Municipal Vulnerability Preparedness Grant

Flood Mitigation Alternatives Summary Report

February 19, 2021

Revised June 30, 2021

Walnut Street Flood Mitigation Study
City of Framingham

Sudbury River flooding at Main Street (2011)

FRAMINGHAM
MASSACHUSETTS

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&

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Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

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TABLE OF CONTENTS

Walnut Street Flood Mitigation Study

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February 19, 2021
Updated June 30, 2021

LIST OF ATTACHMENTS

EXECUTIVE SUMMARY

The Walnut Street neighborhood is amongst those identified by the City's as particularly susceptible to flooding in the City's Multiple Hazard Mitigation Plan (2017). Due to the presence of the Sudbury River and large wetland areas, much of the neighborhood is located within the 100-year and 500-year flood zones. The City identified sixteen structures within the City as suffering repetitive losses from flooding, resulting in damages of nearly $400,000 in the City's Multiple Hazard Mitigation Plan (2017). Of the loss properties within the City, the three repetitive loss properties and one severe repetitive loss property are located on Walnut Street.

The main objective of the Walnut Street Flood Mitigation Study (Study) was to develop design alternatives to mitigate not only current flooding experienced by the residents but take into account projections from future climate impacts (Year 2070). As detailed in this report, ancillary benefits such as establishing wild life corridor connectivity and ecological restoration and potential flood mitigation along Route 9 (MassDOT) could be achieved in addition to providing flooding relief to residents at Walnut Street.

As part of the Study the following were completed:

- Compilation of existing information
- Collection of on-the-ground supplemental survey data
- Conducting on-the-ground flow metering at four major culverts
- Updating and recalibrating Hydologic/Hydraulic (H/H) Models
- Completing H/H Model runs for existing conditions under design storm events (2-, 5-, 10-, 25- and 100-year frequency events)
- Developing flood mitigation alternatives including nature-based solutions
- Completing H/H Modeling of alternatives to assess flood mitigation benefits
- Completing environmental permitting assessment of alternatives
- Completing a preliminary structural condition assessment of critical culverts
- Recommending preferred flood mitigation alternatives for implementation

A total of ten (10) flood mitigation alternatives were developed and evaluated as listed below.

Flood magnification factors projected for Year 2070 were also applied to assess future flooding risks from climate change.

Summary of Sucker Brook Flood Mitigation Design Alternatives

Design Alternative	*Description (all elevations relative to NAVD88)*
01	Berm along Sucker Brook from east of 147 Walnut Street to 223 Walnut Street. Berm elevation: 154 ft
02	Create flood storage south of existing walking path from the end of Stony Brook Road to Buckminster Street, new elevated walkway 300 ft at elevation: 156 ft
03	Channel clearing and stream restoration in main channels of Sucker Brook from Main Street to Stony Brook Road.
04	Subsurface storage underneath Fuller Middle School playing fields. Total storage: 2 ac-ft
05	Redesign of Sucker Pond outlet structure. 36-inch orifice outfall at elevation: 165.4 ft Weir overflow at elevation: 168.4 ft
06	Green infrastructure installations at the Framingham Housing Authority property on Normandy Road. Treated watershed area: 2.6 acres
07	Green infrastructure installations in the Hastings Street neighborhood. Treated watershed area: 11.7 acres
08	Upsize of culvert across Main Street 36" x 54" box culvert set to same invert elevations as existing pipe.
09	Weir and flap gate installation on upstream side of culvert under Main Street. Weir crest elevation: 153.3 ft, Flap gate diameter: 2 ft, invert at 150.3
10	Acquisition of private property

Recommended Flood Mitigation Alternatives for Implementation

Each of the ten (10) alternatives were evaluated based on the following factors:

- Achieving maximum flood mitigation benefits based on H/H analysis taking into account climate impacts
- Consequence of failure of critical infrastructure
- Requiring minimal environmental permits with smaller timelines for approvals
- Relatively low design, construction and long-term operation and maintenance costs compared to the flood mitigation benefits
- Built on City/Publicly owned land

Based the evaluation following alternatives are recommended for implementation.

Alternative 8: Replace and upsize existing culvert across Main Street from 36" Dia. to 36"x54" box culvert

Alternative 2: Replace culvert with stream channel across walkway between Walnut St. and Stony Brook Rd & creating/providing additional flood storage

Alternative 3: Channel clearing and limited stream restoration to enhance conveyance capacity

Project Background

The Walnut Street neighborhood in the City of Framingham is a densely populated Environmental Justice neighborhood that has experienced historical flooding issues. Flooding events in the area have only been increasing in severity and occurrence in recent years as the City faces record-breaking storm events associated with global climate change. Framingham's Walnut Street Flood Mitigation Study reflects Framingham's commitment to better understand opportunities and threats associated with their urban waters and was one of the high priorities of Framingham's Community Resilience Building Workshop and Multi-Hazard Mitigation Plan.

Sudbury River flooding at Main Street (2011)

The Walnut Street neighborhood is amongst those identified by the City as particularly susceptible to flooding. Due to the presence of the Sudbury River and large wetland areas, much of the neighborhood is located within the 100-year and 500-year flood zones. The City identified sixteen structures within the City as suffering repetitive losses from flooding, resulting in damages of nearly $400,000 in the City's Multiple Hazard Mitigation Plan (2017). Of the loss properties within the City, the three repetitive loss properties and one severe repetitive loss property are located on Walnut Street. Several important public facilities are located within the drainage area that will be studied including MEMA headquarters, State Police Barracks, Middlesex County Courthouse, MassBay Community College, Fuller Middle School, McCarthy Elementary School, the Framingham public schools administration offices, the City's Bowditch Field Athletic & Cultural Complex, the Callahan Senior Center, the City's Parks, Recreation, & Cultural Affairs headquarters, and sewer pump stations.

As part of the initial task under the project, existing information including stormwater drainage studies, hydrologic and hydraulic modeling and reports, stormwater infrastructure design and improvements by City and Private development projects completed/in-progress or proposed within the project area were compiled.

On-the-ground survey data was collected for critical features where elevation data does not exist. This included:

- Low-point elevations for at risk structures
- Elevations of portions of roads that flood
- Elevation data for culvert and storm drain infrastructure
- Existing stream channel cross-sections along the main branch of Sucker Brook and the stream behind Walnut Street homes

On-the-ground flow metering was conducted at four minimum major culverts at three locations along the main channel of Sucker Brook to collect data regarding rainfall and waterbody and wetlands elevations.

Existing SWMM model developed for the City under Phase II SWMP was updated and recalibrated with the flow metering data and supplemental topographic survey that was collected. Modeling was then completed for existing conditions under a range of storm events (2-, 5-, 10-, 25- and 100-year frequency events) in order to better understand potential frequency of flooding and thereby the overall risks.

Flood magnification factors projected for Year 2070 were also applied to assess future flooding risks from climate change.

Flood mitigation alternatives were developed based on results from recalibrated SWMM model simulation runs of the existing conditions taking into account recommended alternatives that were developed under Phase II SWMP. Potential alternatives made special emphasis on the following:

- Acquisition of at-risk properties
- Improvements to public drainage system including culverts (i.e. Main Street) based on consequence of failure and provision for flood mitigation from climate change
- Increased flood storage
- Restoration and ecological enhancement to return natural habitat and function to floodplains

A total of ten (10) flood mitigation alternatives were developed and evaluated.

Summary of Sucker Brook Flood Mitigation Design Alternatives

Design Alternative	*Description (all elevations relative to NAVD88)*
01	Berm along Sucker Brook from east of 147 Walnut Street to 223 Walnut Street. Berm elevation: 154 ft
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10	Acquisition of private property

Each of the alternatives is described below. Figures included in Attachment A illustrate each of these alternatives.

The results from the H/H modeling to evaluate the alternatives are summarized in a technical memorandum included as Attachment B of the report.

Summary of the environmental permitting assessment of the alternatives is presented in a technical memorandum included as Attachment C of the report.

A summary of the preliminary condition assessment of critical culverts along Sucker Brook is presented in a technical memorandum included as Attachment D of the report.

Alternative 1:
Install earthen berm – Western bank of existing stream behind Walnut Street

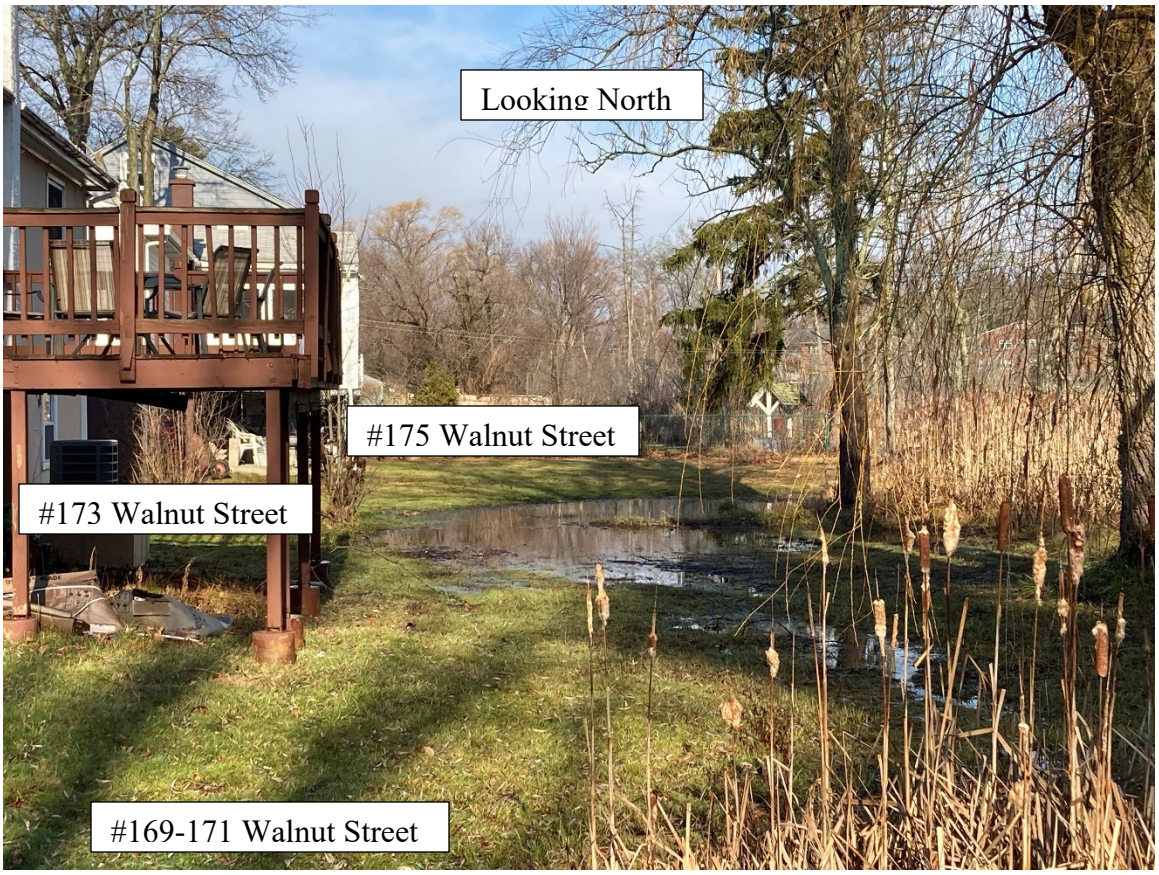
Backyards of #175 Walnut Street and adjacent homes experience flooding following heavy rains and usually coinciding with high levels of Sudbury River. As mentioned above, of the flood loss properties within the City, the three repetitive loss properties and one severe repetitive loss property are located on Walnut Street.

Backyard Flooding at #175 Walnut Street

As shown on photo below:

1. The stream behind #175, #173 and #171-169 Walnut Street has silted up with minimum channel depth, resulting in ponding in the backyards even during non-rainfall periods.
2. Due to constant ponding of water in the backyards the wetland areas east of the channel have expanded into the backyards.
3. Due to loss of a defined bank of the stream channel, backflow as a result of elevation of Sudbury River during large rain events, flows into the backyards and enters the basement especially #175 Walnut Street.

Alternative 1 proposes installation of an earthen berm approximately 700 LF with a top elevation of 154.0’ along the western bank of the stream channel. The purpose of this berm is to keep the flow to within existing stream channel and limit it from entering the backyards and basements of the homes up to a 5 to 10-year design storm rain event. During larger rain events flows are allowed to overtop the berm so as not to alter the existing floodplain. Once the flow subsides in the stream channel, a flow control structure with check valve, will drain the flows from backyards to the stream channel across the berm.

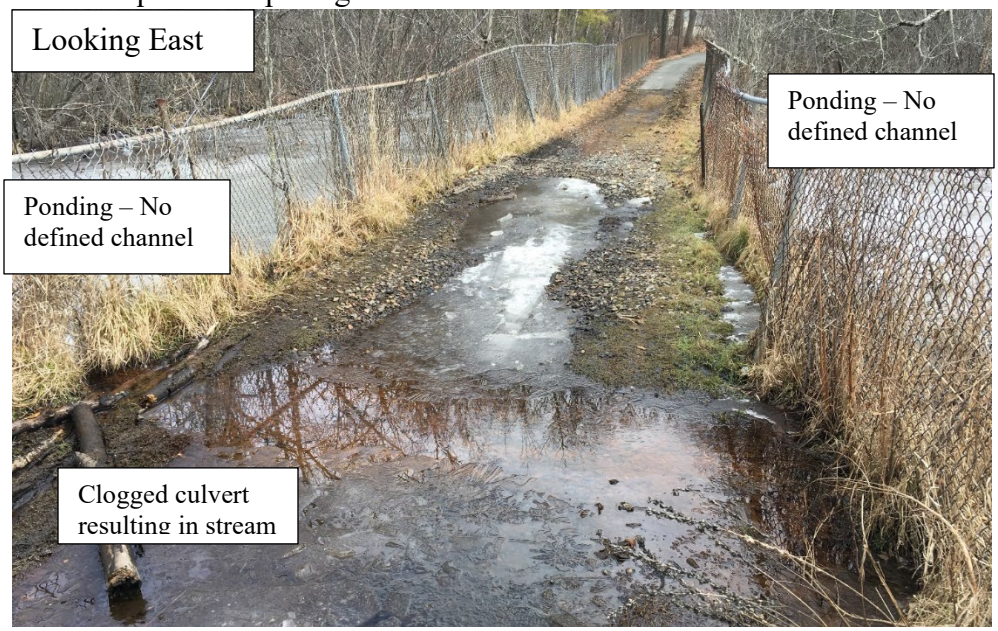


Wetland vegetation and ponding observed on December 13, 2020 behind #169-171, 173 and 175 Walnut Street

Alternative 2:
Replace culvert with stream channel across walkway between Walnut St. and Stony Brook Rd & creating/providing additional flood storage

An existing walking path has been utilized for accessing Fuller Middle School between Walnut Street and Stony Brook Road. A partially clogged 8 or 10-inch pipe across the walking path was observed in 2011; however, currently this pipe appears to be buried and inundated. As shown on the photos taken below, a natural stream seems to have been established.

It appears that the stream channel north and south of the path has been silted up resulting in ponding. In addition to making the path impassable due to standing water, available flood storage appears to have been lost/reduced. A chain-link fence on both sides of the path severely restricts wild-life and aquatic life passage.



Looking East – Stream across walking path and ponding observed on October 2, 2020.

Alternative 2 proposes the following that will address major issues:

1. Limited stream channel sediment removal from sections of the stream channel north and south of the path. This will enhance channel flow conveyance and restore flood storage capacity for large rain events. This will help alleviate the backyard and basement flooding of homes along Walnut Street.
2. Remove chain-link fence to restore wild-life and aquatic life connectivity and passage resulting in ecological benefits.
3. Install approximately 300 LF of 6’ wide boardwalk on helical piles at an elevation of 156.0’. This will provide safe passage for accessing the school year-round and provide opportunity for public to enjoy the wetland resources.

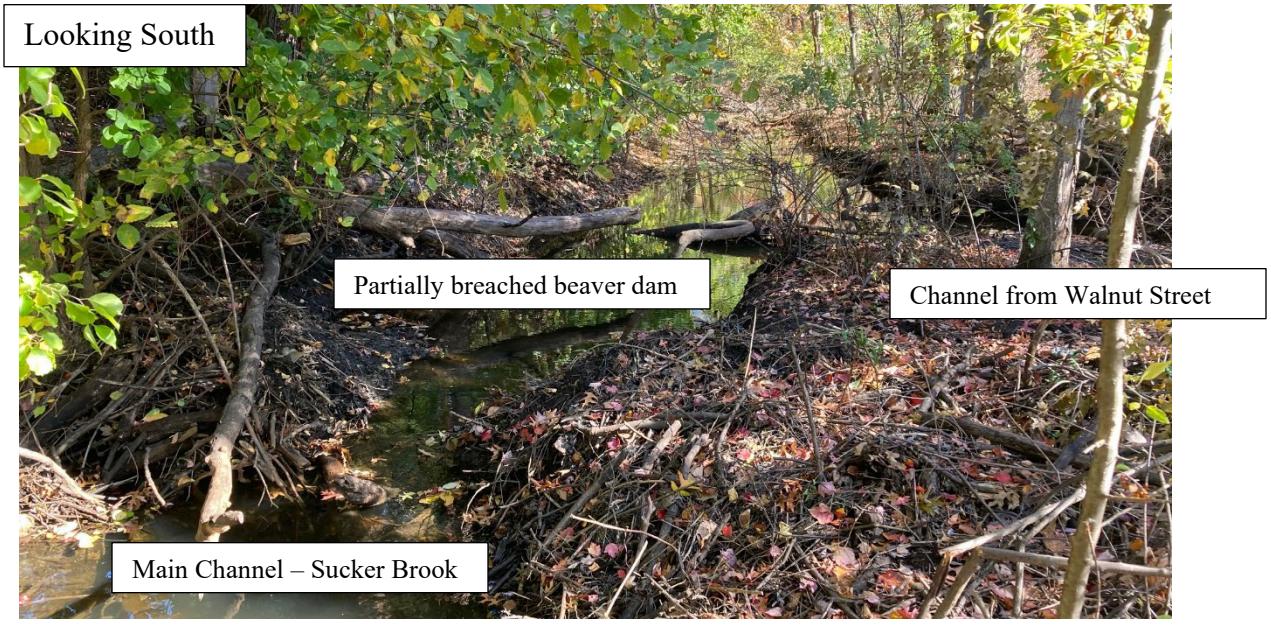
Looking East - Ponding of walking path observed on December 13, 2020.

Alternative 3:
Channel clearing and limited stream restoration to enhance conveyance capacity

Ponded water has been observed at existing culvert at Stony Brook along Sucker Brook and the unnamed stream behind Walnut Street north and south of the school walking path (Alternative 2 area). It appears that fallen tree limbs across portions of the stream channel have created sediment and debris dams impeding flow resulting in ponding. Ponding results in sediment deposition within the stream channel reducing its conveyance capacity.

Alternative 3 proposes to remove sediment/debris to restore conveyance capacity to eliminate ponding during non-rain events. The City recognized the benefits of restoring conveyance capacity of the stream channel when sediment and debris was removed from the Sucker Brook upstream of the Main Street culvert and along the stream behind Walnut Street around year 2011. It appears that sediment removal occurred between Main Street culvert and channel just north of #205 Walnut Street.

The residents of Walnut Street at #211 and #213 reported reoccurrence of backyard flooding and ponding in Fall of 2020 due to a beaver dam. The homeowners at #211 Walnut Street removed a major portion of the Beaver Dam upon getting approval from Conservation Commission in October 2020.



Looking South – Partially breached beaver dam behind #217 Walnut Street observed on October 15, 2020.

Alternative 3 proposes to remove sediment/debris dams and limited sediment removal from sections of channel along Sucker Brook between Stony Brook Road culvert discharge and Georgetown Apartments. Similar work is proposed along the stream channel behind Walnut Street from #205 and south of school access path.

Sediment/debris dams sediment removal and limited stream restorations from sections of channel will enhance channel flow conveyance and restore flood storage capacity for large rain events. This will help alleviate the backyard and basement flooding of homes along Walnut Street.

Looking East – Typical sediment and debris dam along channel behind Walnut Street observed on December 13, 2020.

Alternative 4:
Subsurface storage on Fuller Middle School property

It is well known that Route 9 underpass at Route 126 floods several times per year. The 24-inch storm drain currently discharges into Sucker Brook near the Massachusetts Police Headquarters building.

Looking South – 9/30/2015 storm event at southeastern corner of Route 9 / Route 126 intersection (CBS Boston, 2015)

MassDOT is developing alternatives designs to alleviate this flooding that involves upsizing the existing 24-inch storm drain to either 42-, 48- or a 54-inch storm drain along with creating detention systems. It is evident from the alternatives developed so far, that available areas for providing required detention are very limited and upsizing the storm drain will significantly increase flows in Sucker Brook as a result. This will add to the current flooding at homes behind Walnut Street.

Alternative 4 proposes to create a portion of the subsurface detention required by MassDOT at Fuller Middle School to help reduce flooding at Routes 9 and 126 intersection and not further impact existing flooding at Walnut Street.

A new school is being built to replace Fuller Middle School. Once complete, the existing building will be demolished and soccer fields are proposed to be built in the future. MassDOT can coordinate with the City to construct and maintain this project. Sub-surface storage under the two potential new school soccer fields could provide an opportunity for MassDOT to collaborate with the City and apply for grant funding for design and construction.

Alternative 5:
Clean Sucker Pond outlet and install flow control structure

A beaver deceiver (small 8- or 10-inch HDPE pipe – picture on left below) was installed around 2011 at the Sucker Pond outlet (36-inch RCP) and still appears to be in place. It appears that the beaver deceiver may be clogged resulting in rise of pond water surface elevation by about 14 inches. Residents have been complaining about water ponding in backyards and trees dying along the Hastings Road area.

Looking North – Beaver deceiver at pond outlet

Looking South – Pond outlet partially blocked by debris

As mentioned above, MassDOT has been evaluating design alternatives to reduce flooding at Route 9 and 126 intersection. One of the alternatives is to redirect flows from Route storm drain into Sucker Pond and utilize pond storage capacity. This may result in increased flow in Sucker Brook and result in making flooding to worsen at Walnut Street.

Alternative 5 proposes to clean Sucker Pond outlet and remove the clogged beaver dam and install a V-notch weir at the pond outlet to control flow. Cleaning of outlet pipe and removing he beaver dam will lower the pond water surface elevation. By installing flow control structure at the pond outlet additional flood storage volume can be created in the pond.

Alternative 6

Bioretention GI features in the vicinity of Pearl Harbor Road.

The John J. Brady outfall receives flow from approximately 40 acres, of which approximately 10 acres are primarily comprised of a housing development owned by the Framingham Housing Authority (FHA).

The FHA development near Pearl Harbor Road provides opportunities for bioretention type green infrastructure systems throughout the housing development. Bioretention cells are recommended as the predominant treatment method, but depending on gauged public interest, a combination of bioretention methodologies can be implemented including rain gardens and planter boxes. Planter boxes are completely contained within an impermeable structure with an underdrain. As stormwater passes through the planting soils, pollutants are filtered, absorbed, and biodegraded by the soil and plants. They are effective at providing peak discharge rate reductions and some volume reduction of roof runoff.

It is also known that a stormwater treatment system exists to treat runoff from the Mass Bay Community College parking lot before entering the wetland. The treatment system consists of subsurface detention / retention chambers, where overflow leads to an open detention system. The potential bioretention BMPs at Pearl Harbor Road will compliment this treatment system by providing additional treatment before discharging in the wetland behind Walnut Street and ultimately, the Sudbury River.

It is estimated that approximately 12, 100-square foot rain gardens leading to a 3,500 square foot vegetated water quality swale could be installed in this neighborhood.

Alternative 7

Bioretention GI features in the Hastings Street Area

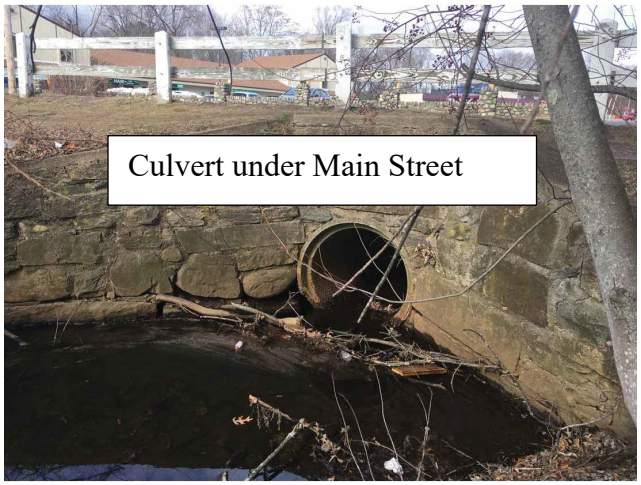
It is recommended that a series of upgradient rain gardens be constructed in the neighborhood of Hastings Street area with an outfall into the Sucker Pond. The rain gardens will act to treat common stormwater pollutants including E. Coli. Treated effluent from the raingardens and any overflow will enter the existing drainage system. Approximately 50 feet of the existing outfall pipe into Sucker Pond will be daylighted with a water quality swale with checkdams. The water quality swale will further treat incoming pollutants and allow sediments to settle before reaching the Sucker Pond and promote infiltration.

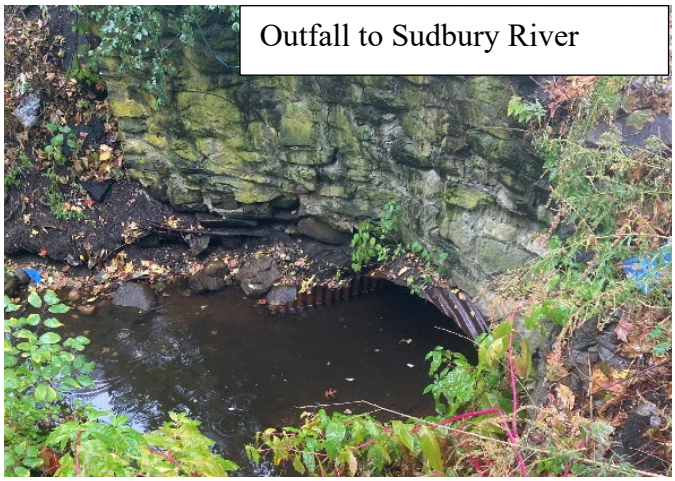
In addition to treating common stormwater pollutants and decreasing elevated E. Coli levels during storm events, the proposed green infrastructure will also serve to decrease the amount of stormwater flow discharging into Sucker Pond.

It is estimated that approximately 20, 100-square foot rain gardens leading to a 3,500 square foot vegetated water quality swale could be installed in this neighborhood.

Alternative 8:
Replace and Upsize Main Street Culvert from 36" Dia. To 36"x54" box culvert

The main trunk line of the Sucker Pond sub-basin crosses the wetland behind Walnut Street in an open channel, to a 36-inch culvert under Main Street, and to a 38x57-inch corrugated metal pipe (CMP) arch culvert that discharges to a shallow open channel before reaching the Sudbury River. City's Phase II SWMP (Plan) existing conditions modeling had shown that the 36-inch culvert served as a major constriction and acts to detain upstream flows. The Plan also evaluated an alternative that sought to install an overly large hydraulic opening (twin 5-ft by 5-ft box culverts) in place of the 36-inch RCP and 38x57-inch CMP culverts to evaluate the maximum potential gains that could be realized if the upstream area were allowed to drain freely.


Culvert under Main Street


Outfall to Sudbury River

It was noted in the Plan that the large box culverts were able to eliminate flooding at the Main Street culvert crossing during the 2-year and 25-year storm events. However, the large culvert opening actually further exacerbated upstream flooding during the 25-year return event because it allows free passage of water from the Sudbury River into the sub-basin drainage area during periods of high flows.

The proposed alternative 8 under the current Study proposes to replace the 36" Dia. RCP culvert across Main Street with a single 36-inch high and 54-inch wide reinforced concrete box culvert and evaluate the flood mitigation benefits while limiting backflow from Sudbury River.

Alternative 9:
Weir and flap gate installation on upstream side of culvert under Main Street.

In this design alternative, a flow control weir with a flap gate is proposed upstream of the culvert under Main Street. The purpose of this weir/flap gate is to allow water from the Sudbury River into the Sucker Brook watershed during large storms (i.e., the 100-year design storm), but to minimize the impact of the Sudbury River on the Sucker Brook during smaller storms. This design alternative used a 2-foot diameter circular flap gate.

Alternative 10:
Acquisition of private properties

This alternative proposes acquisition and relocation or flood protection of private properties with repetitive loss in the Walnut Street neighborhood. This was listed as a priority project in the City's Multiple Hazard Mitigation Plan (2017 Update) to identify, acquire, and/or relocate flood-prone buildings so that they are out of the floodplain. It was also recommended that restrictions be placed on purchased land in floodplain to prevent future development. The affected homes along Walnut Street have completed floodproofing, elevated utilities and minor structural projects. It is recommended that the City purchase 169-171, 173 and 175 Walnut Street.

Hydrologic and Hydraulic Analysis (H/H)

The alternatives described above have been evaluated for determining their flood mitigation benefits by completing the hydrologic and hydraulic modeling. A detailed and separate technical memorandum has been prepared to analyze each of the alternatives for the design storm events. In addition, each of the alternatives was also evaluated to determine flood mitigation benefits under the projected climate adaptation models for year 2070.

Design Storm	*Precipitation (in)*	*Sudbury River Stage (ft NAVD88)*
2-year	3.31	151.2*
10-year	5.18	152.5
25-year	6.34	153.8
50-year	7.20	154.8
100-year	8.14	155.5
50-year (2070)	9.00	156.2**
100-year (2070)	10.42	158.0**

* The applicable FIS does not include a flood elevation for a 2-year event. It was estimated that the likely river stage by interpolating between the average river stage and the 10-year event stage.
** The impact of climate change on the hydrology of the Sudbury River is beyond the scope of this work. It was assumed that the increase in river stage relative to the average stage in the river would increase by the same amount as the precipitation increases.

The results from the H/H modeling to evaluate the alternatives are summarized in a technical memorandum included as Attachment B of the report.

Environmental Permitting Analysis

Numerous local, state and federally jurisdictional resources, including regulations and supporting documents, were reviewed to determine environmental and human receptors that may be affected and environmental permits that will likely be required for the alternatives.

A technical memorandum has been prepared to analyze each of the alternatives for required permits. Local, state and federal regulations, and supporting documents, were reviewed to determine which permits will likely be required for the alternatives. These resources include the following:

- City of Framingham Wetlands Protection Bylaw (Section 18)
- City of Framingham Wetlands Protection Regulations
- Massachusetts Wetlands Protection Act (310 CMR 10.00)
- Massachusetts Environmental Policy Act (MEPA) (301 CMR 11.00)
- Massachusetts Chapter 91 regulations (310 CMR 9.00)
- Massachusetts 401 Water Quality Certification Regulations (314 CMR 9.00
- Massachusetts Endangered Species Act regulations (321 CMR 10.00)
- Department of the Army – General Permits for the Commonwealth of Massachusetts (effective date 4/16/18)

To determine which permits will be required for the three preferred alternatives, environmental and human receptors maps were also created to identify any constraints. Once identified, area impacts were then estimated to determine which permits would be required as many of these permits are triggered by impact areas. The additional supporting maps included:

- Environmental receptors map created by Weston & Sampson using MassGIS data layers on 12/09/20
- Human receptors map created by Weston & Sampson using MassGIS data layers on 12/15/20

A preliminary desktop survey of environmental and human receptors in the area was conducted in ArcView using MassGIS data layers and contains the following information:

- Aerial photography
- Perennial rivers and intermittent streams (USGS 1:25,000 Topographic Quadrangle)
- Ponds, lakes, oceans, reservoirs (USGS 1:25,000 Topographic Quadrangle)
- MassDEP mapped wetlands (Stereo color infrared photography at 1:12,000 scale)
- 100-year flood zone (FEMA, 2017)
- Natural Heritage and Endangers Species Program (NHESP) Estimated and Priority habitats (NHESP, 2017)
- NHESP certified vernal pools (NHESP, 2017)
- Areas of Environmental Concern (ACECs) (EEA, 2009)

The human resource receptors contain the following information resources:

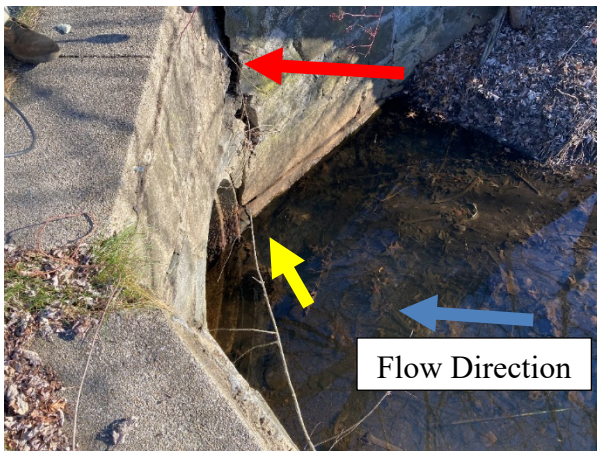
- - State registry of historic places
- - Underground storage tanks
- - Tier classified sites
- - Public water supplies
- - Chapter 21E sites
- - MassDEP major facilities (large quantity generators)
- - Surface water supply protection zones
- - Groundwater supply protection zones
- - Landfill facilities
- - Open space lands

Summary of the environmental permitting assessment of the alternatives is presented in a technical memorandum included as Attachment C of the report.

Preliminary Structural Condition Assessment of Critical Culverts

Field investigation was completed on January 8, 2021 to visually inspect critical culverts along Sucker Brook to assist with assessing consequence of failure and resulting flooding. A summary of the preliminary structural condition assessment of critical culverts along Sucker Brook is presented in a technical memorandum included as Attachment D of the report. The main findings are listed below:

- Sucker Pond outlet and culvert under Route 9: The 36-inch RCP drain and culvert appeared to be in fair structural condition but will require sediment and debris removal at the Sucker Pond outlet and replacing/removing the beaver deceiver
- Culvert under Oaks Road and Stony Brook Road: The 54-inch RCP drain and culvert appeared to be in fair structural conditions. The standing water at the culvert discharge off Stony Brook Road is due to sediment and debris dams along the downstream segments of the existing stream channel to the west.
- Culvert/drain between Main Street and outlet to Sudbury River through parking lot: Wingwall of the 36-inch RCP culvert inlet across Main Street appeared to be in poor condition with severe settlement issues (red arrow). During dry conditions, flow was seen entering a large opening under the wingwall (yellow arrow) bypassing the culvert. This could likely indicate that flow has been washing the fines around and under the headwall and culvert pipe and potentially resulting in sinkholes and culvert failure. Existing 38"x57" CMP within the parking lot north of Main Street to outfall into Sudbury River appeared to be in fair condition.



Opinion of Permitting, Final Designs, Construction and Maintenance Costs

Conceptual level costs for the alternatives was estimated that included final designs and securing required permits, construction costs and long-term operation and maintenance costs and summarized in the table.

Preferred Alternatives – Recommended Plan

The alternatives were evaluated based on the following factors:

1. Achieving maximum flood mitigation benefits based on H/H analysis taking into account the climate impacts
2. Requiring minimal environmental permits with smaller timelines for approvals
3. Relatively low design, construction and long-term operation and maintenance costs compared to the flood mitigation benefits
4. Built on City/Publicly owned land

Based on completing an evaluation of the alternatives the following are the preferred alternatives recommended for implementation. The final recommended plan for the project will summarize each of the evaluation criteria and the preferred alternatives.

Alternative 2: Replace culvert with stream channel across walkway between Walnut St. and Stony Brook Rd & creating/providing additional flood storage

Alternative 3: Limited Channel clearing to restore conveyance capacity

Alternative 8: Upsize Main Street Culvert from 36" Dia. To 36"x54" box culvert

It should be noted that Alternative 4 – Sub-surface storage at Fuller Middle School and Alternative 5 - Clean Sucker Pond outlet and install flow control structure, faired high on the above evaluation criteria; however, these alternatives provide direct and greater flood mitigation at the Route 9 and 126 intersection and indirect benefits to flood mitigation at Walnut Street Area (which is the focus of this study). The City can share this information with MassDOT for it to explore further consideration and implementation of these alternatives.

Alternatives 6 and 7 – Green Infrastructure Projects though rank low in providing flood mitigation benefits offer good guidance and information that can be incorporated into the City's future plans for climate resiliency City-wide.

Concept Level Cost Estimate
Walnut Street Area Flood Mitigation Project

Flood Mitigation Alternative	Design and Permitting		Construction Costs (Base)	Construction Oversight	Traffic Management	Flow Diversion & Control	Site Restoration	Easements	Total	Annual Operation and Maintenance
	Final Designs	Permitting								
1 Install earthen berm – Western bank of existing stream behind Walnut Street	$ 70,000	$ 20,000	$ 300,000	$ 45,000	$ 20,000	$ 30,000	$ 20,000	$ 20,000	$ 525,000	$ 10,000
2 Boardwalk to replace culvert between Walnut St. and Stony Brook Rd & additional flood storage	$ 100,000	$ 50,000	$ 500,000	$ 100,000	$ 50,000	$ 50,000	$ 50,000		$ 900,000	$ 10,000
3 Limited Channel clearing and stream stabilization to restore conveyance capacity	$ 50,000	$ 40,000	$ 400,000	$ 100,000	$ 50,000	$ 100,000	$ 50,000	$ 50,000	$ 840,000	$ 10,000
4 Subsurface storage on Fuller Middle School property	$ 150,000	$ 40,000	$ 1,500,000	$ 100,000	$ 50,000	$ 20,000	$ 100,000	$ 20,000	$ 1,980,000	$ 5,000
5 Clean Sucker Pond outlet and install flow control structure	$ 70,000	$ 20,000	$ 100,000	$ 30,000	$ 10,000	$ 30,000	$ 10,000	$ 30,000	$ 300,000	Minimal
6 Bioretention GI features in the vicinity of Pearl Harbor Road	$ 75,000	$ 10,000	$ 150,000	$ 25,000	$ 20,000		$ 20,000	$ 20,000	$ 320,000	$ 2,000
7 Bioretention GI features in the Hastings Street Area	$ 75,000	$ 10,000	$ 150,000	$ 25,000	$ 20,000		$ 20,000	$ 20,000	$ 320,000	$ 2,000
8 Upsize Main Street Culvert from 36” Dia. To 36”x54” box culvert	$ 125,000	$ 40,000	$ 250,000	$ 100,000	$ 50,000	$ 50,000	$ 50,000	$ 20,000	$ 685,000	Minimal
9 Weir and flap gate installation on upstream side of culvert under Main Street.	$ 50,000	$ 35,000	$ 100,000	$ 25,000	$ 20,000	$ 50,000	$ 20,000	$ 20,000	$ 320,000	Minimal
10 Acquisition of private property	$ 40,000	$ 20,000	$ 2,000,000	$ 50,000	$ 30,000	$ 20,000	$ 50,000	$ 40,000	$ 2,250,000	Minimal

Near Preliminary Designs – Preferred Alternatives

Additional design work and associated field investigations were completed utilizing remaining funds following discussion with the EEA. The work mainly focused on developing near Preliminary Design stage for the three preferred alternatives. Following is a brief summary of the supplemental work that was completed:

Alternative 2: Replace culvert with stream channel across walkway between Walnut St. and Stony Brook Rd & creating/providing additional flood storage

- Relevant existing topographic and utility survey information from the City's previous design projects including previously proposed Walnut Street Pumping Station and associated sewer piping along Walnut Street, Main Street and the walking path between Walnut Street and Kittridge Road was compiled.
- Supplemental topographic survey was completed along the existing walking path and the newly formed stream across the path due to clogged culvert. Limited spot grade elevations of the now silted up channel on either side of the path were obtained.
- Information from the above was utilized to update and prepare an existing conditions map of the path. A plan and profile of an elevated boardwalk utilizing ecofriendly building materials and foundation support with helical piles to limit temporary disturbance to existing wetlands and resource areas. The drawing with the construction details is included in Attachment F.

Alternative 3: Limited Channel clearing to restore conveyance capacity

- A field investigation program for stream assessment was completed along Sucker Brook section between Main Street and Route 9 and within the stream along east side of Walnut Street. The objectives of the stream assessment were to document and record stream channel geometry, notable sediment/debris dams and obstructions that are limiting the conveyance capacity and make a preliminary assessment of potential source(s) of sediment within the stream channels.
- A memorandum was prepared to summarize the findings of stream assessment field work and is included as Attachment E. The major findings are summarized below:
    - Majority of the sediment observed in the stream channels appears to be organic matter from dead vegetation. This likely is an indication that there is very little contribution of sediment from roadways and other impervious surfaces.
    - In general, the section of Sucker Brook between Stonybrook Road and Route 9 appeared to be clear of sediment with well-defined channel geometry with unimpeded flows. This section appears in a stable geomorphic condition. The sandbar that had formed just downstream of Route 9 was removed by MassDOT in 2020 along with restoring channel geometry.
    - The City had previously removed sediment within section of Sucker Brook and the stream along Walnut Street south of Main Street about 2010. These sections

appeared to maintain their channel geometry and did not show signs of sedimentation.
    - It was noted that a fallen tree limb and subsequent sediment/debris dam across Sucker Brook just downstream from Stonybrook Road diverts normal flows south towards the homes along Walnut Street.
- Sections of the brook and stream have been identified for cleaning and stabilization to restore conveyance capacity. A Preliminary Design sketch that shows the limits of the proposed work is included in Attachment F.

Alternative 8: Upsize Main Street Culvert from 36" Dia. To 36"x54" box culvert

- As mentioned above relevant existing topographic and utility survey information from the City's previous design projects relevant to Main Street culvert was compiled.
- Supplemental topographic survey was completed across Main Street along the existing culvert. Limited spot grade elevations of the roadway and existing utilities was obtained.
- Information from the above was utilized to update and prepare an existing conditions map of the culvert. A plan and profile of the proposed replacement culvert at near preliminary design stage was developed. The drawing with the construction details is included in Attachment F.

Opinion of Permitting, Final Designs, Construction and Maintenance Costs

Preliminary level costs for the three preferred alternatives were estimated that included final designs and securing required permits, construction costs and long-term operation and maintenance costs. This is summarized in tables included in Attachment G.

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

LIST OF ATTACHMENTS

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT A

FIGURES

N

Alt. 7

Alt. 5

Sucker Pond

Route 9 - Worcester Rd

Alt. 8

Alt. 9

Alt. 1

Alt. 10

Alt. 4

Walnut St

Alt. 3

Concord St

Alt. 2

Alt. 6

Sudbury River

Framingham Boundary
Watershed
WaterHydrants
Sewer Pump Station
Sewer Manhole
Catch Basin
Drainage Manhole
Outfall
Abandoned Water Main
Water Main
Sewer Gravity Sewer
Sewer Pressure
Sewer Siphon
Channel
Culvert
Drain Line
Elevation (2ft)

600 0 600
Scale In Feet

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO Community

FIGURE EX

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

PROPOSED ALTERNATIVES LOCATION MAP

OCTOBER 2020 SCALE: NOTED

Weston & Sampson SM

User

Prop. Top of Berm
El. 152.0'

Prop. Top of Berm
El. 153.0'

Prop. Top of Berm
El. 154.0'

Prop. Top of Berm
El. 154.0'

175 Walnut Street

Proposed Earthen Berm

Prop. Top of Berm
El. 154.0'

Walnut Street
(Public ~40' Wide)

FLOOD ZONE "X-0.2%"

FLOOD ZONE "X"

FLOOD ZONE "AE-158 FEET"

SINGLE FAMILY RESIDENCE (R-1)

E GENERAL RESIDENCE (G)

APPROX. WOODED MARSH

APPROX. POTENTIAL VERNAL POOL (SEE NOTE 6)

Bowditch Field

WALNUT ST

N

WaterHydrants
Sewer Manhole
Catch Basin
Drainage Manhole
Water Main
Sewer Gravity Sewer
Sewer Pressure
Channel
Drain Line
Elevation (2ft)

75 37.5 0 75 Feet

FIGURE 1

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 1
EARTHEN BERM AT
175 WALNUT STREET

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

Proposed 6' wide boardwalk
installed on Helical Piles
Approx. 300' +/- long
Approx. El. of Top of Board Walk
156' +/-

Center Line of
Prop. Channel

Profile of Prop. Channel

Approx. 150' +/-

Approx. 150' +/-

Meet exist El. 156.0' +/-

Meet exist El. 156.0' +/-

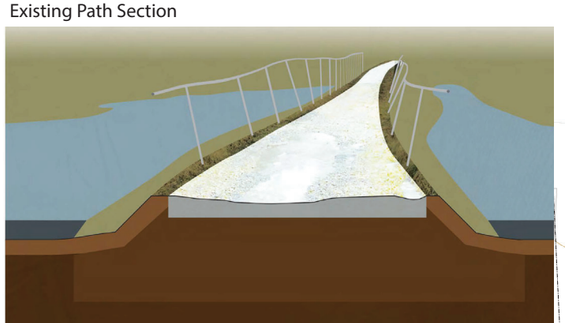
Regrade exist ground surface at
Approx. 0.022 ft/ft slope

Regrade exist ground surface at
Approx. 0.022 ft/ft slope

Center Line of
Prop. Channel

Prop. 3-6" size rip-rap stone lined trapezoidal channel
Bottom of Channel El. 152.0' +/-
Bottom Width: 2'
Side Slopes : 2H:1V
Top of Channel El. 152.8' +/-

Existing Path Section



Proposed Path Section

WaterHydrants
Sewer Manhole
Catch Basin
Drainage Manhole
Outfall
Water Main
Sewer Gravity Sewer
Sewer Pressure
Channel
Drain Line
Elevation (2ft)

40 20 0 40 Feet

FIGURE 2

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 2
REPLACE CULVERT WITH STREAM CHANNEL & FLOOD STORAGE

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

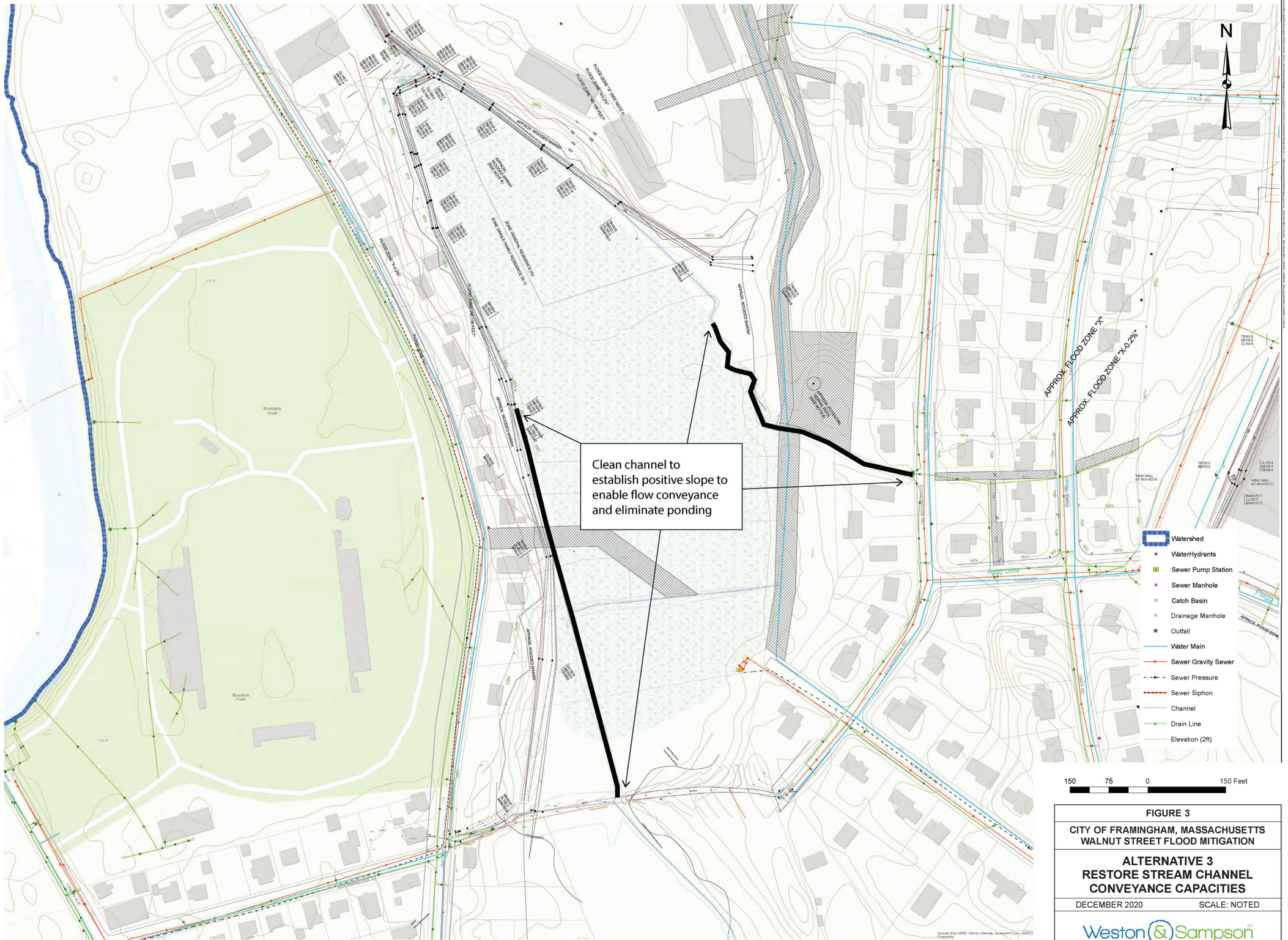


FIGURE 3

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 3
RESTORE STREAM CHANNEL CONVEYANCE CAPACITIES

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

Prop. High Flow Diversion Intake Headwall

Bottom El. of Stream Ctr Line: 157.0 +/-

5' Dia. Concrete Manhole with 4' Deep Sump with anti-flotation collars

Prop. Twin 18" HDPE intake pipes
Inv. El. at Stream 159.25' +/-
Inv. El. at Infiltration System 158.5' +/-

Prop. Sub-Surface Infiltration/Detention System below turf fields
Bottom El. 158.0' +/-

12" Overflow HDPE Pipe.
Inv. El. out at infiltration system 161.0'
Inv. El. at exist. DMH 159.0'

WING WALL
24" INV=156.22
24" INV=156.30
24" INV=156.34

WING WALL
24" INV=156.92
24" INV=156.80
24" INV=156.77

WING WALL
24" INV=156.14
24" INV=157.77

WING WALL
42" INV=152.17

TB157.4
BB155.8
CL155.5
BANK155.6

TB161.8
BB154.9
CL154.6

TB155.0
BB153.8

CL153.9
BB154.5
TB158.4

BANK157.7
CL156.7
BANK157.5

TB157.9

TB160.5
BB157.2
CL157.3
BB157.7
TB160.6

CL157.9

CL158.15
BB158.13
TB159.90

TB160.3
BB158.9
CL158.9
BB159.3
TB161.4

CL160.5
BB159.7
TB161.0

BENCHMARK #3
SEWER MANHOLE
RIM=161.53

APPROX. FLOOD ZONE "X-0.2%"

APPROX. FLOOD ZONE "X" (SEE NOTE 5)

SHEET 3 MATCH LINE

200-FT RIVERFRONT

30-FT NO ALTERATION

50-FT NO BUILD

125-FT WETLAND BUFFER

Flagg Drive

FLAGG DR.

APPROX

312±

607±

239±

261±

N

WaterHydrants
Sewer Manhole
Catch Basin
Outfall
Water Main
Sewer Gravity Sewer
Channel
Culvert
Drain Line
Elevation (2ft)

50 25 0 50 Feet

FIGURE 4

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 4
SUB-SURFACE FLOOD STORAGE TURF FIELDS, FULLER MIDDLE SCHOOL

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

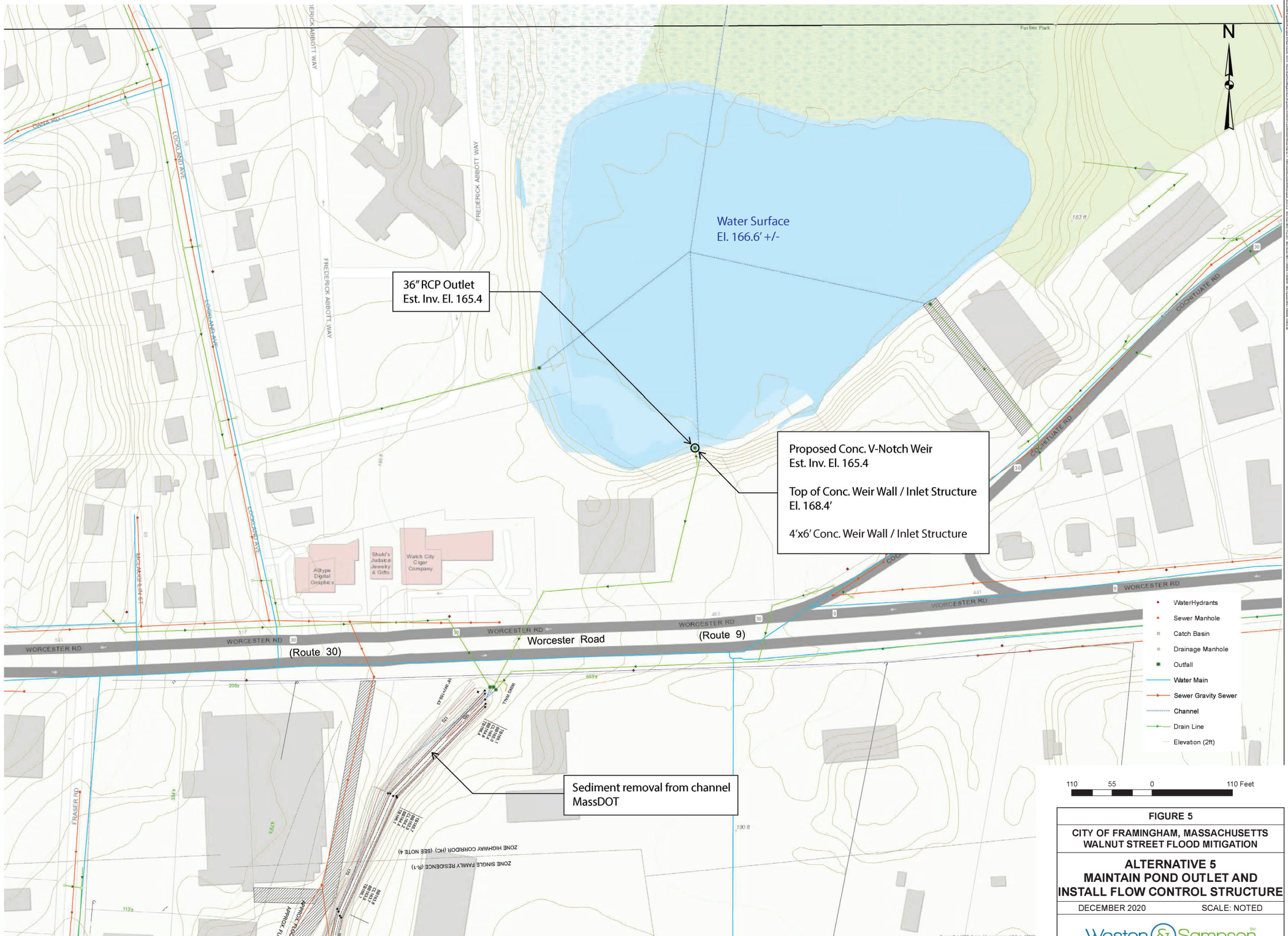


FIGURE 5

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 5
MAINTAIN POND OUTLET AND INSTALL FLOW CONTROL STRUCTURE

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

Housing Development for GI Implementation

Existing Storm Drain Outfall

Daylighting Outfall Pipe

John J. Brady Drive Outfall

E. Coli:

6,500 CFU/100 mL (wet)
5,800 CFU/100 mL (dry)

Peak simulated 2-year storm discharge is 20 - CFS

Potential Bioretention Treatment Area

Potential Bioretention Treatment Area

N

JOHN J BRADY DR
PEARL HARBOR RD
ARSENAL RD
CONCORD ST
NORMANDY RD
GORHAM RD
BELVEDERE AVE
DUFFETT RD

Watershed
WaterHydrants
Sewer Pump Station
Sewer Manhole
Catch Basin
Drainage Manhole
Outfall
Water Main
Sewer Gravity Sewer
Sewer Pressure
Channel
Drain Line
Elevation (2ft)

90 45 0 90 Feet

FIGURE 6

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 6 POTENTIAL GREEN INFRASTRUCTURE - FHA

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

Areas for Up-Gradient Rain Garden Implementation (TYP.) and Potential Bio-retention BMP's

Daylighting Outfall Pipe with Vegetated Water Quailty Swale w/ Checkdams

Existing Storm Drain Outfall

Areas for Up-Gradient Rain Garden Implementation (TYP.) and Potential Bio-retention BMP's

Hastings Street Neighborhood

N

CAVANAUGH RD

BEACON ST

PITT RD

MURRAY RD

HIGHLAND CT

HASTINGS ST

FAIRBANKS RD

- Watershed
- WaterHydrants
- Sewer Manhole
- Catch Basin
- Drainage Manhole
- Outfall
- Water Main
- Sewer Gravity Sewer
- Channel
- Drain Line
- Elevation (2ft)

90 45 0 90 Feet

FIGURE 7

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 7
POTENTIAL GREEN INFRASTRUCTURE
HASTINGS STREET AREA

DECEMBER 2020 SCALE: NOTED

Weston & Sampson

Replace existing 36" RCP with
36" x 54" RC Box Culvert
Install New Headwall

Inv. El. Ext 36" RCP
150.06'

Main Street (Public ~ Variable Width)

CATCH BASIN
RIM=155.50

MANHOLE
RIM=156.37

CATCH BASIN
RIM=155.49

WING WALL
36" INV=150.06

BENCHMARK #1
CHISEL SQUARE
AT PUMPING STATION
ELEV=158.58

487'±

205'±

150

153

TB154.4
BB150.1
CL148.9
BB150.6
TB153.4

BB151.3
CL149.4
BB150.6
TB152.8

CL149.2
BB151.3

TB153.4

ZONE HIGHWAY CORRID

ZONE SINGLE FAMILY

N

Watershed
Sewer Manhole
Catch Basin
Drainage Manhole
Abandoned Water Main
Water Main
Sewer Gravity Sewer
Sewer Pressure
Channel
Drain Line
Elevation (2ft)

30 15 0 30 Feet

FIGURE 8

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

ALTERNATIVE 8
UPSIZE MAIN STREET CULVERT

JANUARY 2021 SCALE: NOTED

Weston & Sampson

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT B

TECHNICAL MEMORANDUM – HYDROLOGIC AND HYDRAULIC ANALYSIS

Hodge.WaterResources

95 Arlington St.
Brighton, MA 02135
617-903-0340

January 22, 2021

TECHNICAL MEMORANDUM

To:	Kerry Reed, P.E., LEED AP, Senior Stormwater & Environmental Engineer	Pages: 9
CC:	Sam Bade, SSV Engineering Inc.	
Subject:	Sucker Brook SWMM Model Application – Flood Mitigation Alternatives	
From:	Matt Hodge, Hodge.WaterResources, LLC	

The purpose of this memorandum is to provide an update on the application of the Sucker Brook stormwater master plan (SWMP) model for the City of Framingham, Massachusetts. Hodge.WaterResources, LLC (HWR) has worked with SSV Engineering Inc. (SSV) to use the model to evaluate a total of nine design alternatives. We modeled each design alternative in a total of seven different design storms. The model results provide insight into which alternatives reduce flood risk in the Sucker Brook watershed.

1.0 MODEL INPUTS

Each design alternative evaluates a single change to the SWMP model. A description of each design alternative is provided in Table 1.

HWR modeled each of the design alternatives under a range of design storms. The design storms include the 2-year, 10-year, 25-year, 50-year, and 100-year storm events as determined by the National Oceanic and Atmospheric Administration (NOAA). HWR used the 24-hour rainfall amounts from Atlas 14 Volume 10 (NOAA, 2020) for the Sucker Brook watershed in conjunction with the SCS Type III hydrograph. In addition to these design storms that reflect present day conditions, we modeled 2070 design storms based on predicted increases in rainfall resulting from climate change. Weston and Sampson, Inc. provided the predicted increases in rainfall based on their down-scaling of regional climate models. HWR evaluated predicted 2070 conditions for the 50-year storm and the 100-year storm. The total precipitation amounts for each storm are listed in Table 2.

The Sucker Brook flows to the Sudbury River, and the stage of the Sudbury River has a large influence on flooding in the Sucker Brook watershed, especially in the wetland area east of Main Street and west of Stony Brook Road. HWR paired each design storm with peak flood elevations as determined by the relevant Flood Insurance Study (FIS) for the Sudbury River (FEMA, 2016). The flood elevation for each design storm scenario is listed in Table 2 and an excerpt from the applicable FIS is included with this memorandum as Attachment 1.

95 Arlington St.
Brighton, MA 02135
617-903-0340

January 22, 2021

Table 1: Summary of Sucker Brook Design Alternatives

Design Alternative	Description (all elevations relative to NAVD88)
00	Existing conditions for comparison to design alternatives. Includes beaver dam removal from September 2020.
01	Berm along Sucker Brook from east of 147 Walnut Street to 223 Walnut Street. Berm elevation: 154 ft
02	Elevated walkway along existing walking path from the end of Stony Brook Road to Buckminster Street, 300 ft walkway at elevation: 156 ft
03	Channel clearing in main channels of Sucker Brook from Main Street to Stony Brook Road. Channel width 5 ft, channel depth approximately 1 ft
04	Subsurface storage underneath Fuller Middle School playing fields. Total storage: 2 ac-ft
05	Redesign of Sucker Pond outlet structure. 36-inch orifice outfall at elevation: 165.4 ft Weir overflow at elevation: 168.4 ft
06	Green infrastructure installations at the Framingham Housing Authority property on Normandy Road. Treated watershed area: 2.6 acres
07	Green infrastructure installations in the Hastings Street neighborhood. Treated watershed area: 11.7 acres
08	Upsize of culvert under Main Street. 4 ft x 6 ft box culvert set to same invert elevations as existing pipe.
09	Weir and flap gate installation on upstream side of culvert under Main Street. Weir crest elevation: 153.3 ft, Flap gate diameter: 2 ft, invert at 150.3

Table 2: Design Storms

Design Storm	Precipitation (in)	Sudbury River Stage (ft NAVD88)
2-year	3.31	151.2*
10-year	5.18	152.5
25-year	6.34	153.8
50-year	7.20	154.8
100-year	8.14	155.5
50-year (2070)	9.00	156.2**
100-year (2070)	10.42	158.0**

* The applicable FIS does not include a flood elevation for a 2-year event. HWR estimated the likely river stage by interpolating between the average river stage and the 10-year event stage.
** The impact of climate change on the hydrology of the Sudbury River is beyond the scope of this work. HWR assumed that the increase in river stage relative to the average stage in the river would increase by the same amount as the precipitation increases.

95 Arlington St.
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2.0 MODEL RESULTS

The model results provide insight into which design alternatives provide the most reduction in flooding. The model results also demonstrate the challenges associated with reducing flooding in the Sucker Brook watershed, especially in the wetland area between Main Street and Stony Brook Road. In all design storms, water from the Sudbury River backflows through the culvert under Main Street. Flood elevations east of Main Street are controlled primarily by the stage of the Sudbury River.

Each design alternative occurs at a different location in the Sucker Brook watershed. There is no single location that will appropriately demonstrate the benefits for all the alternatives. HWR and SSV understand that flooding at 175 Walnut Street is one of the highest concerns for the City of Framingham. Figure 1 through Figure 4 shows the maximum flood elevation for existing conditions and the design alternatives at that property for the 2-year, 10-year, 100-year, and 100-year (2070) design storms.

This set of graphs demonstrate that most of the design alternatives will not provide reduced flood risk for the largest design storms (i.e., 100-year design storm and larger). Design alternative 3 is the only design alternative that reduces flooding for all design storms. Design alternative 8 reduces flooding in all storms but the largest design storm (i.e., 100-year (2070)). These alternatives achieve reduced flooding by improving the conveyance of Sucker Brook and getting more water out of the watershed before the Sudbury River stage increases.

These model results are strongly influenced by the assumed behavior of the Sudbury River. HWR used the SCS Type III dimensionless hydrograph curve to simulate increased river stage. This means that the Sudbury River stage increases at the same rate as the total rainfall. HWR also assumed that when the Sudbury River reaches its peak elevation, the river remains at that stage for the duration of the model run. If the Sudbury River were to drop rapidly after the peak of its hydrograph, then design alternatives that provide storage in the watershed would provide more flood reduction benefit within the watershed. HWR considered adjustments to the modeling approach, but we concluded that the assumption of maintaining the maximum water level for remaining duration of the model run (24 hours) is both reasonable and conservative.

The following discussion includes an explanation of the benefits for each design alternative separately, identifying a relevant location for comparison, and the model results at that location.

95 Arlington St.
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617-903-0340

January 22, 2021

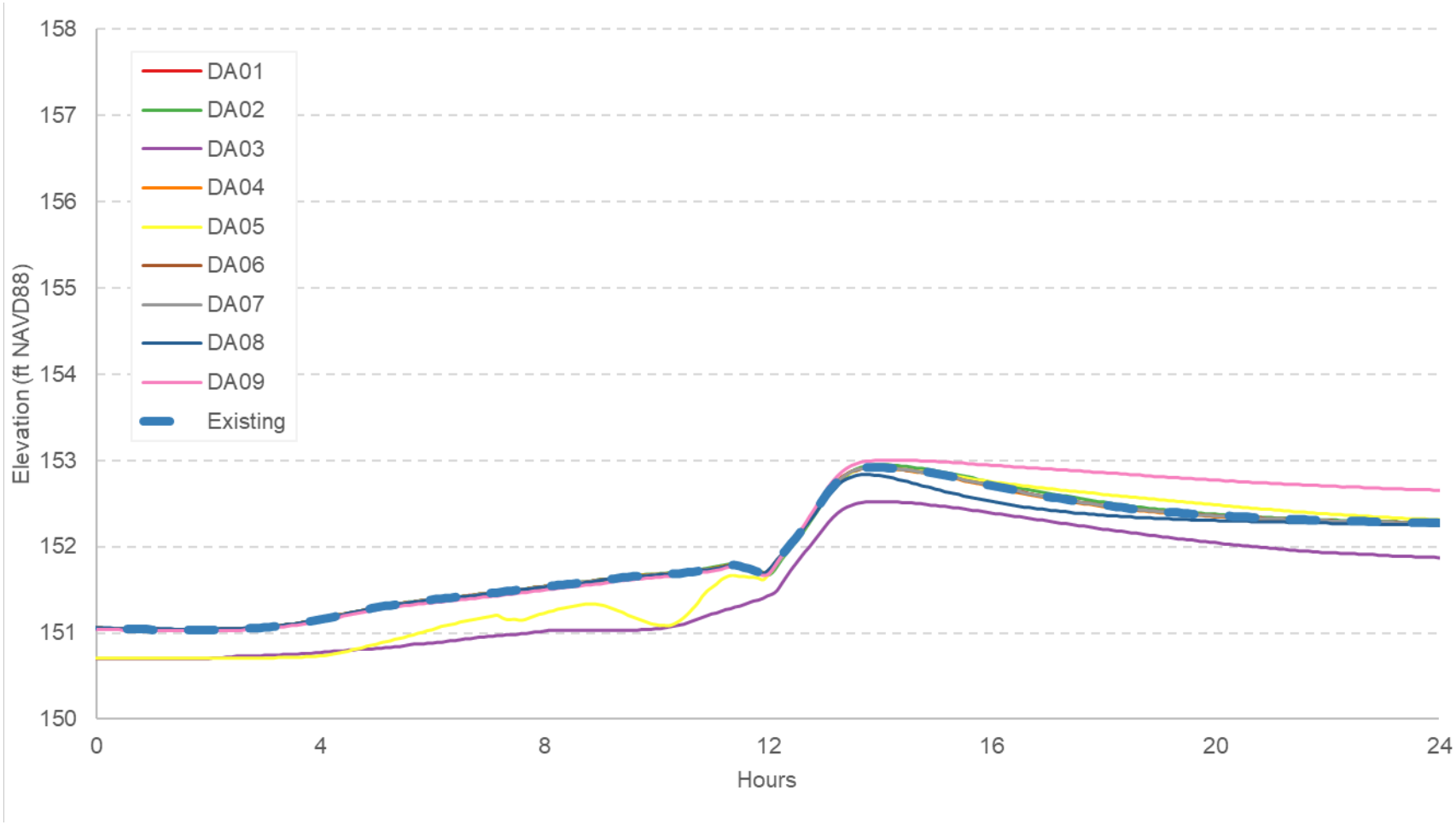

Figure 1 Water Level at 175 Walnut Street for 2-Year Design Storm

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January 22, 2021

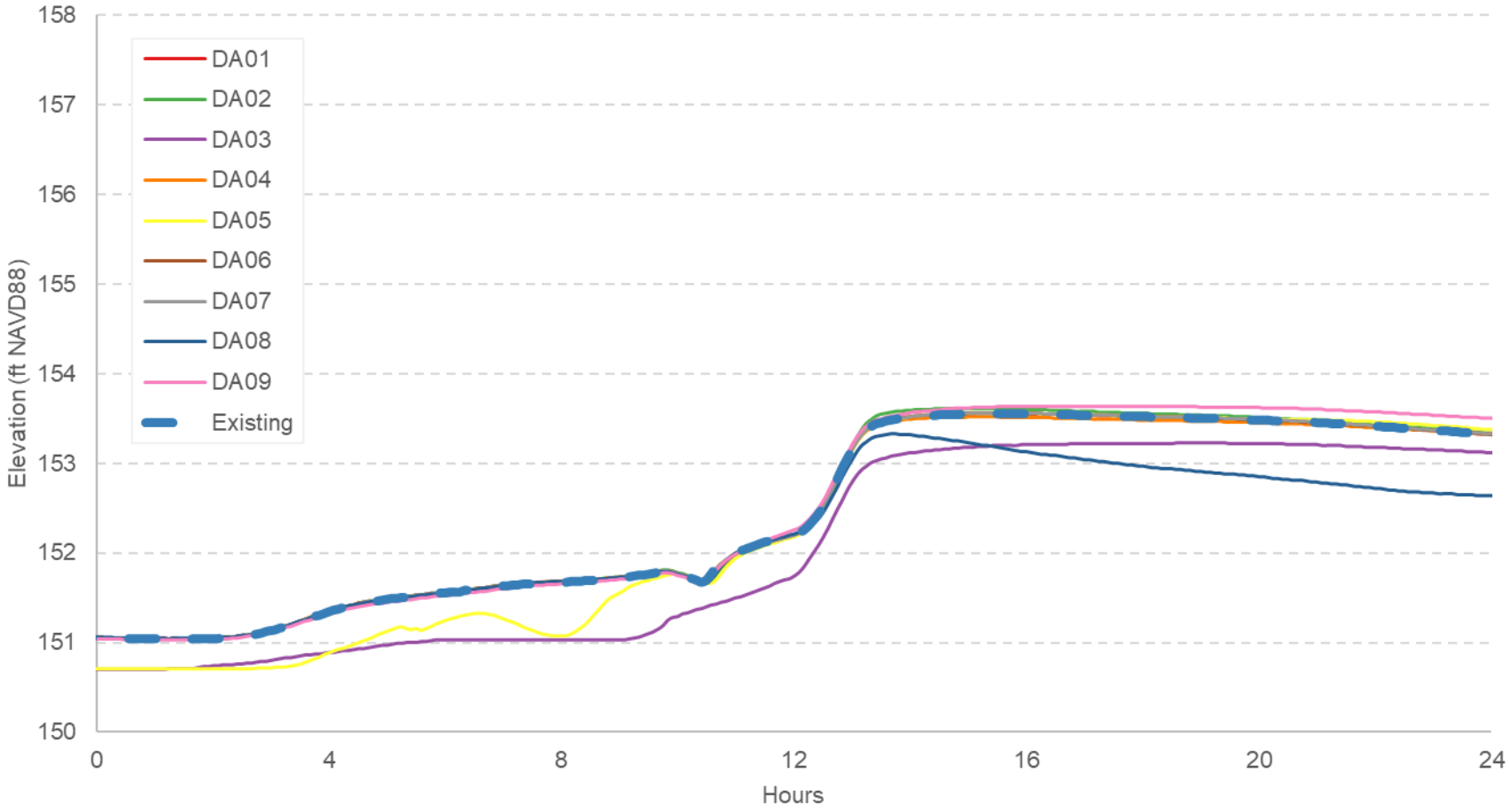

Figure 2 Water Level at 175 Walnut Street for 10-Year Design Storm

95 Arlington St.
Brighton, MA 02135
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January 22, 2021

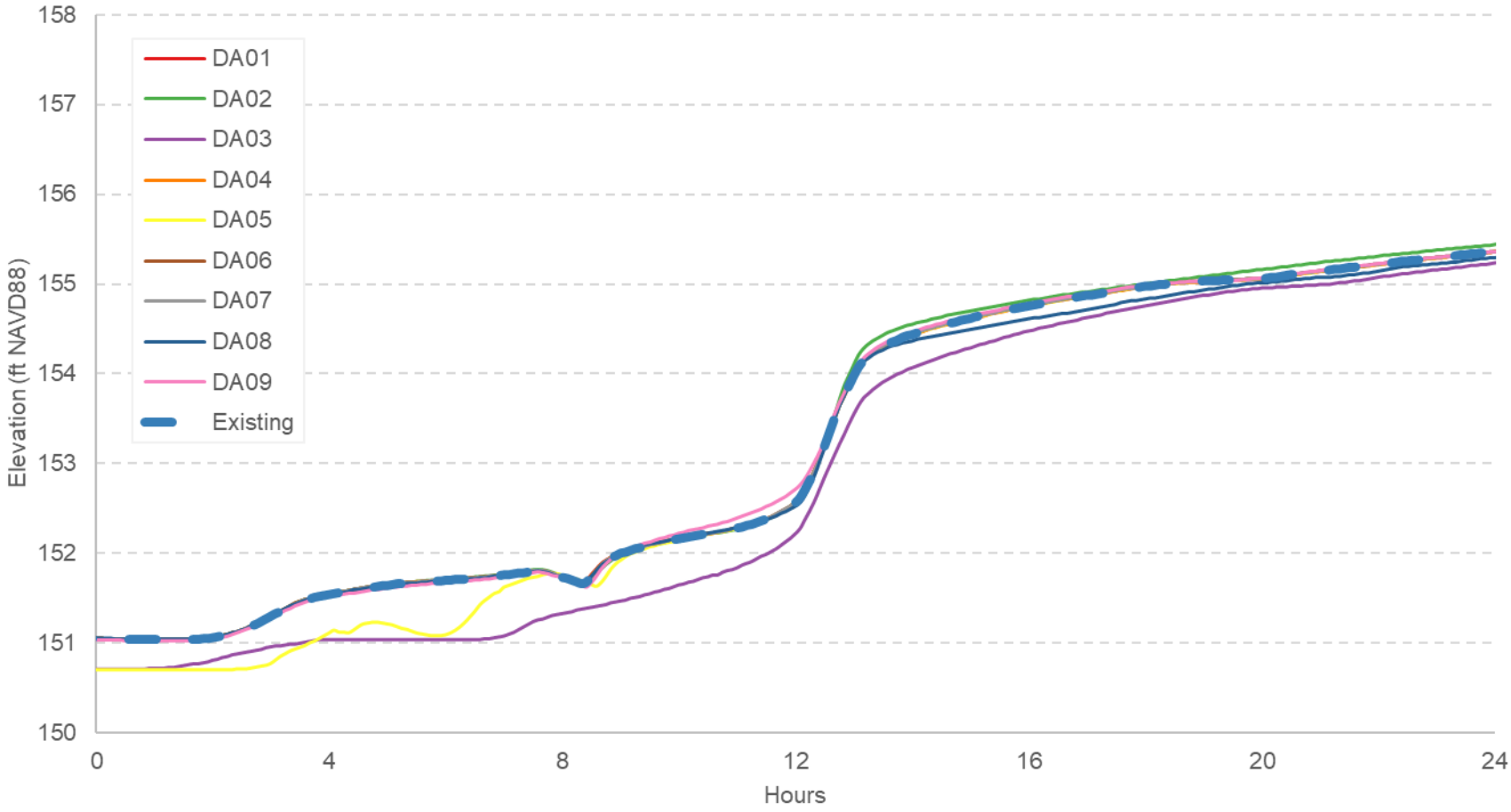

Figure 3 Water Level at 175 Walnut Street for 100-Year Design Storm

95 Arlington St.
Brighton, MA 02135
617-903-0340

January 22, 2021

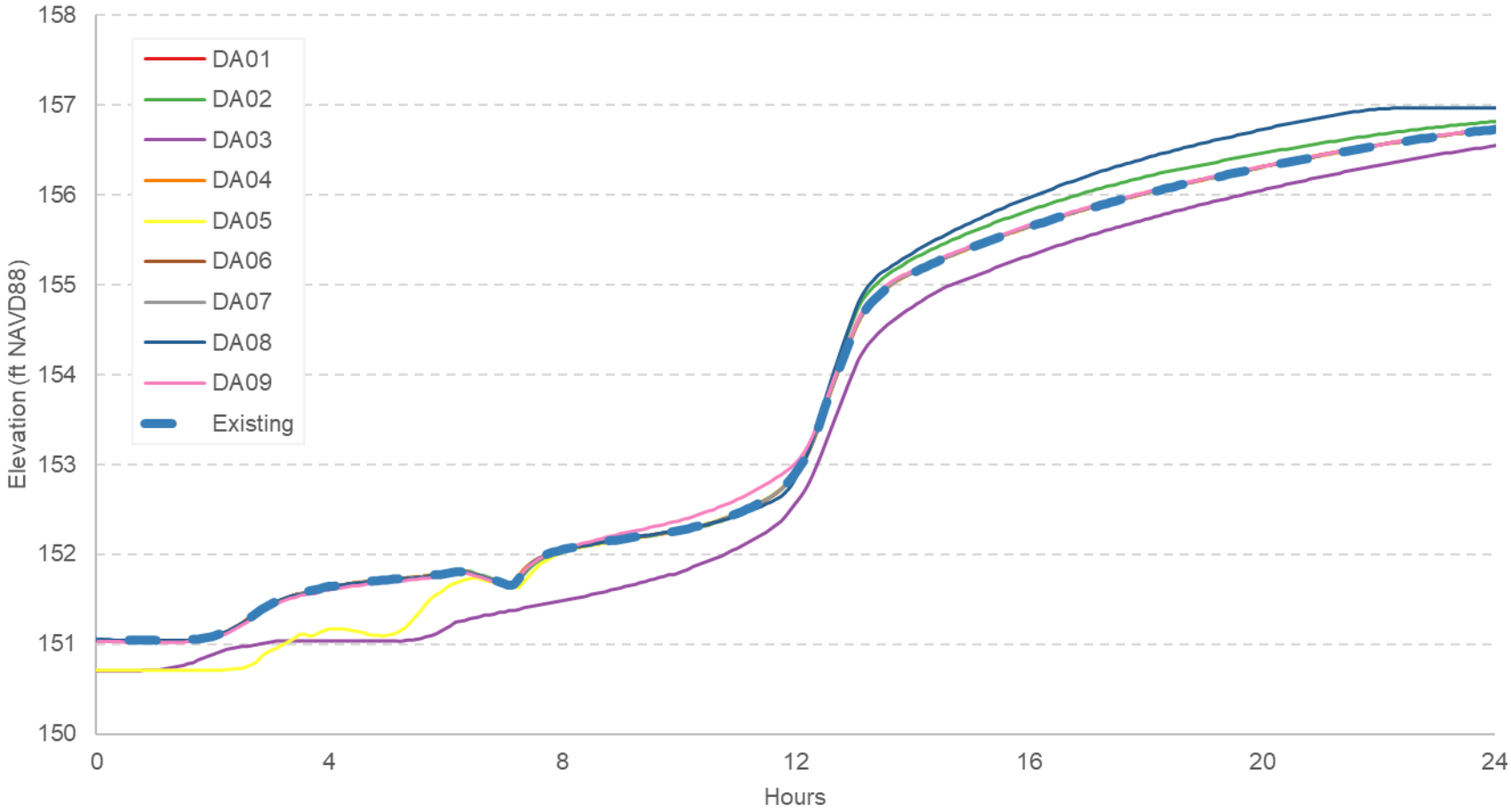

Figure 4 Water Level at 175 Walnut Street for 100-Year 2070 Design Storm

95 Arlington St.
Brighton, MA 02135
617-903-0340

January 22, 2021

Design Alternative 1

In this design alternative, a berm is built along the backside of multiple properties along Walnut Street. The berm begins at or near the property 147 Walnut Street, tying into the ground surface at elevation 154 ft NAVD88. The berm extends along the property line of each property in a northwesterly direction until it reaches the property at 223 Walnut Street, again tying into the existing ground surface at elevation 154 ft NAVD88. It is important that the berm extends far enough to tie into the existing ground surface at both ends, otherwise flood waters will flow around the end of the berm and flooding will be present on both sides of the berm. Figure 5 shows the maximum water level for the 2-year, 10-year, and 25-year storms. The berm will protect properties to the west of the berm from flooding related to the 2-year and 10-year design storm, but the 25-year storm surpasses the height of the berm.

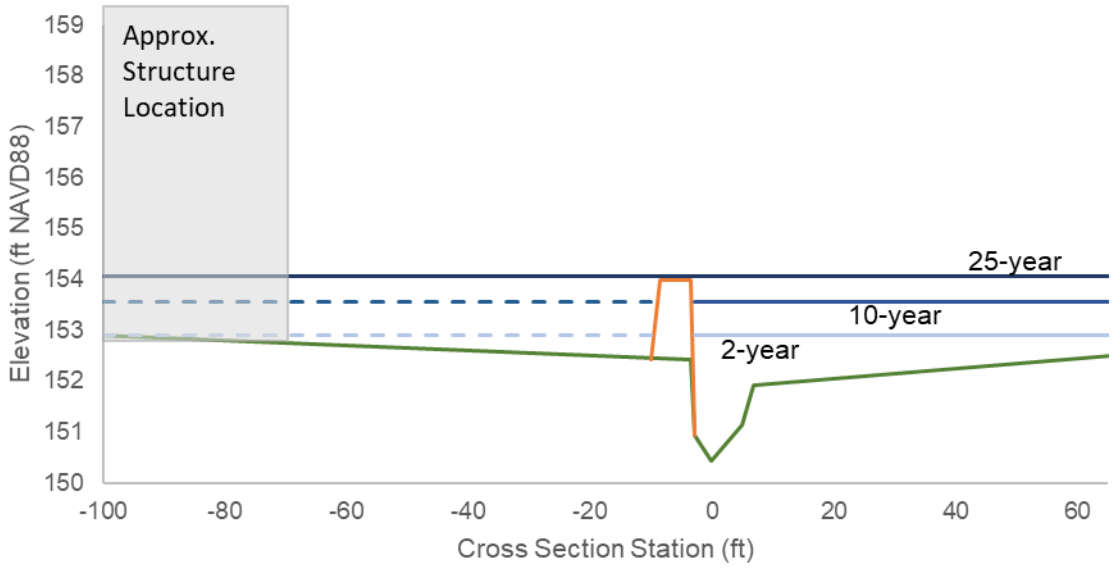

Figure 5 Approximate Ground Surface and Design Storms for Design Alternative 1

95 Arlington St.
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617-903-0340

Design Alternative 2

In this design alternative, the walkway that connects Buckminster Street to Stony Brook Road is removed and replaced by an elevated walkway (elevation 156.5 ft NAVD88). The existing walkway (elevation 155.2 ft NAVD88) functions as a small dam with only a 10-inch pipe to convey water through the dam. By elevating the walkway and excavating a channel, there will no longer be standing water on the upstream side of the walkway, and water will flow freely downstream. Table 3 shows the maximum water elevation at the walkway for each storm under existing conditions and the design alternative.

Table 3: Maximum Depth at Existing Walkway for Design Alternative 2

	Water Depth (ft) Over Walkway	
Design Storm	Existing	Elevated Walkway
2-year	--	--
10-year	--	--
25-year	--	--
50-year	--	--
100-year	0.5	--
50-year (2070)	0.8	--
100-year (2070)	2.0	0.7

The results shown in Table 3 indicate that the existing 10-inch conduit is sufficient to pass the 2-year through the 50-year design storms without overtopping the existing walkway. Both the existing walkway and the proposed elevated walkway are both overtopped by the 100-year, 50-year (2070), and the 100-year (2070) design storms. These model results show that this design alternative does not provide any reduction in flooding assuming that the 10-inch conduit through the existing walkway is functional.

Design Alternative 3

In this design alternative, the existing two channels of Sucker Brook that extend from Main Street to Stony Brook Road are cleaned out to establish a five-foot wide, at least one-foot deep channel with positive drainage (i.e., elevation drops continuously along channel center line). This alternative increases the capacity of the stream channel and promotes the movement of water out of the Sucker Brook watershed quickly, prior to the stage of the Sudbury River rising. The benefits of this design alternative are shown in Figure 1 through Figure 4.

95 Arlington St.
Brighton, MA 02135
617-903-0340

Design Alternative 4

In this design alternative, subsurface storage underneath the playing fields of Fuller Middle School is intended to capture water prior to it traveling downstream of Fuller Middle School. The water stored in this system is eventually discharged to the ground as opposed to being discharged to the Sudbury River. Figure 6 shows how the subsurface storage shifts the hydrograph of the Sucker Brook immediately downstream of the intake to the storage.

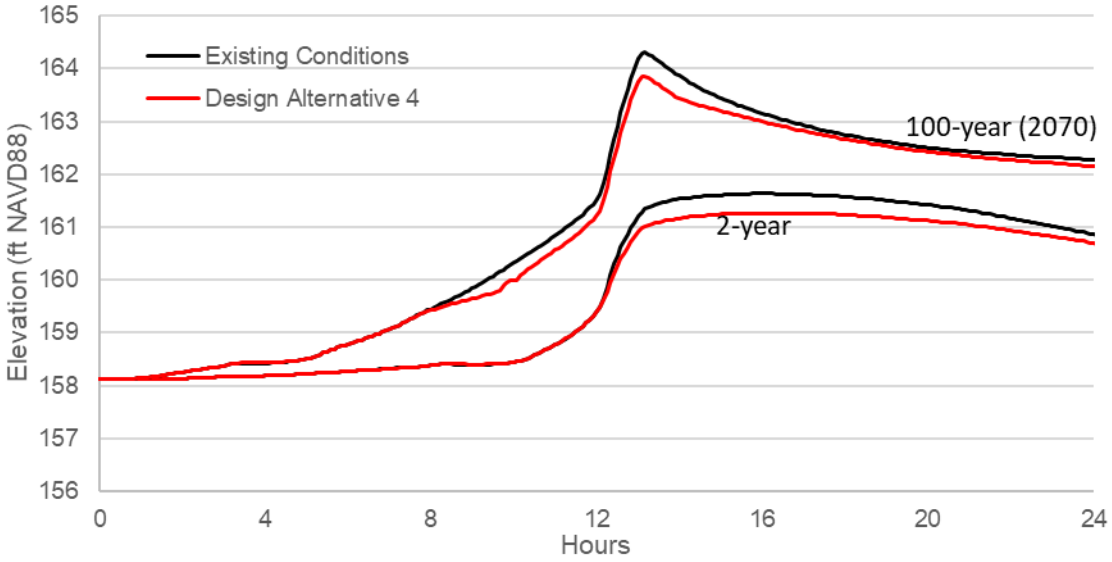

Figure 6 2-year and 100-year (2070) Water Levels Immediately Downstream of Subsurface Storage Intake

The subsurface storage provides limited benefits to the peak flood elevation downstream of the intake. The benefits increase as the storm ends. During real storms when the Sudbury River drops quickly, the benefits of the subsurface storage would be more pronounced. An investigation of the water table and hydrogeologic conditions underneath the site of the storage may provide useful information for appropriately estimated the rate of infiltration at the site.

95 Arlington St.
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Design Alternative 5

In this design alternative, the outfall from Sucker Pond is restored to include a three-foot diameter discharge pipe and an overflow weir. The purpose of this work is to more appropriately control the water level in Sucker Pond. Figure 7 shows the water level in Sucker Pond for the existing conditions and design alternative 5 for the 2-year and the 100-year (2070) storm. The model results shown in Figure 7 demonstrate the change in water levels in the pond itself. The increased storage does not change the flooding downstream of the pond.

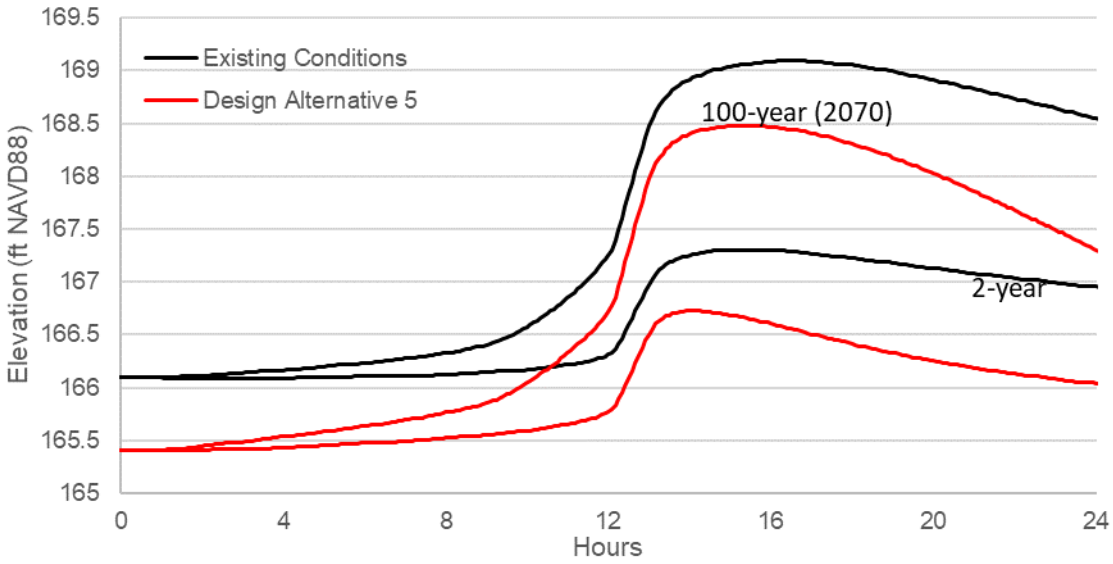

Figure 7 2-year and 100-year (2070) in Sucker Pond

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Design Alternative 6

In this design alternative, the Framingham Housing Authority (FHA) would install a set of green infrastructure (GI) features that capture and detain stormwater before it enters Sucker Brook. These GI features accomplish two things. They permanently capture a portion of the stormwater from the FHA property, and they delay the release of water from the subcatchment into Sucker Brook. This design alternative does not provide a measurable benefit at the downstream end of Sucker Brook (see Figure 1 through Figure 4). Closer to the FHA, there are measurable benefits. Figure 8 shows the water level in the wetland area that receives stormwater from the FHA. Figure 8 shows that this design alternative decreases the maximum water level in both the 2-year and the 100-year (2070) design storms, but the reduction in flooding is on the order of a couple of inches.

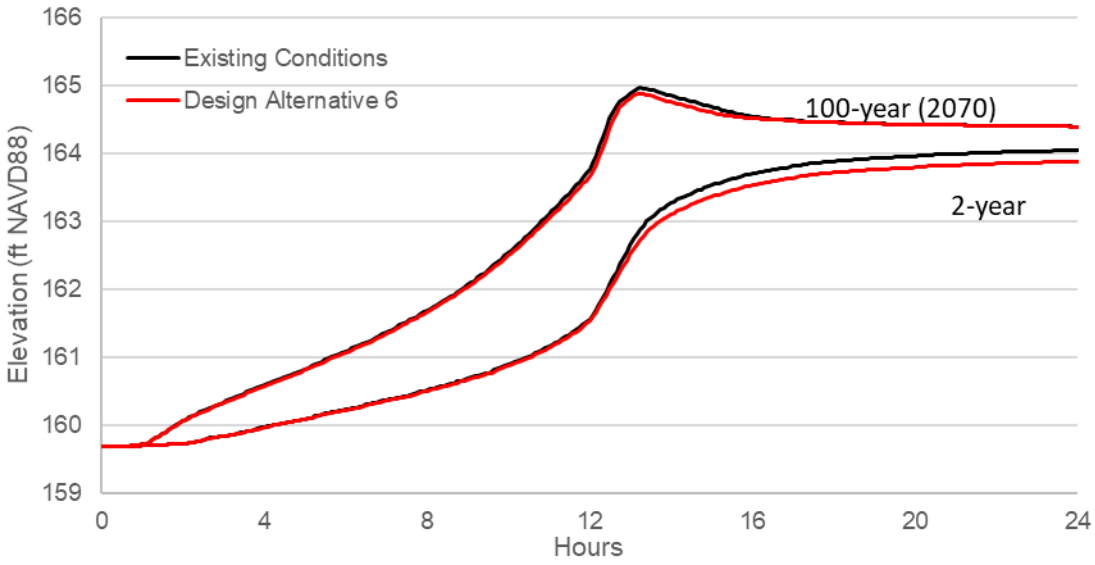

Figure 8 2-year and 100-year (2070) Water Level in Downstream Wetland for Design Alternative 6

Design Alternative 7

In this design alternative, a set of GI features would be installed in the Hastings Street neighborhood. These GI features would and detain stormwater before it enters Sucker Pond. These GI features accomplish two things. They permanently capture a portion of the stormwater from the subcatchment, and they delay the release of water from the subcatchment into Sucker Pond. This design alternative does not provide a measurable benefit at the downstream end of Sucker Brook (see Figure 1 through Figure 4). There is no measurable benefit closer to the Hastings Street neighborhood. Figure 9 shows the water level in Sucker Pond for both the 2-year and the 100-year (2070) design storms. The model results for both the existing conditions and the design alternative s are almost the same. The Hastings Street neighborhood has a much less impervious cover (28.2% of the subcatchment) than the FHA property (67.9% of the subcatchment), and Hastings Street neighborhood makes up less than a third of the overall drainage area to Sucker Pond. The combination of lower pervious area and small portion of the total watershed means that the net benefits of GI in the Hastings Street neighborhood are limited.

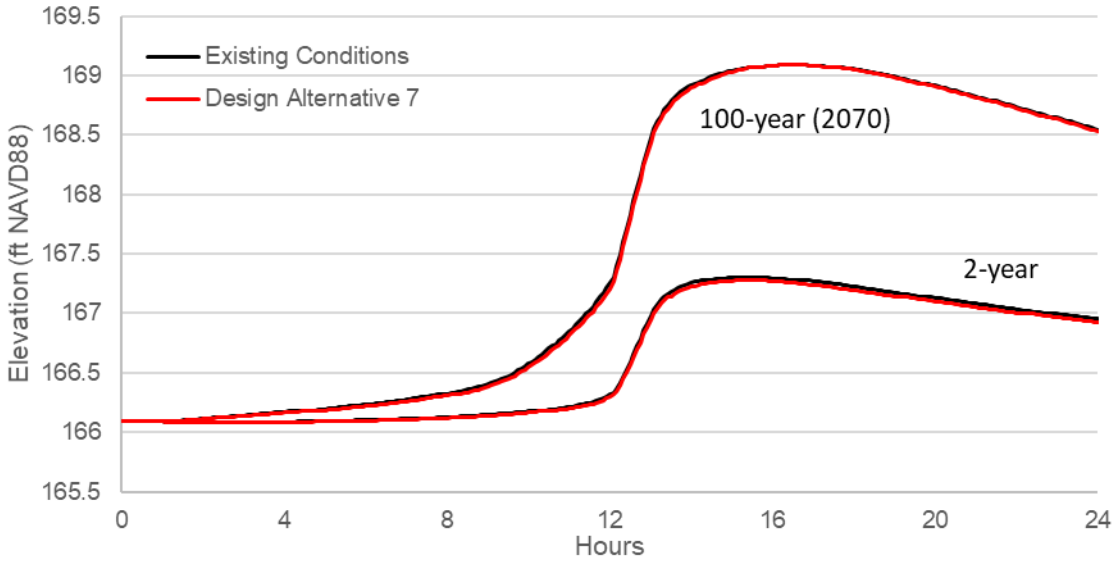

Figure 9 2-year and 100-year (2070) Water Level in Sucker Pond for Design Alternative 7

Design Alternative 8

In this design alternative, the existing 3-foot diameter circular culvert underneath Main Street is replaced by a 4-foot-high by 6-foot-wide box culvert. This culvert significantly increases the amount of water that can be passed downstream. The net result of this design alternative is that more water gets out of the Sucker Brook watershed sooner and before the stage in the Sudbury River rises. The water level at the property 175 Walnut Street is a good indicator of the flood reduction benefits achieved by this design alternative. Figure 8 shows both existing conditions and design alternative 8 for all of the design storms that were modeled.

Design alternative 8 is a promising alternative. It reduces flooding upstream of Main Street for all design storms except the 100-year (2070) design storm.

95 Arlington St.
Brighton, MA 02135
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January 22, 2021

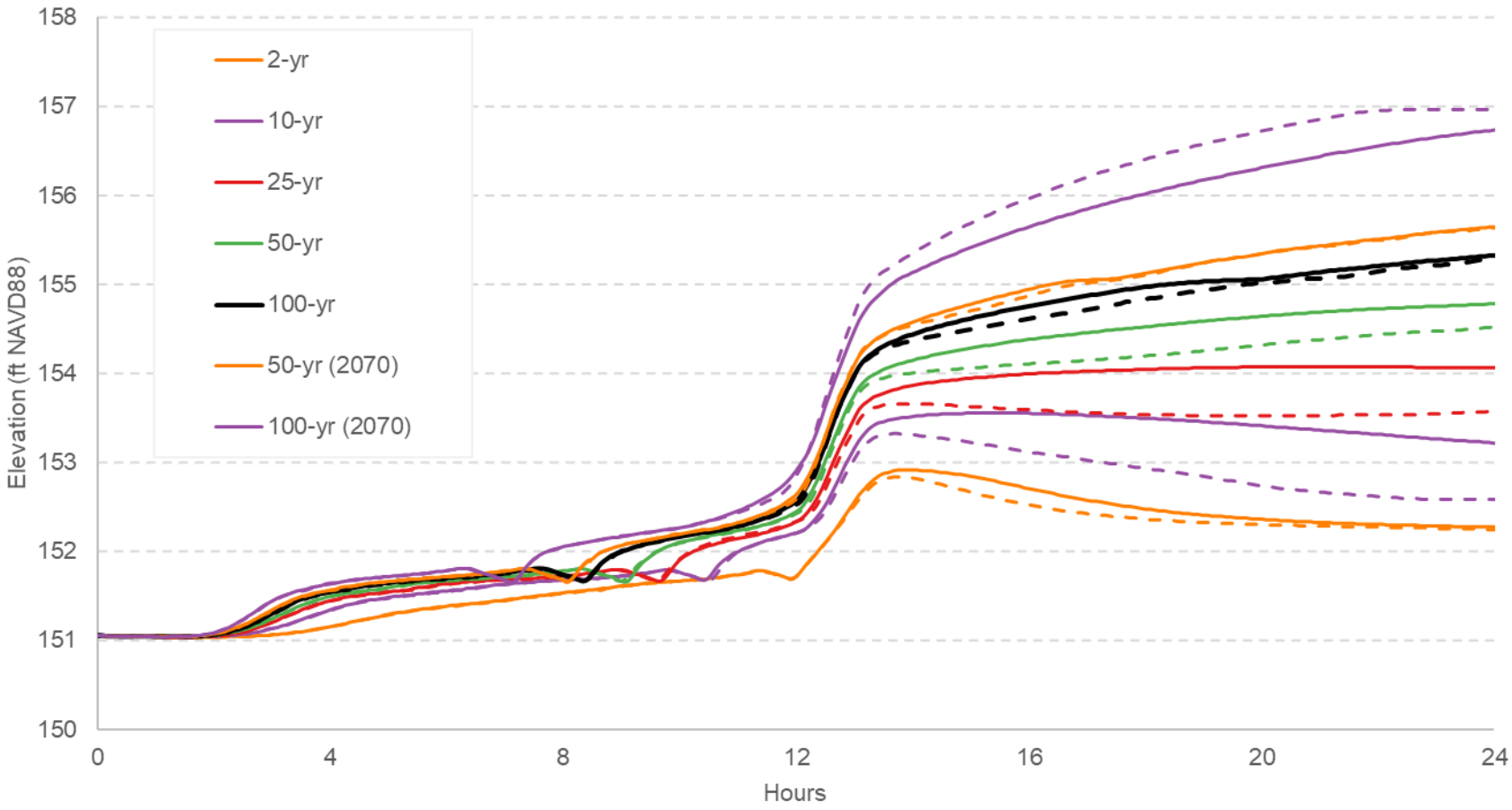

Figure 10 Design Alternative 08 Model Results at 175 Walnut Street for All Design Storms

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Design Alternative 9

In this design alternative, a small weir with a flap gate is installed upstream of the culvert under Main Street. The purpose of this weir/flap gate is to allow water from the Sudbury River into the Sucker Brook watershed during large storms (i.e., the 100-year design storm), but to minimize the impact of the Sudbury River on the Sucker Brook in smaller storms. Figure 9 shows the water level at 175 Walnut Street for the 2-year and the 100-year (2070) design storms. This design alternative serves to increase the water level upstream of the weir and flap gate during smaller storms. This design alternative used a 2-foot diameter circular flap gate. As the water level downstream of the flap gate increases, the flap gate passes less and less water. As the amount of water passed through the flap gate decreases, the water level upstream of the weir increases until the water flows over the top of the weir.

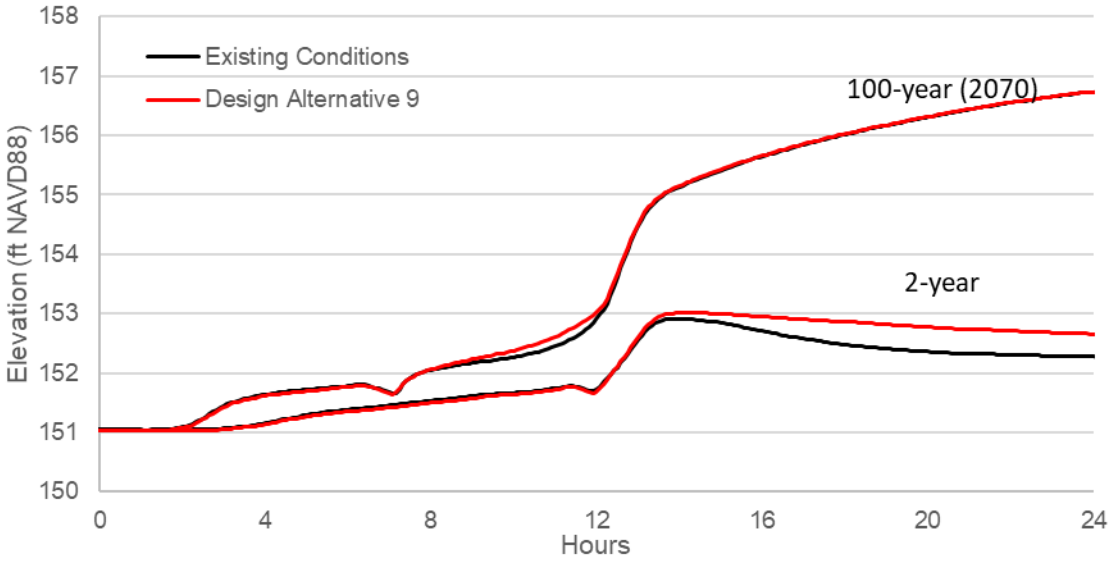

Figure 11 2-year and 100-year (2070) for Design Alternative 9

Figure 10 provides a helpful visual for understanding the mechanics of design alternative 9. Figure 10 shows the water level from the Sudbury River to a point upstream of the weir. The figure demonstrates how the weir holds water back at the highest water levels because very little water can pass through the flap gate.

95 Arlington St.
Brighton, MA 02135
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January 22, 2021

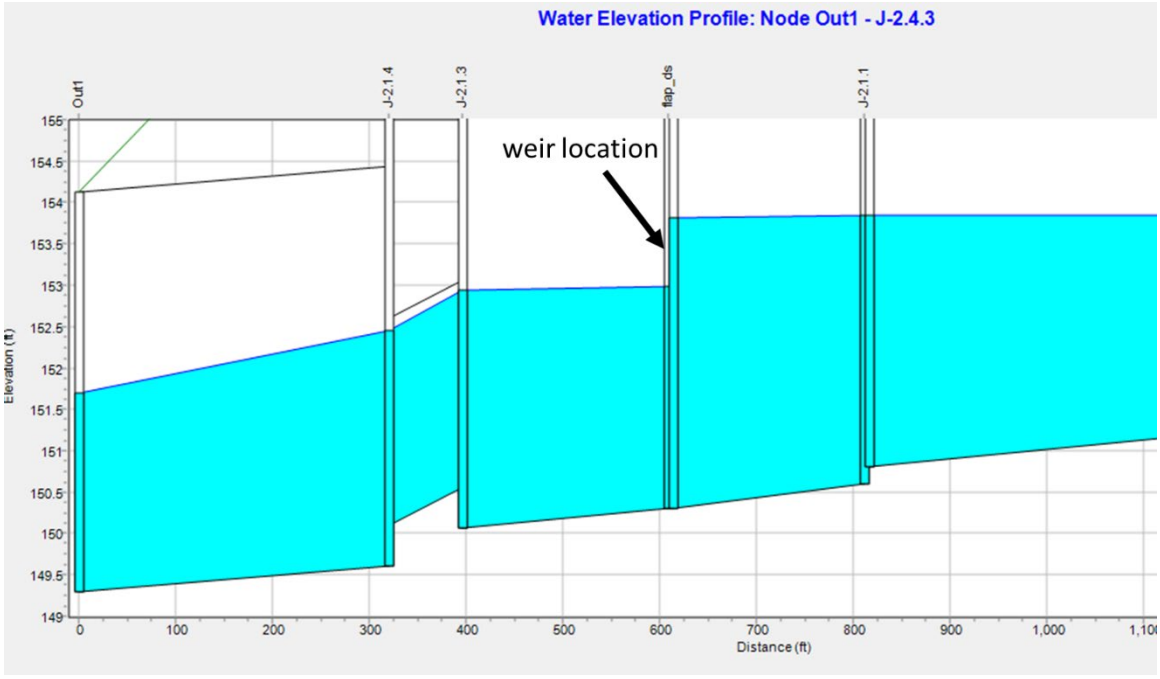


Figure 12 Excerpt for 2-year Design Alternative Model Run

3.0 NEXT STEPS

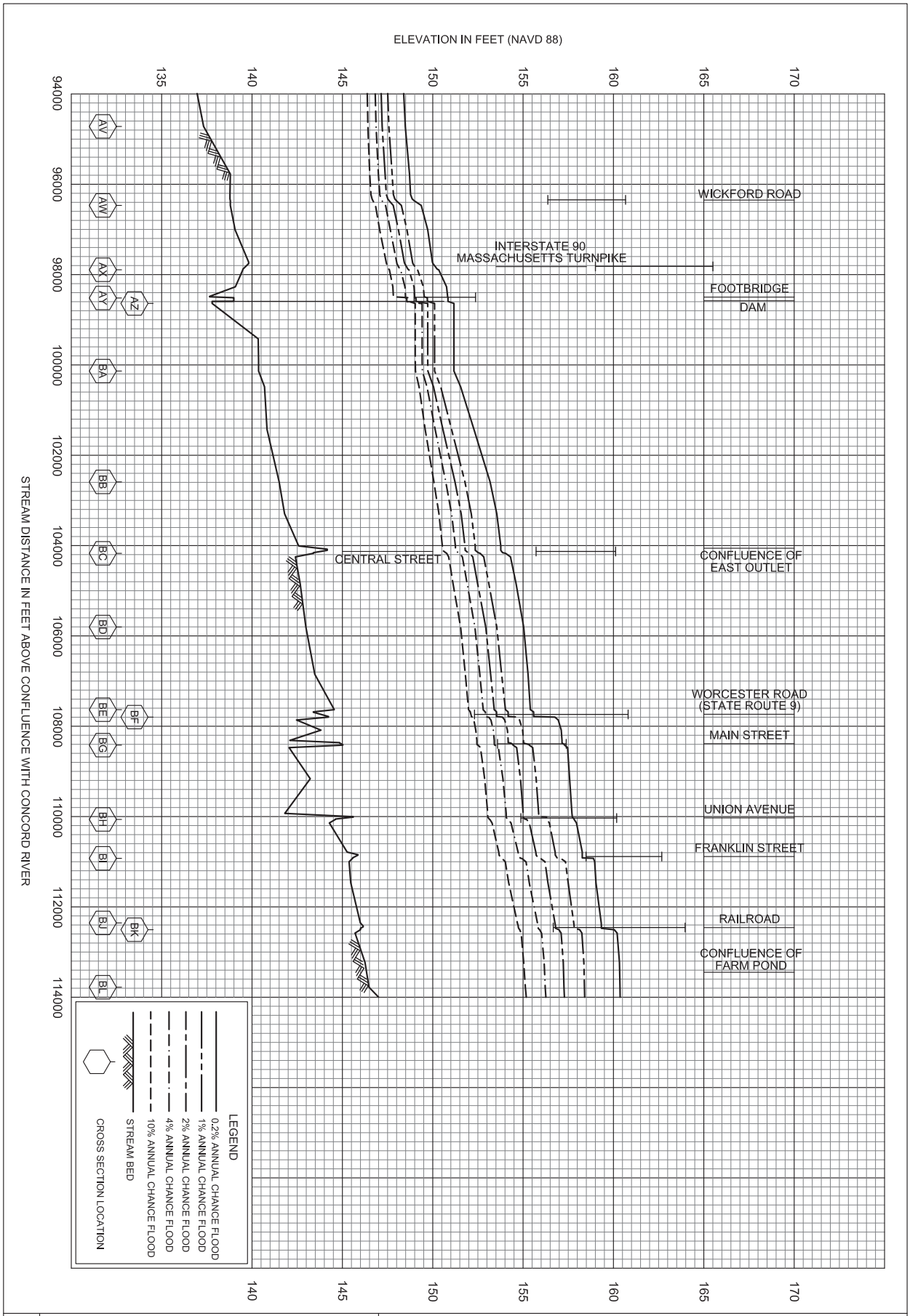
In the next phase of this work, HWR will evaluate the combination of multiple design alternatives. These "super" alternatives will provide an indication of what the maximum benefit might be for work in the Sucker Brook watershed. Design alternative 3 and design alternative 8 both help to reduce flooding by accelerating the discharge of water from the Sucker Brook watershed. If these two alternatives are combined, the benefits will likely increase. HWR also believes that design alternative 2 and design alternative 9 should be evaluated again in conjunction with design alternatives 3 and 8.

In addition to evaluation the super design alternatives, HWR will provide support to SSV and Weston & Sampson as they complete their permitting analysis of the design alternatives.

4.0 REFERENCES

FEMA, 2016. Flood Insurance Study, Volume 1 of 8, Middlesex County, Massachusetts. Flood Insurance Study Number 25017CV001C. Federal Emergency Management Agency. July 6, 2016.

NOAA, 2020. NOAA National Weather Service, Hydrometeorological Design Studies Center, Precipitation Frequency Data Server (PFDS). United States Department of Commerce, National Oceanic and Atmospheric Administration. Available from: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html. Accessed December 3, 2020.



509P

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDDLESEX COUNTY, MA

(ALL JURISDICTIONS)

FLOOD PROFILES

SUDBURY RIVER

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT C

TECHNICAL MEMORANDUM – ENVIRONMENTAL PERMITTING ANALYSIS

Weston & Sampson SM

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Reading, MA 01867
tel: 978.532.1900

Permitting Feasibility Study

WALNUT STREET FLOOD MITIGATION
FRAMINGHAM, MASSACHUSETTS

PREPARED FOR:
CITY OF FRRAMINGHAM

PREPARED BY:
WESTON & SAMPSON ENGINEERS, INC

December 2020

TABLE OF CONTENTS

Page

1.0 INTRODUCTION

The Walnut Street neighborhood in the City of Framingham is a densely populated Environmental Justice neighborhood that has experienced historical flooding issues. This neighborhood is amongst those identified by the City as particularly susceptible to flooding. Due to the presence of the Sudbury River and large wetland areas, much of the neighborhood is located within the 100-year and 500-year flood zones.

In order to better understand the specific flooding causes, ways to mitigate the flooding, and potential improvements to the community's resiliency to climate change, the City will undertake the *Walnut Street Neighborhood Flood Mitigation Study*.

A total of eight (8) flood mitigation alternatives were investigated in the Walnut Street neighborhood. These included:

- Alternative 1: Install earthen berm – Western bank of existing stream behind Walnut Street
- Alternative 2: Boardwalk to replace culvert between Walnut Street and Stony Brook Road
- Alternative 3: Limited channel clearing to restore conveyance capacity
- Alternative 4: Subsurface storage of Fuller Middle School property
- Alternative 5: Clean Sucker Pond outlet and install flow control structure
- Alternative 6: and 7: Green infrastructure projects
- Alternative 8: Upsize Main Street culvert from 36" diameter to 36" x 54" box culvert

Environmental and human resource maps were created for each of the eight alternative which were used to determine which environmental permits may be required for each of the alternatives. A brief summary of each alternative is provided, below.

Alternative 1: Install earthen berm. This alternative would include creation of a 700-foot berm along the western bank of the unnamed stream behind Walnut Street. This work would occur in bordering vegetated wetlands (BVW) and the 100-year flood zone. It is assumed that less than 5,000 square feet (sf) of BVW will be impacted. Wetlands restoration and compensatory storage of flood zone would be required for this project. A Notice of Intent (NOI) and filing with the Massachusetts Historical Commission (because of assumed state funding) would need to be filed with the Framingham conservation commission.

Alternative 2: Boardwalk to replace culvert between Walnut Street and Stony Brook Road. This alternative would impact the 100-year flood zone. As such, a Notice of Intent (NOI) and filing with the Massachusetts Historical Commission (because of assumed state funding) would need to be filed with the Framingham conservation commission.

Alternative 3: Limited channel clearing to restore conveyance capacity. Impacts to protected environmental resources would include the following:

- Land under water impacts (dredging >100 cubic yards (CY) of material in perennial stream
- Impacting > 5,000 sf of BVW
- Riverfront area impacts
- 100-year flood zone impacts

These impacts would result in the need for the following permits:

- Notice of Intent
- Environmental Notification Form (ENF)
- 401 Water Quality Certificate
- Chapter 91 permit
- US Army Corps of Engineers Pre-Construction Notification
- Massachusetts Historical Commission submission

Alternative 4: Subsurface storage of Fuller Middle School property. Work would occur within the 200-foot Riverfront Area and within the 100-foot buffer zone. A Notice of Intent (NOI) and filing with the Massachusetts Historical Commission (because of assumed state funding) would need to be filed with the Framingham conservation commission.

Alternative 5: Clean Sucker Pond outlet and install flow control structure. This work would occur within the 100-foot buffer zone of Sucker Pond and should be considered maintenance work and would require a Notice of Intent (NOI) and filing with the Massachusetts Historical Commission (because of assumed state funding).

Alternative 6: and 7: Green infrastructure projects. The vast majority of both of these alternatives is outside the jurisdictional area of any agency that protects environmental resources. The only pats of both projects that would be within jurisdictional area is the proposed daylighting of a stormwater outfall at both sites. This work would be within 100-feet of wetlands and would, therefore, require a (NOI) and filing with the Massachusetts Historical Commission (because of assumed state funding) would need to be filed with the Framingham conservation commission.

Alternative 8: Upsize Main Street culvert from 36" diameter to 36" x 54" box culvert. This work would require open excavation down to the existing culvert, remove existing culvert, and install larger replacement culvert. Protected environmental resources in this area include:

- Land under water
- Bank
- 100-year flood zone

These impacts would result in the need for the following permits:

- Notice of Intent
- Environmental Notification Form (ENF)
- Chapter 91 permit
- US Army Corps of Engineers Pre-Construction Notification
- Massachusetts Historical Commission submission

This study provides an in-depth analysis and discussion on environmental permitting considerations for the City's three preferred project alternatives. These alternatives include:

- Alternative 2: Boardwalk to replace culvert between Walnut Street and Stony Brook Road
- Alternative 3: Limited channel clearing to restore conveyance capacity
- Alternative 8: Upsize Main Street culvert from 36" diameter to 36" x 54" box culvert

Figure 1, below, provides the locations of each of the three preferred alternatives.

Figure 1. Location of Alternatives 2, 3 and 8

Numerous local, state and federally jurisdictional resources, including regulations and supporting documents, were reviewed to determine environmental and human receptors that may be affected and environmental permits that will likely be required for the three different alternatives. These resources used for this study are provided, below.

2.0 METHODOLOGY

2.1 RESOURCES

A number of resources were reviewed in order to inform this study of the environmental and human impacts that may occur as part of this project. Local, state and federal regulations, and supporting documents, were reviewed to determine which permits will likely be required for the three preferred alternatives. These resources include the following:

- City of Framingham Wetlands Protection Bylaw (Section 18)
- City of Framingham Wetlands Protection Regulations
- Massachusetts Wetlands Protection Act (310 CMR 10.00)
- Massachusetts Environmental Policy Act (MEPA) (301 CMR 11.00)
- Massachusetts Chapter 91 regulations (310 CMR 9.00)
- Massachusetts 401 Water Quality Certification Regulations (314 CMR 9.00
- Massachusetts Endangered Species Act regulations (321 CMR 10.00)
- Department of the Army – General Permits for the Commonwealth of Massachusetts (effective date 4/16/18)

To determine which permits will be required for the three preferred alternatives, environmental and human receptors maps were also created to identify any constraints. Once identified, area impacts were then estimated to determine which permits would be required as many of these permits are triggered by impact areas. The additional supporting maps included:

- Environmental receptors map created by Weston & Sampson using MassGIS data layers on 12/09/20
- Human receptors map created by Weston & Sampson using MassGIS data layers on 12/15/20

Environmental and human receptor mapping are discussed in further detail in the next section.

2.2 ENVIRONMENTAL AND HUMAN RECEPTORS MAPPING

A preliminary desktop survey of environmental and human receptors in the area was conducted in ArcView using MassGIS data layers. The environmental resources map (see attached Figures 1, 2 and 3) contains the following information:

- Aerial photography
- Perennial rivers and intermittent streams (USGS 1:25,000 Topographic Quadrangle)
- Ponds, lakes, oceans, reservoirs (USGS 1:25,000 Topographic Quadrangle)
- MassDEP mapped wetlands (Stereo color infrared photography at 1:12,000 scale)
- 100-year flood zone (FEMA, 2017)
- Natural Heritage and Endangers Species Program (NHESP) Estimated and Priority habitats (NHESP, 2017)
- NHESP certified vernal pools (NHESP, 2017)
- Areas of Environmental Concern (ACECs) (EEA, 2009)

The human resource receptors map (see attached Figures 1a, 2a and 3a) contains the following information resources:

- State registry of historic places
- Underground storage tanks
- Tier classified sites
- Public water supplies
- Chapter 21E sites
- MassDEP major facilities (large quantity generators)
- Surface water supply protection zones
- Groundwater supply protection zones
- Landfill facilities
- Open space lands

The map provides information on any hazardous sites, water supply protection areas and protected open space, all of which may require additional approvals other than environmental approvals to move forward with the project. Based on the human receptor map, it does not appear that any of the three preferred alternatives would pass over any hazardous sites, landfills, or water supply protection zones. Alternatives 2 and 3 do travel through a mapped open space which is considered municipally owned land.

3.0 FINDINGS

Results from the environmental resource mapping are used to determine which permits will likely be required for each of the preferred alternatives. Results of this desktop analysis, as well as a discussion of local, state and federal permit requirements for each of the three preferred alternatives, is provided below.

3.1 MAPPING RESULTS

Environmental resource maps were created for each of the three preferred alternatives (see attached Figures 1, 2 and 3). Existing protected environmental resources in the proposed work areas for each of the preferred alternatives are provided, below.

Alternative 2: Boardwalk to replace culvert between Walnut Street and Stony Brook Road
As shown on Figure 1, protected environmental resources that are in the general location of the work area include the following:

- Bordering vegetated wetlands (BVW)
- 100-years flood zone
- Intermittent stream

The work would involve the installation of approximately 300 linear feet (lf) of 6-foot wide boardwalk on helical piles at approximately EL 156 (NAVD88).This would be placed on the existing path, thus no impacts to BVW or intermittent stream. There would be negligible impacts to the 100-year flood zone associated with the helical piles.

Work would also include re-defining the channel of a recently formed stream. This work would include removal of leaf and other debris and very slight regrading (in the order of a few inches). This would result in impacts to the flood zone, but these would be in the positive nature as this slight modification would allow for improved stormwater movement along the area.

The existing pipe across the path which conveys water from the mapped intermittent stream, will not be touched.

Alternative 3: Limited channel clearing to restore conveyance capacity
Figure 2 shows environmental resources in proximity to the proposed limited clearing of two streams. This work would include sediment and debris removal within Sucker Brook and along the unnamed stream behind Walnut Street. Protected environmental resources in this area include:

- Intermittent stream (unnamed stream behind Walnut Street
- Perennial stream (Sucker Brook)
- Bank (to intermittent and perennial stream)
- Riverfront area
- BVW
- 100-year flood zone
- Land under water

This study assumes that marsh mats will be placed over existing BVW along the edge of both streams to allow excavator and dump trucks to move along the streams and remove sediment and debris from the streams. The following environmental impacts are assumed:

- Land under water impacts (dredging >100 cubic yards (CY) of material in perennial stream (sediment removal from intermittent stream is not considered dredging))
- Impacting > 5,000 sf of BVW (associated with marsh mat placement
- Riverfront area impacts
- 100-year flood zone impacts

Alternative 8: Upsize Main Street culvert from 36" diameter to 36" x 54" box culvert
Figure 3 shows the proposed work area for the culvert upsizing alternative. It is assumed that this work would require open excavation down to the existing culvert, remove existing culvert, and install larger replacement culvert. Protected environmental resources in this area include:

- Land under water
- Bank
- 100-year flood zone

All of the above mentioned resources would be impacted as a result of this alternative.

The following sections discuss local, state and federal permitting requirements associated with the three preferred alternatives.

3.2 LOCAL PERMITTING DISCUSSION

A review of the Framingham Wetlands Protection Bylaw (Section 18) indicate that there are some standards that are more stringent or more inclusive when compared with the Massachusetts Wetlands Protection Act (WPA). Some of these items include:

- Protection of isolated wetlands
- Presence of a 125-foot buffer zone around resource areas,
- Presence of a 30-foot no alteration zone off of wetland resources,
- Presence of a 50-foot no build zone off of wetland resources
- Presence of a 125-foot no alteration zone off vernal pools
- Presence of a unique habitat no alteration zone (for important bird areas (IBA), the "wild and scenic" portions of the riverfront area of the Sudbury River, and estimated habitat for rare wetlands wildlife)

Also of interest is that the wetland bylaw states that there is no riverfront area on the island.

As noted above, when reviewing the environmental receptors maps (Figures 1, 2 and 3) it appears that all three of the preferred alternatives would fall under the jurisdictional area of the Framingham conservation commission. Additional areas not covered by the WPA that may be impacted include the following:

- Work in the 125-foot buffer zone,
- Work in the 30-foot no alteration zone,
- Work in the 50-foot no build zone

Work in these additional areas will be addressed as part of the Massachusetts Notice of Intent (NOI) filing. While the NOI is considered a local permit, it is discussed under the state discussion because the NOI is governed by the state Massachusetts Wetlands Protection Act.

A discussion of applicable state permit follows.

3.3 STATE PERMITTING DISCUSSION

Numerous state regulations were reviewed to determine if any state environmental permits would be required for any of the three preferred alternatives. A discussion of state environmental permits is provided, below, which includes a determination of whether each state environmental permit would be required.

The Massachusetts Wetlands Protection Act (310 CMR 10.00)

The Massachusetts Wetlands Protection Act (MGL c.131 § 40) (WPA) and implementing regulations (310 CMR 10.00) is a State statute administered locally. While a Notice of Intent (NOI) submission would be reviewed by the local Framingham conservation commission, this permit is being discussed under this state review discussion because of the state regulations that govern the WPA submissions. Jurisdiction under the WPA would occur for proposed removal, fill, dredge and/or alteration of a wetland resource protected under the WPA. The WPA requires the preparation of a NOI for work within a wetland resource area, work within 100 feet of certain resource areas and/or within the 100-year flood plain. The general performance standards for work or activities occurring within each wetland resource are identified in the WPA.

Based on the attached environmental receptors maps, it appears that a NOI will be required for Alternative 2 (for work in 100-year flood zone and 100-foot buffer zone), Alternative 3 (for work in land under water, BVW, riverfront area, 100-year flood zone and 100-foot buffer zone) and Alternative 8 (for work in land under water, BVW, 100-year flood zone and 100-foot buffer zone)

Massachusetts Environmental Policy Act (MEPA, 301 CMR 11.0)

The purpose of MEPA and 301 CMR 11.00 is to provide meaningful opportunities for public review of the potential environmental impacts of a project for which a permit is required from an agency of the Commonwealth, and to assist agencies of the Commonwealth in using all feasible means to avoid damage to the environment or, to the extent damage to the environment cannot be avoided, to minimize and mitigate damage to the environment to the maximum extent practicable. MEPAs review is intended to inform the participating agencies of the project, to maximize consistency between agency actions, and to facilitate coordination of all environmental and development review and permitting processes of the Commonwealth. The MEPA process provides an opportunity for the project proponent to identify required agency actions and to describe and analyze how the project will comply with applicable regulatory standards and requirements. Through review of the MEPA documents, each participating agency can comment on aspects of the project or issues regarding its agency action that require additional description or analysis.

There are several MEPA review thresholds. In addition to triggering a threshold, a state action (i.e. state funding or state permitting) would be needed for MEPA review. The following MEPA thresholds would likely be triggered for the following preferred alternatives:

- Alternative 2: no thresholds will be triggered
- Alternative 3: > 5,000 sf of BVW impacts (associated with marsh mat placement)
- Alternative 8: > 500 lf bank impacts

An ENF would likely be required for Alternatives 3 and 8.

Massachusetts Waterways Regulation (310 CMR 9.00) (Ch. 91 Review)

310 CMR 9.00 was enacted for the following purposes:

(1) to protect and promote the public's interest in tidelands, Great Ponds, and non-tidal rivers and streams in accordance with the public trust doctrine,

(2) to preserve and protect the rights in tidelands of the inhabitants of the Commonwealth by ensuring that the tidelands are utilized only for water-dependent uses or otherwise serve a proper public purpose,

(3) protect the public health, safety, and general welfare as it may be affected by any project in tidelands, Great Ponds, and non-tidal rivers and streams,

(4) support public and private efforts to revitalize unproductive property along urban waterfronts in a manner that promotes public use and enjoyment of the water, and

(5) foster the right of the people to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, and historic, and esthetic qualities of their environment.

Work for Alternative 2 will not not fall within tidelands, Great Ponds or non-tidal rivers or navigable streams. Work for alternatives 3 and 8 will occur within a stream. As such, this work will fall under Chapter 91 jurisdiction and require a Chapter 91 submittal.

Massachusetts 401 Water Quality Certification (314 CMR 9.00)

Projects in Massachusetts involving the discharge of dredged or fill material, dredging, or dredged material disposal activities in waters of the United States, which require federal licenses or permits are subject to 314 CMR 9.00. 314 CMR 9.07 also applies to any dredging project and the management of dredged material within the marine boundaries and at upland locations within the Commonwealth.

The purpose of the 401 Water Quality Certification is to ensure that proposed discharges of dredged or fill material, dredging and dredged material disposal in the waters of the United States within the Commonwealth comply with the Surface Water Quality Standards and other appropriate requirements of the state law.

Work for Alternative #2 will not be with waters of the United States and will not require a 401 WQC submission. It is assumed that Alternative #3 will result in dredging more than 100 CY of material and impact more than 5,000 sf of BVW and will, therefore, require a 401 WQC submission. It is assumed that Alternative 8 will not result in dredging of > 100 CY of material and not impact BVW and will not require a 401 WQC submittal.

Massachusetts Endangered Species Act (MESA) (321 CMR 10.00)

Priority Habitat mapped by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) is protected under Massachusetts Endangered Species Act (MESA) (321 CMR 10.00). The MESA review assists proponents with projects or activities that will take place in mapped Priority Habitat in order to avoid a take of a state-listed species. An initial MESA project review submission will be required. If it is determined that the project will result in a "take" of endangered species habitat, a more involved MESA Conservation and Management permit may be required. To gain approval from the MESA office, the proponent would have to explain how the project will avoid, minimize and mitigate impacted habitat. This would likely involve hiring a MESA-approved scientist to assess the area to confirm NHESP habitat and develop a habitat protection and mitigation plan for the project.

None of the three preferred alternatives are located within NHESP habitat and will not need to file with the MESA office.

Massachusetts Historic Commission (MHC)

A Section 106 MHC submittal is required for projects with state actions (i.e. state funding or state permitting). It is assumed that state funding (MVP grant funding) will be involved for any of the three alternatives and thus would require a Section 106 MHC submittal.

The next section, below, provides a discussion of permitting the bike path project at the federal level.

3.4 FEDERAL PERMITTING DISCUSSION

US Army Corps of Engineers General Permits for the Commonwealth of Massachusetts

The U.S. Army Corps of Engineers (Corps) regulates construction and other work in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899, and has authority over the discharge of dredged or fill material into "waters of the United States" (a term which includes wetlands and all other aquatic areas) under Section 404 of the Clean Water Act. Under these laws, those who seek to carry out such work must first receive a permit from the Corps. The program considers the full public interest by balancing the favorable impacts against the detrimental impacts. This is known as the "public interest review." The program reflects the national concerns for both the protection and utilization of important resources.

In Massachusetts, regional ACOE general permits can be issued for certain activities with no more than minimal adverse effects on the aquatic environment. Work for Alternative #2 will not be with waters of the United States and will not require an ACOE submission. It is assumed that Alternative #3 and Alternative #8 will both result in work within waters of the United States and will, therefore, require an ACOE submission. It is assumed that the ACOE Pre-Construction Notification (PCN) submission would be required for both Alternatives #3 and #8.

US Environmental Protection Agency (EPA) Construction General Permit (CGP)

If more than one acre of land will be disturbed for any of the three preferred alternatives, a US Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) Construction General Permit (CGP) will be required. As part of this submission, a stormwater pollution prevention plan (SWPPP) will need to be developed.

Neither of the three preferred alternatives will result in disturbance of more than one acre of land. As such, an EPA CGP will not be required.

Estimated costs for local, state and federal review are provided in the next section.

3.5 COSTS

Reviewing agencies that will likely need to be consulted as part of this project include Framingham conservation commission (NOI), Massachusetts Department of Environmental Protection (Ch. 91, 401 WQC), MEPA office (ENF), and the U.S. Army Corps of Engineers (PCN). A summary of permit costs is provided in Table 1, below.

Table 1. Costs Summary

	Mitigation Alternatives					
	Alternative 2 (Boardwalk)		Alternative 3 (Channel Clearing)		Alternative 8 (Upsize Culvert)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Local Considerations						
Conservation Commission NOI	$10,000	$15,000	$10,000	$15,000	$10,000	$15,000
Sub-Total	$10,000	$15,000	$10,000	$15,000	$10,000	$15,000
State Considerations						
MEPA ENF	$0	$0	$3,000	$4,000	$3,000	$4,000
401 WQC	$0	$0	$4,000	$6,000	$0	$0
Chapter 91	$0	$0	$4,000	$6,000	$4,000	$6,000
Section 106 MHC	$500	$1,000	$500	$1,000	$500	$1,000
Sub-Total	$500	$1,000	$11,500	$17,000	$7,500	$11,000
Federal Considerations						
ACOE PCN	$0	$0	$6,000	$8,000	$6,000	$8,000
Sub-Total	$0	$0	$6,000	$8,000	$6,000	$8,000
Overall Costs (TOTAL)	$10,500	$16,000	$27,500	$40,000	$23,500	$34,000

Note: Costs do not include engineering design, plan set development, or additional studies or monitoring efforts.

The above mentioned costs include the following:

- Preparation of application form(s) and address all relevant elements
- Preparation of Project Narrative providing history and justification of project
- Identification of resources and methods for mitigation and restoration as well as minimization of impacts
- Incorporation of plans illustrating project limits and resource areas

- Attend and assist in presentation of project at public site meetings
- Continued communication with reviewing agencies throughout the permit review period
- Incorporation of agency and client comments from site meeting

Permitting costs do not include the following:

- Engineering design
- Plan set development
- No project segmentation within component
- Additional studies

Review times for the above-mentioned permits are provided, below.

3.6 SCHEDULE

The permit review timeline is dependent on the type of permit being submitted. General permit review timelines include the following:

- NOI: 2 – 3 months from filing
- ENF: 1 – 2 months from filing
- 401 WQC: 4 – 5 months
- Chapter 91: 7 – 9 months
- Section 106 MHC: 1 month
- ACOE PCN: 4 – 5 months

The permits can all be submitted at the same time. Therefore the permit review timelines for the three preferred alternatives include:

- Alternative #2: 2 – 3 months (to gain approval for NOI and MHC submissions)
- Alternative #3: 7 – 9 months (to gain approval for NOI, ENF, 401 WQC, Ch. 91, 106 MHC, ACOE PCN)
- Alternative #8: 7 – 9 months (to gain approval for NOI, ENF, Ch. 91, 106 MHC, ACOE PCN)

4.0 SUMMARY AND CONCLUSIONS

4.1 SUMMARY

As part of the initial planning efforts to mitigate flooding in the Walnut Street Neighborhood, the City of Framingham hired Weston & Sampson to conduct an environmental permitting feasibility study for different flood mitigation alternatives. The City selected three preferred mitigation alternatives, which this study focused on. These preferred alternatives include:

- Alternative 2: Boardwalk to replace culvert between Walnut Street and Stony Brook Road
- Alternative 3: Limited channel clearing to restore conveyance capacity
- Alternative 8: Upsize Main Street culvert from 36" diameter to 36" x 54" box culvert

A number of resources were used to inform this study of the environmental and human impacts that may occur as part of this project. Additionally, state and federal regulations were reviewed to determine which permits will likely be required for the three preferred alternatives.

Results from the environmental resource mapping shows that no various protected environmental resources will be impacted depending on the alternative. Potentially impacted environmental resources per alternative include:

- Alternative #2:
  - 100-year flood zone
- Alternative #3:
  - Land under water impacts (dredging >100 cubic yards (CY) of material in perennial stream (sediment removal from intermittent stream is not considered dredging))
  - Impacting > 5,000 sf of BVW (associated with marsh mat placement
  - Riverfront area impacts
  - 100-year flood zone impacts
- Alternative #8:
  - Land under water
  - Bank
  - 100-year flood zone

Based on the human receptor maps, it does not appear that any of the preferred alternatives would pass over any hazardous sites, landfills, or water supply protection zones. Alternatives 2 and 3 do travel through a mapped open space which is considered municipally owned land.

Table 2, below, provides a list of local, state and federal reviews that should occur for the three preferred alternatives.

Table 2. Permitting Summary

	Mitigation Alternatives		
	Alternative 2 (Boardwalk)	Alternative 3 (Channel Clearing)	Alternative 8 (Upsize Culvert)
	Minimum	Minimum	Minimum
Local Considerations			
Conservation Commission NOI	X	X	X
State Considerations			
MEPA ENF		X	X
401 WQC		X	
Chapter 91		X	X
Section 106 MHC	X	X	X
Federal Considerations			
ACOE PCN		X	X

Costs for local, state and federal consultation and approvals concerning historic and environmental issues are estimated to be as follows:

- Alternative #2: $10,500 and $16,000
- Alternative #3: $27,500 – 40,000
- Alternative #8: $23,500 and $34,000

Permit review timelines for the three preferred alternatives include:

- Alternative #2: 2 – 3 months
- Alternative #3: 7 – 9 months
- Alternative #8: 7 – 9 months

4.2 CONCLUSION

Depending on the preferred alternative, different protected environmental resources will likely be impacted. These different impacts will result in different permits being required, which will result in different permit costs and review timelines for each of the preferred alternatives. Permitting costs can be as low as $10,500 (Alternative #2 minimum cost) to as high as $40,000 (Alternative #3 maximum cost). Time to gain permit approval can be as short as 2 months (for Alternative #2) to as long as 9 months (for Alternatives #3 and 8).

Appendix A

Figures

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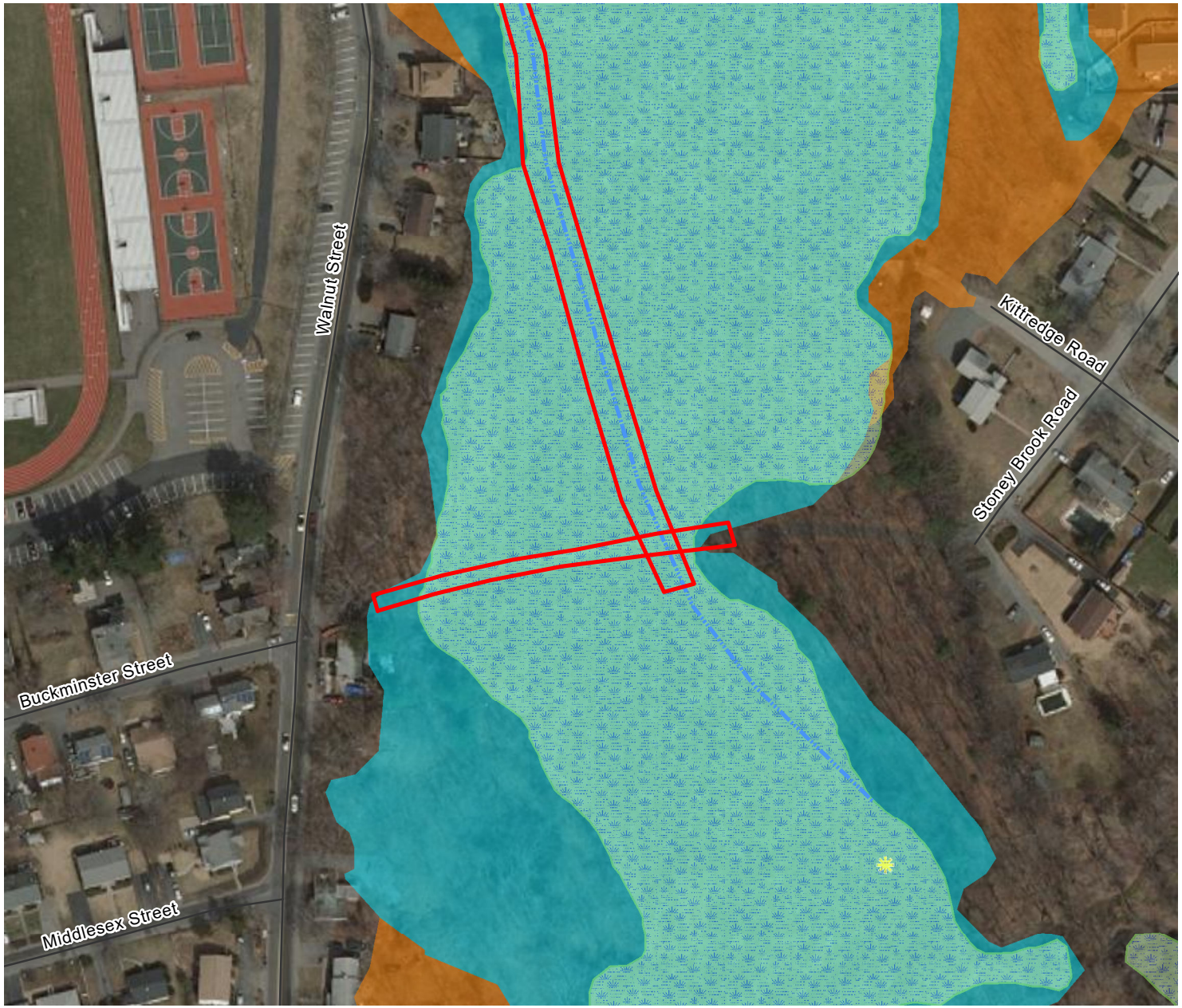

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Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Legend

- Work Area
- Perennial Stream
- Intermittent Stream
- Marsh/Bog
- Wooded marsh
- Cranberry Bog
- Salt Marsh
- Open Water
- Reservoir (with PWSID)
- Tidal Flats
- Beach/Dune

ACECs

- ACECs

NHESP Habitats

- NHESP Estimated Habitats of Rare Wildlife
- NHESP Priority Habitats of Rare Species
- NHESP Certified Vernal Pools
- NHESP Potential Vernal Pools

FEMA National Flood Hazard Layer

Flood Zone Designations

- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- AE: Regulatory Floodway
- AH: 1% Annual Chance of 1-3ft Ponding, with BFE
- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

Outstanding Resource Waters

- Public Water Supply Contributor
- ORW for ACEC
- ORW for both Water Supply and Other

FIGURE 1

Alternative 2 - Boardwalk
Framingham, MA

Environmental Resource Map

Weston & Sampson

<BOL>Path:</BOL> \\wse03.local\WSE\Projects\MA\Framingham MA\Task Order No. 10 & 11 - Walnut Street Flood Mitigation Study (Project Nos. ENG20-0213 and ENG20-0215)\Task Order No. 10 - MVP Grant Documents\permitting feasibility study\GIS\Human Receptor - alt 2.mxd <BOL>User:</BOL> higginsm <BOL>Saved:</BOL>

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Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

- Work Area
- State Registry of Historic Places
- All Underground Storage Tanks

Tier Classified Sites
- Tier 1A
- Tier 1B
- Tier 1C
- Tier 1D
- Tier II

PUBLIC WATER SUPPLIES
- Community Ground Water
- Community Surface Water
- Surface Distribution Site
- Non-Transient Non-Community
- Transient Non-Community
- Proposed Well

CH21E AUL Sites
- CH21E AUL Sites

DEP BWP Major Facilities
Large Quantity Generators (LQG)
- EPA/RCRA-regulated Hazard. Waste
- MA-regulated Hazard. Waste
- MA and EPA/RCRA-regulated Hazard. Waste
- MassDOT Roads
- Zone I
- Solid Waste Facilities - All Landfills
- IWPAs
- DEP Approved Zone IIs
- Zone A
- ZONE B

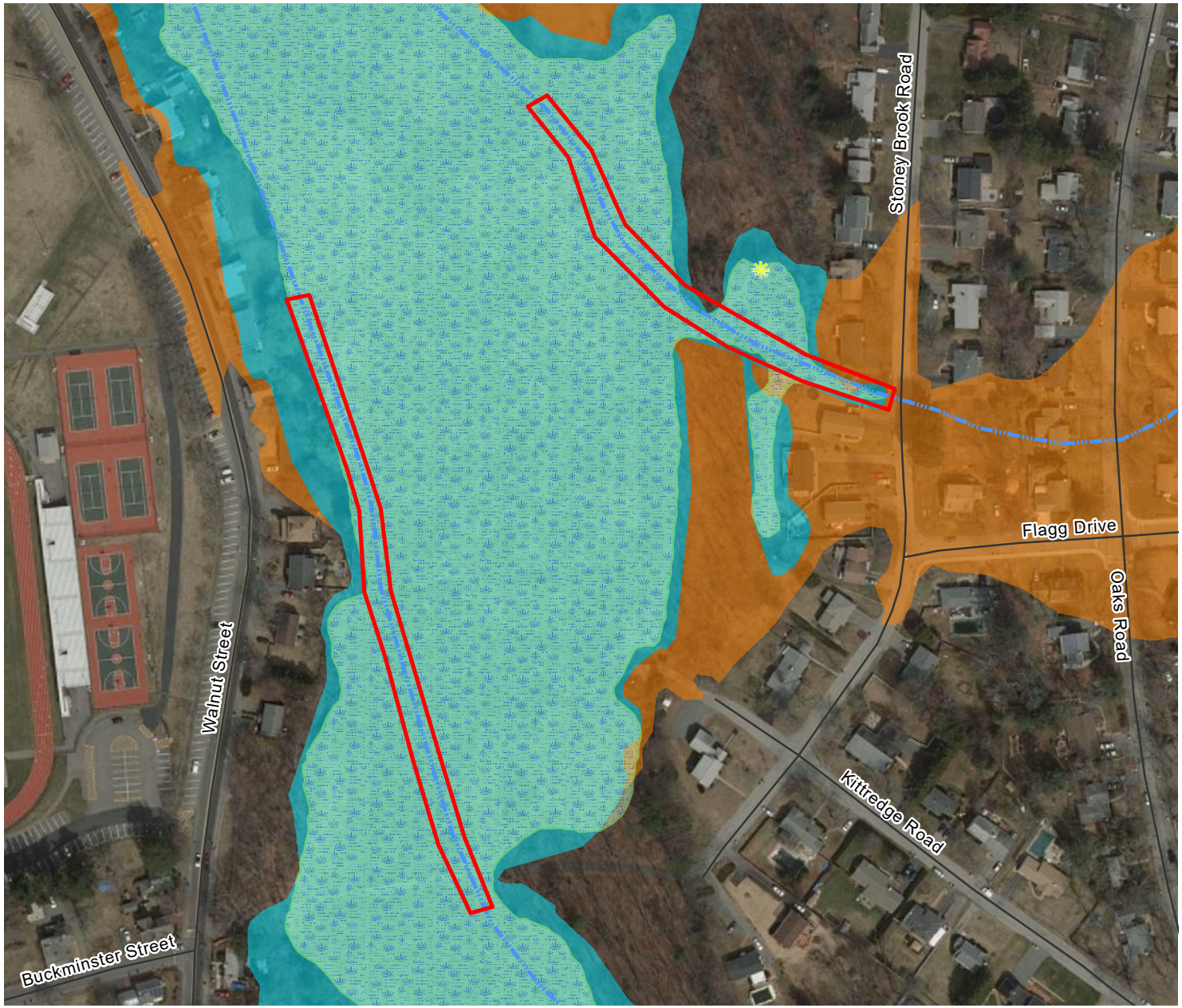
Open Space
- Municipal

FIGURE 1.a
Alternative 2 - Boardwalk
Framingham MA

Human Receptor Map

Weston & Sampson

<BOL>Path:</BOL> \\wse03.local\WSE\Projects\MA\Framingham MA\Task Order No. 10 & 11 - Walnut Street Flood Mitigation Study (Project Nos. ENG20-0213 and ENG20-0215)\Task Order No. 10 - MVP Grant Documents\permitting feasibility study\GIS\Environmental Receptor - alt 3.mxd <BOL>User:</BOL> higginsm <BOL>Saved:</BOL>



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ACECs

- ACECs
- NHESP Priority Habitats of Rare Species
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- AH: 1% Annual Chance of 1-3ft Ponding, with BFE
- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

Outstanding Resource Waters

- Public Water Supply Contributor
- ORW for ACEC
- ORW for both Water Supply and Other

FIGURE 2

Alternative 3 - Channel Clearing
Framingham, MA

Environmental Resource Map

Weston & Sampson

<BOL>Path:</BOL> \\wse03.local\WSE\Projects\MA\Framingham MA\Task Order No. 10 & 11 - Walnut Street Flood Mitigation Study (Project Nos. ENG20-0213 and ENG20-0215)\Task Order No. 10 - MVP Grant Documents\permitting feasibility study\GIS\Human Receptor - alt 3.mxd <BOL>User:</BOL> higginsm <BOL>Saved:</BOL>

Data Source: Office of Geographic and Environmental Information (MassGIS), Commonwealth of Massachusetts Executive Office of Environmental Affairs

Work Area
State Registry of Historic Places
All Underground Storage Tanks

Tier Classified Sites
Tier 1A
Tier 1B
Tier 1C
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Tier II

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MassDOT Roads
Zone I
Solid Waste Facilities - All Landfills
IWPAs
DEP Approved Zone IIs
Zone A
ZONE B

Open Space
Municipal

FIGURE 2.a

Alternative 3 - Channel Clearing
Framingham MA

Human Receptor Map

Weston & Sampson

<BOL>Path:</BOL> \\wse03.local\WSE\Projects\MA\Framingham MA\Task Order No. 10 & 11 - Walnut Street Flood Mitigation Study (Project Nos. ENG20-0213 and ENG20-0215)\Task Order No. 10 - MVP Grant Documents\permitting feasibility study\GIS\Environmental Receptor - alt 8.mxd <BOL>User:</BOL> higginsm <BOL>Saved:</BOL>

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Feet

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Outstanding Resource Waters

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- ORW for both Water Supply and Other

FIGURE 3

Alternative 8 - Upsize Culvert
Framingham, MA

Environmental Resource Map

Weston & Sampson

<BOL>Path:</BOL> \\wse03.local\WSE\Projects\MA\Framingham MA\Task Order No. 10 & 11 - Walnut Street Flood Mitigation Study (Project Nos. ENG20-0213 and ENG20-0215)\Task Order No. 10 - MVP Grant Documents\permitting feasibility study\GIS\Human Receptor - alt 8.mxd <BOL>User:</BOL> higginsm <BOL>Saved:</BOL>

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MA-regulated Hazard. Waste
MA and EPA/RCRA-regulated Hazard. Waste
MassDOT Roads
Zone I
Solid Waste Facilities - All Landfills
IWPAs
DEP Approved Zone IIs
Zone A
ZONE B

Open Space
Municipal

FIGURE 3.a
Alternative 8 - Boardwalk
Framingham MA

Human Receptor Map

Weston & Sampson

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT D

TECHNICAL MEMORANDUM – CRITICAL CULVERTS INSPECTIONS

MEMORANDUM

TO: Kerry A. Reed, PE, Senior Stormwater Engineer, City of Framingham

FROM: Andrew Gaughan and Steve Roy

DATE: January 18, 2021

SUBJECT: Walnut Street Flood Mitigation – Culvert Inspections

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On January 8, 2020, Andrew Gaughan of Weston & Sampson Engineers and Sam Bade of SSV Engineering Inc. inspected critical drainage infrastructure as part of the Walnut Street Flood Mitigation Project. During the investigation, a zoom camera was used to capture video of the condition of the culverts. Culvert size and condition were documented as well as preliminary assessment of structural condition based on visual observations. Culvert condition, as well as recommendations to mitigate localized flooding, are incorporated herein.

Main Street Culvert

For the culvert that conveys flow under Main Street and the Ski Haus parking lot as shown in the attachments as Figure 1, pipe condition was documented as well as the approximate location where the pipe transitions size and material. The inspection began at the culvert inlet south of Main Street and progressed downstream towards the outfall into Sudbury River. Opening the catch basin; structure ID 2012279 in the parking lot the culvert was inspected upstream and downstream – approximately 50-feet in either direction. The final inspection access point was through the catch basin located directly upstream of the outfall. The culvert was inspected both upstream and downstream - approximately 50-feet in either direction. The findings from this inspection include:

- The culvert transitions from a 36-inch reinforced concrete pipe to a 38-inch x 57-inch corrugated metal arch pipe approximately 70-feet downstream from the culvert inlet. It is suspected that there is a manhole located at the transition point. However, there was a car parked at this location during the inspection, and therefore this could not be confirmed.

Main Street Culvert transitions from 36-inch RCP to a 38-inch X 57inch CMP

- There is a 2-foot by 2-foot section of metal pipe located approximately 20-feet downstream from the catch basin in the middle of the Ski Haus parking lot that shows signs of deterioration where active groundwater infiltration was observed. Further investigation is recommended to pinpoint the exact location of this defect, and a point repair should be conducted to repair this defect to prevent further deterioration and potential future collapse.

2-foot x 2-foot deteriorated metal pipe section. Active groundwater infiltration observed.

- No sediment was observed in the culvert.
- A 2-inch vertical crack in the headwall at the culvert inlet runs from top to bottom.

Two-inch crack in the headwall at the Main Street culvert inlet

Stony Brook and Oaks Road Culvert near Fuller Middle School

The 54-inch reinforced concrete pipe culvert conveying flow from the Fuller Middle School under Oaks Road and Stonybrook Road was inspected at the following locations: the outlet, the inlet, and at an access manhole located halfway between the inlet and the outlet. A map of the drainage can be found in the attachments as Figure 2. Findings from this inspection include:

- The headwall at the culvert inlet had no visible structural defects. There was an excess of debris pushed against the trash rack. It is recommended that this debris be removed, as not to hinder any flow.

Debris blocking flow at the culvert inlet near Fuller Middle School

- The section of pipe extending from the culvert outlet upstream towards the access manhole had no visual structural defects.

Culvert inlet by Fuller Middle School looking downstream.

At access manhole looking upstream towards the culvert inlet

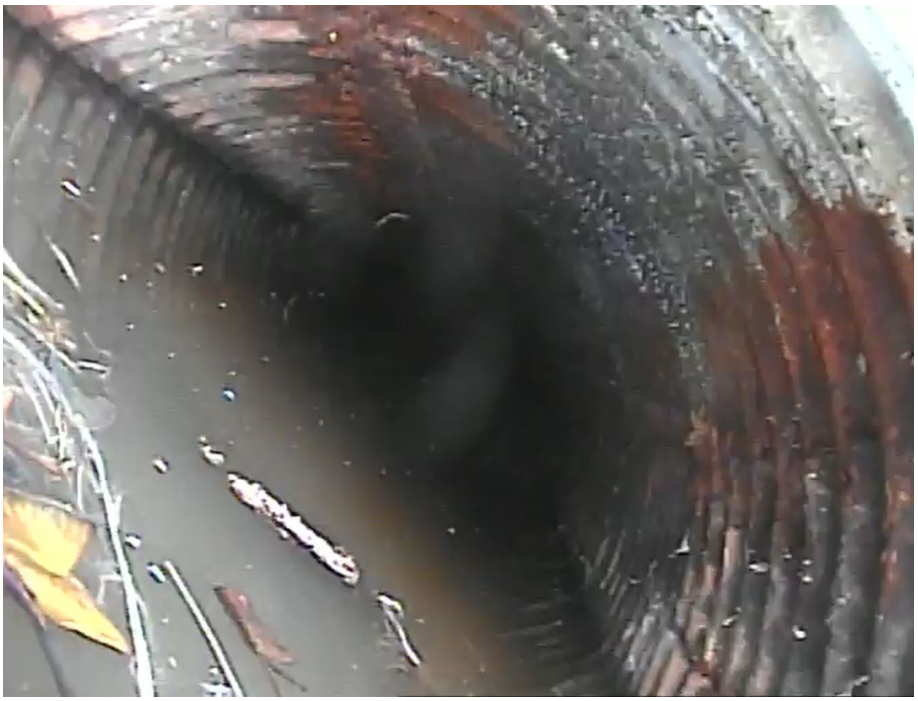
Sucker Pond Outlet and Culvert Under Route 9

The discharge pipe from Sucker Pond is a 36-inch reinforced concrete pipe that conveys flow under Route 9 and discharges into Sucker Brook. This system is shown in Figure 3 in the attachments. No visual defects were observed during the inspection. A few small roots were observed throughout the pipe.

Culvert at Sucker Pond inlet looking downstream.

Outlet of Sucker Pond culvert looking upstream.

Adjacent to the outlet pipe for Sucker Pond is a partially buried corrugated metal pipe. Inspection of this pipe was attempted to determine its origination, but it was found to be completely submerged. This pipe is believed to be abandoned.



Corrugated metal pipe of unknown origin at Sucker Pond.

Adjacent to the Sucker Pond culvert outlet there is a 24-inch reinforced concrete outfall pipe. This outfall is owned and maintained by The Massachusetts Department of Transportation, and discharges flow from Route 9 into Stony Brook. The inspection began at the outfall and ended approximately 30 feet upstream where the pipe changed direction. No defects were observed during this inspection.

MassDOT outfall pipe discharges to Sucker Brook

Attachment A

Location Maps

A.1 Main Street Culvert
A.2 Stony Brook Culvert at Fuller Middle School
A.3 Sucker Pond Culvert Under RT. 9

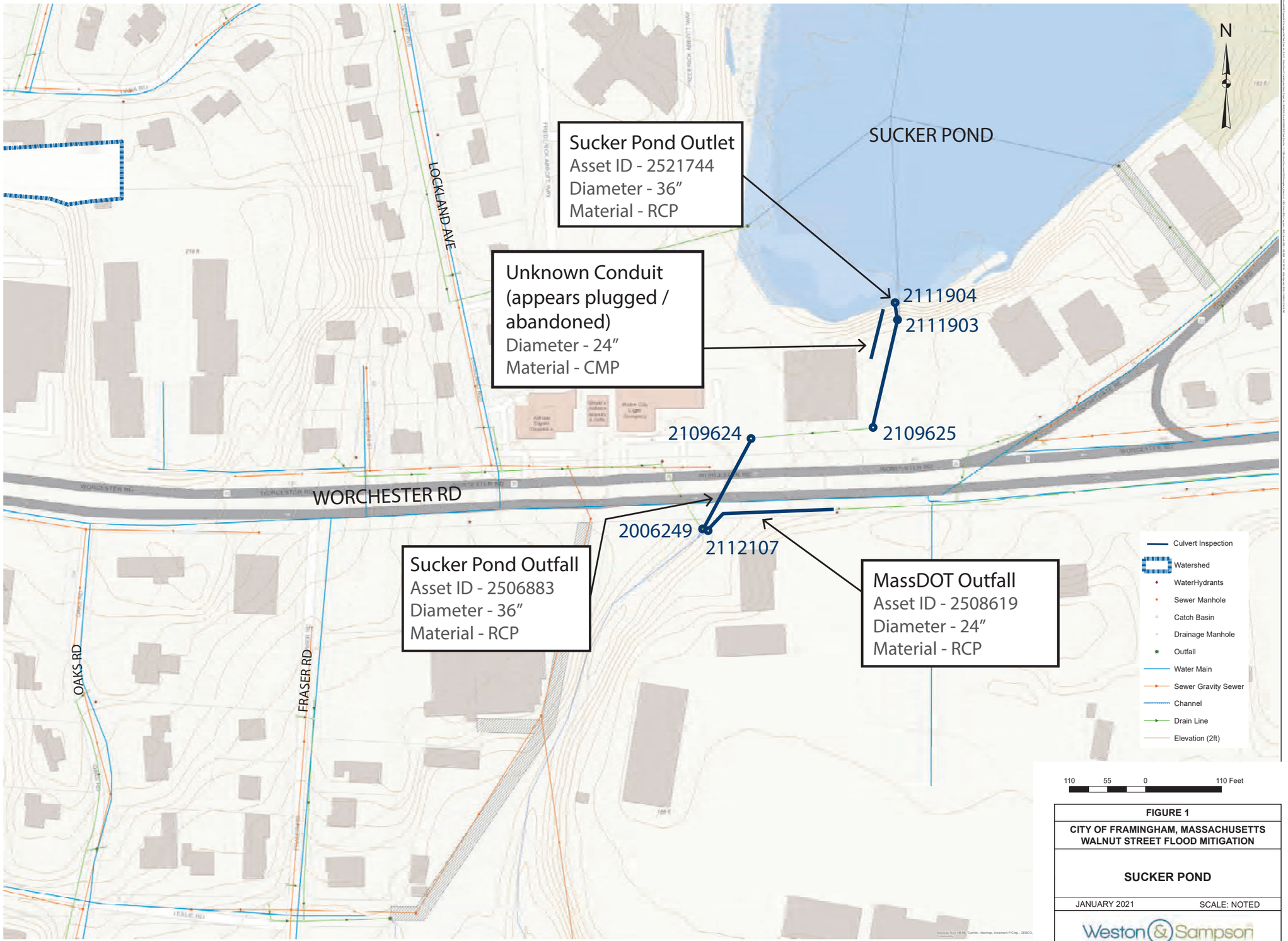


FIGURE 1

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

SUCKER POND

JANUARY 2021 SCALE: NOTED

Weston & Sampson

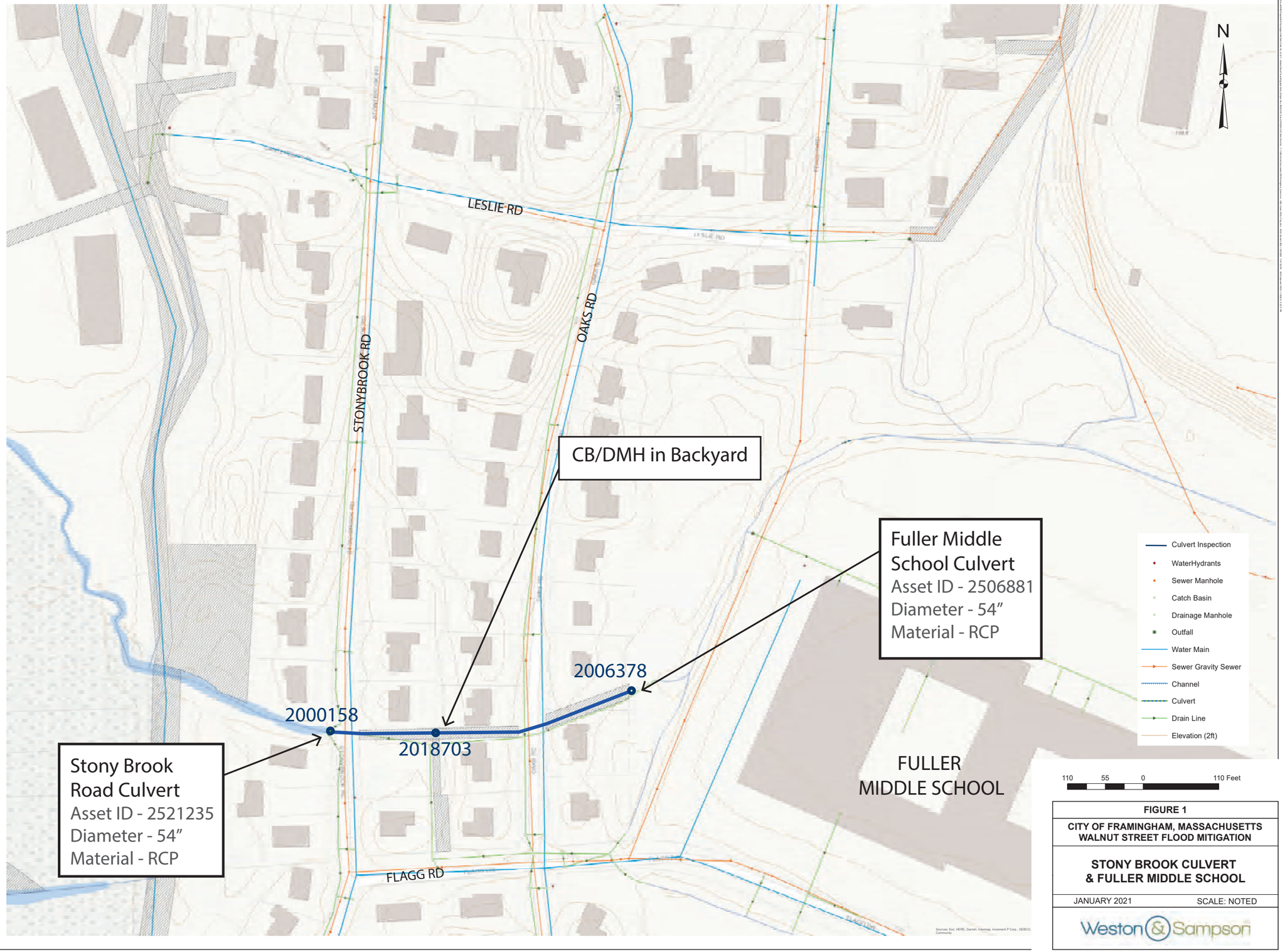


FIGURE 1

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

STONY BROOK CULVERT & FULLER MIDDLE SCHOOL

JANUARY 2021 SCALE: NOTED

Weston & Sampson

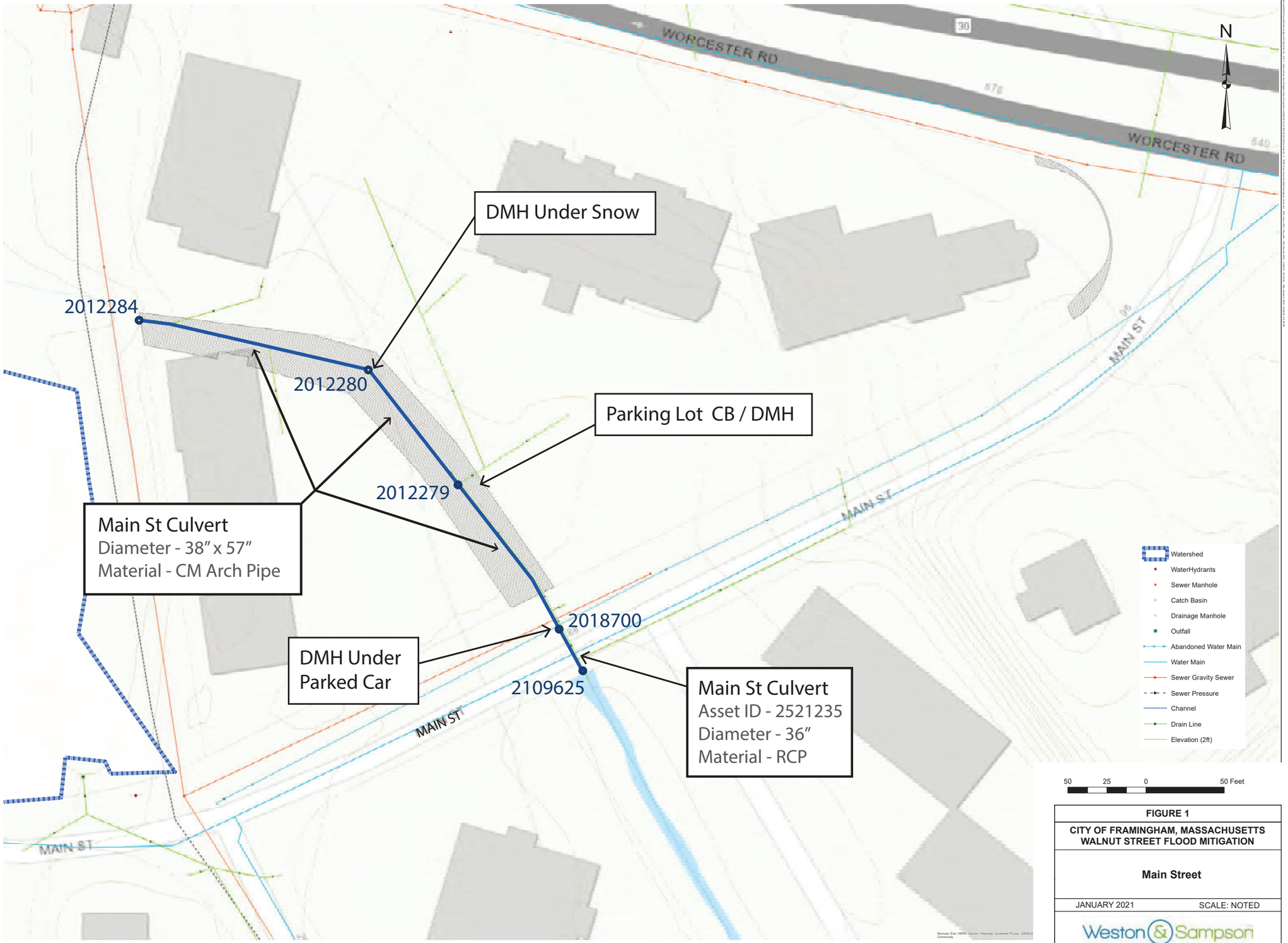


FIGURE 1

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION

Main Street

JANUARY 2021 SCALE: NOTED

Weston & Sampson

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT E

MEMORANDUM - STREAM ASESSMENT

MEMORANDUM

TO:	Kerry A. Reed, PE, Senior Stormwater Engineer, City of Framingham
FROM:	Andrew P. Gaughan, EIT, Jaurice A. Schwartz, PE, Weston & Sampson; Sam Bade, President, SSV Engineering Inc.
DATE:	May 24, 2021
SUBJECT:	Walnut Street Flood Mitigation – Stream Assessment

On April 27 and 28, 2021, Sam Bade of SSV Engineering Inc., assisted by Andrew Gaughan and Andrew Wojciak of Weston & Sampson Engineers, conducted stream assessments of Sucker Pond Brook and an unnamed stream east of Walnut Street. The goal of the stream assessment was to walk the centerline of the streams and document conditions such as cross section, water depth, debris in stream, location of main stream channel, bank erosion, vegetative overgrowth, etc. The data was collected using Trimble GPS units, and each notable condition in the stream was marked as a separate GPS point and documented with photos. Cross section measurements of the stream were taken at approximately every 100 feet. The stream width was measured, and the depth to the bottom of the stream bed was recorded at two-foot intervals along the width of the stream every 100-feet. A photo looking both upstream and downstream was taken at each cross section. All data was uploaded in GIS to serve as a future resource for the City in prioritizing needs and conducting stream maintenance. Utilizing the data collected, a map of the stream areas was generated, and includes photos and points of debris, vegetative overgrowth, and erosion. The map is included in Attachment A.

Streams are an integral part of the stormwater system. Sediment build-up, debris, and undersized culverts or culverts in poor condition can all be problematic and contribute to localized flooding. The stream assessment data collected was analyzed and potential options for flood mitigation and enhanced stream flow were investigated and are summarized in this memorandum.

Sucker Pond Brook – Between Route 9 and Stonybrook Road

Sucker Pond Brook, originating at Sucker Pond, travels south under Route 9 as culverted stream flow, and daylights in a defined stream channel flowing through developed areas near Fuller Middle School. The flow in the open section of stream downstream of Sucker Pond, is fast moving, the water is shallow,

and the stream bed has a sandy bottom. There are signs of erosion, and many trees overhanging the stream with the potential to fall and block flow. Further down, there is a culverted section of stream under Oaks Road and Stony Brook Road. After the culvert outlets, the stream flows in an open channel through a small, wooded area. The stream is narrow, and the bottom of the stream bed is comprised of sand and organics. Minor erosion along the low banks can be seen in small sections of this channel. Fallen trees and branches slow flow.

The stream section looking downstream from Stonybrook Road. Moderate vegetative overgrowth and minor erosion can be seen.

Towards the end of the wooded area, the stream channel becomes less defined, and sand is more evident at the bottom of the stream bed. A fallen tree and a large pile of debris consisting of sticks and organic matter at the border between woodland and wetland is blocking flow from the main channel. Channelized flow appears to be redirected to the south splitting into three smaller channels and eventually fanning out with no defined channel. It appears that most of the flow from the main channel is being directed south and west towards the backyards of homes along Walnut Street.

Small dam approximately 6-feet wide with 6-inches of head is causing ponding upstream which forces water to fan out into the swamp, eliminating the defined main stream channel.

Sucker Pond Brook – Georgetown Apartments

The stream channel behind Georgetown Apartments and upstream towards Stonybrook Road was shallow with stagnant water with a thick organic base. Following the channel upstream water began to become scarce and eventually the channel appeared dry. The channel was traced upstream to a fallen tree where streamflow is being diverted. It is believed that because of the fallen tree, the dam comprised of fallen debris, and sediment build up, that the stream has changed course creating the wetlands area.

The main stream channel near Georgetown Apartments is overgrown, has a deep bed of organic sediment, and has ponding water.

Unnamed Stream – East of Walnut Street

This unnamed stream east of Walnut Street flows north from Learned Pond, towards the Georgetown Apartments near Main Street. Over the years, together the accumulation of debris behind fallen tree limbs and beaver activity, have slowed flow resulting in sediment buildup within the stream bed, which has resulted in chronic flooding behind the homes on Walnut Street and at the walking path connecting Stony Brook Road to Walnut Street. Stream inspections began at the walking path and progressed downstream to follow the likely defined stream channel that may have existed until recently. The section of channel through the existing swamp consists of deep, slow moving water, with little to no defined banks. The bottom of the channel is comprised of a deep layer of organic material consisting of decomposing trees, branches, grass, and leaves, likely originating from the surrounding vegetation.

The walking path can be found continuously flooded and the area on either side of the path has deep slow moving nearly stagnant water ponding.

Directly downstream of the walking path, low stream banks, fallen debris, and thick organics block and hinder water from flowing. The main stream channel in this area is severely overgrown.

The stream flow begins to quicken along the section of stream that runs parallel behind the house along Walnut Street. The eastern bank of the stream was generally low in many locations and barely existed in others, leading flow to migrate towards the swamp. The western bank of the stream was slightly sloped towards residential properties. The yards had visible evidence of flooding, and many homes have recorded water damage. The channel is generally narrower and shallower than upstream with a deep layer of organics on the bottom, which is comprised of fallen trees, leaves, grass, and other organic material. Further downstream, flow became shallower and increased, and the stream channel was overgrown with thick vegetation.

Vegetative overgrowth was prominent throughout the entire stream.

A small footbridge behind 155 Walnut Street. There is a small pile of debris built up, which is forcing water through a narrow section of the stream.

From 193 Walnut Street to the culvert at Main Street

Along the stream section from 193 Walnut Street to the culvert at Main Street, there was no vegetative overgrowth observed, and the stream banks were higher and the stream channel more defined. Trees are adjacent to the stream on either side, which has led to debris accumulating and forming dams blocking flow. Evidence of a beaver dam that was breached can be found next to the steam channel in the swamp. This section of stream was cleaned approximately 10 years ago, and the stream channel was redefined and the section near Main Street appears to have been maintained. The stream continued to flow with only minor debris obstructing flow until it converges with Sucker Pond Brook.

Looking upstream at the end of the section of the stream comprised of cattails that extended for approximately 475-feet. Decomposing cattails in the water have nearly filled in the stream channel.

Evaluation of Potential Sources of Sediment and Debris in Sucker Pond Brook

Sediment build up in streams occurs both naturally and anthropogenically. Sources include winter sanding operations, erosion, construction, and sedimentation due to decomposing organics. Sedimentation overtime can alter the stream channel, reducing the storage volume and changing flow paths. The stream channel from the walking path to the culvert on Main Street has a deep layer of organic material on the bottom, consisting of decomposing leaves, grass, and fallen trees. The thick sediment in certain areas is hindering flow, causing it to over top the banks into the wetland. Approximately 10 years ago, the lower portion of this stream was cleared of vegetative overgrowth and sediment. Currently this area does have an organics layer; the stream channel is much more defined, and flow is able to travel more freely through the channel.

The section of Sucker Pond Brook located from south of Route 9 to Stonybrook Road has a sandy stream bed with a few inches of organic material. After Stonybrook Road, and extending to the wetland, the sandy bottom continues with a few inches of organics along the way. The sediment has formed large deposits that are obstructing stream flow. As the stream enters the wetlands, the organics become more widespread and deeper as the bottom of the channel starts to become less defined.

Sedimentation occurs naturally in the stream, but human activities can increase the rate at which it occurs. Organics entering the stream channel all come from the surrounding vegetation within the wetland and the forested areas. The sandy soil originating upstream of the wetland could come from a number of sources. Sanding during the winter months can cause the sand to runoff into nearby streams.

Construction activities also generate a large amount of sediment in runoff due to excavation and heavy traffic on loose soil. Sediment in runoff can be mitigated by reducing the amount of sand used during the winter months as part of road maintenance, and through the use of proper best management practices at construction sites.

Due to the vegetative overgrowth, sediment build up, and debris, flooding along the walking path and back yards along Walnut Street is constant. In the event of heavy rain, the water level can easily rise causing damage to nearby homes and making the walking path impassable for students. In addition, standing water caused by flooding is the perfect breading area for disease carrying mosquitos. Cleaning these stream channels of debris and sediment will allow for continual flow of water and lead to an increase in storage for flood waters, ultimately reducing damage caused by flooding and minimizing the mosquitoes' breading ground. In addition to clearing stream channels, sedimentation sources should be investigated further, and mitigation measures implemented to ensure the stream channels remain clear.

Attachment A

Preliminary Stream Assessment Mapping

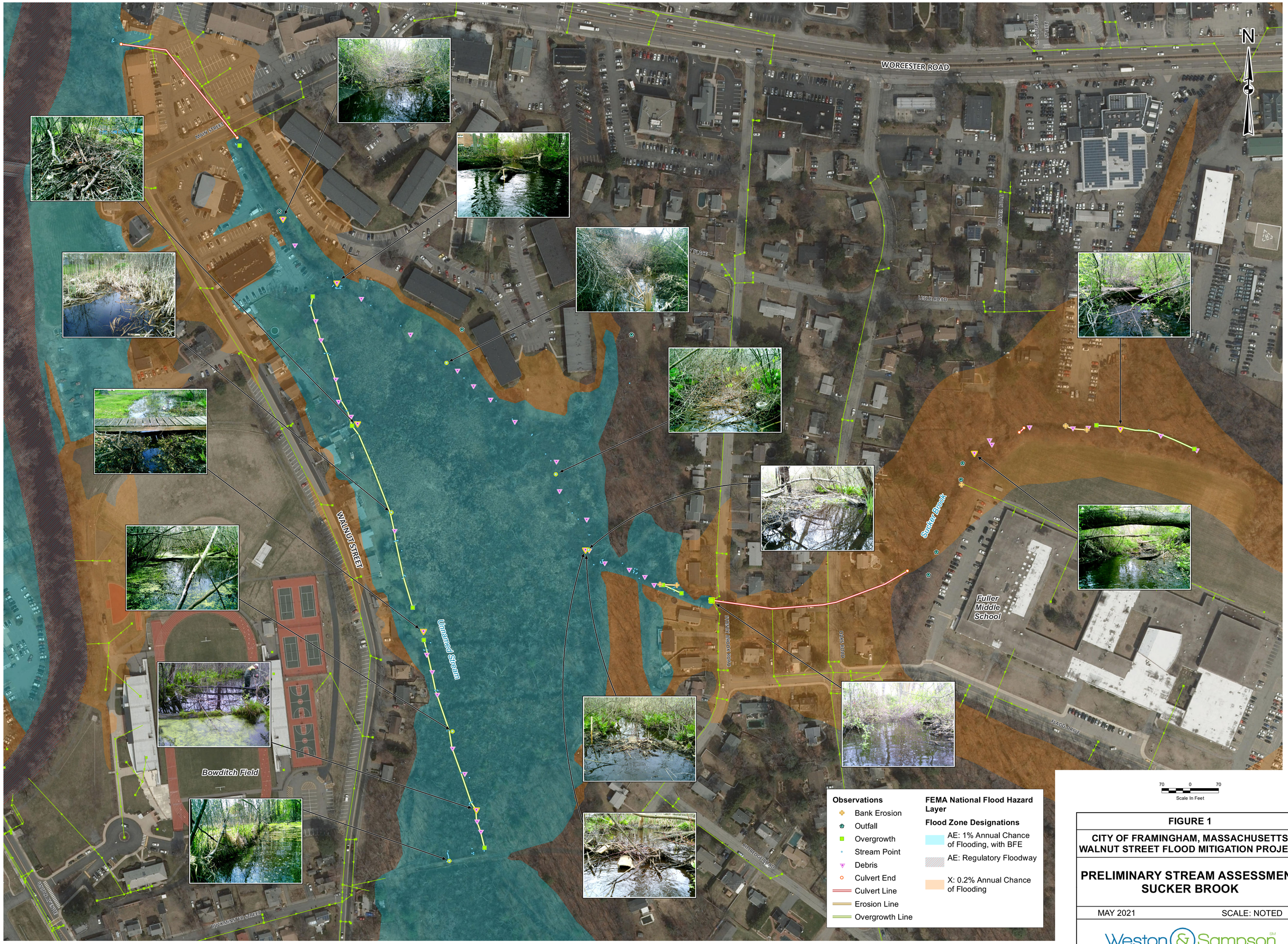


FIGURE 1

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION PROJECT

PRELIMINARY STREAM ASSESSMENT SUCKER BROOK

MAY 2021 SCALE: NOTED

Weston & Sampson

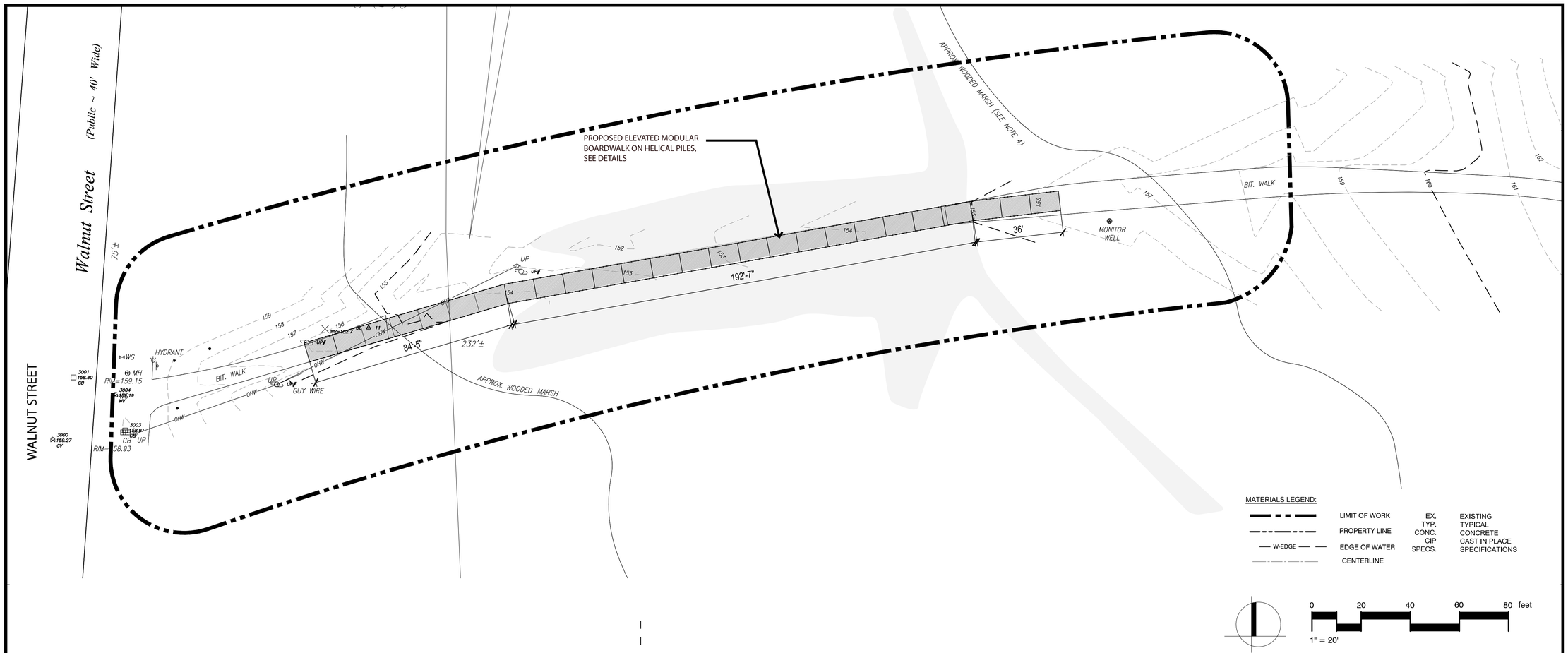
Walnut Street Flood Mitigation Study

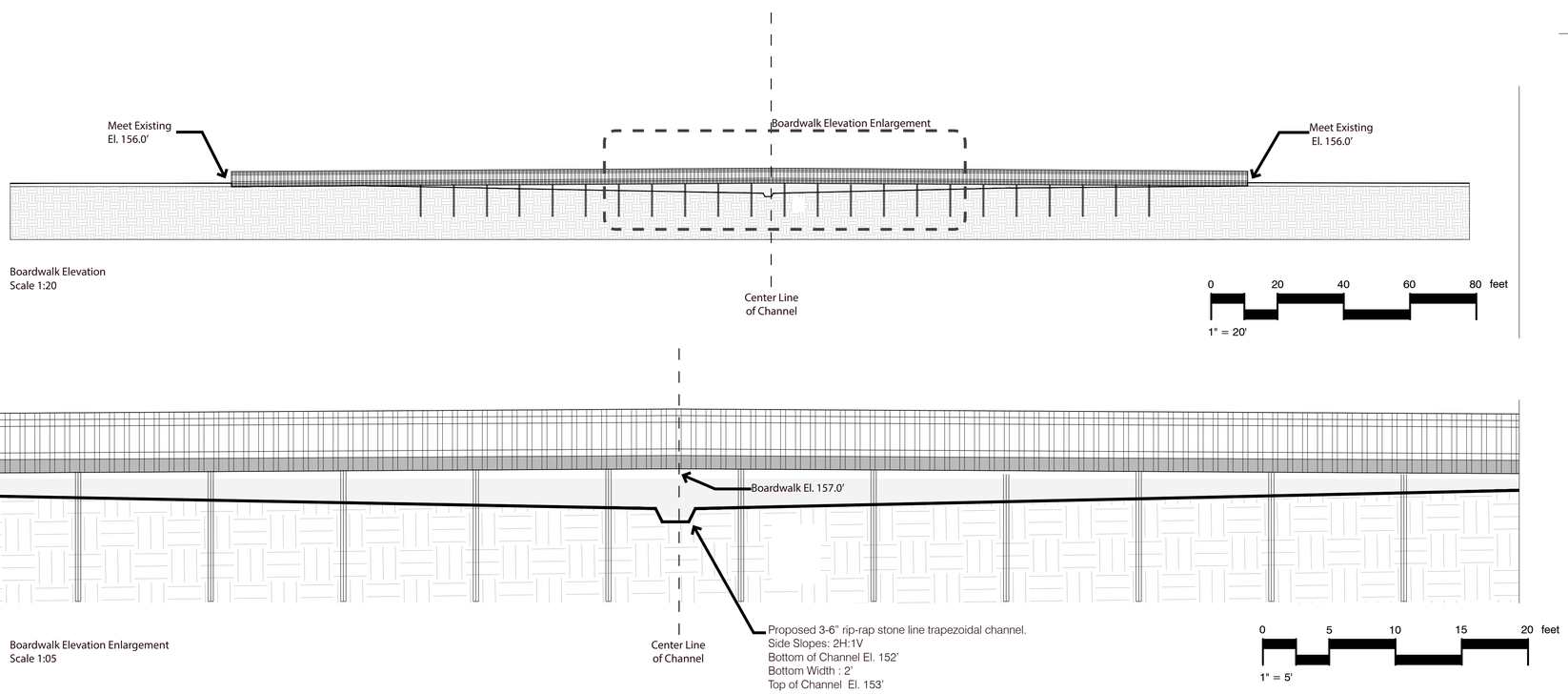
Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT F

PRELIMINARY DESIGN DRAWINGS/SKETCHES





Project:

WALNUT STREET
FLOOD MITIGATION

CITY OF FRAMINGHAM, MA

Weston & Sampson

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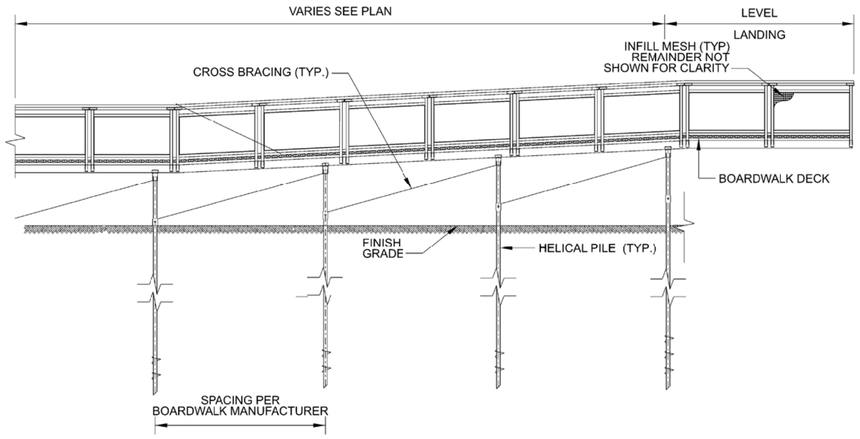
Drawing Title:

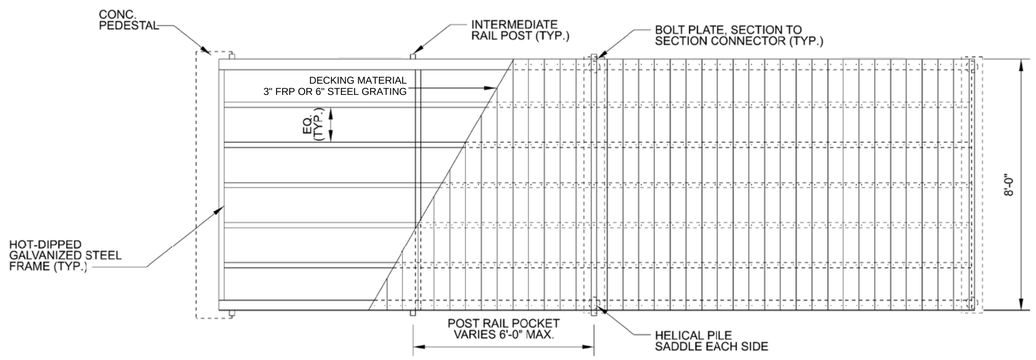
FLOOD STORAGE AND BOARDWALK

Sheet Number:

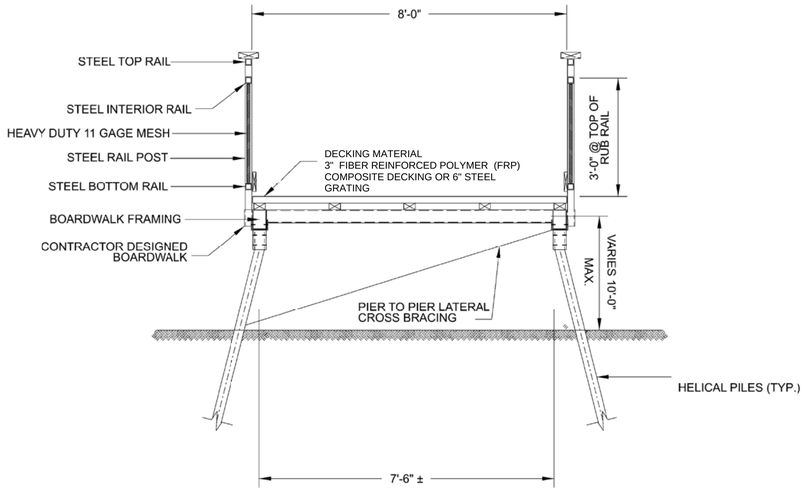
L1.00



TYPICAL BOARDWALK DECK ELEVATION
NOT TO SCALE



TYPICAL BOARDWALK DECK PLAN
NOT TO SCALE



SCHEMATIC BOARDWALK SECTION
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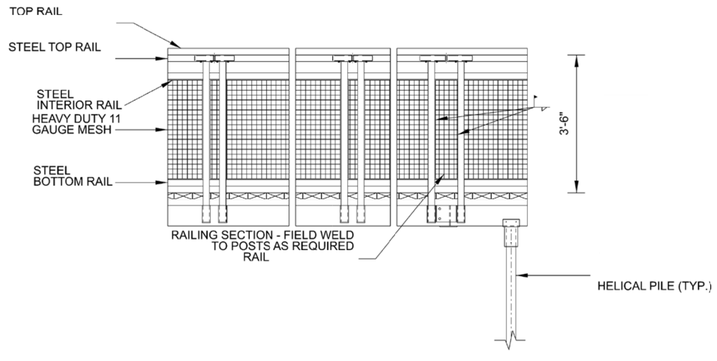

TYP. HANDRAIL DETAIL
NOT TO SCALE

NOTE:
THE BORADWALK DECK, HANDRAIL AND MESH TO BE FROM AN ECOFRIENDLY MATERIAL.

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FLOOD STORAGE
AND BOARDWALK

Sheet Number:
L2.00

FIGURE 1

CITY OF FRAMINGHAM, MASSACHUSETTS
WALNUT STREET FLOOD MITIGATION PROJECT

Draft Preliminary Design
Stream Restoration
Sucker Pond Brook

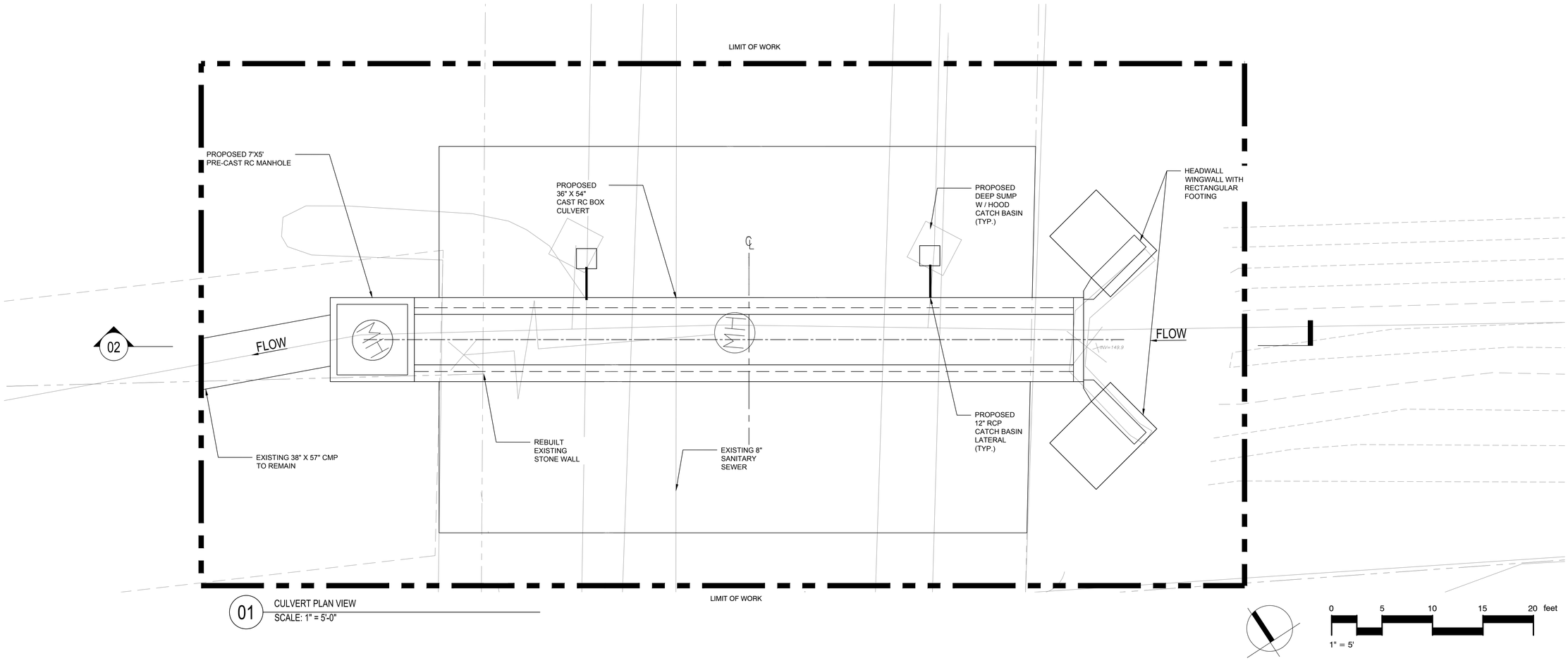
JUNE 2021 SCALE: NOTED

Weston & Sampson

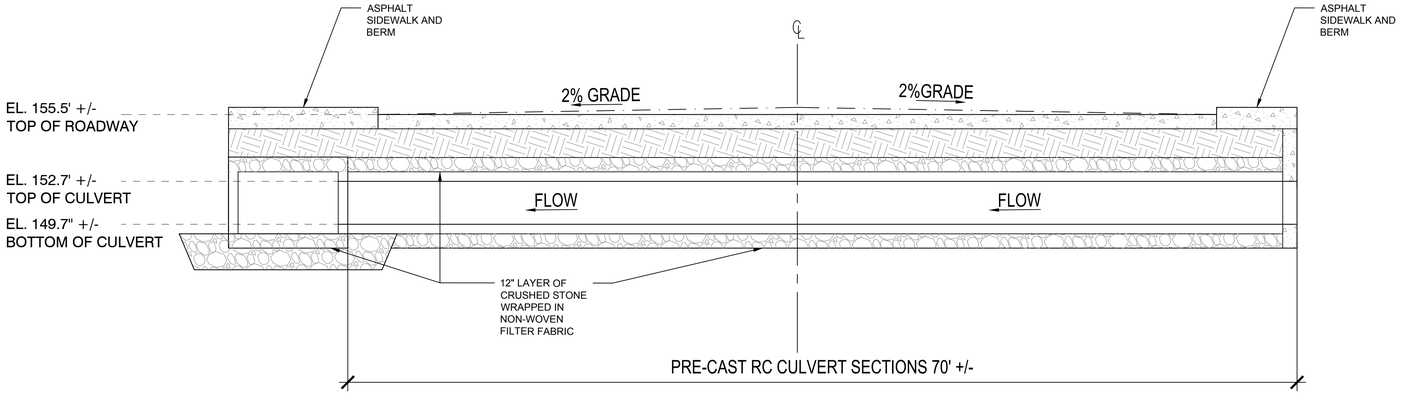
MATERIALS LEGEND:

LIMIT OF WORK

EX.	EXISTING
TYP.	TYPICAL
CONC.	CONCRETE
CIP	CAST IN PLACE
SPECS.	SPECIFICATIONS



01 CULVERT PLAN VIEW
SCALE: 1" = 5'-0"



02 CULVERT PROFILE ELEVATION
SCALE: 1" = 5'-0"

Project:

WALNUT STREET
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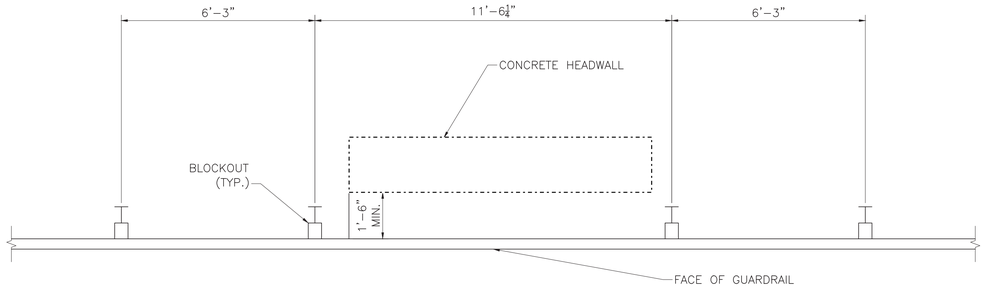
Drawing Title:

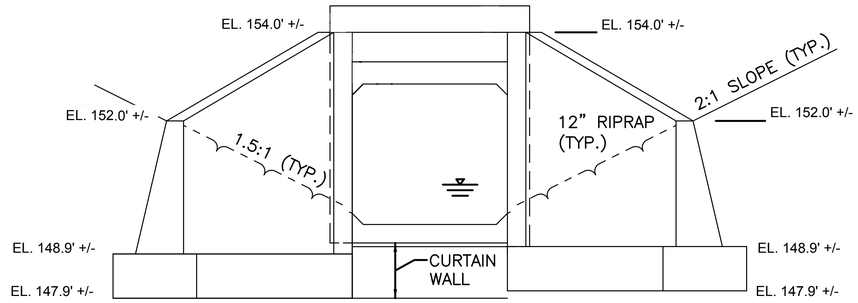
MAIN STREET CULVERT
REPLACEMENT

Sheet Number:

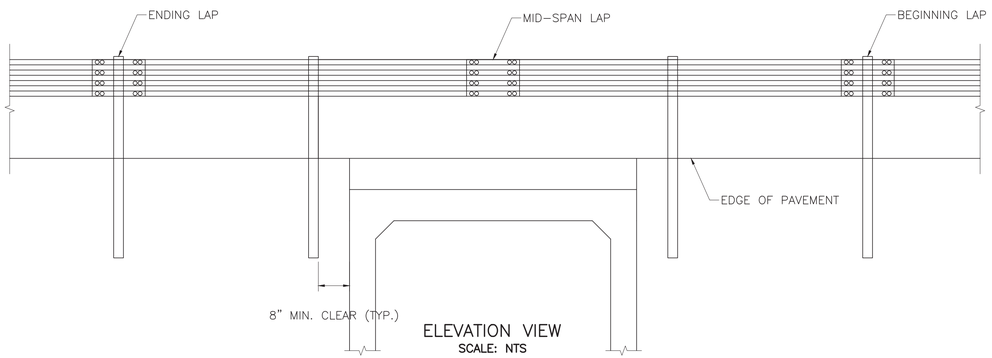
C-1



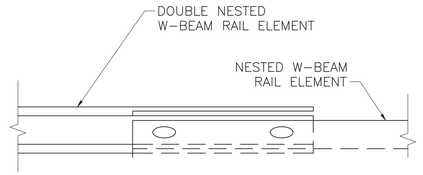
01 HEADWALL PLAN VIEW
SCALE: NTS



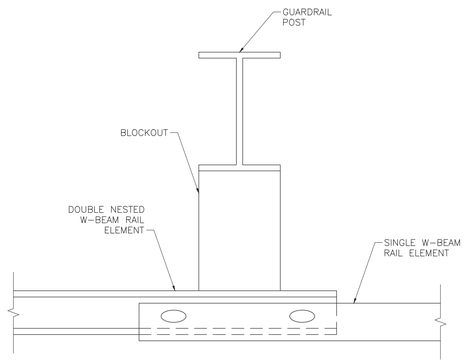
03 CULVERT ENTRANCE ELEVATION
SCALE: NTS



02 DOUBLE NESTED RAIL OVER CULVERT TYP.
SCALE: NTS



04 MID-SPAN LAP
SCALE: NTS



05 BEGINNING LAP
SCALE: NTS

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MAIN STREET CULVERT
REPLACEMENT DETAILS

Sheet Number:
C-2

Walnut Street Flood Mitigation Study

Summary Report - Flood Mitigation Alternatives

February 19, 2021
Updated June 30, 2021

ATTACHMENT G

PRELIMINARY DESINGS – COST ESTIMATES

Planning Level Cost Estimate - Preferred Flood Mitigation Alternatives
Walnut Street Area Flood Mitigation Project

Preferred Flood Mitigation Alternative	Design and Permitting		Construction Costs (Base)	Construction Oversight	Traffic Management	Flow Diversion & Control	Site Restoration	Easements	Total	Annual Operation and Maintenance
	Final Designs	Permitting								
2 Boardwalk to replace culvert between Walnut St. and Stony Brook Rd & additional flood storage	$ 100,000	$ 50,000	$ 580,000	$ 100,000	$ 50,000	$ 50,000	$ 50,000		$ 980,000	$ 10,000
3 Limited Channel clearing and stream stabilization to restore conveyance capacity	$ 100,000	$ 40,000	$ 480,000	$ 100,000	$ 50,000	$ 100,000	$ 50,000	$ 50,000	$ 970,000	$ 10,000
8 Upsize Main Street Culvert from 36” Dia. To 36”x54” box culvert	$ 125,000	$ 40,000	$ 300,000	$ 100,000	$ 50,000	$ 50,000	$ 50,000	$ 20,000	$ 735,000	Minimal

Planning Level Engineer's Construction Cost Estimate
Flood Storage and Boardwalk
Walnut Street Flood Mitigation - City of Framingham MA
June 29, 2021

Item No.	Item Description Unit Price in Words	Units	Estimated Quantity	Unit Price (In Figures)	Estimated Cost (In Figures)
1	Mobilization and Demobilization	LS	1	$ 25,000.00	$ 25,000.00
2	Test Pits Dollars and Cents	CY	20	$ 100.00	$ 2,000.00
3	Temporary Water Management/Brook Diversion Dollars and Cents	LS	1	$ 20,000.00	$ 20,000.00
4	Helical Piers furnish and install Dollars and Cents	ea.	50	$ 1,200.00	$ 60,000.00
5	Walking surface decking and support system Dollars and Cents	LF	400	$ 400.00	$ 160,000.00
6	Handrails, posts, balusters/screens Dollars and Cents	LF	400	$ 200.00	$ 80,000.00
7	Stream restoration and stabilization Dollars and Cents	LS	1	$ 75,000.00	$ 75,000.00
10	Bituminous Concrete Binder Course - At grade asphalt walkway Dollars and Cents	TON	60	$ 300.00	$ 18,000.00
11	Bituminous Concrete Wearing Course - At grade asphalt walkway Dollars and Cents	TON	50	$ 400.00	$ 20,000.00
				Sub-Total Project Cost	$ 460,000.00
				25% Contingency	$ 115,000.00
				Total Project Cost	**$ 575,000.00**
				Say	**$580,000**

Planning Level Engineer's Construction Cost Estimate
Stream Restoration
Walnut Street Flood Mitigation - City of Framingham MA
June 29, 2021

Item No.	Item Description Unit Price in Words	Units	Estimated Quantity	Unit Price (In Figures)	Estimated Cost (In Figures)
1	Mobilization and Demobilization Dollars and Cents	LS	1	$ 20,000.00	$ 20,000.00
2	Test Pits Dollars and Cents	CY	20	$ 100.00	$ 2,000.00
3	Temporary Water Management/Brook Diversion Dollars and Cents	LS	1	$ 20,000.00	$ 20,000.00
4	Stream restoration and stabilization Dollars and Cents	LF	2000	$ 100.00	$ 200,000.00
5	Vegetation overgrowth management Dollars and Cents	LF	2300	$ 40.00	$ 92,000.00
6	Remove debris dams Dollars and Cents	ea.	8	$ 6,000.00	$ 48,000.00
				Sub-Total Project Cost	$ 382,000.00
				25% Contingency	$ 95,500.00
				Total Project Cost	**$ 477,500.00**
				Say	**$480,000**

Planning Level Engineer's Construction Cost Estimate
Main Street Culvert Replacement
Walnut Street Flood Mitigation - City of Framingham MA
June 29, 2021

Item No.	Item Description Unit Price in Words	Units	Estimated Quantity	Unit Price (In Figures)	Estimated Cost (In Figures)
1	Mobilization and Demobilization Dollars and Cents	LS	1	$ 5,000.00	$ 5,000.00
2	Test Pits Dollars and Cents	CY	20	$ 100.00	$ 2,000.00
3	Temporary Brook Diversion Dollars and Cents	LS	1	$ 20,000.00	$ 20,000.00
4	CB Lateral Piping (12" RCP), & Appurtenances Dollars and Cents	lf	30	$ 300.00	$ 9,000.00
5	Deep Sump and Hooded Catch Basins Dollars and Cents	ea.	2	$ 10,000.00	$ 20,000.00
6	7x 5-foot Precast Concrete Manhole Dollars and Cents	ea.	1	$ 30,000.00	$ 30,000.00
7	Precast RC 36"x54" Box Culvert Dollars and Cents	LF	70	$ 1,500.00	$ 105,000.00
8	Install guardrail Dollars and Cents	LS	1	$ 10,000.00	$ 10,000.00
9	Precast RC headwall and wingwalls Dollars and Cents	LS	1	$ 50,000.00	$ 50,000.00
10	Bituminous Concrete Binder Course Dollars and Cents	TON	30	$ 300.00	$ 9,000.00
11	Bituminous Concrete Wearing Course Dollars and Cents	TON	25	$ 400.00	$ 10,000.00
				Sub-Total Project Cost	$ 270,000.00
				10% Contingency	$ 27,000.00
				Total Project Cost	**$ 297,000.00**
				Say	**$300,000**