NOTICE OF PUBLIC HEARING
SUDBURY CONSERVATION COMMISSION

The Sudbury Conservation Commission will hold a public hearing to review the Notice of Intent filing for the replacement of a failed culvert that conveys Pantry Brook under Marlboro Road, pursuant to the State Act and local Bylaw, at 270 Marlboro Road, Sudbury MA. Dan Nason, DPW Director, applicant. The hearing will be held on Mon., March 22, 2021 at 6:45 pm, via Zoom. Please see the Conservation Commission web page for further information.

https://sudbury.ma.us/conservationcommission/meeting/conservation-commission-meeting-monday-march-22-2021/

SUDBURY CONSERVATION COMMISSION
March 10, 2021

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 / Fax: 508-752-9494

NOTICE OF INTENT

Marlboro Road – Pantry Brook Culvert Replacement
Sudbury, MA

March, 2021

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Massachusetts Department of Environmental Protection

eDEP Transaction Copy

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Username:	**ECOTEC**
Transaction ID:	**1262875**
Document:	**WPA Form 3 - NOI**
Size of File:	**249.18K**
Status of Transaction:	**In Process**
Date and Time Created:	**3/8/2021:1:14:30 PM**

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Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
WPA Form 3 - Notice of Intent
Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
MassDEP File #:
eDEP Transaction #:1262875
City/Town:SUDBURY

A.General Information

1. Project Location:

a. Street Address	MARLBORO ROAD		
b. City/Town	SUDBURY	c. Zip Code	01776
d. Latitude	42.40836N	e. Longitude	71.41296W
f. Map/Plat #	N/A	g.Parcel/Lot #	N/A

2. Applicant:

☐ Individual ☑ Organization

a. First Name	DANIEL	b.Last Name	NASON		
c. Organization	TOWN OF SUDBURY DEPT. OF PUBLIC WORKS				
d. Mailing Address	275 OLD LANCASTER ROAD				
e. City/Town	SUDBURY	f. State	MA	g. Zip Code	01776
h. Phone Number	978-443-2209	i. Fax		j. Email	nasond@sudbury.ma.us

3.Property Owner:

☐ more than one owner

a. First Name	DARLENE	b. Last Name	MURPHY		
c. Organization					
d. Mailing Address	270 MARLBORO ROAD				
e. City/Town	SUDBURY	f.State	MA	g. Zip Code	01776
h. Phone Number	150-875-2966	i. Fax		j.Email	aallen@ecotecinc.com

4.Representative:

a. First Name	ARTHUR	b. Last Name	ALLEN		
c. Organization	ECOTEC, INC.				
d. Mailing Address	102 GROVE STREET				
e. City/Town	WORCESTER	f. State	MA	g. Zip Code	01605
h.Phone Number	508-752-9666	i.Fax		j.Email	aallen@ecotecinc.com

5.Total WPA Fee Paid (Automatically inserted from NOI Wetland Fee Transmittal Form):

a.Total Fee Paid	0.00	b.State Fee Paid	0.00	c.City/Town Fee Paid	0.00

6.General Project Description:

REPLACE FAILING CULVERT CARRYING PANTRY BROOK UNDER MARLBORO ROAD.

7a.Project Type:

1. ☐ Single Family Home	2. ☐ Residential Subdivision
3. ☐ Limited Project Driveway Crossing	4. ☐ Commercial/Industrial
5. ☐ Dock/Pier	6. ☐ Utilities
7. ☐ Coastal Engineering Structure	8. ☐ Agriculture (eg., cranberries, forestry)
9. ☑ Transportation	10. ☐ Other

7b.Is any portion of the proposed activity eligible to be treated as a limited project subject to 310 CMR 10.24 (coastal) or 310 CMR 10.53 (inland)?

Massachusetts Department of Environmental Protection
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Provided by MassDEP:
MassDEP File #:
eDEP Transaction #:1262875
City/Town:SUDBURY

1. ☑ Yes ☐ No If yes, describe which limited project applies to this project:
2. Limited Project: 310 CMR 10.53(3)(F). MAINTENANCE AND IMPROVEMENT OF AN EXISTING PUBLIC ROADWAY.

8.Property recorded at the Registry of Deeds for:

a.County:	b.Certificate:	c.Book:	d.Page:
SOUTHERN MIDDLESEX		N/A	N/A

B. Buffer Zone & Resource Area Impacts (temporary & permanent)

1.Buffer Zone & Resource Area Impacts (temporary & permanent):

☐ This is a Buffer Zone only project - Check if the project is located only in the Buffer Zone of a Bordering Vegetated Wetland, Inland Bank, or Coastal Resource Area.

2.Inland Resource Areas: (See 310 CMR 10.54 - 10.58, if not applicable, go to Section B.3. Coastal Resource Areas)

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
a. ☑ Bank	128 1. linear feet	128 2. linear feet
b. ☑ Bordering Vegetated Wetland	346 1. square feet	346 2. square feet
c. ☑ Land under Waterbodies and Waterways	560 1. Square feet	560 2. square feet
	0 3. cubic yards dredged	
d. ☑ Bordering Land Subject to Flooding	2381 1. square feet 0 3. cubic feet of flood storage lost	2381 2. square feet 4. cubic feet replaced
e. ☐ Isolated Land Subject to Flooding	 1. square feet	
	 2. cubic feet of flood storage lost	3. cubic feet replaced
f. ☑ Riverfront Area	Pantry Brook 1. Name of Waterway (if any)	
2. Width of Riverfront Area (check one)	☐ 25 ft. - Designated Densely Developed Areas only ☐ 100 ft. - New agricultural projects only ☑ 200 ft. - All other projects	
3. Total area of Riverfront Area on the site of the proposed project		8000 square feet

4. Proposed Alteration of the Riverfront Area:

800 a. total square feet	800 b. square feet within 100 ft.	0 c. square feet between 100 ft. and 200 ft.

5. Has an alternatives analysis been done and is it attached to this NOI? ☑ Yes ☐ No

6. Was the lot where the activity is proposed created prior to August 1, 1996? ☑ Yes ☐ No

3.Coastal Resource Areas: (See 310 CMR 10.25 - 10.35)

Resource Area	Size of Proposed Alteration	Proposed Replacement (if any)
a. ☐ Designated Port Areas	Indicate size under	Land under the ocean below,
b. ☐ Land Under the Ocean	1. square feet 2. cubic yards dredged	
c. ☐ Barrier Beaches	Indicate size under Coastal Beaches and/or Coatstal Dunes, below	
d. ☐ Coastal Beaches	1. square feet	2. cubic yards beach nourishment
e. ☐ Coastal Dunes	1. square feet	2. cubic yards dune nourishment
f. ☐ Coastal Banks	1. linear feet	
g. ☐ Rocky Intertidal Shores	1. square feet	
h. ☐ Salt Marshes	1. square feet	2. sq ft restoration, rehab, crea.
i. ☐ Land Under Salt Ponds	1. square feet	
	2. cubic yards dredged	
j. ☐ Land Containing Shellfish	1. square feet	
k. ☐ Fish Runs	Indicate size under Coastal Banks, Inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above	
	1. cubic yards dredged	
l. ☐ Land Subject to Coastal Storm Flowage	1. square feet	

4.Restoration/Enhancement

☐ Restoration/Replacement

If the project is for the purpose of restoring or enhancing a wetland resource area in addition to the square footage that has been entered in Section B.2.b or B.3.h above, please entered the additional amount here.

a. square feet of BVW

b. square feet of Salt Marsh

5.Projects Involves Stream Crossings

☑ Project Involves Streams Crossings

If the project involves Stream Crossings, please enter the number of new stream crossings/number of replacement stream crossings.

a. number of new stream crossings	b. number of replacement stream crossings
	1

C. Other Applicable Standards and Requirements

Streamlined Massachusetts Endangered Species Act/Wetlands Protection Act Review

1. Is any portion of the proposed project located in **Estimated Habitat of Rare Wildlife** as indicated on the most recent Estimated Habitat Map of State-Listed Rare Wetland Wildlife published by the Natural Heritage of Endangered Species program (NHESP)?

a. ☐ Yes ☑ No

If yes, include proof of mailing or hand delivery of NOI to:
Natural Heritage and Endangered Species
Program
Division of Fisheries and Wildlife
1 Rabbit Hill Road
Westborough, MA 01581

b. Date of map:9/12/2019

If yes, the project is also subject to Massachusetts Endangered Species Act (MESA) review (321 CMR 10.18)....

c. Submit Supplemental Information for Endangered Species Review * (Check boxes as they apply)

1.☐ Percentage/acreage of property to be altered:

(a) within Wetland Resource Area — percentage/acreage

(b) outside Resource Area — percentage/acreage

2.☐ Assessor's Map or right-of-way plan of site

3.☐ Project plans for entire project site, including wetland resource areas and areas outside of wetland jurisdiction, showing existing and proposed conditions, existing and proposed tree/vegetation clearing line, and clearly demarcated limits of work **

a.☐ Project description (including description of impacts outside of wetland resource area & buffer zone)

b.☐ Photographs representative of the site

c.☐ MESA filing fee (fee information available at: http://www.mass.gov/eea/agencies/dfg/dfw/natural-heritage/regulatory-review/mass-endangered-species-act-mesa/mesa-fee-schedule.html)
Make check payable to "Natural Heritage & Endangered Species Fund" and **mail to NHESP** at above address

*Projects altering **10 or more acres** of land, also submit:*

d.☐ Vegetation cover type map of site

e.☐ Project plans showing Priority & Estimated Habitat boundaries

d. OR Check One of the following

1.☐ Project is exempt from MESA review. Attach applicant letter indicating which MESA exemption applies. (See 321 CMR 10.14, http://www.mass.gov/eea/agencies/dfg/dfw/laws-regulations/cmr/321-cmr-1000-massachusetts-endangered-species-act.html#10.14; the NOI must still be sent to NHESP if the project is within estimated habitat pursuant to 310 CMR 10.37 and 10.59.)

2.☐ Separate MESA review ongoing.

a. NHESP Tracking Number

b. Date submitted to NHESP

3. ☐ Separate MESA review completed.
Include copy of NHESP "no Take" determination or valid Conservation & Management Permit with approved plan.

* Some projects **not** in Estimated Habitat may be located in Priority Habitat, and require NHESP review...

2. For coastal projects only, is any portion of the proposed project located below the mean high waterline or in a fish run?
a. ☑ Not applicable - project is in inland resource area only
b. ☐ Yes ☐ No

If yes, include proof of mailing or hand delivery of NOI to either:

South Shore - Cohasset to Rhode Island, and the Cape & Islands:

Division of Marine Fisheries -
Southeast Marine Fisheries Station
Attn: Environmental Reviewer
836 S. Rodney French Blvd
New Bedford, MA 02744

North Shore - Hull to New Hampshire:

Division of Marine Fisheries -
North Shore Office
Attn: Environmental Reviewer
30 Emerson Avenue
Gloucester, MA 01930

If yes, it may require a Chapter 91 license. For coastal towns in the Northeast Region, please contact MassDEP's Boston Office. For coastal towns in the Southeast Region, please contact MassDEP's Southeast Regional office.

3. Is any portion of the proposed project within an Area of Critical Environmental Concern (ACEC)?

a. ☐ Yes ☑ No

If yes, provide name of ACEC (see instructions to WPA Form 3 or DEP Website for ACEC locations). **Note:** electronic filers click on Website.

b. ACEC Name

4. Is any portion of the proposed project within an area designated as an Outstanding Resource Water (ORW) as designated in the Massachusetts Surface Water Quality Standards, 314 CMR 4.00?
a. ☐ Yes ☑ No

5. Is any portion of the site subject to a Wetlands Restriction Order under the Inland Wetlands Restriction Act (M.G.L.c. 131, § 40A) or the Coastal Wetlands Restriction Act (M.G.L.c. 130, § 105)?
a. ☐ Yes ☑ No

6. Is this project subject to provisions of the MassDEP Stormwater Management Standards?
a. ☐ Yes, Attach a copy of the Stormwater Report as required by the Stormwater Management Standards per 310 CMR 10.05(6)(k)-(q) and check if:
1. ☐ Applying for Low Impact Development (LID) site design credits (as described in Stormwater Management Handbook Vol.2, Chapter 3)
2. ☐ A portion of the site constitutes redevelopment
3. ☐ Proprietary BMPs are included in the Stormwater Management System

b. ☑ No, Explain why the project is exempt:
1. ☐ Single Family Home

2. ☑ Emergency Road Repair

3. ☐ Small Residential Subdivision (less than or equal to 4 single-family houses or less than or equal to 4 units in multi-family housing project) with no discharge to Critical Areas.

D. Additional Information

Applicants must include the following with this Notice of Intent (NOI). See instructions for details.

Online Users: Attach the document transaction number (provided on your receipt page) for any of the following information you submit to the Department by regular mail delivery.

1. USGS or other map of the area (along with a narrative description, if necessary) containing sufficient information for the
☑ Conservation Commission and the Department to locate the site. (Electronic filers may omit this item.)
2. Plans identifying the location of proposed activities (including activities proposed to serve as a Bordering Vegetated Wetland
☑ [BVW] replication area or other mitigating measure) relative to the boundaries of each affected resource area.
3. Identify the method for BVW and other resource area boundary delineations (MassDEP BVW Field Data Form(s).
☑ Determination of Applicability, Order of Resource Area Delineation, etc.), and attach documentation of the methodology.
4. List the titles and dates for all plans and other materials submitted with this NOI.
☑

a. Plan Title:	b. Plan Prepared By:	c. Plan Signed/Stamped By:	c. Revised Final Date:	e. Scale:
ENGINEER'S TECHNICAL MEMORANDUM INCLUDING PROJECT PLANS, ALTERNATIVES ANALYSIS, WETLAND REPORT WITH DATA FORMS, ETC.	WOODARD & CURRAN		4/13/2020; Scale as Noted	

5. If there is more than one property owner, please attach a list of these property owners not listed on this form.
☐

6. Attach proof of mailing for Natural Heritage and Endangered Species Program, if needed.
☐

7. Attach proof of mailing for Massachusetts Division of Marine Fisheries, if needed.
☐

8. Attach NOI Wetland Fee Transmittal Form.
☑

9. Attach Stormwater Report, if needed.
☐

E. Fees

1. Fee Exempt: No filing fee shall be assessed for projects of any city, town, county, or district of the Commonwealth, federally recognized Indian tribe housing authority, municipal housing authority, or the Massachusetts Bay Transportation Authority.

Applicants must submit the following information (in addition to pages 1 and 2 of the NOI Wetland Fee Transmittal Form) to confirm fee payment:

2. Municipal Check Number	3. Check date
4. State Check Number	5. Check date
6. Payer name on check: First Name	7. Payer name on check: Last Name

F. Signatures and Submittal Requirements

I hereby certify under the penalties of perjury that the foregoing Notice of Intent and accompanying plans, documents, and supporting data are true and complete to the best of my knowledge. I understand that the Conservation Commission will place notification of this Notice in a local newspaper at the expense of the applicant in accordance with the wetlands regulations, 310 CMR 10.05(5)(a).

I further certify under penalties of perjury that all abutters were notified of this application, pursuant to the requirements of M.G.L. c. 131, § 40. Notice must be made by Certificate of Mailing or in writing by hand delivery or certified mail (return receipt requested) to all abutters within 100 feet of the property line of the project location.

1. Signature of Applicant	2. Date
3. Signature of Property Owner(if different)	4. Date
Arthur Allen	3/8/2021
5. Signature of Representative (if any)	6. Date

For Conservation Commission:

Two copies of the completed Notice of Intent (Form 3), including supporting plans and documents, two copies of the NOI Wetland Fee Transmittal Form, and the city/town fee payment, to the Conservation Commission by certified mail or hand delivery.

For MassDEP:

One copy of the completed Notice of Intent (Form 3), including supporting plans and documents, one copy of the NOI Wetland Fee Transmittal Form, and a **copy** of the state fee payment to the MassDEP Regional Office (see Instructions) by certified mail or hand delivery.

Other:

If the applicant has checked the "yes" box in Section C, Items 1-3, above, refer to that section and the Instructions for additional submittal requirements.

The original and copies must be sent simultaneously. Failure by the applicant to send copies in a timely manner may result in dismissal of the Notice of Intent.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
WPA Form 3 - Notice of Wetland FeeTransmittal Form
Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
MassDEP File #:
eDEP Transaction #:1262875
City/Town:SUDBURY

A. Applicant Information

1. Applicant:

a. First Name	DANIEL	b.Last Name	NASON		
c. Organization	TOWN OF SUDBURY DEPT. OF PUBLIC WORKS				
d. Mailing Address	275 OLD LANCASTER ROAD				
e. City/Town	SUDBURY	f. State	MA	g. Zip Code	01776
h. Phone Number	9784432209	i. Fax		j. Email	nasond@sudbury.ma.us

2.Property Owner:(if different)

a. First Name	DARLENE	b. Last Name	MURPHY		
c. Organization					
d. Mailing Address	270 MARLBORO ROAD				
e. City/Town	SUDBURY	f.State	MA	g. Zip Code	01776
h. Phone Number	15087529666	i. Fax		j.Email	aallen@ecotecinc.com

3. Project Location:

a. Street Address	MARLBORO ROAD	b. City/Town	SUDBURY

Are you exempted from Fee? ☐ (YOU HAVE SELECTED 'YES')

Note: Fee will be exempted if you are one of the following:

- City/Town/County/District
- Municipal Housing Authority
- Indian Tribe Housing Authority
- MBTA

State agencies are only exempt if the fee is less than $100

B. Fees

Activity Type	Activity Number	Activity Fee	RF Multiplier	Sub Total
		City/Town share of filling fee	State share of filing fee	Total Project Fee
		$0.00	$0.00	$0.00

abutters_id_field	abutters_owner1
D09-0001	AMES LOIS S TRUSTEE
D09-0201	TOWN OF SUDBURY
D09-0202	MURPHY DARLENE M & VONGOELER
D09-0213	GRUENTZIG ALEXANDER WILLMAR
D09-0214	MCCALLIG MICHAEL T & GERI L
E09-0803	NYGREN PER J & COLETTE B

abutters_owner2	abutters_address	abutters_address2
THE LOIS S AMES REVOCABLE	285 MARLBORO RD	
CONSERVATION	278 OLD SUDBURY RD	
FRIEDEL S	270 MARLBORO ROAD	
	255 MARLBORO ROAD	
	249 MARLBORO RD	
	260 MARLBORO RD	

abutters_town	abutters_state	abutters_zip	abutters_bookpage
SUDBURY	MA	01776	74116-100
SUDBURY	MA	01776	14547-323
SUDBURY	MA	01776	64361-463
SUDBURY	MA	01776	61442-529
SUDBURY	MA	01776	24688-525
SUDBURY	MA	01776	29884-481

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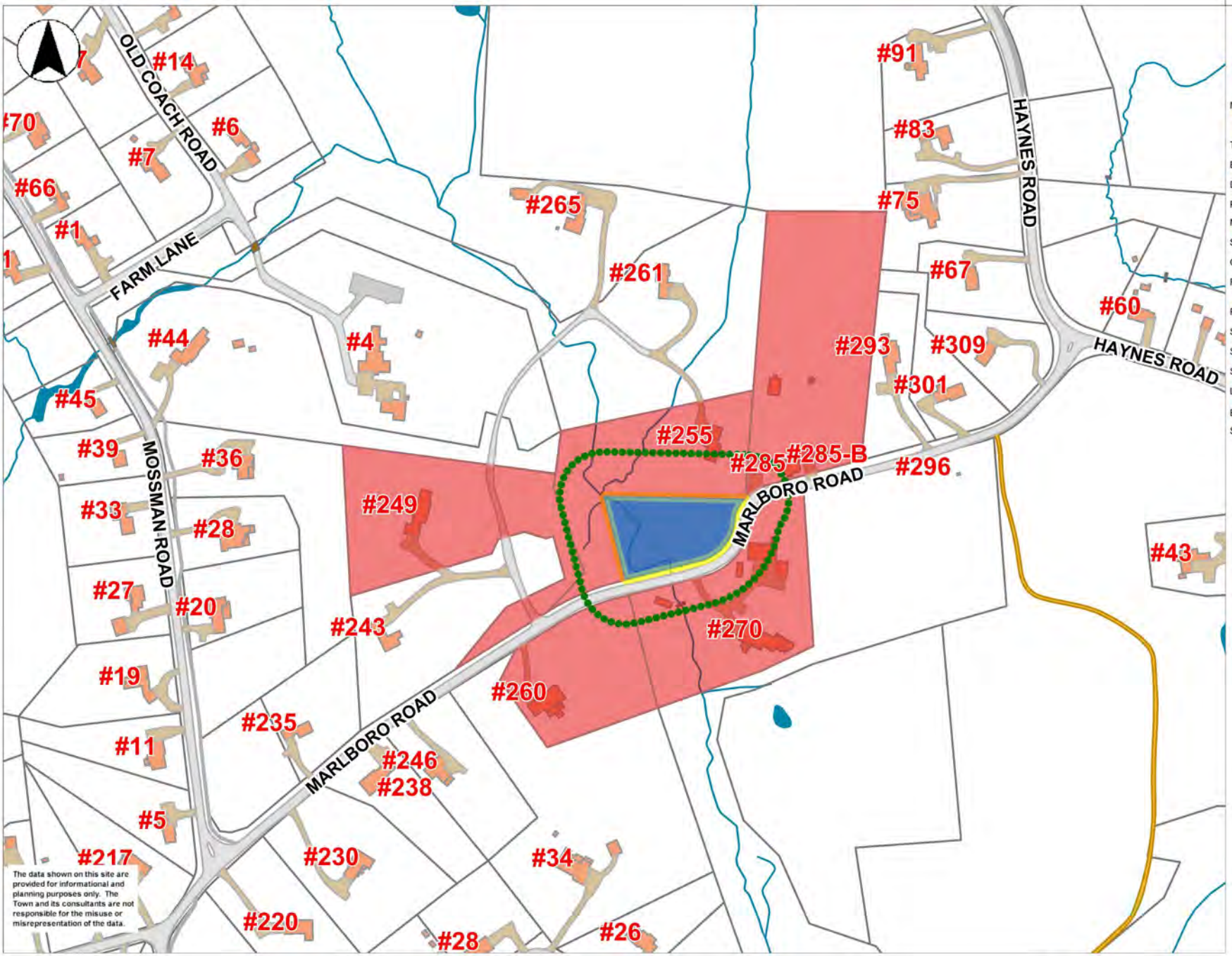
MARLBORO RD
270 MARLBORO RD
255 MARLBORO RD
249 MARLBORO RD
260 MARLBORO RD


OLD COACH ROAD
FARM LANE
MOSSMAN ROAD
MARLBORO ROAD
MARLBORO ROAD
HAYNES ROAD
HAYNES ROAD
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MA Highways
Interstate
US Highway
Numbered Routes
Town Boundary
Bridges
Driveways
Parking Lots
Medians
Sidewalks
Curbs
Roads
Paved Roads
UnPaved Roads
Parcels
Scenic Roads
Streams Ortho
Streams CIR
Lake/Reservoir
Buildings
Streets
The data shown on this site are provided for informational and planning purposes only. The Town and its consultants are not responsible for the misuse or misrepresentation of the data.
0
400
800 ft
Printed on 02/19/2021 at 09:50 AM
MapsOnline

abutters_id_field	abutters_owner1
D09-0001	AMES LOIS S TRUSTEE
D09-0201	TOWN OF SUDBURY
D09-0202	MURPHY DARLENE M & VONGOELER
D09-0204	TOWN OF SUDBURY
D09-0213	GRUENTZIG ALEXANDER WILLMAR
E09-0802	SOJA MICHAEL J & MARSHA R
E09-0803	NYGREN PER J & COLETTE B
E09-0501	MURPHY DARLENE TRS

abutters_owner2	abutters_address	abutters_address2
THE LOIS S AMES REVOCABLE	285 MARLBORO RD	
CONSERVATION	278 OLD SUDBURY RD	
FRIEDEL S	270 MARLBORO ROAD	
CONSERVATION	278 OLD SUDBURY ROAD	
	255 MARLBORO ROAD	
TRUSTEE MICHAEL J SOJA TRUST	34 MUSKET LANE	
	260 MARLBORO RD	
BARTON FARMS TRUST	270 MARLBOROUGH RD	

abutters_town	abutters_state	abutters_zip	abutters_bookpage
SUDBURY	MA	01776	74116-100
SUDBURY	MA	01776	14547-323
SUDBURY	MA	01776	64361-463
SUDBURY	MA	01776	14547-323
SUDBURY	MA	01776	61442-529
SUDBURY	MA	01776	68668-402
SUDBURY	MA	01776	29884-481
SUDBURY	MA	01776	70844-377

abutters_location
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270 MARLBORO RD
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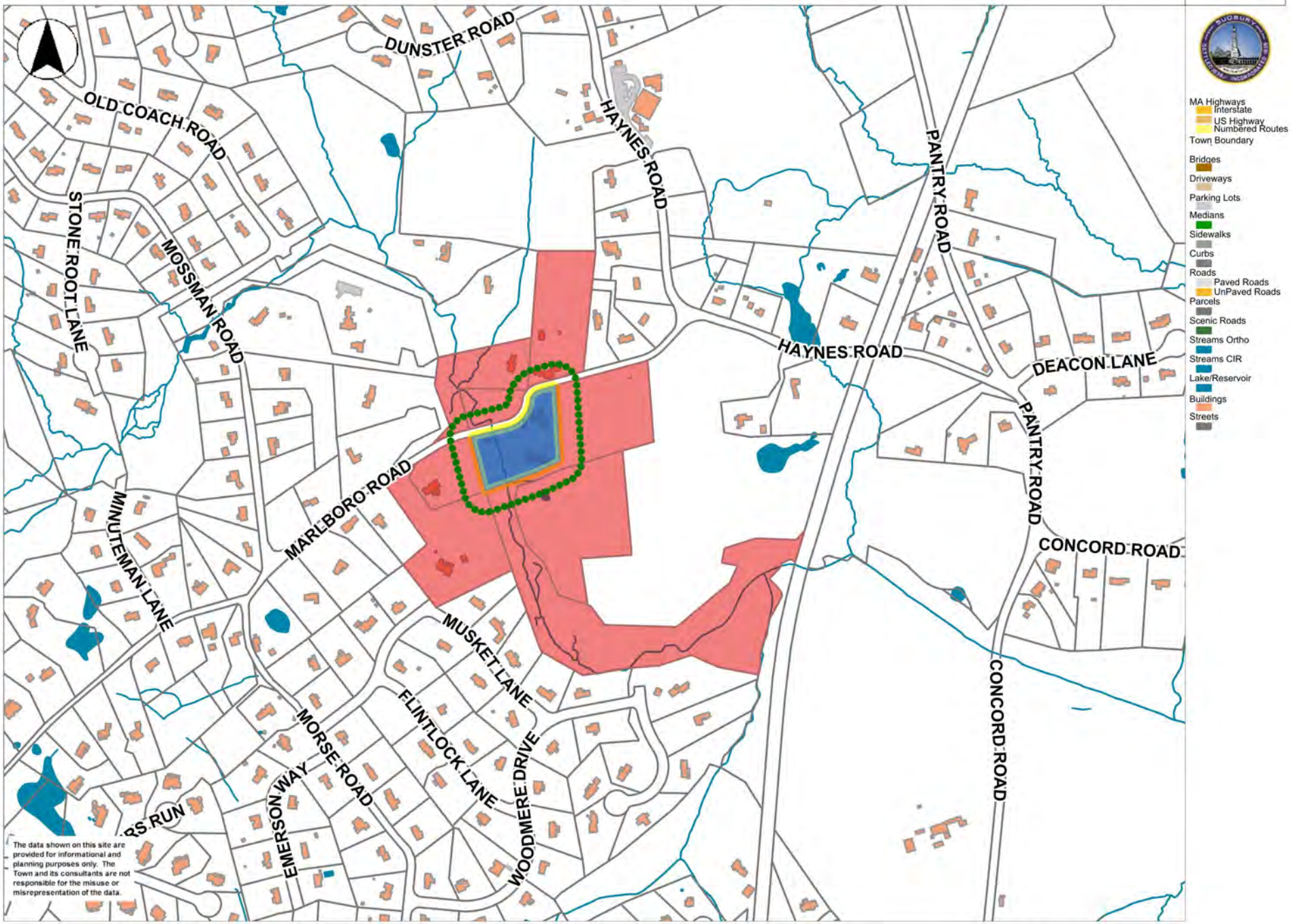
MARLBORO RD



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MapsOnline

COMMITMENT & INTEGRITY
DRIVE RESULTS

41 Hutchins Drive
Portland, Maine 04102
www.woodardcurran.com

T 800.426.4262
T 207.774.2112
F 207.774.6635

TECHNICAL MEMORANDUM

TO: Arthur Allen, EcoTec, Inc.

PREPARED BY: Suzanna Taytslin & Kevin Trainor, Woodard & Curran

REVIEWED BY: Darrin Stairs, Woodard & Curran

DATE: April 13, 2020

RE: Marlboro Road Culvert Replacement – Design Basis Memorandum

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1. INTRODUCTION

The purpose of this memorandum is to summarize Woodard & Curran's hydraulic evaluation of an existing culvert carrying Pantry Brook, a mapped perennial stream, beneath Marlboro Road. This memorandum is intended to support development of a Notice of Intent to file an application with the Conservation Commission for authorization to replace the existing culvert. The existing 42-inch concrete culvert is deteriorating and the associated roadway embankment has failed. Woodard & Curran recommends replacing the existing culvert with an 8-foot wide, open-bottom culvert with natural streambed material and a maximum depth of 3.5 feet. Please refer to Figures 1 and 2 for Site Location Map and Project Area.

2. EXISTING CONDITIONS EVALUATION

The existing culvert crossing beneath Marlboro Road is in poor condition and requires replacement. The embankment above the downstream end is reinforced with a field stone headwall, which failed in August of 2019 necessitating replacement of the crossing. Gabion baskets have been placed to temporarily support the roadway until a replacement culvert is installed.

2.1 Survey

An existing conditions survey of the site was performed by Chappell Engineering Associates on September 17, 2019. The existing culvert pipe is 29.8 feet long, flowing north to south beneath Marlboro Road. The downstream pipe end is located on private property. Survey is included as Attachment A.

2.2 Wetland Resource Evaluation

A wetland resource evaluation was performed by EcoTec, Inc. on August 15, 2019 to evaluate the presence of resource areas within the project area. Wetland flags were delineated for the boundary of bordering vegetated wetlands (BVW) associated with the upstream wetland complex and downstream perennial stream, labeled A1-A15 and B1–B8, respectively. Stream bank flags were delineated for the boundary of the mean annual high-water line (MAHWL) along the eastern and western bank of Pantry Brook central and northern to the Site, labeled RA1-RA13, RB1-RB7, RAA1-RAA6 and RC1-RC10. Pantry Brook and an associated floodplain, mapped by the MassDEP as a deep marsh, lie immediately upstream of the culvert. Pantry Brook continues from the downstream pipe end through one additional roadway culvert crossing at Concord Road prior to discharging into the Sudbury River. The Wetland Resource Evaluation is included as Attachment B.

2.3 Pantry Brook Channel Conditions

The Pantry Brook channel immediately upstream of the Marlboro Road crossing is meandering, characteristic of marsh areas. The slope upstream of the culvert within the surveyed area is approximately 0.68%, and there appears to be some sediment deposition upstream of the culvert entrance. The channel downstream of the culvert is a perennial stream with a slope of approximately 3.7%; however, there is a scour hole with a depth of approximately 1.7 feet, indicating that exit velocity is high, and the culvert is likely undersized.

The channel width, measured using bank flags, ranges from 7 feet to 12 feet, not including the scour hole. The existing culvert is set at approximately 4.25% slope, contains no substrate, and provides no bank area for wildlife passage.

2.4 Geotechnical Exploration

GZA GeoEnvironmental, Inc. completed subsurface exploration and compiled a geotechnical memorandum dated October 25, 2019 presenting the subsurface findings. Borings B-1 and B-2 were drilled on August 14, 2019 at the Marlboro Road culvert crossing. Subsurface conditions at the site consist of loose sand and silt fill over natural sand and gravel, with the soils encountered generally becoming denser with depth. The groundwater level was found to be generally in the range of the upstream MAHWL. The geotechnical exploration is included as Attachment C.

2.5 FEMA FIRM Review

Review of the FEMA flood maps indicates that the site is within Zone AE, with the downstream portion of the site within a regulatory floodway. The FEMA Base Flood Elevation (BFE) is 141.4 feet in the marsh upstream of the culvert and approximately 141.02 feet immediately upstream of the culvert. Based on survey data, the roadway centerline elevation appears to be 141 feet, indicating that the road may overtop during the simulated precipitation event, despite not being included in the flood zone as mapped on FEMA FIRM Panel 25017CO0366F. The FIRM panel is included as Attachment D.

2.6 Hydrologic & Hydraulic Analysis

Woodard & Curran performed a hydrologic and hydraulic analysis of the Marlboro Road catchment to establish probable flow during 1%-annual chance (“100-year”) precipitation event. The watershed was modeled using the Environmental Protection Agency (EPA) Storm Water Management Model, version 5.1.013 (SWMM5) on the PCSWMM v7.2.2785 platform.

Woodard & Curran utilized data from a variety of sources to represent the Pantry Brook drainage area upstream of Marlboro Road using the EPA SWMM 5 nonlinear reservoir and modified Green-Ampt infiltration hydrologic models coupled with the dynamic wave routing hydraulic model. Subcatchments within the watershed were delineated using the watershed delineation tool with a target discretization area of 10 acres. Survey data, in conjunction with a 1-meter resolution digital elevation model (DEM) generated by the National Oceanic and Atmospheric Administration (NOAA) in 2016, was used to delineate the overall contributing watershed area. The NOAA High Resolution Land Cover database was used to determine impervious versus pervious area. The Natural Resources Conservation Service (NRCS) soil survey of Middlesex County maps were used to define infiltration parameters, and the surface friction parameters were defined using the NOAA High Resolution Land Cover database data compiled in 2016. Catchment delineation using the DEM and Land Use data indicate that the contributing drainage area to the culvert crossing at Marlboro Street is approximately 573 acres and 11% impervious. A summary report of hydrologic and hydraulic analysis is included as Attachment E.

Precipitation event simulations were selected to represent 1%-annual chance storm, or approximately 8.27 inches of precipitation using a 24-hour, Type D distribution based on the Northeast Regional Climate Center precipitation frequency estimates. Based on our analysis, the existing culvert conveys a maximum of approximately 125 cubic feet per second (cfs) during the 1%-annual chance event. The culvert acts as a flow restriction, impounding water upstream of Marlboro Road. Based on FEMA mapping, as well as Woodard & Curran's analysis, the water level upstream of Marlboro Road approaches the elevation of the road, but may not overtop the road.

3. DESIGN CONSIDERATIONS

The purpose of this project is to improve the structural integrity of the culvert and roadway, while improving the hydraulic capacity of the culvert and habitat conditions at the crossing where possible. The design considerations of the culvert replacement concentrated on maintaining existing flood conditions for the 100-year storm event. Hydraulic performance, potential for downstream flooding; effect on upstream, downstream, and riparian habitat; potential for erosion and overall effect on stream stability were taken into consideration. We evaluated the following alternatives:

- In-kind replacement of 42-inch RCP culvert matching existing invert elevations
- Embedded 10-foot wide by 6-foot high four-sided pre-cast concrete culvert embedded with 2.5-feet of natural streambed material
- Open-bottom, 8-foot wide culvert with natural streambed and maximum depth of 3.5-feet

Design considerations also included utility and roadway elevation constraints. The existing culvert has a maximum depth of 3.5-feet and an invert elevation of 133.23 feet. A 12-inch asbestos cement water utility runs over the existing culvert. To limit negative impacts on existing utilities, options were limited to a maximum depth of 3.5-feet and an inlet invert elevation of 133.23.

3.1 Hydraulic Analysis Results

To evaluate the potential effects of increasing the hydraulic capacity of the channel, the model domain included downstream channel reaches extending to the crossing at Concord Road. Hydraulic conditions in the area immediately upstream and downstream of the Marlboro Road crossing were compared for the 1%-annual chance event for a replacement in-kind, an embedded 10-foot by 6-foot box culvert with a 4-foot by 10-foot clear opening and an open-bottom, three sided culvert with a natural channel bottom.

Increasing the hydraulic capacity at the Marlboro Road Crossing may reduce the water level upstream and increase the water level downstream. Table 3-1 below summarizes the effects of the culvert replacement on the upstream and downstream water levels during the 100-year (1% annual chance) event.

Table 3-1: Hydraulic Summary of Options

Alternative	Description	Approximate Peak Flow (cfs)	Approximate Max Upstream Water Level (feet NAVD88)	Approximate Max Downstream Water Level (feet NAVD88)
1: In-Kind Replacement	42-inch RCP @ 4.25% slope	125	141	132.1
2: Box Culvert	10' x 6' closed box (embedded 2.5 feet) @ 4.25% slope	355	139.6	132.9
3: Open-bottom Culvert	8' open bottom with max depth of 3.5' @ 4.25%	245	141	132.6

3.2 Results Discussion

The following sections address the results in the context of hydraulic performance, upstream and downstream water levels, potential for downstream flooding; effect on upstream, downstream, and riparian habitat; potential for erosion and overall effect on stream stability.

3.2.1 Alternative 1

Alternative 1 will maintain existing hydraulic performance during the 100-year event and will not change upstream and downstream water levels. Alternative 1 will also continue to separate habitat upstream and downstream of the culvert. Material deposition upstream of the culvert and erosion downstream will likely continue. Erosion may be mitigated by construction of energy dissipation measures to prevent further scour.

With respect to the Massachusetts Stream Crossing Standards, Alternative 1:

- Does not meet the structure type general or optimal standards. Alternative 1 is neither an open-bottom structure nor a bridge.
- Does not meet the embedment general standard. Alternative 1 is not embedded.
- Does not meet the crossing span general or optimal standards. The diameter of Alternative 1 is 0.5 x the stream's bankfull width of 7 feet.
- Does not meet the substrate general or optimal standards. Alternative 1 is not embedded.
- Does not meet the water depth and velocity general or optimal standards.
- Does not meet the openness general or optimal standards. The openness of Alternative 1 is 0.32 feet.
- Does not meet the banks general or optimal standards. Alternative 1 does not provide banks within the crossing.

3.2.2 Alternative 2

Alternative 2 is likely to reduce the water level upstream of the culvert during the 100-year event and most lighter precipitation events, as well as during dry weather, which may have a negative impact on upstream habitat. Downstream water levels would likely increase somewhat during heavy precipitation events; however, buildings are unlikely to be impacted by this level of increase. Alternative 2 would provide a habitat connection upstream and downstream of the culvert; however, the potential for reducing water levels in the upstream marsh may ultimately reduce riparian habitat.

With respect to the Massachusetts Stream Crossing Standards, Alternative 2:

- Does not meet the structure type general or optimal standards. Alternative 2 is neither an open-bottom structure nor a bridge.
- Meets the embedment general standard. Alternative 2 is embedded 2.5 feet.
- Meets the crossing span optimal standard. The span of Alternative 2 is 1.4 x the stream's bankfull width of 7 feet.
- Meets the substrate optimal standard. Alternative 2 is embedded with substrate that matches that of the stream.
- Meets the water depth and velocity optimal standard.
- Meets the openness optimal standard. The openness of Alternative 2 is 1.17 feet. Because the steepness of the embankment below Marlboro Road significantly inhibits wildlife passage, the optimum openness standard at this crossing is 1.64 feet.
- Meets the banks optimal standard. Alternative 2 provides banks on both sides of the stream that match the horizontal profile of the existing stream and banks and would be constructed to not hinder use by riverine wildlife. In addition, Alternative 2 meets the optimal standard of providing sufficient headroom for wildlife.

3.2.3 Alternative 3

Alternative 3 improves hydraulic capacity of the culvert and generally maintains the upstream water elevation during the 100-year event. Downstream water levels may increase marginally during the 100-year precipitation event; however, buildings are unlikely to be impacted by this level of increase. By constructing a stream channel within the open-bottom culvert that resembles the geometry of the stream channel upstream and downstream, the upstream water level will be maintained during low flow, dry-weather conditions. Alternative 3 is suited to provide improved habitat connection and preserve existing upstream habitat.

With respect to the Massachusetts Stream Crossing Standards, Alternative 3:

- Meets the structure type general standard. Alternative 3 is an open-bottom structure.
- The embedment standard does not apply. Alternative 3 is an open-bottom structure.
- Does not meet the crossing span general or optimal standards. The diameter of Alternative 3 is 1.14 x the stream's bankfull width of 7 feet (optimal standard would be 8.4 feet or 1.2 x bankfull width).
- Meets the substrate general and optimal standards. Alternative 3 would be filled with substrate that matches that of the stream.

- Meets the water depth and velocity optimal standard.
- Meets the openness general standard. The openness of Alternative 3 is 0.94 feet.
- Meets the banks general standard. Alternative 3 provides banks on both sides of the stream that match the horizontal profile of the existing stream and banks and would be constructed to not hinder use by riverine wildlife. In addition, Alternative 2 meets the optimal standard of providing sufficient headroom for wildlife.

4. RECOMMENDED REPLACEMENT ALTERNATIVE

Based upon the design considerations and hydraulic calculations, the recommended culvert replacement is Alternative 3. Please refer to Figure 6 for a conceptual culvert section.

In Section 3, all alternatives were evaluated to determine the ability to meet the "Replacing or Retrofitting Crossings" section of the latest version of the Massachusetts River and Stream Crossing Standards. There are no practicable and substantially equivalent economic alternatives to the proposed project to meet all of the general standards of the Massachusetts River and Stream Crossing Standards, while maintaining upstream habitat. The proposed alternative was designed to comply with the Massachusetts River and Stream Crossing Standards for culvert replacement projects to the extent practicable. In addition, energy dissipation measures will be included at the culvert outlet to prevent scour.

5. CONCEPTUAL SEQUENCE OF CONSTRUCTION

Plans depicting erosion control measures, proposed grading, and other features for the project are currently under development. The anticipated sequence of construction is as follows:

1. Install temporary erosion and sedimentation control measures, including cofferdam, flow diffuser, and/or flow diversion;
2. Protection of existing utilities, including water, natural gas, and telecommunications;
3. Remove and dispose of the existing culvert, headwalls, and emergency repair gabions and riprap up to approximately the roadway centerline, maintaining alternating one-way traffic with flaggers;
4. Install new culvert and headwall;
5. Reconstruct road to approximate centerline;
6. Repeat steps 3 through 5 for the remaining side of Marlboro Road;
7. Stabilize side slopes;
8. Install erosion control matting, loam, and seed on all disturbed areas; and
9. Remove temporary erosion and sedimentation control measures and cofferdam.

6. ATTACHMENTS

Figures

Figure 1 – Site Location Map

Figure 2 – Project Area

Figure 3 – Project Area Terrain

Figure 4 – Project Area Land Cover

Figure 5 – Project Area Soil Map

Figure 6 – Replacement Culvert Concept

Attachments

Attachment A – Existing Conditions Survey

Attachment B – Wetland Resource Evaluation

Attachment C – Geotechnical Evaluation

Attachment D – FEMA FIRMETTE

Attachment E – Culvert Analysis Report

7. REFERENCES

Environmental Protection Agency Storm Water Management Model User's Manual, Version 5.1. Revised September 2015.

Extreme Precipitation in New York & New England, Northeast Regional Climate Center, Extreme Precipitation Tables obtained October, 2019

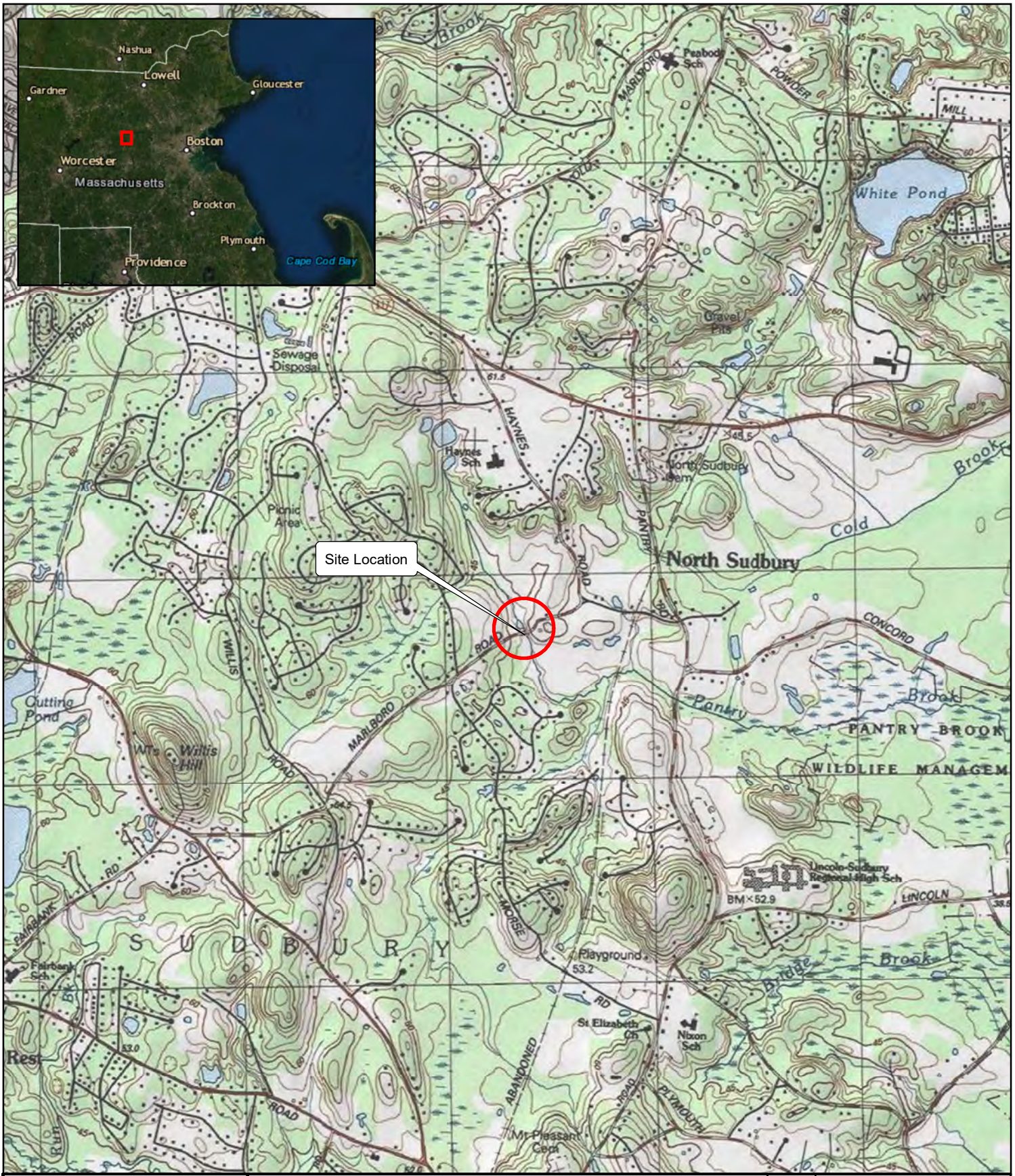
Soil Survey Geographic (SSURGO) database for Middlesex County, Massachusetts," Natural Resources Conservation Service Web Soil Survey, accessed online October, 2019.

Topobathymetric Model for the New England Region: States of New York, Connecticut, Rhode Island, and Massachusetts, 1887 to 2016. Accessed electronically October, 2019.

FEMA FIRM Panel 25017CO0366F

Massachusetts River and Stream Crossing Standards, River & Stream Continuity Partnership

Figure 1: Site Location Map



0 0.1 0.2 0.3 0.4 0.5 Miles

MARLBORO ROAD - PANTRY BROOK CULVERT REPLACEMENT

MARLBORO ROAD
SUDBURY, MA

FIGURE 1 - SITE LOCATION MAP

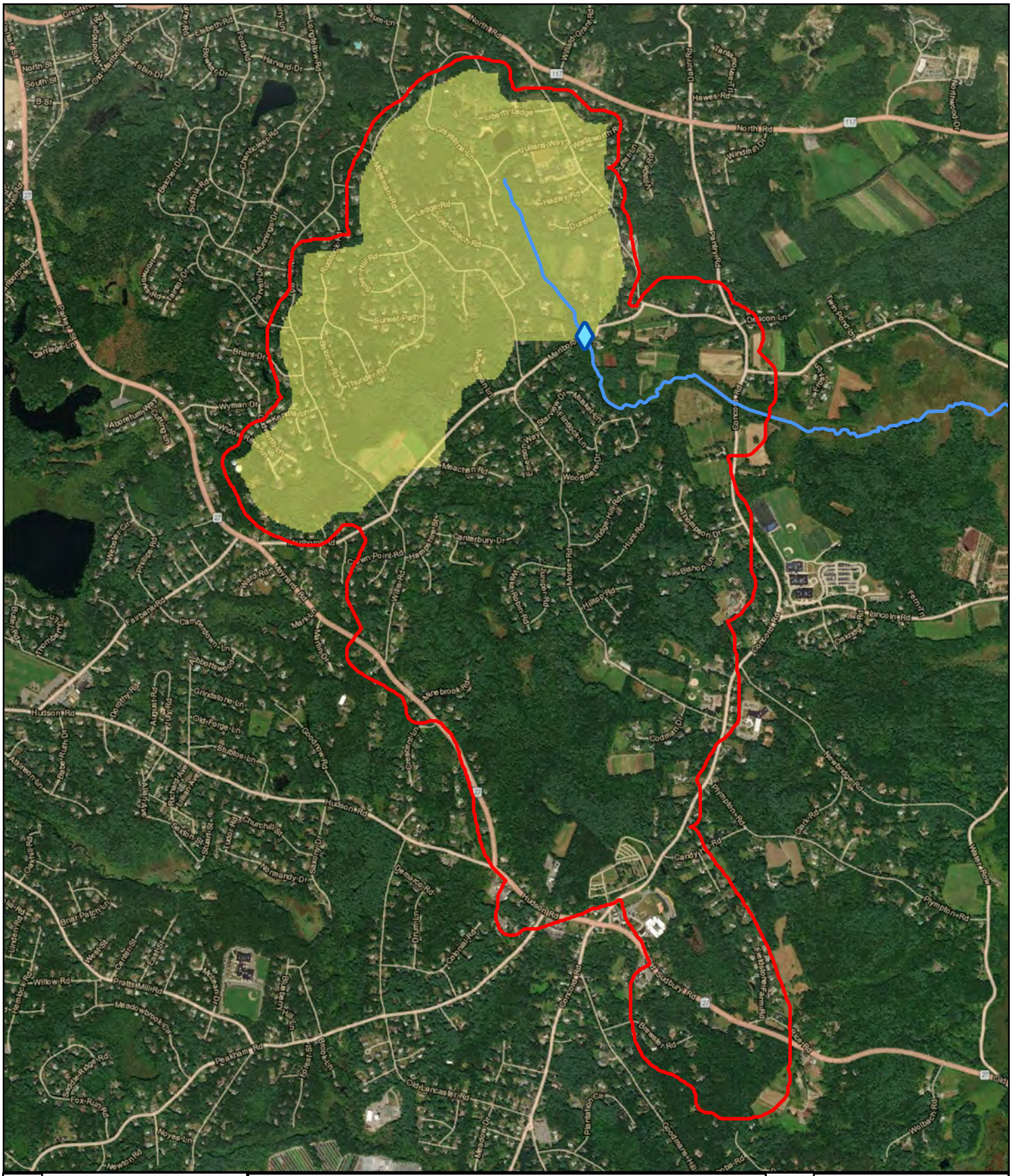
N

WOODARD &CURRAN

Project #: 0227202.06
Map Created: February 2020

Figure Exported: 2/6/2020 By: staylin Using: \\woodardcurran.net\shared\Projects\0227202.06 Sudbury MA - Marlboro Rd Culvert Replace\wip\GIS\Projects\Marlboro Road Site Location.mxd

Figure 2: Project Area



MARLBORO ROAD - PANTRY BROOK CULVERT REPLACEMENT

MARLBORO ROAD
SUDBURY, MA

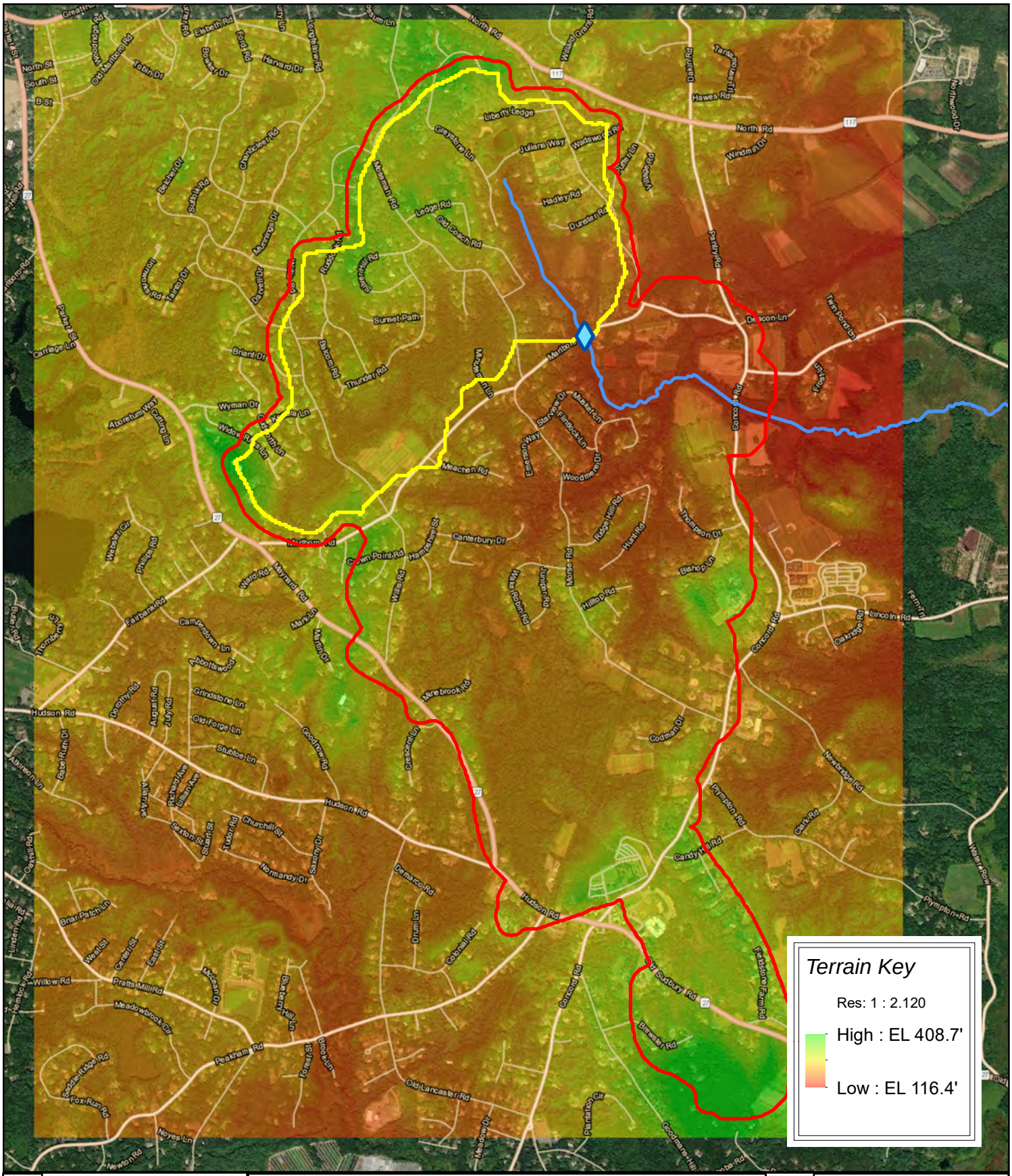
FIGURE 2 - DRAINAGE STUDY MAP

N

WOODARD &CURRAN

Project #: 0227202.06
Map Created: February 2020

Figure 3: Project Area Terrain



Legend

- Marlboro Rd Culvert
- Study Area
- Pantry Brook
- Contributing Area

0 0.1 0.2 0.3 0.4 0.5 Miles

MARLBORO ROAD - PANTRY BROOK CULVERT REPLACEMENT

MARLBORO ROAD
SUDBURY, MA

FIGURE 3 - TERRAIN MAP

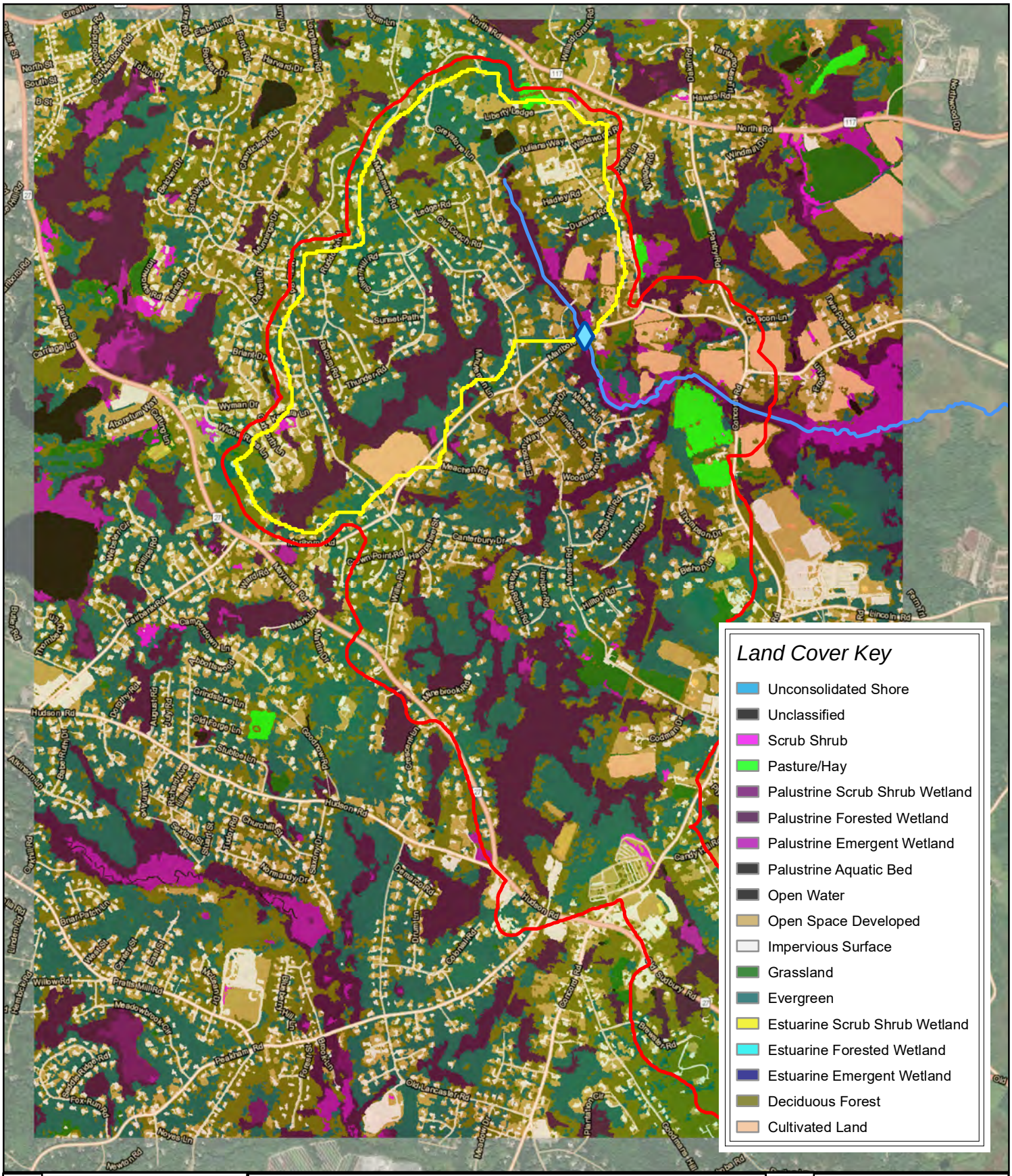
N

WOODARD &CURRAN

Project #: 0227202.06
Map Created: February 2020

Figure Exported: 2/7/2020 By: staylsn Using: \\woodardcurran.net\shared\Projects\0227202.06 Sudbury MA - Marlboro Rd Culvert Replacement\GIS\Projects\Marlboro Road Figures.mxd

Figure 4: Project Area Land Cover



Legend

- Marlboro Rd Culvert
- Study Area
- Pantry Brook
- Contributing Area

0 0.1 0.2 0.3 0.4 0.5 Miles

MARLBORO ROAD - PANTRY BROOK CULVERT REPLACEMENT

MARLBORO ROAD
SUDBURY, MA

FIGURE 4 - LAND COVER MAP

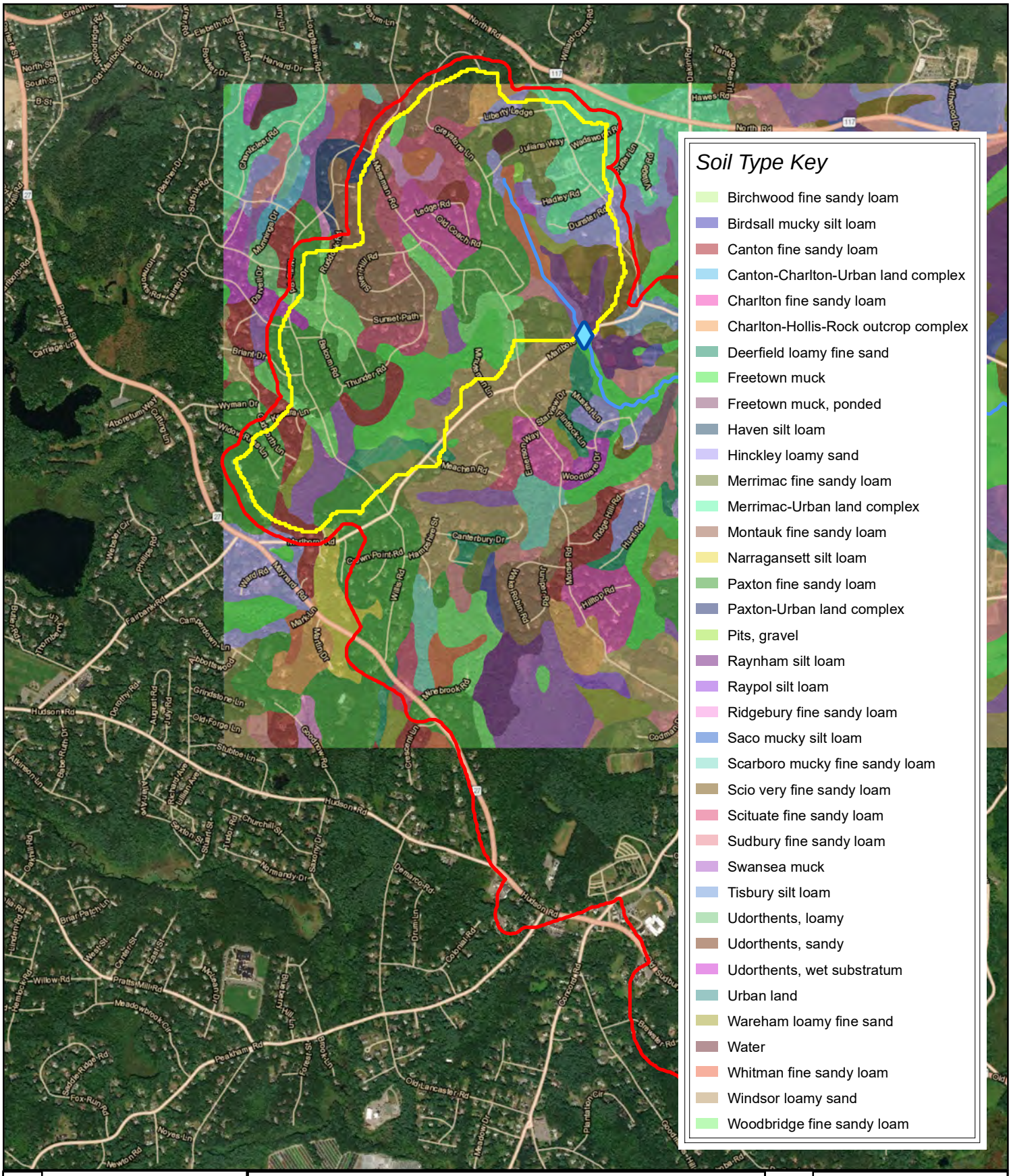
N

WOODARD &CURRAN

Project #: 0227202.06
Map Created: February 2020

Figure Exported: 2/7/2020 By: staylsn Using: \\woodardcurran.net\shared\Projects\0227202.06 Sudbury MA - Marlboro Rd Culvert Replace\wip\GIS\Projects\Marlboro Road Figures.mxd

Figure 5: Project Area Soil Map



Legend

- Marlboro Rd Culvert
- Study Area
- Pantry Brook
- Contributing Area

0 0.1 0.2 0.3 0.4 0.5 Miles

MARLBORO ROAD - PANTRY BROOK CULVERT REPLACEMENT

MARLBORO ROAD
SUDBURY, MA

FIGURE 5 - SOIL MAP

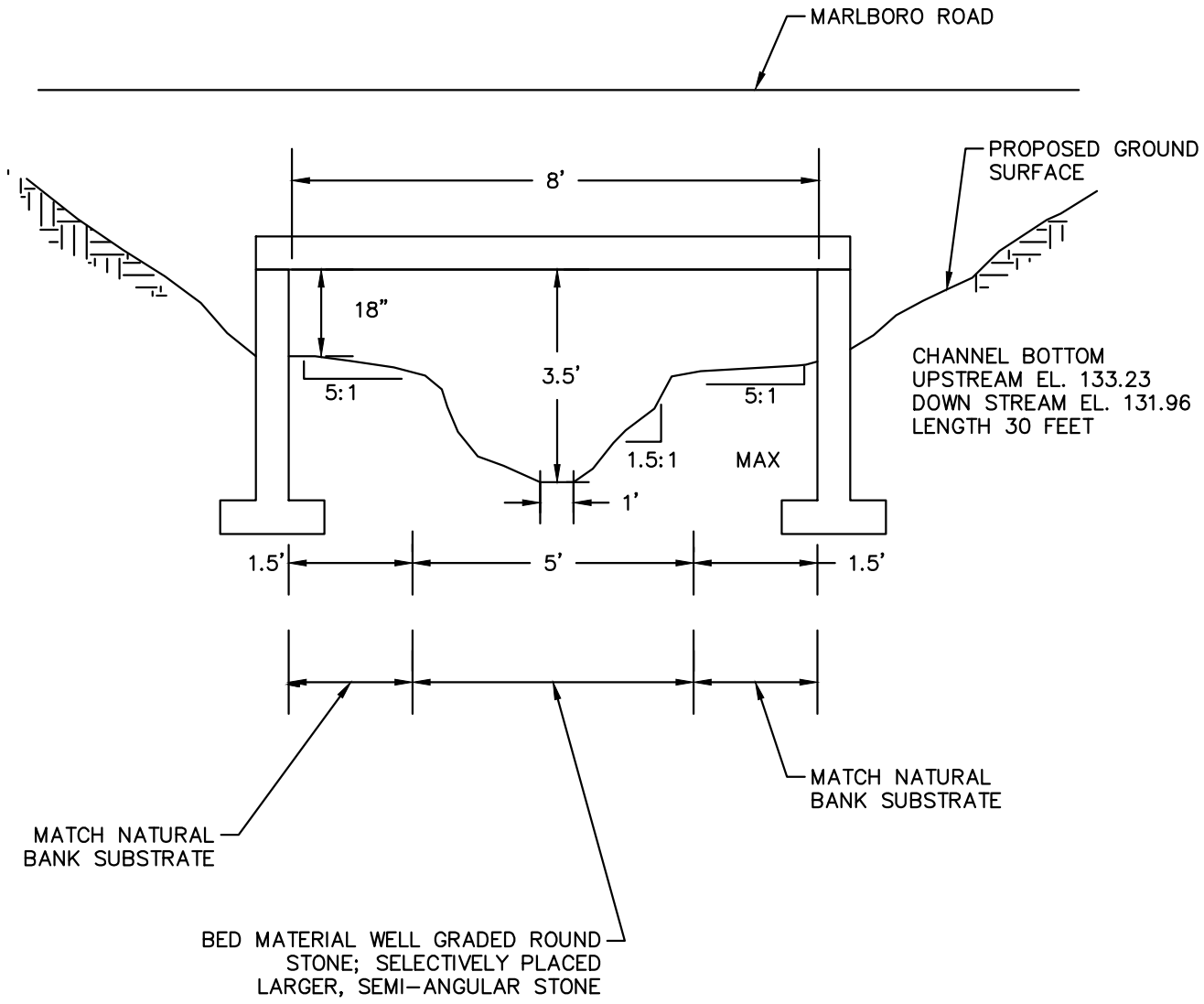
N

WOODARD &CURRAN

Project #: 0227202.06
Map Created: February 2020

Figure Exported: 2/7/2020 By: staylsn Using: \\woodardcurran.net\shared\Projects\0227202.06 Sudbury MA - Marlboro Rd Culvert Replacewip\GIS\Projects\Marlboro Road Figures.mxd

Figure 6: Replacement Culvert Concept



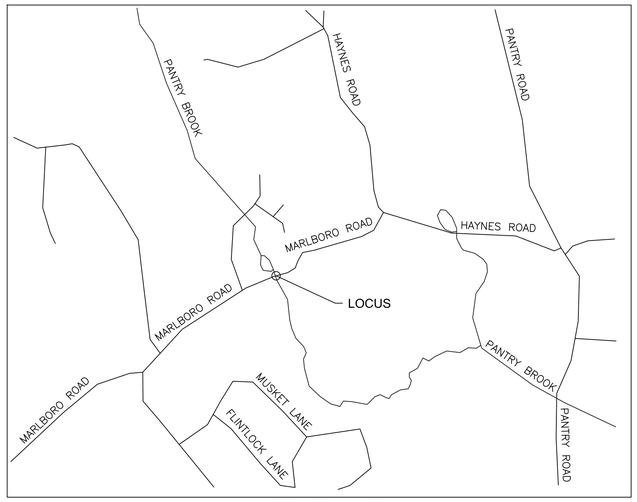
PROPOSED CULVERT CONCEPT

NOT TO SCALE

WOODARD &CURRAN
41 Hutchins Drive
Portland, Maine 04102
800.426.4262 | www.woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

CULVERT CONCEPT		TOWN OF SUDBURY, MA 275 OLD LANCASTER ROAD SUDBURY, MA.	JOB NO: 227202.06 DATE: FEBRUARY 2020 SCALE: AS NOTED
DESIGNED BY: KJT	CHECKED BY: DSS	MARLBORO ROAD CULVERT CONCEPT	FIGURE 6
DRAWN BY: PF	CULVERT DETAIL.dwg		

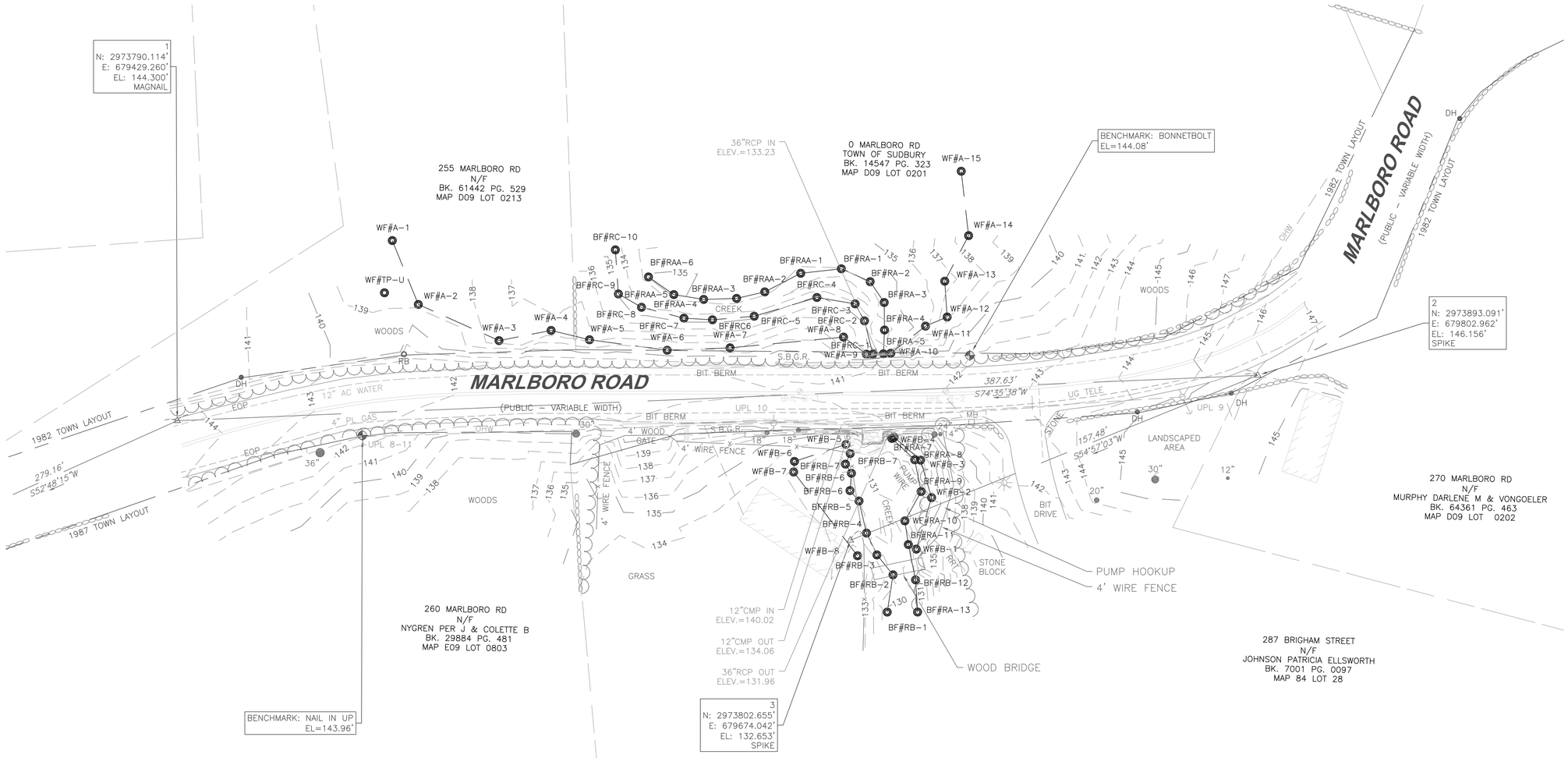
ATTACHMENT A: EXISTING CONDITIONS SURVEY



LOCUS MAP

GENERAL NOTES:

1. THE EXISTING CONDITIONS INFORMATION SHOWN HEREON IS THE RESULT OF AN ON-THE-GROUND SURVEY PERFORMED BY CHAPPELL ENGINEERING ASSOCIATES, LLC., BETWEEN AUGUST 20TH – 22ND, 2019.
2. ALL DEED/PLAN REFERENCES ARE TO MIDDLESEX REGISTRY OF DEEDS SOUTHERN DISTRICT.
3. THE PROJECT AREA IS LOCATED IN FLOOD ZONE "AE" AS SHOWN ON FLOOD INSURANCE RATE MAP FOR THE TOWN OF SUDBURY, COMMUNITY PANEL NUMBER 25017C 0366 F, EFFECTIVE DATE JULY 6, 2014.
4. PROPERTY DOES NOT RESIDE IN A WATER RESOURCE PROTECTION DISTRICT.
5. PORTION OF PROPERTY DOES RESIDE IN MUNICIPAL OPEN SPACE BARTON FARMS CONSERVATION AREA. ZONING DISTRICT RESIDENCE A.
6. LOCATION OF SUBSURFACE UTILITIES SHOWN HEREON ARE APPROXIMATE AND ADDITIONAL UTILITIES MAY EXIST THAT ARE NOT SHOWN ON THIS PLAN. LOCATIONS ARE COMPILED FROM UTILITY PLANS OF RECORD AND DIG-SAFE FIELD MARKINGS. RIM AND INVERT INFORMATION HAS BEEN FIELD VERIFIED WHERE POSSIBLE. THIS INFORMATION IS NOT TO BE USED FOR CONSTRUCTION. PRIOR TO ANY CONSTRUCTION, CONTACT DIG-SAFE (1-800-344-7233) TO FIELD VERIFY LOCATION OF ALL UTILITIES.
7. PLAN REFERENCES: (PLAN NO, / PLAN YEAR)
   183-4 OF 1982 14 OF 1987 312 OF 2012 268 OF 2018
8. BORDERING WETLAND LOCATION FLAGS SET BY ECHOTEC, LLC. ON AUGUST 15TH, 2019.
9. HORIZONTAL DATUM: NAD 83 MASS STATE PLANE MAINLAND ZONE HORIZONTAL CONTROL SYSTEM.
10. VERTICAL DATUM: NAVD 88 VERTICAL CONTROL SYSTEM.



NAD 83

SCALE 1" = 20'

0 10' 20' 40' 60'

- STREET R.O.W. LINE
- ABUTTER PROPERTY LINE
- EASEMENT LINES
- EDGE OF PAVEMENT
- IRON HAND RAIL
- CHAIN-LINK FENCE
- PAINTED TRAFFIC LINES
- OVERHEAD WIRES
- GUARD RAIL
- DRAIN MANHOLE
- SEWER MANHOLE
- CATCH BASIN
- FIRE HYDRANT
- WATER GATE
- GUY WIRE
- LIGHT POLE
- UTILITY POLE
- TREE
- MONUMENT
- IRON PIN SET
- SIGN
- CONCRETE
- WF#A-14 BORDERING VEGETATIVE WETLAND FLAG

LEGEND

REVISIONS		
1		
0		
REV. #	DATE	DESCRIPTION

PROJECT NO.	DRAWN BY: MLT	SCALE:
XXXXX	CHECK'D BY: TPC	1" = 20'

EXISTING CONDITIONS SURVEY

MARLBORO ROAD,
SUDBURY, MASSACHUSETTS

CHAPPELL ENGINEERING ASSOCIATES, LLC
Civil Structural Land Surveying
201 BOSTON POST ROAD WEST-SUITE 101
MARLBOROUGH, MA 01752
TEL (508) 481-7400

SEPTEMBER 17, 2019

SHEET 1 OF 1

ATTACHMENT B: WETLAND RESOURCE EVALUATION

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 – Fax: 508-752-9494

September 12, 2019

Darrin B. Stairs, PE
Woodard & Curran, Inc.
41 Hutchins Drive
Portland, ME 04102

RE: Wetland Resource Evaluation, Marlboro Road Culvert, Sudbury, MA

Dear Darrin:

On August 15, 2019, EcoTec, Inc. inspected the above-referenced property for the presence of wetland resources as defined by: (1) the Massachusetts Wetlands Protection Act (M.G.L. Ch. 131, § 40; the "Act") and its implementing regulations (310 CMR 10.00 *et seq.*; the "Regulations"); and (2) the U.S. Clean Water Act (i.e., Section 404 and 401 wetlands). Arthur Allen, CPSS, CWS conducted the inspection.

The subject site consists of the vicinity of an existing culvert carrying Pantry Brook under Marlboro Road in Sudbury. The upland portions of the site consist of a public roadway and wooded road shoulder slopes. The wetland resources observed on the site are described below.

Methodology

The site was inspected, and areas suspected to qualify as wetland resources were identified. The boundary of Bordering Vegetated Wetlands was delineated in the field in accordance with the definition set forth in the regulations at 310 CMR 10.55(2)(c). Section 10.55(2)(c) states that "The boundary of Bordering Vegetated Wetlands is the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist." The methodology used to delineate Bordering Vegetated Wetlands is further described 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. The plant taxonomy used in this report is based on the *National List of Plant Species that Occur in Wetlands: Massachusetts* (Fish and Wildlife Service, U.S. Department of the Interior, 1988). Federal wetlands were presumed to have boundaries conterminous with the delineated Bordering Vegetated Wetlands. One set of DEP Bordering Vegetated Wetland Delineation Field Data Forms completed for observation plots located in the wetlands and uplands near flag A-2

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

Flag Numbers	Flag Type	Wetland Types and Locations
A1 to A15 (Test Plots at A-2)	Blue Flags	Boundary of Bordering Vegetated Wetlands located in the central portion of the site that is associated with a perennial stream located to the North.
B1 to B8 (Water Pump in stream between B-2 and B-3)	Blue Flags	Boundary of Bordering Vegetated Wetlands located in the central portion of the site that is associated with a perennial stream located to the South.
RA1 to RA13 (RA-6 Connect to Culvert) (RA-7 Connect to Culvert) (Water Pump Near RA-8)	Red Flags	Mean Annual High-water Line (MAHWL) of Pantry Brook located in the central portion of the site.
RA1 to RAA6	Red Flags	Mean Annual High-water Line (MAHWL) of Pantry Brook located in the central portion of the site.
RB1 to RB7 (RB-7 Connect to Riprap)	Red Flags	Mean Annual High-water Line (MAHWL) of Pantry Brook located in the central portion of the site.
RC1 to RC10 (RC-1 Connect to Culvert)	Red Flags	Mean Annual High-water Line (MAHWL) of Pantry Brook located in the central portion of the site.

Findings

Wetland A/B consists of a wooded swamp fringing on a marsh and wet meadow that is associated with a perennial stream (i.e., Pantry Brook). Plant species observed include red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), gray birch (*Betula populifolia*), and American elm (*Ulmus americana*) trees and/or saplings; poison ivy (*Toxicodendron radicans*) climbing woody vines; highbush blueberry (*Vaccinium corymbosum*), common winterberry (*Ilex verticillata*), arrow-wood (*Viburnum dentatum*), withe-rod (*Viburnum cassinoides*), swamp rose (*Rosa palustris*), speckled alder (*Alnus rugosa*), silky dogwood (*Cornus amomum*), maleberry (*Lyonia ligustrina*), glossy buckthorn (*Rhamnus frangula*), sweet pepper-bush (*Clethra alnifolia*), swamp azalea (*Rhododendron viscosum*), and American elderberry (*Sambucus canadensis*) shrubs; and sheep-laurel (*Kalmia angustifolia*), bristly blackberry (*Rubus hispidus*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), subarctic lady fern (*Athyrium filix-femina*), marsh fern (*Thelypteris thelypteroides*), Massachusetts fern (*Thelypteris simulata*), spinulose woodfern (*Dryopteris spinulosa*), skunk-cabbage (*Symplocarpus foetidus*), swamp Jack-in-the-pulpit (*Arisaema triphyllum*), spotted touch-me-not (*Impatiens capensis*) and sphagnum moss (*Sphagnum sp*.) ground cover. Evidence of wetland hydrology, including hydric soils, high groundwater, saturated soils, pore linings, evidence of flooding, and drainage patterns, was observed within the delineated wetland. This vegetated wetland borders a perennial stream; accordingly, the vegetated wetlands would be regulated as Bordering Vegetated Wetlands and the perennial stream would be regulated as Bank and Land Under Water Bodies and Waterways under the Act. A 100-foot Buffer Zone extends horizontally outward from the edge of Bordering Vegetated Wetlands under the Act.

Bordering Land Subject to Flooding is an area that floods due to a rise in floodwaters from a bordering waterway or water body. Where flood studies have been completed, the boundary of Bordering Land Subject to Flooding is based upon flood profile data prepared by the National Flood Insurance Program. Section 10.57(2)(a)3. states that "The boundary of Bordering Land Subject to Flooding is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm." The project engineer should evaluate the most recent National Flood Insurance Program flood profile data to determine the extent and elevation of the Bordering Land Subject to Flooding that occurs on the site. Bordering Land Subject to Flooding would occur in areas where the 100-year flood elevation is located outside of or upgradient of the delineated Bordering Vegetated Wetlands boundary. Bordering Land Subject to Flooding does not have a Buffer Zone under the Act.

The Massachusetts Rivers Protection Act amended the Act to establish an additional wetland resource area: Riverfront Area. Based upon a review of the current USGS Map (attached), a stream (i.e., Pantry Brook) that is shown as perennial is located within the delineated wetland. Streams that are shown as perennial on the current USGS map are designated perennial under the Massachusetts Wetlands Protection Act regulations. Unless this perennial designation is overcome, Riverfront Area is presumed to extend 200 feet horizontally upgradient from the mean annual high-water line of the stream. Section 10.58(2)(a)2. states that the "Mean annual high-water line of a river is the line that is apparent from visible markings or changes in the character of soils or vegetation due to prolonged presence of water and that distinguishes between predominantly aquatic and predominantly terrestrial land. Field indicators of bankfull conditions shall be used to determine the mean annual high-water line. Bankfull field indicators include but are not limited to: changes in slope, changes in vegetation, stain lines, top of pointbars, changes in bank materials, or bank undercuts." Section 10.58(2)(a)2.a. states that "In most rivers, the first observable break in slope is coincident with bankfull conditions and the mean annual high-water line." The mean annual high-water line of the stream was delineated in the field with flag series RA, RB ad RC based upon the above-referenced regulation. Furthermore, based upon a review of the current USGS Map and observations made during the site inspection, there are no other mapped or unmapped streams located within 200 feet of the site. Accordingly, except as noted above, Riverfront Area would not occur on the site. Riverfront Area does not have a Buffer Zone under the Act, but may overlap other wetland resources and their Buffer Zones.

The Regulations require that no project may be permitted that will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures set forth at 310 CMR 10.59. Based upon a review of the *Massachusetts Natural Heritage Atlas*, 14th edition, Priority Habitats and Estimated Habitats from the NHESP Interactive Viewer, valid from August 1, 2017, and Certified Vernal Pools from MassGIS, there are no Estimated Habitats [for use with the Act and Regulations (310 CMR 10.00 *et seq*.)], Priority Habitats [for use with Massachusetts Endangered Species Act (M.G.L. Ch. 131A; "MESA") and MESA Regulations (321

CMR 10.00 *et seq*.)], or Certified Vernal Pools on or in the immediate vicinity of the site. A copy of this map is attached.

The reader should be aware that the regulatory authority for determining wetland jurisdiction rests with local, state, and federal authorities. A brief description of my experience and qualifications is attached. If you have any questions, please feel free to contact me at any time.

Cordially,
ECOTEC, INC.

Arthur Allen, CWS, CPSS
Vice President

Attachments (5, 8 pages)

AA/NOI/Sudbury Marlboro EcoTec Wet Report 9.12.2019

EcoTec, Inc.

ENVIRONMENTAL CONSULTING SERVICES
102 Grove Street
Worcester, MA 01605-2629
508-752-9666 / Fax: 508-752-9494

Arthur Allen, CPSS, CWS, CESSWI
Vice President
Soil & Wetland Scientist

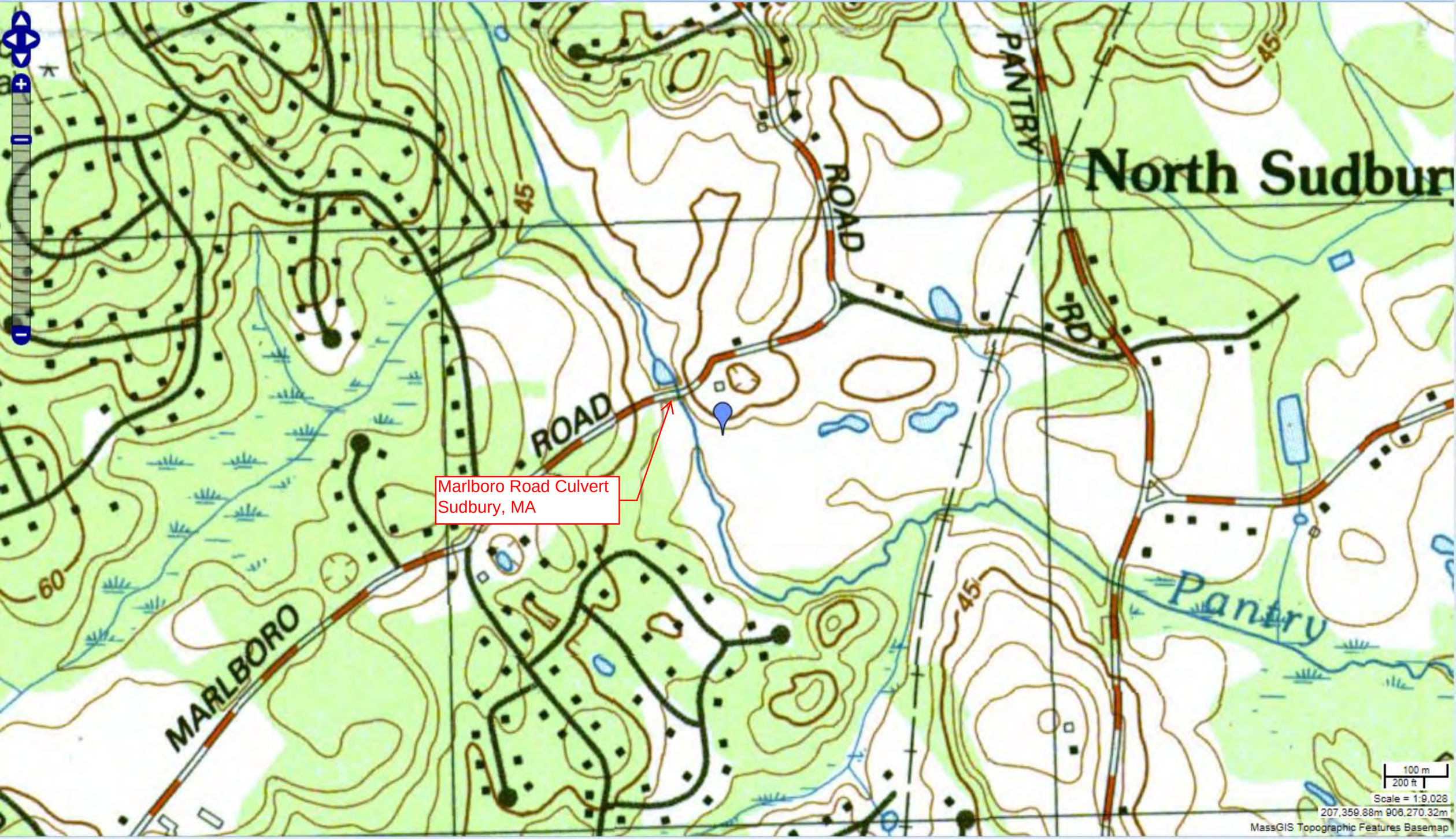
Arthur Allen is the Vice President of EcoTec, Inc. and has been a senior environmental scientist there since 1995. His work with EcoTec has involved wetland delineation, wildlife habitat evaluation, environmental permitting (federal, state and local), environmental monitoring, expert testimony, peer reviews, contaminated site assessment and the description, mapping and interpretation of soils. His clients have included private landowners, developers, major corporations and regulatory agencies. Prior to joining EcoTec, Mr. Allen mapped and interpreted soils in Franklin County, MA for the U.S.D.A. Natural Resources Conservation Service (formerly Soil Conservation Service) and was a research soil scientist at Harvard University's Harvard Forest. Since 1994, Mr. Allen has assisted the Massachusetts Department of Environmental Protection and the Massachusetts Association of Conservation Commissions as an instructor in the interpretation of soils for wetland delineation and for the Title V Soil Evaluator program.

Mr. Allen has a civil service rating as a soil scientist, an undergraduate degree in Natural Resource Studies and a graduate certificate in Soil Studies. His work on the Franklin County soil survey involved interpretation of landscape-soil-water relationships, classifying soils and drainage, and determining use and limitation of the soil units that he delineated. As a soil scientist at the Harvard Forest, Mr. Allen was involved in identifying the legacies of historical land-use in modern soil and vegetation at a number of study sites across southern New England. He has a working knowledge of the chemical and physical properties of soil and water and how these properties interact with the plants that grow on a given site. While at Harvard Forest he authored and presented several papers describing his research results which were later published. In addition to his aforementioned experience, Mr. Allen was previously employed by the Trustees of Reservations as a land manager and by the Town of North Andover, MA as a conservation commission intern.

Education:
1993-Graduate Certificate in Soil Studies, University of New Hampshire
1982-Bachelor of Science in Natural Resource Studies, University of Massachusetts

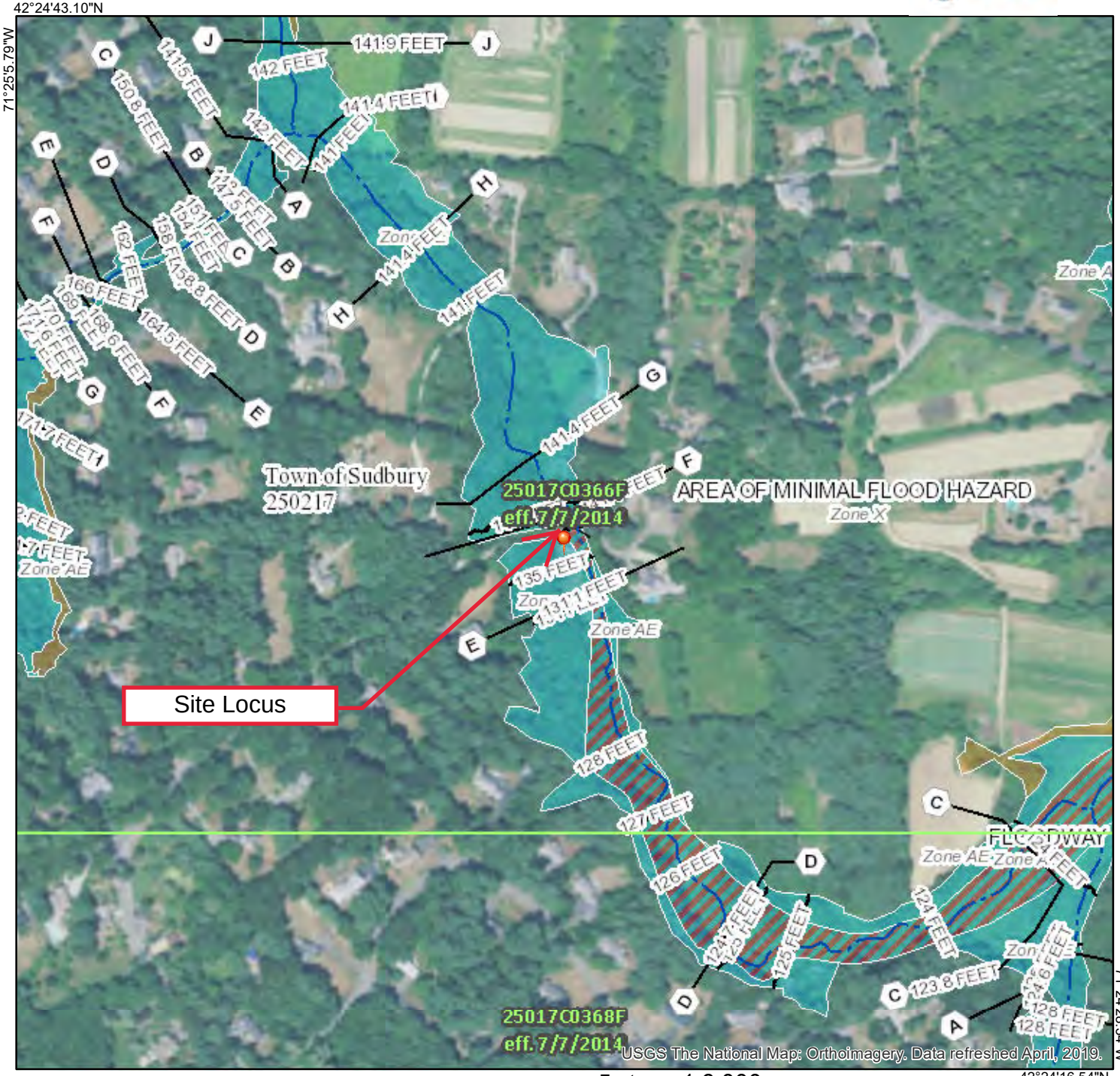
Professional Affiliations:
Certified Professional Soil Scientist (ARCPACS CPSS #22529)
New Hampshire Certified Wetland Scientist (#19)
Registered Professional Soil Scientist – Society of Soil Scientists of SNE [Board Member (2000-2006)]
Certified Erosion, Sediment & Stormwater Inspector (#965)
Massachusetts Approved Soil Evaluator (#13764)
Massachusetts Arborists Association-Certified Arborist (1982 – 1998)
New England Hydric Soils Technical Committee member
Massachusetts Association of Conservation Commissions member
Society of Wetland Scientists member

Refereed Publications:
Soil Science and Survey at Harvard Forest. A.Allen. *In*: Soil Survey Horizons. Vol. 36, No. 4, 1995, pp. 133-142.
Controlling Site to Evaluate History: Vegetation Patterns of a New England Sand Plain. G.Motzkin, D.Foster, A.Allen, J.Harrod, & R.Boone. *In*: Ecological Monographs 66(3), 1996, pp. 345-365.
Vegetation Patterns in Heterogeneous Landscapes: The Importance of History and Environment. G.Motzkin, P.Wilson, D.R.Foster & A.Allen. In: Journal of Vegetation Science 10, 1999, pp. 903-920.


Marlboro Road Culvert
Sudbury, MA
MARLBORO
ROAD
ROAD
PANTRY
RD
North Sudbur
Pantry
45
45
45
60
100 m
200 ft
Scale = 1:9,028
207,359.88m 906,270.32m
MassGIS Topographic Features Basemap

National Flood Hazard Layer FIRMette

FEMA



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
  - 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

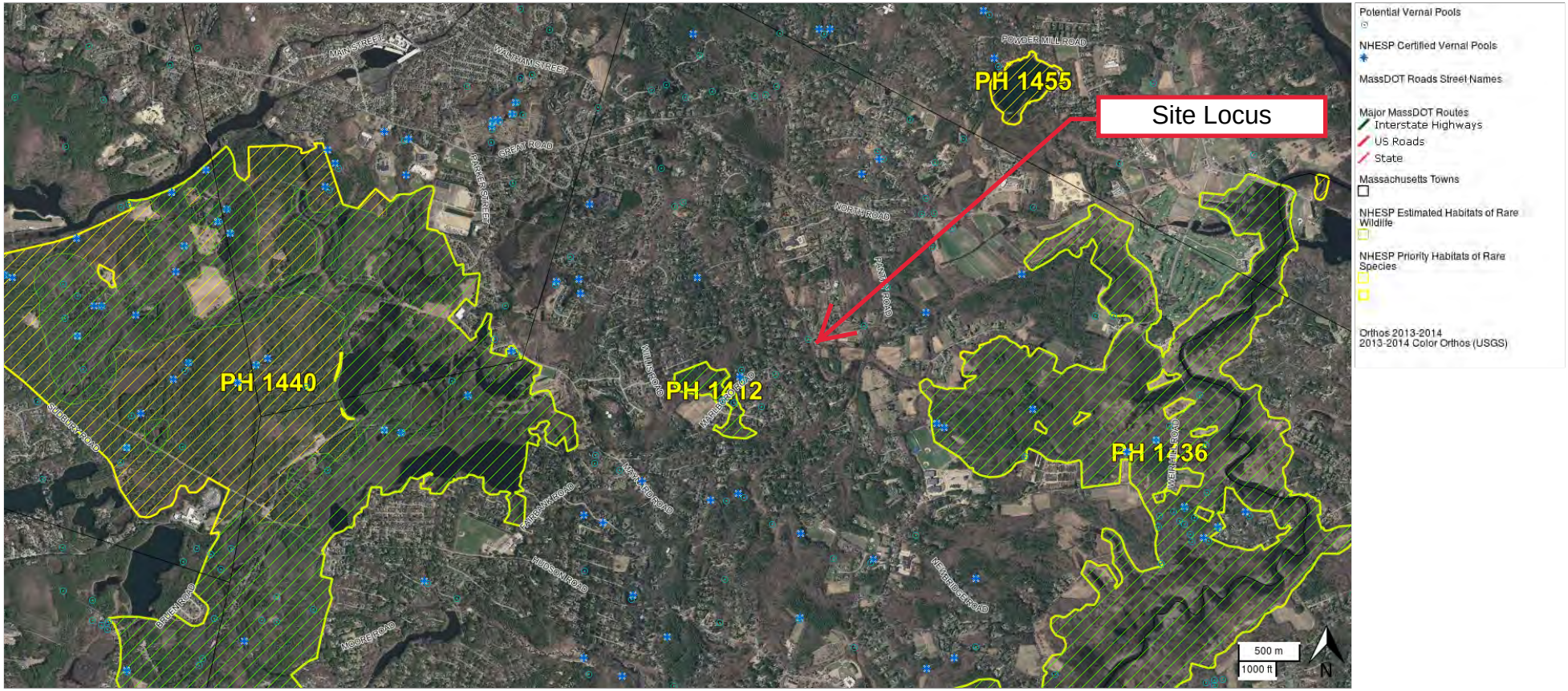
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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 8/12/2019 at 1:38:21 PM 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.

NHESP Map 1_Marlboro Rd. Culvert Sudbury, Ma



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

Applicant | Prepared by: EcoTec, Inc | Project Location: Marlborough Rd. Sudbury | DEP File #

Section I. Vegetation | Number: TP-Upland | Transect # A-2 | Date of Delin: 8.15.19

A. Sample layer and plant species (Enter largest to smallest % cover by layer)			Percent Cover (or basal area)	Percent Dominance	Dominant Plant?	Wetland Indicator Category	
Tree	red maple	Acer rubrum	40	40.0	YES	FAC	*
	red oak	Quercus rubra	30	30.0	YES	FACU-	
	white pine	Pinus strobus	30	30.0	YES	FACU	
Sapling							
Shrub	glossy buckthorn	Rhamnus frangula	30	50.0	YES	FAC	*
	highbush blueberry	Vaccinium corymbosum	20	33.3	YES	FACW-	*
	winterberry	Ilex verticillata	10	16.7	NO	FACW+	*
Ground	poison ivy	Toxicodendron radicans	20	40.0	YES	FAC	*
	virginia creeper	Parthenocissus quinquefolia	10	20.0	YES	FACU	
	meadow rue	Thalictrum dioicum	10	20.0	YES	FAC	*
	jewelweed	Impatiens capensis	5	10.0	NO	FACW	*
	sensitive fern	Onoclea sensibilis	5	10.0	NO	FACW	*
Vine							

Vegetation Conclusions

Number of dominant wetland indicator plants **5** | Number of dominant non-wetland indicator plants **3**

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

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

Applicant		Prepared by: EcoTec, Inc	Project Location: Marlborough Rd. Sudbury	DEP File #
Section II. Indicators of Hydrology	Number: TP-Upland		Transect # A-2	Date of Delin: 8.15.19

1. Soil Survey

Is there a published soil survey for this site?

- title/date
- map number
- soil type mapped
- hydric soil inclusions

Are field observarions consistent with soil survey?

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottle Color
Litter	1		
O	2-0		
A	0-8	10YR2/2	
Bw	8-15	10YR4/6	10%b 7.5Y4/4

Remarks Loamy sandys

3. Other

Conclusion: Is the soil hydric? No

Other Indicators of hydrology (check all that apply):

- ☐ 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 BVWs
- ☐ Oxidized rhizospheres
- ☐ Water stained leaves
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ number of non-wetland indicator plants	☑	☐
Wetland hydrology present:		
Hydric soil present	☐	☑
Other indicators of hydrology present	☐	☑
Sample Location is in a BVW	☐	☑

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

Applicant | Prepared by: EcoTec, Inc | Project Location: Marlborough Rd. Sudbury | DEP File #

Section I. Vegetation | Number: TP-Wetland | Transect # A-2 | Date of Delin: 8.15.19

A. Sample layer and plant species (Enter largest to smallest % cover by layer)			Percent Cover (or basal area)	Percent Dominance	Dominant Plant?	Wetland Indicator Category	
Tree	red maple	Acer rubrum	90	81.8	YES	FAC	*
	white pine	Pinus strobus	10	9.1	NO	FACU	
	american elm	Ulmus americana	10	9.1	NO	FACW-	*
Sapling	red maple	Acer rubrum	20	100.0	YES	FAC	*
Shrub	glossy buckthorn	Rhamnus frangula	30	37.5	YES	FAC	*
	highbush blueberry	Vaccinium corymbosum	30	37.5	YES	FACW-	*
	winterberry	Ilex verticillata	20	25.0	YES	FACW+	*
Ground	poison ivy	Toxicodendron radicans	20	50.0	YES	FAC	*
	skunk cabbage	Symplocarpus foetidus	10	25.0	YES	OBL	*
	jewelweed	Impatiens capensis	10	25.0	YES	FACW	*
Vine							

Vegetation Conclusions

Number of dominant wetland indicator plants **8** | Number of dominant non-wetland indicator plants **0**

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

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

Applicant		Prepared by: EcoTec, Inc	Project Location: Marlborough Rd. Sudbury	DEP File #
Section II. Indicators of Hydrology	Number: TP-Wetland		Transect # A-2	Date of Delin: 8.15.19

1. Soil Survey

Is there a published soil survey for this site?

title/date

map number

soil type mapped

hydric soil inclusions

Are field observarions consistent with soil survey?

Remarks:

2. Soil Description

Horizon	Depth (inches)	Matrix Color	Mottle Color
litter	1		
O	3-0		
A	0-12	10YR2/1	
Bg	12-18	10YR5/2	10%7.5YR4/6

Remarks A: Mucky loam Bg: stony loam

3. Other

Conclusion: Is the soil hydric? Yes

Other Indicators of hydrology (check all that apply):

- ☐ Site Inundated
- ☐ Depth to free water in observation hole
- ☑ Depth to soil saturation in observation hole 6"
- ☐ Water marks
- ☐ Drift lines
- ☐ Sediment Deposits
- ☐ Drainage patterns in BVWs
- ☐ Oxidized rhizospheres
- ☐ Water stained leaves
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other):
- ☐ Other:

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ number of non-wetland indicator plants	☑	☐
Wetland hydrology present:		
Hydric soil present	☑	☐
Other indicators of hydrology present	☑	☐
Sample Location is in a BVW	☑	☐

ATTACHMENT C: GEOTECHNICAL EVALUATION

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CONSTRUCTION MANAGEMENT

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Bedford, NH 03110
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www.gza.com

MEMORANDUM

To: Mr. Darrin Stairs, P.E.
Woodard & Curran, Inc.

From: Mirsad Alihodzic, Project Manager
Bruce W. Fairless, P.E., Principal
GZA GeoEnvironmental, Inc. (GZA)

Date: October 25, 2019

File No: 04.0191011.00

Re: Geotechnical Engineering Memorandum
Marlboro Road Culvert over Pantry Brook
Sudbury, Massachusetts

This memorandum presents the results of the subsurface exploration program performed at the above-referenced site by GZA. The subsurface exploration program was completed in accordance with GZA's Proposal for Geotechnical Services dated May 16, 2019. GZA's objectives were to evaluate subsurface conditions and provide geotechnical recommendations, including bearing capacity, for the proposed culvert replacement. The contents of this report are subject to the **Limitations** contained in **Appendix A** and the Terms and Conditions of our agreement.

BACKGROUND/SITE DESCRIPTION

Based on discussions with you, we understand that the existing 42-inch inside diameter reinforced concrete pipe (RCP) culvert located on Marlboro Road needs to be replaced due to the deteriorating conditions of the RCP pipe. The existing culvert allows Pantry Brook to pass under the roadway and flow downstream to the south. The current culvert spans the width of the roadway and slopes from the north to the south. Based on the survey plan provided to us on August 9, 2019, the typical water elevation of the brook upstream is about Elevation 134 feet, with the pipe invert at about Elevation 133 feet. A stone headwall is located at the north (inlet) side of the culvert, while the south (outlet) side of the culvert is incorporated into the stone retaining wall retaining the road embankment. The roadway currently slopes from the east to the west with an asphalt curb on both sides of the road. The south roadway curb outlets approximately 15 feet to the west of the culvert, and any water collecting near the culvert on the south side of the road flows into a 12-inch-diameter corrugated metal pipe (CMP) which is located in the stone retaining wall and can be seen in **Photograph 1** below.

Water collecting near the culvert on the north side of the roadway follows the roadway curb and outlets approximately 35 feet to the west of the culvert in the existing slope. In this section of the roadway, a guard rail is present on both sides of the road. Multiple utilities are also present under the existing roadway, including: a 12-inch-diameter water line utility along the north side of the roadway, a 4-inch-diameter gas line, and an underground communication line on the south side of the roadway. An overhead utility is also present on the south side of the roadway.

Based on the "Existing Conditions Survey" plan dated September 17, 2019, prepared by Chappell Engineering Associates, LLC of Marlborough, Massachusetts, the culvert appears to be approximately 25 feet long. During our subsurface drilling program, which was completed in August 2019, GZA observed erosion on the south roadway retaining wall slope, as well as pavement cracking following the existing gas line and underground communication utility on the south side of the roadway. The observed pavement cracking, which starts from the gas gate near the driveway of 270 Marlboro Road and can be seen in **Photograph 3**, extends to approximately the area near the overhead utility pole #10 (UPL10) as shown on **Figure 1 – Exploration Location Plan**. Similar slope erosion was observed on the north side of the roadway but was localized around the culvert inlet headwall and the north roadway curb outlet; the observed erosion above and around the inlet and headwall can be seen in **Photograph 2**. Due to the recently observed erosion along the south roadway edge, the Town of Sudbury made repairs at the south side of the roadway in line with, and above, the culvert outlet in August 2019. The repairs included the installation of gabion wire baskets and rip rap stone located west of the culvert, along with re-paving the curb and road in this area. **Photograph 4** below shows the recently installed gabion baskets and rip rap stone.

Photo 1 – Retaining stone wall, RCP outlet and CMP

Photo 2 – Stone headwall and inlet

Photo 3 – Pavement cracking following the utilities

Photo 4 – Installed gabion baskets and rip rap

At this time, two concept options are being considered for the proposed replacement of the culvert:

- Concept 1 is a 10-foot-wide and 6-foot-high precast concrete box culvert, and
- Concept 2 is 10-foot-wide and 5-foot-high, open bottom, precast concrete arch culvert.

Based on our communications with you, we understand that the proposed replacement may or may not include a headwall or wingwalls at this time. With the information provided, we assume that the proposed culvert will be located in the vicinity of the existing culvert, that the headwall upstream will be replaced, and that a retaining wall is being considered on the downstream side to retain the roadway embankment. The footings and/or frost wall of the culvert will likely bear below the frost line.

SUBSURFACE EXPLORATIONS

GZA performed a subsurface exploration program to evaluate subsurface conditions in the vicinity of the existing culvert. New England Boring Contractors (NEBC), of Derry, New Hampshire coordinated utility clearance and performed the test borings on August 14, 2019; boring B-1 extended to a depth of 14.7 feet below ground surface (bgs) and boring B-2 extended to a depth of 22.5 feet bgs. Boring B-1 was drilled in the roadway to the east of the existing culvert and boring B-2 was completed to the west of the existing culvert, also in the roadway.

Boring B-1 was drilled using a truck-mounted drill rig with 4.25-inch outside-diameter hollow stem augers. Standard Penetration Testing and split-spoon sampling was performed continuously for the first 10 feet and then at 5-foot intervals to a depth of 14.7 feet, whereupon refusal was encountered in probable bedrock. Boring B-2 was drilled using a truck-mounted drill rig with 4-inch outside-diameter steel casing and drive-and-wash methods. Standard Penetration Testing and split-spoon sampling was performed continuously for the first 10 feet and then at 5-foot intervals to a depth of 17 feet, whereupon a bedrock core was collected from 17.5 feet to 22.5 feet bgs. Samples were classified in accordance with the Modified Burmister System. The test borings were backfilled with drill cuttings upon the completion of the drilling. GZA field personnel monitored the drilling work and prepared the test boring logs which are included in **Appendix B.**

GZA field personnel located the test borings by tape measurements from prominent site features. The approximate locations of the test borings are shown on **Figure 1 – Exploration Location Plan**.

GENERALIZED SUBSURFACE CONDITIONS

Based on the completed test borings, subsurface conditions at the site consisted of loose sand and silt fill over natural sand and gravel, with the soils encountered generally becoming denser with depth. It was difficult to distinguish between fill and natural soil. Descriptions of the geologic units encountered are as follows, in general order of occurrence below ground surface.

GENERALIZED SUBSURFACE CONDITIONS		
Soil Unit	**Approx. Depth (feet)**	**Generalized Description**
Asphalt	0 to 0.6	5 to 7 inches of bituminous asphalt pavement was encountered at the ground surface.
Sand and Silt (Fill)	0.4 to 12.5	Approximately 8 feet of sand and silt was encountered directly below the asphalt at boring B-1; at boring B-2, approximately 12.5 feet of sand and silt was encountered. The material generally consisted of loose, brown, fine to medium SAND and Silt, with up to about 20 percent Gravel.

GENERALIZED SUBSURFACE CONDITIONS		
Soil Unit	**Approx. Depth (feet)**	**Generalized Description**
Sand and Gravel	8.8 to 16.5	Approximately 4.0 and 5.9 feet of sand and gravel was encountered at depths of 8.8 and 12.5 feet bgs in borings B-2 and B-1, respectively. The material generally consisted of dense, gray and brown, fine to coarse SAND, with up to 50 percent Gravel, and up to 20 percent Silt. Cobbles or boulders were encountered from approximately 10.5 to 16.5 feet bgs in boring B-2. Bedrock was encountered at the bottom of the sand and gravel stratum in both borings. Bedrock was confirmed with a 5-foot rock core in boring B-2. Both drilling and split spoon refusal may indicate bedrock in boring B-1.

Detailed descriptions of the materials encountered are presented on the boring logs in **Appendix B**.

GROUNDWATER

Groundwater was measured in test boring B-1 at approximately 7.1 feet bgs (Elevation 134.8) and B-2 at approximately 6.6 feet bgs (Elevation 134.6), as shown on the boring logs included in **Appendix B**. This depth and elevation is an approximate groundwater level observed at the time the test borings were performed. Therefore, the groundwater level observed in the test borings may not represent stabilized groundwater levels.

Water level readings were made in the borings at the time and under conditions stated on the logs. Note that fluctuations in the level of the groundwater will occur due to variations in season, rainfall, temperature, construction and other factors occurring since the time measurements were made.

BEDROCK

Split spoon and drilling refusal was encountered in test boring B-1 on probable bedrock at a depth of 14.7 bgs, corresponding to Elevation 126.5. Confirmatory bedrock coring was performed in test boring B-2 at a depth of 17.5 feet bgs, corresponding to Elevation 125.5. GZA reviewed bedrock type and structure information available from published geologic maps to develop an understanding of bedrock geology in the vicinity of the Site. The bedrock underlying the Site is mapped as a Biotite Granite to Granodiorite of the Nashoba formation. The bedrock core appeared to match this rock type.

GEOTECHNICAL LABORATORY TESTING

Two soil samples obtained from test borings were submitted to GZA's geotechnical laboratory subcontractor, Thielsch Engineering, for grain size distribution analyses. Laboratory test results for these samples taken from the explorations are attached as **Appendix C**. Boring Logs are included as **Appendix B**.

Test Boring No.	Sample ID	Depth Below Grade (ft)	Stratum	Soil Description	Test Performed
B-1	S-4	6-8	Sand and Silt	Brown, fine to medium SAND and Silt, trace Gravel.	Index (Gradation, Moisture)
B-2	S-3	4.5-6.5	Sand and Silt	Brown, fine to medium SAND and Silt, trace Gravel.	Index (Gradation, Moisture)

IMPLICATIONS OF SUBSURFACE CONDITIONS

The subsurface conditions at the site generally consist of loose sand and silt fill over medium dense to very dense sand and gravel. The estimated elevation of the bottom of the proposed culvert will be about Elevation 131 feet, which is below the anticipated frost zone. Soils at this elevation are likely to be within the loose sand and silt fill, but with limited over-excavation of the sand and silt fill and replacement with compacted dense-graded crushed stone to the proposed foundation grade of Elevation 131 feet, spread footing foundations are feasible for supporting the new precast culvert. The excavated subgrade before backfilling should be observed by a qualified geotechnical engineer to confirm that the exposed subgrade is suitable for bearing. Based on the borings, the anticipated over-excavation depth will be about 2 feet.

RECOMMENDATIONS

The following recommendations are based on the assumption that a proposed pre-cast culvert structure will be installed at or below Elevation 131 feet on 2 feet of compacted dense-graded crushed stone.

DEWATERING

Based on the survey plan provided to us on September 9, 2019, the typical water elevation of the brook upstream is about Elevation ±134 feet. With the current culvert bottom at Elevation ±133, approximately 1 foot below the brook elevation, temporary construction dewatering will be required to control groundwater seepage, precipitation and surface inflow in excavations, to maintain the integrity of soil bearing surfaces, and allow foundation construction in-the-dry. However, the anticipated excavated sand subgrade can become unstable if exposed to high dewatering gradients; care will be required to maintain a stable excavation bottom.

Temporary lateral earth support systems may be needed to support adjacent travel ways, wetlands, structures and control water infiltration. It should be noted that occasional cobbles were encountered in test boring B-2 from approximately 10.5 to 16.5 feet bgs, which may make sheet piling difficult to drive; pre-excavation may be necessary to mitigate the risk of encountering boulder obstructions during driving. Temporary dewatering and/or lateral earth support systems should be designed by a Professional Engineer licensed in the Commonwealth of Massachusetts.

FROST PROTECTION

Typical frost depth in the Commonwealth of Massachusetts is 4 feet bgs. We recommend that spread footings be supported a minimum of 4 feet below the lowest adjacent ground surface to provide frost protection. We anticipate that the foundation bearing elevation will be at least 4 feet lower than the adjacent ground based on the proposed culvert subgrade Elevation at 131 feet.

BEARING PRESSURE

The proposed box culvert foundation loads can be supported in the natural, undisturbed Sand and Gravel at approximately elevation 131 feet (or below), assuming up to about 2 feet of over excavation of the Sand and Silt fill and replacement with dense-graded crushed stone to the anticipated footing subgrade of elevation 131 feet. The dense-graded crushed stone should meet the gradation requirements of the Massachusetts Highway Department Item M2.01.7, Dense-Graded Crushed Stone for Sub-base. Recommended maximum net allowable bearing pressure for the proposed box culvert foundation bearing on at least 1 foot of dense-graded crushed stone over the undisturbed natural Sand and Gravel is 1.5 tons per square foot. At this bearing pressure, total potential foundation settlement is estimated to be less than 1 inch and differential settlements across the culvert length are estimated to be less than ½ inch.

RETAINING WALLS

GZA considered several retaining wall types to provide grade separation between the existing property to the south and the roadway. A retaining wall system could be utilized to maintain the current top of slope elevations and limit impacts to the abutting property. Four potential wall solutions, including gabions, precast modular block gravity wall, mechanically stabilized earth (MSE), and boulder walls, are discussed below. Each potential wall solution would bear on natural Sand and Gravel.

Gabion Wall

Gabion walls can be designed with either a stepped front face or a smooth front face and are typically suitable for grade separations of about 15 feet or less. Walls can be constructed on a 5- to 6-degree batter towards the retained slope to increase stability, as required. Gabion baskets have a standard width of 3 feet and are typically available in baskets heights of 1 foot, 1.5 feet and 3 feet. Gabion walls are typically designed with a base width generally 1/2 to 2/3 times the design wall height to provide adequate stability. Therefore, walls on the order of 10 to 12 feet in height would require corresponding minimum base width of approximately 6 feet.

Acceptable stone for gabion wall construction includes stone that is hard, durable, equally graded, angular in shape, and between 4 and 8 inches in any given dimension. Accordingly, a good source of stone is required for gabion wall construction.

Gabion wall construction is labor intensive. However, construction does not require skilled labor or specialized equipment. Most gabion retaining walls do not require a concrete leveling pad. Even though gabion basket wire is typically galvanized or coated with plastic, wire baskets used for wall construction are subject to corrosion over time. Walls should also be constructed with filter fabric behind the gabion baskets to prevent the migration of fines into and through the wall over time.

Precast Modular Block Wall

A precast modular block wall, such as Redi-Rock, uses interlocking precast concrete cells to construct the wall from the bottom up. Construction would involve excavating to the natural Sand and Gravel surface, placement of a leveling pad, and construction of a conventional modular block wall system. Similar to the gabion wall alternative, precast block walls typically require a base width that is 0.5 to 0.7 times the height of the wall.

Precast modular block walls have several significant advantages over other wall types, including speed of construction, ability to construct “in-the-wet”, and sometimes lower construction cost. Precast block walls also required less select backfill as compared to MSE walls. Sometimes block walls can have a relatively long construction time compared to other wall alternatives.

Mechanically Stabilized Earth (MSE) Wall

An MSE wall is a technically feasible solution to provide grade separation. However, an MSE wall is not ideal for the proposed culvert concepts because the existing utilities in the roadway would need to be within the zone where geogrid would be required, requiring temporary utility support. MSE walls typically require that reinforcement extend up to 0.7 times the height of the wall. A leveling pad is required and excavation for wall installation would likely extend further back than that required for a precast modular or gabion alternative to allow for installation of geogrid reinforcement.

MSE walls and modular block walls are typically designed by the contractor’s engineer with ties to the proprietary wall type manufacturer. GZA’s experience indicates performance of MSE and modular block walls is greatly dependent up on the quality of their construction. Of particular concern for MSE walls are: the gradation and compaction of the fill materials within the reinforced soil zone; the size, location, and orientation of reinforcing grids; the construction of wall drains; and the sequence of wall construction. Therefore, we recommend that MSE wall construction be observed by the wall designer, or by a qualified engineer who is familiar with MSE wall design and construction.

Boulder Wall

A boulder wall is a retaining structure that consists of stacked boulders without any reinforcement, such as mortar, concrete, or steel. The walls have no mechanical connections; instead rocks are stacked in an interlocking pattern and rely on the weight, size, shape and interface friction of the rock elements to provide stability. The stability of the wall is greatly dependent on proper rock layout, rock weight, and frictional interaction between rock elements. Rock dimensions for components of these wall types typically need to be a minimum of 18 inches and generally weigh more than 200 lbs. With proper design, boulder walls can generally be constructed to heights of about 10 feet in fill conditions without geogrid reinforcement.

Boulder walls are typically designed with a base width equal to half the height of the wall, but not less than 4 feet, and a face batter angle between 4V:1H and 6V:1H.

Boulder walls should be constructed with filter fabric behind the rock elements to prevent the migration of fines into and through the wall over time. A good source of large boulders is also required for boulder wall construction.

Failure or poor performance of a boulder wall is commonly related to little or no drainage, poor quality or poorly placed backfill, wall face constructed too steep or too high, wall constructed over a poor foundation/base, use of unsound rock, and overall poor workmanship. Therefore, we recommend that boulder/rockery wall construction be observed by a qualified engineer who is familiar with boulder wall design and construction.

Drainage

Regardless of the preferred retaining wall alternative, retaining wall solutions should be designed to prevent hydrostatic pressure buildup behind the wall. This may require installation of free-draining structural fill behind the wall, the installation of drains through the face of the wall, weep-holes and/or affixing a drainage board to the back of precast walls.

CONCLUSION

We appreciate the opportunity to work with Woodard & Curran, Inc. on this project. If you have any questions regarding this memorandum, please contact Mr. Mirsad Alihodzic at 603-232-8755 or Mr. Bruce Fairless at 617-963-1002.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Mirsad Alihodzic
Project Manager

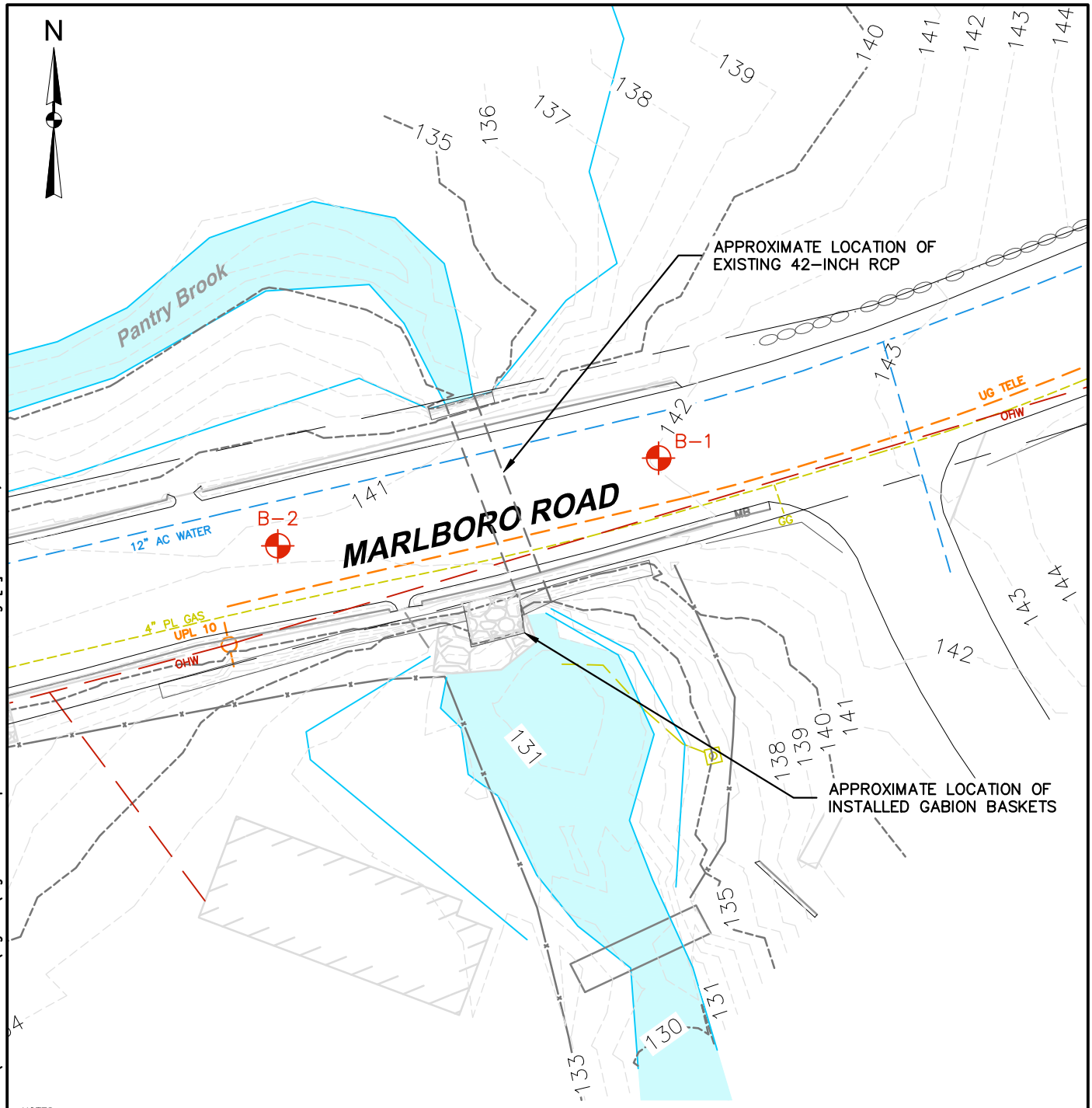
David G. Lamothe, P.E.
Consultant/Reviewer

Bruce W. Fairless, P.E., LEED AP
Associate Principal

P:\04Jobs\0191000s\04.0191011.00\Report\FINAL 04 0191011 00 Geotech Memo 102519.docx

Attachments: Figure 1 – Exploration Location Plan
Appendix A – Limitations
Appendix B – Boring Logs
Appendix C – Laboratory Test Results

Figure 1 – Exploration Location Plan



NOTES:

1. BASE PLAN WAS DEVELOPED FROM AN ELECTRONIC BASE PLAN ENTITLED "EXISTING CONDITIONS SURVEY" DATED SEPTEMBER 17, 2019; PREPARED BY CHAPPELL ENGINEERING ASSOCIATES, LLC OF MARLBOROUGH, MASSACHUSETTS PROVIDED BY WOODARD AND CURRAN VIA EMAIL ON SEPTEMBER 9, 2019.
2. TEST BORINGS B-1 AND B-2 WERE PERFORMED BY NEW ENGLAND BORING CONTRACTORS OF DERRY, NEW HAMPSHIRE ON AUGUST 14, 2019 AND WERE OBSERVED AND LOGGED BY GZA PERSONNEL.
3. TEST BORING B-1 AND B-2 LOCATIONS WERE DETERMINED BY GZA USING TAPE MEASUREMENTS FROM EXISTING TOPOGRAPHIC FEATURES. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

LEGEND:

B-1 APPROXIMATE BORING LOCATION AND DESIGNATION

0 10' 20' 40' 60'

SCALE IN FEET

NO.	ISSUE/DESCRIPTION	BY	DATE

MARLBORO ROAD CULVERT
SUDBURY, MA

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
WOODARD & CURRAN, INC

EXPLORATION LOCATION PLAN

PROJ MGR: MA	REVIEWED BY: BWF	CHECKED BY: DGL	FIGURE 1
DESIGNED BY: MA	DRAWN BY: MA	SCALE: AS SHOWN	
DATE: OCTOBER, 2019	PROJECT NO. 04.0191011.00	REVISION NO.	SHEET NO.

Appendix A – Limitations

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the contract documents, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report,as appropriate, to reflect the unanticipated changed conditions .

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

7. Water level readings have been made in test holes (as described in this Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.

8. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

9. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

COMPLIANCE WITH CODES AND REGULATIONS

10. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

COST ESTIMATES

11. Unless otherwise stated, our cost estimates are only for comparative and general planning purposes. These estimates may involve approximate quantity evaluations. Note that these quantity estimates are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over either when the work will take place or the labor and material costs required to plan and execute the anticipated work, our cost estimates were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

ADDITIONAL SERVICES

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

Appendix B – Boring Logs

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Woodard and Curran
Marlboro Road Culvert
Subdury, MA

EXPLORATION NO.: B-1
SHEET: 1 of 1
PROJECT NO: 04.0191011.00
REVIEWED BY: MA

Logged By: L. Williams
Drilling Co.: NEBC
Foreman: P. Schofield

Type of Rig: Truck
Rig Model: MB-48
Drilling Method: HSA

Boring Location: See Plan
Ground Surface Elev. (ft.): 141.2
Final Boring Depth (ft.): 14.7
Date Start - Finish: 8/14/2019 - 8/14/2019

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic Hammer
Hammer Weight (lb.): 140
Hammer Fall (in.): 30
Auger or Casing O.D./I.D Dia (in.): 2.25 I.D.

Sampler Type: SS
Sampler O.D. (in.): 2.0
Sampler Length (in.): 24
Rock Core Size: None

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
8/14/19	14:31	7.13	None.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0.5-2	18	10	14 21 13	34	S-1: Dense, brown, fine to medium SAND, little Gravel, little Silt, dry.	1		0.6	ASPHALT	140.6
		S-2	2-4	24	7	7 6 11 11	17	S-2: Medium dense, brown, fine to medium SAND, little Silt, trace Gravel, dry.					
5		S-3	4-6	24	12	2 1 1 2	2	S-3: Very loose, brown, fine to medium SAND and Silt, little Gravel, dry.				SAND AND SILT (FILL)	
		S-4	6-8	24	11	3 2 2 2	4	S-4: Very loose, brown, fine to medium SAND and Silt, trace Gravel, moist.					
		S-5	8-10	24	14	1 3 17 21	20	S-5: A: Top 10 inches: Medium dense, brown, fine SAND and Silt, trace Gravel, wet. S-5: B: Bottom 4 inches: Medium dense, brown, fine to coarse SAND, little Gravel, little Silt, wet.			8.8		132.4
10												SAND AND GRAVEL	
		S-6	14-14.7	8	5	39 50/2	R	S-6: Very dense, brown, fine to coarse SAND, some Gravel, little Silt, dry.	2 3		14.7		126.5
15								End of exploration at 14.7 feet.					
20													
25													

REMARKS

1 - The ground surface elevation at the this test boring location is based on interpolation of topographic contours shown on the Figure 1 - Exploration Location Plan
2 - Split spoon and auger refusal encoutered at approximately 14.7 feet b.e.g.s.
3 - Borehole was backfilled with drill cuttings upon completion.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.: B-1

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Woodard and Curran
Marlboro Road Culvert
Subdury, MA

EXPLORATION NO.: B-2
SHEET: 1 of 1
PROJECT NO: 04.0191011.00
REVIEWED BY: MA

Logged By: L. Williams
Drilling Co.: NEBC
Foreman: P. Schofield

Type of Rig: Truck
Rig Model: MB-48
Drilling Method: Drive & Wash

Boring Location: See Plan
Ground Surface Elev. (ft.): 142
Final Boring Depth (ft.): 22.5
Date Start - Finish: 8/14/2019 - 8/14/2019

H. Datum: NAD83
V. Datum: NAVD88

Hammer Type: Automatic Hammer
Hammer Weight (lb.): 140
Hammer Fall (in.): 30
Auger or Casing O.D./I.D Dia (in.): 4 O.D.

Sampler Type: SS
Sampler O.D. (in.): 2.0
Sampler Length (in.): 24
Rock Core Size: NX

Groundwater Depth (ft.)

Date	Time	Water Depth	Stab. Time
8/14/19	10:30	6.62	None.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0.5-2.5	24	14	21 21 16 13	37	S-1: Dense, brown, fine to medium SAND, little Gravel, trace Silt, dry.	1		0.4	ASPHALT	141.6
		S-2	2.5-4.5	24	17	7 7 9 8	16	S-2: Medium dense, brown, fine to medium SAND and Silt, trace Gravel, dry.					
5		S-3	4.5-6.5	24	9	9 3 3 2	6	S-3: Loose, brown, fine to medium SAND and Silt, trace Gravel, trace organics, wet.				SAND AND SILT (FILL)	
		S-4	6.5-8.5	24	9	5 5 5 4	10	S-4: Loose, brown, fine to medium SAND and Silt, trace Gravel, wet.					
10		S-5	8.5-10.5	24	9	7 6 8 15	14	S-5: Medium dense, gray, fine to medium SAND, some Silt, trace Gravel. wet.	2		12.5		129.5
15		S-6	14-16	24	6	20 24 28 24	52	S-6: Very dense, gray, fine to coarse SAND and GRAVEL, little Silt, wet.				SAND AND GRAVEL	
											16.5		125.5
20	4 5 4 6 5	C-1	17.5-22.5	60	55	RQD = 89%		C-1: Hard, fresh to slightly weathered, slightly fractured, dark gray, fine to medium grained, BIOTITE GRANITE, joints/fractures are closely to moderately spaced, sub-horizontal to moderately dipping.	3			BEDROCK	
											22.5		119.5
25								End of exploration at 22.5 feet.	4				

REMARKS

1 - The ground surface elevation at the this test boring location is based on interpolation of topographic contours shown on the Figure 1 - Exploration Location Plan
2 - Drilling difficulty increased at approximately 10.5 feet to 16.5 feet below existing ground surface (b.e.g.s.); possible cobbles and boulder zone encountered.
3 - Top of bedrock was encountered at approximately 16.5 feet b.e.g.s. roller bit was advanced to approximately 17.5 feet b.e.g.s. prior to starting core run.
4 - Borehole was backfilled with drill cuttings upon completion.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Exploration No.: B-2

Appendix C – Laboratory Test Results

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

Client Information:
GZA GeoEnvironmental, Inc
Bedford, NH
PM: Misrad Alihodzic
Assigned By: Misrad Alihodzic
Collected By: Leland Williams

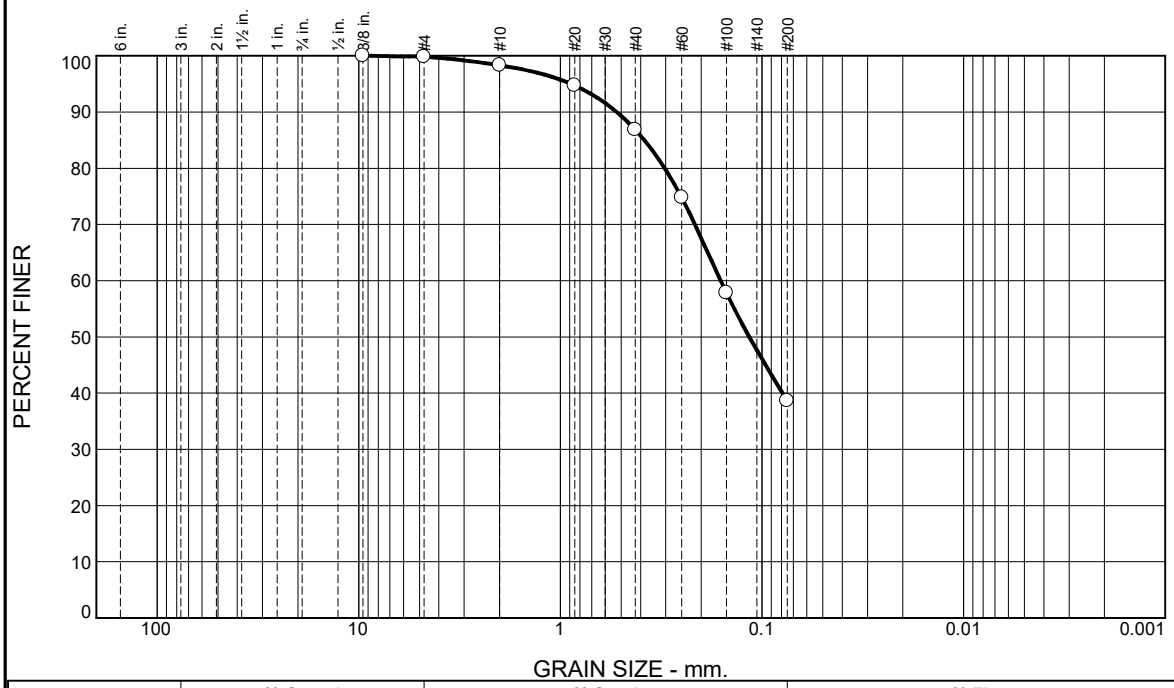
Project Information:
Marlboro Road Culvert
Sudbury, MA
GZA Project Number: 04.0191011.00
Summary Page: 1 of 1
Report Date: 08.22.19

LABORATORY TESTING DATA SHEET

Boring ID	Sample No.	Depth (ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Perme-ability cm/sec	
				D2216	D4318		D6913			D2874	D854			D1557						
B-1	S-4	6-8	S-1	28.7			0.2	61.2	38.6											Brown f-m SAND and SILT, trace Gravel
B-2	S-3	4.5-6.5	S-2	22.4			5.2	56.7	38.1											Brown f-m SAND and SILT, trace Gravel

Date Received: 08.20.19 Reviewed By: Date Reviewed: 08.23.19

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	1.5	11.5	48.2	38.6	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375"	100.0		
#4	99.8		
#10	98.3		
#20	94.7		
#40	86.8		
#60	74.8		
#100	57.8		
#200	38.6		

* (no specification provided)

Material Description

Brown f-m SAND and SILT, trace Gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.5261 D_{85}= 0.3835 D_{60}= 0.1603
D_{50}= 0.1156 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 08.20.19 **Date Tested:** 08.22.19

Tested By: IA

Checked By: Steven Accetta

Title: Laboratory Coordinator

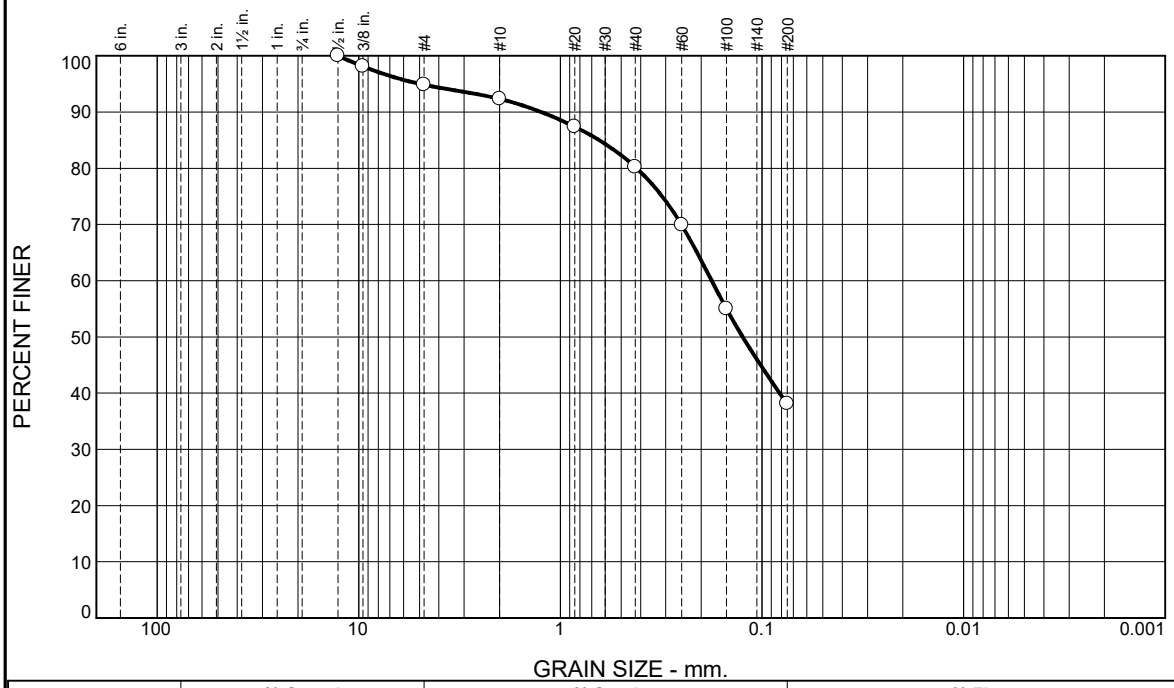
Source of Sample: Borings **Depth:** 6-8' **Date Sampled:**
Sample Number: B-1 / S-4

Thielsch Engineering Inc.

Cranston, RI

Client: GZA GeoEnvironmental
Project: Marlboro Road Culvert
Sudbury, MA
Project No: 04.0191011.00 **Figure** S-1

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.2	2.5	12.1	42.1	38.1	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.5"	100.0		
0.375"	98.1		
#4	94.8		
#10	92.3		
#20	87.4		
#40	80.2		
#60	69.9		
#100	55.0		
#200	38.1		

* (no specification provided)

Material Description

Brown f-m SAND and SILT, trace Gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 1.2447 D_{85}= 0.6415 D_{60}= 0.1776
D_{50}= 0.1247 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as non-plastic.

Date Received: 08.20.19 **Date Tested:** 08.22.19

Tested By: IA

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Borings **Depth:** 4.5-6.5' **Date Sampled:**
Sample Number: B-2 / S-3

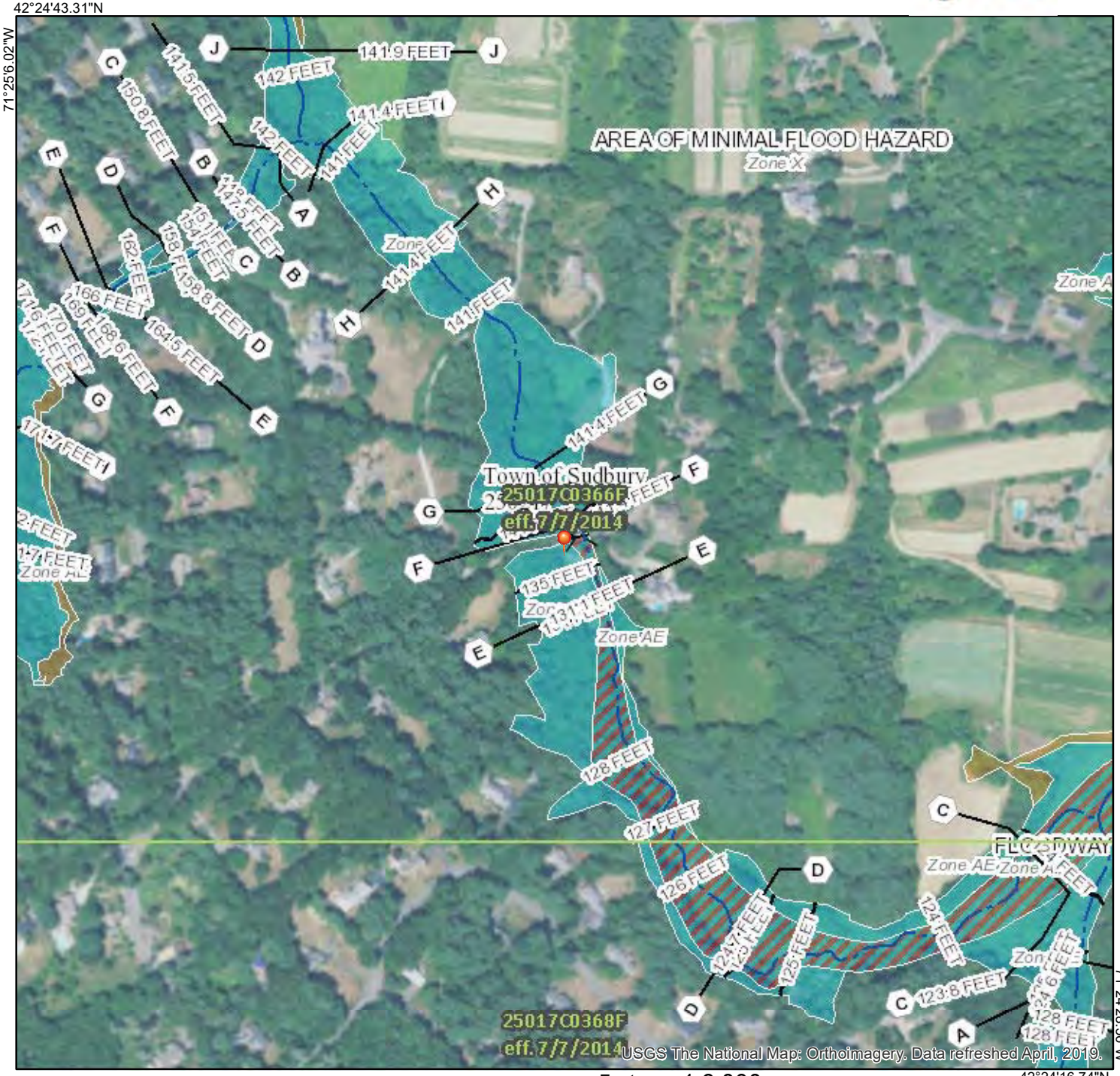
Thielsch Engineering Inc.

Cranston, RI

Client: GZA GeoEnvironmental
Project: Marlboro Road Culvert
Sudbury, MA
Project No: 04.0191011.00 **Figure** S-2

ATTACHMENT D: FEMA FIRMETTE

National Flood Hazard Layer FIRMette



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 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
  - Coastal Transect
  - 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 9/17/2019 at 1:14:03 PM 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.

ATTACHMENT E: CULVERT ANALYSIS REPORT

PCSWMM Report

Culvert Analysis Report

Model Marlboro_Rd_2.4.inp

February 7, 2020

Table of Contents

Summary 1: Options

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Flow Units	CFS	CFS
Infiltration method	MODIFIED_GREEN_AMPT	MODIFIED_GREEN_AMPT
Flow routing method	Dynamic Wave	Dynamic Wave
Link offsets defined by	Depth	Depth
Allow ponding	No	No
Skip steady flow periods	No	No
Inertial dampening	Partial	Partial
Define supercritical flow by	Both	Both
Force Main Equation	H-W	H-W
Variable time step	On	On
Adjustment factor (%)	75	75
Conduit lengthening (s)	0	0
Minimum surface area (ft²)	0	0
Starting date	Oct-3-2019 12:00:00 AM	Oct-3-2019 12:00:00 AM
Ending date	Oct-4-2019 12:00:00 AM	Oct-4-2019 12:00:00 AM
Duration of simulation (hours)	24	24
Antecedent dry days (days)	0	0
Rain interval (h:mm)	0:06	0:06
Report time step (h:mm:ss)	00:01:00	00:01:00
Wet time step (h:mm:ss)	00:05:00	00:05:00
Dry time step (h:mm:ss)	00:05:00	00:05:00
Routing time step (s)	5	5
Minimum time step used (s)	0.48	0.12
Average time step used (s)	0.65	0.65
Minimum conduit slope	0	0
Ignore rainfall/runoff	No	No
Ignore snow melt	No	No
Ignore groundwater	No	No
Ignore flow routing	No	No
Ignore water quality	No	No
Report average results	No	No

Summary 2: Model inventory

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Raingages	3	3
Subcatchments	158	158
Aquifers	0	0
Snowpacks	0	0
RDII hydrographs	0	0
Junction nodes	165	165
Outfall nodes	1	1
Flow divider nodes	0	0
Storage unit nodes	0	0
Conduit links	163	163
Pump links	0	0
Orifice links	0	0
Weir links	0	0
Outlet links	0	0
Treatment units	0	0
Transects	55	55
Control rules	0	0
Pollutants	0	0
Land Uses	0	0
Control Curves	0	0
Diversion Curves	0	0
Pump Curves	0	0
Rating Curves	0	0
Shape Curves	0	1
Storage Curves	0	0
Tidal Curves	0	0
Weir Curves	0	0
Time Series	3	3
Time Patterns	0	0

Summary 3: Model complexity

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Subcatchments	2044	2044
Groundwater	0	0
Aquifers	n/a	n/a
Snowpacks	n/a	n/a
RDII hydrographs	n/a	n/a
Junction nodes	173	172
Outfall nodes	1	1
Flow divider nodes	n/a	n/a
Storage unit nodes	n/a	n/a
Conduit links	678	678
Pump links	n/a	n/a
Orifice links	n/a	n/a
Weir links	n/a	n/a
Outlet links	n/a	n/a
Transect	165	165
Pollutants	n/a	n/a
Land Uses	n/a	n/a
Model complexity (total uncertain input parameters)	3061	3060

Summary 4: Subcatchment statistics

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Max. width (ft)	1511.541	1511.541
Min. width (ft)	209.876	209.876
Max. area (ac)	46.294	46.294
Min. area (ac)	1.3901	1.3901
Total area (ac)	1705.9708	1705.9708
Max. length of overland flow (ft)	1964.5914	1964.5914
Min. length of overland flow (ft)	141.173	141.173
Max. slope (%)	18.769	18.769
Min. slope (%)	2.902	2.902
Max. imperviousness (%)	69.834	69.834
Min. imperviousness (%)	0	0
Max. imp. roughness	0.015	0.015
Min. imp. roughness	0.015	0.015
Max. perv. roughness	0.419	0.419
Min. perv. roughness	0.066	0.066
Max. imp. depression storage (in)	0.05	0.05
Min. imp. depression storage (in)	0.05	0.05

Summary 4: Subcatchment statistics (continued...)

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Max. perv. depression storage (in)	0.1	0.1
Min. perv. depression storage (in)	0.1	0.1

Summary 5: Node statistics

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Max. ground elev. (ft)	238.28	238.28
Min. ground elev. (ft)	119.35	119.35
Max. invert elev. (ft)	238.28	238.28
Min. invert elev. (ft)	119.08	119.08
Max. depth (ft)	10.5	10.5
Min. depth (ft)	0	0

Summary 6: Conduit statistics

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Max. roughness	0.1	0.1
Min. roughness	0.015	0.015
Max. entry loss coef.	0.5	0.5
Min. entry loss coef.	0	0
Max. exit loss coef.	1	1
Min. exit loss coef.	0	0
Max. avg. loss coef.	0	0
Min. avg. loss coef.	0	0
Max. length (ft)	2314.4	2314.4
Min. length (ft)	2.567	2.567
Total length (ft)	69145.79	69145.79
Max. slope (ft/ft)	0.0953	0.0953
Min. slope (ft/ft)	-0.2395	-0.2395

Summary 7: Runoff quantity continuity

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Initial LID storage (in)	n/a	n/a
Initial snow cover (in)	n/a	n/a
Total precipitation (in)	8.270	8.270
Outfall runon (in)	n/a	n/a
Evaporation loss (in)	0.000	0.000
Infiltration loss (in)	5.929	5.929
Surface runoff (in)	2.340	2.340
LID drainage (in)	n/a	n/a
Snow removed (in)	n/a	n/a
Final snow cover (in)	n/a	n/a
Final storage (in)	0.006	0.006
Continuity error (%)	-0.060	-0.060

Summary 8: Flow routing continuity

Name	Marlboro_Rd_2.0	Marlboro_Rd_2.4
Dry weather inflow (MG)	0.000	0.000
Wet weather inflow (MG)	108.499	108.499
Groundwater inflow (MG)	0.000	0.000
RDII inflow (MG)	0.000	0.000
External inflow (MG)	0.129	0.129
External outflow (MG)	69.708	69.692
Flooding loss (MG)	16.111	16.117
Evaporation loss (MG)	0.000	0.000
Exfiltration loss (MG)	0.000	0.000
Initial stored volume (MG)	0.000	0.000
Final stored volume (MG)	20.844	20.840
Continuity error (%)	1.809	1.822

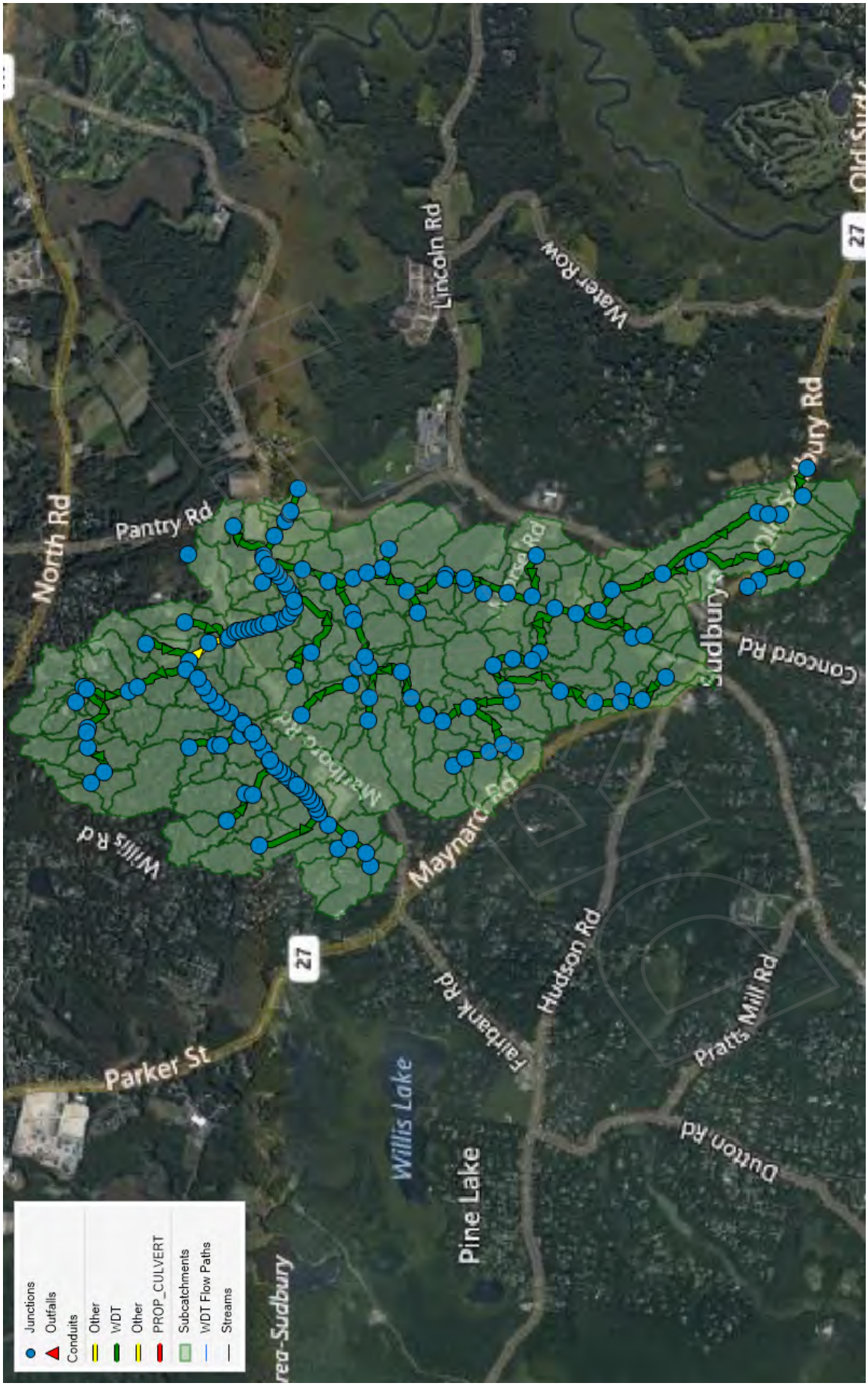


Figure 1: Study Area

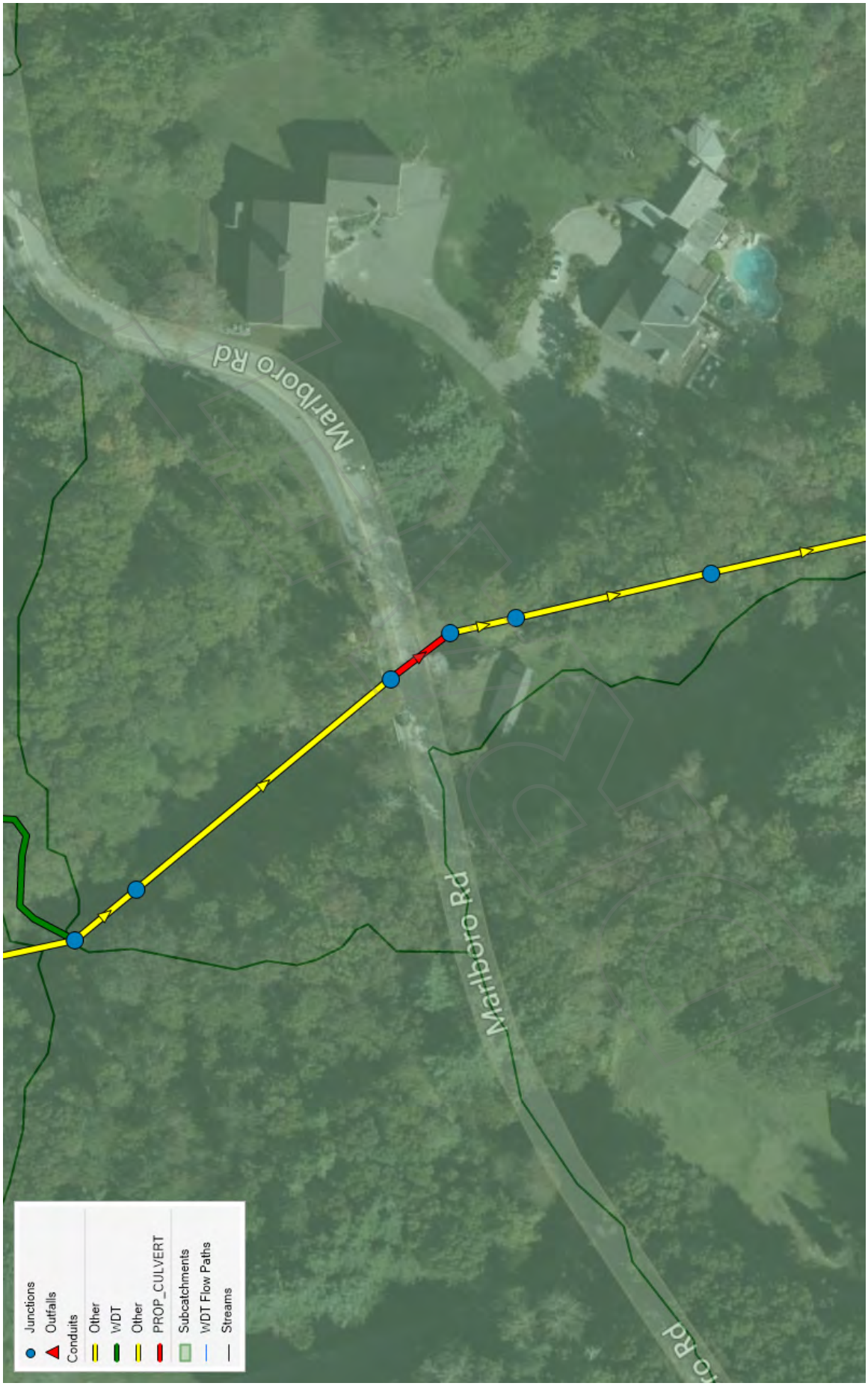


Figure 2: PantryBrk_MarlboroRd

Figure 3: PantryBrk_MarlboroRd

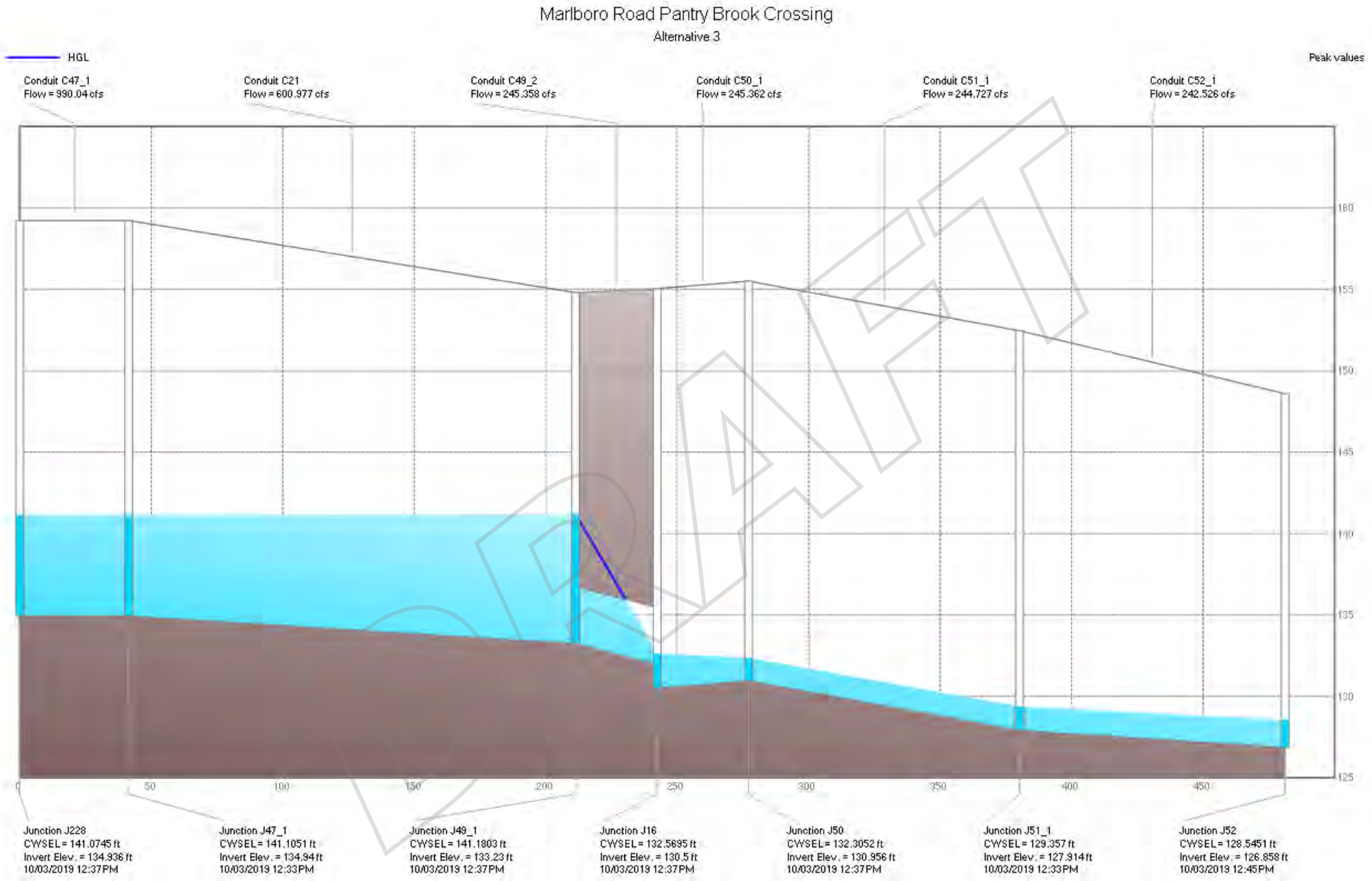
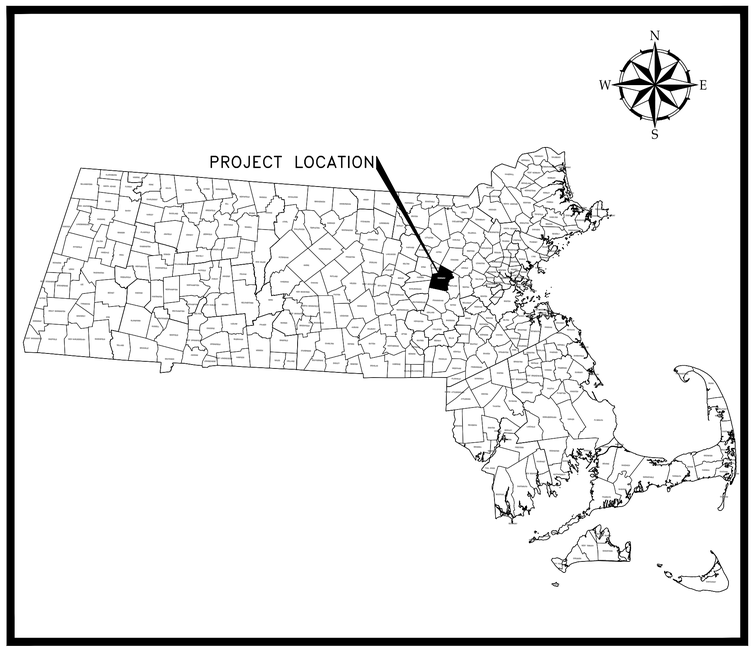


Figure 4: PantryBrk_MarlboroRd

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

PROJECT NO. 227202.06



PROJECT LOCATION MAP

50 0 50 100
scale mile

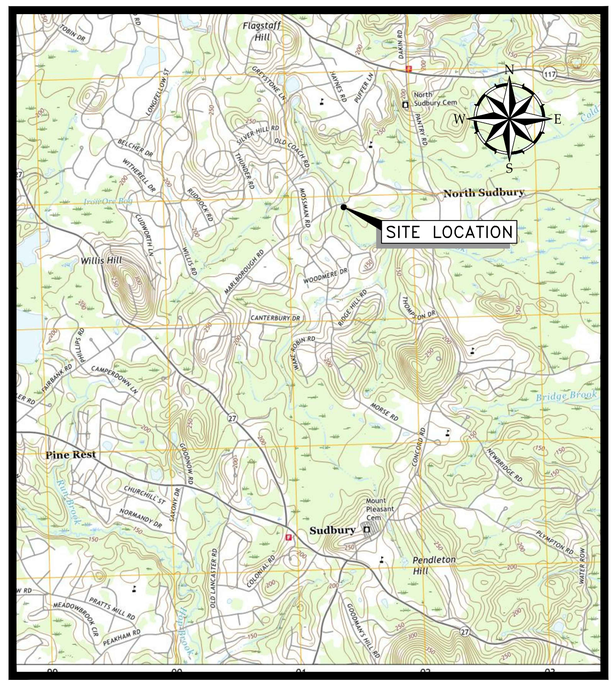
AUGUST 2020

NOTICE OF INTENT
NOT FOR CONSTRUCTION

WOODARD & CURRAN

40 Shattuck Road, Suite 110
Andover, Massachusetts 01810
866.702.6371 | www.woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS



SOURCE: USGS TOPOGRAPHIC MAP

SITE LOCATION MAP

½ 0 ½ 1
scale mile

2000 0 2000 4000
scale feet

GENERAL NOTES:

1. EXISTING CONDITIONS ARE BASED ON A SURVEY PERFORMED BY CHAPPELL ENGINEERING ASSOCIATES, LLC. 201 BOSTON POST ROAD WEST – SUITE 101 MARLBOROUGH, MA 01752. PLAN TITLED, "EXISTING CONDITIONS SURVEY MARLBORO ROAD, SUDBURY, MASSACHUSETTS.", DATED NOVEMBER 1, 2019.
2. GEOTECHNICAL INVESTIGATION WAS CONDUCTED BY GZA GEOENVIRONMENTAL ON JUNE 15, 2018 AND DOCUMENTED IN A REPORT DATED OCTOBER 25, 2019.
3. WETLAND DELINEATION WAS PREPARED BY ECOTEC, INC. 102 GROVE STREET, WORCESTER, MA 01605. THE WETLAND RESOURCE EVALUATION REPORT IS DATED SEPTEMBER 12, 2019 AND WETLAND FIELD INSPECTION WAS CONDUCTED ON AUGUST 15, 2019.
4. THE HORIZONTAL DATUM DEPICTED ON THE MAPS HEREON IS BASED ON THE MASSACHUSETTS STATE PLANE COORDINATE SYSTEM, MAINLAND ZONE, REFERENCED TO THE NORTH AMERICAN DATUM OF 1983. THE VERTICAL DATUM IS BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
5. ANY PROPERTY AND RIGHT OF WAY LOCATIONS THAT MAY BE SHOWN HEREON ARE APPROXIMATE AND DO NOT REPRESENT A PROPERTY BOUNDARY SURVEY.
6. WOODARD & CURRAN ASSUMES NO RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN.
7. COORDINATE CONSTRUCTION ACTIVITY WITH UTILITY COMPANIES, EMERGENCY SERVICES AND TOWN. CONTRACTOR SHALL NOTIFY ALL UTILITIES PRIOR TO COMMENCING WORK, ALLOWING SUFFICIENT TIME TO LOCATE AND MARK THE LOCATION OF BURIED UTILITIES. CONTRACTOR SHALL CONTACT "DIG SAFE", TELEPHONE 811, PRIOR TO EXCAVATION.
8. RESTORE ALL AREAS DISTURBED BY CONTRACTOR'S OPERATIONS TO ORIGINAL FINISH (GRAVEL, PAVEMENT, GRASS, ETC.) UNLESS NOTED OTHERWISE ON THE PLANS. RESTORATION OF PAVED SURFACES, GRAVEL SURFACES, DRIVEWAYS, AND LAWNS DAMAGED BY CONSTRUCTION ACTIVITIES SHALL BE PERFORMED AT NO ADDITIONAL COST TO OWNER. ANY CURB DAMAGED BY CONSTRUCTION ACTIVITIES SHALL BE REPLACED IN KIND AND SHALL CONFORM TO TOWN OF SUDBURY AND MASSACHUSETTS DOT SPECIFICATIONS AT NO ADDITIONAL COST TO OWNER.
9. PROPERLY PROTECT AND DO NOT DISTURB PROPERTY IRONS AND MONUMENTS. IF DISTURBED, THE PROPERTY MONUMENT SHALL BE RESET AT THE CONTRACTOR'S EXPENSE BY A LICENSED LAND SURVEYOR ACCEPTABLE TO THE TOWN.
10. EXISTING FACILITIES (I.E. TREES, POLES, LIGHT POSTS, CATCH BASINS, STONE FROM CULVERT, ETC.) SHALL BE REMOVED AND PROTECTED DURING CONSTRUCTION. THE TOWN RETAINS RIGHT TO KEEP ANY AND ALL REMOVED FACILITIES. CONTRACTOR SHALL DISPOSE OF ANY REMOVED FACILITY AT THE REQUEST OF THE TOWN AT NO ADDITIONAL COST TO OWNER.
11. ALL TREES NOT NOTED TO BE REMOVED OR RELOCATED SHALL BE PROTECTED BY CONTRACTOR DURING CONSTRUCTION.
12. DO NOT PARK, IMPEDE ACCESS TO, OR STORE EQUIPMENT BEYOND LIMIT OF WORK, UNLESS PERMISSION HAS BEEN GRANTED IN WRITING BY TOWN AND/OR LAND OWNER.
13. RESTRICT ACCESS TO SITE THROUGH THE USE OF APPROPRIATE SIGNAGE, BARRIERS, FENCES, ETC. SITE SHALL BE LEFT WITH APPROPRIATE SAFETY MEASURES IN PLACE DURING NON–WORKING HOURS. SITE SAFETY IS THE RESPONSIBILITY OF CONTRACTOR, DURING BOTH WORKING AND NON–WORKING HOURS.
14. CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY CONSTRUCTION PERMITS INCLUDING "PERMIT TO CONSTRUCT WITHIN A PUBLIC WAY" FROM THE TOWN. PERMIT APPLICATIONS SHALL BE SUBMITTED WITH ADEQUATE TIME SO AS NOT TO DELAY CONSTRUCTION.
15. ALL WORK ASSOCIATED WITH THE PROJECT SHALL BE COMPLETED IN ACCORDANCE WITH THE TOWN OF SUDBURY BYLAW AND LOCAL REGULATIONS AND MASSACHUSETTS DOT STANDARD SPECIFICATIONS.
16. UPON COMPLETION OF CONSTRUCTION, A COMPLETE SET OF "RECORD" DRAWINGS SHALL BE SUBMITTED TO THE TOWN ENGINEER. THESE DRAWINGS SHALL BE SUBMITTED IN BOTH DIGITAL AND HARD COPY FORMAT AS DEFINED IN THE SPECIFICATIONS PRIOR TO PAYMENT OF FINAL RETAINAGE.
17. PROTECTION OF EXISTING UTILITIES DURING CONSTRUCTION SHALL BE PROVIDED AT NO ADDITIONAL COST.
18. CONTRACTOR SHALL BE RESPONSIBLE FOR SWEEPING MARLBORO ROAD EVERY FRIDAY AND AS NECESSARY DURING THE DURATION OF THE WORK.
19. PRIOR TO CONSTRUCTION, CONTRACTOR SHALL ATTEND A PRE–CONSTRUCTION MEETING HELD AT THE PROJECT SITE WITH THE CONTRACTOR, ENGINEER, OWNER, AND CONSERVATION OFFICE TO REVIEW THE CONSTRUCTION SCHEDULE AND SEQUENCING, ORDER OF CONDITIONS, STOCKPILE LOCATIONS AND CRITICAL ASPECTS OF THE PROJECT.
20. PRIOR TO THE START OF WORK, CONTRACTOR SHALL CONFIRM EXISTING WETLAND FLAGS ARE IN PLACE AND SHALL BE MAINTAINED DURING CONSTRUCTION. MISSING FLAGS SHALL BE RESET PRIOR TO CONSTRUCTION. AN AUTOCAD FILE OF THE WETLAND FLAG LOCATIONS SHALL BE PROVIDED FOR CONTRACTOR'S USE IN RESETTING WETLAND FLAGS.
21. NO EQUIPMENT IS TO CROSS OR ENTER WETLAND RESOURCE AREAS AT ANY TIME UNLESS THE LOCATION OF DISTURBANCE IS MARKED ON THE PLANS REFERENCED IN THE ORDER OF CONDITIONS AND FLAGGED IN THE FIELD (DEP FILE #XXX–XXXX).
22. ALL DISTURBED UPLAND AREAS SHALL BE BROUGHT TO FINAL GRADE AND SHALL BE PERMANENTLY STABILIZED WITHIN 30 DAYS AFTER DISTURBANCE. BARE GROUND AND DISTURBED AREAS THAT CANNOT BE PERMANENTLY VEGETATED WITHIN 30 DAYS SHALL BE TEMPORARY STABILIZED BY AN APPROVED METHOD.
23. CONTRACTOR SHALL DEMARCATE CONSTRUCTION EQUIPMENT AND MATERIAL STORAGE AREAS PRIOR TO CONSTRUCTION.
24. THE CONSTRUCTION SITE SHALL BE MAINTAINED IN CLEAN CONDITIONS AT ALL TIMES AND CONSTRUCTION REFUSE AND DEBRIS SHALL BE DISPOSED OF PROMPTLY AND IN A LEGAL MANNER.
25. STORING, SERVICING, OR CLEANING OF TRUCKS OR EQUIPMENT SHALL BE PERFORMED IN AN UPLAND AREA AT A HORIZONTAL DISTANCE GREATER THAN 100 FEET FROM THE WETLAND RESOURCE AREAS.
26. THE CONTRACTOR, SITE ENGINEER, OR OTHER INDIVIDUAL IN CHARGE OF WORK ON THE SITE SHALL HAVE A COPY OF THE ORDER OF CONDITIONS AT ALL TIMES (DEP FILE #XXX–XXXX).
27. CONTRACTOR SHALL REFER TO SPECIFICATION XXX MASSACHUSETTS COVID ORDER AND CONSTRUCTION GUIDELINES AND EXECUTE CONSTRUCTION IN COMPLIANCE WITH APPLICABLE SOCIAL DISTANCING PROTOCOLS.

DEWATERING NOTES:

1. THE CONTRACTOR SHALL SUBMIT A WATER CONTROL MANAGEMENT PLAN FOR THE PROJECT LOCATION IN ACCORDANCE WITH THE SPECIFICATIONS. THE PLAN SHALL INCLUDE A DESCRIPTION OF PROPOSED PROCEDURE FOR DEWATERING METHODS.
2. ALL DEWATERING ACTIVITIES SHALL MEET LOCAL, STATE, AND FEDERAL REGULATIONS.
3. THE CONTRACTOR IS RESPONSIBLE FOR ALL LABOR AND EQUIPMENT REQUIRED TO PERFORM THE WORK INCLUDING BUT NOT LIMITED TO PROPER SHORING, DEWATERING EQUIPMENT, AND WATER TREATMENT EQUIPMENT IN ACCORDANCE WITH THE SPECIFICATIONS AND ALL LOCAL, STATE, AND FEDERAL REGULATIONS.
4. IN ACCORDANCE WITH THE TIME OF YEAR RESTRICTIONS SET FORTH IN 310 CMR 10.11(5) AND THE US ARMY CORPS OF ENGINEERS GENERAL PERMIT FOR MASSACHUSETTS GENERAL CONDITION 18, ALL SILT–GENERATING, IN–WATER WORK SHALL BE CONDUCTED BETWEEN JULY 1ST AND SEPTEMBER 30TH. WORK BEYOND THE LIMITS OF THE WATER, SUCH AS SEEDING AND INSTALLATION OF RESTORATION PLANTINGS, MAY BE CONDUCTED AFTER SEPTEMBER 30TH, PER CONTRACT TIMES LISTED IN THE PROJECT SPECIFICATIONS.
5. ALL DREDGING OPERATIONS SHALL BE CONDUCTED FROM UPLAND AREAS.
6. ALL DREDGE SPOILS SHALL BE DEWATERED AND DISPOSED OF AT AN UPLAND LOCATION (OR OTHER APPROVED LOCATION).
7. THE REMOVAL OF MATERIAL FROM THE STREAM BOTTOM SHALL BE DONE IN SUCH A MANNER AS TO ENSURE THAT THE RECONFIGURED BOTTOM AREA WILL NOT IMPEDE OR OBSTRUCT FISH MIGRATION, OR INTERFERE WITH THE NATURAL FLOW OF THE BROOK.
8. DEWATERING ACTIVITIES SHALL BE CONDUCTED AS SHOWN ON THE APPROVED PLANS AND SHALL BE MONITORED DAILY TO ENSURE THAT SEDIMENT LADEN WATER IS APPROPRIATELY SETTLED PRIOR TO DISCHARGE TOWARD THE RESOURCE AREAS. NO DISCHARGE OF WATER IS ALLOWED DIRECTLY INTO AN AREA SUBJECT TO JURISDICTION OF THE WETLANDS PROTECTION ACT. SHOULD EMERGENCY DEWATERING REQUIREMENTS ARISE, THE APPLICANT SHALL SUBMIT A CONTINGENCY PLAN TO THE COMMISSION FOR APPROVAL WHICH PROVIDES FOR THE PUMPED WATER TO BE CONTAINED IN A SETTLING BASIN, TO REDUCE TURBIDITY TO DISCHARGE INTO A RESOURCE AREA.

EROSION CONTROL NOTES:

1. EROSION CONTROL DEVICES SHALL REMAIN IN PLACE, UNTIL ALL DISTURBED SURFACES HAVE BEEN STABILIZED WITH FINAL VEGETATION COVER OR THE COMMISSION HAS AUTHORIZED THEIR REMOVAL.
2. EROSION CONTROL MEASURES AND BARRIERS SHALL BE MONITORED DAILY AND MAINTAINED, OR REINFORCED AS NECESSARY TO ENSURE AND PREVENT EROSION AND SILTATION OF SOILS TO WETLAND RESOURCE AREAS. ADDITIONAL FILTER FABRIC AND STRAW WATTLES SHALL BE STORED ON SITE FOR EMERGENCY USE.
3. DURING ALL PHASES OF CONSTRUCTION, ALL DISTURBED OR EXPOSED AREAS OUTSIDE THE ROADWAY SHALL BE BROUGHT TO FINISHED GRADE AND EITHER A) LOAMED AND SEEDED FOR PERMANENT STABILIZATION, IN ACCORDANCE WITH U.S. SOIL CONSERVATION SERVICE PROCEDURES, OR B) STABILIZED IN ANOTHER WAY APPROVED BY THE COMMISSION. AREAS THAT CANNOT BE PERMANENTLY STABILIZED WITHIN 30 DAYS OF DISTURBANCE SHALL BE STABILIZED WITH HAY, STRAW, MULCH OR ANY OTHER PROTECTIVE COVERING AND/OR METHOD APPROVED BY THE U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE OR BY OTHER TEMPORARY MEASURES ACCEPTABLE TO THE COMMISSION.
4. PROJECT IS SUBJECT TO THE CONDITIONS SET FORTH IN PERMITS ISSUED BY THE US ARMY CORPS OF ENGINEERS, SUDBURY CONSERVATION COMMISSION, AND MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION, SPECIFICALLY RELATED TO LIMITS OF IMPACT, EROSION CONTROL MEASURES, RESTORATION ACTIVITIES, AND TIMEFRAME RESTRICTIONS. CONTRACTOR SHALL READ PERMIT DOCUMENTS FULLY AND CARRY OUT WORK IN ACCORDANCE WITH PERMIT DOCUMENTS. COPIES OF PERMIT DOCUMENTS ARE APPENDED TO THE PROJECT SPECIFICATIONS.
5. AN ADEQUATE STOCKPILE OF EROSION AND SEDIMENTATION CONTROL MATERIALS SHALL BE ON SITE AT ALL TIMES FOR EMERGENCY OR ROUTINE REPLACEMENT.
6. ANY DAMAGE CAUSED AS A DIRECT RESULT OF CONSTRUCTION TO THE WETLAND RESOURCE AREAS SHALL BE REPAIRED, RESTORED AND/OR REPLACED. SEDIMENTATION OR EROSION SHALL BE CONSIDERED DAMAGE TO THE WETLAND RESOURCE AREAS. IF SEDIMENTATION REACHES THESE AREAS, THE CONSERVATION COMMISSION SHALL BE CONTACTED AND A PLAN FOR THE PROPOSED RESTORATION SHALL BE SUBMITTED FOR APPROVAL.
7. THE SILT FENCE AND STRAW BALES MUST BE INSPECTED PRIOR TO THE START OF ANY WORK OR A $100 PER DAY FINE WILL BE LEVIED ON THE CONTRACTOR.

ABBREVIATIONS

&	AND
A.G.	ABOVE GROUND
BIT	BITUMINOUS
B/W	BETWEEN
BVW	BORDERING VEGETATED WETLAND
CB	CATCH BASIN
CI	CAST IRON
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
D	STORM DRAIN
DI	DUCTILE IRON
DIA.	DIAMETER
DMH	DRAIN MANHOLE
DOT	DEPARTMENT OF TRANSPORTATION
DTL.	DETAIL
E	UNDERGROUND ELECTRICAL
EL.	ELEVATION
E.O.P.	EDGE OF PAVEMENT
EXIST.	EXISTING
FF	FINISH FLOOR
FT	FOOT/FEET
G	GAS MAIN
GS	GAS SERVICE
GALV.	GALVANIZED
GRAN.	GRANITE
HDPE	HIGH DENSITY POLYETHYLENE
HDPP	HIGH DENSITY POLYPROPYLENE
HYD	HYDRANT
INV.	INVERT
LF	LINEAR FEET
MASSDEP	MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
MADOT	MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
MAX.	MAXIMUM
MIN.	MINIMUM
MON	MONUMENT
N.I.C.	NOT IN CONTRACT
NO.	NUMBER
NR	NO RESPONSE
N.T.S.	NOT TO SCALE
OE	OVERHEAD ELECTRIC
OH	OVERHEAD
±	PLUS OR MINUS
LLS	LICENSED LAND SURVEYOR
PROP.	PROPOSED
PT.	POINT
PVC	POLYVINYL CHLORIDE
R.O.W.	RIGHT–OF–WAY
RCP	REINFORCED CONCRETE PIPE
REINF.	REINFORCED
REQ'D	REQUIRED
RPP	RIBBED PLASTIC PIPE
S	SLOPE (FT./FT.)
S	SEWER
SMH	SEWER MANHOLE
SCH	SCHEDULE
STA.	STATION
TOWN	TOWN OF SUDBURY
TYP.	TYPICAL
UNO	UNLESS NOTED OTHERWISE
UP	UTILITY POLE
VC	VITRIFIED CLAY
VIT.	VITRIFIED CLAY
W	WEST
W	WATER
W/	WITH
W	WATERMAIN
WS	WATER SERVICE
WV	WATER VALVE

SYMBOLS

DESCRIPTION	EXISTING
HYDRANT	
CATCH BASIN	
PK NAIL	
WETLAND FLAG LOCATION	WF–A1
BORING	B–X
MANHOLE	

SHEET INDEX

RESOURCE AREA LEGEND

- BORDERING LAND SUBJECT TO FLOODING (100 YEAR FLOOD ZONE, DEFINED BY FEMA)
- BORDERING VEGETATED WETLAND
- EDGE OF PERENNIAL STREAM/ TOP OF BANK
- COFFERDAM
- LIMIT OF WORK — LW —
- SEDIMENT BARRIER
- TURBIDITY CURTAIN

NOTE:

ENTIRE PROJECT AREA WITHIN 100' INNER RIPARIAN ZONE.

LINE TYPES & HATCHES

DESCRIPTION	EXISTING	PROPOSED
CONTOUR (1' INTERVAL)	201	201
CONTOUR (INDEX)	200	200
STORM DRAIN	SD	
BITUMINOUS CURB		
EDGE OF PAVEMENT		
OVERHEAD ELECTRIC	OE	
UNDERGROUND GAS	G	
UNDERGROUND TELEPHONE	T	
WATER LINE	W	W
RIGHT OF WAY/ PROPERTY LINE		
GUARDRAIL	T T T	T T T
LIMIT OF WORK		LW
SEDIMENT BARRIER/COFFERDAM		CD
SEDIMENT BARRIER/SILTSOXX/ SILT FENCE		
TURBIDITY CURTAIN		
SAWCUT		
RETAINING WALL		
STONE WALL		
RIPRAP		
VEGETATED GEOCELL SLOPE STABILIZATION		
TEMPORARY CONSTRUCTION ENTRANCE		
BITUMINOUS PAVEMENT		
TEMPORARY CONSTRUCTION EASEMENT		

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Andover, Massachusetts 01810
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COMMITMENT & INTEGRITY DRIVE RESULTS

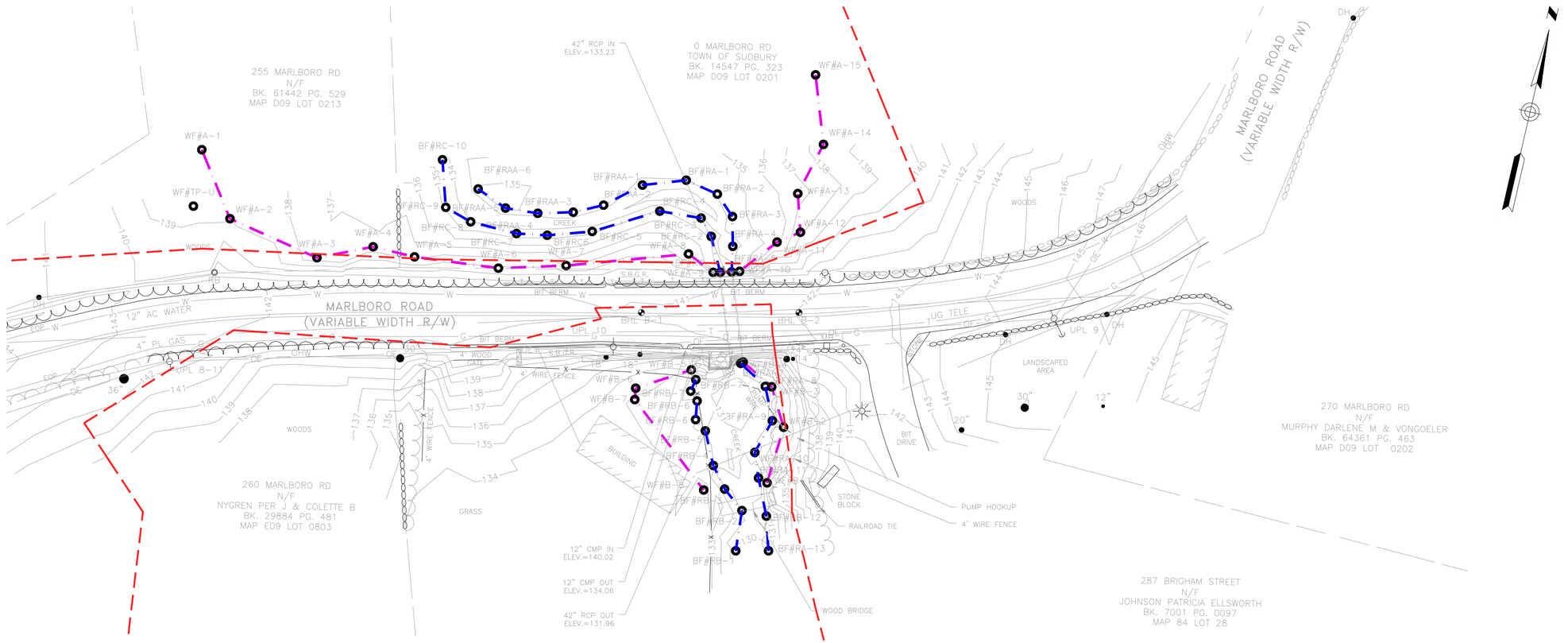
REV	DESCRIPTION	DATE
DESIGNED BY: SET	CHECKED BY: MDM	
DRAWN BY: WSW	227202.06_G-001.dwg	

GENERAL NOTES, LEGEND, ABBREVIATIONS AND SHEET INDEX

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	AS NOTED
SHEET:	2 OF 9

G-001



20' 0 20' 40'

BAR SCALE
1" = 20'
CHECK GRAPHIC SCALE BEFORE USING

RESOURCE AREA LEGEND

BORDERING LAND SUBJECT TO FLOODING
(100 YEAR FLOOD ZONE, DEFINED BY FEMA)

BORDERING VEGETATED WETLAND

EDGE OF PERENNIAL STREAM/
TOP OF BANK

NOTE:

ENTIRE PROJECT AREA WITHIN 100' INNER RIPARIAN ZONE.

NOTICE OF INTENT - NOT FOR CONSTRUCTION

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Andover, Massachusetts 01810
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COMMITMENT & INTEGRITY DRIVE RESULTS

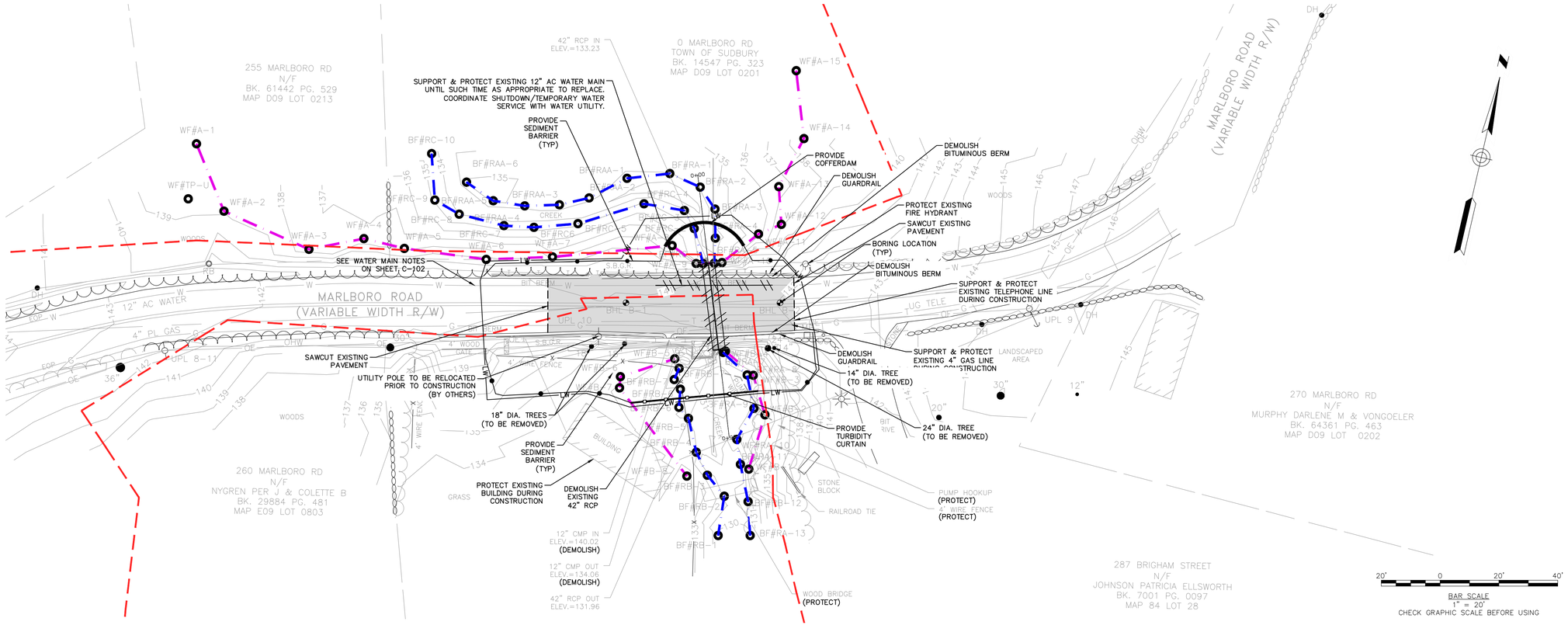
REV	DESCRIPTION	DATE
DESIGNED BY:	SET	CHECKED BY: MDM
DRAWN BY:	WSW	227202\6_C-100.dwg

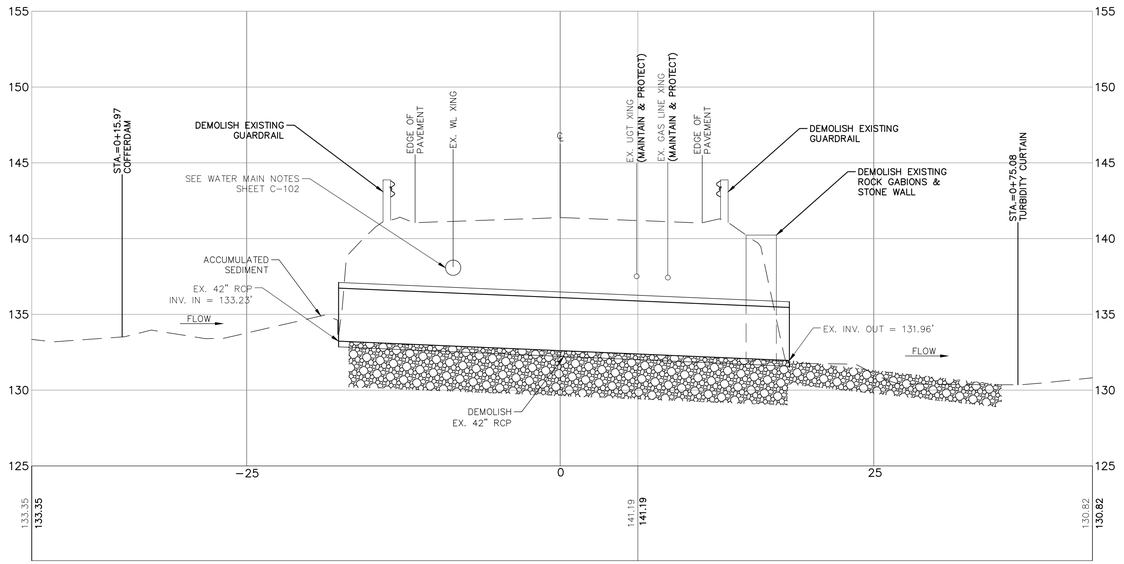
EXISTING CONDITIONS

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT
REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	1" = 20'
SHEET:	3 OF 9

C-100





EXISTING CULVERT SECTION – STA. 1+55

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

RESOURCE AREA LEGEND

- BORDERING LAND SUBJECT TO FLOODING (100 YEAR FLOOD ZONE, DEFINED BY FEMA)
- BORDERING VEGETATED WETLAND
- EDGE OF PERENNIAL STREAM/ TOP OF BANK
- COFFERDAM
- LIMIT OF WORK (LW)
- SEDIMENT BARRIER
- TURBIDITY CURTAIN

NOTE:

ENTIRE PROJECT AREA WITHIN 100' INNER RIPARIAN ZONE.

NOTICE OF INTENT - NOT FOR CONSTRUCTION

WOODARD & CURRAN
40 Shattuck Road, Suite 110
Andover, Massachusetts 01810
866.702.6371 | www.woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

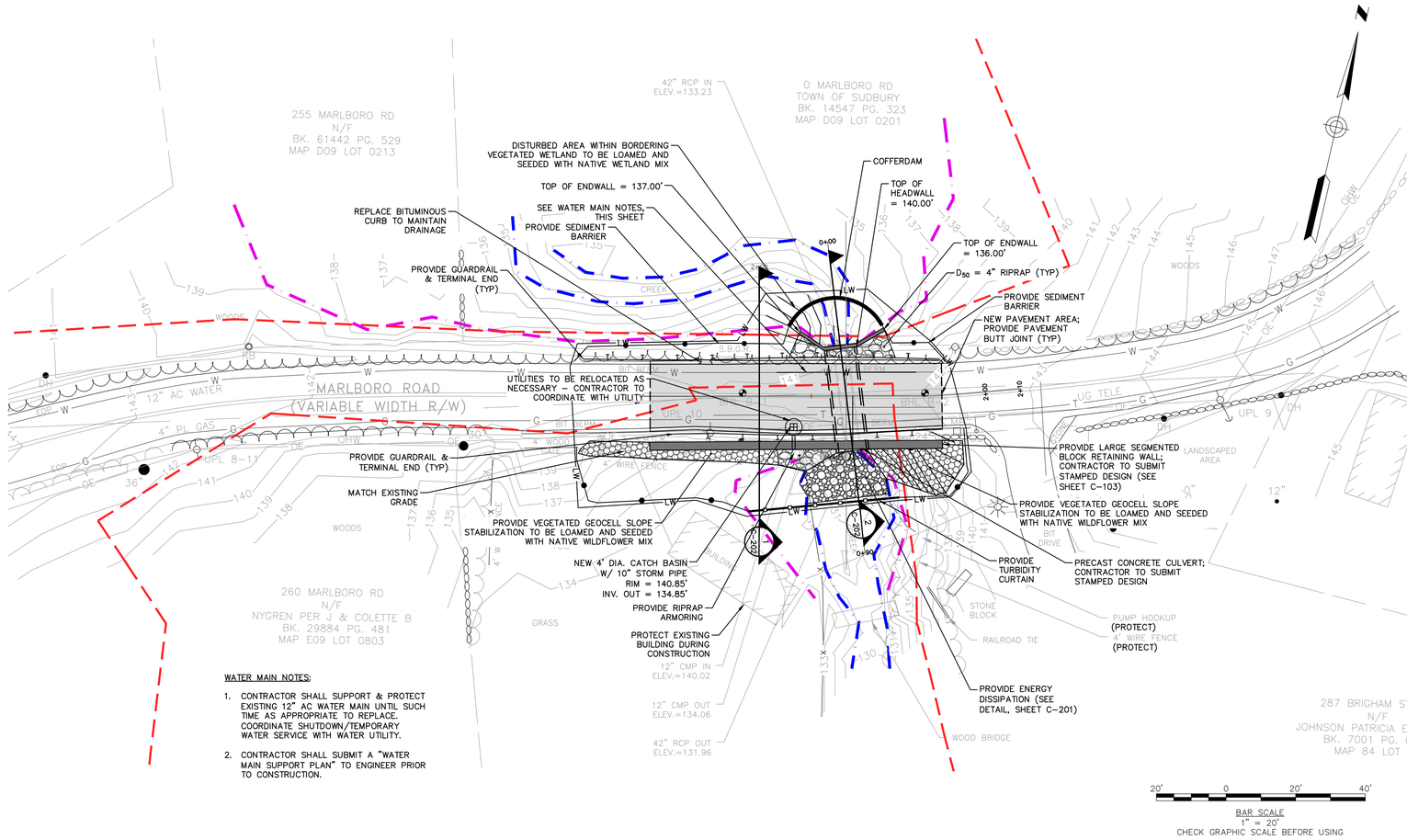
REV	DESCRIPTION	DATE
DESIGNED BY: SET	CHECKED BY: MDM	
DRAWN BY: WSW	227202.06_C-101.dwg	

EROSION CONTROL & DEMOLITION PLAN

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	1" = 20'
SHEET:	4 OF 9

C-101



WATER MAIN NOTES:

1. CONTRACTOR SHALL SUPPORT & PROTECT EXISTING 12" AC WATER MAIN UNTIL SUCH TIME AS APPROPRIATE TO REPLACE. COORDINATE SHUTDOWN/TEMPORARY WATER SERVICE WITH WATER UTILITY.
2. CONTRACTOR SHALL SUBMIT A "WATER MAIN SUPPORT PLAN" TO ENGINEER PRIOR TO CONSTRUCTION.

RESOURCE AREA IMPACT TABLE

	PERMANENT	TEMPORARY
BANK	0 L.F.	128 L.F.
BVW	0 S.F.	346 S.F.
BORDERING LAND SUBJECT TO FLOODING	0 S.F.	2,381 S.F.
LAND UNDER WATERBODIES & WATERWAYS	0 S.F.	560 S.F.
RIVERFRONT AREA (100' INNER RIPARIAN AREA)	0 S.F.	800 S.F.
TOTAL	0 S.F. 0 L.F.	4,087 S.F. 128 L.F.

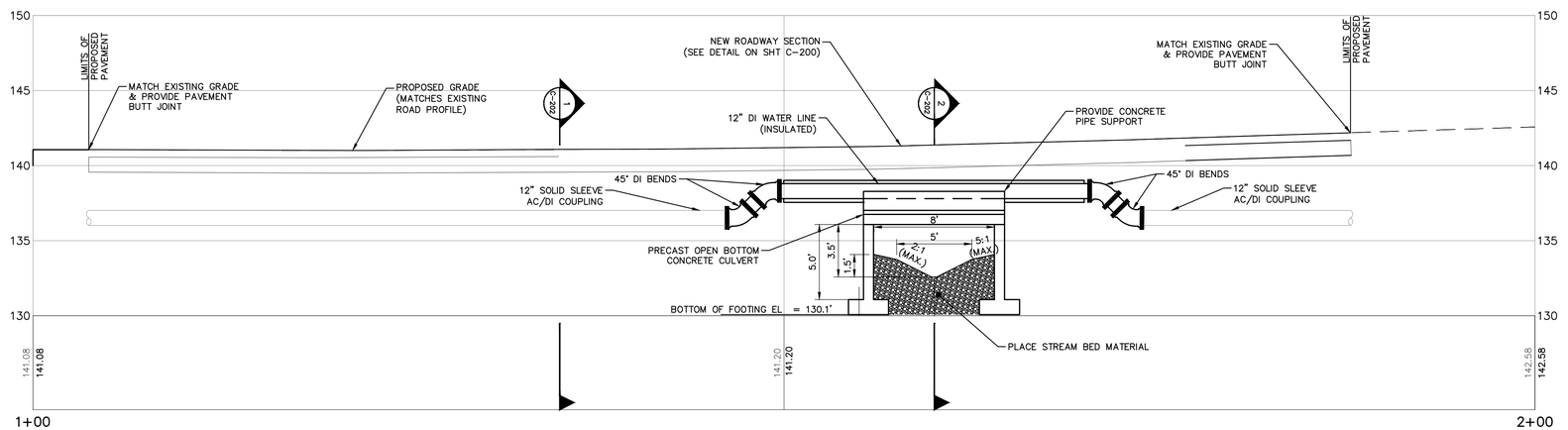
NOTE: ALL SLOPES STEEPER THAN 3:1 SHALL RECEIVE EROSION CONTROL MATTING UNLESS NOTED OTHERWISE.

RESOURCE AREA LEGEND

- BORDERING LAND SUBJECT TO FLOODING (100 YEAR FLOOD ZONE, DEFINED BY FEMA)
- BORDERING VEGETATED WETLAND
- EDGE OF PERENNIAL STREAM/ TOP OF BANK
- COFFERDAM
- LIMIT OF WORK — LW —
- SEDIMENT BARRIER
- TURBIDITY CURTAIN

NOTE:

ENTIRE PROJECT AREA WITHIN 100' INNER RIPARIAN ZONE.



PROFILE STA. 1+00 TO STA. 2+00

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

NOTICE OF INTENT - NOT FOR CONSTRUCTION

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COMMITMENT & INTEGRITY DRIVE RESULTS

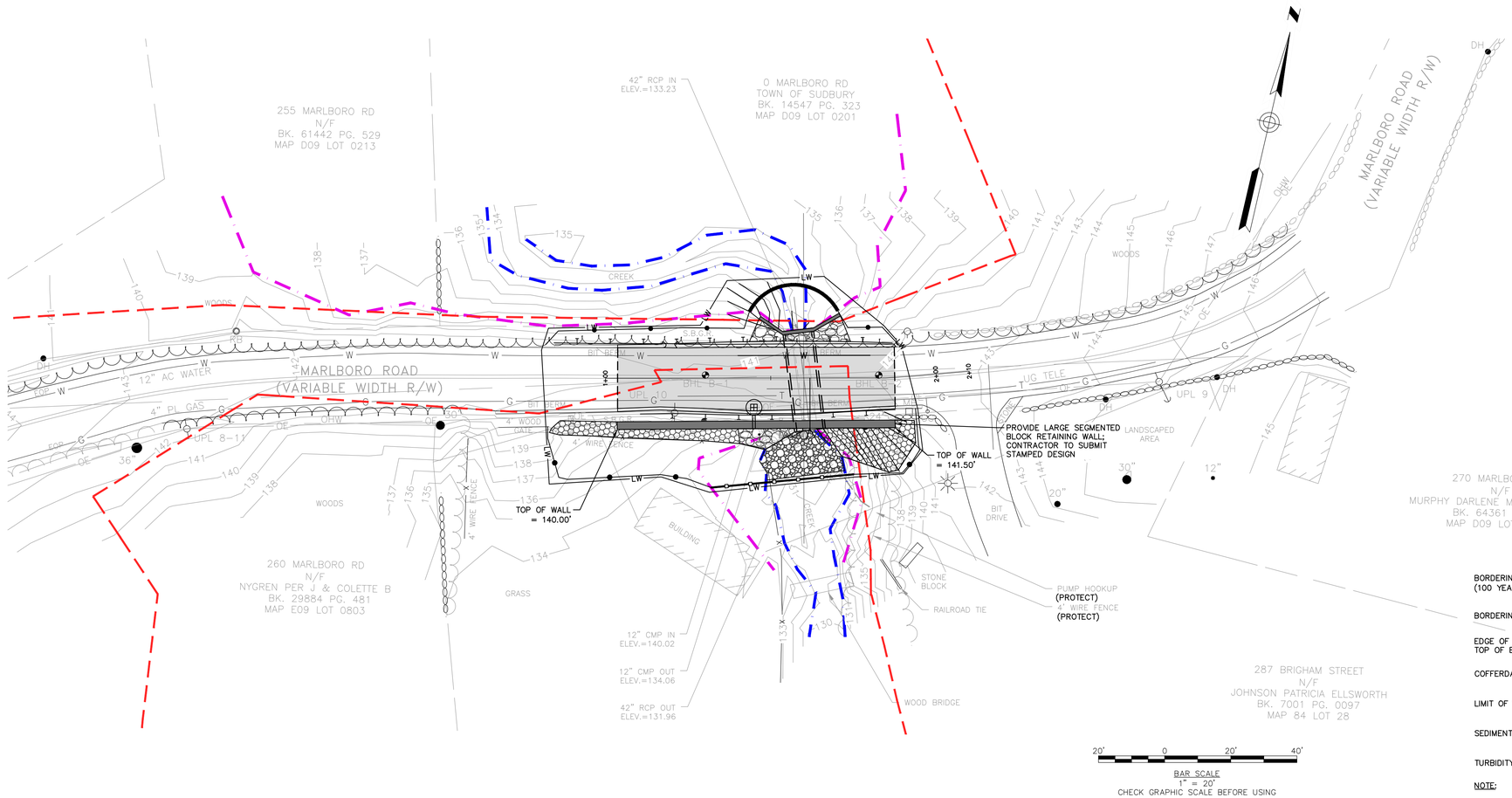
REV	DESCRIPTION	DATE
DESIGNED BY: SET	CHECKED BY: MDM	
DRAWN BY: WSW	227202\6_C-102.dwg	

SITE PLAN & PROFILE

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

JOB NO: 227202.06
DATE: MAY 2020
SCALE: 1" = 20'
SHEET: 5 OF 9

C-102

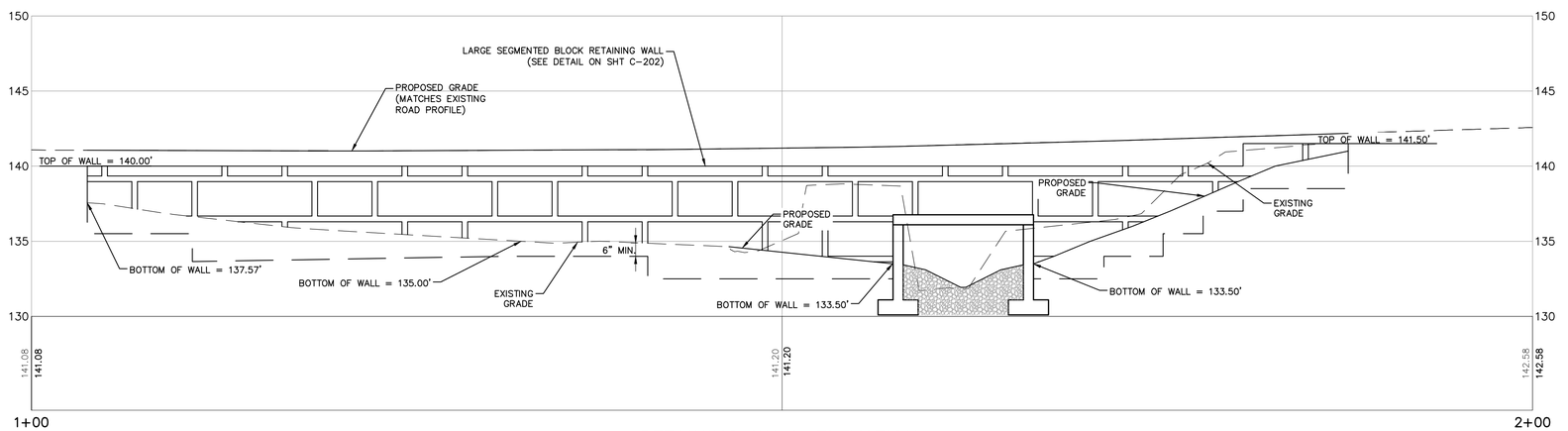


RESOURCE AREA LEGEND

- BORDERING LAND SUBJECT TO FLOODING (100 YEAR FLOOD ZONE, DEFINED BY FEMA)
- BORDERING VEGETATED WETLAND
- EDGE OF PERENNIAL STREAM/ TOP OF BANK
- COFFERDAM
- LIMIT OF WORK — LW —
- SEDIMENT BARRIER
- TURBIDITY CURTAIN

NOTE:

ENTIRE PROJECT AREA WITHIN 100' INNER RIPARIAN ZONE.



RETAINING WALL ELEVATION

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

NOTICE OF INTENT - NOT FOR CONSTRUCTION

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REV	DESCRIPTION	DATE
DESIGNED BY: SET	CHECKED BY: MDM	
DRAWN BY: WSW	227202\8_C-103.dwg	

RETAINING WALL - PLAN & ELEVATION

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT
REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	1" = 20'
SHEET:	6 OF 9

C-103

EROSION AND SEDIMENT CONTROL NOTES

Temporary Erosion Control

Measure	Dates For Use	Timing, Activity, and Location
Sedimentation Barrier	ALL	Before soil disturbance, install downhill of areas to be disturbed and around material stockpiles.
Up-slope Diversion	ALL	Before soil disturbance, install uphill of areas to be disturbed and material stockpiles.
Catch Basin Protection	ALL	Before soil or pavement disturbance, install ACF Environmental, Inc. High Flow Siltsack, Siltsaver Inlet Filter. or equal, installed per manufacturer's requirements.
Dust Control	ALL	During dry weather, apply water and calcium chloride to control dust.
Temporary Seeding	April 15 to Oct. 15	Soil stockpiles that are not covered and disturbed areas that will not be disturbed again within 14 days. If grass growth provides less than 95% soil coverage by Nov. 1, apply mulch and anchor with erosion control blanket.
Mulch	April 15 to Sept. 15	On all areas of exposed soil prior to rain events apply 100-150 lbs (2.5 bales) per 1,000 sq ft. by mechanical blower.
Winter Mulch	Sept. 16 to Oct. 31	On all areas of exposed soil prior to precipitation apply 150 to 170 lbs. mulch (4 bales) per 1,000 sq. ft. by mechanical blower, Erosion control blanket may be used as a substitute for winter mulch.
	Nov. 1 to April 14	On all areas of exposed soil, apply 150 to 170 lbs. mulch (4 bales) per 1,000 sq. ft. and anchor with netting at the end of each working day. Erosion control blanket may be used as a substitute for winter mulch.
Inspections	Until site is permanently stabilized	Inspect the erosion and sedimentation control measures daily, and after rainfall of half inch or greater in a 24-hour period, and maintain and repair as necessary.

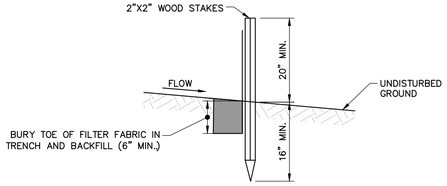
Permanent Erosion Control:

Measure	Dates For Use	Timing, Activity, and Location
Pavement - Base Course - Final Course	When no frost is in ground	Install only in areas shown on the plan, shortly after pavement base is brought to final grade. Install near completion of project.
Permanent Seeding	April 15 to Sept. 15	On final grade areas, within 7 days of grade preparation, prepare topsoil, followed by seed and mulch application.
Dormant Seeding	Sept. 16 to April 15	On final grade areas, with prepared topsoil. Apply seed at double the specified rate on bare soil, and follow with an application of winter mulch.
Ground Cover, Trees, Shrubs	April 15 to Nov. 1	Install with final landscaping.
Permanent Mulch	ALL	Install with final landscaping.

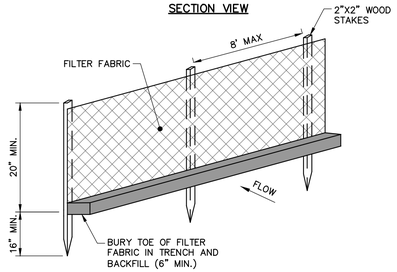
Inspections:

Regular inspections of all erosion and sedimentation controls shall be made at least weekly and prior to and following storm events. Minimum inspections shall be made as listed in the table below.

Inspected Item	Look For
Mulched Surfaces	Thin mulch or inadequate application. Wind movement.
Seeded Surfaces	Poor seed germination. Loss of mulch. Development of rivulets.
Sediment Barrier	Sediment build-up to one half the height of the barrier. Undermining of the barrier. Supporting stakes loose, toppled, or unmarked. Breaks in barrier.
Perimeter Diversion	Discharge is to stabilized area. Erosion or breaks in barrier. Supporting stakes loose, toppled or unmarked.
Catch Basin Protection	Sediment build-up and structure blockages. Slow flow/Ponding water. Breaks in fabric or voids in barrier.
Dewatering Filter	Breaks in fabric or supporting structure. Slow flow, indicating high sediment build-up.
Construction Entrance	Sedimentation of roadways. Off-site dust complaints.



SECTION VIEW



ISOMETRIC VIEW

NOTES:

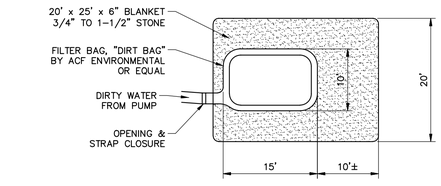
1. INSTALL FABRIC ON UPHILL SIDE OF WOOD STAKES.
2. SPACING BETWEEN WOOD STAKES PER MANUFACTURER'S RECOMMENDATION.
3. SILT FENCE WILL NOT BE USED IN DRAINAGE WAYS.
4. MAINTENANCE: INSPECT FOR TEARS IN THE FABRIC OR DAMAGE TO SUPPORTS. REPAIR AS NECESSARY. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES A DEPTH OF SIX-INCHES OR MORE.
5. REMOVAL: WHEN UPSLOPE AREAS ARE STABILIZED, THE STRUCTURE AND ANY ACCUMULATED SEDIMENT WILL BE REMOVED.

SEDIMENT BARRIER - SILT FENCE (CONTRACTOR OPTION)

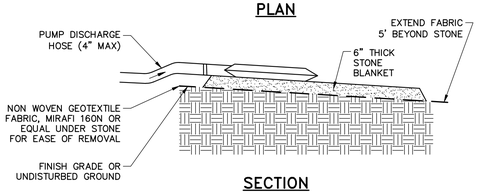
N.T.S.

DEWATERING NOTES

1. LOCATE DISCHARGE SITE ON FLAT UPLAND AREAS AS FAR AWAY AS POSSIBLE FROM STREAMS, WETLANDS, OTHER RESOURCES AND POINTS OF CONCENTRATED FLOW.
2. NEVER DISCHARGE TO AREAS THAT ARE BARE OR NEWLY VEGETATED.
3. DIRT BAG MATERIAL BASED ON PARTICLE SIZE IN DIRTY WATER, I.E., FOR COARSE PARTICLES A WOVEN MATERIAL; FOR SILTS/CLAYS A NON-WOVEN MATERIAL.
4. DO NOT OVER PRESSURIZE DIRT BAG OR USE BEYOND CAPACITY.
5. CHANNELS DUG FOR DISCHARGING WATER FROM THE EXCAVATED AREA NEED TO BE STABLE. IF FLOW VELOCITIES CAUSE EROSION WITHIN THE CHANNEL THEN A DITCH LINING SHOULD BE USED.
6. BUCKETED WATER SHOULD BE DISCHARGED IN A STABLE MANNER TO THE SEDIMENT REMOVAL AREA. A SPLASH PAD OF RIPRAP UNDERLAIN WITH GEOTEXTILE MAY BE NECESSARY TO PREVENT SCOURING OF SOIL.
7. DEWATERING IN PERIODS OF INTENSE, HEAVY RAIN, WHEN THE INFILTRATIVE CAPACITY OF THE SOIL IS EXCEEDED, SHOULD BE AVOIDED.
8. INSTALL DIVERSION DITCHES OR BERMS TO MINIMIZE THE AMOUNT OF CLEAN STORMWATER RUNOFF ALLOWED INTO THE EXCAVATED AREA.
9. DURING THE ACTIVE DEWATERING PROCESS, INSPECTION OF THE DEWATERING FACILITY SHOULD BE REVIEWED FREQUENTLY. SPECIAL ATTENTION SHOULD BE PAID TO THE BUFFER AREA FOR ANY SIGN OF EROSION AND CONCENTRATION OF FLOW THAT MAY COMPROMISE THE BUFFER AREA. OBSERVE WHERE POSSIBLE THE VISUAL QUALITY OF THE EFFLUENT AND DETERMINE IF ADDITIONAL TREATMENT CAN BE PROVIDED.
10. EROSION CONTROL REQUIRED AROUND DEWATERING DISCHARGE SEDIMENT CONTROL DEVICE.



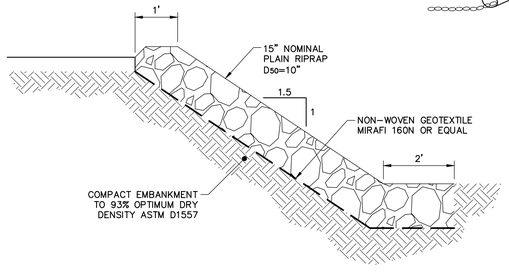
PLAN



SECTION

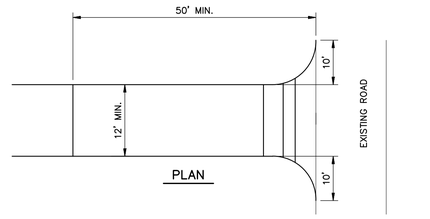
DEWATERING DISCHARGE SEDIMENT CONTROL DEVICE

N.T.S.

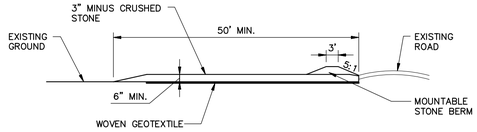


RIPRAP SLOPE DETAIL

N.T.S.



PLAN



PROFILE

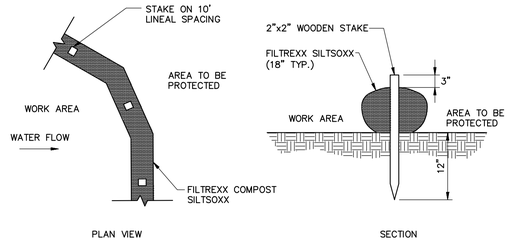
NOTES:

MAINTENANCE: INSPECT FOR EFFECTIVE REMOVAL OF SOIL FROM VEHICLES PRIOR TO LEAVING THE SITE. SWEEP ANY SOIL FROM ADJACENT ROADWAYS.

REMOVAL: AT LEAST ONE CONSTRUCTION ENTRANCE SHALL BE MAINTAINED UNTIL ALL AREAS OF THE SITE ARE STABILIZED.

STABILIZED CONSTRUCTION ENTRANCE

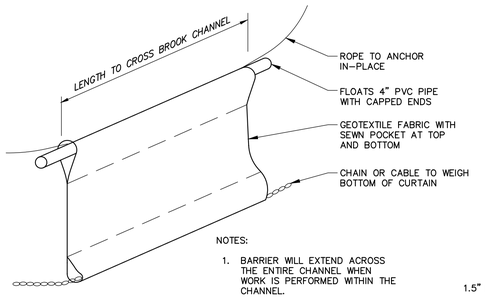
N.T.S.



PLAN VIEW SECTION

SEDIMENT BARRIER - SILTSOXX (CONTRACTOR OPTION)

N.T.S.

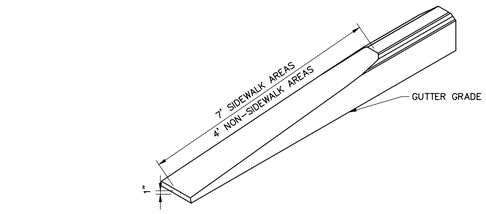


NOTES:

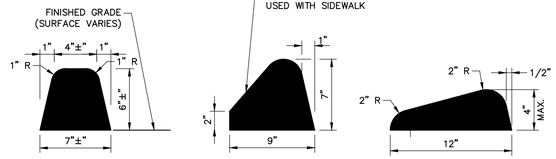
1. BARRIER WILL EXTEND ACROSS THE ENTIRE CHANNEL WHEN WORK IS PERFORMED WITHIN THE CHANNEL.
2. ROPE SHALL BE 1/2" NYLON OR MANILA.

FLOATING TURBIDITY BARRIER

N.T.S.

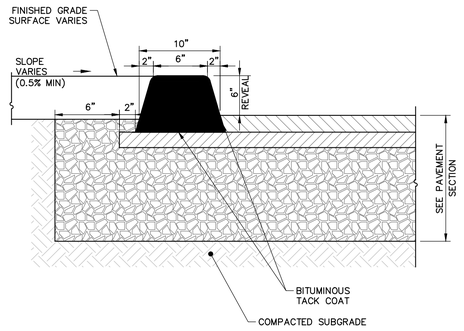


ISOMETRIC VIEW



MOLD 1 MOLD 2 MOLD 3

ALTERNATIVE CURB MOLDS



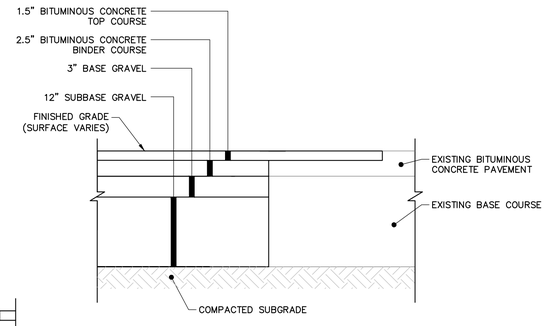
PLAN VIEW

NOTES:

1. CURB MOLD 2 WILL BE USED IN ALL SITUATIONS EXCEPT WHERE THE CURB FORMS THE EDGE OF THE SIDEWALK. MOLD 1 SHALL BE USED IN CONJUNCTION WITH SIDEWALKS OR WHERE THERE IS A POTENTIAL FOR SIDEWALKS.

BITUMINOUS CURB

NOT TO SCALE



BITUMINOUS PAVEMENT BUTT JOINT

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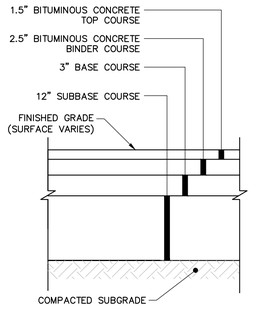

BITUMINOUS PAVEMENT SECTION

N.T.S.

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COMMITMENT & INTEGRITY DRIVE RESULTS
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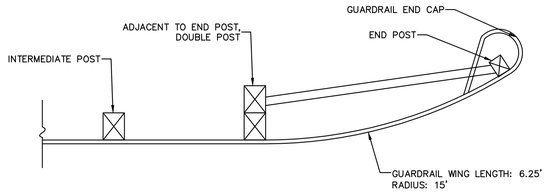
REV	DESCRIPTION	DATE
DESIGNED BY:	SET	CHECKED BY: MDM
DRAWN BY:	WSW	227202.06_C-200.dwg

PROJECT DETAILS - 1

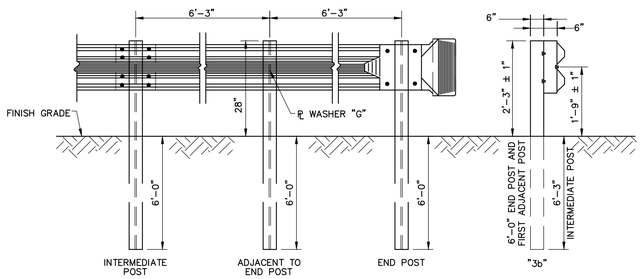
TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	AS NOTED
SHEET:	7 OF 9

C-200



PLAN VIEW

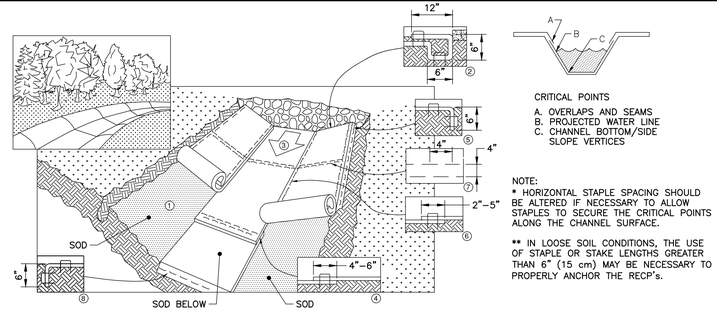


NOTES:

- ALL POST SPACING SHALL BE 6'-3" UNLESS OTHERWISE DIRECTED BY ENGINEER.
- GUARDRAIL SHALL BE MDOT SPECIFICATION TYPE "3b" POSTS
- ALL HOLES IN BEAM SHALL BE SHOP-PUNCHED BEFORE GALVANIZING.

STEEL GUARDRAIL DETAIL

SCALE: NOT TO SCALE



CRITICAL POINTS

A. OVERLAPS AND SEAMS
B. PROJECTED WATER LINE
C. CHANNEL BOTTOM/SIDE SLOPE VERTICES

NOTE:
* HORIZONTAL STAPLE SPACING SHOULD BE ALTERED IF NECESSARY TO ALLOW STAPLES TO SECURE THE CRITICAL POINTS ALONG THE CHANNEL SURFACE.

** IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" (15 cm) MAY BE NECESSARY TO PROPERLY ANCHOR THE RECP's.

1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SOD. PROVIDE SOD BELOW TRM.

2. BEGIN AT THE TOP OF THE CHANNEL BY ANCHORING THE RECP's IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH WITH APPROXIMATELY 12" (30 CM) OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMAPCT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" (30 CM) PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30 CM) ACROSS THE WIDTH OF THE RECP's.

3. ROLL CENTER RECP's IN DIRECTION OF WATER FLOW IN BOTTOM OF CHANNEL. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM , STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.

4. PLACE CONSECUTIVE RECP's END OVER END (SHINGLE STYLE) WITH A 4" – 6" (10 CM –15 CM) OVERLAP. USE A DOUBLE ROW OF STAPLES STAGGERED 4" (10 CM) APART AND 4" (10 CM) ON CENTER TO SECURE RECP's.

5. FULL LENGTH EDGE OF RECP's AT TOP OF SIDE SLOPES MUST BE ANCHORED WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.

6. ADJACENT RECP's MUST BE OVERLAPPED APPROXIMATELY 2" – 5" (5 CM –12.5 CM) (DEPENDING ON RECP's TYPE) AND STAPLED.

7. IN HIGH FLOW CHANNEL APPLICATIONS, A STAPLE CHECK SLOT IS RECOMMENDED AT 30 TO 40 FOOT (9 M – 12 M) INTERVALS. USE A DOUBLE ROW OF STAPLES STAGGERED 4" (10 CM) APART AND 4" (10 CM) ON CENTER OVER ENTIRE WIDTH OF THE CHANNEL.

8. THE TERMINAL END OF THE RECP's MUST BE ANCHORED WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.

NOTE:
* IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" (15 CM) MAY BE NECESSARY TO PROPERLY ANCHOR THE RECP's.

TURF REINFORCING MATTING

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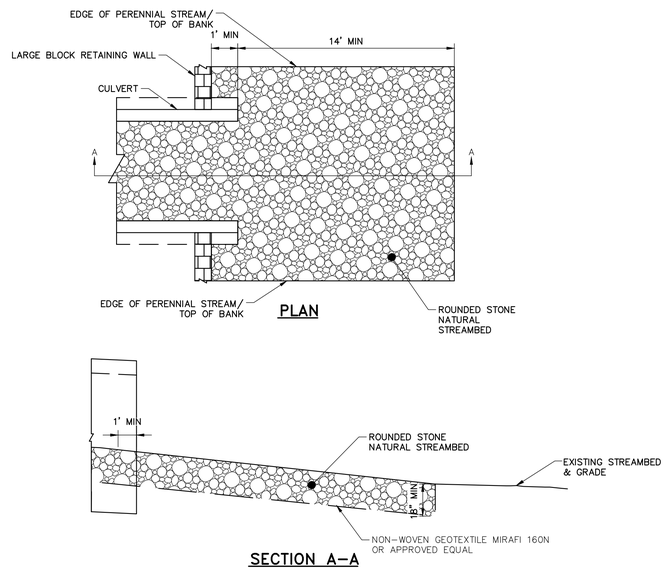
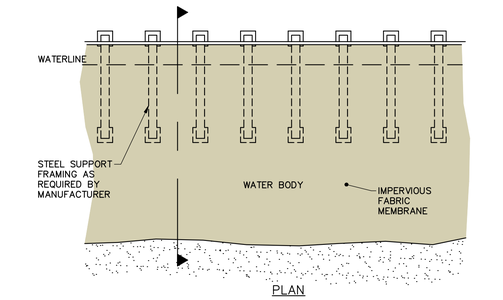


PLAN

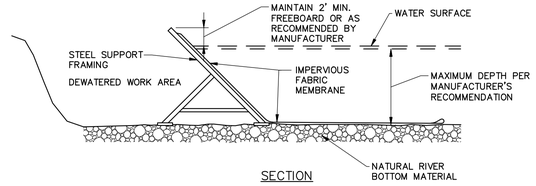
SECTION A-A

ENERGY DISSIPATION DETAIL

N.T.S.



PLAN



SECTION

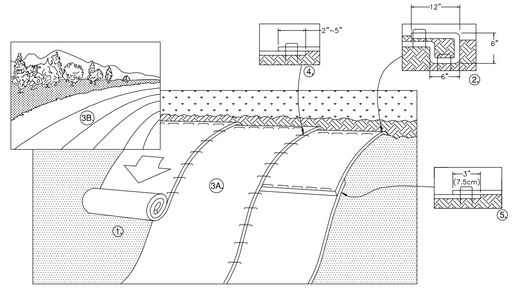
NOTE:

COFFERDAM DETAIL SHOWN FOR REFERENCE PURPOSES. CONTRACTOR SHALL PROVIDE DESIGN OF TEMPORARY COFFERDAMS, STAMPED BY A LICENSED PROFESSIONAL ENGINEER IN THE COMMONWEALTH OF MASSACHUSETTS.

COFFER DAM DETAIL

N.T.S.

TO BE INSTALLED AROUND WORK AREA IN ACCORDANCE WITH CONTRACTOR'S WORK PLAN



1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED AS WELL AS REMOVING ANY PROTRUDING ROCKS, STUMPS OR ROOTS. DURING THE GROWING SEASON (APRIL 15 – SEPTEMBER 15) USE RECP'S ON SLOPES HAVING A GRADE GREATER THAT 15%, OR ANYWHERE WHERE HAY MULCH HAS PROVEN TO BE INEFFECTIVE AT CONTROLLING SHEET EROSION. RECP'S ARE A MANUFACTURED COMBINATION OF MULCH AND NETTING DESIGNED TO PREVENT EROSION AND RETAIN SOIL MOISTURE. FOR OVER WINTER PROTECTION, APPLY RECP'S ON SLOPES STEEPER THAN AN 8% GRADE.

2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE RECP's IN A 6" DEEP X 6" WIDE TRENCH WITH APPROXIMATELY 12" OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH (USE OF METAL STAPLES IS PROHIBITED). BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" APART ACROSS THE WIDTH OF THE RECP's.

3. ROLL THE RECP's (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.

4. THE EDGES OF PARALLEL RECP's MUST BE STAPLED WITH APPROXIMATELY 2" – 5" OVERLAP DEPENDING ON RECP's TYPE.

5. CONSECUTIVE RECP's SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" APART ACROSS ENTIRE RECP's WIDTH. NOTE: *IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" MAY BE NECESSARY TO PROPERLY SECURE THE RECP's.

6. UNTIL GRASS HAS GOOD COVERAGE, INSPECT PERIODICALLY AND AFTER EACH RAINSTORM TO CHECK FOR EROSION. IMMEDIATELY REPAIR AND ADD MORE MULCH UNTIL GRASSES ARE FIRMLY ESTABLISHED. DO NOT MOW THE FIRST YEAR.

7. EROSION CONTROL MATTING AND GROUND FASTENERS SHALL BE 100% BIODEGRADABLE.

EROSION CONTROL MATTING

N.T.S.

NOTICE OF INTENT - NOT FOR CONSTRUCTION

WOODARD & CURRAN
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Andover, Massachusetts 01810
866.702.6371 | www.woodardcurran.com
COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE

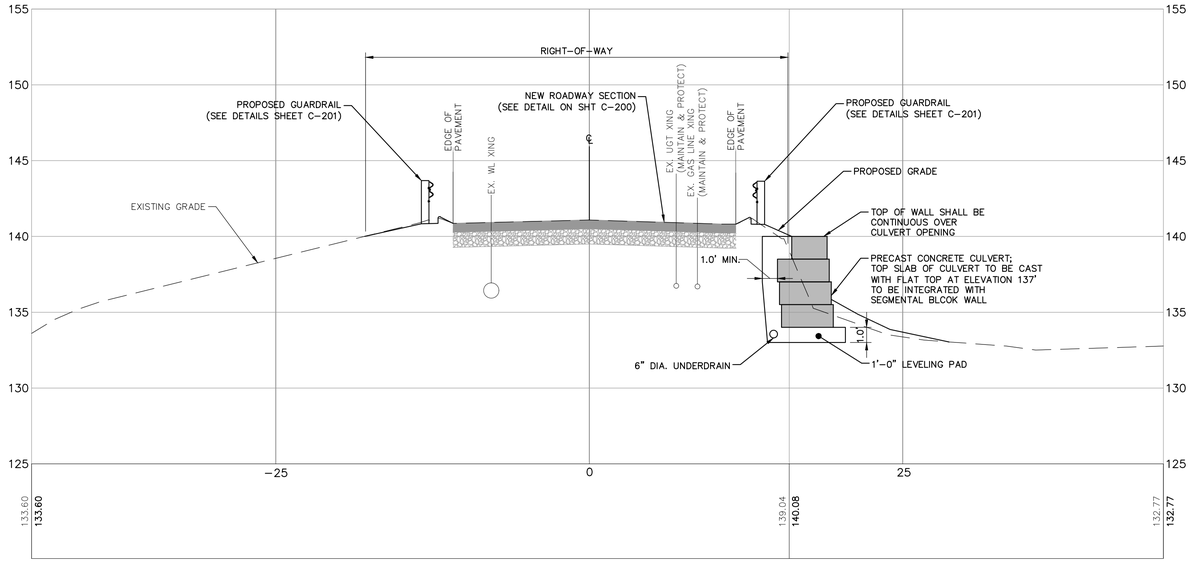
DESIGNED BY: SET
DRAWN BY: WSW
CHECKED BY: MDM
227202.06_C-201.dwg

PROJECT DETAILS - 2

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	AS NOTED
SHEET:	8 OF 9

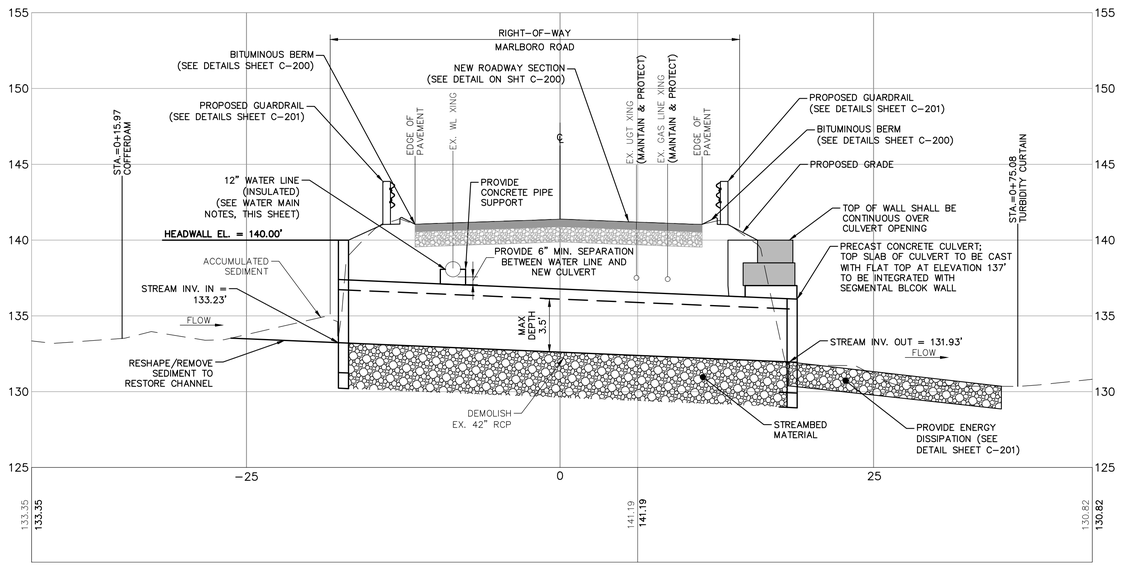
C-201



SECTION 1

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

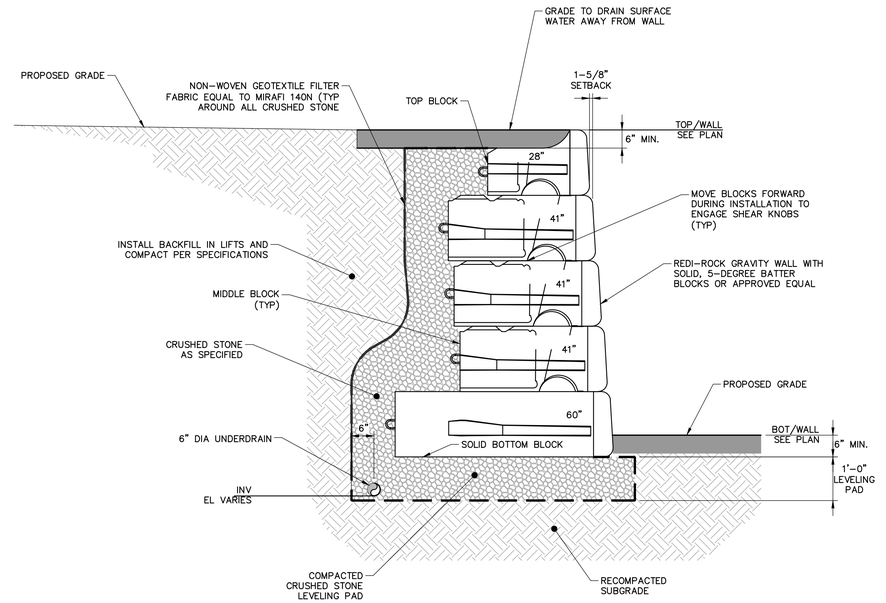
1 / C-202



SECTION 2

HORIZONTAL SCALE: 1" = 5'
VERTICAL SCALE: 1" = 5'

2 / C-202



RETAINING WALL DETAIL

N.T.S.

NOTES:

1. RETAINING WALL SECTIONS ARE CONCEPTUAL IN NATURE AND FOR REFERENCE PURPOSES TO AID IN THE LAYOUT AND DEVELOPMENT OF WALL DESIGN (BY OTHERS). GRAVITY WALL ENGINEER SHALL PROVIDE FINAL WALL DESIGN AND CALCULATIONS, STAMPED AND SIGNED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF MASSACHUSETTS SUBJECT TO REVIEW OF THE ENGINEER.
2. REFER TO SHEET C-102 FOR PLAN VIEW AND LIMITS OF PROPOSED RETAINING WALL.
3. REFER TO SPECIFICATION SECTION 31 00 00 FOR MATERIAL GRADATIONS AND REQUIREMENTS.
4. ELEVATIONS SHOWN ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.
5. REFER TO SECTIONS AND PLANS FOR BACK FILL INFORMATION.

NOTICE OF INTENT - NOT FOR CONSTRUCTION

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COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE
DESIGNED BY:	SET	CHECKED BY: MDM
DRAWN BY:	WSW	227202.06_C-202.dwg

PROJECT DETAILS - 3

TOWN OF SUDBURY, MA
MARLBORO ROAD CULVERT REPLACEMENT

JOB NO:	227202.06
DATE:	MAY 2020
SCALE:	AS NOTED
SHEET:	9 OF 9

C-202