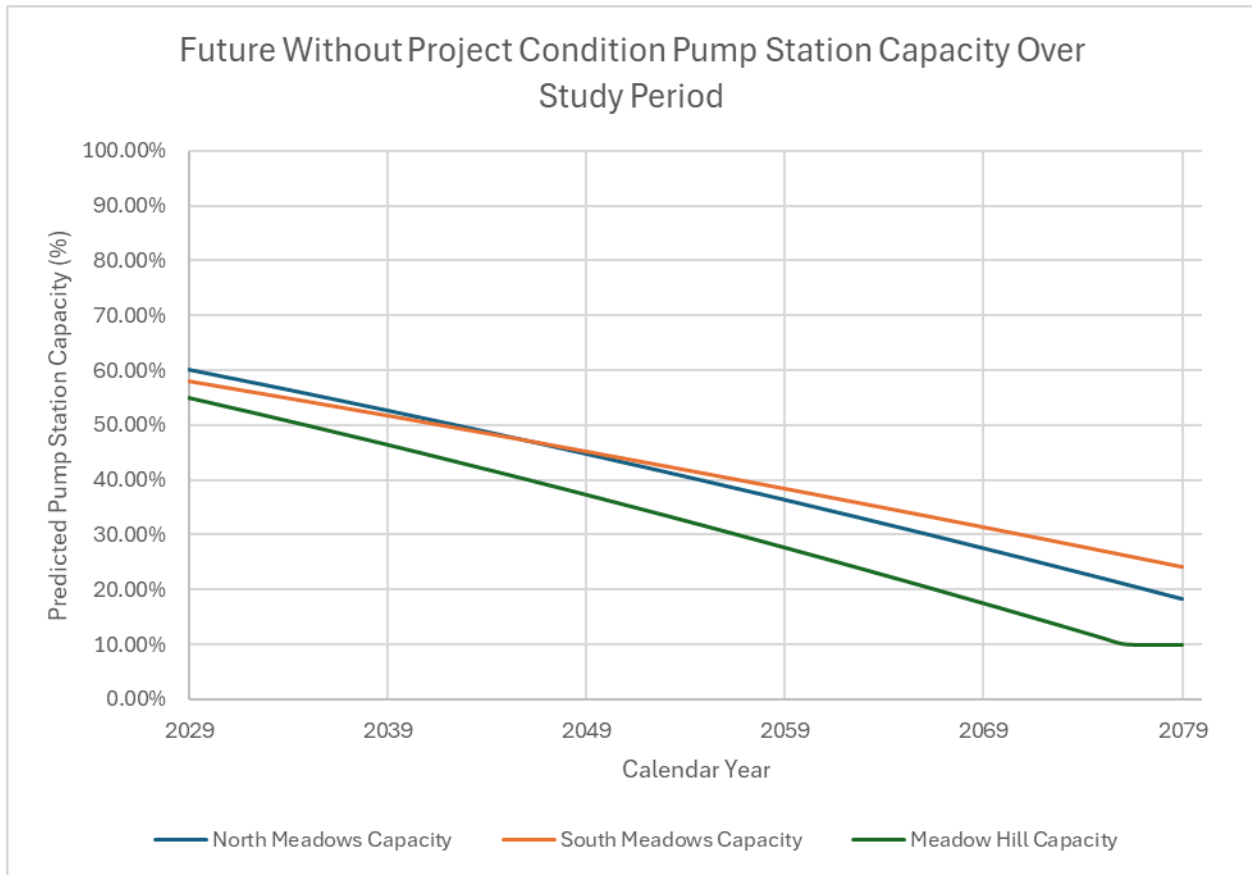


Figure 34: Future Without Project Condition Prediction for Pump Station Capacity Over the Study Period

3.3 LEVEE RISK

Note that the hydrology, hydraulics, and consequence analysis results discussed in this section are from the 2019 SQRA for Hartford and 2023 Abbreviated Risk Assessment using the Levee Screening Tool version 2.0 (LST v2.0) for East Hartford.

The risk characterizations from these studies as presented here have been documented, reviewed, and approved. Additional hazard and consequence analyses were conducted as part of this Section 216 Study, the results of which are discussed in other sections of this report, particularly **Section 3.1**, and in detail in **APPENDIX 2-F: Geotechnical, Geology and Risk Assessment** and **APPENDIX 1-G: Economic Analysis**.

The term “levee risk” was previously referred to as “incremental risk” and is used to describe the risk (likelihood and consequences) posed by failure of the levee system beyond the risk that would exist without a failure (background risk). Levees are designed to provide a specific level of risk reduction, and larger flood events can cause them to breach (fail) resulting in consequences. The annual exceedance probabilities (AEP) of the incipient overtopping event for the Hartford and East Hartford systems are

approximately 1/35,000 years and 1/3,600 years, respectively. For perspective, the flood of record had an AEP of approximately 1/300 years.

Life safety consequences due to a failure of the levee system are quantified when reporting levee risk as an expected annual life loss (EALL) which considers the average annual probability of various levee failure scenarios and the estimated life loss that could result from those failures. EALL does not represent an actual fatality every year, rather it is used to communicate the levee risk on an annual basis.

Population at risk (PAR) is comprised of the people within the inundated area for a given flood hazard scenario and is divided into two general exposure categories based on when the warning is issued to the public, day and night. Daytime population represents the expected number of people in a given structure during an average working day; hence day populations will typically be higher than night for commercial structures, and lower in residential structures. PAR is a function of both inundation extents (spatial) and warning issuance time (temporal).

In general terms, life loss is computed by estimating the population caught in a structure (home or business) when the flood hazard arrives and are unable to elevate themselves above the maximum water elevation by climbing to second or third stories or onto the roof. It also includes those attempting to evacuate by car but are caught by the flood hazard before they reach the evacuation destination.

The critical factors in determining fatalities are the following:

- Hazard Communication Delay and Warning Communication Delay
- Warning Diffusion Time
- Mobilization Time
- Evacuation Destinations
- Characteristics of the flood hazard (arrival times and depth of water)
- Characteristics of structures (number of occupants, 1st floor elevations and number of stories)

Economic consequences are typically quantified considering direct property damages.

3.3.1 Hartford Levee Risk

From the 2019 SQRA, the best estimate of the EALL for Hartford levee is 0.001 (1.0×10^{-3}) lives per year. The primary driver of levee risk is a breach due to an overtopping of the levee embankment. The H&H team members reviewed the probability for flows that would overtop the levee at three locations in detail and noted that the probabilities were sensitive to the skew coefficient causing the team to have only moderate confidence in their overall probability estimate. Using a different part of the uncertainty bounds could move the probability by a factor of ten. A surveyed low-spot on North Meadows Dike was selected as the location to be evaluated in the SQRA for overtopping because it would be the first of the embankments to overtop, therefore exposed to the longest duration. The team

found that the probability of an event generating flows that would overtop the embankment by a depth of 1 foot of water was similar in magnitude to incipient overtopping (0 feet depth, just touching the crest). This means that during a 1 in 110,000-year event ($9.1E-06$ AEP), flood water from the Connecticut River would be 1 foot higher than the top of the levee and possibly cause the levee to breach. The SQRA team came to that conclusion based primarily on the duration of the modeled event and historical data regarding levee performance during overtopping events. A breach during this 1 in 110,000-year event would lead to an inundated area that contains commercial and industrial development and potential significant consequences.

Since overtopping flows would begin prior to breach resulting in non-failure life loss, the excess life loss would be relatively low, approximately 3 to 30. Flood depths would range from 20 to 32 feet. Forecasting for an overtopping event is expected to allow for a day or more of warning. Therefore, the ample warning scenarios were used, which are based on the nighttime PAR as most of the work population would have left the area.

The total excess economic loss is driven by the large number of inundated structures (approximately 22,000), which includes a significant number of commercial structures. The estimated weighted average excess life loss is between 10 and 100 lives per failure and estimated weighted average excess economic loss between \$300 million and \$3 billion per failure.

Other failure modes judged by the risk assessment team to be risk drivers were:

- Backward erosion piping through foundation;
- Seepage through the embankment resulting in progressive sloughing;
- Internal instability of concrete floodwall due to a flood event; and
- Collapse of abandoned structures leading to lowering of the crest of the embankment or floodwall.

3.3.2 East Hartford Levee Risk

From the 2023 levee screening, the best estimate of the EALL for East Hartford levee is 0.0023 (2.3×10^{-3}) lives per year. Performance modes other than overtopping assessed using the LST v2.0 are all assessed at a top of levee (100%) loading. The LST v2.0 assesses overtopping at a loading of 1 foot of water over the top of levee by default. This was the loading used during the 2023 Screening.

The primary driver of levee risk is a breach due to a failure of the Main Street Closure Structure. The City is aware of the flood risk and monitors the Connecticut River level forecast daily. The sill elevation for the closure structure corresponds to approximately the 1 in 100-year event ($1E-02$ AEP). Therefore, the screening team felt that the City would receive plenty of advance warning to operate the closure structure.

The estimated weighted average excess life loss is between 3 and 30 lives per failure and estimated weighted average excess economic loss between \$30 million and \$300 million per failure.

Other failure modes assessed were:

- Backward erosion and piping through foundation materials under both the embankments and floodwalls;
- Internal erosion through the embankment, specifically concentrated leak erosion;
- Embankment Slope Instability;
- Riverine erosion along the levee embankments;
- ; and
- Internal or global floodwall instability.

4.0 IDENTIFICATION OF FLOOD RISK MANAGEMENT SYSTEM CONCERNS

During site visits and scoping meetings for the East Hartford and Hartford FRM systems that took place from March 28-30, 2023, the PDT met with NFS staff, who expressed significant concerns about the systems' long-term viability. While the FRM systems have a proven record of reliable flood protection, their underlying infrastructure is a growing hazard.

The NFS has diligently maintained the systems, but much of the equipment is original, with some components now over 75 years old and past their useful service life. This aging infrastructure creates severe maintenance challenges. Replacement parts are no longer commercially available and must be custom-fabricated by foreign manufacturers, leading to significant delays and equipment downtime. Furthermore, some original design features, like toe drains, are now considered obsolete. The NFS faces increasing difficulty maintaining the systems as authorized due to these compounding issues, as well as limited manpower and funding.

Although the NFS performs emergency repairs, the difficulty in sourcing parts is escalating. The funding they have managed to secure provides only "band-aid" solutions that fail to address the systemic problems of an aging and under-resourced flood protection system.

These on-the-ground concerns are validated by formal risk assessments. A 2019 SQRA for the Hartford system and a 2023 Abbreviated Risk Assessment for East Hartford both found that risks were near or exceeded USACE's Tolerable Risk Guidelines. This indicates the level of risk has become unacceptable for the communities protected by the levees.

Specific areas of concern identified by the NFSs for the Hartford FRM System are listed in **Table 26** and concerns related to the East Hartford FRM System are included in **Table**

27.

Table 26: Non-Federal Sponsor’s Concerns Related to the Hartford Flood Risk Management System

SYSTEM FEATURE	PROBLEM
Floodwall Concerns	
Dutch Point Floodwall Joint Displacement	Movement of the floodwall monoliths has resulted in joint displacement
Closure Structure #6 Floodwall Joint Displacement	Movement of the floodwall monoliths has resulted in joint displacement.
MIRA Site	Abandoned Equipment on and over the Floodwalls
Bank Failure	
Charter Oak Bridge Embankment	Levee overshadowed by bridge – No vegetation (grass) on embankment slopes - May lead to bank failure by erosion
Embankment at MIRA Site	Embankment supporting the Floodwall is too steep
Flooding	
Wethersfield Avenue Closure	No Closure structure - Inadequate solution to close Roadway opening
North Meadows Drainage Swale/CTDOT transit facility	Incorrectly sized drainage swale results in flooding
Scour	
North Meadows Storage Pond	Scour in the forebay
Seepage	
I-91/ I-84 interchange	Existing sheet pile at this location is not sufficient to act as an effective seepage cutoff. May result in seepage underneath the Floodwall/ Railroad exiting in the highway.
Clark Dike	Seepage
Penetrations	
Clark Dike	Penetrations through the levee including buried utility structures, weakens levee embankment
MIRA Site	Known and unknown penetration through Levee weakens levee embankment
Ancillary Equipment	
Park River Area Sluice gates	Old gates in poor condition may result in the gates getting stuck in either the open or closed position.
Pump Stations	
North Meadows Pump Station	Concerns associated with all pump stations include:

SYSTEM FEATURE	PROBLEM
South Meadows Pump Station	Failure of Pump Stations results in flooding Safety hazard for town employees Pump Stations with original or old equipment: <ul style="list-style-type: none"> - <i>Antiquated pumps</i> - <i>Antiquated electrical system</i> - <i>Old diesel engines</i> - <i>Lack of automation</i> - <i>Inadequate ventilation</i> - <i>Inadequate climate control</i> - <i>Old, inoperable cranes</i>
Keney Lane Pump Station	
Bushnell Pump Station	
Armory Pump Station	
Pope Pump Station	

Table 27: Non-Federal Sponsor's Concerns Related to the East Hartford Flood Risk Management System

SYSTEM FEATURE	PROBLEM
SEEPAGE	
Embankment north of Railroad Closure	Potential seepage due to the design of the toe drain
Main Street Closure Structure	Potential seepage due to concentrated leak erosion at this closure structure.
Segment 2 (<i>Bulkeley Bridge to the Railroad Closure Structure</i>)	Potential seepage at the crib wall location due to backward erosion piping
TOE DRAINS	
Segment 2 (<i>Bulkeley Bridge to the Railroad Closure Structure</i>)	Toe drain design is original to the FRM system. The existing toe drain design doesn't allow monitoring and maintenance without damaging the drain.
Section 4 (<i>Hartland Street to Meadow Hill PS outlet structure</i>)	
Section 5 (<i>Meadow Hill PS outlet structure to Main Street closure structure</i>)	
Section 6 (<i>Main Street closure structure to end of levee at Brewer Lane</i>)	
CRIB WALL	
Crib Wall near the Cherry Street Pump Station	The crib wall weakens the levee structure
INTERIOR CHANNEL	
Interior Channel	The interior channel does not have adequate capacity to move the drainage volume
OUTLET STRUCTURES	
Meadow Hill Pump Station Outlet Structure	Outlet elevation is too low which reduces pump station efficiency.

SYSTEM FEATURE	PROBLEM
Cherry Street Pump Station Outlet Structure	The outlet structure is leaking and could weaken the levee
Pitkin Pump Station Outlet Structure	The outlet structure is leaking and could weaken the levee
PUMP STATIONS	
Meadow Hill Pump Station	Concerns associated with all pump stations include: Failure of Pump Stations results in flooding Safety hazard for town employees Pump Stations with original or old equipment: - <i>Antiquated pumps</i> - <i>Antiquated electrical system</i> - <i>Old diesel engines</i> - <i>Lack of automation</i> - <i>Inadequate ventilation</i> - <i>Inadequate climate control</i> - <i>Old, inoperable cranes</i>
Cherry Street Pump Station	
Pitkin Pump Station Outlet	

4.1 GENERAL DESCRIPTION OF COMPONENTS OF CONCERN

4.1.1 Levee Components

A levee is an engineered barrier constructed with the primary purpose of managing flood risk in a certain area. The term “levee system” can include several types of structures such as earthen embankments, floodwalls, toe drains and closure structures. Levee systems are carefully designed to consider drainage, seepage, erosion, and slope stability, and the design must account for various loading conditions, including steady-state seepage, rapid drawdown, and seismic events to reduce the risk of failure.

Earthen embankments are typically constructed out of compacted soil to form high ground that blocks water from inundating the protected area (**Figure 35**). The fundamental geometry of an earthen levee consists of a crest, which is the horizontal surface at the top of the structure, a riverside and landside slope, and the toe, the place where the embankment meets the natural ground.



Figure 35: Levee Embankment Near the Hartford-Brainard Airport

In areas where real estate is restricted, earthen embankments are often replaced by concrete floodwalls, which are vertically oriented, rigid structures designed to withstand significant hydrostatic loads (**Figure 36**). The most prevalent configurations are the I-wall and the T-wall. The stability of floodwalls is fundamentally dependent on the geotechnical properties of the foundation soils, which must provide adequate bearing capacity and resistance to sliding.

The floodwall itself is constructed from reinforced concrete, with material specifications dictating the required compressive strength, durability, and reinforcement grade and placement to resist bending moments and shear forces. Proper design and sealing of construction and expansion joints are also imperative to accommodate thermal expansion and contraction without compromising the wall's hydraulic integrity, ensuring the floodwall functions as a monolithic and impermeable barrier within the larger flood protection system.

The interface between a concrete floodwall and the adjacent earthen levee sections represents a critical transition zone that requires careful design to ensure system continuity and prevent localized failure. These transitions often incorporate flared wing walls and intricate compaction details to prevent the formation of seepage paths.



Figure 36: An Example of a Concrete Floodwall Located at Dutch Point in Hartford, CT

Closure structures are critical components within a levee system, representing engineered openings that allow for the passage of transportation infrastructure such as roadways and railways during normal, non-flood conditions. These gaps are flanked by robust concrete monoliths or abutments that serve as the terminal points for the adjacent earthen embankments or floodwalls and provide the structural framework needed to seal the opening when a flood threat occurs. The method of closure varies depending on the span and operational requirements, but common types include stoplog structures, where prefabricated beams are placed into vertical slots; swing or rolling gates that pivot or slide into position; and channel, especially when the river level is too high for gravity drainage miter gates, which operate like canal locks. Due to their nature as a planned discontinuity in the line of protection, the reliable and timely deployment of these closure devices is paramount to the integrity of the entire flood risk management system, requiring rigorous maintenance and clear operational protocols to ensure a watertight seal is achieved under emergency conditions.

Toe drains are crucial safety features constructed on the landward side of a levee. Their primary purpose is to intercept and manage seepage that occurs when high water levels create a saturation zone within the levee embankment. By collecting this excess water, toe drains prevent unwanted flooding and erosion at the base of the structure, ensuring its stability. The collected water is then channeled into the local storm sewer system.

4.1.2 Pump Station Overview

While the specific size and number of their components vary, pump stations in a Flood Risk Management system all operate on the same fundamental principles. Their essential function is to collect interior drainage from the protected side of a levee and discharge it into the main river or to work.

At the heart of each station are large pumps (**Figure 37**). These can be driven by either large electric motors or, particularly in older systems, direct-drive diesel engines. Water from the drainage area collects in an intake bay or sump. From there, a system of gates and valves directs the flow. During low river stages, gravity-flow gates can be opened to allow water to drain freely through a conduit. However, when the river rises, these gates are closed to prevent backflow, and the water is directed to the pumps. Once pumped, the water is forced through large discharge pipes or conduits that pass through or over the levee and empty into the river. A critical flap gate or check valve is located at the end of the discharge pipe to prevent river water from flowing back into the system when the pumps are not operating. Within the station, isolation gates or valves allow individual pumps to be taken offline for maintenance without shutting down the entire facility.

DRAFT

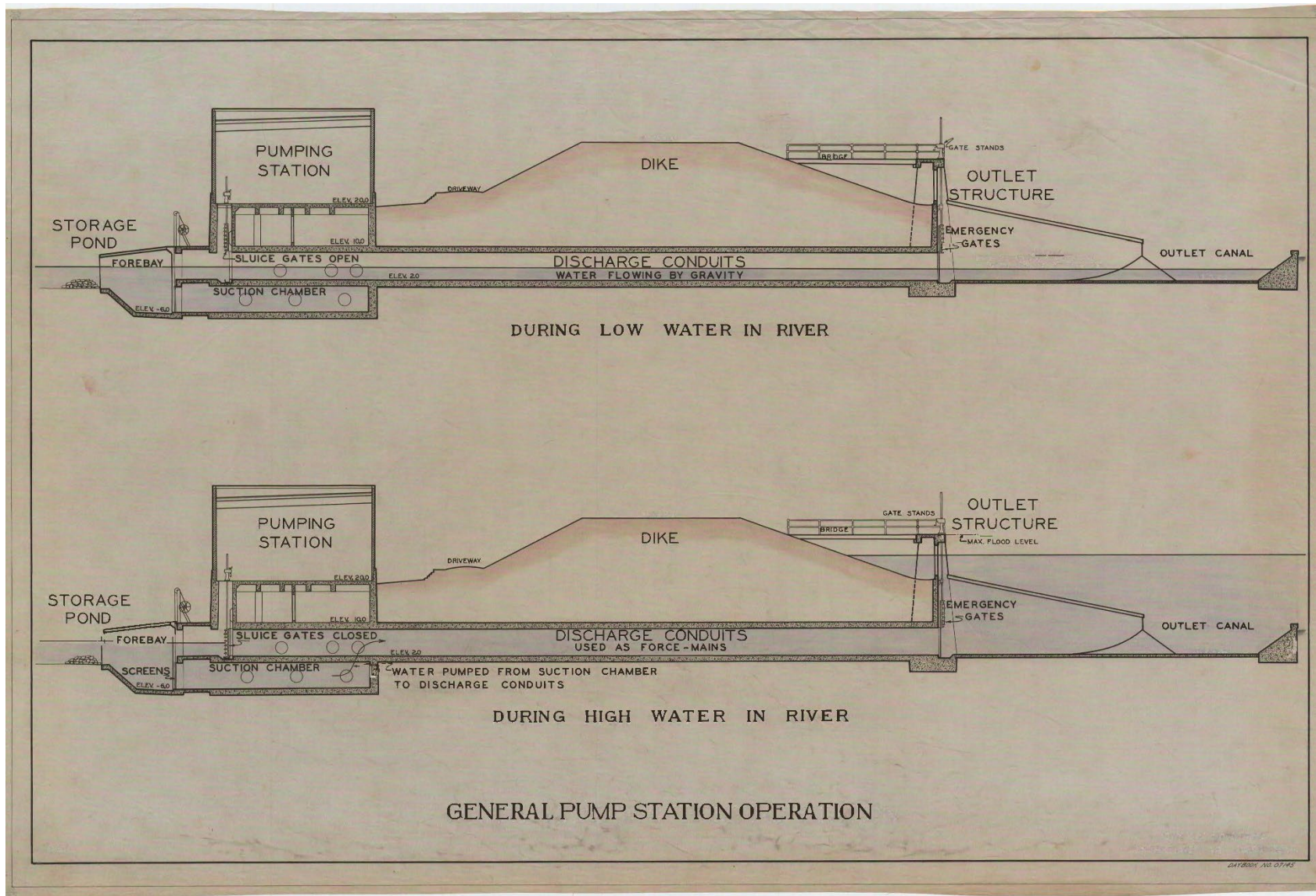


Figure 37: General Description of Pump Station Operation

Water may collect in large ponds that serve as detention basins at locations adjacent to the designed low points, to be released more slowly after a storm event. These locations do require ongoing maintenance such as dredging to ensure their storage capacity is maintained. **Figure 38** shows the storage pond at the Meadow Hill Pumping Station.



Figure 38: Pond Area Adjacent to Meadow Hill Pumping Station, East Hartford, CT

Under normal "sunny day" conditions, the Hartford and East Hartford areas rely on gravity to drain stormwater into the Connecticut River. However, when storms occur upstream, the river's water level rises. During minor river rises, the communities are protected by passive defenses—a system of flap gates and sluice gates on the drainage conduits that pass through the levees and floodwalls. These gates automatically close to prevent the rising river from backing up into the local drainage system. During larger storm events, the river rises so high that it completely blocks the gravity drainage outlets. Local stormwater, with nowhere to go, begins to accumulate behind the levees. This leads to flooding within the protected communities, inundating basements, making roads impassable, and potentially causing overflows of partially treated wastewater into local channels. It is precisely at this point, when gravity drainage fails, that the pump stations become essential. Their critical role is to mechanically lift the trapped stormwater up and over the flood defenses and discharge it into the river.

4.1.3 Sluice Gates

Sluice gates are rectangular gates that can be raised or lowered to allow for flow under them. In certain designs, the resting gate crests can be lower than the water “contained” by them, so that the crest forms a weir over which water flows when there is an adequate build-up of water behind the gate. The gate position is adjusted by lifting the gates using chains attached to electric motors. In the event of sluice gate failures at the pumping stations, there are means for manual raising and lowering of the gates, but these are slow and labor-intensive exercises.

4.2 COMPONENTS OF CONCERN IN THE HARTFORD FLOOD RISK MANAGEMENT SYSTEMS

4.2.1 Hartford Pump Stations

The Hartford FRM system relies on six pump stations to manage interior drainage: North Meadows, South Meadows, Keney Lane, Pope, Armory, and Bushnell (**Figure 39**). The system is highly interconnected, with different stations managing specific, and sometimes overlapping, watercourses. The Bushnell Pump Station is a key component, pumping water from the Park River through its main conduit, with the ability to divert flow to an auxiliary conduit if needed. The Pope, Armory, and Bushnell stations all work together to manage flows along the North Branch of the Park River. In southern Hartford, flows from Park Street and Folly Brook combine before being managed by either the Keney Lane or South Meadows pump stations. Due to this interdependent design, it is impossible to definitively isolate a single pump station's contribution to reducing flood risk from any specific stream.

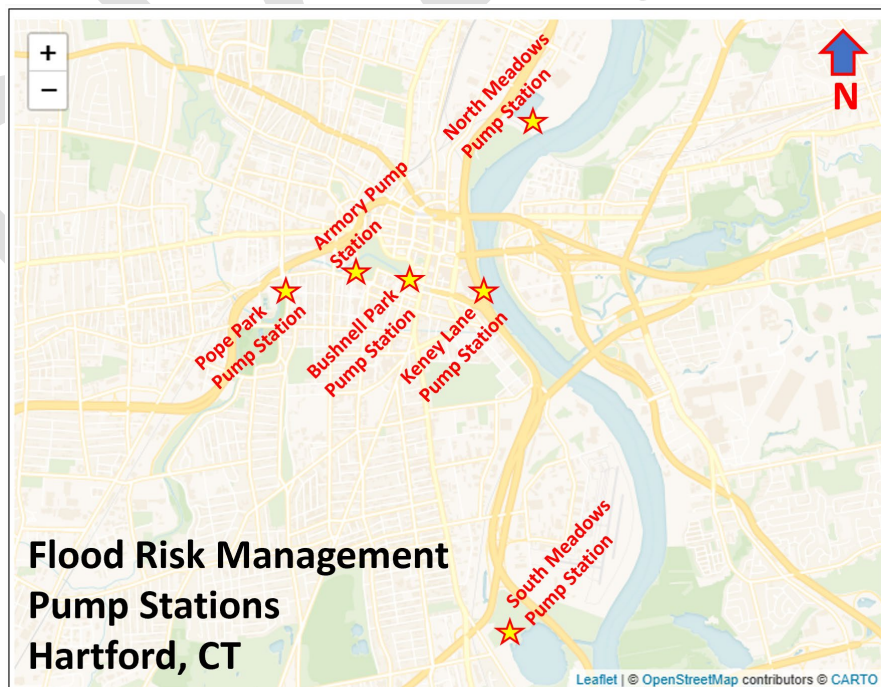


Figure 39: Locations of Pump Stations in Hartford Flood Risk Management System

During site visits, Hartford Department of Public Works (DPW) staff expressed grave concerns about the condition and long-term viability of the city's six pump stations. The core issue is the extreme age of the equipment. Many key components are original to their installation, dating back 60 to 80 years, with some as old as 95 years. Having only received routine maintenance like lubrication, much of this machinery is now operating in a state of unacceptable performance and has surpassed its useful service life. This advanced age creates a cascade of critical problems.

First, maintenance has become a logistical nightmare. Replacement parts for the pumps and motors are largely obsolete. When a component fails, parts cannot be bought off the shelf; they must be custom-designed and fabricated, often by foreign manufacturers. This process drastically increases repair costs and leads to extreme downtime, sometimes leaving a pump inoperable for years and reducing the station's flood-fighting capacity during that entire period.

Second, system reliability is questionable. The current practice of testing pumps for short periods is likely insufficient to guarantee they can sustain operation during a severe, prolonged flood. Compounding this, a growing number of ancillary components—such as the sluice gates, gate valves, and their actuators—are now completely inoperable, further degrading the capacity and resilience of the entire system.

Most importantly, the stations pose significant safety risks to DPW staff. The electrical systems have exceeded their design life and are considered a near-term replacement priority. Built-in maintenance cranes are viewed as unsafe to use. The most urgent threat, however, comes from the heating and ventilation (HVAC) systems, which fail to meet current USACE safety standards (Engineer Memorandum 1110-2-3105).

The inadequate ventilation creates hazardous conditions in two primary areas. In the sump pits, where water collects, the system fails to remove dangerous gases that can accumulate, creating a life-threatening environment for staff entering these confined spaces. In the main operating areas, the system cannot adequately remove heat generated by machinery, leading to temperatures that exceed the 95°F standard. This not only creates an unsafe work environment but can also cause critical equipment to overheat and fail.

In conclusion, the existing pump stations are not just inefficient; they are unreliable and unsafe. A "band-aid" approach of emergency repairs is no longer sustainable. To protect city personnel and ensure the stations can function as intended, a comprehensive upgrade is required, including the immediate replacement of the HVAC and electrical systems and the installation of permanent gas detection equipment.

4.2.1.1 North Meadows Pump Station

In Hartford, the North Meadows pump station is located in Riverside Park, adjacent to the North Meadows Storage Pond (**Figure 40**). This pump station was put into service in 1939 at the intersection of Jennings and Liebert Roads, next to the Connecticut Transit

Building. It serves a drainage area of 1,340 acres of residential, industrial, and agricultural land. Originally, the pump station consisted of three 36" engine driven pumps and one 16" electric motor driven pump, resulting in a total maximum pump station capacity of about 330 cfs. In 1958, a fourth 36" engine driven pump was added that increased the maximum capacity of the pump station to about 440 cfs.

All pumps are original to their year of installation, with only one pump having had a replacement impeller installed in 2018. Pump 1, installed in 1958, is currently restricted to being the last pump on call due to concerns for condition of the thrust bearing. This likely indicates an imminent failure for this pump. The 16-inch electrically driven pump is currently inoperable due to a broken discharge gate valve, and the electric motor is original to its installation. All the diesel motors were replaced in 2007 at the same time that the gear boxes were refurbished. All suction and discharge gate valves at this pump station are original to the installation of their corresponding pump. The suction gate valves at this pump station are manual operation only and are very rarely exercised due to the difficulty of their operation.



Figure 40: North Meadows Pump Station (*Inset, from 2009 inspection, shows the fuel tank and the shed housing the emergency generator*)

4.2.1.2 Pope and Armory Pump Stations

The Pope Pump Station is on Sigourney Street, approximately 1,000 feet north of Park Street (**Figures 41** and **42**). It has a total pump station capacity of about 75 cfs at 23.3 feet total head from 20" pumps. The pumps at this project have not been operated for their designed intent since 2009. There is a total of 5 sluice gates for this station. The

outdoor housing covers of four of those sluice gates prevent access and testing of their manual operation, so a valuable backup means of operation is nonfunctional. One sluice gate at this project is entirely non-operational due to a failed actuator. The maintenance crane end truck structure does not meet minimum lateral clearance, so therefore cannot be used without being repaired or replaced. The manual operators for the gate valves at this project are either inoperable or inaccessible for use. The suction and discharge gate valves for pump three do not respond to calls from the operating panel. Because the gate valves for this pump are inoperable electrically and the manual backup operation is inaccessible, this could severely impact the readiness of this pump station to operate to full capacity.



Figure 41: The Pope Pump Station



Figure 42: The Pope Pump Station and Fuel Tank; Maintenance Work in Progress

The Armory Pump Station is located at the intersection of Elm Street and Trinity Street in Bushnell Park (**Figures 43** and **44**). It has a total pump station capacity of about 120 cfs at 29.1 feet total head from 24” pumps. This pump station has never been called upon to pump storm water. There are four sluice gates at this pump station. The two inlet sluice gates are currently not operational and are stuck in an open position. No sluice gate actuator at this pump station operates satisfactorily. Most sluice gate actuators are entirely not operational, with one noted as being “minimally operational”. The manual hand wheel operators of the gate valves at this project are non-operational, but the electric actuator operates with expected open and close times.

Both of these pump stations were put into service in 1981 and have three diesel engine driven pumps. Apart from a single gear box which was refurbished in 2017 at the Armory Pump Station, no major maintenance or repairs have been conducted for any of the key machinery at these pump stations since they were put into service. The lack of operation of either of these pump stations for their designed intent for long periods of time combined with their age creates substantial uncertainty that they would be capable of meeting their designed purpose at the time they were needed.



Figure 43: Armory Pump Station



Figure 44: Armory Pump Station and Reserve Fuel Tank

4.2.1.3 Bushnell and Keney Lane Pump Stations

The Bushnell Pump Station (**Figures 45 and 46**) is located at the intersection of Elm Street and Pulaski Circle. It has a total pump station capacity of about 235 cfs. The main

pumps at this project are of 36" diameter and the electric pump diameter is 16". There are four sluice gates for this station. No sluice gate actuator at this pump station performs adequately, and the performance of these gates can therefore not be tested. The gate valve actuators at this project are mostly electrically operated with a manual backup, except for pump 4, which is manual operation only. While the gate valve actuators at this project perform adequately, the manual backups are inaccessible due to their height and the lack of suitable means of access. For pump 4, this means that the gate valves for pump 4 are likely not frequently operated. This could severely impact the readiness of this pump station to operate to full capacity.



Figure 45: The Bushnell Pump Station



Figure 46: Motors for Five Pumps at the Bushnell Pump Station

The Keney Lane Pump Station (**Figure 47**) is located adjacent to the levee embankment near Route 91 access ramps to the Connecticut Convention Center. It has a total pump station capacity of about 340 cfs. The main pumps at this project are 30" and the electric pump is 16". There are three sluice gates at this station. Two of the three actuators have known issues indicating imminent failure. Pump 3 at this project is currently not operational due to a failed discharge gate valve which prevents water from exiting the discharge pipe into the outlet conduit. All of the gate valves at this station are electrically operated with a manual backup, but considerable effort is needed to operate using the manual backup mechanism. Maintenance reports indicate that this difficulty would make it unlikely that the gate could be manually opened or closed in a timely fashion in an emergency.

Both of these pump stations were put into service in 1944 and have three large diesel engine driven pumps and one smaller pump driven by an electric motor. Neither of these pump stations have noted any major maintenance or replacements of any of their key operating machinery since they were put into service.



Figure 47: The Keney Lane Pump Station
(Reserve Fuel Tank Outside the Main Building)

4.2.1.4 South Meadows Pump Station

At the southern end of Hartford's levee system, near the southern end of Clark Dike, the South Meadows Pump Station is located at the off-ramp from Route 99 to Wethersfield Ave (**Figure 49**). The station is designed to drain/pump flow from Folly Brook and Park River with a drainage area of approximately 1,540 acres and was put into service in 1931, predating the construction of the Main Stem FRM system. The pumping equipment consists of six diesel-engine driven 36" volute pumps. Pumps are connected to their driving engine by way of right-angle gear boxes that provide various gear reductions. The engines are cooled using a municipal water supply. Flows into and out of the pumps are controlled by gate valves.



Figure 49: The South Meadows Pump Station

Six sluice gates control the flow at the pump station. When the station was originally constructed, the sluice gates on the intake side would be open under normal conditions, allowing water to flow by gravity through the discharge conduits and would only be closed under high water conditions. The city DPW has modified the O&M protocols for the South Meadows Pump Station and storage pond to provide additional storage capacity within the storage pond for various storm events. As a result of this change, most flows passed South Meadows are now pumped, rather than draining naturally by gravity.

Four 36" pumps were originally installed in the station, with the addition of two more 36" pumps in 1958, bringing the station capacity to approximately 700 cfs. Many of these pumps have experienced repairs which would be considered more than operational maintenance, but none have been fully replaced. Based on reports of unreliability from the NFS, it is likely that these repairs or rehabilitations have not restored them to "like new" status. Additionally, Pump 5 is known to currently be missing a flow guide. This is a component that guides water into the pump impeller and is critical to ensure the pump can meet its design capacity. Without this component, pump capacity testing performed in 2009 indicates that this pump does not meet its design capacity.

Four of the six gear boxes at this pump station were rebuilt in 2007, with an additional gear box being rebuilt in 2014. This leaves one gear box being original to its installation in 1958. Two of the six diesel motors were replaced in 1998, with the remaining four being replaced in 2007. All gate valves and their actuators were replaced in 2017 at South Meadows.

All the sluice gates are original to the project, having been put into service in 1931. It is noted that none of the inlet sluice gates seal properly due to failure of fasteners from advanced corrosion and wear of components. The condition of the outlet sluice gates is unknown due to their failed actuators, but it can be assumed that they are in similar shape given that they were put into service at the same time and have similar operational environments. Five of the Six sluice gate actuators were also put into service in 1931. None of the three outlet sluice gate actuators at this project perform adequately. Two of them are fully non-operational and the third (which is the only one at the project to have ever been replaced) requires direct assistance from operational staff in order to operate.

Structural assessments have noted cracks between bricks from ground level up to the crane rail support level, and spalling concrete; leaks have been reported from several of the centrifugal pumps (**Figure 50**).



Figure 36: Detail of Damaged Concrete on the Rook of the South Meadows Pump Station

4.2.2 The Materials Innovation and Recycling Authority Site

Positioned between the Hartford levee and Clark Dike, the MIRA site was originally a coal-fired power plant before its conversion to a waste-to-energy facility. The plant is now defunct and, as of July 1, 2023, is owned by the MIRA Dissolution Authority (MDA). The site is located along the western bank of the Connecticut River, with a portion of the Main Stem FRM system running through the MIRA property. The onsite flood control infrastructure has been modified over several decades. The initial 1941 construction incorporated T-wall structures to mitigate undermining from seepage. In 1963, an

authorized penetration was added, featuring a screen house with a flap-gated conduit and associated gauges. Following the identification of operational limitations in the 1964 O&M manual, a seven-by-ten-foot sluice gate system was installed to manage pressure differentials. Throughout the history of the facility, substantial amounts of equipment have been mounted directly on or across the concrete floodwalls.

Significant concerns exist regarding the integrity and upkeep of the FRM infrastructure on the MIRA property. The primary issues are outlined below.

Levee Penetrations: Numerous conduits, ranging from 4 to 48 inches in diameter and made of concrete, cast iron, steel, or unknown materials, penetrate the levee embankment at various heights. A lack of documentation makes it difficult to determine which are active versus abandoned, their condition, or their sealing methods. While the NFS noted seepage as a potential concern, no seepage or related performance issues have been observed.

Critical Failure Mode: The 2019 Hartford Levee SQRA identified a critical risk from two improperly abandoned conduits beneath the floodwall near the former chlorine house. The potential collapse of these conduits presents a substantial threat to the levee's performance.

Operational & Maintenance Issues: The system requires manual valve operation during high-water events. With the facility now closed, executing these procedures and performing ongoing maintenance has become a more pressing challenge.

Structural Deficiencies: Other identified problems include an excessively steep land-side levee slope that requires re-grading (**Figure 51**) and abandoned equipment that remains installed on the floodwall.



Figure 51: The Riverbank slope at the Materials Innovation and Recycling Authority Site

Any rehabilitation work on the FRM system is complicated by significant environmental contamination. The property is under an Environmental Land Use Restriction due to contaminated soils. Per federal guidance for cost-shared projects, the local sponsor, in this case, the MDA, is responsible for 100 percent of the costs associated with any required HTRW response actions. The site's contamination is documented across several environmental databases, including:

- Oil & Chemical Spill Database (SPILLS)
- Connecticut Leaking Underground Storage Tank (CT LUST)
- Recovered Government Archive Leaking Underground Storage Tank (RGA LUST)
- Resource Conservation and Recovery Act (RCRA) Large Quantity Generator
- Per-and polyfluoroalkyl substances-Enforcement and Compliance History Online (PFAS-ECHO)

4.2.3 Hartford Levee System

There are three main levee sections that make up the Hartford FRM system, along the western bank of the Connecticut River. These are the North Meadows, Hartford, and Clark Dikes.

The North Meadows Dike runs south from the intersection of Windsor Street with West Service Road, south past Riverside Park and the North Meadows Storage Pond. The dike continues south of the North Meadows Pump Station and ends just north of the I-91/I-84 interchange at the Bulkeley Bridge. There is a rail bridge along the levee route, at the

southern end of Riverside Park (about two-thirds of the distance from the northern end of the levee).

The Hartford Dike is located south of the North Meadows Dike, running from just north of the I-91/I-84 interchange (Bulkeley Bridge), past the Route 2 (State Street) bridge. It continues past the Keney Lane Pump Station and the Dutch Point Floodwall to the Charter Oak (Route 15) Bridge. At the southern end of the levee structure there is a floodwall, with two closure structures, and the levee ends at the MIRA facility.

The Clark Dike begins at the end of the floodwall at the MIRA facility. Following the curve of the Connecticut River, it wraps around the east side of the Hartford-Brainard Airport and extends past the South Meadows Pump Station, extending past the Wethersfield Avenue closure structure on Victoria Road and ending at high ground near Deming Place.

The NFS implements a comprehensive maintenance program for the dikes, which encompasses regular inspections, vegetation management, and measures for erosion and animal control. The City's attention to levee safety is proving effective in avoiding issues with the levee embankment surfacing. However, concerns remain regarding the integrity of specific elements within the dike system, which are as follows:

4.2.3.1 North Meadows Dike

At the Bulkeley Bridge, and immediately south of the bridge, the levee was altered when the bridge was constructed. Since the core of the levee embankment did not include a sheet-pile cut-off, this was reviewed as a potential failure mode in the 2019 SQRA

4.2.3.2 Hartford Dike

The shading issue arises along the Hartford Dike, as it passes under the Charter Oak Bridge (Routes 5 and 15). Vegetation beneath the bridge is dying, making the bank less stable.

The Dutch Point floodwall was constructed at a low point on the crest of the dike embankment system. The July 2024 USACE inspection noted relative movement in the floodwall monoliths and also noted the sponsor's intention to monitor the condition going forward. This floodwall has a jagged shape in plan-view (C shaped; alternatively E shaped). The wall geometry adds significant length to any likely seepage/leakage path, and so the PDT noted a diminished concern for this as a failure risk.

4.2.3.3 Clark Dike

The closure structure at Wethersfield Avenue near the South Meadows Pump Station can be closed during exceptional storms to prevent flooding. Currently the method of closing the structure is placing thousands of sandbagging within the dike system opening. The NFS is concerned that the level of effort required to place the sandbags might be beyond the resources of the Hartford DPW.

The NFS expressed concerns related to utility penetrations through the Clark Dike. Concerns included damage or breaks in large diameter penetrations through the body of the embankment that could potentially result in significant damage to Clark Dike. A large sewer outlet at Clark Dike consists of two 84" x 78" rectangular reinforced concrete conduits that are located to the west of the South Meadows pump station outlets. The seepage path would most likely have to exit at the pump station pond giving a seepage path length of more than 400 feet. There have been no signs of performance issues at this location. Due to the long seepage-path to the landside exit, the 2018 SQRA team determined that this penetration at the Clark Dike was not a risk driver.

Concerns about the levee embankment at the MIRA facility have been discussed in **Section 4.2.2**.

4.2.4 Park River Conduit Sluice Gates

The Park River Conduit was constructed in the 1940s to 1980s, diverting the Park River under the city from the Hartford West End neighborhood to the Connecticut River. The conduit connects to the city storm water system at 28 locations. During normal operation, the Park River Conduit is not pressurized, but during flood events water could back up into the stormwater system. Therefore, 28 sluice gates were installed at the connections between the stormwater system and the conduit. Fifteen gates are maintained by the city of Hartford and were considered during this feasibility study, while the remaining thirteen of these sluice gates are operated by the MDC and are not within the purview of this feasibility study. **Figure 52** shows the locations of the sluice gates in the Park River System. Gates highlighted in blue are managed by the city of Hartford.

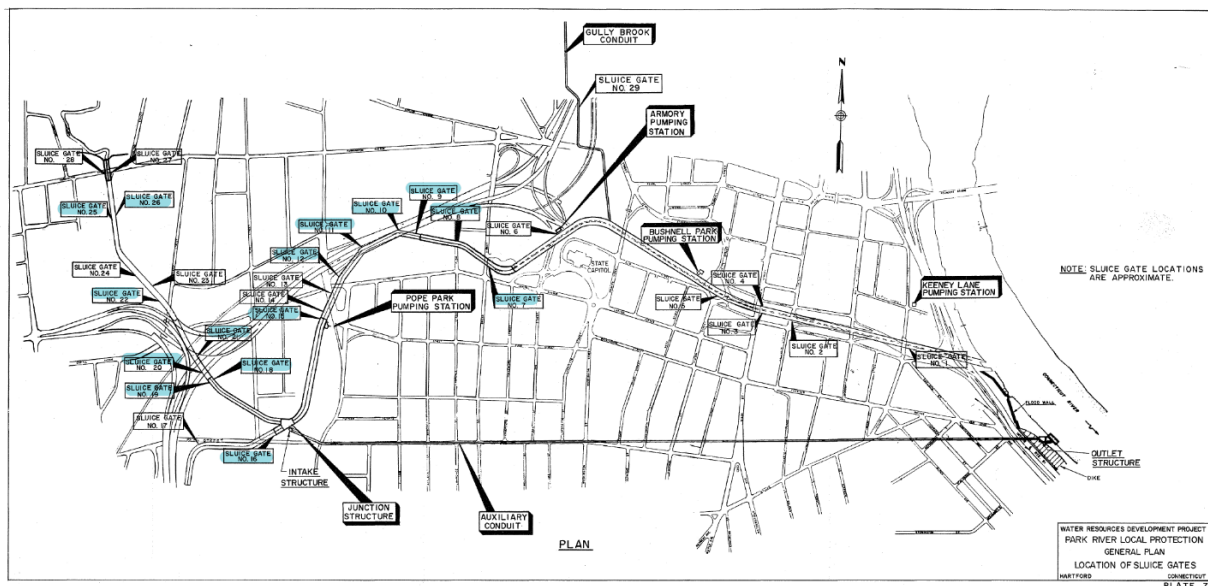


Figure 52: Location of Sluice Gates in the Park River System

Because they are original to the systems, the NFS is concerned about the condition of the sluice gates. As FRM systems age, sluice gates can become a significant point of potential failure. Because these gates were installed decades ago, they often suffer from corrosion and mechanical wear that may not be visible from the surface. Over time, rust can eat away at the gate or the frame it slides into, preventing it from forming a tight, waterproof seal. In other cases, the manual or electric mechanisms used to move these heavy gates can seize up due to lack of use or metal fatigue. If a sluice gate fails to close completely during a storm, river water can backflow through the drainage pipes and flood the very streets and neighborhoods the FRM system was designed to protect. Conversely, if a gate becomes stuck shut, internal rainwater cannot be pumped out, leading to "interior flooding" behind the levee system. Additionally, older gates may lack modern remote-control sensors, requiring crews to manually operate them during dangerous flood conditions. Other potential issues with these types of sluice gates include seized or striped operating nuts, stem support failure, axial failure of the gate stem due to insufficient stem support distance, coating failure and section loss due to corrosion.

4.3 COMPONENTS OF CONCERN IN THE EAST HARTFORD FLOOD RISK MANAGEMENT SYSTEMS

4.3.1 The East Hartford Interior Channel

The East Hartford FRM system physically separates the town from the Connecticut River, requiring a specialized drainage network to manage rainwater that collects behind the embankment. To prevent flooding, runoff is channeled through a central interior channel (**Figure 53**) that runs three miles from north to south.

Under normal "sunny day" conditions, this water flows parallel to the Connecticut River and gathers in Meadow Hill Pond. From there, it drains naturally via gravity into the Hockanum River just before the Hockanum's confluence with Connecticut River. During heavy rain or storm events, the system must work harder to push water out against rising river levels. When gravity is no longer enough to drain the area, high-capacity pump stations are activated to force water from the central channel into the Hockanum River. In extreme weather conditions, the Cherry Hill and Pitkin Pump Stations provide additional support, pumping storm flows out of the local drainage system to ensure the town remains dry behind the levee.

The NFS has raised concerns that the interior channel possesses inadequate hydraulic capacity for the anticipated drainage volume. This deficiency stems from a lack of maintenance, resulting in the channel being clogged with sediment, overgrown with vegetation, and blocked by other debris. These obstructions have substantially diminished the channel's capacity to transport runoff effectively.

The interior channel flows through property owned by several different entities, including the Town of East Hartford and the Department of Transportation.



Figure 53: The Interior Drainage Channel in East Hartford

4.3.2 East Hartford Pump Stations

The East Hartford FRM system consists of three pump stations: the Meadow Hill, Pitkin Street and Cherry Street pump stations (**Figure 54**). The Cherry Street and Pitkin Street Stations typically pump water from the northern parts of the town, and from overflows from the central Interior Channel, in addition to surface flows and street drainage, while Meadow Hill Pump Station routinely passes/pumps water from the Interior Channel and from urban street runoff to the Hockanum River. In extreme high-water events in Hockanum River, overbank flows from the Hockanum River, upstream of Elm Street, are channeled through urban drainage to the pump station. In larger storm events, inundation from these sources cannot be differentiated as any buildup of water at one pump station adds to the loading at its neighbors.

Concerns related to the pump stations in East Hartford are similar to those described for the Hartford FRM system. These concerns include reliability of the aging equipment, increased difficulty and expense of proper maintenance and DPW staff safety.

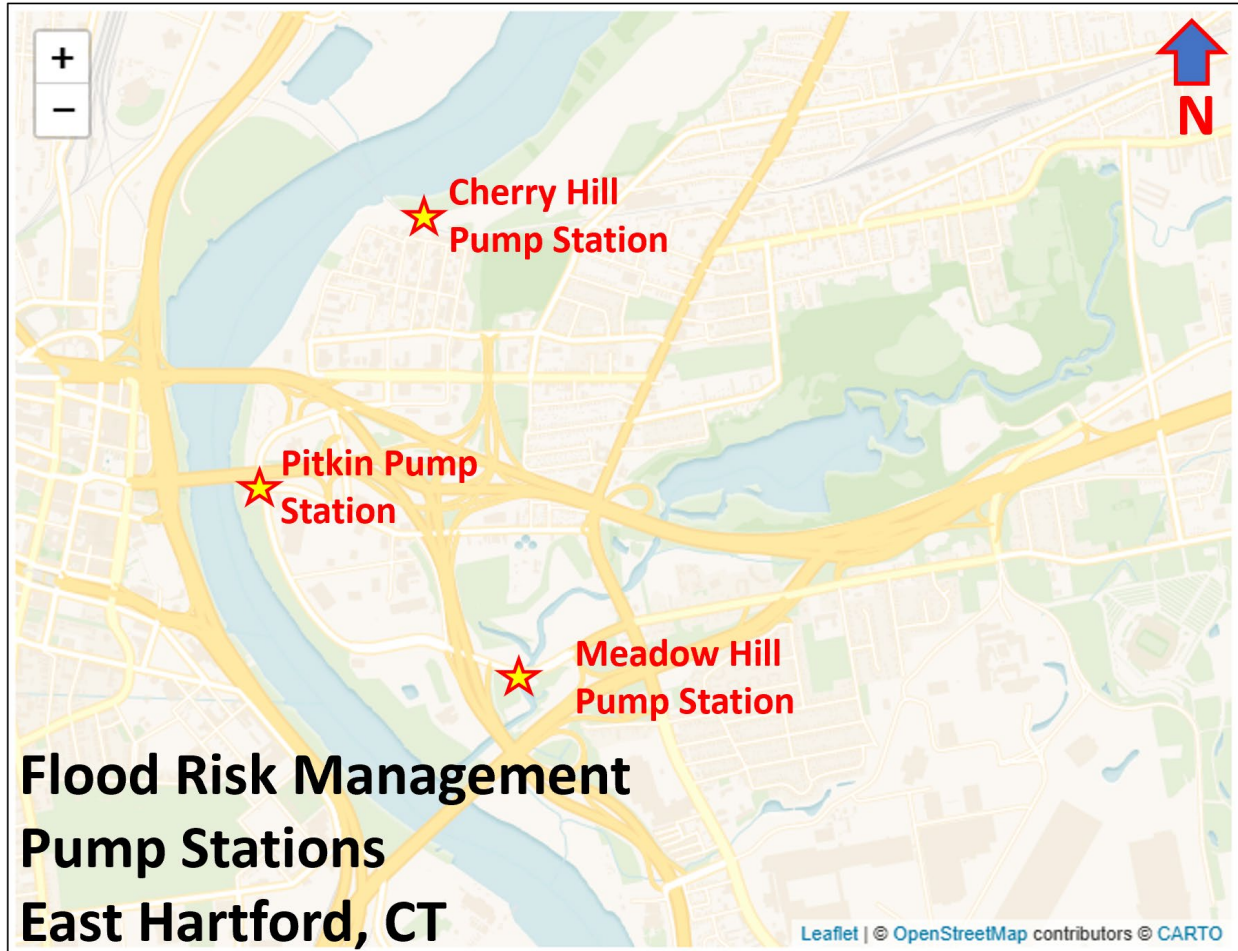


Figure 37: Locations of East Hartford Flood Risk Management Pump Stations

4.3.2.1 Meadow Hill Pump Station

The Meadow Hill Pump Station was put into service in 1941 as a part of the local flood protection works for the town of East Hartford (**Figure 55**). It serves a drainage area of 980 acres of residential, commercial, industrial, and public property in East Hartford and has a total pump station capacity of around 208 cfs excluding the volute pump, which has a relatively low flow rate. The storage pond for the pump station was designed to have a capacity of 40 acre-feet and has a surface area of about 7 acres. The pumping equipment consists of four diesel engine-driven 30-inch vertical flow propeller style pumps, and one electrically driven 20-inch volute pump. Pumps are connected to their driving pumps by way of gear reducers. The engines are cooled using a municipal water supply. Flows out of the pumps are controlled by manually operated gate valves. Flow into the 20" electrically driven pump is controlled by manually operated gate valves.



Figure 38: The Meadow Hill Pump Station

There are three sluice gates that control flow at the pump station. The River Gate controls the flow of water from the storage pond to the outlet conduit. The Cellar Gate controls the flow from the storage pond to the wet sump or cellar. The Emergency River Gate is located at the end of the gravity conduit and would prevent the river from backing up into the protected area in the event of pump station failure. Under normal conditions, water is allowed to flow naturally by gravity through the outlet conduit. At this pump station, water is pumped from the wet well into the outlet conduit by the four 30" diesel engine driven vertical axial pumps or can be pumped from the holding pond into the outlet conduit by the 20" electrically driven volute pumps for low flows. **Figure 56** shows the wet well and the volute pumps at Meadow Hill.

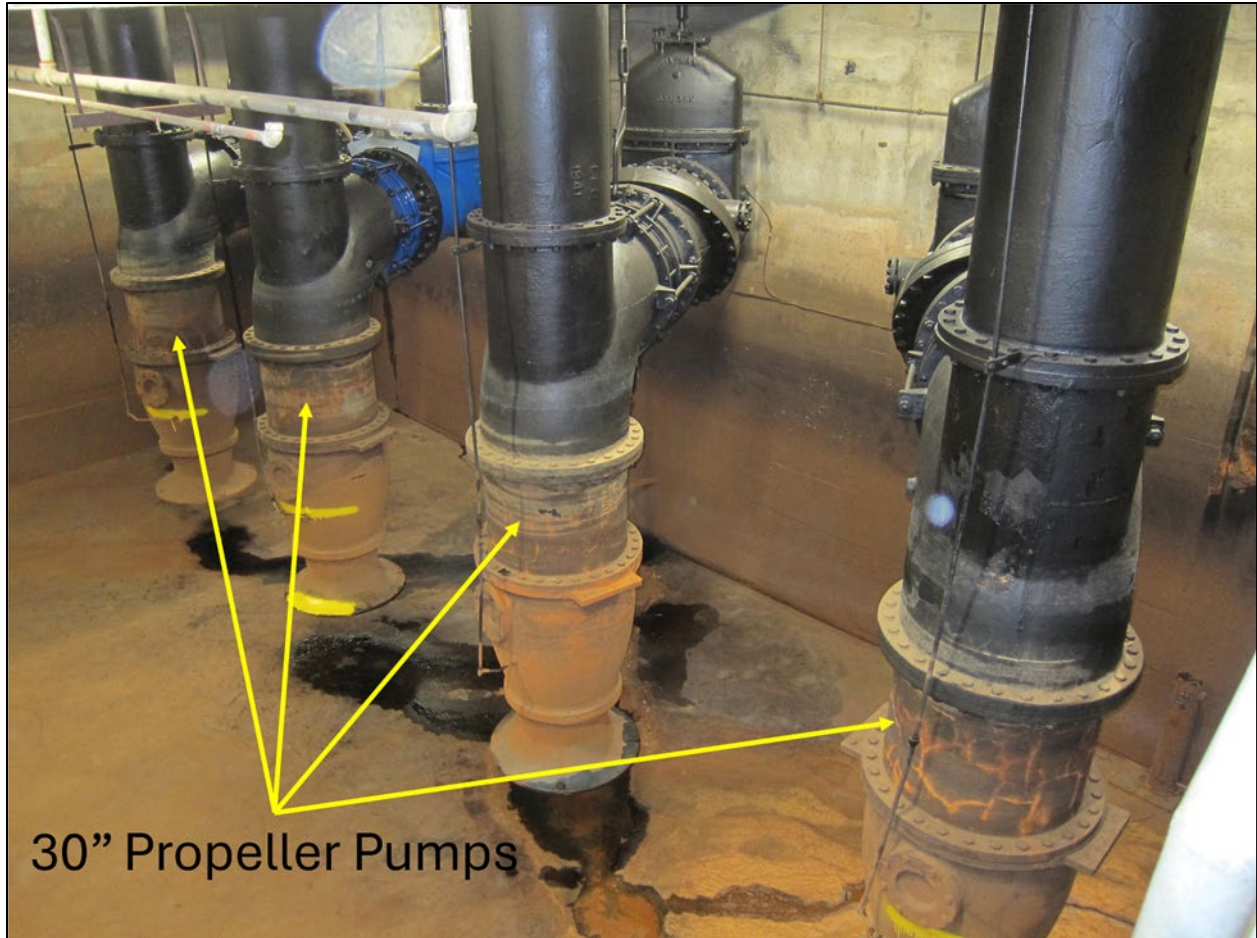


Figure 56: The Wet Well and 30" Volute Pumps at Meadow Hill Pump Station

Most of the key equipment at this pump station is original to the pump station and has not seen more than operational maintenance. This is true for every pump, gear box, gate valve, and its actuator. The age of all of this equipment is 85 years old as of 2026. The diesel motors at this project were replaced in 1978, so while they were replaced it was almost 50 years ago. The only operating components that have experienced replacements at this project within the last 20 years are the River Gate actuator (replaced in 2009), the Cellar Gate actuator (replaced in 2019), and the Cellar Gate itself (replaced in 2009). The Emergency River Gate had a gear box refurbishment in 2017 but was not fully replaced.

4.3.2.2 Pitkin Street and Cherry Street Pump Stations

Both the Cherry Street (**Figure 57**) and Pitkin Street (**Figure 58**) pump stations were put into service in 1941 and have two diesel engine driven pumps; Pitkin has 20", and Cherry Street has 16" pumps. They are very similar in design to one another, and each have gate valves which control the flow to and from each pump. Each of these pump stations have a flap gate on the end of the outlet conduit which prevents backflow from the channel. They also each have one sluice gate which controls flows for the intake side of the pump station which is closed under normal conditions. They also each have two gate valves,

one of which is open under normal conditions for gravity flow and will be closed under pump conditions. The second will be open under gravity and pumped flows but can be closed in an emergency or for maintenance purposes. Pitkin has an estimated design pumping capacity of 60 cfs, and Cherry Street has an estimated design capacity of 38 fs. Apart from the diesel motors which were replaced in 1989, absolutely no critical pumping components have been replaced since their installation at either of these pump stations.



Figure 57: The Cherry Street Pump Station.



Figure 58: The Pitkin Street Pump Station

4.3.3 East Hartford Levee

There are six main sections of levee embankment in East Hartford, along the eastern bank of the Connecticut River from north to south and turning east to follow the right bank of the Hockanum River, which is a tributary of the Connecticut River. The sections are labeled Segment 1 through Segment 6.

- Segment 1 is approximately 1.1 miles long. It runs from the intersection of Greene Terrace and Rose Street, following the Connecticut River south as far as the Amtrak rail closure structure.
- Segment 2 (approx. 0.5-mile in total length) extends from the rail closure structure south, past the Cherry Street Pump Station and ending at high natural ground at the Bulkeley Bridge (Route I-84) over the Connecticut River. Around 500 feet south of the pump station, there is a section of the levee embankment that includes a crib wall (**Figure 59**). This section of levee was built around a private residence. That structure has been demolished, so the crib wall is no longer needed. Due to the poor condition of the crib wall, the town of East Hartford is concerned about the impact of the crib wall on the stability of the levee embankment.



Figure 59: The Crib Wall in Segment 2 of the East Hartford Levee System

Segment 3 (approx. 0.6 mile) continues along the Connecticut River, from the Bulkeley Bridge south, passing under Founders Bridge, where Route 2 (the VFW Memorial Highway) passes over the Connecticut River, and continues to Hartland Street. The Pitkin Pump Station is located along this route, immediately south/downstream of the Route 2 crossing. This segment also includes a floodwall, which protects the Riverpoint Condominium Tower. **Figure 60** is a panoramic view that shows the floodwall from the riverside. Route 2 can be seen on the left side of the image and is upstream of the floodwall, while the Connecticut River on the right of the image, facing downstream and **Figure 61** illustrates the floodwall from the condominium side of the wall, facing upstream.



Figure 60: Riverpoint Condominium Complex Rising Above the Floodwall



Figure 61: A Landside View of the Floodwall at the Riverpoint Condominium Tower

Segment 4 (approx. 0.4 mile) is elbow-shaped (**Figure 62**). The levee follows the Connecticut River south for about 1,000 feet, and then turns east to follow the left bank of the Hockanum River for approximately 1,300 feet. The end of the segment is co-located with the Meadow Hill Pump Station, which is located at the downstream end of the East Hartford Interior Channel, ending in the intake pond for the pump station.



Figure 62: The Condition of the Levee Adjacent to Connecticut Natural Gas Corporation

- Segment 5 (approx. 0.5 mile) begins at the Meadow Hill Pump Station. Although the segment is a continuous levee, there are additional floodwalls notably around a wastewater treatment plant and at the easternmost end (the MDC Floodwall), leading to the Main Street closure structure.
- Segment 6 (approx. 0.6 mile) continues the eastward line from the Main Street closure structure. The gentle arc of the segment ends at high natural ground at Brewer Lane.

Although the levee embankments are well maintained, with a healthy grass cover, animal burrows removal and embankments kept clear of woody vegetation (like trees or large shrubs), the NFS specifically identified concerns related to the levee embankments of the East Hartford FRM system, including the toe drains and seepage concerns.

The toe drains in the East Hartford FRM system, originally built in the late 1930s, no longer meet modern engineering standards. Although acceptable at the time of their construction, they now present several challenges. The drains were built without

manholes, which are essential for allowing DPW employees to inspect for failures and perform routine maintenance. Additionally, the pipes used in the system are beyond their intended design life, increasing the risk of failure.

The second concern related to the levee embankment is the potential for seepage areas. Three locations along the East Hartford system have been identified. These include:

- Segment 1 north of the railroad closure
- Segment 2 at the crib wall
- Segment 5/6 at the Main Street closure structure (**Figure 39**Error! Reference source not found.)



Figure 39: Site Potential Seepage at the Steps of the Main Street Closure

5.0 PLAN FORMULATION

Plan formulation is an iterative process resulting in the development, evaluation, and comparison of alternative plans to address the identified study problems. To facilitate the plan formulation process, the methodology outlined in the USACE Engineer Regulation 1105-2-103 “*Planning Policy for Conducting Civil Works Planning Studies*”. The steps in this methodology are summarized below:

Step 1 - Identifying problems and opportunities

Step 2 - Inventorying and forecasting conditions

Step 3 - Formulating alternative plans

Step 4 - Evaluating alternative plans

Step 5 - Comparing alternative plans

Step 6 - Recommendation of a plan

5.1 PROBLEMS AND OPPORTUNITIES

Step 1 in the plan formulation process, outlined above, is to identify the study problems, opportunities, objectives, and constraints that relate to the primary project purpose. The problems, objectives and constraints identified in this section are applicable to both the Hartford and East Hartford systems unless explicitly stated.

5.1.1 Study Problems

The Hartford and East Hartford FRM systems are approximately 80 years old and are facing a growing risk of catastrophic failure. Key components of these USACE-built systems (**Table 26** and **Table 27**) have reached the end of their service life, a problem stemming from system-wide aging infrastructure rather than a lack of maintenance. The city of Hartford and town of East Hartford have partnered with the New England District under the Section 216 Authority to analyze the systems with the goal of addressing end of service life issues that exceed the capability of the local sponsors.

A failure of either FRM system would have devastating consequences for the Connecticut Capitol region. The two primary flooding mechanisms are:

1. **Levee Breach:** A levee breach can unleash a catastrophic and violent form of flooding, fundamentally different from the slow rise of a river overflowing its banks. When a levee fails, it releases a sudden, high-velocity torrent of water that surges into the low-lying protected area behind it. This initial wave carries immense destructive power, capable of leveling structures, scouring the landscape, and turning debris into projectiles. As the water pours through the gap, it rapidly inundates the entire basin the levee was designed to protect, leading to deep and widespread flooding in areas far from the actual breach. Because the floodwater is often trapped in this "bowl" with no natural drainage path back to the river, it remains for extended periods, complicating rescue efforts and causing prolonged damage to property and infrastructure long after the river's peak has passed.
2. **Interior Drainage Flooding:** Malfunctioning pump stations and sluice gates would result in interior drainage flooding, which occurs when the system designed to remove rainwater and snow melt from behind a levee fails, leading to a "bathtub effect" where the protected area floods from within. During a major storm, while levees hold back the swollen river, they also trap the immense volume of rainwater falling inside the protected zone. This trapped water is collected and mechanically lifted over the levees by a series of critical pump stations. Should these pumps fail due to a power outage, mechanical breakdown, or simply being overwhelmed by the

intensity of the rainfall, the rainwater has no escape route. It rapidly accumulates, causing severe and widespread flooding that can inundate homes, businesses, and infrastructure, even if the river levees themselves remain fully intact.

Such an event would endanger over 41,000 people and could inflict more than \$2 billion in property damage according to the USACE National Structure Inventory, not including the potential for crippling damage to nationally and regionally significant infrastructure.

During the initial phase of this study, increasing the capacity of the pump stations was considered. However, further analysis determined that no additional capacity is required in either the Hartford or East Hartford systems.

Problems

- Risk to property related to flooding events in the city of Hartford and town of East Hartford over the 50-year period of analysis due to inadequate, out of date, or end of service life features of the FRM systems and /or interior drainage components.
- Risk to public health, safety, and critical infrastructure related to flooding events in areas of the city of Hartford and town of East Hartford defended by the FRM systems over the 50-year period of analysis.

5.1.2 Study Opportunities

Opportunities are the desirable future outcomes which address the water resource problems and improve conditions in the study area.

The FRM systems included in this study have been highly effective in protecting residents and resources of the capitol region. **Table 28** illustrates the proven economic value of each FRM System as reported by the USACE National Structure Inventory. The New England District Project Benefits Report Tool estimates that between January 01, 2006, through January 01, 2026, the FRM systems provided Hartford \$466,556,000 in benefits and East Hartford \$225,311,000. This equates to \$32,000,000 and \$15,000,000 average annualized benefits respectively.

Table 28: Resources Defended by the Flood Risk Management Systems

System	Structures Inundated	Daytime Population	Estimated Property Value
Hartford	820	30,700	\$1.0 Billion
East Hartford	760	10,600	\$1.0 Billion

*Source: USACE National Structure Inventory 2023

This study, initiated under the Section 216 Authority, provides a crucial opportunity to analyze the vulnerabilities of the current systems and to develop a plan for a modernized

and reliable flood protection system. A robust FRM system is not only essential for public safety but also for the financial well-being of residents, businesses and communities who depend on the FRM systems.

Opportunities

1. Reduce risk of damages due to breach and non-breach flooding and life safety risks through long-term, effective, and environmentally sustainable solutions.
2. Address non-breach and incremental risk through permanent flood risk management measures.
3. Support community resiliency by reducing the risks of breach and non-breach flooding.
4. Contribute to the overall safety of the FRM systems.

5.2 PLANNING GOALS, OBJECTIVES AND CONSTRAINTS

5.2.1 Planning Goals

The core goal of the study is to find feasible ways to improve the aging FRM systems to reduce risks to life and safety, minimize property damage, and increase the overall resiliency of the communities they protect, with the NFS assuming full responsibility for future operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project. Study objectives were developed to support this goal and inform measure screening and alternative development and evaluation.

5.2.2 Planning Objectives

Planning objectives are the desired results of the planning process that will solve the identified problems and typically result in the desired changes between the without- and with- project conditions. Planning objectives serve to eliminate from consideration, alternatives and considerations that will not solve the identified problem.

The first objective centers on life safety and addresses the requirements outlined in Planning Bulletin 2019-04, *Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies* (2019) to address the four Tolerable Risk Guidelines (TRG)s.

TRG 1 – Understanding the Risk. The first tolerable risk guideline involves considering whether society is willing to live with the risk associated with the FRM system to secure the benefits of living and working in the leveed area. In other words, answering the basic question – are the risks commensurate with the benefits?

TRG 2 – Building Risk Awareness. The second tolerable risk guideline involves determining that there is a continuation of recognition and communication of the levee risk, because the risk associated with FRM systems are not broadly acceptable and cannot be ignored.

TRG 3 – Fulfilling Daily Responsibilities. The third tolerable risk guideline involves determining that the risks associated with the FRM system are being properly monitored and managed by those responsible for managing the risk.

TRG 4 – Actions to Reduce Risk. The fourth guideline is determining if there are cost effective, socially acceptable, or environmentally acceptable ways to reduce risks from an individual or societal risk perspective.

The second objective supports the intent of the August 2005 Reconstruction Guidance in returning features in the system to a level of operation resulting in the system's ability to perform its authorized project functions.

Planning Objectives

1. Reduce current risks to life, health, property and safety of residents in the study area for the 50-year period of analysis.
2. Address major performance deficiencies caused by degradation or exceedance of service life to restore the study area to authorized level of flood risk management through the 50-year period of analysis.

5.2.3 Planning Constraints

Planning constraints are any policy, technical, economic, local, regional, social, and institutional factors that act to restrict the planning process. The constraints identified for this study include:

- Should not address a design or construction deficiency as specified in the August 16, 2005, Memorandum for Commanders
- Should not address non-federal O&M responsibilities as specified in the August 16, 2005, Memorandum for Commanders
- Must comply with constraints of the Section 216 authority, found in the Flood Control Act of 1970

There are environmental considerations that also must be incorporated into the planning process. For this study, the environmental constraints are:

- Should avoid and minimize environmental impacts within the project area to the maximum degree practicable
- Should not adversely impact threatened or endangered species, and their habitat within the study area
- Should avoid or minimize negative impacts to wetlands and Essential Fish Habitat
- Should avoid or minimize impacts that negatively affect authorized navigation projects downstream of the project area
- Should avoid or minimize impacts that contribute to poor water quality in the Connecticut River

- Should avoid or minimize effects on cultural resources and historic structures, sites, and features within the project area

Study considerations were also identified by the PDT. These are items to be considered in the plan formulation process and include:

- Consider local responsibilities for the Levee Safety Program and SWIF plan.
- Avoid sites with HTRW contamination.
- Consider the complicated real estate environment
- Consideration of economically under-served communities
- Minimize impacts to community cohesion

5.3 MANAGEMENT MEASURES DEVELOPMENT*

The third step in the planning process is to formulate management measures to achieve planning objectives and avoid planning constraints. Measures are features or activities that can be implemented at a specific geographic location to address all or a portion of the identified planning objectives.

A comprehensive list of measures was developed by the PDT after scoping meetings with the NFSs and site visits to both Hartford and East Hartford FRM systems. These measures include solutions to the concerns described by the NFSs that were discussed in the previous section and additional measures that would address comprehensive flood control in the Greater Hartford Area. The following measures have been frequently used in past restoration projects within the USACE. **Table 29** lists the measures considered for the Hartford FRM System, while **Table 30** provides a complete list of measures considered for the East Hartford FRM System.

Table 29: Measures Considered for the Hartford Flood Risk Management System

CONCERN	MEASURE
UPSTREAM MODIFICATION	
Control of flood waters	Upstream FRM Structures
FLOODWALL CONCERNS	
Dutch Point Floodwall Joint Displacement	Compaction grouting, helical piles or anchoring to stabilize the floodwall monoliths plus joint waterproofing.
	Mini piles on both sides of the monoliths with joint waterproofing
	Mini piles on the landside of the monoliths with joint waterproofing
Closure Structure #6 Floodwall Joint Displacement	Repair and realign the monoliths
	Monitoring
Abandoned Equipment on and over the Floodwalls at the MIRA site	Removal of Abandoned Equipment
BANK FAILURE	

CONCERN	MEASURE
De-vegetation of Embankment under the Charter Oak Bridge	Armor Embankment
Slope of Embankment at the MIRA site is too Steep	Regrade levee embankment to a less steep slope
FLOODING	
Potential Overtopping of the Levees	Overtopping Modifications
Control Interior Drainage	Detention Basins
No Closure Structure at the Wethersfield Avenue Closure	Nonstructural Solution - Improved flood-fighting equipment, such as larger sandbags
	Stop logs
	Install a swing gate
Flooding at the North Meadows Drainage Swale/CTDOT Transit Facility	Line Channel with Concrete
	Resized the Culverts Leading into the North Meadows Storage Pond
	Altering the Shape of the Trapezoidal Channel.
	Nonstructural Solution - Floodproofing the Affected Buildings
SCOUR	
North Meadows Storage Pond Scour	Re-armor and Extend the Riprap
	Reposition pipes
	Extend the Forebay
South Meadows Storage Pond Scour	Study the Forebays
SEEPAGE	
Seepage at the I-91/I-84 Interchange	Bentonite Cutoff Wall
	Sheet Pile Cutoff Wall
	Monitoring
	Toe Drain Repair
Seepage Through the Clark Dike	Impervious Blanket
	Bentonite Cutoff Wall
	Sheet Pile Cutoff Wall
	Monitoring
PENETRATIONS	
Clark Dike - Penetrations through Levee	Impervious Blanket
MIRA Site - Penetrations through Levee	Fill Penetrations
	Impervious Blanket
ANCILLARY EQUIPMENT	
Park River Area - Sluice gates	Replace Sluice Gates
	Repair Equipment
PUMP STATIONS	
All Concerns Related to the Pump Stations	Rehabilitation Pump Stations
	Replace Pump Stations
	Increase capacity

Table 28: Measures Considered for the East Hartford Flood Risk Management System

CONCERN	MEASURE
Upstream Modification	
Control of Flood Waters	Upstream Structures
FLOODING	
Potential Overtopping of the Levees	Overtopping Modifications
Collect Precipitation and Control Interior Drainage	Construct Detention Basins
Reduced Capacity of Interior Channel	Third Party Maintenance Agreement
SEEPAGE	
Seepage at the Embankment North of Railroad Closure	Impervious Blanket
	Sheet Pile Wall
	Bentonite Wall
	No Action/Monitor
	Install Manholes and Replace Toe Drain
	Install Manholes and Don't Replace Toe drain
Seepage at the Main Street Closure Structure	Provide a Filtered Seepage Exit at Main Street Closure Structure
Seepage at Segment #2 of the levee embankment	Toe Drain Replacement at Segment #2
	Remove Crib Wall and Restore Levee Embankment
TOE DRAINS	
Obsolete Toe Drain (Segment #2)	Toe Drain Replacement
Obsolete Toe Drain (Segment #4)	Toe Drain Replacement
Obsolete Toe Drain (Segment #5)	Toe Drain Replacement
Obsolete Toe Drain (Segment #6)	Toe Drain Replacement
LEEVE EMBANKMENT MODIFICATION	
Weakened Levee Embankment Due to Crib Wall in Segment 2	Remove Crib Wall and Restore Levee Embankment
OUTLET STRUCTURES	
Elevation of the Meadow Hill Pump Station Outlet Structure	Construct a New Outlet Structure
	Pipe lining
	Monitoring
Cherry Street Pump Station Leaking Outlet Structure	Construct a new outlet structure
	Pipe lining?
	Monitoring
Pitkin Pump Station Leaking Outlet Structure	Construct a new outlet structure
	Pipe Lining

CONCERN	MEASURE
	Monitoring
PUMP STATIONS	
All Concerns Related to the Pump Stations	Rehabilitate Pump Stations
	Replace Pump Stations
	Increase capacity

All measures listed in **Table 29** and **Table 30** are structural, except for floodproofing the affected structures at the CTDOT Transit Facility and a non-structural solution at the Wethersfield Avenue Closure. 33 U.S.C. 701b-11 requires that in the survey, planning, or design by any Federal agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages. 33 U.S.C. 2289a(b)(3) states, in part, that “in studying the feasibility of projects for flood risk management... the Secretary shall, with the consent of the non-Federal sponsor of the feasibility study, consider, as appropriate — nonstructural measures.” USACE did consider nonstructural alternatives and measures. The PDT presented the advantages and challenges of considering non-structural alternatives and measures to the NFSs. The NFSs were not interested in pursuing non-structural alternatives, and thus nonstructural alternatives were not considered further and were screened out of consideration.

Natural/nature-based solutions were not appropriate for the rehabilitations of the FRM systems. No natural/nature-based alternatives were carried forward.

Study measures fall into two distinct categories: interior drainage and levee breach. The measures descriptions are organized into these two categories.

Levee Breach Measures

Overtopping Modifications (Hartford & East Hartford): This measure evaluates if the current overtopping location should be modified for both the Hartford and East Hartford FRM system.

Upstream FRM Structures (Hartford & East Hartford): This measure reduces stage frequencies in the study area. This type of measure(s) would be located on the Connecticut River, upstream of the study area.

Remove Crib Wall and Repair Levee Embankment (East Hartford): This measure removes the crib wall in Segment #2 of the levee, restoring the levee embankment to its design cross section, thereby removing a weak spot in the FRM system.

Toe Drain Replacement (East Hartford): This measure provides modern toe drains allowing staff to access the drains through access points to complete maintenance and monitor toe drain performance. This treatment was considered at Segments #2, #4, #5, and #6 and north of the Railroad Closure in Segment #1 of the East Hartford levee system.

Toe Drain Renovation (East Hartford): This measure involves installing manholes in the existing toe drain in Segment #1 of the embankment north of the railroad closures to address potential seepage.

Toe Drain Repair (Hartford): This measure involves repairing the toe drain to address potential seepage through the Clark Dike.

Sheet Pile Cutoff Wall to address Seepage (Hartford & East Hartford): This measure involves installation of a sheet pile system that provides positive seepage cutoff on riverside of levee embankment. This treatment was considered at the I-91/I-84 Interchange and Clark Dike in Hartford and at the Railroad Closure and Main Street Closure Structure in East Hartford.

Bentonite Cutoff Wall to Address Seepage (Hartford & East Hartford): This measure involves installation of a bentonite cutoff wall system that provides positive seepage cutoff on riverside of levee embankment. This treatment was considered at the I-91/I-84 Interchange and Clark Dike in Hartford and at the Railroad Closure and Main Street Closure Structure in East Hartford.

Impervious Blanket to Address Seepage (Hartford & East Hartford): This measure involves installation of blanket made of impervious embankment material that reduces likelihood of seepage through the embankment or foundation soils. This treatment was considered at the Clark Dike in Hartford and at the Railroad Closure Structure in East Hartford.

Continued Monitoring of Area of Concern (Hartford): This measure involves continuing monitoring of the area of concern for signs of seepage such as water at the toe, increased vegetation, rust-colored iron bacteria, or boils. Monitoring was considered in Hartford at the I-91/I-84 Interchange and Clark Dike where there are concerns about potential seepage and the Closure Structure #6 Floodwall at the joint displacement. In East Hartford, monitoring was considered at the Railroad Closure and at the outlet structures of the Meadow Hill, Cherry Street, and Pitkin Pump Stations.

Compaction Grouting or Helical Piles (Hartford): This measure includes the use of compaction grouting or installation of helical piles to stop further settlement of the floodwall monoliths and replacing the waterstop between the floodwall monoliths.

Mini Piles on Both Sides of the Dutch Point Floodwall (Hartford): This measure involves installation of mini piles on both sides of the floodwall to stop further settlement of the floodwall monoliths and replacing the waterstop between the floodwall monoliths.

Mini Piles on the Landside of the Dutch Point Floodwall (Hartford): This measure involves installation of mini piles on one side of the floodwall to stop further settlement of the floodwall monoliths and replacing the waterstop between the floodwall monoliths.

Repair of Monoliths at the Closure Structure #6 Floodwall Displacement (Hartford): This

measure involves repairing and realigning the monoliths of closure structure #6 that have settled and rotated.

Filling Levee Embankment Penetrations (Hartford): This measure consists of filling abandon penetrations through the levee embankment. This measure was considered at the MIRA site.

Bank Armoring under the Charter Oak Bridge (Hartford): This measure involves armoring the levee embankment under the Charter Oak Bridge. The bridge overshadows the embankment, causing the vegetation to die, which weakens the embankment.

Removal of Abandoned Equipment at MIRA Site (Hartford): This measure includes removal of abandoned equipment at the MIRA Site that is impeding function of the floodwall.

Regrade Embankment Slope at the MIRA Site (Hartford): The levee embankment slope at the MIRA site would be regraded to a less steep slope. This measure would increase the resiliency of the levee embankment.

Installation of Stop Log Structure at Wethersfield Avenue (Hartford): This measure involves installation of a Stop Log style closure structure at Wethersfield Avenue. The closure structure could be closed at times of flooding, protecting the properties behind the levee from flooding. Stop logs would be stored when not in flood conditions.

Installation of a Swing Gate at Wethersfield Avenue (Hartford): This measure involves installation of a swing gate at Wethersfield Avenue. The swing gate could be closed at times of flooding, protecting the properties behind the levee from flooding.

Non-structural Solution at Wethersfield Avenue (Hartford): This measure provides better flood-fighting strategies and equipment to protect properties from flood damage.

Interior Drainage Measures

Detention Basins (Hartford & East Hartford): This measure reduces interior drainage at specified locations.

Pump Station Rehabilitation (Hartford & East Hartford): This measure addresses pump station buildings, discharge lines and gates, as well as electrical components including switch gear, motors and pumps. This measure assumes that pump station components can be removed, inspected and brought back to the level of performance equal to their original installation. For components that cannot be repaired because of their deteriorated condition or lack of available replacement parts, parts need to be manufactured. The measure also applies to pump station components that have exceeded their expected service life. This treatment was considered at all of the pump stations in the Hartford and East Hartford FRM systems.

Pump Station Full Replacement (Hartford & East Hartford): This measure includes

construction of new pump stations at existing pump station locations, and/or constructing new pump stations at other locations. This measure was considered at all of the pump stations in the Hartford and East Hartford FRM systems.

Capacity Increase of Pump Stations (Hartford & East Hartford): This measure increases the name plate pump capacity at a station. Increasing the capacity of the pump stations to handle stormwater is possible through rehabilitating existing pump stations, constructing new pump stations at existing pump station locations, and/or constructing new pump stations. This measure was considered at all of the pump stations in the Hartford and East Hartford FRM systems.

Re-armor North Meadows Storage Pond (Hartford): This measure involves repairing the scoured riprap lined forebays to their design configuration at North Meadows and South Meadows Pump Station storage ponds. Repairing these forebays would restore the intended design functionality of the storage ponds, but would not influence the performance of the FRM system in any way.

Reposition Pipes Leading to the North Meadows Storage Pond (Hartford): This measure includes an assessment of the stormwater outlet pipes layout within the North Meadows storage pond.

Extend Forebays of the North Meadows Storage Pond (Hartford): This measure includes extending the size of the existing forebays at the stormwater outlet pipes within the North Meadows Pond to decrease the scour that has been observed within the storage pond.

Construct new Outlet Structure (East Hartford): This measure involves constructing an outlet structure next to the existing structure and connecting to the new outfall to the pump station. This treatment was considered for both the Cherry Street and Pitkin Pump Station Outlet Structure.

Pipe Lining of the Outlet Structure (East Hartford): This measure involves lining the existing outlet pipes with a steel liner to resolve any leakage issues. Pipe Lining was considered for both the Cherry Street and Pitkin Pump Station Outlet Structure.

Increase the Elevation of the Meadow Hill Pump Station Outlet Structure (East Hartford): This measure consists of reconstructing the entire outlet conduit of the Meadow Hill Pump Station with a higher invert elevation to decrease the frequency when the river gate needs to be closed due to high tailwater conditions caused by the Connecticut River.

Resize the Drainage Swale at the CTDOT Transit Facility (Hartford): This measure increases the size and capacity of the drainage swale leading to the North Meadows storage pond in order to reduce flooding at the CTDOT Transit Facility. The channel would be altered to have same top width, instead of a trapezoidal shape channel.

Alter the channel at the CTDOT transit Facility (Hartford): This measure includes altering the channel behind the CTDOT Transit Facility from grass to concrete-lined to reduce

flooding.

Floodproofing the Affected Buildings at the CTDOT Transit Facility (Hartford): This non-structural measure involves floodproofing the buildings affected by flooding.

Resized the culverts leading into the North Meadows Storage Pond (Hartford): This measure increases the size and capacity of the drainage swale culverts immediately upstream of the North Meadows Storage Pond to reduce flooding at the CTDOT Transit Facility.

Replace Malfunctioning Sluice Gates (Hartford): This measure involves the replacement of old and malfunctioning sluice gates on the Park River System. Gates are now stuck either in the open or closed positions and cannot be moved as needed. A typical system consists of an operator, gate stem, stem guides, stem supports, a gate frame, and the sluice gate.

Repair Sluice Gate Equipment (Hartford): This measure involves repairing deficient components within the sluice gate system. A typical system consists of an operator, gate stem, stem guides, stem supports, a gate frame, and the sluice gate. As part of the repair, consumables like anchors, gate seals, and fasteners are replaced. The gates, stems, and stem guides are removed, cleaned, and thoroughly inspected. Any deficient components found are then repaired or replaced, depending on the repair's complexity and the availability of parts.

Third Party Maintenance Agreement for the Interior Channel (East Hartford): This measure ensures maintenance of the interior channel that runs through the study area. Allowing the Interior Channel to become filled with debris, vegetation and trash reduces the capacity and flow through the conduit.

Figure 40 shows the locations of the measures considered for the Hartford FRM system, while **Figure 41** shows the locations of measures at the East Hartford FRM system.

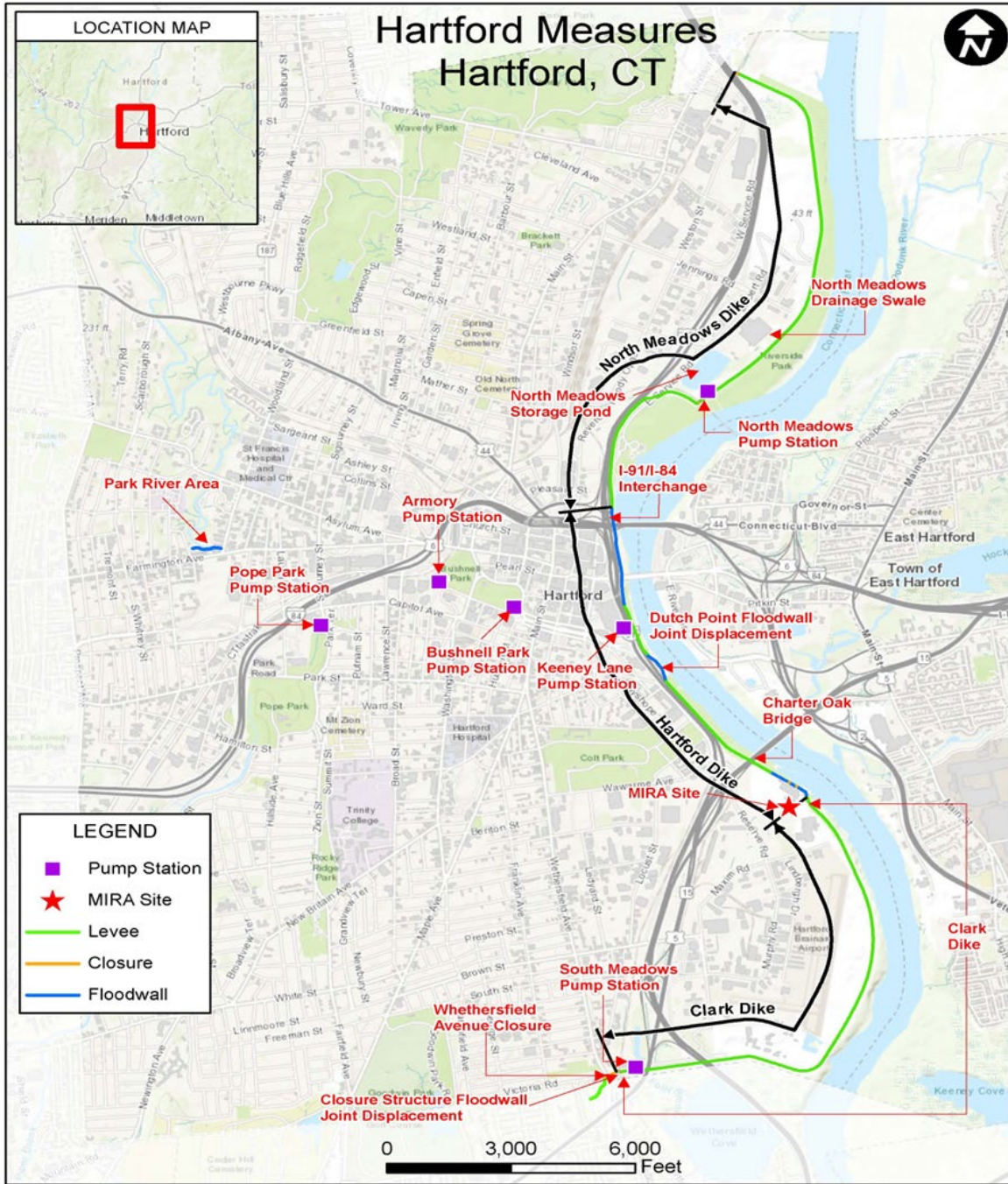


Figure 40: Location of Measures Developed for the Hartford Flood Risk Management System

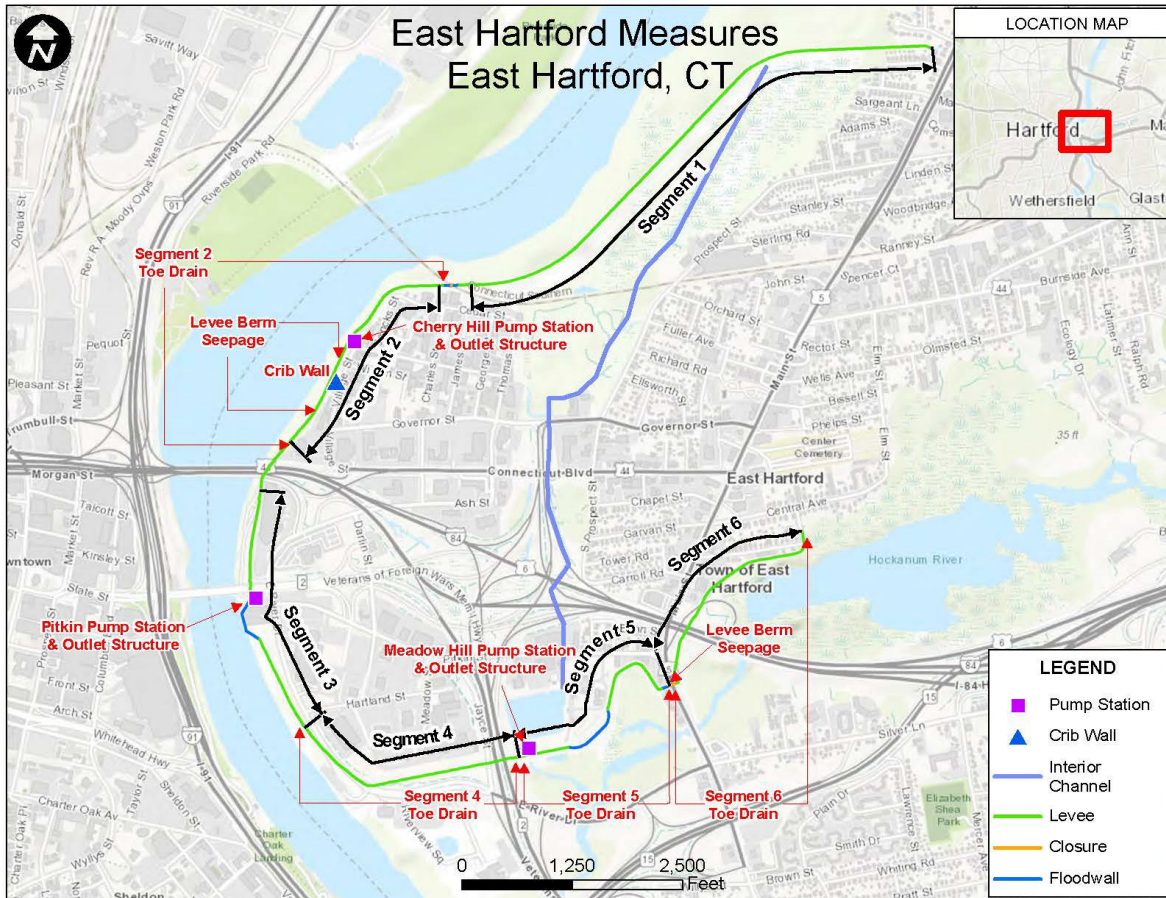


Figure 41: Location of Measures Developed for the East Hartford Flood Risk Management System

5.4 MEASURE SCREENING

The initial array of measures underwent three screenings.

5.4.1 Initial Measures Screening

The first screening sought to identify measures that met the study objectives and complied with both the Section 216 Authority and with USACE policy as outlined in the Memorandum for Commanders entitled *Reconstruction of USACE Structural Flood Damage Reduction Projects for which Non-Federal Interests are Responsible for Operations, Maintenance, Repair, Rehabilitation and Replacement, 16 August 2005*. **Table 31** includes the criteria that were used during the initial measures screening.

Table 29: Initial Screening Criteria

<i>Met the Study Objectives</i>
Addresses major performance deficiencies caused by degradation or exceedance of service life to restore the study area to authorized level of flood risk management through the 50-year period of analysis
Reduces current risks to life, health, property and safety of residents in the study area for the 50- year period of analysis
<i>Complied with the Section 216 Authority</i>
A significantly changed condition, either physically or economically has occurred since the original construction of the FRM system
<i>Complied with USACE Policy</i>
Address a design or construction deficiency
Addresses non-federal O&M responsibilities

Many measures were eliminated from consideration during the initial screening. **Table 1** of **APPENDIX 1-E: Plan Formulation** illustrates the results of the first screening.

5.4.2 Second Measures Screening Iteration

The second screening iteration sought to identify and carry forward measures that provided measurable risk reduction. The team developed hydraulic models of interior pump stations using HEC-HMS to support the economical incremental justification of the pump stations in the project area. The modeling uses a conservative approach and assumes all water within the drainage area of the individual pump stations arrives at the station without attenuation through the sewer network. The analysis utilizes design specifications for pumps currently installed with the assumption that all pumps are functioning properly.

Each pump station was modeled at 100%, 50%, and 10% total station capacity at eight interior precipitation frequency events: 2 year (0.5 AEP), 5 year (0.2 AEP), 10 year (0.1 AEP), 25 year (0.04 AEP), 50 year (0.02 AEP), 100 year (0.01 AEP), 200 year (0.005 AEP), and 500 year (0.002 AEP). A coincident frequency analysis was conducted using the resulting interior modeling ponding depths and tailwater conditions along the Connecticut River for final interior ponding depths for each pump station condition. A complete description of the modeling that was completed for this study can be found in **Section 3.0** of this report, **Appendix 2-B1:** and **Appendix 2-B2: Hydraulics & Hydrology, Interior Drainage.**

Additionally, the PDT used the Semi-Qualitative Risk Assessment for the Hartford FRM system completed in March 2019 and the Abbreviated Risk Assessment for the East Hartford system completed in 2023 to further assess risk reduction. Measures were eliminated from consideration when the risk of failure didn't support the repair or rehabilitation costs.

Measures that were removed from consideration during the second round of screening include:

Flooding at the North Meadows Drainage Swale/CTDOT transit facility (all treatments): A proposed flood mitigation measure for the North Meadows Drainage Swale was removed from consideration due to minimal risk and limited impact. An investigation found that localized flooding—caused by the prior removal of a protective berm—affects only the access road and the electric bus charging station, located behind the main CTDOT transit facility. The H&H analysis performed to assess the potential impacts of measures (constructing a concrete-lined channel, changing the channel configuration, etc.) resulted in small reductions of flood depths. Given that the charging station is already wet-flood-proofed and the area has flooded only once during a brief, intense rainstorm, the measure was eliminated from further consideration.

Seepage at the I-91/I-84 Interchange (all treatments): Although a levee breach near downtown Hartford would have significant consequences, the 2019 SQRA shows the probability is extremely low. An engineered solution was explored but found to be financially unviable due to severe site constraints, including lack of construction space and proximity to sensitive railroad and bridge infrastructure, which drove projected costs to an extremely high level. Given the low probability of levee breach at this location, the PDT decided that the expenditure was not justified. USACE recommends not including this measure in the TSP and instead suggests implementing a program of continued monitoring, with the plan to revisit future action if seepage is observed.

Pump Stations: The following pump stations were screened out based on the H&H modeling performed. H&H modeling results showed that rehabilitating or replacing the following pump stations would not significantly reduce damages from interior drainage flooding.

- *Armory Pump Station*
- *Bushnell Pump Station*
- *Keney Street Pump Station*
- *Cherry Street Pump Station*
- *Pitkin Pump Station*
- *Pope Pump Station*

5.4.3 Third Measures Screening Iteration

The remaining measures underwent a final round of screenings. During this round, the most effective engineering approach was identified for those sites with multiple possible solutions that could address the problem. The team considered constructability, value and if the approach provided a complete solution to determine that best engineering approach. Measures that were eliminated from consideration included:

- *Dutch Point Flood Wall Joint Displacement (Mini piles on both sides of the monoliths with joint waterproofing):* Although this method would correct the displacement of the joint, the slope on the riverside of the floodwall would limit site access and make it difficult to install mini piles on the riverside of the floodwall monoliths. Anchors installed through the floodwall would

encounter site access issues on the riverside and the presence of the railroad on the landside would limit the anchor lengths and their capacity. Another solution was determined to be more cost effective and constructable.

- *Dutch Point Flood Wall Joint Displacement (Mini piles on the landside of the monoliths with joint waterproofing)*: This method faced the same constructability constraints as were listed above. Another solution was determined to be more cost effective and constructable, so this measure was screened from consideration.
- *Seepage at Segment #2 of the Levee Embankment (Remove crib wall and restore levee embankment)*: This measure was screened out because replacement of the toe drain in Segment #2 of the East Hartford FRM system was determined to adequately address the seepage concerns at the site. Additionally, removal of the crib wall would not improve the resiliency of the levee embankment as it does not address the seepage issue through the foundation soils. For these reasons, this measure was removed from consideration

5.5 MEASURES CARRIED FORWARD

Eleven measures were carried forward to create an initial array of alternatives. These measures included:

- Pump Station Rehabilitation
 - North Meadows Pump Station (Hartford)
 - South Meadows Pump Station (Hartford)
 - Meadow Hill Pump Station (East Hartford)
- Pump Station Complete Replacement
 - North Meadows Pump Station (Hartford)
 - South Meadows Pump Station (Hartford)
 - Meadow Hill Pump Station (East Hartford)
- Replace Sluice Gates on the Park River System (Hartford)
- Toe Drain Replacement - Segments #4, #5 & #6 (East Hartford)
- Dutch Point Floodwall Joint Displacement Repair (Hartford)
- Filter Blanket at Main Street Closure Structure - Seepage Risk (East Hartford)
- Toe Drain Replacement – Segment #2 – Seepage Risk (East Hartford)

5.6 INITIAL ARRAY OF ALTERNATIVE PLANS AND SCREENING

The measures carried forward were used to create an initial array of alternatives. Alternatives plans included the no action alternative, alternatives that included the reconstruction of system elements which had reached the end of their service lives, an alternative that includes elements with identified risk drivers and alternatives that combined reconstruction measures and measures associated with risk drivers. The initial array of alternatives is provided below in **Table 32**.

Table 30: Initial Array of Alternatives

Initial Array of Alternatives	
Alternative 1 – No Action Alternative	
No Measures	
Alternative 2a – Reconstruction Plan with Pump Stations Rehabilitation	
<ul style="list-style-type: none"> • Pump Station Rehabilitation North Meadows Pump Station (<i>Hartford</i>) South Meadows Pump Station (<i>Hartford</i>) Meadow Hill Pump Station (<i>East Hartford</i>) • Replace Sluice Gates on the Park River System (<i>Hartford</i>) • Toe Drain Replacement - Segments #4, #5 & #6 (<i>East Hartford</i>) 	
Alternative 2b– Reconstruction Plan with Pump Stations Replacement	
Same as Alternative 2a, but includes complete replacement of the three pump stations	
Alternative 3 – Risk Driver Plan	
<ul style="list-style-type: none"> • Dutch Point Floodwall Joint Displacement Repair (<i>Hartford</i>) • Filter Blanket at Main Street Closure Structure - Seepage Risk (<i>East Hartford</i>) • Toe Drain Replacement – Segment #2 – Seepage Risk (<i>East Hartford</i>) 	
Alternative 4a – Combined Plan with Pump Station Rehabilitation	
<ul style="list-style-type: none"> • Pump Station Rehabilitation North Meadows Pump Station (<i>Hartford</i>) South Meadows Pump Station (<i>Hartford</i>) Meadow Hill Pump Station (<i>East Hartford</i>) • Replace Sluice Gates on the Park River System (<i>Hartford</i>) • Toe Drain Replacement - Segments #4, #5 & #6 (<i>East Hartford</i>) • Dutch Point Floodwall Joint Displacement Repair (<i>Hartford</i>) • Filter Blanket at Main Street Closure Structure - Seepage Risk (<i>East Hartford</i>) • Toe Drain Replacement – Segment #2 – Seepage Risk (<i>East Hartford</i>) 	
Alternative 4b – Reconstruction Plan with Pump Stations Replacement	
Same as Alternative 4a, but includes complete replacement of the three pump stations	

Screening of the initial array of alternatives included a rough order of magnitude estimate for construction costs. Alternatives 2b and 4b were removed from consideration due to:

High Implementation Cost: Additional costs of full replacement (pump stations) was not found to provide significant flood risk reduction.

Constructability Challenges: Connecting inlet and outlet channels/structures of the new pump station was prohibitively expensive.

Real Estate Complexity/Cost: The areas surrounding the existing North and South Meadows Pump Stations are extremely congested, creating significant constructability challenges for any onsite replacement. To avoid these issues, the project would need

to identify and secure additional land. This would require the city of Hartford to acquire permanent property interests (land acquisition or easements), which would significantly increase the overall project costs and extend the development timeline.

5.7 SELECTION OF THE TENTATIVELY SELECTED PLAN

5.7.1 Focused Array of Alternatives

The focused array of alternatives (**Table 33**) includes four plans, including the No Action Alternative. All alternatives are structural. No Locally Preferred Plan has been identified.

Table 31: The Focused Array of Alternatives

Focused Array of Alternatives
Alternative 1 – No Action Alternative
No Measures
Alternative 2a– Reconstruction Plan with Pump Stations Rehabs
<ul style="list-style-type: none"> • Pump Station Rehabilitation <ul style="list-style-type: none"> North Meadows Pump Station (<i>Hartford</i>) South Meadows Pump Station (<i>Hartford</i>) Meadow Hill Pump Station (<i>East Hartford</i>) • Replace Sluice Gates on the Park River System (<i>Hartford</i>) • Toe Drain Replacement - Segments #4, #5 & #6 (<i>East Hartford</i>)
Alternative 3 – Risk Driver Plan
<ul style="list-style-type: none"> • Dutch Point Floodwall Joint Displacement Repair (<i>Hartford</i>) • Filter Blanket at Main Street Closure Structure - Seepage Risk (<i>East Hartford</i>) • Toe Drain Replacement – Segment #2 – Seepage Risk (<i>East Hartford</i>)
Alternative 4a – Combined Plan
Alternative 2a + Alternative 3

5.7.2 Comprehensive Benefits Analysis

The 1983 “*Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies*” (P&G) established four accounts for comparison of the alternatives. These are the national economic development (NED), regional economic development (RED), other social effects (OSE), and environmental quality/impacts (EQ) accounts. These four accounts encompass all potential significant beneficial effects of a plan on the human environment as required by NEPA (42 U.S.C. 4321 et seq.) and social well-being as required by Section 122 of the Flood Control Act of 1970 (Public Law 91-611, 84 Stat. 1823). The January 5, 2021, “*Memorandum for Commanding General, U.S. Army Corps Of Engineers, Policy Directive – Comprehensive Documentation of Benefits in Decision Documents*” supplements the guidance provided in ER 1105-2-103 (formally known as the Planning Guidance Notebook) by requiring comprehensive consideration of total project benefits including economics, environmental, and social categories. Study teams must identify and analyze benefits in total and equally across a full array of benefit categories. The level of the analysis will vary based on the magnitude of the change, its

relevance to decision-making, and the availability of data, tools, and procedures to quantify or monetize the benefit or impact.

5.7.2.1 National Economic Development Account

NED benefits of a USACE project are the increases in net value to the national output of goods and services as the result of a plan, such as by reducing flooding damage to communities, improving navigation, or expanding recreation opportunities. These benefits are measured in monetary terms and include both direct and indirect effects — for example, reduction in flood damages to existing property, land intensification (increased economic output as a result of the proposed plan), or location changes that move assets out of the floodplain. Types of flood damage includes physical damages, income loss such as wages or lost profits, and emergency expenses resulting from flood cleanup and recovery.

To evaluate the merits of a proposed plans implementation, USACE compares the expected annual value of total NED benefits against the total expected annual costs of the proposed project (such as construction, operation, and negative side effects). If project NED benefits exceed the costs, the project is considered to contribute positively to national economic welfare. Planning guidance requires identification of the plan that would produce the greatest contribution to NED, from among the focused array of alternatives. The NED plan is the plan with a positive Benefit-Cost Ratio that most reasonably maximizes net annual benefits.

For this study, the Hydraulic Engineering Center's Flood Damage Reduction Analysis 2.0 (HEC-FDA 2.0) software was utilized for interior drainage measures, to estimate the dollar value of expected annual physical flood damages to structures, contents, and vehicles. This was completed for both the FWOP and FWP conditions, and the difference in value between the two conditions provides NED benefit results. The complete NED analysis can be found in **APPENDIX 1-G: Economic Analysis**.

5.7.2.2 Regional Economic Development Account

The RED account registers changes in the distribution of regional economic activity that result from each alternative plan, including the regional incidence of NED effects, income transfers, and employment effects. The impacts of project spending on the employment, income, and output of the regional economy are considered part of the RED account. These regional impacts associated with construction spending for the plan are calculated using the USACE Regional Economic System (RECONS) certified regional economic model. The model is based on data collected by the U. S. Department of Commerce, the U.S. Bureau of Labor Statistics, and other federal and state government agencies. Nationally developed input-output tables represent the relationships between the many different sectors of the economy to allow an estimate of changes in economic activity on the larger economy as a whole, brought about by spending in the study area.

There are two types of effects estimated by the RECONS model—direct and secondary effects. These effects, or impacts, are described as follows:

- Direct effects are the change in dollars or number of jobs that are created because of the direct construction spending made through payroll and direct purchases from businesses for goods and services.
- Secondary impacts measure the change in dollars or employment caused by the next round of spending as businesses make further purchases and pay their employees—these are often called the multiplier effect.

The complete RED analysis can be found in **APPENDIX 1-G: *Economic Analysis***.

5.7.2.3 Environmental Quality

The EQ benefits measure non-monetary, qualitative impacts to natural resources. Although cultural resources are often included in this account, cultural resources were instead assessed in the OSE account under the Community Identity metric. The resources assessed in the EQ account include wildlife, federally threatened and endangered species, and habitat health. The complete EQ analysis can be found in **Appendix 1-F: *Comprehensive Benefits Analysis***.

5.7.2.4 Other Social Effects

OSE benefits measure social well-being factors that influence personal and group definitions of satisfaction, wellbeing, and happiness. This analysis describes how social well-being could change in the absence of a solution to a water resources issue, and how social well-being could be affected by alternative solutions proposed in the feasibility study.

During the feasibility study, the PDT determined that allowing FRM systems to operate without equipment rehabilitation or replacement would lead to significant community impacts not captured by the NED, RED, and EQ benefit categories. Therefore, a detailed OSE analysis was conducted to provide additional information on these community-level effects.

Five OSE themes that were considered during this study. They include:

Health and Safety: The life, security, health and safety of the people living within the project area was considered during the development of each alternative. The measures considered in this study would protect the health and safety of residents from the direct impact of flooding resulting from the failure of the FRM systems by keeping flood waters away from property and eliminating future damages. To understand the impact on the health and safety of these communities, five metrics were chosen. These included affected population, access to healthcare, displaced population, contaminated sites and workplace safety/workforce utilization.

Economic Vitality: Economic vitality refers to how well a community's local economy supports a good standard of living and quality of life. Elements that could be considered

include whether a project helps or harms people's ability to find jobs, maintain incomes, support local businesses, attract investment, or make the area more or less economically stable or growing. For example, if a flood risk management project protects downtown businesses, the project supports economic vitality. Conversely, if a project blocks access to a commerce area, causes business disruptions, or increases costs, that could reduce economic vitality. Economic vitality also includes how residents feel about their economic opportunities — not just raw numbers, but whether people believe they can get good jobs, earn enough, and plan for the future. During this feasibility study, economic vitality was explored through two metrics: exposed businesses and impacts to property owners.

Social Connectedness: The social connectedness dimension of OSE relates to the sustained sense of connection that people feel to their community and neighbors. Recurring storm and flooding events can disrupt the interpersonal networks in the community and the vision of the future held by community members when people and businesses are displaced. Social identity is the feeling of pride in the community, which can be destroyed when flooding causes significant property damage and community members must leave the area of impact. Social Connectedness was explored in this study through two metrics: public transportation and community vision (as expressed through redevelopment).

Community Identity: Community Identity addresses how people in a place feel connected to where they live — their history, culture, landmarks, customs, and shared sense of belonging. In an OSE analysis, the study team considers how a project might strengthen or weaken this sense of identity. The analysis of community identity attempts to understand these nonphysical but deeply meaningful factors: what gives a place its character, how people view their community, what shared memories or symbols matter. With the understanding that projects don't just affect physical infrastructure or economics but also could impact the deeper social and cultural ties people have to a place, the USACE's goal is to avoid harm to identity, or where possible enhance it, when designing solutions to water resource problems. Community identity was understood through the impact on cultural resources and community facilities.

Social Vulnerability & Resilience: Social vulnerability refers to how some people or groups are more likely to suffer harm from flooding because of factors like low income, poor health, limited access to transportation or services, or weaker social networks. Resilience, in this setting, is the ability of those same people and communities to absorb shocks from natural disaster and other stresses, recover (bounce back), and adapt (change to reduce future harm). Social vulnerability and resilience analysis is used to understand who might be most affected and how well they can cope or recover. This helps planners choose alternatives that reduce harm to the most vulnerable, enhance recovery capacity, and improve fairness in project outcomes. Probability of a community being damaged or negatively affected by hazards and its ability to recover from a traumatic event. The themes of Social Vulnerability & Resilience were investigated through the effects on underserved communities and critical infrastructure.

The existing conditions within the community were established using the metrics detailed in **Table 33**. Following this, the OSE analysis utilized H&H modeling to evaluate the FWOP impacts. As previously noted, the modeling analyzed several scenarios for both interior drainage and levee breach mechanisms. To assess potential interior drainage flooding, eight standard storm events were used, ranging from a 50% AEP (2-year event) to a 0.2% AEP (500-year event). For the levee breach analysis, standard loading events were modeled based on peak water stages at the LCL, including specific loading scenarios for Hartford (62.5% and 92.5%) and East Hartford (62.5% and 87.5%).

To ensure the report remains clear and actionable, the PDT opted not to present every possible scenario, as doing so would be overwhelming and counterproductive. Conversely, selecting only a single data point would be misleading. Instead, the PDT identified a representative range of impacts occurring above the 10% AEP (10-year) threshold—the original design capacity of the pump stations. Three specific scenarios were selected to represent low, intermediate, and high levels of flooding:

- Interior Drainage: Low (2% AEP), Intermediate (0.5% AEP), and High (0.2% AEP).
- Levee Breach: Low (50% loading), Intermediate (62.5% loading), and High (75% loading).

The following maps (**Figure 42** through **Figure 44**) illustrate the projected flood extents and the benefits provided by each project alternative. In these maps, red cross-hatching indicates flooding caused by interior drainage, while solid blue areas represent flooding from a levee breach. Although these are separate mechanisms that are not expected to occur simultaneously, the maps illustrate the comprehensive risk reduction provided by each alternative. Areas marked with both patterns benefit from protection against both flooding types.

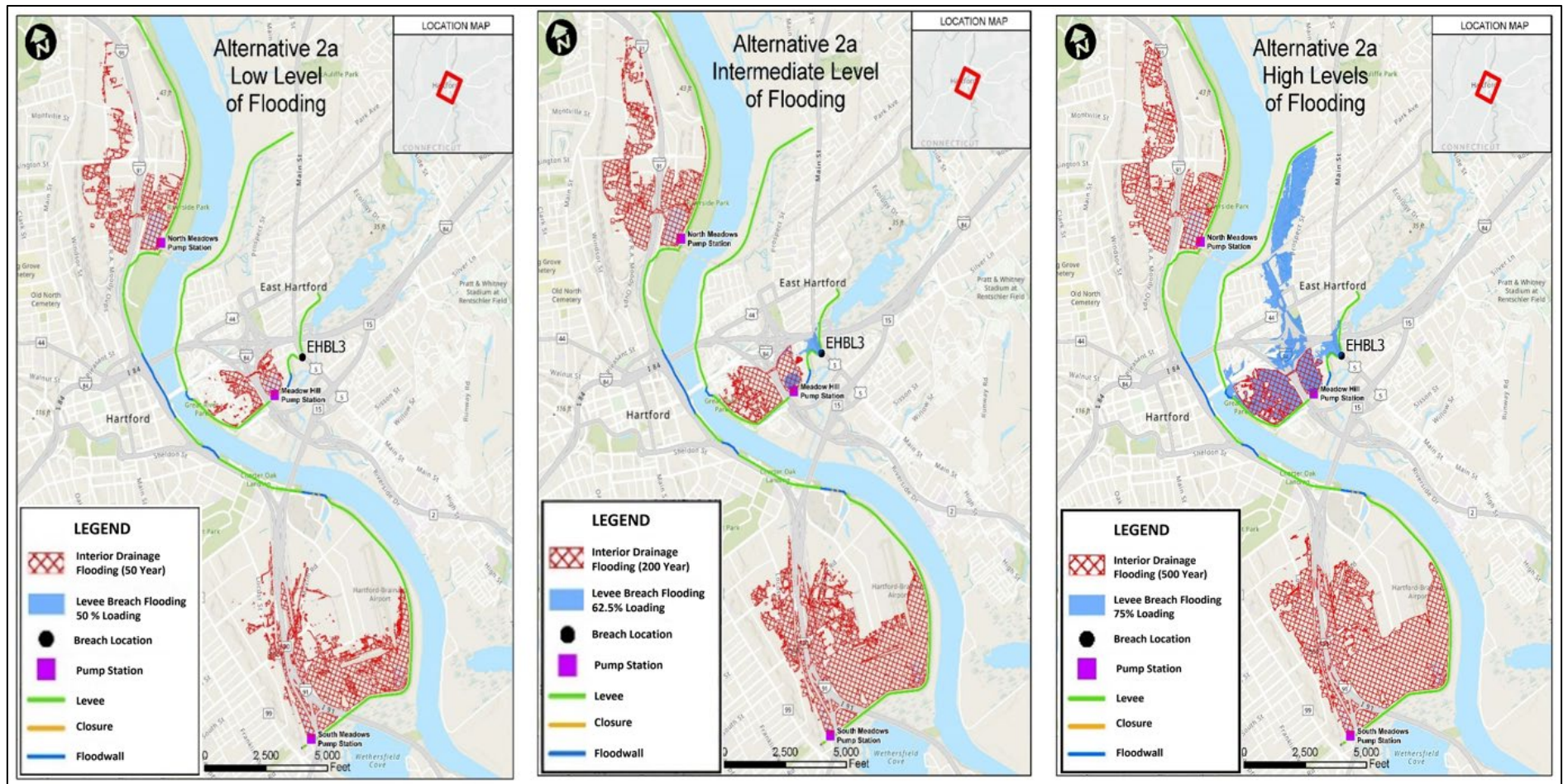


Figure 42: Projected Flooding for Alternative 2a at the Low, Intermediate and High Levels

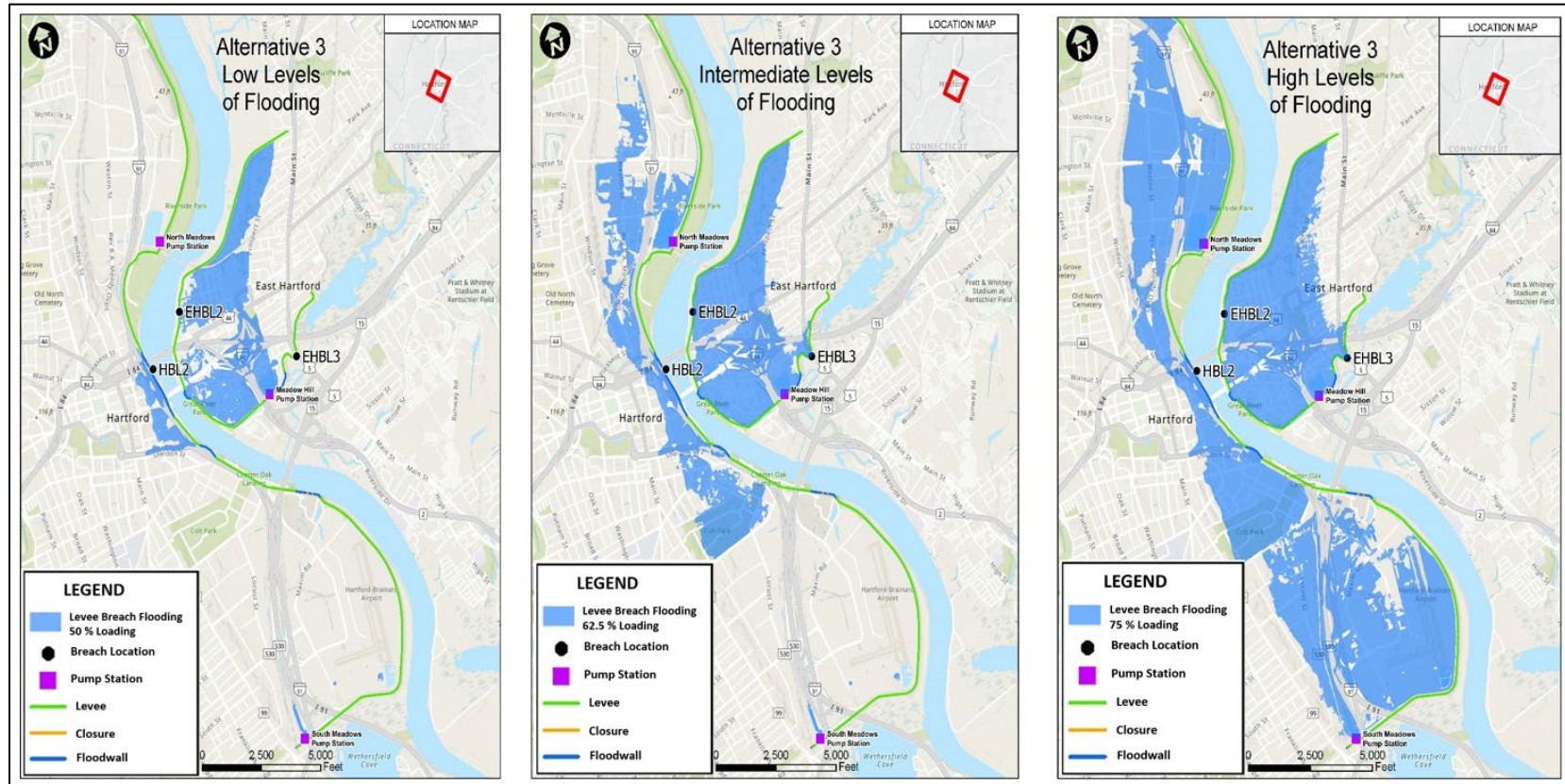


Figure 43: Projected Flooding for Alternative 3 at the Low, Intermediate and High Levels

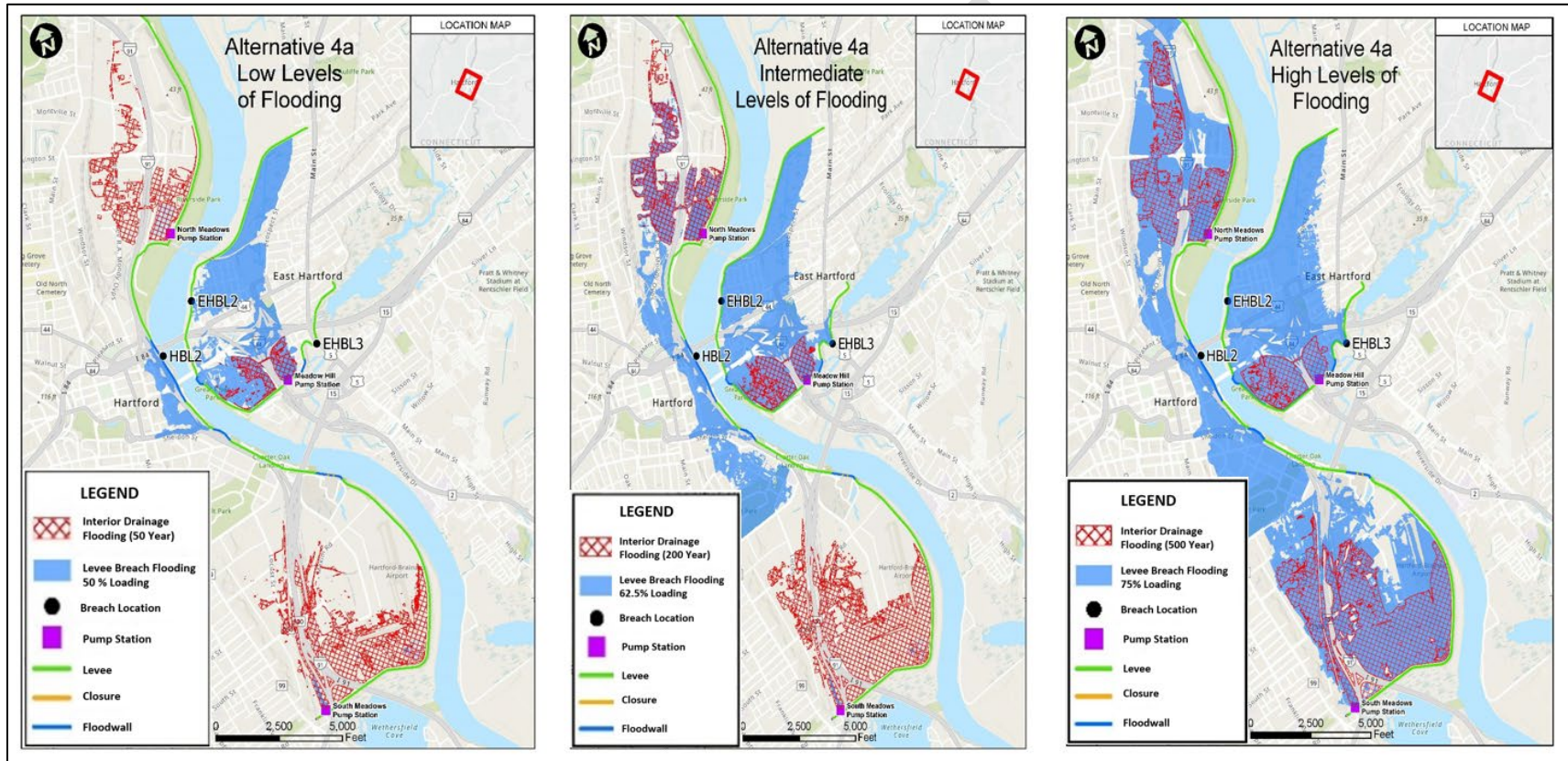


Figure 44: Projected Flooding for Alternative 4a at the Low, Intermediate and High Levels

The maps illustrate the projected flood extents and affected area that would benefit from the risk reduction provided by each project alternative. Note that during larger and more intense rain events, the flooding may occur initially, even if rehabilitation efforts are completed. This is because the pump stations may not be able to keep up with flooding and will need time to clear the water from the protected areas. As a result alternatives may not initially be able to eliminate the displayed flooding depths and extents, they will reduce them as well as reducing their probability of occurrence

The project team compared the final array of alternatives by evaluating their benefits across low, intermediate, and high flooding scenarios. During this process, several metrics were identified as insensitive, meaning they showed no significant variation in benefits between the different plans. To ensure a focused and meaningful comparison, these insensitive metrics were excluded from the final evaluation.

In **Table 34**, the metrics used to differentiate and compare the alternatives are highlighted in **BOLD**. Metrics shown in standard text were found to be insensitive to conditions within the study area and did not influence the final selection. To ensure a comprehensive analysis, at least one metric was utilized from each of the five primary impact themes.

Table 32: Metrics Investigated to Describe Other Social Effects Impact in the Study Area

OTHER SOCIAL EFFECTS
Health & Safety
Affected Population
Access to Healthcare
Displaced Population
Contaminated Sites
Workplace Safety/Workforce Utilization
Economic Vitality
Exposed Businesses
Impact to Property Ownership
Social Connectedness
Community Vision (Redevelopment)
Transportation
Community Identity
Cultural Resources
Community Facilities
Social Vulnerability & Resiliency
Effects on Underserved Communities
Critical Infrastructure

The complete OSE analysis can be found in **APPENDIX 1-F: Comprehensive Benefits Analysis**.

5.7.2.5 Principles and Guideline Criteria

The Federal P&G established four criteria for evaluation of water resources projects (USACE, 1983). These are completeness, effectiveness, efficiency, and acceptability. These criteria and their definitions are listed below.

Completeness: Completeness is the extent to which alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities. Part of the evaluation of completeness will include the contribution of the plan towards the resilience in the engineered infrastructure, as well as in the community, economy, and environment. Resilience is generally defined as the ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or anthropogenic, under all circumstances of use. Completeness also considers sustainability, which is an evaluation of whether plans include features and resources needed to meet study objectives in the study area beyond the period of analysis, and the impact of the proposed project.

Effectiveness: Effectiveness is the extent to which alternative plans contribute to achieving planning objectives. Effectiveness will also consider the resiliency of the plan, the contribution of redundant features to overall plan effectiveness, and the robustness of the plan. Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe. Robustness is the ability of a system to continue to operate as intended across a wide range of foreseeable operational conditions, with minimal damage, alteration, or loss of functionality, and to fail in a predictable way outside of that range.

Efficiency: Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the objectives. Efficiency also considers redundancy and robustness and should describe any potential trade-offs with economic efficiency.

Acceptability: The 1983 P&G defines the terms as “the viability and appropriateness of an alternative from the perspective of the Nation’s general public and consistency with existing Federal laws, authorities, and public policies”.

The final array of alternatives were compared across the four P&G criteria. See **Table 36** for the results of the P&G criteria screening across the final array of alternatives.

5.7.3 Final Screening of Alternatives and Plan Selection

The results of the comprehensive benefits analysis are compiled in the array provided in **Table 35**.

Table 33: Screening Summary Information for Alternatives 2a, 3, and 4a

		Alternative 2a	Alternative 3	Alternative 4a
NED	Total Investment Cost (\$1,000)	\$86,796	\$13,835	\$100,623
	Annual NED Benefits (\$1,000)	\$1,824	\$0	\$1,824
	Benefit Cost Ratio	0.5	0.0	0.43
	Net Benefits (\$1,000)	(\$1,817)	(\$577)	(\$2,394)
RED	RED Benefits (\$1,000)	\$138,235	\$22,035	\$160,270
EQ	Habitat Health	Low	Low	Low
OSE	Health & Safety	Low	Low	Med
	Economic Vitality	Med	Med	Med
	Social Connectedness	Med	Med	Med
	Community Identity	Low	Med	Med
	Social Vulnerability & Resiliency	Med	Med	High
P&G	Completeness	No	No	Yes
	Effectiveness	Yes	No	Yes
	Efficiency	No	No	Yes
	Acceptability	Yes	Yes	Yes

Alternative 4a provided the most RED, and OSE. It was also found to be complete, effective, efficient and acceptable. Alternative 4a has been chosen as the TSP.

6.0 ENVIRONMENTAL EFFECTS AND CONSEQUENCES

6.1 DEFINITION OF IMPACTS

This section describes all reasonably foreseeable adverse and beneficial environmental effects associated with the No Action Alternative (NAA) and the action alternatives carried forward for detailed evaluation in the project’s focused array of alternatives. A baseline of environmental resources was described previously in **Section 2.0**. Impacts on a resource are described as either beneficial or adverse; beneficial if there is a positive change in the condition of the resource, or adverse if there is a negative change. The impact assessment also considers duration (short term or long term) and magnitude of impact (none/negligible, minor, moderate, or significant).

Short term: Temporary effects caused by the construction and/or implementation of a selected alternative.

Long term: Effects beyond completion of construction, and/or when the alternative is in full and complete operation.

None/Negligible: The impact would cause no change, or no discernible change, in the condition of the resource.

Minor: The impact would cause minor, detectable effects to the resource, although they would be localized, small, and of little consequence. Mitigation measures, if needed to offset adverse effects, would be simple and achievable.

Moderate: The impact would cause greater detectable effects. Mitigation measures, if needed to offset adverse effects, would be extensive but likely achievable.

Significant: The impact would cause obvious change in the condition of the resource. An adverse impact would severely impair the resource. Mitigation measures would be required and would likely be extensive and success not guaranteed.

6.2 NATURAL ENVIRONMENT

6.2.1 Wetlands

Alternative 1 – No Action: It is expected that the NAA would have minor short-term adverse effects to wetland resources. There are a few small, isolated wetlands within the project areas for Hartford and East Hartford. The larger wetlands are beyond the project areas, with one occurring just below the East Hartford FRM system and two occurring just downriver along the Connecticut River. Future flood events are likely to cause damage to structures and mobilize debris and urban pollutants, releasing them into the river and wetlands. . Flooding could also impact the WWTP in Hartford as soon as (during a 501,000-year event due to pump station failure,) and the WWTP in East Hartford as soon as (during a 50-year event due to levee breach,) exposing wetlands to untreated wastewater. Mobilization of raw sewage could increase nutrient loading, promote algal blooms, reduce dissolved oxygen levels, and degrade aquatic habitat. The industrial and commercial land use in both areas would likely contain environmentally hazardous pollutants such as pesticides, tire microplastics, and metals (e.g. lead) that would cause harm to humans and aquatic organisms if mobilized by floodwaters (Cojoc et al., 2024; Hatter et al., 2025). However, during low frequency floods (up to a 5-year event), wetlands are efficient at trapping or reducing pollutants through processes developed by the vegetation, microorganisms, and soil substrate that make up wetlands (Ferriera et al., 2023). The function of wetlands to attenuate polluted floodwater decreases at greater flood events (10 to 50-year storms).

Alternative 2a: Construction activities associated with this alternative are not expected to affect wetlands, as no in-water work would occur, and construction debris would be managed in accordance with applicable best management practices (BMPs). Upon completion, this alternative would result in minor long-term beneficial effects to wetlands due to partial reduction in flood risk associated with levee breaches and reduction of interior drainage flooding. This alternative includes replacement of toe drain segments along the southern portion of the East Hartford levee (EHLB3) adjacent to the Hockanum River. Improved drainage at this potential levee breach location would reduce flooding from the Hockanum River; however, the other potential breach area in East Hartford (EHLB2), which encompasses a larger flood-prone area than EHLB3, would not be

addressed. In Hartford, levee breach risks would remain; however, rehabilitation of the pump stations would reduce interior flooding risks for both Hartford and East Hartford. These interior drainage areas contain WWTPs, which are anticipated to flood beginning at a 25-year storm event. Replacement of the pump stations would therefore reduce the possibility of flood impacts to the WWTPs. Replacement of the sluice gates in Hartford would further reduce interior drainage flooding. Overall, minimizing interior drainage flooding would substantially reduce the potential for raw sewage and associated contaminants to adversely affect wetlands.

Alternative 3: Construction activities associated with this alternative are not expected to affect wetlands, as no in-water work would occur, and construction debris would be managed in accordance with applicable BMPs. Upon completion, this alternative would result in negligible long-term beneficial effects to wetlands by reducing the risk of flooding associated with levee breaches at all locations. Replacement of the Dutch Point floodwall at the LB2 location in Hartford would notably reduce flood risk to the South Meadows WWTP. This alternative does not address interior drainage flooding, which is expected to impact both WWTPs during a 25-year storm event. As a result, significant interior drainage flooding could still occur, with the potential for pollutants from the WWTPs and urban flooding to be pumped into the Connecticut River and impact the connected wetlands that border the river. In East Hartford, replacement of toe drain at levee segment 2 and the filter blanket would reduce the mobilization of urban pollutants, resulting in a long-term benefit to water quality. Despite reductions in levee breach flooding, the absence of interior drainage improvements would continue to pose a risk to wetlands, resulting in negligible long-term benefits from this alternative.

Alternative 4a: Similar to Alternatives 2 and 3, construction activities associated with this alternative are not expected to affect wetlands, as no in-water work would occur. Upon completion, this alternative would result in moderate long-term beneficial effects to wetlands by reducing flood risk associated with both levee breaches and interior drainage flooding at all locations. Although flooding of the WWTPs could occur during a 25-year storm event, the extent and severity of such flooding would be substantially reduced with implementation of this alternative. Overall, the significant reduction in flood risk would minimize the potential for pollutant mobilization and subsequent transport to nearby wetlands.

6.2.2 Vegetative Resources

Alternative 1 – No Action: It is expected that the NAA would have a minor short-term adverse impact on vegetative resources. The majority of the project areas are highly developed for industrial and commercial use. There are narrow strips of forest land along the Connecticut River, but these are just outside of the levied project areas. The few inland parks contain some trees, but there is an overall lack of natural terrestrial habitats within the project areas. Reoccurrence of low frequency flooding (e.g., 5-year storm) is not expected to have a major impact on vegetative resources, but more intense and longer-lasting storms (e.g., 50-year storm) can uproot trees, suffocate roots, and leave trees vulnerable to fungus (Basak, 2015).

Alternative 2a: The construction activities from this alternative would be expected to have no effect on vegetative resources. The activities would occur on developed land and would not require removal of vegetation, besides disturbance of developed grassy areas along the levees. Natural areas would remain undisturbed.

This alternative would address interior drainage flooding and levee breach at one location in East Hartford (LB3). However, the larger levee breach area in East Hartford (LB2) would not be addressed, leaving portions of the levee system vulnerable to breach-related flooding. In addition, levee breach risks in Hartford would remain unmitigated. Interior drainage improvements would nonetheless provide benefits to vegetation, as flooding during intense, longer-lasting storms, can damage trees or suffocate roots (Basak, 2015). It is expected that there will still be a risk of flooding under this alternative and would therefore have a negligible long-term impact on these resources.

Alternative 3: Similar to the Alternative 2a, construction activities under this alternative are expected to have no effect on vegetative resources, with the exception of temporary disturbance to developed grassy areas along the levees. Natural vegetated areas would remain undisturbed. Due to the highly urbanized nature of Hartford and East Hartford, vegetation within the project areas is limited and consists primarily of maintained parkland and a small number of fragmented natural areas. Adjacent to, but outside, the project areas, are narrow forested corridors along the Connecticut River in both communities and along the Hockanum River in East Hartford.

This alternative would address flood risk associated with levee breaches, thereby reducing flood impacts to recreational parks and their associated vegetation, as well as to nearby natural areas located immediately outside the levees. Interior drainage flooding does not typically extend into interior recreational parks; moreover, riparian vegetation along the rivers is generally more tolerant of periodic inundation than vegetation within urban park settings. Although interior drainage risks would remain, the levee breach measures would reduce flooding across a broader area, encompassing parkland and adjacent natural areas. As a result, this alternative would result in a minor long-term beneficial impact on vegetative resources.

Alternative 4a: This alternative would comprehensively address flood risks associated with both interior drainage and levee breaches in Hartford and East Hartford. Vegetative resources within the project areas are limited and consist primarily of maintained parkland and a small number of fragmented natural areas. Adjacent to, but outside, the leveed areas are narrow forested corridors along the Connecticut and Hockanum rivers. While interior drainage flooding does not typically extend into interior recreational parks, flooding could affect forested areas outside the levees. By minimizing both interior drainage and levee breach flooding, this alternative would substantially reduce the potential for flood-related impacts to vegetative resources. As a result, this alternative would result in a minor long-term beneficial impact on vegetation.

6.2.3 Fish and Wildlife Resources

Alternative 1 – No Action: It is expected that the NAA would have a minor short-term adverse impact on fish and wildlife resources. The project areas are highly developed and contain few natural habitats, which are generally small, fragmented, and isolated. During flood events, terrestrial wildlife and migratory birds may be disturbed and temporarily displaced. Although aquatic habitat within the project areas is limited, flood-related mobilization of urban pollutants could enter nearby wetlands, the Connecticut River, and the Hockanum River, potentially resulting in temporary adverse effects on aquatic species. Flooding could also impact the WWTP in Hartford (during a 1,000-year event) and the WWTP in East Hartford (during a 50-year event), exposing fish and wildlife to untreated wastewater. Mobilization of raw sewage could increase nutrient loading, promote algal blooms, reduce dissolved oxygen levels, and degrade aquatic habitat. The industrial and commercial land use in both areas would likely contain environmentally hazardous pollutants such as pesticides, tire microparticles, and metals (e.g. lead) that would cause harm to fish and wildlife if mobilized by floodwaters (Cojoc et al., 2024; Hatter et al., 2025). However, the impact of polluted floodwaters may vary, with acute toxicity effects on organisms impacting lower levels of the food web (i.e., bacteria, algae) more than vertebrates (i.e., fish). Habitat can generally rebound quickly during smaller frequency floods (e.g., 10-year storm) than during more significant floods (e.g. 100-year storm).

Alternative 2a: The construction activities from this alternative would be expected to have no effect on fish and wildlife resources. The activities would occur on developed land and would not require disturbance of natural areas. There would be no in-water work. Upon completion, this alternative would result in minor long-term beneficial effects on fish and wildlife resources due to reductions in interior drainage flooding and mitigation of levee breach risk at one location in East Hartford (LB3). These measures would reduce the potential for mobilized urban pollutants to impact various wetlands, rivers, and forested areas within and near the project areas. However, the larger levee breach area in East Hartford (LB2) would not be addressed under this alternative, leaving portions of the levee system vulnerable to breach-related flooding. In addition, levee breach risks in Hartford would remain unmitigated.

Interior drainage improvements would nonetheless provide benefits to fish and wildlife, as flooding of WWTPs is anticipated to occur during an approximately 25-year storm event, and reducing such flooding would limit the release of contaminants that could negatively affect habitat. Although levee breach flooding would be partially mitigated in East Hartford and not addressed in Hartford, impacts to WWTPs from breach-related flooding are anticipated only during larger, but less frequent, storm events (approximately a 50-year event in East Hartford and a 1,000-year event in Hartford). Overall, while residual flood risk would remain, the combined reduction in interior drainage flooding and partial breach mitigation would result in minor long-term beneficial effects on fish and wildlife.

Alternative 3: Similarly to Alternative 2a, construction of this alternative would be expected to have no impact on fish and wildlife resources. There would be no in-water work, and any construction debris would be managed through BMPs. This alternative

would address only flood risk from levee breaches in both Hartford and East Hartford, and not interior drainage. Therefore, there would still be a risk of urban pollutants being mobilized within the project area, potentially to be pumped into the Connecticut River to impact aquatic resources, if the pump stations are operating at a limited capacity. Although interior drainage flooding would not be addressed, measures to address levee breach would benefit a greater area of land, encompassing park land and natural areas that may support wildlife resources. Therefore, this alternative would largely benefit species existing within the levied area. This alternative would result in a partial benefit to reducing risk of mobilized urban pollutants and therefore would have a minor long-term beneficial impact to fish and wildlife resources.

Alternative 4a: This alternative would address all risks of interior drainage and levee breach flooding in both Hartford and East Hartford. This alternative requires more construction, but as there will be no in-water work and if BMPs were followed, it is not expected that construction will impact fish and wildlife. All risk of flooding would be minimized, resulting in a moderate long-term beneficial impact.

6.2.4 Essential Fish Habitat

Alternative 1 – No Action: It is expected that the NAA would have minor short-term adverse effects on EFH. EFH for 15 species has the potential to exist in the Connecticut River. However, only the Atlantic salmon (*Salmo salar*) is likely to occur in or near the project areas, because the Connecticut River, Park River, and Hockanum River may be used as migration routes to freshwater spawning and rearing habitats (NOAA, 2021). The other species of black sea bass (*Centropristis striata*), summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), bluefish (*Pomatomus saltatrix*), Atlantic butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), longfin inshore squid (*Doryteuthis pealeii*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), winter skate (*Leucoraja ocellata*), red hake (*Urophycis chuss*), pollock (*Pollachius virens*), Atlantic herring (*Clupea harengus*), and little skate (*Leucoraja erinacea*) require a certain amount of salinity and therefore won't be found in the Connecticut River outside of Hartford and East Hartford (NOAA, 2021). Reoccurrence of flooding could result in mobilization of urban pollutants and raw sewage from the WWTPs which would enter nearby rivers. Exposure of these pollutants on Atlantic salmon EFH, especially from CSOs, would likely be temporary, with conditions returning to normal levels within two hours after a rain event or after the discharge ends (CTDEEP, 2021). Salmon populations are likely to rebound quickly during small, seasonal floods, but more extreme floods can degrade water quality and impact salmon health during critical life history stages (i.e., spawning and rearing) (McCarthy, 2008).

Alternative 2a: The construction activities from this alternative would be expected to have no effect on EFH because there would be no in-water work and BMPs would be followed to contain construction debris. Upon completion, this alternative would result in minor long-term beneficial effects on EFH due to reductions in interior drainage flooding and mitigation of levee breach risk at one location in East Hartford (LB3). During interior flooding, the limited capacity of the pump stations would cause flooding to back up, mobilizing pollutants to be pumped into the Connecticut River. Rehabilitation of the pump

stations would therefore reduce the risk of pumping capacity issues. These measures would reduce the potential for mobilized urban pollutants to enter the Connecticut River, thereby limiting adverse effects on Atlantic salmon EFH, especially during critical life stages (i.e., spawning and rearing) (McCarthy, 2008). However, the larger levee breach area in East Hartford (LB2) would not be addressed under this alternative, leaving portions of the levee system vulnerable to breach-related flooding. In addition, levee breach risks in Hartford would remain unmitigated.

Interior drainage improvements would nonetheless provide benefits to EFH, as flooding of WWTPs is anticipated to occur during an approximately 25-year storm event, and reducing such flooding would limit the release of contaminants that could negatively impact aquatic habitat. Although levee breach flooding would be partially mitigated in East Hartford and not addressed in Hartford, impacts to WWTPs from breach-related flooding are anticipated only during larger, but less frequent, storm events—approximately a 50-year event in East Hartford and a 1,000-year event in Hartford. Critical Atlantic salmon life stages (i.e., spawning and rearing) would be most vulnerable to negative impacts of polluted floodwaters (McCarthy, 2008). Overall, while residual flood risk would remain, the combined reduction in interior drainage flooding and partial breach mitigation would result in minor long-term beneficial effects on EFH.

Alternative 3: Similarly to Alternative 2a, construction of this alternative would be expected to have no impact on EFH due to no in-water work and the use of BMPs to control construction debris. This alternative would address flood risk associated with levee breaches in both Hartford and East Hartford but would not include measures to mitigate interior drainage flooding. As a result, urban and WWTP pollutants could still be mobilized within the project area and potentially discharged to the Connecticut River—particularly during periods when pump stations are operating at limited capacity, posing continued risks to Atlantic salmon EFH. Interior drainage flooding is expected to occur during more frequent storm events (e.g., 25-year storms) than levee breach flooding. Consequently, while levee breach measures would reduce flooding over a larger spatial extent during extreme events, flooding associated with more frequent interior drainage events would remain unaddressed. However, the more extreme events generally pose negative impacts to Atlantic salmon because of the critical life stages that use the rivers (McCarthy, 2008). Implementation of this alternative would result in negligible long-term benefits to EFH.

Alternative 4a: This alternative would address all risks of interior drainage and levee breach flooding in both Hartford and East Hartford. This alternative requires more construction, but as there would be no in-water work and BMPs would be followed, it is not expected that construction will impact EFH. All risk of flooding would be minimized, resulting in a minor long-term beneficial impact on EFH.

6.2.5 Threatened & Endangered Species

Alternative 1 – No Action: It is expected that the NAA would have minor short-term adverse effects on T&E species due to the continued occurrence of flooding within the

project area. The IPaC (USFWS, 2025) identified the following federally listed species with the potential to occur in the vicinity: tricolored bat (*Perimyotis subflavus*), monarch butterfly (*Danaus plexippus*), shortnose sturgeon (*Acipenser brevirostrum*), and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). The TCB prefers suburban areas, suburban parks, open spaces, and open woodlands. Suitable habitat for TCB is found in East Hartford outside of the levee, particularly around the Hockanum River and Keeney Cove. There is also suitable habitat in Hartford outside of the levee, particularly around Wethersfield Cove. There is no suitable TCB habitat within the Hartford levied project area and little suitable habitat within the East Hartford levied project area. In the spring, summer, and fall, TCB roost in live or recently dead deciduous hardwood trees and in pine needles. Recurrent flooding may affect TCB if roost trees are toppled during pup season (summer) when pups are not yet able to fly. Although no designated critical habitat for the monarch butterfly is present within the project area, flood events could temporarily inundate common vegetation used by monarch butterflies for foraging and breeding, potentially resulting in minor short-term adverse effects. The two anadromous sturgeon species are not likely to be impacted during smaller storm events, but extreme flooding may degrade water quality and impact the species health during critical life history stages (i.e., spawning and rearing) (McCarthy, 2008). The industrial and commercial land use in both areas would likely contain environmentally hazardous pollutants such as pesticides, tire microparticles, and metals (e.g. lead) that would cause harm to fish if mobilized by floodwaters (Cojoc et al., 2024; Hatter et al., 2025). State-listed species in the area include several avian, plant, and aquatic species. Flooding associated with the NAA could inundate protected plant communities and mobilize pollutants into adjacent wetlands and riverine environments. These conditions could temporarily degrade habitat quality, suffocate roots, and affect sensitive aquatic species, resulting in minor short-term adverse effects. Overall, because flooding impacts would be episodic and habitats are expected to recover following flood events, adverse effects to T&E species under the NAA are anticipated to be minor and short term.

Alternative 2a: The construction activities from this alternative would have no effect on the proposed endangered tricolored bat (*Perimyotis subflavus*) or the proposed threatened monarch butterfly (*Danaus plexippus*) as the work would occur in an already developed and urban area, and there would be no tree cutting. There would also be no effect on the endangered/threatened Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), the endangered shortnose sturgeon (*Acipenser brevirostrum*), or designated critical habitat for the New York Bight distinct population segments of Atlantic sturgeon because there would be no in-water work.

Alternative 3: Similarly to Alternative 2a, construction of this alternative would have no effect on the proposed endangered tricolored bat (*Perimyotis subflavus*) or the proposed threatened monarch butterfly (*Danaus plexippus*) as the work would occur in an already developed and urban area, and there would be no tree cutting. There would also be no effect on the endangered/threatened Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), the endangered shortnose sturgeon (*Acipenser brevirostrum*), or designated critical habitat for the New York Bight distinct population segments of Atlantic sturgeon because there would be no in-water work.

Alternative 4a: This alternative would comprehensively address flood risks associated with both interior drainage and levee breaches in Hartford and East Hartford. Although implementation would involve a greater extent of construction activities, the work would occur in an already developed area and no tree cutting would occur; therefore, construction is not expected to affect the proposed endangered tricolored bat (*Perimyotis subflavus*) or the proposed threatened monarch butterfly (*Danaus plexippus*). There would also be no effect on the endangered/threatened Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), the endangered shortnose sturgeon (*Acipenser brevirostrum*), or designated critical habitat for the New York Bight distinct population segments of Atlantic sturgeon.

6.3 PHYSICAL ENVIRONMENT

6.3.1 Climate & Air Quality

Hartford County is in serious non-attainment for 8-hour ozone and in maintenance for carbon monoxide. An emissions analysis was performed for this study that assessed volatile organic carbon (VOC) and nitrous oxides (NO_x) as markers of ozone, and CO. An impact on air quality would be considered significant if the total emissions of an alternative would equal or exceed the *de minimis* thresholds of NAAQS pollutants (EPA, 2025c). The threshold for ozone (VOC and NO_x) in an area rated as “serious” is 50 tons a year. For areas in maintenance, the threshold for CO is 100 tons a year. Emissions associated with Alternatives 2A, 3, and 4A are described below.

Emissions were expressed by grams (g), horsepower (hp), emission factor (EF), and load factor (LF). Emissions of a pollutant were calculated as Emissions (g) = Power Demand (hp-hr) x Emission Factor (g/hp-hr). Power demand was calculated as hp x LF x hours of equipment use. Grams of emissions were converted to tons for this analysis. The LF was dependent on the general equipment type and was obtained from EPA’s 2010 report on nonroad engine emission modeling (EPA, 2010). The EFs for NO_x and CO were obtained from EPA’s MOVES 3.0.2 technical report (EPA, 2021). NO_x estimates were conservatively based on Tier 1 equipment. Due to limitations in data and analytical scope, EF for VOC was based on an air quality analysis performed by USACE with similar construction equipment.

Alternative 1 – No Action: The Northeast region of the United States has seen an increasing trend of extreme heat, flooding, droughts, and poor air quality, as well as an increase in extreme precipitation events and more severe and long-lasting heatwaves. Extreme flood events are expected to increase in the foreseeable future. State Implementation Plans for 8-hour ozone and CO are expected to be continued within Hartford County. Under the NAA, the project areas are expected to become exposed to more frequent or intense flood events, potentially requiring construction and maintenance to repair damaged infrastructure which would generate a temporary increase in NAAQS pollutants.

Alternative 2a: The construction activities from this alternative would be expected to have short-term minor impacts on air quality. A summary of expected air quality emission for

Alternative 2A is presented in **Table 36**. A detailed analysis is provided in **APPENDIX 1-A: Environmental Documentation**. Emissions during construction are estimated to be below *de minimis* thresholds and are not anticipated to adversely affect local or regional long-term air quality. Excavation required for the toe drain replacements would follow BMPs to reduce airborne dust and sediment. An environmental protection plan will be established prior to construction that will include provisions to address air pollution.

Table 36: Summary of Estimated Emissions (tons) for Alternative 2a

Pollutant	General Conformity Applicability Rate (ton/year)	Estimated Emissions
NOx	50	28.3
VOC	50	2.8
CO	100	14.6

Alternative 3: The construction activities from this alternative would be expected to have short-term minor impacts on air quality. A summary of expected air quality emission for Alternative 3 is presented in **Table 37**. A detailed analysis is provided in **APPENDIX 1-A: Environmental Documentation**. Emissions during construction are estimated to be below *de minimis* thresholds and are not anticipated to adversely affect local or regional long-term air quality. Excavation required for the toe drain replacement would follow BMPs to reduce airborne dust and sediment. An environmental protection plan will be established prior to construction that will include provisions to address air pollution.

Table 37: Summary of Estimated Emissions (tons) by Measure for Alternative 3

Pollutant	General Conformity Applicability Rate (ton/year)	Estimated Emissions
NOx	50	6.3
VOC	50	0.6
CO	100	3.1

Alternative 4a: The construction activities from this alternative would be expected to have short-term minor impacts on air quality. A summary of expected air quality emission for Alternative 4A, including information from **Tables 36** and **Table 37**, is presented in **Table 38**. A detailed analysis is provided in **APPENDIX 1-A: Environmental Documentation**. Emissions during construction are estimated to be below *de minimis* thresholds and are not anticipated to adversely affect local or regional long-term air quality. Excavation required for the toe drain replacement would follow BMPs to reduce airborne dust and sediment. An environmental protection plan will be established prior to construction that will include provisions to address air pollution.

Table 38: Summary of Estimated Emissions (tons) by Measure for Alternative 4A

Pollutant	General Conformity Applicability Rate (ton/year)	Estimated Emissions
NOx	50	34.6
VOC	50	3.4
CO	100	17.7

6.3.2 Topography, Geology, & Soils

Alternative 1 – No Action: The NAA would likely have minimal impacts to the topography, geology, or soils of the project area. If repairs or rehabilitation are not conducted, the risk for longer duration flooding conditions could increase. Poor interior drainage could result in greater overbank and natural levee deposits of silt and sand than deposits seen with a fully functional system. The deposits left behind could be a few feet in height and require earth moving equipment to remove. However, long-term impacts on topography, geology, or soils are minimal in the context of a human timescale.

Alternative 2a: The construction activities associated with this alternative focus upon functionality of the existing systems, specifically interior drainage. Excavation would be required to replace toe drains in East Hartford (Segments #4, #5, and #6), and substantially less excavation would be necessary to replace the Park River sluice gates in Hartford. No excavation would be required for the planned rehabilitation of pump stations in both Hartford and East Hartford. The toe drain and sluice gates replacement would occur on previously disturbed land and would not significantly impact topography, geology, or soils of the projects. The slight potential benefit to Alternative 2a could be minor reduction in the overbank and natural levee deposits due to improved drainage as discussed in Alternative 1.

Alternative 3: This alternative addresses risk driving failure mechanisms. Alternative 3 includes the Dutch Point floodwall joint displacement repair in Hartford, which will involve deeper excavation than other alternatives. Although construction activity will be more complex given space limitations adjacent to the Connecticut River, the end result at Dutch Point will be a repaired floodwall in the same location with the same topographic features and soils as the existing structure.

The Main Street Closure Structure filter blanket installation and toe drain replacement (Segment #2) both in East Hartford will involve excavation, but all work would occur on previously disturbed land. All three aspects of Alternative 3 help reduce the risk of levee breach. No meaningful impact on topography, geology, or soils of the projects would result due to Alternative 3.

Alternative 4a: The construction activities associated with this alternative are a combination of Alternatives 2a and 3. Alternative 4a reduces the risk of levee breach as seen in Alternative 3 and improves the resilience of interior drainage functionality as seen

in Alternative 2a. No meaningful impact to topography, geology, or soils of the projects would result.

6.3.3 Hydrology

Alternative 1 – No Action: It is expected that the NAA would have minor short term adverse effects on hydrology or the watershed over the period of analysis. Reoccurrence of flooding is expected to alter the flow and width of the Connecticut River temporarily during flood events. Erosion potentially could alter the riverbanks during high flow periods, similar to erosion reported by the town of Middletown located south of the project area (Gecan, 2013). However, there are large corridors of forest and wetlands that flank the Connecticut River around the project areas that are beneficial in reducing erosion during flood events (NPS, 2025). The surface water hydrology in both communities has since been heavily altered by urban development and is therefore limited in future. Potential for levee breach may result in a new floodplain designation from FEMA for both project areas if extreme flooding causes levee failure.

Alternative 2a: The construction activities from this alternative would be expected to have no effect on hydrology because there would be no in-water work. Upon completion, this alternative would have a negligible long-term beneficial impact on hydrology and the watershed due to partial minimized flood risk from levee breach. This alternative includes replacement of toe drain segments along the southern part of the East Hartford levee (EHLB3), alongside the Hockanum River. Improved drainage at one potential levee breach location in East Hartford would reduce flooding from the Hockanum River. However, the other potential levee breach area (EHLB2) would not be addressed, which is considered to have greater flooding implications than EHLB3. Partial minimization of levee breach risk would result in negligible long-term benefits to hydrology. Replacement of the sluice gates in Hartford, and pump stations in both communities, would minimize interior drainage flooding only, and therefore would have little impact to hydrology. This alternative would not address levee breach in Hartford.

Alternative 3: The construction activities from this alternative would be expected to have no effect on hydrology because there would be no in-water work. Upon completion, this alternative would have a minor long-term beneficial impact on hydrology and the watershed due to minimized flood risk from levee breach at all locations. Replacement of the Dutch Point floodwall at the LB2 location in Hartford, replacement of toe drain segment 2 associated with East Hartford LB2, and installation of a filter blanket at EHLB3 would substantially reduce the likelihood of levee failure in both communities. These measures would improve levee stability and reduce uncontrolled flood flows into adjacent floodplains, thereby moderating changes to surface water flow patterns during extreme flood events. As a result, overall hydrologic conditions within the protected areas would be more stable during high-flow events, resulting in minor long-term beneficial effects on hydrology.

Alternative 4a: Similar to Alternative 3, the construction activities from this alternative would be expected to have no effect on hydrology because there would be no in-water work. Upon completion, this alternative would have a minor long-term beneficial impact

on hydrology and the watershed due to minimized flood risk from levee breach at all locations.

6.3.4 Water Quality

Alternative 1 – No Action: Past modifications such as storm-sewer construction and the paving of formerly pervious surfaces have increased both the rate and volume of surface runoff within the project area. However, due to both project areas being already highly developed, future development is limited. The Connecticut River, Park River, and Hockanum River suffer from water quality impairments and are subject to a Total Maximum Daily Load cleanup plan. It is expected that the NAA would have repeated minor short-term adverse effects on water quality. Reoccurrence of flooding is likely to mobilize debris and urban pollutants, releasing them into the rivers and adversely affecting water quality. The WWTPs in both South Meadows (Hartford) and in East Hartford would be vulnerable to flooding. Although the MDC would be subject to a Long-Term Control Plan and would eventually eliminate combined sewer systems, the proximity of the WWTPs to the Connecticut River leaves them vulnerable to flooding, potentially mobilizing wastewater. Additionally, the industrial and commercial land use in both areas would likely contain various environmentally hazardous pollutants such as pesticides, metals (e.g., lead), and tire microparticles that would cause harm to humans and aquatic organisms (Cojoc et al., 2024; Hatter et al., 2025). The impact of polluted floodwaters on water quality also depends on dilution, as the impact may be more severe if water levels are low or the area is experiencing a drought (Graham et al., 2024).

Alternative 2a: Construction activities associated with this alternative are not expected to affect water quality, as no in-water work would occur, and construction debris would be managed in accordance with applicable BMPs. Upon completion, this alternative would result in minor long-term beneficial effects on water quality due to partial reduction in flood risk associated with levee breaches and reduction of interior drainage flooding. This alternative includes replacement of toe drain segments along the southern portion of the East Hartford levee (EHLB3) adjacent to the Hockanum River. Improved drainage at this potential levee breach location would reduce flooding from the Hockanum River; however, the other potential breach area in East Hartford (EHLB2), which encompasses a larger flood-prone area than EHLB3, would not be addressed. In Hartford, levee breach risks would remain; however, rehabilitation of the pump stations would reduce interior flooding risks, particularly in South Meadows and in East Hartford. These interior drainage areas contain WWTPs, which handle raw sewage that could be mobilized during extreme flood events and discharged to the river if pump stations are operating. Flooding at these WWTPs is anticipated to begin during a 25-year storm event. Replacement of the sluice gates in Hartford would further reduce interior drainage flooding. Overall, minimizing interior drainage flooding would substantially reduce the potential for raw sewage and associated contaminants to adversely affect water quality.

Alternative 3: Construction activities associated with this alternative are not expected to affect water quality, as no in-water work would occur, and construction debris would be managed in accordance with applicable BMPs. Upon completion, this alternative would result in negligible long-term beneficial effects on water quality by reducing the risk of

flooding associated with levee breaches at all locations. Replacement of the Dutch Point floodwall at the LB2 location in Hartford would notably reduce flood risk to the South Meadows WWTP. However, the WWTP is not anticipated to be affected by a levee breach until the modeled 75% loading scenario, which corresponds to an approximately 1,000-year flood event. This alternative does not address interior drainage flooding, which is expected to impact the South Meadows WWTP during a 25-year storm event. As a result, significant interior drainage flooding could still occur, with the potential for pollutants from the WWTP and urban flooding to be discharged into the Connecticut River if the pump stations remain operational. In East Hartford, replacement of toe drain segment 2 and the filter blanket would reduce the mobilization of urban pollutants, resulting in a long-term benefit to water quality. The East Hartford WWTP could be affected under the 50% loading scenario, equivalent to a 50-year flood event. Despite reductions in levee breach flooding, the absence of interior drainage improvements would continue to pose a risk to water quality, resulting in only negligible long-term benefits from this alternative.

Alternative 4a: Similar to Alternatives 2 and 3, construction activities associated with this alternative are not expected to affect water quality, as no in-water work would occur. Upon completion, this alternative would result in moderate long-term beneficial effects on water quality by reducing flood risk associated with both levee breaches and interior drainage flooding at all locations. Although flooding of the WWTPs could occur during a 25-year storm event, the extent and severity of such flooding would be substantially reduced with implementation of this alternative. Overall, the significant reduction in flood risk would minimize the potential for pollutant mobilization and subsequent transport to nearby wetlands and rivers.

6.3.5 Hazardous, Toxic, & Radioactive Waste

Alternative 1 – No Action: Over the period of analysis, it is expected that the NAA would have repeated moderate short term adverse effects on the mobilization of HTRW found within the project area potentially resulting in contamination of soil and/or water resources. Without efforts to reduce risk driving failure mechanisms (Alternative 3), the likelihood of levee breach in both Hartford and East Hartford would remain higher under the NAA. Levee breach would lead to mobilization of existing HTRW contamination throughout inundated areas. Cleanup efforts following flooding would likely be more expensive and time consuming given the presence of HTRW.

Without improvements to reliability of interior drainage systems (Alternative 2a), increased water surface elevations and longer duration interior flooding could occur. Such deeper and long-lasting flooding could more thoroughly mobilize known HTRW contamination found in soils, underground storage tanks, and other structures found throughout Hartford and East Hartford.

Alternative 2a: Construction activities associated with this alternative may result in negligible short-term adverse effects to HTRW contamination present within the study area. Pump station rehabilitation would likely have no HTRW impact unless material found in the pump houses, e.g., asbestos insulation, were negligently discarded elsewhere. Toe drain replacement (Segments #4, #5, and #6 in East Hartford) could

encounter minor HTRW, but no areas of significant contamination are documented in the vicinity. As discussed in **APPENDIX 2-J: Hazardous, Toxic and Radioactive Waste Analysis**, care should be taken during replacement of the Park River sluice gates in Hartford due to known HTRW contamination in the vicinity. Although the volume of soil expected to be generated replacing the gates is small, the stockpiling, management, testing, and transportation of potentially contaminated soil and groundwater must be performed appropriately. Similarly, construction processes involve the risk of equipment malfunction or failure resulting in spills, e.g., hydraulic fluid. Care should be taken during storage, fueling, and lubrication of equipment and motor vehicles associated with construction processes (e.g., cement trucks, trenchers, etc.) and conducted in a manner that affords the maximum protection against accidents and spills.

Benefits of Alternative 2a include reduction in overall flood risk and improved interior drainage. Both of these benefits would, in concert, reduce the mobilization of HTRW contamination in Hartford and East Hartford.

Alternative 3: Construction activities associated with this alternative may result in negligible short-term adverse effects to HTRW contamination present within the study area. The Dutch Point floodwall joint displacement repair location is situated hydrologically downgradient of known HTRW contamination. As such, the same measures discussed above related to the Park River sluice gates would apply at this location albeit for a significantly larger volume of soil. The Main Street Closure Structure filter blanket installation in East Hartford and toe drain replacement (Segment #2) have low risk of encountering known HTRW contamination. However, all proper construction processes from Alternative 2a discussed previously should apply to Alternative 3.

Benefits of Alternative 3 include reduction in flood risk and improved interior drainage. Both of these benefits would, in concert, reduce the mobilization of HTRW contamination in Hartford and East Hartford.

Alternative 4a: As seen in Alternatives 2a and 3, construction activities associated with this alternative could result in negligible short-term adverse effects on mobilization of HTRW. A larger area of overall construction, by combining both alternatives, does increase the likelihood of encountering HTRW or having a minor spill occurring during construction, but the benefits of Alternatives 2a and 3 greatly outweigh the HTRW risks.

6.3.6 Public Health & Safety

Alternative 1 – No Action: It is expected that the NAA would have moderate short term adverse effects on public health and safety. Because the existing FRM system is already vulnerable to extreme flood events, the absence of rehabilitation of pump stations or replacement of deteriorating FRM system components would leave the system susceptible to failure. Recurrent flooding is therefore expected and could mobilize contaminants within flood-prone areas, potentially exposing the public to raw sewage and urban pollutants. Mobilization of raw sewage could increase nutrient loading which promotes algal blooms, some of which (i.e., cyanobacteria, dinoflagellates, and diatoms) make people sick (CDC, 2024). More severe flood events would inundate larger areas,

affecting commercial, industrial, and public infrastructure, and disrupting business operations. In addition, emergency response services, including police and fire departments, would likely face restricted access to flooded areas, further compromising public safety.

Alternative 2a: Construction activities associated with this alternative may result in negligible short-term adverse effects on public health and safety due to potential diversions of traffic routes from construction-related activities. Construction on the toe drain replacement for segment 6 may require temporary access to a neighborhood street. However, access to residences would not be impeded. Access roads would be used when applicable to reduce disturbance to main roads. Construction areas would be fenced or otherwise secured to prevent unauthorized access and address safety concerns. Construction debris would be managed in accordance with BMPs.

Upon completion, this alternative would result in minor long-term beneficial effects on public health and safety due to partial reduction in flood risk associated with levee breaches and reduction of interior drainage flooding. Replacement of toe drain segments associated with EHLB3 would reduce the risk of breach-related flooding along the Hockanum River. However, the other potential breach area in East Hartford (EHLB2), which encompasses a larger flood-prone area than EHLB3, would not be addressed. In addition, this alternative does not reduce levee breach risks in Hartford. As a result, residual flood risk would remain in both communities, potentially exposing the public to hazardous conditions and damage to infrastructure during flood events.

Rehabilitation of pump stations in both Hartford and East Hartford would reduce interior drainage flooding. Interior flooding in both communities affects WWTPs during 25-year storm events, creating the potential for exposure to raw sewage and associated contaminants. Replacement of sluice gates in Hartford would further reduce interior drainage flooding. Overall, mitigation of interior drainage flooding would substantially reduce risks to public health and safety associated with flooding and contaminant exposure.

Alternative 3: Construction activities associated with this alternative may result in negligible short-term adverse effects on public health and safety due to potential diversions of traffic routes from construction-related activities. Construction on the Main Street closure structure would occur next to Main Street and may temporarily impact traffic during travel to and from the construction zone. Access roads would be used when applicable to reduce disturbance to main roads. Construction areas would be fenced or otherwise secured to prevent unauthorized access and address safety concerns. Construction debris would be managed in accordance with BMPs.

Upon completion, this alternative would result in minor long-term beneficial effects on public health and safety by reducing flood risk associated with levee breaches at all locations. Replacement of the Dutch Point floodwall at the LB2 location in Hartford would notably reduce flood risk to the South Meadows WWTP; however, the WWTP is not anticipated to be affected by a levee breach until the modeled 75 percent loading

scenario, equivalent to an approximately 1,000-year flood event. This alternative does not address interior drainage flooding, which is expected to impact the South Meadows WWTP during a 25-year storm event. Consequently, significant interior drainage flooding could still occur, with the potential for public exposure to pollutants from the WWTP and urban sources.

In East Hartford, replacement of toe drain segment 2 and the filter blanket would reduce flood inundation to infrastructure and businesses and limit the mobilization of urban pollutants. The East Hartford WWTP could be affected under the 50 percent loading scenario, corresponding to a 50-year flood event. Despite reductions in flooding associated with levee breaches, the absence of interior drainage improvements would continue to pose risks to public health and safety. Overall, although interior drainage flooding would remain unaddressed, the larger flood extents associated with levee breach would be decreased, resulting in minor long-term beneficial effects from this alternative.

Alternative 4a: Similar to Alternatives 2 and 3, construction activities associated with this alternative may result in negligible short-term adverse effects on public health and safety due to potential diversions of traffic routes from construction-related activities.

Upon completion, this alternative would result in moderate long-term beneficial effects on public health and safety by reducing flood risk associated with both levee breaches and interior drainage flooding at all locations. Although flooding of the WWTPs could occur during a 25-year storm event, the extent and severity of such flooding would be substantially reduced with implementation of this alternative. Reduction of levee breach-related flooding, which affects a larger area than interior drainage flooding, would improve access for emergency response services during extreme storm events. Overall, the substantial reduction in flood risk would minimize the potential for pollutant mobilization and hazardous conditions affecting the public.

6.3.7 Cultural Resources

Aspects of the APE are reviewed for the alternatives that are central to this study, with emphasis on cultural resources, in the listing that follows.

Alternative 1 – No Action: Continued and increased flooding in the Study Area over time could have indirect, potentially significant adverse impacts on cultural resources by altering historic architecture, changing the environment around historic properties, and potentially impacting archaeological resources. The No Action Alternative could result in an induced change to the character-defining features of a historic resource(s) and could result in substantial alteration of a historic property's viewshed, acoustic environment, or other environmental component, notably affecting an element that contributes to the significance of a historic property.

Alternative 2a: Cultural resources impacts resulting from Alternative 2a are considered to be minor and low risk. Currently, no cultural resources have been identified in the direct APE/project footprints for Alternative 2a. Several historic properties and districts have been identified in the viewshed/indirect APE for the replacement of sluice gates on the

Park River system, the rehabilitation of the South Meadows pump station, and the replacement of toe drains along Segment 6. Therefore, based on this assessment, the USACE determined Alternative 2a has the potential to affect historic properties. Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, a Programmatic Agreement is being prepared and will be executed between USACE and the CTSHPO to conduct additional evaluations as needed, make determinations of NRHP eligibility, and evaluate for potential effects.

Alternative 3: Cultural resources impacts resulting from Alternative 3 are considered to be minor and low risk. Currently, no cultural resources have been identified in the direct APE/project footprints for Alternative 3. Several historic properties and districts have been identified in the viewshed/indirect APE for the repairs to the Dutch Point floodwall, the reconstruction of the filter blanket at the Main St Closure Structure, and the replacement of toe drains along Segment 2. Therefore, based on this assessment, the USACE determined Alternative 3 has the potential to affect historic properties. Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, a Programmatic Agreement is being prepared and will be executed between USACE and the CTSHPO to conduct additional evaluations as needed, make determinations of NRHP eligibility, and evaluate for potential effects.

Alternative 4a: Cultural resources impacts resulting from Alternative 4a are considered to be minor and low risk. Currently, no cultural resources have been identified in the direct APE/project footprints for Alternative 4a. Several historic properties and districts have been identified in the viewshed/indirect APE for the repairs to the Dutch Point floodwall, the reconstruction of the filter blanket at the Main St Closure Structure, the replacement of sluice gates on the Park River system, the rehabilitation of the South Meadows pump station, and the replacement of toe drains along Segments 2 and 6. Therefore, based on this assessment, the USACE determined Alternative 4a has the potential to affect historic properties. Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, a Programmatic Agreement is being prepared and will be executed between USACE and the CTSHPO to conduct additional evaluations as needed, make determinations of NRHP eligibility, and evaluate for potential effects.

More information regarding the impact to cultural resources is provided in **APPENDIX 1-H: Cultural Resource Report and Background Study.**

6.3.8 Recreation & Aesthetics

Alternative 1 – No Action: It is expected that the NAA would have minor short term adverse effects on public recreation and aesthetics. The project areas are heavily developed and urban, with land-use tied to commercial and industrial activities and businesses. Visual resources are mainly related to the Connecticut River, Hockanum River, the historic Colt Park, and various recreational parks. Recurrent flooding is expected to impact these resources, notably interior recreational areas such as Colt Park in Hartford and Center Park in East Hartford. Although outside of the levied areas, several riverfront recreational areas would be impacted by extreme storm events that would cause flood encroachment of the Connecticut River and exposure to mobilized pollutants

from urban runoff. As a result, recreational use of the forested areas would be limited, and recreational swimming and boating may be impacted if the water quality is above threshold levels established by the USEPA. The aesthetics of Colt Park and the various recreational parks would be temporarily affected during flood encroachment.

Alternative 2a: Construction activities associated with this alternative may result in negligible short-term adverse effects on aesthetics due to construction-related activities that would temporarily impact visual resources. However, the construction would occur in already developed areas and would not impact recreation. Upon completion, this alternative would result in minor long-term beneficial effects on recreation and aesthetics due to partial reduction in flood risk associated with levee breaches and reduction of interior drainage flooding. Although riverfront recreation areas, such as Great River Park (East Hartford), would not be directly affected by breach flooding measures due to not being within the levied areas, these parks would benefit indirectly from reduced exposure to mobilized pollutants in the event of a levee breach. However, the other potential breach area in East Hartford (EHLB2), which encompasses a larger flood-prone area than EHLB3, would not be addressed in this alternative. In addition, this alternative does not reduce levee breach risks in Hartford. Interior drainage measures would also beneficially impact riverfront recreation, reducing exposure to mobilized pollutants from the WWTP and urban runoff. However, interior drainage flooding does not reach Central Park (East Hartford) or Colt Park (Hartford). Because these interior parks are not impacted by interior drainage flooding, absence of this measure would not affect interior parks. Risk of flooding to Central Park would be reduced through measures addressing EHLB3, although still leaving it exposed to flooding at EHLB2. As a result, residual flood risk would persist in both communities, limiting the overall beneficial effects on recreation and aesthetics.

Alternative 3: Construction activities associated with this alternative may result in negligible short-term adverse effects on aesthetics due to construction-related activities that would temporarily impact visual resources. However, the construction would occur in already developed areas and would not impact recreation.

Upon completion, this alternative would result in minor long-term beneficial effects on recreation and aesthetics due to reduction in flood risk associated with levee breach in both communities. Although riverfront recreation areas, such as Great River Park (East Hartford) or Charter Oak Landing (Hartford), would not be directly affected by breach flood reduction measures due to being outside of the levied areas, these parks would benefit indirectly from reduced exposure to mobilized pollutants in the event of a levee breach. Additionally, reduced flooding from the breach measures would also benefit interior recreation areas such as Colt Park (Hartford) and Central Park (East Hartford).

Because interior parks, such as Colt Park (Hartford) and Center Park (East Hartford), are not impacted by interior drainage flooding, absence of this measure would not affect interior parks. However, interior drainage flooding could still impact riverfront recreation due to mobilized pollutants being pumped outside of the levied areas. Water quality threshold levels established by the USEPA for recreational swimming and boating may

be temporarily exceeded. The notable WWTPs in both communities are anticipated to be impacted at a 25-year storm event. The likelihood of interior drainage flooding is greater than levee breach flooding, which is anticipated to affect the East Hartford WWTP at a 50-year event and the Hartford WWTP at an approximately 1,000-year event. Despite reductions in flooding associated with levee breaches, the absence of interior drainage improvements would continue to pose risks to recreational areas. Overall, although interior drainage flooding would remain unaddressed, the larger flood extents associated with levee breach would be decreased, resulting in minor long-term beneficial effects from this alternative.

Alternative 4a: Similar to Alternatives 2 and 3, construction activities associated with this alternative may result in negligible short-term adverse effects on aesthetics due to construction-related activities that would temporarily impact visual resources. Upon completion, this alternative would result in moderate long-term beneficial effects on recreation by reducing flood risk associated with both levee breaches and interior drainage flooding at all locations. Reduction of levee breach-related flooding, which affects a larger area than interior drainage flooding, would therefore reduce flooding to all recreational parks within the project areas. Overall, the substantial reduction in flood risk would minimize the potential for pollutant mobilization, improving future conditions for recreational areas and aesthetics.

6.3.9 Noise

Alternative 1 – No Action: The NAA would have no effect on noise. There would be no construction or demolition activities associated with the NAA.

Alternative 2a: Construction activities associated with this alternative are expected to result in a minor short-term adverse impact on noise due to an increase in construction-related activities. Construction required for this alternative includes toe drain segment replacement in East Hartford, replacement of sluice gates in Hartford, and rehabilitation of pump stations in both communities. Toe segment replacement requires excavation along the levee, sluice gate replacement requires minor demolition of the concrete chamber, and pump station rehabilitation requires some minor internal demolition and construction. East Hartford would likely experience impacts on noise for a longer period than in Hartford, as this alternative does not include a levee breach measure in Hartford. Power tools and other equipment used for construction and demolition would create a temporary increase in noise for the community. These tools would range from about 75 dBA (e.g., compactors) to 90 dBA (e.g., chainsaw) (FHWA, 2006). However, since average urban ambient noise is between 70-90 dBA, it is not expected that noise levels would be significantly higher than typical levels found in urban communities. Upon completion of the alternative, noise levels would return to normal conditions.

Alternative 3: Construction activities associated with this alternative are expected to result in a minor short-term adverse impact on noise due to an increase in construction-related activities. Construction required for this alternative includes toe segment replacement and filter blanket installation in East Hartford, and repair of the Dutch Point floodwall joint in Hartford. The toe segment and filter blanket construction requires excavation, while the

floodwall joint repair requires excavation and the driving of mini-piles. Power tools and other equipment used for construction would create a temporary increase in noise for the community. These tools would range from about 75 dBA (e.g., compactors) to 100 dBA (e.g., pile driver) (FHWA, 2006). However, since average urban ambient noise is between 70-90 dBA, it is not expected that noise levels would be significantly higher than typical levels found in urban communities. Upon completion of the alternative, noise levels would return to normal conditions.

Alternative 4a: Construction activities associated with this alternative are expected to result in a minor short-term adverse impact on noise due to an increase in construction-related activities. Both levee breach and interior drainage measures would be implemented in this alternative, requiring equipment for excavation, minor demolition, and pile driving. Power tools and other equipment used for construction and demolition would create a temporary increase in noise for the community. These tools would range from about 75 dBA (e.g., compactors) to 100 dBA (e.g., pile driver) (FHWA, 2006). However, since average urban ambient noise is between 70-90 dBA, it is not expected that noise levels would be significantly higher than typical levels found in urban communities. Upon completion of the alternative, noise levels would return to normal conditions.

6.4 BUILT ENVIRONMENT

6.4.1 Land Use

Alternative 1 – No Action: It is expected that the NAA would have minor long-term adverse effects on land use. The project areas are heavily developed and urban, with land-use tied to commercial and industrial activities and businesses. There are future and currently proposed redevelopment projects within the project areas for Hartford and East Hartford. However, recurrent flooding is expected to negatively impact businesses, infrastructure, and traffic, as the hydrological future flooding models show increasing inundation of buildings and streets. Future redevelopment of the land may be impacted if areas are expected to be flooded more frequently, decreasing the desirability of new or redevelopment.

Alternative 2a: Construction activities associated with this alternative are not likely to affect land use as the area is already heavily developed and would only result in localized impacts directly to FRM system infrastructure. Upon completion, this alternative would result in negligible long-term beneficial effects on land use due to partial reduction in flood risk associated with levee breaches and reduction of interior drainage flooding. This is because reduction in flooding would allow redevelopment opportunities in areas that may have otherwise been considered undesirable due to flood inundation. In East Hartford, measures associated with LB3 would reduce flood risk to a large number of businesses. However, the other potential breach area in East Hartford (EHLB2), which encompasses a larger flood-prone area than EHLB3, would not be addressed in this alternative. In addition, this alternative does not reduce levee breach risks in Hartford. Because there would be no breach measures in Hartford and partial breach measure in East Hartford, residual flood risk would persist in both communities, limiting the overall beneficial effects on land use. Future development would be at risk of flooding.

Alternative 3: Construction activities associated with this alternative are not likely to affect land use as the area is already developed, and would only result in localized impacts directly to FRM system infrastructure. Upon completion, this alternative would result in negligible long-term beneficial effects on land use due to reduction in flood risk associated with all levee breaches. This is because reduction in flooding would allow redevelopment opportunities in areas that may have otherwise been considered undesirable due to flood inundation. Replacement of the Dutch Point floodwall at the LB2 location in Hartford would notably reduce flood risk to businesses in both the South and North Meadows neighborhoods of Hartford, although effects aren't anticipated to occur until the modeled 62.5% loading scenario, equivalent to an approximately 250-year flood event. Similarly, measures addressing levee breach in East Hartford would minimize flood risk to businesses that otherwise would be expected to occur at the 50% loading scenario, equivalent to a 50-year event. Despite reductions in flooding associated with levee breaches, the absence of interior drainage improvements would continue to pose risks to land use. Interior drainage flooding, although a smaller area than breach flooding, still encompasses a large area of businesses and infrastructure. Future development would still be at risk of flooding.

Alternative 4a: Construction activities associated with this alternative are not likely to affect land use as the construction would occur in already developed areas and would only result in localized impacts directly to FRM system infrastructure. Upon completion, this alternative would result in minor long-term beneficial effects on recreation by reducing flood risk associated with both levee breaches and interior drainage flooding at all locations. This is because reduction in flooding would allow redevelopment opportunities in areas that may have otherwise been considered undesirable due to flood inundation. Overall, the substantial reduction in flood risk would minimize the potential for extreme flooding to occur, improving desirability of the land and promote redevelopment projects.

6.4.2 Transportation

Alternative 1 – No Action: It is expected that the NAA would have moderate short-term adverse effects on transportation due to temporary flooding limiting bus transit routes. Hartford and East Hartford are closely connected by an extensive, integrated transportation network that includes local and regional bus service, commuter and freight rail, and multiple major roadways. The two communities rely on three primary bridge crossings over the Connecticut River that carry interstate highways, state routes, and local roads, serving as critical links for daily commuting, emergency response, freight movement, and public transit operations. Because the existing FRM system would remain vulnerable to extreme flood events under the NAA, recurrent flooding is expected to inundate or restrict access to major roads, highway interchanges, and bridge approaches. Flood-related closures would disrupt traffic flow, increase congestion, and force lengthy detours, reducing the reliability of the regional transportation network. Public transit service would be particularly affected, as bus routes and rail access depend on these roadways and crossings; flooding would severely limit available routes, reduce service frequency, and impair connectivity between Hartford and East Hartford. Over time, repeated transportation disruptions would adversely affect commuter mobility, access to employment and essential services, and overall regional transportation efficiency.

Alternative 2a: Construction activities associated with this alternative are not expected to impact transportation as buses will not be prevented from operating on their normal routes. Upon completion, this alternative would result in minor long-term beneficial effects on transportation by partially reducing flood risk associated with levee breaches and reducing interior drainage flooding. In East Hartford, measures addressing LB3 would reduce flooding impacts to nearby roadways and transportation corridors; however, flood risks associated with LB2, which encompasses a larger and more critical flood-prone area, would remain unmitigated. In addition, this alternative does not reduce levee breach risks in Hartford, leaving much of the regional transportation network vulnerable to flooding during major storm events. Interior drainage measures would also beneficially impact transportation, although to a smaller degree than breach measures. However, as interior drainage flooding begins impacting roadways around a 25-year flood event, these measures to address interior drainage flooding could be more impactful than breach measures. Because there would be no breach measures in Hartford and a measure addressing partial breach issues in East Hartford, residual flood risk would persist in both communities, limiting the overall beneficial effects on transportation.

Alternative 3: Construction activities associated with this alternative are not expected to affect transportation, as work would be limited to existing FRM system infrastructure and buses will not be prevented from operating on their normal routes. Upon completion, this alternative would result in minor long-term beneficial effects on transportation by reducing flood risk associated with levee breaches. By minimizing the extent of breach-related flooding, this alternative would reduce the likelihood of widespread inundation of major roadways, bridge approaches, and transportation corridors during extreme flood events. Reduced breach flooding would improve regional mobility and enhance access for emergency response services during severe storms. However, Alternative 3 does not include interior drainage improvements. Interior drainage flooding, which typically occurs during more frequent storm events (e.g., 25-year storms), would continue to impact roadways, although the flood prone areas are much smaller than levee breach flooding. As a result, localized transportation disruptions, including roadway closures and reduced transit reliability, would persist.

Alternative 4a: Construction activities associated with this alternative are not expected to affect transportation, as work would be limited to existing levee and pump station infrastructure and buses will not be prevented from operating on their normal routes. Upon completion, this alternative would result in moderate long-term beneficial effects on transportation by reducing flood risk associated with levee breaches and interior drainage. Implementation of levee breach mitigation measures would reduce the extent of widespread inundation during extreme storm events, protecting major roadways, bridge approaches, and critical transportation corridors that serve as primary connections between Hartford and East Hartford. This would improve regional mobility, reduce the likelihood of prolonged roadway closures, and enhance access for emergency response and transit services during severe flooding events. In addition, interior drainage improvements would address flooding that occurs during more frequent storm events, such as 25-year storms. By reducing the frequency and severity of these flooding events,

this alternative would improve day-to-day transportation reliability, maintain access to businesses and residences, and support uninterrupted public transit operations.

6.4.3 Critical Infrastructure

Alternative 1 – No Action: The NAA would likely lead to moderate long-term adverse effects on essential services that local communities and the wider Hartford area depend on. Recurrent flooding would not only damage equipment but also inundate or block access to critical facilities (e.g., WWTP, CNG, Eversource), causing a domino effect of service disruptions across various sectors. Widespread power outages are a primary concern, as flooding can damage substations and other vital equipment, leading to long-term disruptions, leaving residents without power for weeks. Flooding could damage WWTP and stop the collection and treatment of sewage. Ultimately floodwaters could contaminate drinking water supplies with sewage and chemicals, posing significant health risks and requiring costly remediation. Power production would be negatively affected. Power and communication lines can also be damaged, disrupting telephone and internet services. Additionally, the main offices and power stations are located within the flooding zone, further risking loss of service. Furthermore, medical facilities can become damaged or inaccessible, compromising their ability to provide essential care during an emergency. The economic and social consequences of such infrastructure failures are profound, resulting in significant direct repair costs and indirect losses from business interruptions. The NAA would perpetuate a cycle of flood-related damage and disruption, with significant and lasting consequences for the well-being and prosperity of the entire region.

Alternative 2a: This alternative's construction activities are not anticipated to impact critical infrastructure as the work would be limited to existing FRM system infrastructure. Post-completion, the project is projected to yield only minor, long-term beneficial effects by partially mitigating flood risks from levee breaches and interior drainage flooding. In East Hartford, the planned measures for the EHLB3 levee segment would reduce flood impacts on infrastructure south of Route 2, including the WPCF, otherwise known as a WWTP, and the CT Natural Gas facility, especially during high-magnitude flood events. However, a significant vulnerability persists, as the more extensive and critical EHLB2 area remains unmitigated. A major deficiency of this alternative is the complete omission of levee breach risk reduction in Hartford, leaving its critical infrastructure vulnerable. While interior drainage improvements would lessen flood damage to distributed infrastructure like power, communication, and sewer lines, the risk to major facilities remains. For example, the Hartford WWTP/WPCF is vulnerable in a 50-year flood event because flood modeling shows inundation beginning at a 50-year storm event, posing a risk of untreated wastewater to mobilize and a risk of damage to equipment. The CNG facility in East Hartford and solid waste facilities in Hartford are at risk in a 200-year event due to projected flood inundation and risks similar to the WWTP. Due to the absence of breach countermeasures in Hartford and only partial measures in East Hartford, a substantial residual flood risk will persist, constraining the overall benefit to critical infrastructure.

Alternative 3: Construction for this alternative is not expected to impact critical infrastructure, as the work is confined to the existing FRM systems without requiring in-

water activity or impacts on critical services. Upon completion, the alternative provides notable long-term benefits by reducing the risk of catastrophic flooding from levee breaches. This mitigation would protect power, wastewater, medical, and other essential systems from widespread inundation, thereby improving their reliability and reducing potential replacement costs. However, the alternative's primary limitation is its failure to address interior drainage issues. Consequently, critical infrastructure will remain vulnerable to flooding from more frequent, smaller storm events (such as 25-year storms) which would expose the infrastructure to flood inundation and risk damage to equipment (e.g., WWTP, CNG). While the affected areas are smaller than those in a levee breach scenario, these persistent service disruptions and associated community costs would continue unmitigated.

Alternative 4a: Construction for this alternative is not expected to disrupt critical infrastructure, as work will be confined to existing levee and pump station sites. Upon completion, this alternative will provide moderate long-term benefits to critical infrastructure by offering a comprehensive solution that reduces flood risk from both major levee breaches and more frequent interior drainage issues. By mitigating large-scale inundations from extreme storms, the project will protect essential structures, equipment, and access to critical services within the FRM system's protected area. Simultaneously, the interior drainage improvements will address localized flooding from smaller storms (e.g., 25-year events), enhancing the day-to-day reliability of services. This dual approach not only reduces potential repair and replacement costs but also fosters a more resilient environment conducive to future infrastructure investment in the Greater Hartford area.

6.5 ECONOMIC ENVIRONMENT

6.5.1 Socioeconomics & Demographics

Alternative 1: The No Action Alternative will have temporary, minor adverse effects on socioeconomic and demographic trends in Hartford and East Hartford. Levee breach or interior drainage flooding would inundate businesses and community facilities, impeding access to places of work and potentially decreasing productivity. Damages to infrastructure would require construction and could be costly to property owners or residents.

Alternative 2a: This alternative's construction activities are not anticipated to impact socioeconomics or demographics as the work would be limited to the existing FRM system infrastructure. No residences or community and public facilities would be affected. Upon completion, this alternative would have a beneficial effect on the resource by reducing the risk of loss of life and property due to flooding events.

Alternative 3: This alternative's construction activities are not anticipated to impact socioeconomics or demographics as the work would be limited to the existing FRM system infrastructure. No residences or community and public facilities would be affected. Upon completion, this alternative would have a beneficial effect on the resource by reducing the risk of loss of life and property due to flooding events.

Alternative 4a: This alternative's construction activities are not anticipated to impact socioeconomics or demographics as the work would be limited to the existing FRM system infrastructure. No residences or community and public facilities would be affected. Upon completion, this alternative would have a beneficial effect on the resource by reducing the risk of loss of life and property due to flooding events.

For additional information on general Hartford and East Hartford population demographics and vulnerabilities, refer to **Appendix 1-F: Comprehensive Benefits** Section 2.1.6.1.

6.5.2 Economy & Unemployment

Alternative 1: The No Action Alternative will have no impacts on the economy and unemployment in Hartford and East Hartford, compared to the FWOP condition. The two conditions are synonymous.

Alternative 2a: This alternative is projected to positively impact the Hartford and East Hartford economies and reduce expected unemployment relative to the FWOP condition. Rehabilitation of North and South Meadows pump stations in Hartford, and Meadow Hill pump station in East Hartford will reduce flooding depths and extents within their drainage areas during rainfall events. These are commercialized areas with a high amount of businesses, so flood risk reduction will prevent likelihood of business closures and resulting layoffs. Similarly, toe drain replacement in East Hartford Levee segments 4 through 6 will reduce the risk of levee breach flooding that would impact the Meadow Hill area, as well as to portions of the commercial district north of it.

Alternative 3: This alternative is projected to positively impact the Hartford and East Hartford economies and reduce expected unemployment relative to the FWOP condition. In Hartford, the Dutch Point floodwall joint displacement repair will reduce risk of levee breach flooding that would impact the commercialized metropolitan area of Hartford just east of the Founders Bridge, as well as North Meadows and South Meadows. These are all commercialized areas with a high amount of businesses, so flood risk reduction will prevent likelihood of business closures and resulting layoffs.

In East Hartford, toe drain replacement levee segment 2 will reduce the risk of levee breach flooding that would impact the Meadow Hill area and the entire commercial district north of it. This flooding is extensive, and would also impact residential communities to the east of Prospect Street and west of Main Street. Repair to the Main Street closure structure will further reduce the probability of levee breach flooding that would impact the Meadow Hill area, as well as to portions of the commercial district north of it.

Alternative 4a: This alternative provides the highest amount of flood risk reduction to benefit the economy and employment in the study area. This is equivalent to the sum of Alternatives 2 and 3. This is equivalent to the sum of Alternatives 2 and 3. In East Hartford, it mitigates flood risk to structures within the Meadow Hill area, EHBL2 and EHBL3 locations. In Hartford, it mitigates flood risk to structures within South Meadows, North Meadows, and the connecting metropolitan area protected by the Dutch Point floodwall.

The resulting positive impacts to the Hartford and East Hartford economies and expected unemployment levels are the most substantial and widespread.

6.5.3 Structure Inventory

Alternative 1: The No Action Alternative will have no difference in impact on the structure inventories of Hartford and East Hartford, compared to the FWOP condition. Risk of levee breach in Hartford at the Dutch Point floodwall, and in East Hartford levee sections 2, 4, 5, and 6, will remain unchanged over the 50-year period of analysis. Similarly, mechanical reliability of North and South Meadows pumping stations in Hartford, and Meadow Hill in East Hartford, will continue to degrade over the next 50 years. This will increase risk of pump failure and increased interior drainage flooding during the period of analysis. Commercial, industrial, and residential structures within the Hartford and East Hartford study areas will be at increased risk of both levee breach flooding and interior drainage flooding.

Alternative 2a: This alternative is projected to yield long-term beneficial effects by mitigating flood risks from levee breaches and interior drainage flooding. In East Hartford, the planned measures for the EHLB3 levee segment (levee segments 4, 5, & 6) would reduce flood impacts on residential and commercial structures south of Route 2, especially during high-magnitude breach events (62.5% and 75% levee loading scenarios). However, the flood risk to EHLB2 area, which contains a mix of commercial and residential communities, remains unmitigated. The drainage area of Meadow Hill's pumping station contains a growing business park which will soon also house hundreds of mixed-use apartments. Alternative 2 will significantly reduce flood risk to these structures. In Hartford, interior drainage flooding in North Meadows and South meadows area is also significantly reduced. Commercial and industrial buildings in North Meadows such as vehicle dealerships benefit significantly. Similarly in South Meadows, airport-related facilities, as well as wholesale, retail, and industrial buildings benefit from flood risk reduction,

Alternative 3: This alternative will reduce levee breach-related flood risk to structures but will not impact flood risk caused by degraded interior drainage capacity from pumping stations. In East Hartford, EHLB2 levee segment (segment 2) toe drain replacement, and the Main Street closure structure repair (EHBL3 area) provide flood risk reduction to the commercial and residential structures in Meadow Hill, as well as north to the Connecticut River east bank, This extends East to Main Street. In Hartford, the Dutch Point Floodwall Joint Displacement will reduce levee breach risk to commercial and industrial structures within North Meadows, South Meadows and the metropolitan area between the two locations. The area between North and South Meadows consists largely of commercial structures, and sits West of the Connecticut River and East of Weathersfield Ave/Main Street.

Alternative 4a: This alternative provides the highest amount of flood risk reduction to structures in the study area. This is equivalent to the sum of Alternatives 2 and 3. In East Hartford, it mitigates flood risk to structures within the Meadow Hill area, EHBL2 and EHBL3 locations. In Hartford, it mitigates flood risk to structures within South Meadows,

North Meadows, and the connecting metropolitan area protected by the Dutch Point floodwall.

For additional information on the interior drainage measures' structure inventories, reference **Appendix 1-G: Economic Analysis**. For additional information on the levee breach measures' structure inventories, reference Hartford and East Hartford Chapter 6 Consequences Reports.

6.5.4 Infrastructure and Installation Resilience

The resilience analysis reviewed vulnerability assessment results from the USACE Civil Works Vulnerability Assessment Tool and detected no obvious change in risk ranking, relative to the other rated hydrologic units in the continental US, Alaska and Hawaii, through 2100. For detailed information on the Infrastructure and Installation Resilience analysis, refer to section 7.6.3.

7.0 TENTATIVELY SELECTED PLAN

As shown in **Table 39**, the TSP is an entirely structural plan that includes replacement and rehabilitation of critical elements of both the East Hartford and Hartford FRM systems, including critical components for three pump stations. Other system features addressed by the TSP are floodwalls, toe drains, sluice gates and embankments. **Figure 69** is a map of the locations of each measure included in the TSP.

Table 39: Components of the Tentatively Selected Plan

Alternative 4a – Combined Plan (Alternative 2A + 3) with Pump Station Rehabilitation

- Pump Station Rehabilitation
 - North Meadows Pump Station (*Hartford*)
 - South Meadows Pump Station (*Hartford*)
 - Meadow Hill Pump Station (*East Hartford*)
- Replace Sluice Gates on the Park River System (*Hartford*)
- Dutch Point Floodwall Joint Displacement Repair (*Hartford*)
- Filter Blanket at Main Street Closure Structure - Seepage Risk (*East Hartford*)
- Toe Drain Replacement - Segments #4, #5 & #6 – Seepage Risk (*East Hartford*)
- Toe Drain Replacement – Segment #2 – Seepage Risk (*East Hartford*)

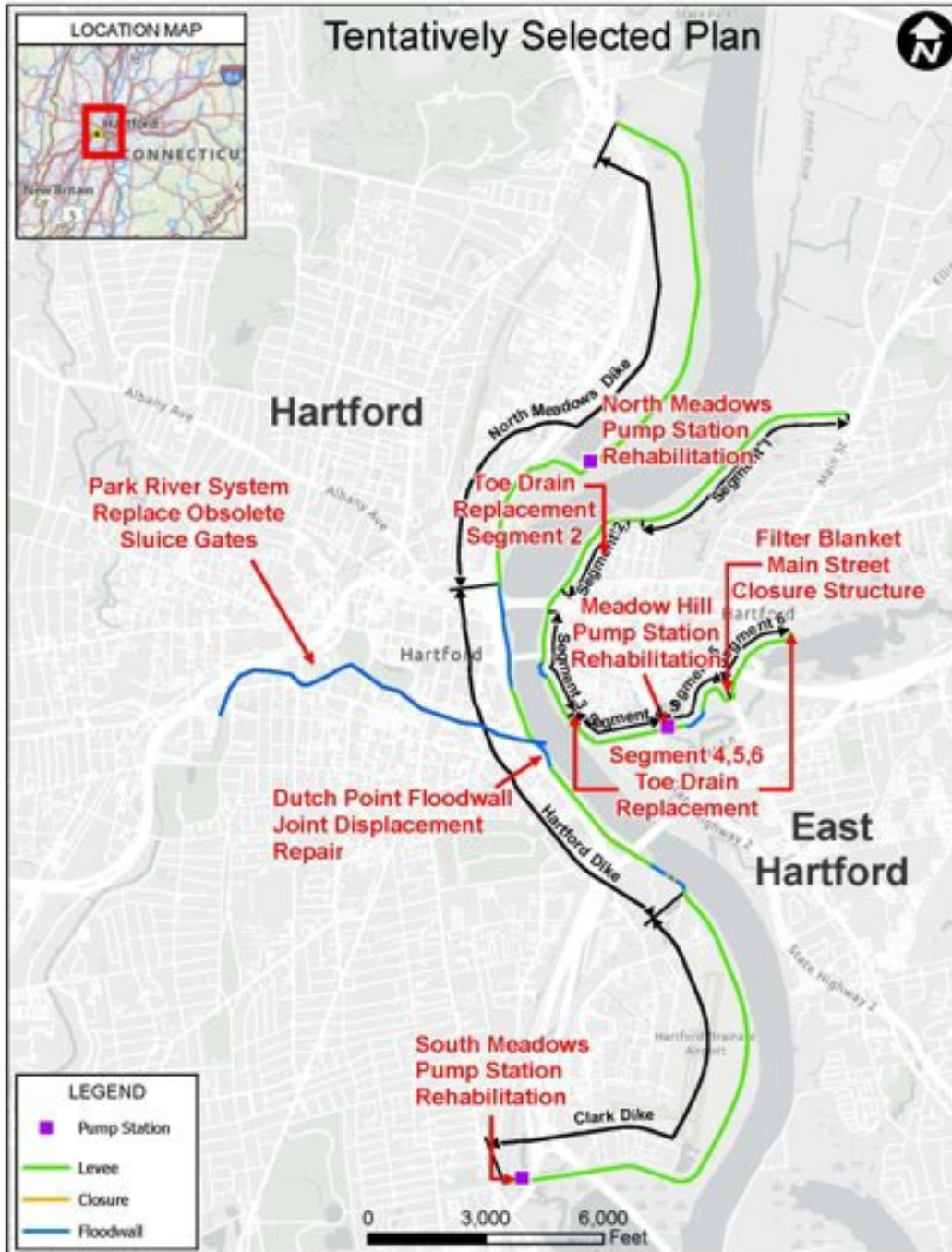


Figure 45: Locations of the Components of the Tentatively Selected Plan

7.1 PLAN COMPONENTS

7.1.1 Pump Station Rehabilitation

The three proposed pump station rehabilitations share many similarities. Architecturally, the planned improvements for each station include cleaning the exterior facades, recaulking existing windows, and replacing exterior doors, frames, and hardware. A new ethylene-propylene-diene-monomer roof system will also be installed. For the interior, the

scope involves power-washing all surfaces and repainting the engine rooms with epoxy paint. Structurally, the proposed work consists of repairing building wall and foundation cracks, along with potential thru-wall conduit repairs. From an electrical standpoint, the pump stations will receive new standby generators, transformers, and distribution systems, in addition to new LED lighting and lightning protection. Finally, the mechanical repairs will involve replacing existing pumps, gear boxes, valves, and components. The plans also include tuning-up and rebuilding the engines (**Figure 70**) and installing new ventilation systems.

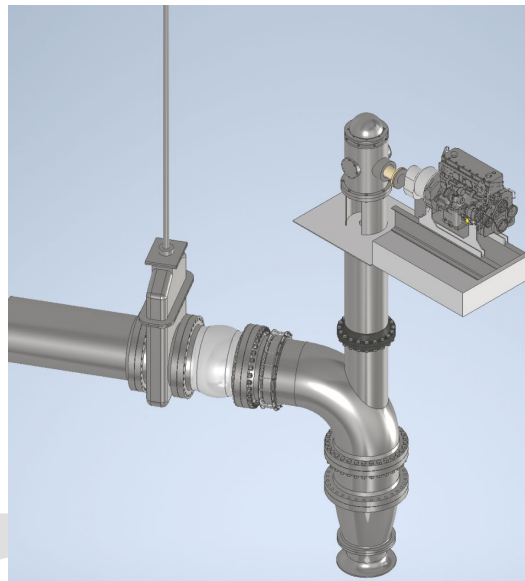


Figure 70: Example Design Image of an Engine Rebuild with Pump and Component Replacements

The proposed rehabilitations also include several unique scopes specific to certain pump stations. At the North and South Meadows Pump Stations, the plans involve replacing the boiler and upgrading the existing steel catwalk and stair systems to new aluminum ones. Additionally, both the Meadow Hill and North Meadows Pump Stations will have their existing sluice gates replaced. Exclusive to the South Meadows Pump Station, the scope includes installing new windows in the engine room and providing new toilet fixtures.

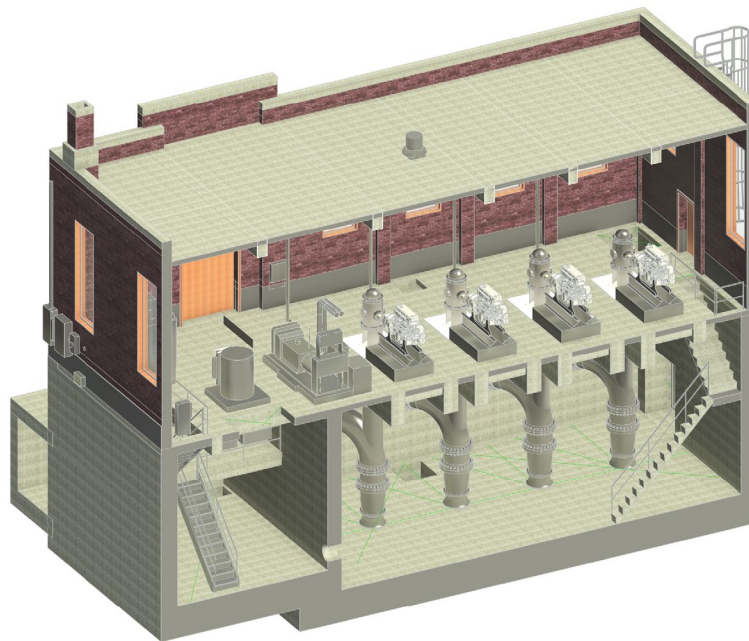


Figure 71: Building Information Model of a Pump Station

7.1.2 Dutch Point Floodwall Joint Displacement Repair

The proposed design to address the Dutch Point Floodwall Joint Displacement (**Figure 72**) consists of installing minipiles on the landside of the floodwall and attaching the minipiles to the floodwall foundations using steel brackets. The minipiles would be installed to depths of about 75 feet below the existing grades to derive their allowable load bearing capacity of about 25 tons per pile from end-bearing in dense glacial till soils. The minipiles will prevent further settlement and rotation of the floodwall monoliths during flooding events. Following installation of the minipiles, the joint in the floodwall would be repaired by installing a new waterstop at the displaced joint in the floodwall to prevent any potential leaks. **Figure 73** shows a sketch of the existing floodwall monolith and also the proposed minipile support system.



Figure 72: Joint Displacement at the Dutch Point Flood Wall Location, Hartford

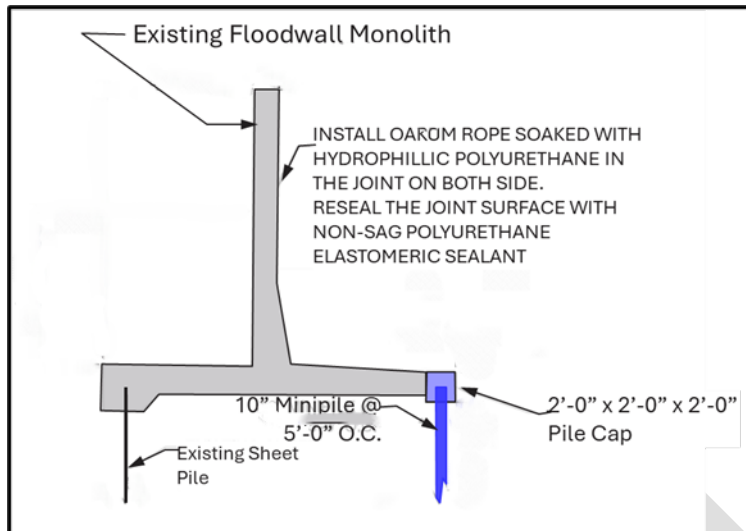


Figure 73: Proposed Mini Pile Design to be Attached to Existing Floodwall Monolith at the Dutch Point Flood Wall Location, Hartford

7.1.3 Sluice Gates Replacement on the Park River System

The TSP addresses critical deficiencies in the aging sluice gates managed by the city of Hartford of the Park River FRM system. Installed in the 1980s, gates of this age exhibit significant corrosion and mechanical wear, necessitating repair or replacement. Although initial assessment of the structural condition of the upper concrete chambers varies from good to poor (**Table 40**), the measure is complicated by a major design flaw: most upper chambers were not designed to allow for maintenance or replacement of the mechanical systems. Consequently, the concrete must be demolished to access the components for service or replacement. Once complete, the chambers can be rebuilt with new precast sections.

While the Hartford DPW has provided initial photo documentation, USACE has not yet performed a direct inspection due to confined space safety requirements. Therefore, the current project cost estimate takes a conservative approach, budgeting for the replacement of all 15 gates. During the Pre-construction Engineering and Design (PED) phase, a thorough inspection will be conducted to identify which gates are structurally and mechanically sound and can be excluded from replacement. To date, one gate (Gate 16) is confirmed to have failed and is already slated for replacement.

The condition of the concrete chambers and appurtenant structures for the sluice gates, including engineering notes, measurements, and photographs, can be found in Chapter 5 of the **APPENDIX 2-G: Structural Engineering**. Discussion of the sluice gate condition can be found in the **APPENDIX 2-C: Mechanical Engineering**.

Table 40: Structural Damage Summaries of the Concrete Sluice Gate Chambers

Sluice Gate #	Damage and Repair Description
Sluice Gate 6	<p><u>Damage</u>: Minor exterior spall to upper chamber. Minor interior spall on the top of the lower chamber. No rebar exposed.</p> <p><u>Proposed Repair</u>: Continue to monitor and repair if rebar is exposed.</p>
Sluice Gate 9	<p><u>Damage</u>: Spalled concrete with exposed rebar in interior of upper chamber.</p> <p><u>Proposed Repair</u>: Upper Chamber to be replaced with precast segments.</p>
Sluice Gate 11	<p><u>Damage</u>: Spalled concrete with exposed rebar in interior of upper chamber.</p> <p><u>Proposed Repair</u>: Upper Chamber to be replaced with precast segments.</p>
Sluice Gate 12	<p><u>Damage</u>: Exterior concrete has widespread spalling with exposed and corroded rebar and rusty efflorescence. Interior major cracks with exposed rebar in the upper chamber. Interior white efflorescence in the lower chamber.</p> <p><u>Proposed Repair</u>: Upper Chamber to be replaced with precast segments. Install bollards at corners to protect the concrete from traffic.</p>
Sluice Gate 18	<p><u>Damage</u>: Rusty efflorescence in lower chamber.</p> <p><u>Proposed Repair</u>: Continue to monitor for spalls or cracking in concrete.</p>
Sluice Gate 21	<p><u>Damage</u>: Minor spalls and white efflorescence in the interior upper chamber. Moderate spalling and cracking in the exterior upper chamber.</p> <p><u>Proposed Repair</u>: Upper Chamber to be replaced with precast segments.</p>
Sluice Gate 22	<p><u>Damage</u>: Spalling on exterior of upper chamber around manhole cover.</p> <p><u>Proposed Repair</u>: Continue to monitor and repair if rebar is exposed or if cover frame becomes loose.</p>

7.1.4 Filter Blanket at Main Street Closure Structure

A concentrated leak erosion (CLE) type internal erosion failure mode was identified as a potential risk driver at the Main Street Closure Structure. The original embankment cross section mostly consists of a large pervious fill zone constructed with free-draining river

sand that is provided with a riprap covered inclined impervious zone on the riverside of the embankment. Wing walls of the closure structure extend on either side into the embankment cross-section. As the river levels rise to the top of the closure structure, a potential CLE type failure mode could manifest at the interface of the embankment fill and the concrete wing walls.

To address CLE type internal erosion, a filter blanket will be installed on the landside of the embankment cross section. The filter blanket provides a filtered exit for seepage and reduces the probability of this CLE from causing a full breach of the levee. The replacement of the existing toe drain at this location should occur at the same time as the installation of the filter blanket. **Figure 74** shows the proposed design of filter blanket to be installed at the Main Street Closure Structure.

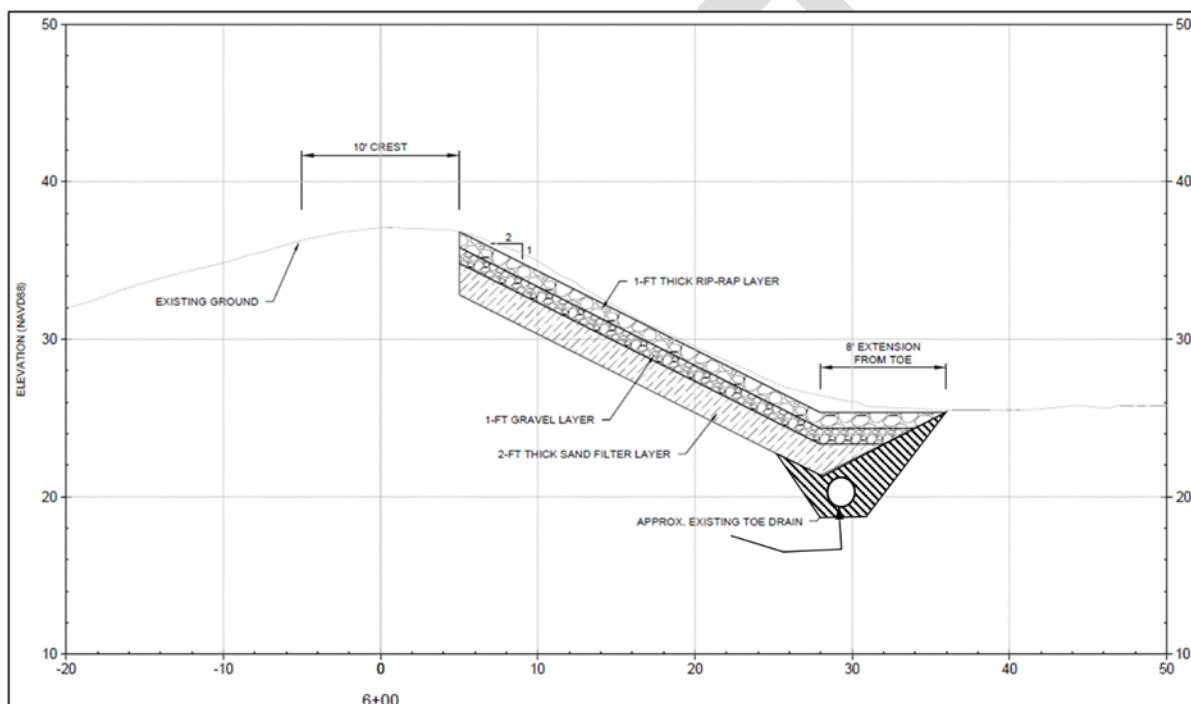


Figure 74: Proposed Filter Design on Downstream Levee Slope at the Main Street Closure Structure Location in East Hartford

7.1.5 Toe Drain Replacement - Segments #4, #5 & #6

As part of the original construction, toe drains were installed along the landside toe of the levee embankment in Segment #4, #5 and #6, to collect seepage through the embankment or foundation soils, thereby lowering the phreatic surface and reduce exit and uplift gradients. Landside toe drains, consisting of vitrified clay pipes embedded in sand and/ or gravel filter, gravel filled drains with no pipe or crushed rock toe drains with no pipe were constructed along most of the levee as part of the original construction. These toe drains were inspected in 2007 and in 2009 by the Town's consultants. These inspections revealed that the toe drain system was compromised in many locations by the infiltration of fine-grained soils into the toe drain system. In several areas, the toe drain system was either destroyed or removed. In addition, a filter compatibility study performed

by the Consultant found that the original design of the toe drains did not meet the current USACE design criteria. Based on the results of these inspections, it was concluded that toe drain system did not appear to function as originally designed. Consequently, it was assumed that no pressure relief was being provided by the toe drains that were installed at the time of original construction. Following this study, an upgraded toe drain design was adopted by the Town and the original toe drains in Segment #3 were replaced with the upgraded toe drains. The proposed measure includes the replacement of the existing toe drains in Segments #4, #5 and #6 with the upgraded toe-drain design that would meet the current USACE design criteria (**Figure**). The upgraded toe drains will be provided with manholes at several locations that would allow maintenance and inspection of the upgraded toe drain system, as required.

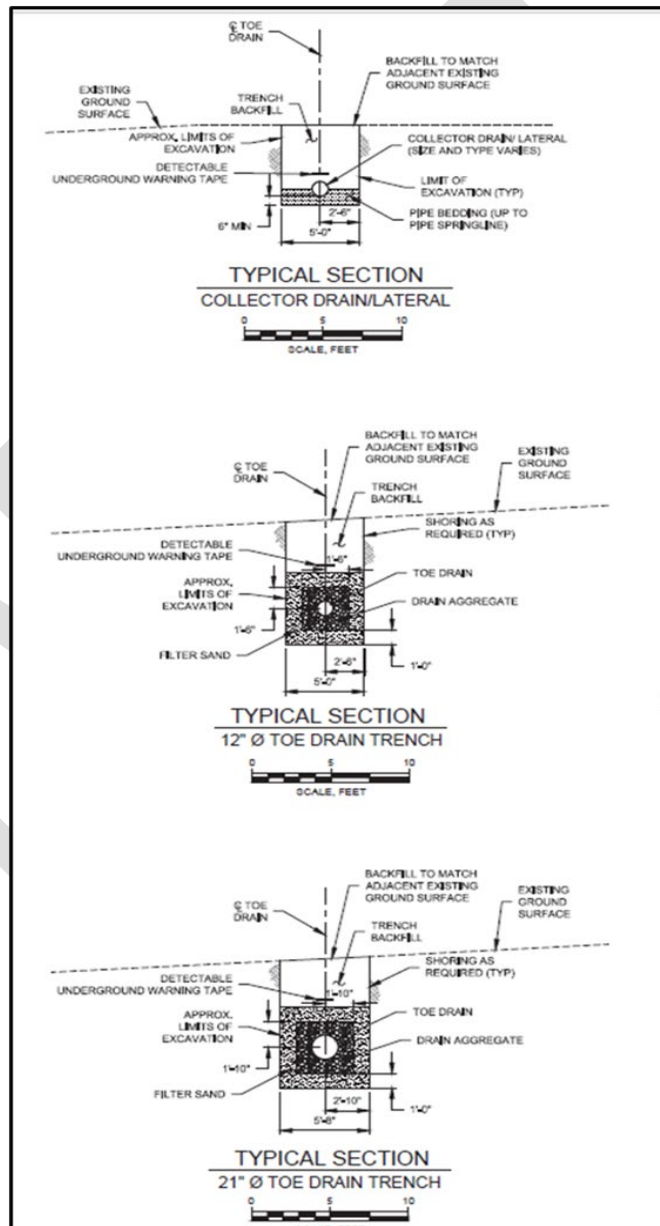


Figure 75: Typical Modern Toe Drain Design

7.1.6 Toe Drain Replacement – Segment #2

The PDT concluded that a BEP type risk driver potential seepage failure mode could occur at the location of an existing crib wall located approximately between levee Stations 116+00 to 118+00 and the floodwater could inundate the leveed area. This potential failure mode was evaluated based on the existing levee embankment cross section, the existing crib wall, the absence of a sheet pile and BEP susceptible soils conditions within the levee embankment and foundation soils. Installation of a sheet pile would be expensive solution but would not eliminate the BEP susceptible soils that are present at this location. The PDT believes that the proposed measure would be replace the old existing damaged toe drains with an updated toe drain system that would meet current USACE design criteria. The new toe drains could be surrounded by properly designed filtering materials that would be filter-compatible with both the existing embankment soils and the BEP susceptible foundation soils. Given that the Town of East Hartford has already restored portions of the existing toe drain system in Segment #3, it would be prudent for the town to continue restoring the functionality of the remainder of the toe drain system in Segment #2.

7.2 PLAN ACCOMPLISHMENTS

7.2.1 National Economic Development Benefits

The Total Project First Cost for the TSP is \$101 million. The average annual cost is \$4.2 million and average annual benefits are \$1.8 million, resulting in net benefits of -\$2.4 million and a benefits-to-cost ratio of 0.4. The complete NED cost and benefit analysis for the Recommended Plan is presented in **APPENDIX 1-G: Economic Analysis**. See **Table** for the economic summary of the TSP. The project costs were calculated using the October 2025 (FY26) Price Levels and annualized using the Federal discount rate of 3.25%.

7.2.2 Regional Economic Development Benefit

The TSP generates 1,587 full-time equivalence jobs, \$134 million in labor income, \$273 million in output, and \$160 million in total value added. For the state of Connecticut as a whole, the construction stimulus would generate approximately 1,195 Full Time Equivalent jobs, \$106 million in labor income, \$175 million in output, and \$114 million in Gross Regional Product.

The local impact area captures about 87% of the direct spending on the project. About 2% of the spending would occur in other parts of the state. The rest of the nation captures the remaining 11%. The secondary impacts, which include the combined indirect and induced multiplier effects, would account for 30% of the total output. They would also account for approximately 24% of jobs, 23% of labor income, and 32% of gross regional product in the impact area.

7.2.3 Environmental Quality Benefit

The TSP would result in minor positive environmental effects. The summary of environmental benefits provided in this section is based on the complete environmental analysis that is presented in **Section 6.0** of this report and the comprehensive benefits analysis in **APPENDIX 1-F: Comprehensive Benefits Analysis**. The environmental benefits of the TSP would include the repair, replacement, and rehabilitation of components of the FRM systems in Hartford and East Hartford, which would result in the reduction of polluted flood waters from reaching local waterways and rivers, beneficially impacting habitat and threatened and endangered species.

7.2.4 Other Social Effects Benefits

Recognizing that the full community impact of the TSP extended beyond traditional metrics like NED benefits and property damage reduction, a robust OSE analysis was conducted. This analysis was essential to fully illustrate the project's significant social and regional value.

Implementation of the TSP to rehabilitate the East Hartford and Hartford FRM systems can lead to significant social benefits that extend beyond simply preventing floods. By reducing the risk of flooding for businesses, critical infrastructure, and residential properties, the TSP fosters a sense of security and stability within the community. This reduction in uncertainty encourages residents and business owners to invest in their properties and futures, knowing their homes and livelihoods are better protected. The decrease in flood risk can also lead to lower insurance premiums and increased property values, further contributing to the economic well-being of the community.

The positive effects of a robust FRM system ripple outwards, creating opportunities for broader community revitalization. With confidence that the community can depend on the FRM system to defend the area from flooding, underutilized or previously flood-prone areas can be redeveloped into valuable community assets like needed residential properties, recreational features, or new commercial spaces. This confidence also sparks continued investment in public infrastructure and amenities, enhancing the overall quality of life.

The areas protected by the FRM systems currently support hundreds of businesses, both nationally recognized corporations and local “Mom and Pop” businesses. Rehabilitation of the FRM systems would also open doors for new business opportunities and strengthens essential services. The areas are starting to see investments in large medical facilities. Additional investment into the FRM systems could encourage other medical facilities like hospitals and nursing homes, to move into the defended areas, ensuring that these vital services can continue to serve the local community and safeguarding public health.

An improved FRM system also leads to more efficient and cost-effective O&M. Modernized systems often require less manual intervention, reducing the strain on staffing and budgets. By proactively managing flood risk, communities can shift resources

from reactive emergency response to planned, preventative maintenance, leading to a more resilient and financially stable future.

These multifaceted benefits, ranging from economic growth to improvements to critical infrastructure, demonstrate that investing in flood resilience is an investment in the long-term social and economic health of a community.

7.2.5 Pump Station Reliability and Flood Damage Reduction

The TSP is expected to substantially improve the reliability and available capacity of the North Meadows, South Meadows, and Meadow Hill Pump Stations over the study period relative to the No Action Alternative. These improvements were quantified using the same mechanical reliability analysis methods applied in the evaluation of the NAA ensuring methodological consistency between alternatives. A revised fault tree model was developed in which system components reflect the proposed replacement and rehabilitation measures included in the selected plan, allowing the analysis to capture the performance gains associated with renewed equipment and restored functionality. **Figure** shows the results of the mechanical reliability analysis for each pump station analyzed over the study period. Note that each pump station begins the study period with 100% capacity in the with project condition, as all the key pump station components are either replaced or rebuilt.

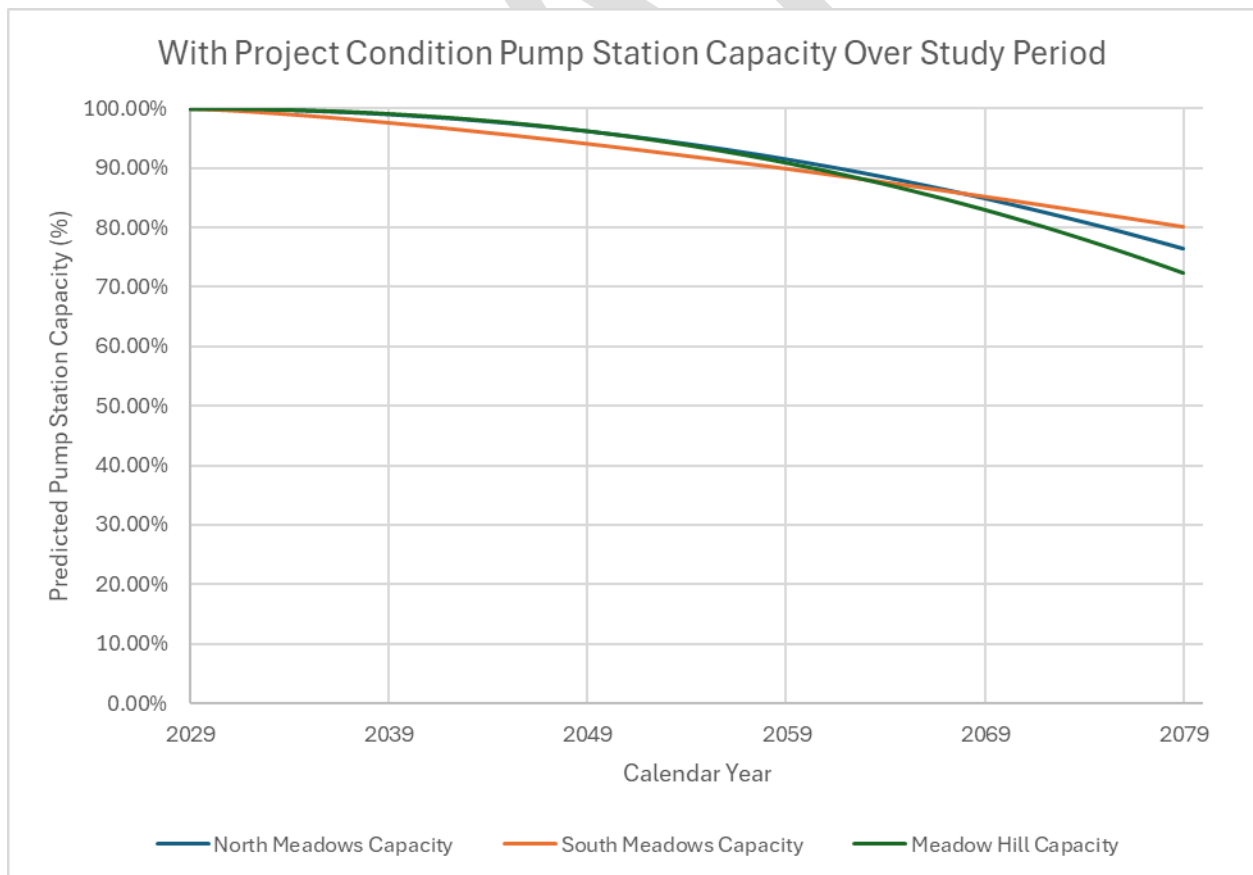


Figure 76: With Project Condition Pump Station Capacity Over Study Period

The results indicate that, although the rehabilitated pump stations would continue to experience degradation over time, they would maintain a substantially higher level of reliability and available capacity throughout the study period than for the No Action Alternative. This sustained improvement reduces the likelihood and duration of capacity shortfalls during high-water events, thereby decreasing the frequency and magnitude of interior flooding relative to the FWOP. **Figure 46** shows a comparison of the predicted capacities of the pump stations in the with project condition and the NAA. The analysis predicts an average capacity increase of about 54% for each pump station in each year over the study period.

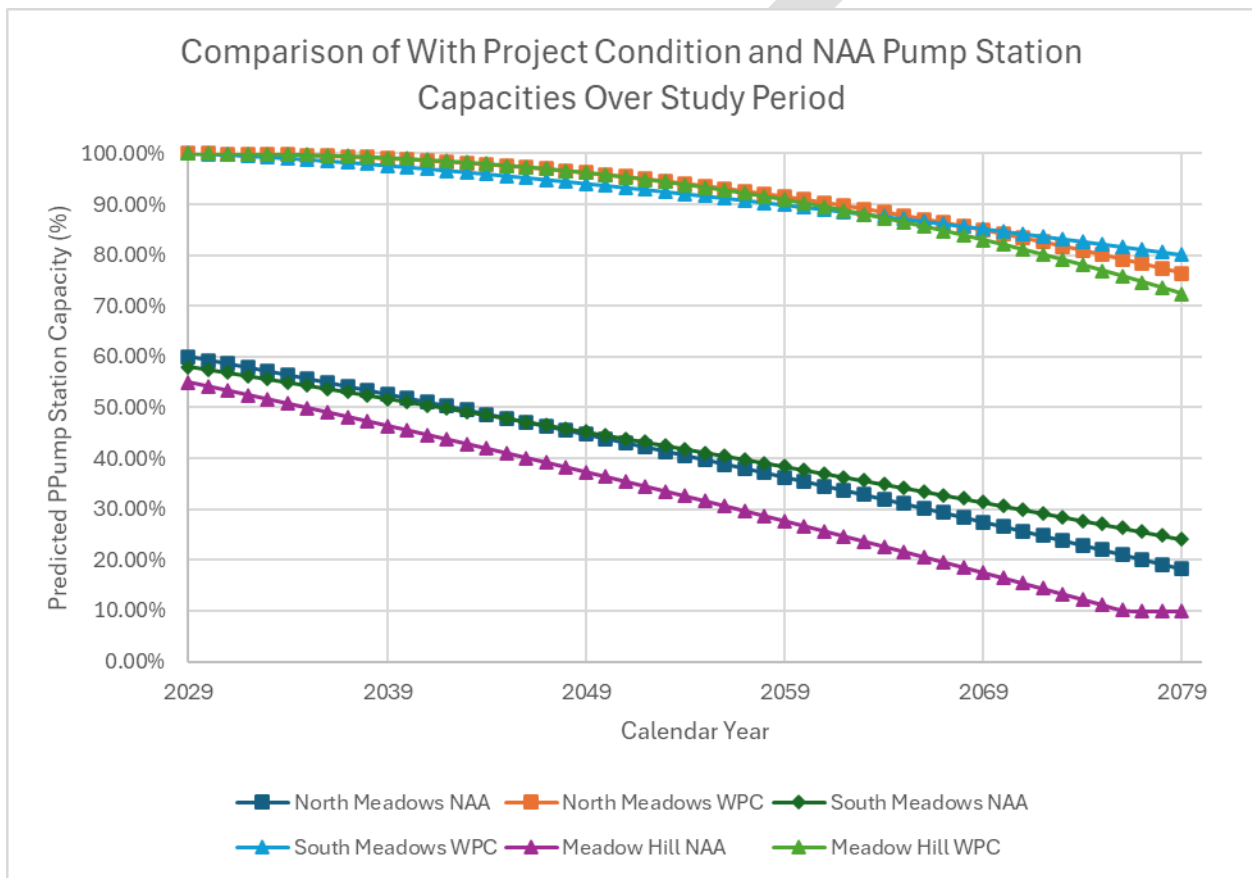


Figure 46: Comparison of the With Project Condition and No Action Alternative Pump Station Capacities Over Study Period

7.3 COST ESTIMATE

A Class 4 cost analysis was completed for the TSP Milestone. It is estimated that the total investment cost of Alternative 4a will be \$100,632,000 (**Table 41**). Total project first costs of the plan were calculated using December 2025 price levels at a federal discount rate of 3.25% for fiscal year 2026. Total project first costs are further divided by NFSs. Project costs will continue to be developed to include real estate costs, cultural resources mitigation and other project first costs.

Table 41: Economic Summary of the Tentatively Selected Plan 4a

Federal discount rate FY2026 = 3.25%, OCT 2025 Price Levels, 50-Year Period of Analysis, Costs in \$1,000	
Project First Costs	
Construction Contract Cost	\$46,077
Preconstruction Engineering & Design (PED)	\$25,803
Contingency (40%)	\$28,752
Project First Costs Total	\$100,632
Interest During Construction (IDC)	\$2,918
Total Investment Cost	\$103,550
Capital Recovery Factor	0.04073
Total Average Annual Cost	\$4,218
Average Annual Benefits	\$1,824
Net Benefits	-\$2,394
Benefit-Cost Ratio (BCR)	0.43

Project Component	Estimated Project First Costs
East Hartford FRM System	\$38,401,000
Hartford FRM System	\$62,231,000
Total Project	\$100,632,000

7.4 LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS AND DISPOSAL AREAS

The NFSs will be responsible for the acquisition of all Lands, Easements, Right of Ways, Relocations, and Disposal/Burrow Areas (LERRD) as determined necessary for completing the project, as well as for operating, maintaining, repairing, rehabilitating, or replacing the project. The TSP is primarily supported by lands owned by the NFS within the existing Flood Risk Management systems they respectively own, operate, and maintain currently and will require the acquisition of standard temporary work easements over roughly 20 properties for construction. The baseline cost estimate for real estate will be developed once appraisal of these properties have been completed. Currently, real estate costs are captured within the contingency in the current project cost estimate. Further details and maps pertaining to LERRD may be found in the **APPENDIX 1-C: Real Estate Plan**.

7.5 OPERATIONS, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

As with most Civil Works projects, NFS are solely responsible for maintaining and operating the system in perpetuity after project turnover. At construction completion of the recommended plan, the flood protection systems will be turned back over to the NFS for long-term management of the OMRR&R required. Given that this project is a rehabilitation project, USACE does not anticipate the need to develop a new O&M manual and will

instead provide the NFS updated information pertaining to any new equipment installed during construction (e.g. O&M information for new pumps).

7.6 RISK AND UNCERTAINTY

7.6.1 Levee Risk

Several components included within the TSP are expected to reduce the incremental risk of three of the risk driving potential failure modes analyzed in the risk assessments previously conducted on the FRM systems. See **APPENDIX 2-F: Geotechnical** for detailed explanations of how the components are expected to provide the risk reduction. The following is a summary of the approximate risk reduction the project team estimated the components could provide:

- The Filter Blanket at the Main Street Closure Structure (see **Section 7.1.4** for details) in East Hartford could reduce the estimated annual probability of failure by approximately two and a half orders of magnitude.
- The Dutch Point Floodwall Joint Displacement Repair (see **Section 7.1.2** for details) could reduce the estimated annual probability of failure by approximately two orders of magnitude.
- The Toe Drain Replacement (see **Sections 7.1.5** and **7.1.6** for details) along the East Hartford system could reduce the estimated annual probability of failure by approximately two orders of magnitude.

7.6.2 Cost Risk

A Cost and Schedule Risk Assessment was conducted in December 2025. The highest cost risks identified included:

- Concern regarding the availability of temporary pumps for North and South Meadows Pump Stations.

The Highest Schedule risks identified are:

- Long lead times for electrical and mechanical equipment for the pump stations.
- Phasing for final design contracts.
- Additional interior demolition at North Meadows Pump Station above what is assumed in the current cost estimate.
- Additional ancillary work at North Meadows Pump Station above what is assumed in the current cost estimate.
- Requirement for additional temporary pump capacity if South Meadows Pump Station if 100% capacity is required.
- Private road access at South Meadows Pump Station.
- CTDOT coordination for the Dutch Point measure.
- Programmatic schedule concerns so construction does not occur at the same time for certain measures.

The risks which have both high cost and schedule impacts are:

- Encountering unknown Hazardous Materials at the measure locations.
- Requirement of additional concrete replacement at sluice gates above what is assumed in the current cost estimate.
- Difficulty accessing sluice gates.
- Coordination and work adjacent to the railroad at the Dutch Point measure.

7.6.3 Infrastructure and Installation Resilience

A qualitative resilience analysis, described as a Phase 1 review in ECB 2018-14 or a Tier 1 review in ECB 2026-1, has been performed at this stage of the project.

Although Hartford and East Hartford are 45 miles upstream on the Connecticut River from Long Island Sound, there is some tidal influence. The tides are not expected to drive pump station operations, even after allowing for projected increases in sea-level, based on knowledge of operations at the pump stations. The tidal influence is seen in the USGS gage records for 2023 and 2024, where the record for a stormy July in 2023 had little trace of tides, whereas July 2024 had clear traces of tides in less stormy days. **APPENDIX 2-B1: Hydraulics & Hydrology, Levee Breach Analysis** and **APPENDIX 2-B2: Hydraulics & Hydrology, Interior drainage** modeled the system in greater detail and found that the observation of storms and smaller tidal influence was valid. The analysis also found that there is no valid statistical correlation between precipitation and the concurrent USGS gage levels (water levels) in Hartford.

In Hartford, a population of approximately 121,000 in 3,000 acres is at potential risk from flooding. In East Hartford, a population of approximately 51,000 in approximately 760 acres is at potential risk from flooding.

Features and measures considered in the resilience study have been summarized as related to:

1. *Improved floodwalls and levees*: Design could allow for incremental improvements, so that the full design would be constructed in phases.
2. *Increased pumping capacity*: The proposed improvements are unlikely to introduce new issues to the systems, regardless of whether they are implemented as new pumps or as renovations to existing pump stations. As detailed in **Appendix 2-B2: Hydraulics & Hydrology, Interior drainage**, the project's focus is on enhancing the reliability of the pump stations rather than increasing their actual capacity. The analysis acknowledged the limited scope for adding new capacity and, therefore, accepted the current design limits while reviewing the possibility of using fractional pumping capacity during a storm event.
3. *Increased detention storage adjacent to the pump stations*: Dredging to deepen or excavation to extend the existing pools at pump stations would

ameliorate any flooding at and around these areas. It was noted that increased standing water could present health and safety risks. There is limited scope for increasing the storage, due to real estate constraints in the municipalities.

4. *Increased urban development.* Urban Development remains an acknowledged source of potential harm. With more people in an inundation region, the chance that a given flooding event would have more consequences in terms of life-loss or damages increases. At the same time, an increased population density would increase the normal flows in sewer lines. This is of particular concern in East Hartford at the Meadow Hill station, where poor management of flows during a storm event would flood a sewage treatment plant.
5. *Repairs to sluice gates at pump stations:* Appropriate sluice gate flows, as designed, are impossible without operational inflow and outflow transitions. Routine maintenance and where necessary repairs and additional capacity from updated sections are therefore important.

Projected increases in flow on/from the “protected” land-side of the levee system are reviewed and summarized to assist with appropriate sizing of hydraulic pumps and storage facilities.

The resilience analysis concluded that increases in urban development are the main flood risk management concerns.

7.6.4 Background Risk

Background risk is defined as the risk of flooding and the economic and life loss consequences associated with a flooding event that overcomes the levee without failure. This would include the scenario of overtopping of the levee without breach. The Hartford and East Hartford levee systems are estimated to be overtopped by flood events with annual probabilities of approximately 1/35,000 years and 1/3,600 years, respectively.

7.7 COST SHARING

Project First Cost is the constant dollar cost of the TSP at current price levels and is the cost used in the authorizing document for a project. The “Total Project Cost” is the constant dollar fully funded cost with escalation to the estimated midpoint of construction. Total Project Cost is the cost estimate used in Project Partnership Agreements (PPA) for implementation of design and construction of a project. Total Project Cost is the cost estimate provided to the NFSs for their use in financial planning as it provides information regarding the overall non-Federal cost sharing obligation. For this project, the TSP First Cost was calculated to be \$101 million.

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 2213), project design and

implementation are cost shared 65 percent Federal and 35 percent non-Federal. The non-Federal costs include credit for the value of LERRDs. The cost share apportionments for the Project First Costs and Total Project Costs are provided in **Table 42**. The cost share for the total project cost will be included in the finalized report.

Table 34: Project First Cost (Constant Dollar Basis) Apportionment
(Fiscal Year 2026 (December 2025) price levels and 3.25% discount rate)

Project First Cost Apportionment	
Project First Cost (Constant Dollar Basis)	\$100,632,168
Federal Share (65%)	\$65,410,909
Non-Federal Share (35%)	\$35,221,258

7.8 DESIGN AND CONSTRUCTION

Before design and construction may be initiated, the USACE Chief of Engineers must approve the recommended project. Then the Chief’s Report and approved IFR/EA are provided to Office of the Assistant Secretary of the Army (Civil Works) and Office of Management and Budget for review, before transmittal to Congress for authorization. The project requires Congressional authorization to receive Federal construction funding. The project would be considered for inclusion in the President’s budget based on: national priorities, magnitude of Federal commitment, economic and environmental feasibility, level of local support, willingness of the Non-Federal Sponsor to fund its share of the project cost and the budget constraints that may exist at the time of funding.

Once Congress appropriates Federal construction funds, USACE and the Non-Federal Sponsor would enter into a project partnership agreement (PPA). In the case of this project individual PPAs may be signed with each NFS, which will include only the measures included in their municipality. This agreement would define the Federal and Non-Federal Sponsor responsibilities for implementing, operating and maintaining the project. USACE would officially request the NFS to acquire the necessary real estate immediately after the signing of this agreement. The advertisement of the first construction contract would follow certification of real estate. USACE would provide as-built drawings to the NFSs at the end of construction when the notice of completion is sent.

The schedule for project implementation shown above assumes additional authorization for the project. The detailed cost estimate assumed a construction completion date of January 2033 which is within the range of uncertainty associated with the administration’s budget process and Congressional appropriation process. The latest timeframes (**Table 43**) are subject to change based on availability of federal and non-federal funding.

Table 43: Estimated Design and Construction Schedule

Action	Estimated Start Date
Integrated Final Feasibility Report/EA to Higher Authority for Approval	September 2026
Sign Chief's Report and Chief's Report submitted to ASA (CW)	December 2026
ASA (CW) Integrated Final Feasibility Report/EA Approval	February 2027
ASA (CW) submits report to OMB	February 2027
Final Report to Congress	April 2027
Start Plans and Specifications (Design Phase)	January 2028
Execute PPA with Non-Federal Sponsor	March 2029
Finalize Plans and Specifications for Contract	June 2029
Real Estate Certification for Contract	March 2030
Ready to Advertise Contract	March 2030
Award Construction Contract with Notice to Proceed	March 2031
Construction Completion	April 2034

7.9 ENVIRONMENTAL COMMITMENTS

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, the USACE determined that historic properties may be adversely affected by the recommended plan. The USACE and the Connecticut Historic Preservation Office, entered into a Programmatic Agreement. The date that the agreement is signed will be included in the final version of this report. All terms and conditions resulting from the agreement shall be implemented in order to minimize adverse impacts to historic properties. The PA is a commitment that is to be carried forward into future planning and design.

7.9.1 Mitigation

The TSP would not have significant long-term negative impacts on the surrounding environment and there will be no effects on EFH or critical habitat. There is no mitigation required for this proposed action.

7.9.2 Monitoring and Adaptive Management

The TSP would not require monitoring or adaptive management because the plan will not negatively impact EFH or designated critical habitat.

7.10 PROJECT SPECIFIC COMMITMENTS

No project specific commitments have been made, and none are anticipated to be made throughout the course of the study.

7.11 ENVIRONMENTAL OPERATING PRINCIPLES

First introduced in 2002 and later reissued in 2012, the USACE Environmental Operating Principles (EOPs) were developed to ensure that the USACE missions include totally

integrated sustainable environmental practices (USACE 2021). The EOPs provided corporate direction to ensure the workforce recognized the USACE's role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the Nation.

Since their introduction, the EOPs have instilled environmental stewardship across business practices from recycling and reduced energy use at USACE and customer facilities to a fuller consideration of the environmental impacts of USACE actions and meaningful collaboration within the larger environmental community.

The EOP related to the human environment and apply to all aspects of business and operations. They apply across Military Programs, Civil Works, Research and Development, and across the USACE. The EOPs require a recognition and acceptance of individual responsibility from senior leaders to the newest team members. Re-committing to these principles and environmental stewardship will lead to more efficient and effective solutions and will enable USACE to further leverage resources through collaboration. This is essential for successful integrated resources management, restoration of the environment and sustainable and energy efficient approaches to all USACE mission areas. It is also an essential component of USACE's risk management approach in decision making, allowing the organization to offset uncertainty by building flexibility into the management and construction of infrastructure.

The USACE's EOPs were considered in the planning process of this study. In particular, the planning process and selection of the TSP leveraged scientific, economic and social knowledge to assess the effects of USACE actions, met the USACE's responsibility and accountability under applicable law for activities which may impact human and natural environments, worked collaboratively with individuals, groups and agencies interested in USACE's activities and employed an open, transparent process. The TSP provided a mutually supported economic and environmentally sustainable solution to flood risk reduction within the project area.

7.12 VIEW OF THE NON-FEDERAL SPONSORS

During a meetings held in early 2026, the city of Hartford and the town of East Hartford expressed support for the TSP and continuation of the feasibility analysis.

8.0 ENVIRONMENTAL AND LEGAL COMPLIANCE

8.1 ENVIRONMENTAL COMPLIANCE

The status of compliance with applicable Federal Statutes and executive orders is summarized in **Table 44**.

Table 44: Environmental Compliance Table

Federal Statutes	Citation	Compliance
Archaeological Resources Protection Act of 1979	54 U.S.C. 3001018 <i>et seq.</i>	Not applicable to this Study, as no federally owned land exists in the Study Area.
American Indian Religious Freedom Act of 1978	42 U.S.C. 1996	This project will not impede access by Native Americans to sacred sites, possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.
Bald and Golden Eagle Protection Act	16 U.S.C. 668 <i>et seq.</i>	No bald or golden eagles will be impacted by the proposed project.
Clean Air Act	42 U.S.C. 7401 <i>et seq.</i>	Public notice of the availability of this report to the USEPA is required for compliance pursuant to Sections 176c and 309 of the Clean Air Act. A Public Notice will be published, and coordination is ongoing.
Clean Water Act	33 U.S.C. 1251 <i>et seq.</i>	There is no in-water work. An analysis of impacts to water quality under Section 404 of the Clean Water Act is not required and a Clean Water Act (Section 401) Water Quality Certificate is not required.
Coastal Barrier Resources Act	16 U.S.C. 3501 <i>et seq.</i>	No properties within Coastal Barrier Resources Act Units have been identified for nonstructural measures.
Coastal Zone Management Act	16 U.S.C. 1451	Not applicable; this project is not within the Connecticut coastal zone.
Endangered Species Act of 1973	16 U.S.C. 1531 <i>et seq.</i>	Current lists of threatened and endangered species were obtained through the USFWS IPaC tool. USACE has determined that the Proposed Action will not affect the proposed endangered tricolored bat (<i>Perimyotis subflavus</i>) and the proposed threatened monarch butterfly (<i>Danaus plexippus</i>). USACE has made the determination that the proposed action will not jeopardize the continued existence of the tricolored bat or the monarch butterfly, and conference with USFWS is not required. USACE has also determined that there will be no effect on the endangered/threatened Atlantic sturgeon (<i>Acipenser oxyrinchus oxyrinchus</i>), the endangered shortnose sturgeon (<i>Acipenser brevirostrum</i>), or designated critical habitat for the New York Bight distinct population segments of Atlantic sturgeon. No other designated critical habitat occurs within the action area.
Estuarine Areas Act	16 U.S.C. 1221 <i>et seq.</i>	Not applicable. The project areas are not located near any estuarine areas.
Federal Water Project Recreation Act	16 U.S.C. 4601-12 <i>et seq.</i>	Public notice of availability to the project report to the NPS and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.

Federal Statutes	Citation	Compliance
Fish and Wildlife Coordination Act	16 U.S.C. 661 <i>et seq.</i>	Development of the EA and coordination with federal and state wildlife agencies signifies compliance under this act.
Land and Water Conservation Fund Act of 1965	54 U.S.C. 200301 <i>et seq.</i>	Public notice of the availability of this report to the NPS and the Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.
Magnuson-Stevens Act Fishery Conservation and Management Act	16 U.S.C. 1855	No in-water work for the TSP. An EFH Assessment is not required.
Marine Mammal Protection Act of 1972	16 U.S.C. 1361-1407	Not applicable. The project area is not located near the ocean and marine mammals will not be present within the project area.
Marine Protection, Research, and Sanctuaries Act of 1972	33 U.S.C. 1401 <i>et seq.</i>	Not applicable. The TSP does not involve disposal of material into ocean waters.
Migratory Bird Treaty Act	16 U.S.C. 703-712 <i>et seq.</i>	Migratory birds will not be adversely impacted by the proposed project. The TSP will occur on already developed land.
Native American Graves Protection & Repatriation Act	25 U.S.C. 3001-3013, 18 U.S.C. 1170	Regulations implementing NAGPRA will be followed if discovery of human remains and/or funerary items occur during implementation of the TSP.
National Environmental Policy Act of 1969	42 U.S.C. 4321 <i>et seq.</i>	Preparation and circulation of the draft feasibility report & EA partially fulfill requirements of NEPA. Full compliance shall be noted at the time the FONSI is issued.
National Historic Preservation Act of 1966	54 U.S.C. 300101 <i>et seq.</i>	A Programmatic Agreement will be executed between the District, the CTSHP, the Tribes, and Consulting Parties to evaluate potential adverse effects and mitigate for such effects as necessary.
Preservation of Historic and Archeological Data Act of 1974	54 U.S.C. 312501 <i>et seq.</i>	It is unlikely that the Study will result in the loss or destruction of historic or archaeological data, but measures will be taken in accordance with a Section 106 agreement to prevent adverse effects, should any be anticipated.
Rivers and Harbors Act of 1899	33 U.S.C. 401 <i>et seq.</i>	No requirements for projects or programs authorized by Congress. The proposed project is being conducted pursuant to the congressionally approved authority.
Watershed Protection and Flood Prevention Act	16 U.S.C 1001 <i>et seq.</i>	This action will not adversely impact watersheds of the rivers and streams of the United States.
Wild and Scenic Rivers Act	16 U.S.C. 1271 <i>et seq.</i>	Not applicable. There are no Wild and Scenic Rivers in or near the project area.
National Invasive Species Act	16 U.S.C. 4701 <i>et seq.</i>	Controls will be put into place during implementation to prevent the unintentional introduction of nonindigenous species.
Statues: Archaeological Resources Protection Act of 1979	16 U.S.C. 470aa – 470mm, <i>et seq.</i>	Not applicable to this project because there are no known archaeological resources within the APE warranting protection under the above referenced Act.
Executive Orders		

Federal Statutes	Citation	Compliance
Protection and Enhancement of the Cultural Environment, 13 May 1971	EO 11593	Coordination with the State Historic Preservation Officer signifies compliance.
Floodplain Management, 24 May 1977	EO 11988 and amendments	The proposed action will not increase the risk of flooding or the impact of floods on human safety, health, and welfare, nor will the action degrade the natural and beneficial values served by floodplains.
Protection of Wetlands, 24 May 1977	EO 11990	The project will avoid adverse impacts to wetlands. Circulation of this report for public and agency review fulfills the requirements of this order.
Environmental Effects Abroad of Major Federal Actions, 4 January 1979	EO 12114	Not applicable to projects located within the United States.
Accommodation of Sacred Sites, 24 May 1996	EO 13007	Access to and ceremonial use of Indian sacred sites by Indian religious practitioners will be allowed and accommodated. No adverse effects to the physical integrity of such sacred sites will occur.
Protection of Children from Environmental Health Risks and Safety Risks. 21 April, 1997	EO 13045	The project will not create a disproportionate environmental health or safety risk for children as the construction of the TSP will utilize fencing to prevent unauthorized access and will not result in an increase in health risks to children.
Federal Support of Community Efforts Along American Heritage River	EO 13061, and Amendments	Cooperation with state, local, and tribal governments, where applicable, signifies compliance.
Invasive Species	EO 13112, as amended by EO 13751	The project will not promote or cause the introduction or spread of invasive species.
Consultation and Coordination with Indian Tribal Governments, 6 November 2000	EO 13175	Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, Department of Defense Indian policy, and USACE Tribal Policy Principles signifies compliance.
Responsibilities of Federal Agencies to Protect Migratory Birds	E.O. 13186	The proposed action will not result in a measurable negative effect on migratory bird populations as the action will occur on already developed land and no buildings will be demolished.
Executive Memorandum		
Analysis of Impacts on Prime or Unique Agricultural Lands in implementing NEPA, 11 August 1980	N/A	The project will not impact Prime or Unique Agricultural Lands as the work will occur on already developed land.
White House Memorandum, Government-to-Government Relations with Indian Tribes 29 April 1994	N/A	Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, Department of Defense Indian policy, and USACE Tribal Policy Principles signifies compliance.

8.2 PUBLIC INVOLVEMENT

8.2.1 Public Coordination

Upon publication of the draft report and EA, a 30-day public notice period will allow for public comments. Comments received during the public notice period will be considered in the final feasibility report.

8.2.2 Agency Coordination

Copies of agency coordination letters are presented in **APPENDIX 1-B: *Public and Agency Coordination***. Formal and informal coordination has been and will continue to be conducted with various federal, state, and local agencies and federally recognized tribes. USFWS, USEPA, NOAA, and CTDEEP have been, and will continue to be, involved in the study process. Further refinement of mitigation needs and further development of avoidance measures will rely heavily on their expertise regarding the protection of local natural resources.

8.2.3 Cultural Resources Programmatic Agreement Coordination

Because USACE cannot fully determine the project's effects on historic properties prior to finalization of this feasibility study, a programmatic agreement has been prepared. The agreement outlines the process to identify and evaluate historic properties and avoid, minimize, and where possible, mitigate for any adverse impacts in accordance with Section 106 of the NHPA and implementing regulations 36 CFR 800. The programmatic agreement will allow USACE to complete the necessary architectural and archaeological surveys during the PED phase of the project, once the final design for the recommended plan has been completed. The programmatic agreement and additional information about the agreement is provided in **APPENDIX 1-H: *Cultural Resource Report and Background Study***.

8.2.4 Tribal Consultation

The U.S. Government has a unique legal relationship with Tribal Nations, governed by treaties, statutes, executive orders, court decisions, and the U.S. Constitution. The United States works with Indian Tribes on a Government-to-Government basis to address issues concerning Indian Tribal self-government, trust resources, Indian Tribal treaties, and other rights. As such, USACE will make good faith efforts to engage Tribes to ascertain interest in USACE projects and obtain information relevant to USACE Federal decisions.

The USACE Tribal Consultation Policy is composed of the following six principles: Tribal Sovereignty; Tribal Responsibility; Government to Government Relations; Pre-Decisional and Honest Consultation; Self-Reliance, Capacity Building, and Growth; and Natural and Cultural Resources. Specific to this action, New England District strives to establish relationships that focus on successful communications and a collaborative process that ensures Tribal involvement in project development and implementation.

Section 106 consultation was initiated with the Mohegan Tribe, the Mashantucket Pequot Tribal Nation, the Narragansett Indian Tribe, and the Wampanoag Tribe of Gay Head

(Aquinnah) in letters dated 27 June 2023 (**APPENDIX 1-B: Public and Agency Coordination**). The tribes have yet to accept our invitation for consultation but will be offered the opportunity to participate in the development of the PA and sign as an invited signatory in accordance with Section 106.

9.0 PROJECT IMPLEMENTATION REQUIREMENTS

9.1 FEDERAL RESPONSIBILITIES

The Federal government will be responsible for final design investigations, preparation of plans and specifications, contract advertisement and award, supervision and inspection of the work, management during design and construction, and post construction monitoring. The Federal government will be responsible for project compliance with Federal environmental laws and regulations, including the NEPA, consistency with the Coastal Zone Management Act, and compliance with the Clean Water Act. As the project site is located within a DHS-FEMA regulatory floodway, floodplain management shall comply with EO 11988 Floodplain Management. State coastal zone management consistency concurrence and water quality certificate would be requested early in the design effort when more detailed project drawings become available. Discussions with both state agencies indicate no significant issues exist with the timely issuance of the required state approvals for the project

9.2 ANTICIPATED NON-FEDERAL RESPONSIBILITIES

For all flood risk management funded by USACE, project costs must be shared between the local sponsor(s) and USACE. This study was authorized by Section 216 of the Flood Control Act of 1970 (Public Law 91-611).

As the NFSs, the city of Hartford, CT and the town of East Hartford, CT are required to provide 35% of total project costs relating to flood risk management. The NFSs are also responsible for 100% of operation and maintenance costs for the 50-year life of the project. The Federal share is 65% of total project costs relating to flood risk management. Total project costs include the costs of developing this report, creating plans and specifications, and completing construction. The NFSs' respective 35% cost share obligations can be in the form of a cash contribution, in-kind services, or credit for LERRDs. The NFSs are responsible for acquiring all LERRDs prior to any construction activity. Before signing the PPA, the NFSs must have secured funds to complete the non-Federal cost-sharing portion.

10.0 DISTRICT ENGINEER RECOMMENDATIONS

I recommend that the Section 216 flood risk management project, as described in this report for Hartford and East Hartford, Connecticut, be authorized in accordance with the reporting officers' TSP, with such modifications as in the discretion of the Chief of Engineers may be advisable.

In making the following recommendations, I have considered all significant aspects in the overall public interest, including environmental, social and economic effects, engineering

feasibility and compatibility of the project with the policies, desires and capabilities of the city of Hartford and the town of East Hartford and other non-federal interests. Federal implementation of the project for flood risk management includes, but is not limited to, the following required items of local cooperation to be undertaken by the non-federal sponsor in accordance with applicable federal laws, regulations, and policies:

- a. Provide 35 percent of construction costs, as further specified below:
 1. Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
 2. Provide all real property interests, including placement area improvements, and perform all relocations determined by the federal government to be required for the project;
 3. Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35 percent of construction costs;
- b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the level of flood risk reduction the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;
- c. Inform affected interests, at least yearly, of the extent of risk reduction afforded by the project; participate in and comply with applicable federal floodplain management and flood insurance programs; prepare a floodplain management plan for the project to be implemented not later than one year after completion of construction of the project; and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with the project;
- d. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the federal government;
- e. Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project to inspect the project, and, if necessary,

to undertake work necessary to the proper functioning of the project for its authorized purpose;

- f. Hold and save the federal government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the federal government or its contractors;
- g. Perform, or ensure performance of, any investigations for hazardous, toxic, and radioactive wastes HTRW that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601 et seq, and any other applicable law, that may exist in, on, or under real property interests that the federal government determines to be necessary for construction, operation and maintenance of the project;
- h. Agree, as between the Federal government and the non-Federal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the Federal government;
- i. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the owner and operator of the project for the purpose of CERCLA liability or other applicable law, and to the maximum extent practicable shall carry out its responsibilities in a manner that will not cause HTRW liability to arise under applicable law; and
- j. Comply with the stipulations outlined in the Programmatic Agreement executed between the USACE and the CTSHPO in accordance with Section 106 of the NHPA of 1966, as amended, in order to minimize adverse impacts to historic properties;
- k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655) and the Uniform Regulations contained in 49 C.F.R Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authorities as proposals for authorization and implementation funding. However, prior to transmittal to higher authority, the sponsor, the states, interested federal agencies, and other parties will be advised of any modifications and with be afforded an opportunity to comment further.

Date: _____

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12.0 LIST OF ACRONYMS AND ABBREVIATIONS

AEP	Annual Exceedance Probability
APE	Area of Potential Effect
ASTM	American Society for Testing and Materials
BCC	Birds of Conservation Concern
BEP	Backward Erosion Piping
BMP	Best Management Plan
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	Center of Disease Control
CHC	Center for Hearing and Communication
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CLE	Concentrated Leak Erosion
CO	Carbon Monoxide
CREC	Capitol Region Education Council
CSO	Combined Sewer Overflows
CSWS	Connecticut Solid Waste System
CT	Connecticut
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDOT	Connecticut Department of Transportation
CTSHPO	Connecticut State Historic Preservation Office
dB	decibel
DOD	Department of Defense
DPW	Department of Public Works
E	Endangered
EA	Environmental Assessment
EALL	Expected Annual Life Loss
EAP	Emergency Action Plan
EDR	Environmental Data Resources, Inc.
EF	Emission Factor
EFH	Essential Fish Habitat

EL	Elevation
EO	Executive Order
EOPs	Environmental Operating Principles
EQ	Environmental Quality
ER	Engineer Regulation
ESA	Endangered Species Act
FHWA	Federal Highways Administration
FEMA	Federal Emergency Management Administration
FONSI	Finding of No Significant Impact
FRM	Flood Risk Management
FRMS	Flood Risk Management System
FWOP	Future Without Project
FWP	Future With Project
g	Grams
GHTD	Greater Hartford Transit District
H&H	Hydrology and Hydraulics
HAPC	Habitat Area of Particular Concern
HBID	Hartford Business Improvement District
HEC-FDA 2.0	Hydraulic Engineering Center's Flood Damage Reduction Analysis 2.0
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System (USACE)
HEC-HMS v4.11	HEC Hydrologic Modeling System (version 4.11)
HEC-RAS	Hydrologic Engineering Center's River Analysis System (USACE)
HEC-RAS 2D	HEC-RAS (Two-dimensional)
HEC-SSP	Hydrologic Engineering Center's Statistical Software Package
hp	Horsepower
HTRW	Hazardous, Toxic, and Radioactive Waste
HUC	Hydrologic Unit Code
HVAC	Heating and Ventilation
IPaC	Information, Planning and Consultation (USWFS)
LCL	Levee Crest Level
LERRDs	Lands, easements, right-of-way, relocations, and disposal areas
LF	Load Factor
LiDAR	Light Detection and Ranging

LST v2.0	Levee Screening Tool Version 2.0 (USACE)
MDA	MIRA Dissolution Authority
MDC	Metropolitan District Commission
MIRA	Materials Innovation and Recycling Authority
NAA	No Action Alternative
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NCEI	National Centers for Environmental Information
NED	National Economic Development
NEPA	National Environmental Policy Act
NFS	Non-Federal Sponsor
NGVD29	National Geodetic Vertical Datum 1929
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO ₂	Nitrogen Dioxide
No _x	Nitrogen Oxides
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NPS	National Park Service
NRHP	National Register of Historic Places
NSI	National Structure Inventory
O ₃	Ozone
O&M	Operations & Maintenance
OASIS	Office of Aquatic Invasive Species
OMRR&R	Operations, Maintenance, Repair, Replacement, and Rehabilitation
OSE	Other Social Effects
P&G	<i>Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies</i>
Pb	Lead
PAR	Population at Risk
PDT	Project Delivery Team
PED	Pre-construction Engineering and Design
PM _{2.5}	Particulate Matter 2.5 Micrometers or Less in Aerodynamic Diameter

PM ₁₀	Particulate Matter 10 Micrometers or Less in Aerodynamic Diameter
PPA	Project Partnership Agreement
RCRA	Resource Conservation and Recovery Act
RECONS	Regional Economic System
RED	Regional Economic Development
SC	Special Concern
SCS	Soil Conservation Service
SLAT	Sea Level Analysis Tool (USACE)
SLC	Sea Level Change
SO ₂	Sulfur Dioxide
SQRA	Semi-Quantitative Risk Assessment
SWIF	System-Wide Improvement Framework
T	Threatened
T&E	Threatened and Endangered
TCB	TriColored Bat
TRG	Tolerable Risk Guideline
TSP	Tentatively Selected Plan
UCONN	University of Connecticut
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
VOC	Volatile Organic Carbon
WPCF	Water Pollution Control Facilities
WWTP	Wastewater Treatment Plant