TEC, Inc.
Jody Trunfio, P.E.
Principal
282 Merrimack Street
Lawrence, MA 01843

February 21, 2023

Re: Wetland Border Report
Park Road Crossing of Martin Brook, North Reading MA

Dear TEC Inc.,

Introduction

On February 16, 2023, the wetland resources were delineated on land located on or near the above-listed site (refer to enclosed locus maps). The brook and wetland border were flagged using the criteria in the most recent edition of MA Wetland Protection Act (WPA) and Regulations 310 CMR 10.00 et al and the local wetland bylaw. Hydric soil indicators, vegetation changes, hydrological indicators, and topography were all considered for delineation purposes.

Two Banks/MAHW were delineated on either side of Martin Brook at Park Street's crossing with series GC B-1 to B-12 and 2B-1 to 2B-12. Three Bordering Vegetated Wetlands lining the flagged banks were flagged with series W-1 to W-5, 2W-1 to 2W-4, and 3W-1 to 3W-4. The wetlands are protected under the MA Wetlands Protection Act and the local bylaw.

According to the Mass GIS data layers for NHESP, this site is not located within Estimated and/or Priority Habitat of Rare Wildlife. The site is not located in an Area of Critical Environmental Concern (ACEC), but is within regulated FEMA flood zone designations AE.

The titles of attached documents are as follows:

- DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form
- *Map 1. USGS of Locus Site*, Goddard Consulting, LLC, 2/15/2023
- *Map 2. Orthophoto & Soils View of Locus Site,* Goddard Consulting, LLC, 2/15/2023
- *Map 3. FEMA Flood Map*, Goddard Consulting, LLC, 2/15/2023
- *Map 4. NHESP Map,* Goddard Consulting, LLC, 2/15/2023

Section 1. Regulatory Framework, Implications, and Delineation Methodology

1.1 Wetlands Protection Act (WPA)

Wetland resource areas were delineated in accordance with relevant federal and state regulations. Definitions of the resource areas on site are provided. As stated in 310 CMR 10.55 (2)(a), "Bordering Vegetated Wetlands are freshwater wetlands which border on creeks, rivers, streams, ponds and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps and bogs. Bordering Vegetated Wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland

indicator plants. The ground and surface water regime and the vegetation community which occur in each type of freshwater wetland are specified in M.G.L. c 131 sec. 40."
Additionally stated in 310 CMR 10.55, "A Bank is the portion of the land surface which normally abuts and confines a water body, It occurs between a water body and a vegetated bordering wetland and adjacent flood plain, or, in the absence of these, it occurs between a water body and an upland."

Further defined in 310 CMR 10.58 (2), "A river is any natural flowing body of water that empties to any ocean, lake, pond, or other river and which flows throughout the year. Rivers include streams that are perennial because surface water flows within them throughout the year."

The methodology used to delineate Bordering Vegetated Wetlands is detailed in: (1) the BVW Policy "BVW: Bordering Vegetated Wetlands Delineation Criteria and Methodology," issued March 1, 1995; and (2) "Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act: A Handbook," produced by the Massachusetts Department of Environmental Protection, dated March 1995.

1.2 Bylaw

Federal, state, and local authorities regulate wetland jurisdiction. North Reading's local bylaws states its purpose is to, "protect the wetlands, related water resources, and adjoining land areas in the Town of North Reading by prior review and control of activities deemed by the Conservation Commission to have a significant or cumulative effect upon resource area values…" Ch. 196 § 1.

Section 2. Description of Regulated Inland Resource Area

- ☒ Bank
- ☒ Land Under Water Bodies and Waterways
- ☒ Riverfront Area
- ☒ Buffer Zone
- ☐ Vernal Pool (Certified and/or Potential)
- ☒ Bordering Vegetated Wetland (BVW)
- ☒ Land Subject to Flooding
- ☐ Isolated Vegetated Wetlands
- ☐ Estimated Habitats of Rare Wildlife
- ☐ Priority Habitats of Rare Species

The table below provides the Flag Numbers, Flag Type, and Wetland Types and Locations for the BVW resources delineated.

Resource Area	Regulatory Buffer Zone	Wetland Types and Locations
Bank/MAHW Line	100-ft for Bank (buffer zone not flagged in field). 200' RFA to the MAHWL.	Bank of Martin Brook, flagged with series B-1to B12 & 2B-1 to 2B-12.
BVW	100-ft (buffer zone not flagged in field)	Boundary of BVW associated with Martin Brook, flagged with series W-1 to W-5, 2-W1 to 2W-4, & 3W-1 to 3W-7.

LUWW	None	Not Flagged. Associated with Martin Brook.
BLSF	None	Not Flagged. Associated with 100-Year floodplain.

2.1 Site Photos

Figure 1. View of Park Road Crossing of Martin Brook.

Figure 2. 2W series BVW along brook.

Figure 3. View of eastern side of crossing along 2B series.

Figure 4. View of 3W series BVW.

2.2 Vegetation

The wetland tree layer is dominant in red maple and American elm. Prominent shrubs in the area include glossy buckthorn and red maple, with inclusions of silky dogwood and highbush blueberry. Tussock Sedge and small amounts of sensitive fern line the wetland forest floor. The adjacent upland tree layer is dominant in white oak and red maple, whereas in the shrub layer buckthorn is the sole dominant plant. Within the upland herbaceous layer there are trace amounts of garlic mustard, and oriental bittersweet is found throughout the upland. All three wetland areas were similar in vegetative character.

2.3 Hydrology

The delineated BVWs connect off the flagged bank of Martin Brook. Evidence of surface water and soil saturation within the wetlands include: Depth to free water in observation hole, saturated soils found at 12 inches, and hydric soils such as Saco mucky silt loam.

2.4 Soils

Consistent with the NRCS survey, soils identified on the property include the above-mentioned Saco mucky silt loam. In the upland, from 0 to 12 inches depth the A-Horizon consists of a fine sandy loam layer with a matrix color of 10YR 5/6. Within the wetland, alternating layers of A and C-Horizons are indicative of floodplain soils. These included layers of 10YR 3/2 matrix of very fine sandy loam, and C-Horizons of 10YR 5/1 fine sand. More detailed information about soils is included in the attached NCRS soil map.

2.5 Topography

Additional site information about elevation and changes in slope that inform delineation of BVW boundary points can be found in the attached topographic maps provided by the U.S. Geological Survey.

Section 3. Buffer Zone

Buffer Zone is defined in 310 CRM 10.04 as the "area of land extending 100 feet horizontally outward from the boundary of any area specified in 310 CMR 10.02(1)(a)." Additionally, the Town of North Reading further defines under General Wetland Protection Rules & Regulations "Lands Within 100 Feet," which is "different from 310 CMR 10.00 in that this area is a protectable resource area: and that this resource area encompasses more than the buffer zone designated in 310 CMR 10.00."

Section 4. FEMA Flood Zones

The MassGIS National Flood Hazard Layer provided by the Federal Emergency Management Agency (FEMA) depicts the crossing to be within an AE & X (500 year flood) designated flood zone, meaning there is a 1% Annual Chance of Flooding with BFE, and a 0.2% Annual Chance of Flooding. BLSF is defined in 310 CMR 10.57 (2)(a)(1) as "an area with low, flat topography adjacent to and inundated by flood waters rising from creeks, rivers, streams, ponds or lakes. It extends from the banks of these waterways and water bodies; where a bordering vegetated wetland occurs, it extends from said wetlands." This area is regulated as Bordering Land Subject to Flooding (BLSF), as it is classified as a 100-year flood zone.

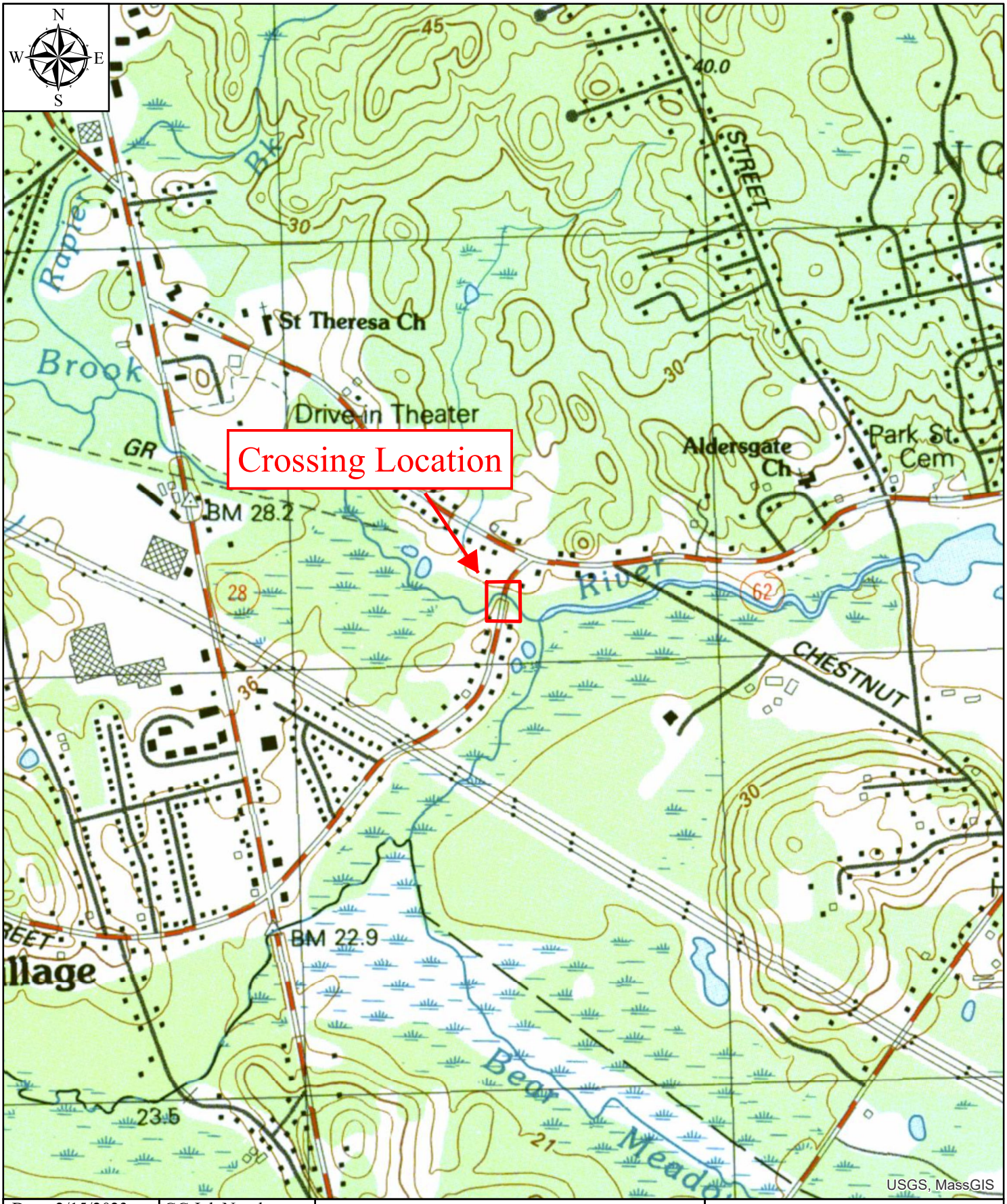
Section 5. Findings

Based on these hydric soil indicators, vegetation, hydrological indicators, and topography, Series W, 2W, and 3W were found to be the boundaries of BVW, and series B & 2B to be Bank and MAHWL of Martin Brook.

This site is not located within Estimated and/or Priority Habitat of Rare Wildlife, nor is the site located in an ACEC. This site is within regulated FEMA flood zones.

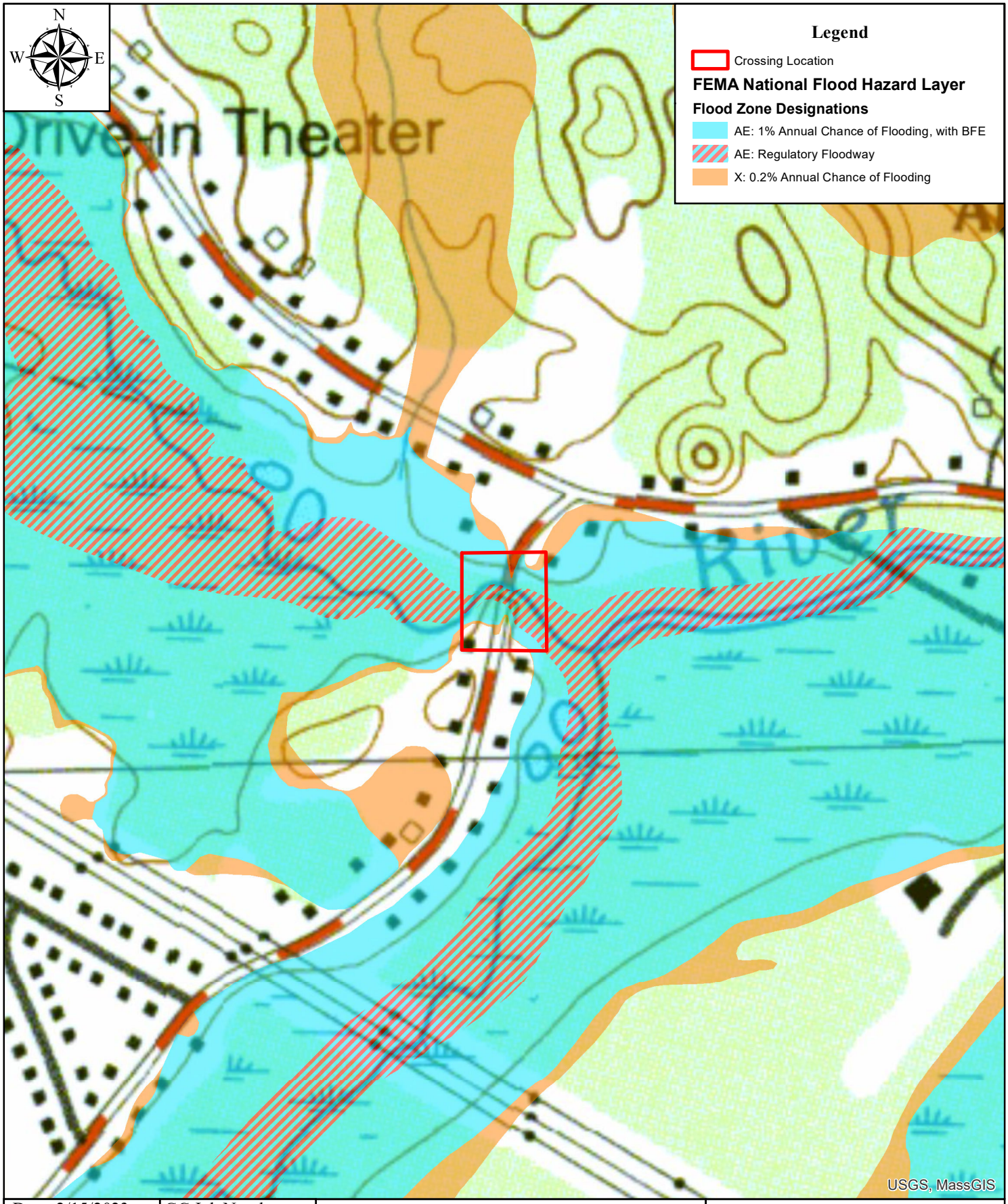
Very truly yours,
GODDARD CONSULTING, LLC

Steven Riberdy, MS, PWS, CWB, CE, CERP, PSS
Lead Biologist, Soil Scientist and Manager

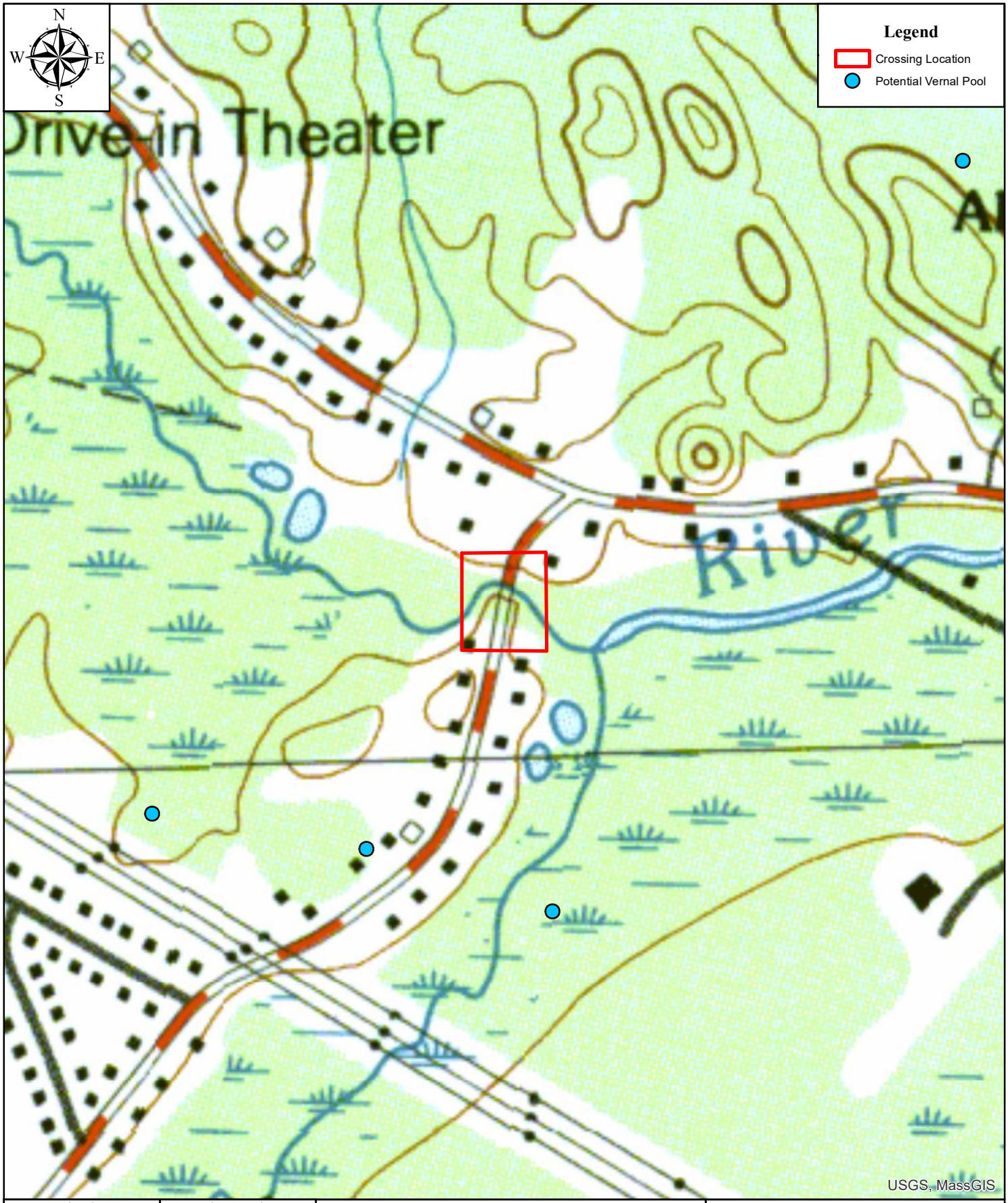


Date: 2/15/2023	GC Job Number: 246	Wetland Border Report Site Locus USGS Map	0 500 1,000 Feet
GODDARD CONSULTING LLC Strategic Wetland Permitting		Park Road Crossing of Martin Brook North Reading, MA	1 in = 1,000 ft Figure 1

Date: 2/15/2023	GC Job Number: 246	Wetland Border Report Orthophoto & Soils Map	0 100 200 Feet 1 in = 200 ft
GODDARD CONSULTING LLC Strategic Wetland Permitting		Park Road Crossing of Martin Brook North Reading, MA	Figure 2



Date: 2/15/2023	GC Job Number: 246	Wetland Border Report FEMA Map	0 200 400 Feet 1 in = 400 ft
GODDARD CONSULTING LLC Strategic Wetland Permitting		Park Road Crossing of Martin Brook North Reading, MA	Figure 3



Date: 2/15/2023	GC Job Number: 246	Wetland Border Report NHESP Map	0 200 400 Feet	
GODDARD CONSULTING LLC Strategic Wetland Permitting		Park Road Crossing of Martin Brook North Reading, MA	1 in = 400 ft Map: #, Lot: #	Figure 4

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant: TEC, Inc. Prepared by: **Goddard Consulting LLC** Project location: **Park Road Crossing of Martin Brook, Natick** DEP File #:

Check all that apply:
- ☐ Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only
- ☑ Vegetation and other indicators of hydrology used to delineate BVW boundary: fill out Sections I and II
- ☐ Method other than dominance test used (attach additional information)

Section I. Vegetation Observation Plot Number: **W5** Transect Number: **Upgradient** Date of Delineation: **16-Feb-23**

Sample Layer and Plant Species	Scientific name	% Cover	% Dominance	Dominant Plant (yes or no)	Wetland Indicator Category*
Tree Layer					
Northern White Oak	*Quercus alba*	38%	50.0%	yes	FACU
Red Maple	*Acer rubrum*	38%	50.0%	yes	FAC*
Sapling Layer					
Shrub Layer					
Glossy Buckthorn	*Frangula alnus*	63%	100.0%	yes	FAC*
Climbing Woody Vine					
Oriental Bittersweet	*Celastrus orbiculatus*	21%	87.2%	yes	UPL
Virginia Creeper	*Entry not found!*	3%	12.8%	no	#N/A
Ground Cover					
Garlic-Mustard	*Alliaria petiolata*	3%	100.0%	yes	FACU

Remarks: * An asterisk after common plant name indicates stunted growth; ** indicates extremely stunted growth

Morphological Adaptations: 0 **Description:**

* An asterisk after indicator status denotes wetlands plants: plants listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; or plants listed as FAC, FACW, or OBL.

Vegetation conclusion:

Number of dominant wetland indicator plants: 2 **Number of dominant non-wetland indicator plants: 3**

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? no

If vegetation alone is presumes adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent.

Section II. Indicators of Hydrology

Hydric Soil Interpretation

1. Soil Survey

Is there a published soil survey for this site? ☑ yes ☐ no

title/date: **Interim Soil Survey of Middlesex County - 1991 (Maps - 1989)**

map number:

soil type mapped:

hydric soil inclusions:

Are field observations consistent with soil survey? ☑ yes ☐ no

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottles Color or Texture
A	0-12	10YR 5/6	FSL

Remarks:

3. Other:

Conclusion: Is soil hydric? ☐ yes ☑ no

Other Indicators of Hydrology: (check all that apply and describe)

- ☐ Site inundated:
- ☐ Depth to free water in observation hole:
- ☐ Depth to soil saturation in observation hole:
- ☐ Water marks:
- ☐ Drift Lines:
- ☐ Sediment deposits:
- ☐ Drainage patterns in BVW:
- ☐ Oxidized rhizoshperes:
- ☐ Water-stained leaves:
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion for Upgradient of W5	**yes**	**no**
Number of wetland indicator plants >= number of non-wetland plants		**X**
Wetland hydrology present:		
hydric soils present		**X**
other indicators of hydrology present		**X**
Sample location is in a BVW		**X**

Submit this form with the Request for Determination of Applicability or Notice of Intent

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant: **TEC, Inc.** Prepared by: **Goddard Consulting LLC** Project location: **Park Road Crossing of Martin Brook, Medfield** DEP File #:

Check all that apply:
- ☐ Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only
- ☑ Vegetation and other indicators of hydrology used to delineate BVW boundary: fill out Sections I and II
- ☐ Method other than dominance test used (attach additional information)

Section I. Vegetation Observation Plot Number: **W5** Transect Number: **Downgradient** Date of Delineation: **16-Feb-23**

Sample Layer and Plant Species	Scientific name	% Cover	% Dominance	Dominant Plant (yes or no)	Wetland Indicator Category*
Tree Layer					
Red Maple	*Acer rubrum*	63%	85.7%	yes	FAC*
American Elm	*Ulmus americana*	11%	14.3%	no	FACW*
Sapling Layer					
Shrub Layer					
Glossy Buckthorn	*Frangula alnus*	63%	60.3%	yes	FAC*
Silky Dogwood	*Cornus amomum*	11%	10.0%	no	FACW*
Highbush blueberry	*Vaccinium corymbosum*	11%	10.0%	no	FACW*
Red Maple	*Acer rubrum*	21%	19.6%	no	FAC*
Climbing Woody Vine					
Ground Cover					
Tussock Sedge	*Carex stricta*	11%	77.8%	yes	OBL*
Sensitive Fern	*Onoclea sensibilis*	3%	22.2%	yes	FACW*

Remarks: * An asterisk after common plant name indicates stunted growth; ** indicates extremely stunted growth

Morphological Adaptations: 0 **Description:**

* An asterisk after indicator status denotes wetlands plants: plants listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; or plants listed as FAC, FACW, or OBL.

Vegetation conclusion:

Number of dominant wetland indicator plants: 4 **Number of dominant non-wetland indicator plants: 0**

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? yes

If vegetation alone is presumes adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent.

Section II. Indicators of Hydrology

Hydric Soil Interpretation

1. Soil Survey

Is there a published soil survey for this site? ☑ yes ☐ no

title/date: **Interim Soil Survey of Middlesex County - 1991 (Maps - 1989)**

map number:

soil type mapped:

hydric soil inclusions:

Are field observations consistent with soil survey? ☑ yes ☐ no

Remarks: Alternating areas of A + C horizons. Floodplain soils.

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottles Color or Texture
A	0-12	10YR 3/2	VFSL
C		10YR 5/1	FS

Remarks:

3. Other:

Conclusion: Is soil hydric? ☑ yes ☐ no

Other Indicators of Hydrology: (check all that apply and describe)

- ☐ Site inundated:
- ☑ Depth to free water in observation hole: 14
- ☑ Depth to soil saturation in observation hole: 12
- ☐ Water marks:
- ☐ Drift Lines:
- ☐ Sediment deposits:
- ☐ Drainage patterns in BVW:
- ☐ Oxidized rhizoshperes:
- ☐ Water-stained leaves:
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion for Downgradient of W5	**yes**	**no**
Number of wetland indicator plants >= number of non-wetland plants	**X**	
Wetland hydrology present:		
hydric soils present	**X**	
other indicators of hydrology present	**X**	
Sample location is in a BVW	**X**	

Submit this form with the Request for Determination of Applicability or Notice of Intent

Bay Colony Group, Inc.
Professional Civil Engineers & Land Surveyors

Four School Street
P.O. Box 9136
Foxborough, MA 02035
(508)543-3939
(508)543-8866 fax

MEMORANDUM

April 29, 2021

To: Robert Niccoli, P.E., Deputy Director of Structures, The Engineering Corp.

From: William R. Buckley, Jr., P.E.

RE: Martin's Brook @ Park Street North Reading, MA Abbreviated Hydraulic Evaluation

1.0 Introduction

1.1 Purpose

The purpose of this technical report is to present the results of an abbreviated hydraulic evaluation at the culvert conveying Martin's Brook under Park Street in North Reading, MA in order to determine if the existing hydraulic opening is adequate to remain. This report was prepared in a manner consistent with the Massachusetts Department of Transportation (MassDOT) guidelines for preparation of hydraulic studies at bridge sites modified to account for the preliminary nature of the design.

1.2 Scope

The scope of work for this investigation consisted of review of pertinent hydrologic and hydraulic data for the project site and an abbreviated hydraulic analysis. Data collected and hydraulic model computer outputs are presented in the appendices of this report. A narrative discussion of the problem statement, engineering methods, as well as results and conclusions of the abbreviated hydraulic analysis follow.

1.3 Executive Summary

The Town of North Reading has asked TEC, Inc. to prepare an evaluation on the replacement of the existing bridge conveying Martin's Brook under Park Street, which is classified as an Urban Local street. The site lies within a National Flood Insurance Program (NFIP) Special Flood Hazard Area (SFHA) as shown on the currently effective National Flood Insurance Rate Map (FIRM) 25017C0303E dated 6/4/2010 (Appendix B).

2.0 Project Description

2.1 Existing Structure

The subject culvert is located in the Town of North Reading, MA and is located about 350' south of Route 62. The Massachusetts State Plane Coordinates (NAD83-feet) are N 3,033,553/E 763,621. The bridge is a single-span, concrete tee beam structure that is a 6'+/- high x 18.5' wide x 35' long. It is listed as structure number N18002-7YC-MUN-BRI by MassDOT and was constructed in 1913. The stream flows from west to east through the bridge and eventually to the Ipswich River which is about 275' east of the site. The source of the stream is Martin's Pond which is located about 2.1 miles west of the site and the drainage area is about 13.2 square miles at the bridge.

The roadway is a two-lane Urban Local roadway approximately 24' wide with no curbing. There is currently a maximum of about 1' of cover over the bridge to the crown of the roadway. The runoff from the roadway sheet flows off of the roadway. The project area contains underground utilities.

TEC, Inc. queried the community on past floods of record and local flooding issues and there was no information provided.

2.2 Proposed Action

The purpose of the evaluation is to evaluate current conditions and site specific hydraulic issues, including past floods of record the bridge has withstood, local flooding issues, FEMA flood profiles, past and current scour in the bridge area, and whether the existing hydraulic opening is adequate.

3.0 Data Collection

3.1 Sources and Applications

Reference No.	Title
1	Flood Insurance Study (FIS) Middlesex County Massachusetts revised July 6, 2016
2	MassDOT LRFD Bridge Manual, January 2020 Revision
3	US Army Corps of Engineer (USACOE), Hydrologic Engineering Center, HEC-RAS River Analysis System, Version 5.0.7 March, 2019
4	United States Geological Survey (USGS) National Streamflow Statistics (StreamStats), Version 4.3.11

4.0 Engineering Methods

4.1 Hydrologic Analysis

The peak flood discharges for the project were determined from the USGS StreamStats program (Reference 4) and the Middlesex County FIS (Reference 1). The following is a summary of the discharges at the project site (Appendix B).

Table 1 – Summary of Discharges

Drainage Area (sq. miles)	10-year (cfs)	50-year (cfs)	100-year (cfs)	500-year (cfs)
13.2	464	738	868	1,200

4.2 Hydraulic Analysis

The hydraulic analysis was conducted using the US Army Corps of Engineer (USACOE), Hydrologic Engineering Center, HEC-RAS River Analysis System (Reference 3). HEC-RAS is capable of calculating steady flow water surface profile computations, one- and two-dimensional unsteady flow simulation, movable boundary sediment transport computations and water quality analysis. For the purposes of this analysis, we will be using the steady flow water surface profile module to calculate the water surface profiles for the existing condition to determine if the existing hydraulic opening is adequate to remain.

The existing conditions geometry was developed through a combination of field survey conducted by this office supplemented by data from the 2011 MA USGS Lidar. Channel and overbank roughness coefficients (Manning's "n") used in the models are 0.075 for the overbank and 0.07 for the channel and these values were based on direct observation and Table 3-1 Manning's "n" Values in the HEC-RAS 5.0 Reference Manual and are consistent with the values in the FIS (Reference 1). A normal depth upstream boundary condition slope of 0.00001 and known water surface elevations for the downstream boundary condition were used to determine the initial condition. The downstream known condition was taken from the FIS profile of Martin's Brook adjusted to account for the "with floodway" condition. The existing conditions profile locks into the FEMA FIS profile at Martin's Brook cross section "B". The FIS 100-year flood elevation is 73.3' (Appendix B) and the model value at Section 319 is 73.1' (Appendix C), which meets the MassDOT LRFD Manual standard (Section 1.3.5.2) of being within 0.5'. Additionally, the FIS predicts a water surface elevation at the bridge outlet due to backflow from the Ipswich River as elevation 71.2' and the model at Section 258 predicts 71.1', which also meets the LRFD Manual standard.

The low chord elevation of the concrete bridge beams is at 68.9' and the point where the stream will transition to weir flow and overtop the roadway is at elevation 71.7'. The 10-year design storm event predicts a water surface elevation of 69.8' at the upstream point of the bridge. The MassDOT standard is 2' of freeboard which is not met for this site since the beam low chord will be below the water surface, but there is no overtopping of the roadway under this condition. At some point between the 10-year and 50-year storm event the roadway will suffer overtopping from the stream in that the predicted water surface elevation for the 50-year event is 72.3'

(Appendix B), which is above the roadway elevation of 71.7'. These findings were supported by a review of the FIS, which also shows overtopping of the roadway at the 50-year event.

Some scour was observed starting about 15' upstream of the bridge. Scour was also observed about 15' downstream of the bridge. The extent of the scour was not completely mapped but the scour was not excessive in either direction. The February 4, 2021 MassDOT inspection report noted moderate abrasion along the water line up to ½" deep on all wingwalls and breast walls.

5.0 Conclusions and Recommendations

5.1 Conclusions

1. The existing opening will accommodate the 10-year hydraulic design flood without overtopping the roadway. It will not accommodate the 50-year event without overtopping the roadway.
2. The water surface elevation and the bottom of the bridge low chord do not meet the MassDOT 2' freeboard standard

Appendices

A – Photographs
B – FEMA Data
USGS Extract
StreamStats Printout
C – HEC-RAS Data

Appendix A – Photographs

Upstream Culvert

Downstream Culvert

Downstream Channel

Upstream Channel

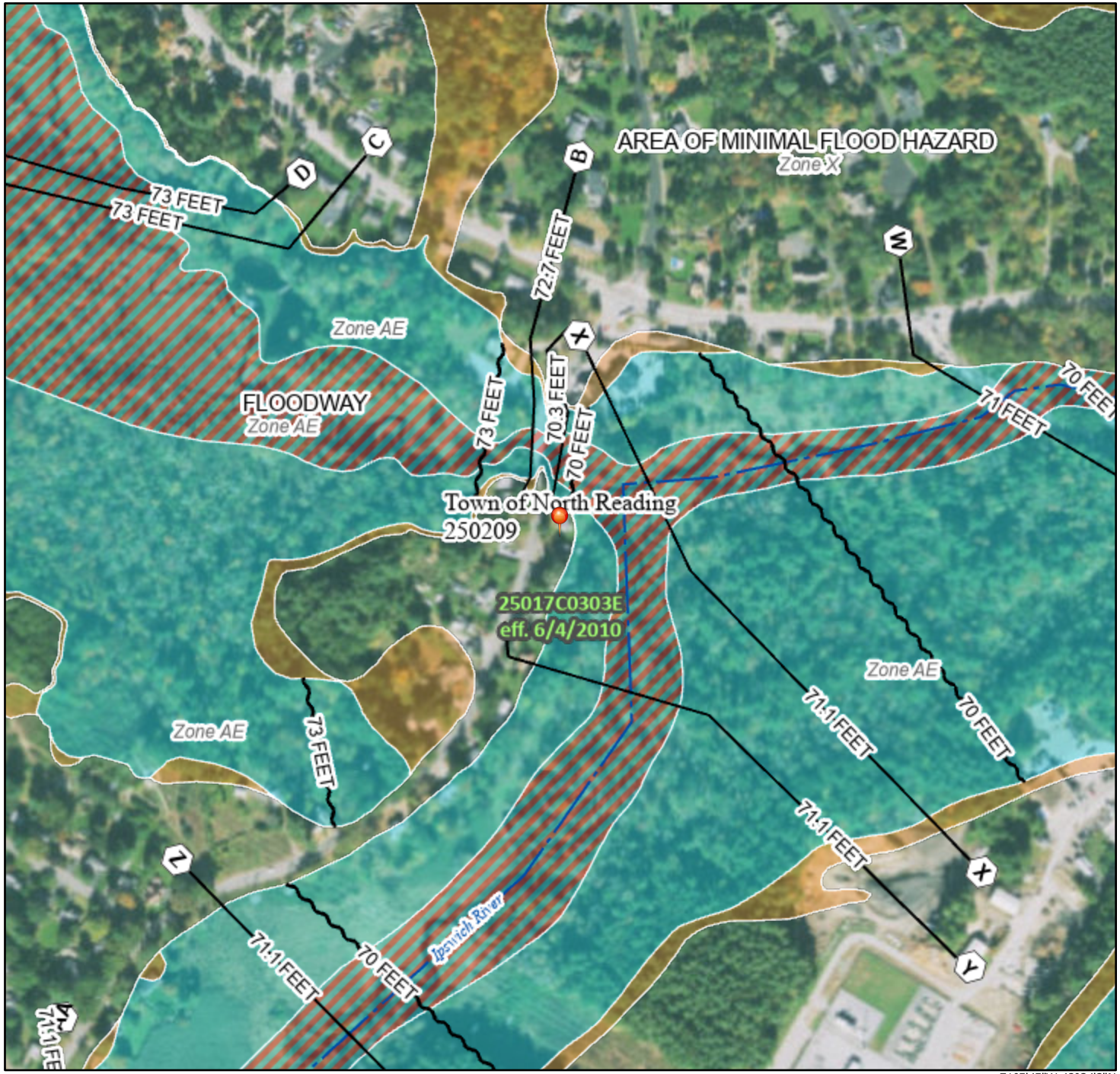
Appendix B

- FEMA FIRM Community Panel No. 25017C0303E Effective Date: June 4, 2010
- FEMA Flood Insurance Study of Middlesex County, Massachusetts Revised 7/6/2016 Extract
- USGS Extract
- StreamStats Printout

National Flood Hazard Layer FIRMette

FEMA

71°6'23"W 42°34'28"N



71°5'45"W 42°34'2"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/27/2021 at 9:57 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

FLOOD INSURANCE STUDY

VOLUME 1 OF 8

MIDDLESEX COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)

Middlesex County

COMMUNITY NAME	COMMUNITY NUMBER
ACTON, TOWN OF	250176
ARLINGTON, TOWN OF	250177
ASHBY, TOWN OF	250178
ASHLAND, TOWN OF	250179
AYER, TOWN OF	250180
BEDFORD, TOWN OF	255209
BELMONT, TOWN OF	250182
BILLERICA, TOWN OF	250183
BOXBOROUGH, TOWN OF	250184
BURLINGTON, TOWN OF	250185
CAMBRIDGE, CITY OF	250186
CARLISLE, TOWN OF	250187
CHELMSFORD, TOWN OF	250188
CONCORD, TOWN OF	250189
DRACUT, TOWN OF	250190
DUNSTABLE, TOWN OF	250191
EVERETT, CITY OF	250192
FRAMINGHAM, TOWN OF	250193
GROTON, TOWN OF	250194
HOLLISTON, TOWN OF	250195
HOPKINTON, TOWN OF	250196
HUDSON, TOWN OF	250197
LEXINGTON, TOWN OF	250198
LINCOLN, TOWN OF	250199
LITTLETON, TOWN OF	250200
LOWELL, CITY OF	250201
MALDEN, CITY OF	250202
MARLBOROUGH, CITY OF	250203
MAYNARD, TOWN OF	250204
MEDFORD, CITY OF	250205
MELROSE, CITY OF	250206
NATICK, TOWN OF	250207
NEWTON, CITY OF	250208
NORTH READING, TOWN OF	250209
PEPPERELL, TOWN OF	250210
READING, TOWN OF	250211
SHERBORN, TOWN OF	250212
SHIRLEY, TOWN OF	250213
SOMERVILLE, CITY OF	250214
STONEHAM, TOWN OF	250215
STOW, TOWN OF	250216
SUDBURY, TOWN OF	250217
TEWKSBURY, TOWN OF	250218
TOWNSEND, TOWN OF	250219
TYNGSBOROUGH, TOWN OF	250220
WAKEFIELD, TOWN OF	250221
WALTHAM, CITY OF	250222
WATERTOWN, TOWN OF	250223
WAYLAND, TOWN OF	250224
WESTFORD, TOWN OF	250225
WESTON, TOWN OF	250226
WILMINGTON, TOWN OF	250227
WINCHESTER, TOWN OF	250228
WOBURN, CITY OF	250229

REVISED:
July 6, 2016

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
25017CV001C

TABLE 8 - SUMMARY OF DISCHARGES – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
MARTINS BROOK					
At the Wilmington/North Reading corporate limits	10.9	460	700	830	1,190
Approximately 2,000 feet downstream of State Route 62 (Salem Street)	10.3	370	570	670	980
MARTINS POND BROOK					
At confluence with Lost Lake	2.1	90	130	150	200
MASCUPPIC BROOK					
At confluence with Lawrence Brook	2.4	50	70	80	115
MASON BROOK					
At the confluence with Walker Brook 2	7.4	320	540	660	940
MEADOW BROOK					
At confluence with Strong Water Brook	5.1	260	425	510	760
Upstream of tributary at Station 1.145	2.6	145	240	285	425
MEADOW RIVER BRANCH					
At Lowell Street	7.9	266	441	537	819
At Curve Street	4.4	177	296	361	554
MERRIMACK RIVER					
At mouth	4,180.0	54,000	85,000	102,000	145,000
At the Andover/Tewksbury corporate limits	4,635.0	58,000	90,000	111,000	156,000
At Dracut/Methuen corporate limits	4,644.0	58,000	90,000	111,000	156,000
At Nashua, New Hampshire (State Route 111)	3,982.0	53,000	85,000	102,000	148,000
MILL BROOK 1					
At confluence with Pine Brook	5.0	70	90	100	130
At Lexington/Wayland corporate limits	1.3	132	225	322	558
At Fottler Avenue	1.0	107	208	264	461

TABLE 10 - MANNING'S "n" VALUES - continued

Stream	Channel "n"	Overbank "n"
Little Brook	0.035-0.10	0.014-0.30
Locke Brook	0.035	0.050-0.075
Lower Spot Pond Brook	0.020-0.024	0.044
Lubbers Brook	0.030-0.055	0.075-0.120
Malden River	0.020-0.050	0.020-0.050
Maple Meadow Brook	0.035-0.055	0.065-0.088
Marginal Brook	0.035-0.045	0.045-0.085
Marshall Brook	0.014-0.045	0.060-0.070
Martins Brook	0.040-0.102	0.060-0.090
Martins Pond Brook	0.035-0.040	0.050-0.070
Mascuppic Brook	0.030	0.070
Mason Brook	0.035	0.050-0.075
Meadow Brook	0.024-0.045	0.060-0.070
Meadow River Branch	0.015-0.050	0.100
Merrimack River	0.020-0.055	0.040-0.200
Mill Brook 1	0.035	0.050-0.075
Mill Brook 2	0.030-0.040	0.030-0.080
Mill Brook 3	0.035-0.150	0.014-0.300
Mill Pond Tributary	0.020-0.035	0.080
Mill River	0.045-0.100	0.110
Mineway Brook	0.030-0.045	0.070-0.100
Mongo Brook	0.040-0.050	0.120-0.160
Morse Brook	0.035	0.050-0.070
Mowry Brook	0.015-0.035	0.045-0.080
Mud Pond Brook	*	*
Muddy Brook[1]	0.050	0.050-0.090
Mulpus Brook	0.035	0.050-0.070
Munroe Brook	0.050-0.080	0.060-0.100
Mystic River	0.035	0.014-0.300
Nagog Brook	0.045	0.070
Nashoba Brook	0.015-0.045	0.040-0.120
Nashua River	0.030	0.060-0.070
Nissitissit River	0.040	0.060-0.090
Nonacoicus Brook 1	0.035	0.050
Nonacoicus Brook 2	0.035	0.050
North Lexington Brook	0.050-0.080	0.060-0.100
Pages Brook	0.013-0.050	0.100
Pages Brook Branch	0.024-0.050	0.100
Pantry Brook	0.016-0.040	0.050-0.100
Pearl Hill Brook	0.035	0.050-0.075
Peppermint Brook	0.035	0.070
Pine Brook	0.035	0.050-0.075

*Data not available

[1]Updated values for the July 7, 2014 countywide analyses

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Martins Brook								
A	183	123	898	1.9	70.3	70.3	71.2	0.9
B	319	36	334	3.8	72.7	72.7	73.3	0.6
C	2,273	563	3,264	1.2	73.0	73.0	73.7	0.7
D	2,330	614	4,272	1.0	73.0	73.0	73.8	0.8
E	3,693	343	2,082	1.9	73.1	73.1	73.9	0.8
F	4,953	28	252	5.0	74.2	74.2	75.0	0.8
G	5,130	304	2,340	1.3	76.4	76.4	77.3	0.9
H	6,189	584	4,247	0.9	76.5	76.5	77.3	0.8
I	7,394	162	1,427	1.1	76.5	76.5	77.4	0.9
J	9,183	435	3,051	0.6	76.6	76.6	77.4	0.8
K	11,307	700	3,867	0.3	76.6	76.6	77.5	0.9
L	12,490	180	1,101	1.4	76.6	76.6	77.5	0.9
M	13,815	819	3,220	0.4	76.7	76.7	77.6	0.9
N	14,796	828	3,273	0.3	76.7	76.7	77.6	0.9
O	15,588	512	2,500	0.7	76.7	76.7	77.6	0.9
P	16,855	184	1,350	0.5	76.8	76.8	77.6	0.9
Q	17,436	246	1,547	0.2	78.5	78.5	79.4	0.9
R-Y*								

[1] Feet above confluence with Ipswich River
* No data available

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDDLESEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

MARTINS BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ipswich River								
A	0	375/225[2]	1,925	0.5	59.6	59.6	59.6	0.0
B	600	70/35[2]	345	3.0	59.6	59.6	59.6	0.0
C	1,900	60/30[2]	380	2.7	60.2	60.2	60.6	0.4
D	3,945	75/45[2]	510	2.0	60.9	60.9	61.5	0.6
E	4,055	55/30[2]	370	2.8	61.1	61.1	61.6	0.5
F	4,915	80/40[2]	590	1.8	61.4	61.4	62.0	0.6
G	4,975	50/25[2]	410	2.5	61.6	61.6	62.1	0.5
H	6,925	45/25[2]	420	2.5	61.9	61.9	62.8	0.9
I	8,965	100/50[2]	675	2.4	62.2	62.2	62.8	0.6
J	14,065	100	675	1.8	62.6	62.6	63.3	0.7
K	16,670	94	455	2.8	63.0	63.0	63.8	0.8
L	16,770	60	475	2.2	63.1	63.1	63.8	0.7
M	17,490	60	400	2.6	63.4	63.4	63.8	0.4
N	18,250	50	315	3.3	64.0	64.0	64.3	0.3
O	18,360	50	325	3.2	64.7	64.7	64.9	0.2
P	20,880	40	330	3.1	66.7	66.7	66.9	0.2
Q	20,975	65	420	2.5	66.8	66.8	67.0	0.2
R	21,875	265	1,320	1.7	67.0	67.0	67.3	0.3
S	23,475	245	2,150	0.5	67.1	67.1	67.3	0.2
T	23,990	120	700	1.5	67.1	67.1	67.3	0.2
U	24,110	135	844	1.2	67.5	67.5	68.5	1.0
V	24,450	41	247	4.2	67.6	67.6	68.6	1.0
W	26,390	150	1,073	1.0	70.2	70.2	70.9	0.7
X	27,290	200	1,715	0.6	70.3	70.3	71.2	0.9
Y	27,840	200	1,558	0.3	70.3	70.3	71.2	0.9
Z	29,530	200	1,292	0.4	70.3	70.3	71.2	0.9

[1] Feet above county boundary, county boundary is approximately 16,710 feet downstream of Washington Street

[2] Width/width within county

TABLE 12

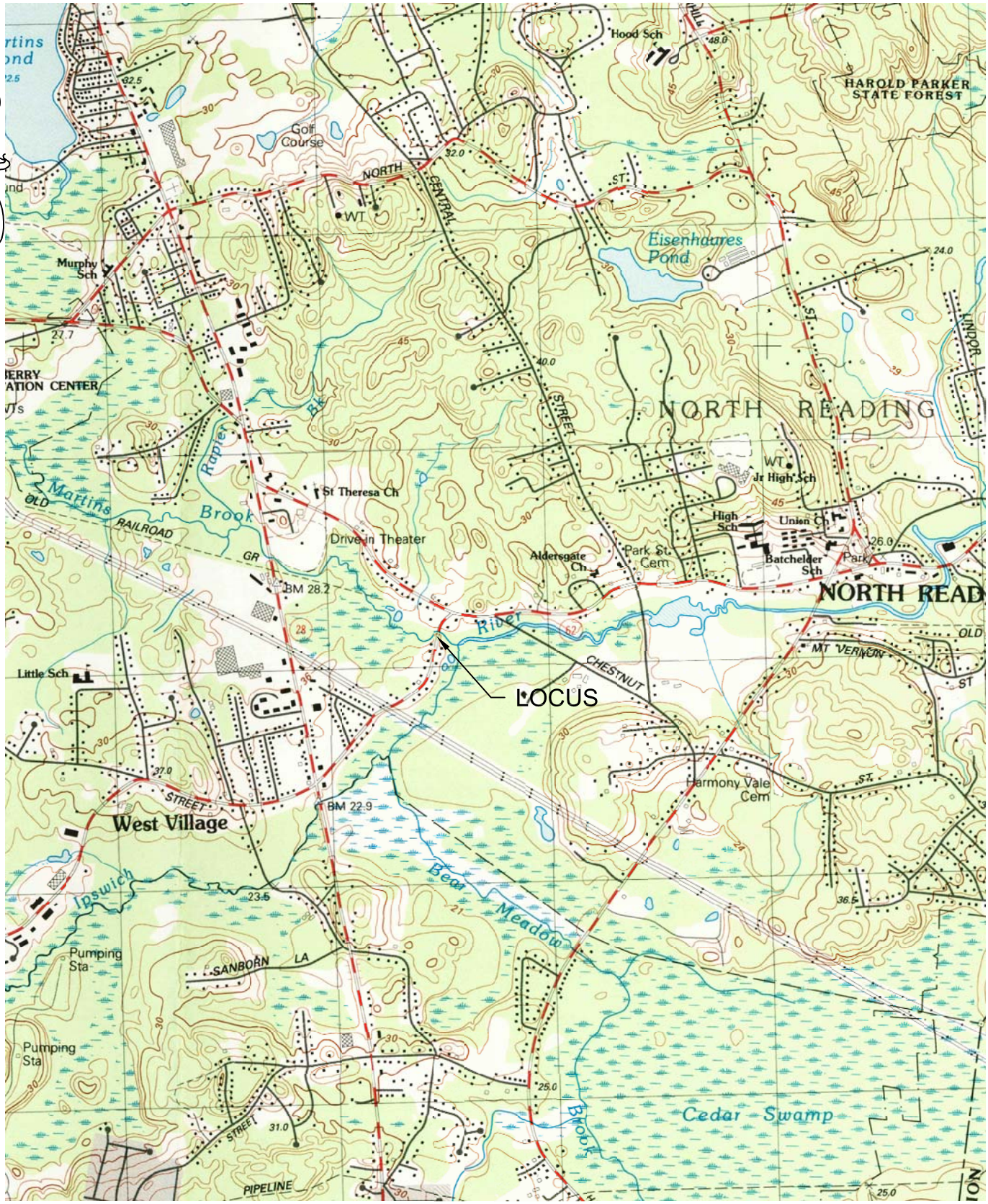
FEDERAL EMERGENCY MANAGEMENT AGENCY

MIDDLESEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

IPSWICH RIVER

ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH IPSWICH RIVER
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
1% ANNUAL CHANCE BACKWATER FROM IPSWICH RIVER
CONFLUENCE WITH IPSWICH RIVER
PARK STREET
ABANDONED RAILROAD
MAIN STREET
(STATE ROUTE 28)

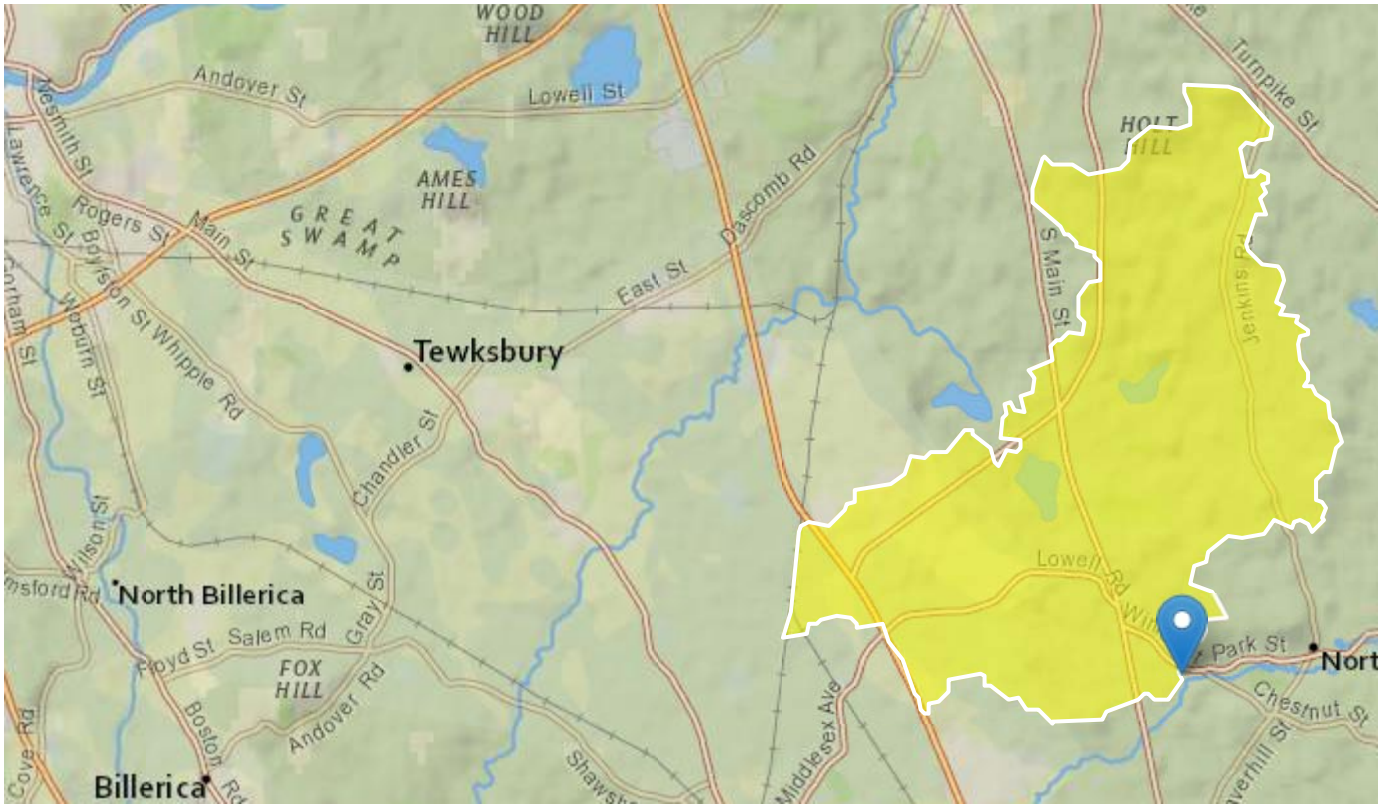


BAY COLONY GROUP, INC.
FOUR SCHOOL STREET
FOXBOROUGH, MA 02035
(508) 543-3939

USGS EXTRACT
PARK STREET
NORTH READING, MA
READING, MA QUADRANGLE
SCALE: 1"= 2000'

StreamStats Report - Martin's Brook @ Park Street North Reading, MA

Region ID: MA
Workspace ID: MA20210429122424744000
Clicked Point (Latitude, Longitude): 42.57151, -71.10152
Time: 2021-04-29 08:25:38 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	13.2	square miles
ELEV	Mean Basin Elevation	121	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	18.14	percent

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	13.2	square miles	0.16	512
ELEV	Mean Basin Elevation	121	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	18.14	percent	0	32.3

Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
50-percent AEP flood	221	ft^3/s	113	431	42.3
20-percent AEP flood	358	ft^3/s	181	707	43.4
10-percent AEP flood	464	ft^3/s	230	938	44.7
4-percent AEP flood	615	ft^3/s	294	1290	47.1
2-percent AEP flood	738	ft^3/s	342	1590	49.4
1-percent AEP flood	868	ft^3/s	390	1930	51.8
0.5-percent AEP flood	1010	ft^3/s	441	2310	54.1
0.2-percent AEP flood	1200	ft^3/s	500	2880	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.5.2
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.1

Appendix C – HEC-RAS Data
Existing Conditions

HEC-RAS Plan: Existing River: Martin's Brook Reach: Park Street

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Park Street	319	10-year	464	62.30	70.21		70.22	0.000287	1.23	502	134	0.09
Park Street	319	50-year	738	62.30	72.41		72.43	0.000200	1.24	963	284	0.07
Park Street	319	100-year	868	62.30	73.05		73.06	0.000186	1.26	1157	327	0.07
Park Street	319	500-year	1200	62.30	73.78		73.80	0.000227	1.46	1416	377	0.08
Park Street	292	10-year	464	63.30	69.98	66.20	70.19	0.004220	3.66	128	34	0.26
Park Street	292	50-year	738	63.30	72.25	67.20	72.40	0.002441	3.45	312	158	0.21
Park Street	292	100-year	868	63.30	72.92	67.61	73.04	0.001982	3.27	445	241	0.19
Park Street	292	500-year	1200	63.30	73.67	68.59	73.78	0.001910	3.39	661	334	0.19
Park Street	275		Bridge									
Park Street	258	10-year	464	62.80	69.45	65.41	69.60	0.002891	3.08	151	38	0.23
Park Street	258	50-year	738	62.80	70.50	66.30	70.77	0.004206	4.14	180	120	0.28
Park Street	258	100-year	868	62.80	71.08	66.68	71.39	0.004407	4.47	196	215	0.29
Park Street	258	500-year	1200	62.80	71.86	67.55	72.04	0.002996	3.94	518	302	0.24
Park Street	231	10-year	464	61.80	69.50	64.83	69.51	0.000249	1.18	538	134	0.08
Park Street	231	50-year	738	61.80	70.60	65.36	70.62	0.000338	1.52	697	162	0.10
Park Street	231	100-year	868	61.80	71.20	65.58	71.22	0.000347	1.61	802	187	0.10
Park Street	231	500-year	1200	61.80	71.90	65.96	71.94	0.000468	1.98	944	219	0.12

HEC-RAS Plan: Existing River: Martin's Brook Reach: Park Street

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
Park Street	319	10-year	70.22	70.21		0.02	0.02	134.04	133.75	292.52	37.73	1.23
Park Street	319	50-year	72.43	72.41		0.01	0.01	284.10	250.24	398.54	89.22	1.24
Park Street	319	100-year	73.06	73.05		0.01	0.01	327.38	319.47	432.42	116.11	1.26
Park Street	319	500-year	73.80	73.78		0.01	0.01	377.34	480.63	542.43	176.94	1.46
Park Street	292	10-year	70.19	69.98	66.20	0.01	0.04	34.10	2.20	461.77	0.03	3.66
Park Street	292	50-year	72.40	72.25	67.20	0.01	0.21	157.70	102.21	599.23	36.56	3.45
Park Street	292	100-year	73.04	72.92	67.61	0.01	0.08	240.93	166.71	614.87	86.42	3.27
Park Street	292	500-year	73.78	73.67	68.59	0.00	0.00	333.93	318.01	690.24	191.76	3.39
Park Street	275 BR U	10-year	70.14	69.81	66.19	0.44	0.06			464.00		4.63
Park Street	275 BR U	50-year	72.19	71.35	67.17	1.12	0.15			738.00		7.36
Park Street	275 BR U	100-year	72.95	72.55	67.59	1.22	0.11	191.77	93.42	651.99	122.59	5.68
Park Street	275 BR U	500-year	73.77	73.67	68.57	0.68	0.40	322.88	398.01	454.42	347.56	3.29
Park Street	275 BR D	10-year	69.64	69.42	65.40	0.00	0.03			464.00		3.74
Park Street	275 BR D	50-year	70.92	70.37	66.27	0.01	0.14			738.00		5.95
Park Street	275 BR D	100-year	71.63	70.87	66.63	0.01	0.23			868.00		7.00
Park Street	275 BR D	500-year	72.69	71.23	67.48	0.01	0.64			1200.00		9.67
Park Street	258	10-year	69.60	69.45	65.41	0.02	0.07	38.47	0.26	463.74		3.08
Park Street	258	50-year	70.77	70.50	66.30	0.02	0.12	120.33	2.48	734.76	0.76	4.14
Park Street	258	100-year	71.39	71.08	66.68	0.03	0.14	215.26	4.40	861.54	2.05	4.47
Park Street	258	500-year	72.04	71.86	67.55	0.03	0.07	301.75	301.96	839.08	58.96	3.94
Park Street	231	10-year	69.51	69.50	64.83			134.25	162.62	228.38	73.00	1.18
Park Street	231	50-year	70.62	70.60	65.36			162.40	280.59	342.91	114.49	1.52
Park Street	231	100-year	71.22	71.20	65.58			187.00	340.74	393.00	134.26	1.61
Park Street	231	500-year	71.94	71.90	65.96			218.50	496.65	521.61	181.74	1.98