AUGUST 2020

CASE STUDY: INCREASING REGIONAL FLOOD RESILIENCY THROUGH RE-DESIGNING CULVERTS IN THE HOWLETT BROOK WATERSHED

TECHNICAL REPORT

Prepared for: Ross Povenmire

Prepared by: Kaitlyn Shaw

Town of Boxford Massachusetts

IPSWICH RIVER WATERSHED ASSOCIATION

TEAMS INVOLVED

This project was a collaboration between the Ipswich River Watershed, as project manager, The Town of Boxford as project proponent, Trout Unlimited National and the Town's of Topsfield and Ipswich.

Funding for this project was provided by EOEEA's Massachusett's Municipal Vulnerability Preparedness Action Grant Program. Project concept and initial funding provided through National Fish and Wildlife Foundation Forest and Rivers Fund, "Restore Coldwater and Diadromous Fish Habitat in Howlett Brook Watershed (MA)."

Massachusetts Municipal Vulnerability Preparedness Program Action Grants

Forest and Rivers Fund

INTRODUCTION

COMMUNITY OVERVIEW

The Town of Boxford is a small semi-rural suburban community located in the low-lying coastal plain region of Northeast Massachusetts. It is located within 3 watersheds of the Ipswich, Parker and Merrimack Rivers and has a large number of ponds, streams and wetland areas. The Town of Boxford committed to working with the Ipswich River Watershed Association and Trout Unlimited to further restoration work in the Towns of Boxford, Ipswich and Topsfield as part of the Howlett Brook project. As part of this project, culverts were prioritized in terms of flood resiliency and ecological impact, then conceptual designs and cost estimates were provided for the top 12 structures. This project will position the Towns of Boxford, Ipswich and Topsfield for the next phase of work which will be on-the-ground project implementation of culverts critical to enhancing community flood resilience and aquatic passage.

DESCRIPTION OF CLIMATE IMPACT

As exemplified by the Mother's Day Flood of 2006, which is the flood of record, the Boxford's roadway infrastructure is exceedingly vulnerable to flooding, largely as a result of undersized and aging culverts. This vulnerability was further identified and assessed in the town's Hazard Mitigation Plan, recently completed Municipal Vulnerability Plan as well as the town's most recent 5-year Capital Improvement Plan (CIP). Careful and appropriate modelling, site assessment and design is a critical precursor to successful culvert upgrade projects. Once designed and successfully implemented, this project will lead to a dramatic reduction in flood risk to vulnerable populations and municipal infrastructure, restore habitats, and provide many other co-benefits that will increase community and ecological resiliency. In addition to meeting the Massachusetts Stream Crossing Standards, culverts will be designed to pass at least the future 100-year storm flow to the maximum extent practicable, and will represent a first step towards progressing culvert replacements throughout the Howlett Brook Watershed.

FUNDING DETAILS

MVP GRANT AWARD: $ 45,855
PROPOSED MATCH: $ 15,360
ACTUAL MATCH: $$17585.25

PROJECT GOAL & OUTCOMES

PROJECT GOAL

Provide twelve, 30% design plans based on the Massachusetts Stream Crossing Standards and future modeled climatic conditions. Position the towns to pursue implementation funding and when implemented will increase flood resiliency, reduce community risk and restore natural habitats in three municipalities (Boxford, Ipswich and Topsfield).

DETAILS

- Topographic survey of project site. Data collected will reflect current MA DER protocols for culvert assessments.
- Collect USFS Stream Simulation protocol measurements and evaluate and select a “reference reach” to be included in the sites hydraulic modeling.
- Perform a preliminary hydraulic modeling analysis of stormwater flows using HY8, analyze stormwater flows using 2, 10, 25, 50 & 100-year return interval storms.
- Select an appropriate replacement structure that will meet or exceed the 100-year stream flow requirements to the extent practicable based on future precipitation model projections.
- Prepare a conceptual design report that includes: preliminary structural and instream conceptual designs and a preliminary cost analysis.
- Engage with the landowners, state agencies, and local/regional suppliers on specific structural requirements and real time material costs.
- Community engagement and presentations

PROJECT STRATEGY

Prioritize Sites & Desktop Analysis

Abutter Determination

Total Station Site Surveys & Abutter Engagement

Analyze Stream Stats and Desktop Analysis of Site

Engineering Design & Cost Estimates Prepared

Disseminate Project to Community

PROJECT BENEFITS

- **Enhanced flood protection through the use of nature-based solutions.**
- **Larger culverts offer reduced vulnerability to climate change impacts.**
- **Re-sizing culverts using a sub-watershed scale approach allows for enhanced habitat restoration and public buy-in for resiliency and restoration work.**
- **Provides a next step for Towns to apply for funding to advance resiliency and restoration projects.**

PROJECT APPROACH & OUTCOMES

A total of 13 30% design plans and cost estimates were developed for the Howlett Brook region in Boxford, Ipswich and Topsfield. First site assessments were performed by Trout Unlimited using a total station to capture aspects of site conditions needed to produce draft plan sets. Site access was gained through direct engagement with project abutters, assistance from Town staff and MassDOT. Next one draft plan set was finalized through engagement with State agencies and Town staff. Next, guidelines to determine realistic project costs for Massachusetts were developed using the MassDOT cost estimator tool and similar local projects. Finally, the remaining site design plans and cost estimates were developed for the remaining 12 sites.

Plan set packets were prepared and delivered to Ipswich, Boxford and Topsfield.

Plans were developed for the following road-stream crossings:

Boxford Rd, Ipswich
East St, Topsfield
Georgetown Rd, Boxford
Haverhill Rd, Topsfield
Herrick Rd, Boxford
Ipswich Rd, Boxford
Linebrook Rd, Ipswich
Private Drive (Off Haverhill St), Topsfield
Old Right Rd, Ipswich
Plains Rd, Ipswich
Pond St, Topsfield
Pye Brook Lane, Boxford
Wildes Rd, Topsfield

OUTCOMES (in Appendix)

- Trout Unlimited Technical memo
- Contact irwainfo@ipswichriver.org for pdf plan sets or CAD files.
- **Web link:** https://www.ipswichriver.org/howlett-brook-watershed-restoration/
- **Youtube project video:** https://youtu.be/IzmBs9OVSrE

TECHNICAL PROJECT APPROACH

DESKTOP ANALYSIS TOOLS:

- USGS StreamStats was used to define drainage area, structural locations, and flow return interval statistics.
- EFH-2 (NRCS) was used in conjunction with StreamStats for confirming runoff and peak discharge volumes.
- Google Earth and related online mapping tools were utilized to collect topographic and satellite imagery to evaluate and collect general project landscape, culvert and road conditions.
- MassGIS Online Mapping Tool - OLIVER was used to derive detailed topographic imagery for road, housing infrastructure and related stream and wetland size and locations.
- The North Atlantic Aquatic Connectivity Collaborative (NAACC) Data Center website supplied road stream crossing locations and ID's as well as field notes, photos, structural condition of crossings, existing AOP conditions, roadway characteristics, and geographic location.

FIELD SURVEY TOOLS:

- Field survey equipment used for this project included a TOPCON GTS 255 W Total Station, FC-500 Handheld Data Collector, and associated prism rods; this equipment allowed field teams to capture all necessary landscape features, structural dimensions, thalweg elevations as well as related roadway or driveway features.
- Additional information collected and or created included the following:
  - permanent benchmarks established to define topographical point and spatial locations and elevations.
  - additional equipment: field notebooks, two-way radios,cameras, traffic cones, and misc. hand tools.

TECHNICAL PROJECT APPROACH CONTINUED

ENGINEERING DESIGN TOOLS:

- All collected survey and assessment data was uploaded into AutoCAD Civil 3D to render field data to create accurate base maps of the site. This software was then used to create and display current site conditions as well as proposed new structure, stream and riverbank conditions post preliminary engineering design work.
- Flow statistics and modeling included the use of the following tools:
  - HY-8 Culvert Hydraulic Analysis Program (Federal Highway Administration Tool)
  - This modeling tool was used to run preliminary hydrology and hydraulics for each design site.
  - additional datasets included: Northeast Regional Climate Center rain fall data, NOAA - Atlas 14 and US Geological Survey's "StreamStats" for the 100-year peak flow statistics.
  - NRCS Hydraulic tools were utilized in conjunction with HY-8 to analyze existing culvert capacities.
  - USFS Stream Simulation Design parameters were considered while developing stream bed surface elevations to design future grade control features to stabilize instream elevations.
- Cost estimate calculations were obtained through several methods:
  - RS Means Cost Manuals
  - Mass DOT rate sheets
  - Calls to local suppliers of construction materials
  - NH DOT actual bid documents (2019)
- Construction quantities obtained from Auto-CAD design plans utilizing hand calculations and data generated out of the C3D program.
- Specifications reflect TU's standard engineering practices related to specific state requirements.

PARTNERS & OTHER SUPPORT

- Town of Boxford- project proponent/ applicant, assistance with monthly progress meetings and conservation commission meetings
- Town of Ipswich- assisted with MassDOT access permit application
- Town of Topsfield- provided guidance on site selection
- Trout Unlimited- plan set and cost development
- Massachusetts Division of Ecological Restoration- review of 30% plan sets for adherence to Stream Crossing Standards
- MassDOT- Assistance with State Highway Access Permit
- Ipswich River Watershed Association- project management
- Trout Unlimited Nor'East- project concept

LESSONS LEARNED

- During this project, we learned that early engagement with abutters and project partners at MassDOT was important.
- We also learned that Massachusetts costs can be determined using the MassDOT cost estimator tool, and can be quite a bit higher than other New England costs for similar structural replacements.

NEXT STEPS

- Apply for funding for wetlands delineation, borings, Geotechnical analysis, Hydrologic and Hydraulic analysis, 100% engineering plans and permitting.
- Contract with a certified wetlands ecologist and environmental engineering firm for wetlands delineation and environmental permitting.
- Contract with Geotechnical firm to coordinate borings and prepare a geotechnical report.
- Contract with consultant to perform Hydrologic and Hydraulic survey and analysis.
- Contract with structural engineering firm to advance these plans to 100% engineering plans.
- Consider timing for MassDOT Chapter 85 review for structures that span >10ft.
- Apply for construction funding through available grant programs.
- Work with abutting landowners and Division of Marine Fisheries when small dams require fish passage.
- Consider whether brook clearing and beaver mitigation devices will be necessary and work with Conservation Commission to permit such work.

- Continue to engage public regarding resiliency and restoration efforts through educational posters in Town Hall's, Schools and Libararies.

SPECIAL THANKS

Trout Unlimited Nor'East
Colin Lawson, Trout Unlimited
Joel DeStasio, Trout Unlimited
Jeff Tenley, Trout Unlimited
Frank Ventimiglia, Town of Ipswich
Heidi Gaffney and Gary Wildes, Town of Topsfield
Chris Olbrot, Town of Boxford
Wayne Castonguay, Ipswich River Watershed Association

APPENDIX

13. Project Outcome Links

14.Trout Unlimited Cover Letter & Technical Memo

17. Example Plan Set

30. Potential Grant Funding for Culvert Replacement

Project Outcome Links

Hold down SHIFT then click on link- to open link in a new tab- otherwise link will open in same tab.

Project Web link:

https://www.ipswichriver.org/howlett-brook-watershed-restoration/

YouTube project video:

https://youtu.be/IzmBs9OVSrE

Contact for pdf plan sets or CAD files:

irwainfo@ipswichriver.org

Colin Lawson
Northeast Coldwater Habitat Program

August 8, 2020

Ipswich River Watershed Association
143 County Road, Ipswich, MA 01938

Attn.: Kaitlyn Shaw
Science and Restoration Program Manager

Dear Ms. Shaw,

The attached Technical Memo was created by Trout Unlimited (TU) for the Ipswich River Watershed Association (IRWA) and addresses our work on the "Increasing Regional Flood Resiliency through Re-designing Culverts in the Howlett Brook Watershed" which was funded through the Municipal Vulnerability Preparedness Grant Program. All descriptions and specifications outlined in this memo details TU's initial project planning, field survey data collection methods, and the development of 30% conceptual designs created by TU engineering staff. The goal of this project was to collect field data to produce twelve (12) conceptual engineering plans to help create accurate cost estimates for the replacement of existing vulnerable road / stream crossings in the Howlett Brook watershed. Additionally, each plan set was designed to meet or exceed requirements set forth in the "Massachusetts Stream Crossing Standards".

The 12 stream crossing locations that were a part of this assessment project were identified and selected by IRWA; these sites were considered high priority locations based on previous IRWA analysis of ecological connectivity and infrastructure vulnerability. TU's contribution was to provide preliminary 30% engineered plan sets allowing project partners to take the next step in soliciting the necessary grant funding to move these projects from conceptual plans to implemented restoration projects. TU engaged with as many abutting landowners as possible during our field work throughout the watershed. We had the opportunity to explain the value of correctly sizing infrastructure, reconnecting the up- and downstream channel to improve flood resiliency and aquatic organism passage as well as the benefits of reducing unnecessary erosion and sediment deposition.

The process TU followed for their initial undertaking for this project was threefold: 1) complete a desktop analysis of each site to gather information on each crossing's drainage area, flow capacity, and structural condition, 2) complete an initial "total station" site survey of both the landscape and roadway features, and 3) complete preliminary engineering designs for review and use by project partners.

TU's engineering goal was to evaluate each sites geomorphology and hydrology, and based on those parameters, design a road / stream crossing capable of passing stream flows at or exceeding the 100-year return interval storm event. Each road crossing evaluated in this project was structurally sized for passing modeled storm flows, received a USFS stream simulation design to stabilize the site's banks and stream bed, as well as a thorough projected cost analysis reflecting the current state of MassDOT Construction Standards. Included below is a Technical Memo outlining the methods and tools used to complete 12 site assessments, surveys and preliminary engineering designs.

Each 30% plan set completed as part of this project is intended to be used by the three participating municipalities as well as future partners associated with this regional landscape-scale restoration effort. Town decision makers and their Public Works departments and consultants will be able to use these plans, along with the provided cost estimates, to help prioritize stream crossing upgrades within their municipal boundaries based on town budgets and/or restoration grant funding available. The 30% design plans included in this package are strictly conceptual designs based on current information accessible to our project team. Further analysis and detailed survey work may be required to bring each completed plan set to the 100% level suitable for MADEP permitting as well as a MassDOT Chapter 85 review - if necessary.

Colin Lawson
Northeast Coldwater Habitat Program

TU's conceptual designs will allow community decision makers and partners to begin to reach out to potential grant funders to help finance these infrastructure projects. Depending on the source of funds, these grants may focus on either flood resiliency objectives, or in some cases, address the ecological benefits associated with restored natural environments (e.g. aquatic and macroinvertebrate aquatic systems). Final crossing designs may vary depending on the results of further survey analysis as well as design specifications, permitting, cost considerations and or community needs. These design plans are intended to serve as a starting point to begin the process of evaluating each project's scale, cost benefit analysis and other town specific discussions prior to final designs and project implementation.

Specific site constraints including issues such as existing utilities, traffic patterns, road topography challenges, and state versus town maintenance of road crossings were not considered during this initial assessment. Further analysis should be completed, with partner input, as each of these preliminary designs move through the 60, 90 and then 100% final design review process.

Data used in the creation of the 30% design plans included up-to-date culvert assessment information provided by the North Atlantic Aquatic Connectivity Collaborative (NAACC) Data Center website. This information included field notes, photos, structural condition of crossings, existing AOP conditions, roadway characteristics, and geographic location information in the form of an interactive ArcGIS map. TU utilized this information, combined with field surveys, Oliver GIS data mapper, state landowner parcel data derived from local GIS resources (where available) and Google Earth, to construct mapping and flow statistics. Significant hands-on field surveying was completed by TU for each of these 12 assessments and 30% engineering designs.

Each conceptual plan, as stated above, should be used as a reference tool during the development of final designs. These 30% plans are not intended to be substituted for final design plans for permitting and/or construction. All crossing replacement designs will need a formal hydrologic analysis performed by a registered professional hydraulic and or structural engineer.

Sincerely,

Colin J Lawson 8/18/20

Colin Lawson Date

New England Culvert Project Coordinator
Trout Unlimited
54 Portsmouth Street
Concord, NH 03301

Technical Specifications listed on following page.

Colin Lawson
Northeast Coldwater Habitat Program

Below is a list which includes technical data and tools used to complete this project:

Desktop Analysis Tools:

- USGS StreamStats was used to define drainage area, structural locations, and flow return interval statistics.
- EFH-2 (NRCS) was used in conjunction with StreamStats for confirming runoff and peak discharge volumes.
- Google Earth and related online mapping tools were utilized to collect topographic and satellite imagery to evaluate and collect general project landscape, culvert and road conditions.
- MassGIS Online Mapping Tool - OLIVER was used to derive detailed topographic imagery for road, housing infrastructure and related stream and wetland size and locations.
- the North Atlantic Aquatic Connectivity Collaborative (NAACC) Data Center website supplied road stream crossing locations and ID's as well as field notes, photos, structural condition of crossings, existing AOP conditions, roadway characteristics, and geographic location.

Field Survey Tools:

- field survey equipment used for this project included a TOPCON GTS 255 W Total Station, FC-500 Handheld Data Collector, and associated prism rods; this equipment allowed field teams to capture all necessary landscape features, structural dimensions, thalweg elevations as well as related roadway or driveway features.
- additional information collected and or created included the following:
  - permanent benchmarks established to define topographical point and spatial locations and elevations.
  - additional equipment: field notebooks, two-way radios, cameras, traffic cones, and misc. hand tools.

Engineering Design Tools:

- all collected survey and assessment data was uploaded into AutoCAD Civil 3D to render field data to create accurate base maps of the site. This software was then used to create and display current site conditions as well as proposed new structure, stream and riverbank conditions post preliminary engineering design work.
- flow statistics and modeling included the use of the following tools:
  - HY-8 Culvert Hydraulic Analysis Program (Federal Highway Administration Tool)
    - this modeling tool was used to run preliminary hydrology and hydraulics for each design site.
    - additional datasets included: Northeast Regional Climate Center rain fall data, NOAA - Atlas 14 and US Geological Survey's "StreamStats" for the 100-year peak flow statistics.
  - NRCS Hydraulic tools were utilized in conjunction with HY-8 to analyze existing culvert capacities.
  - USFS Stream Simulation Design parameters were considered while developing stream bed surface elevations to design future grade control features to stabilize instream elevations.
  - Cost estimate calculations were obtained through several methods:
    - RS Means Cost Manuals
    - Mass DOT rate sheets
    - Calls to local suppliers of construction materials
    - NH DOT actual bid documents (2019)
  - Construction quantities obtained from Auto-CAD design plans utilizing hand calculations and data generated out of the C3D program.
  - Specifications reflect TU's standard engineering practices related to specific state requirements.

TROUT UNLIMITED

IPSWICH RIVER ASSOCIATION

RESTORATION AND RESILIENCY PROJECT

GEORGETOWN ROAD CULVERT REPLACEMENT

BOXFORD, MA

JULY 2020

*Quantities provided are estimates. Contractors are responsible for verifying quantities as appropriate for completing the job.

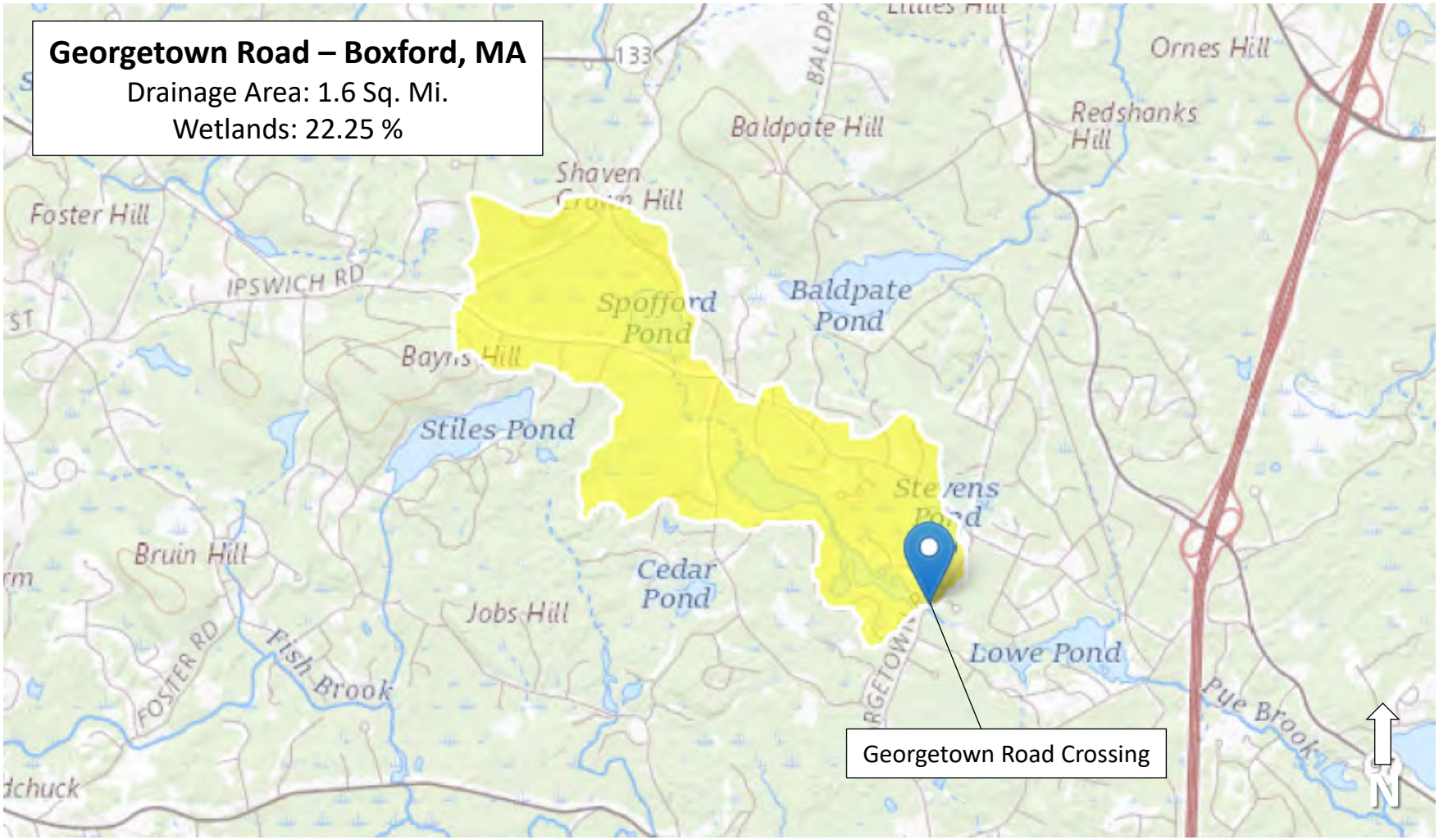
ESTIMATED QUANTITIES	
Excavation	2331 CY
Earthfill	1951 CY
Hot-Mix, Bituminous, 6" thickness	312 sy
Hauling	380 cy
RCP Culvert Removal, 5' SQUARE X 60',W/Headwall and Wingwalls	1 ea
Asphalt Removal	2800 SQ FT
Tree Removal	6 ea
Excavation/Grade Control Strutures	LS
Contech Concrete Box Culvert, 17' wide x 6' rise x 60' long	1 ea
Contech Concrete headers	2 ea
Contech Concrete wingwalls, 45 deg	4 ea
Seeding/Mulching	0.10 ac
Silt Fence	200 lf
Non-Woven Geotextile	978 sy
Gravel for footers	82 cy
Gravel for Road	80 cy
Substrate gravel	175 cy
Traffic Control	LS
Dewatering	LS
Erosion/Sediment Control	LS
Temporary Access	LS
D100 = 18" rock	68 cy

LOCATION PLAN
no scale

Construction Specifications		
TU	3	Structure Removal
TU	5	Pollution Control
TU	6	Seeding, Sprigging, and Mulching
TU	8	Mobilization/Demobilization
TU	11	Removal of Water
TU	21	Excavation
TU	23	Earthfill
TU	61	Loose Rock Riprap
TU	95	Geotextile
TU	600	Erosion and Sediment Control

Material Specifications		
TU	523	Rock
TU	592	Geotextile

Site Map – Drainage Area:



Map and data produced using U.S. Geological Survey (USGS) StreamStats. Blue marker indicates the location of the Georgetown Road crossing. Yellow-shaded area indicates the crossing's drainage area.

Site Photographs – Existing Conditions

Structure Inlet

View of existing structure inlet.

Structure Outlet

View of existing structure outlet.

Upstream of Structure

View looking upstream of structure.

Downstream of Structure

View looking downstream of structure.

Site Photographs – Existing Conditions

Upstream Spillway

View looking upstream of spillway.

Upstream Spillway

View looking across spillway.

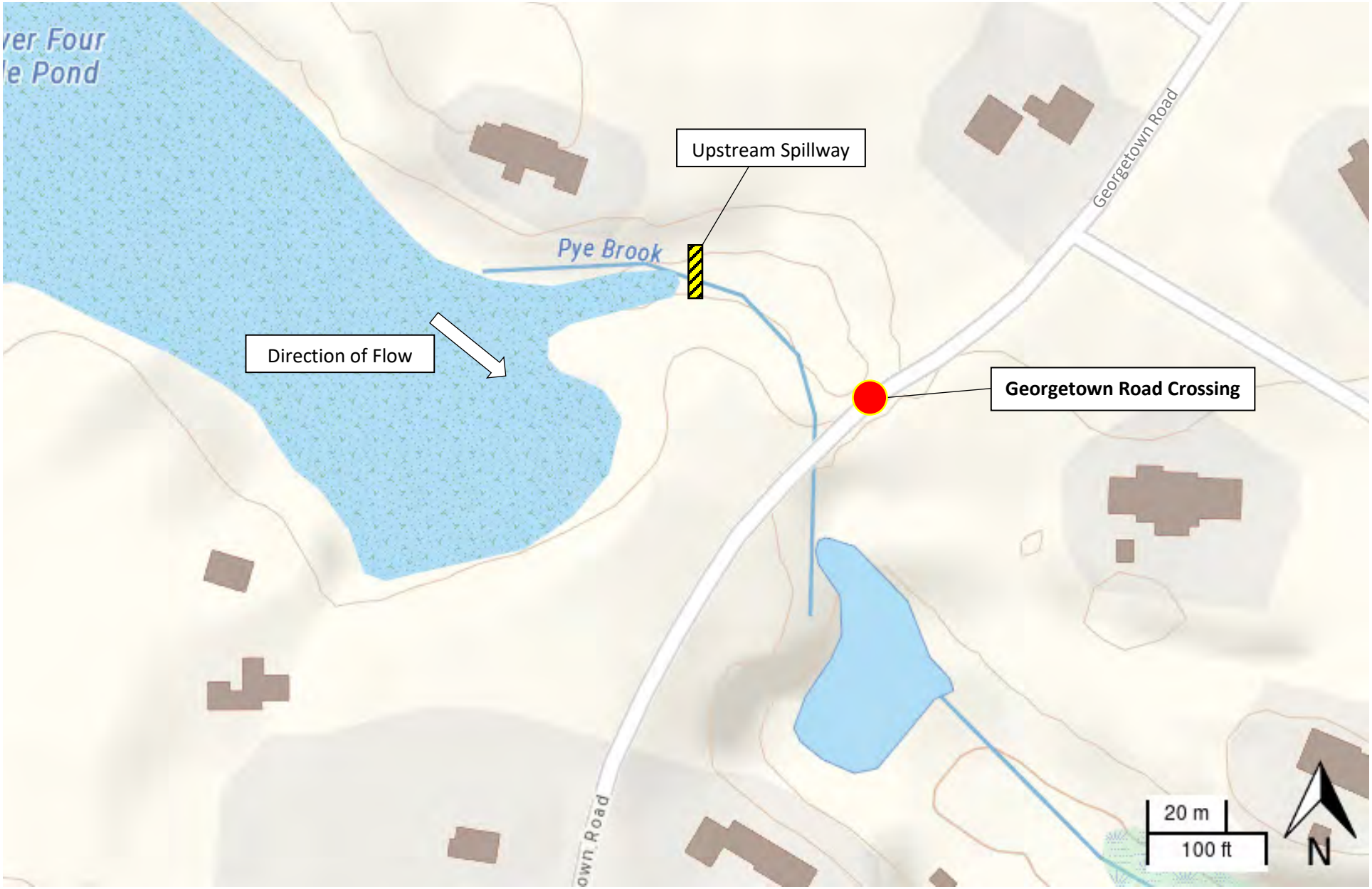
Upstream Spillway

View of spillway looking upstream.

Upstream Spillway

View looking downstream of spillway.

Existing Conditions – Site Topography



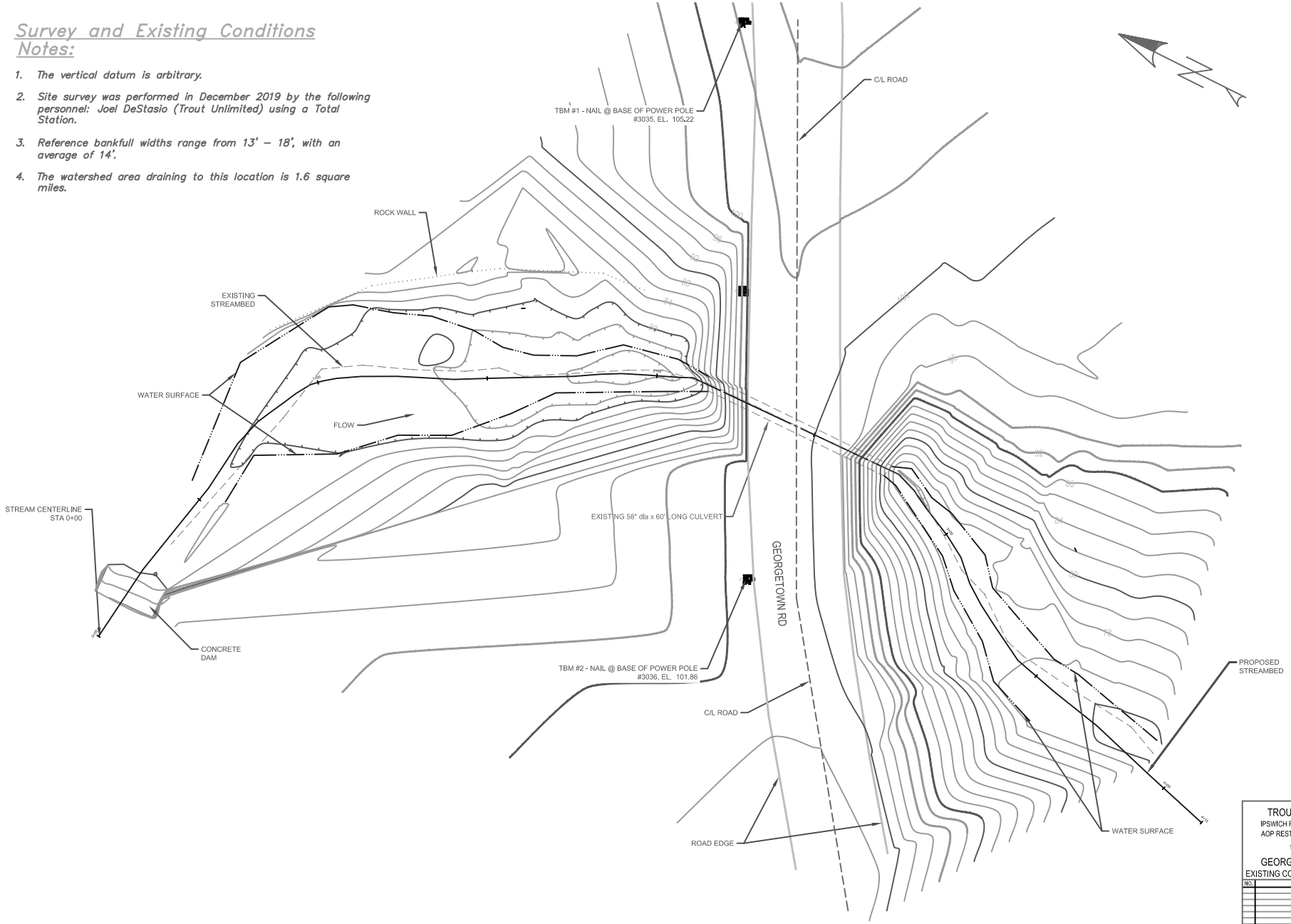
Map and data produced using OLIVER – MassGIS Online Data Viewer. Red dot indicates the location of the Georgetown Road crossing.

Existing Conditions – Aerial Imagery

Map and data produced using OLIVER – MassGIS Online Data Viewer. Red dot indicates the location of the Georgetown Road crossing.

Survey and Existing Conditions Notes:

1. *The vertical datum is arbitrary.*
2. *Site survey was performed in December 2019 by the following personnel: Joel DeStasio (Trout Unlimited) using a Total Station.*
3. *Reference bankfull widths range from 13' – 18', with an average of 14'.*
4. *The watershed area draining to this location is 1.6 square miles.*

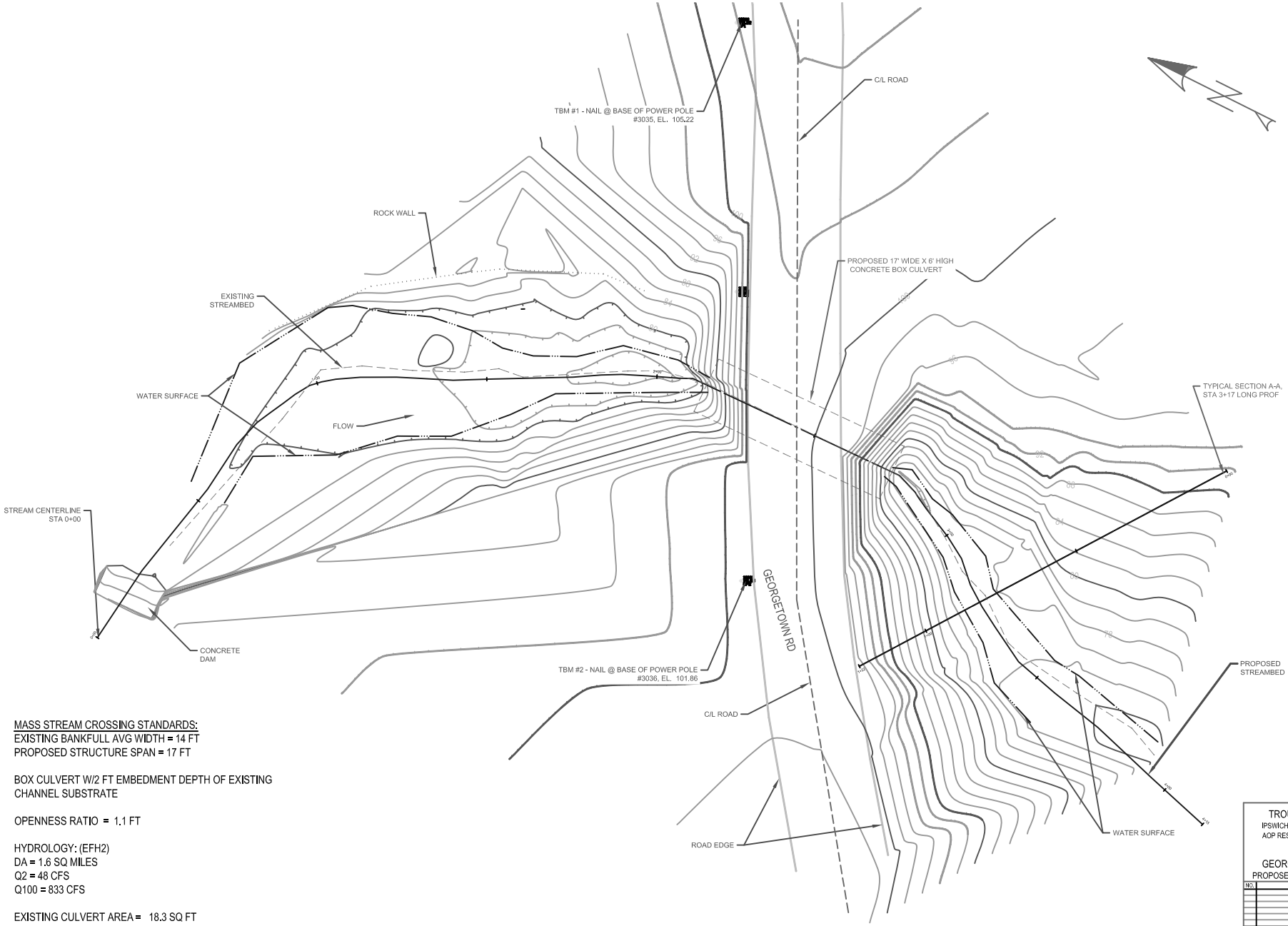


TROUT UNLIMITED
IPSWICH RIVER ASSOCIATION
AOP RESTORATION PROJECT
TOPSFIELD, MA

GEORGETOWN ROAD
EXISTING CONDITIONS SITE PLAN

NO.	REVISION	DATE

DATE: JULY 2020
PROJECT #:
DESIGNED BY: JDT
DRAWN BY: JDT



MASS STREAM CROSSING STANDARDS:
EXISTING BANKFULL AVG WIDTH = 14 FT
PROPOSED STRUCTURE SPAN = 17 FT

BOX CULVERT W/2 FT EMBEDMENT DEPTH OF EXISTING CHANNEL SUBSTRATE

OPENNESS RATIO = 1.1 FT

HYDROLOGY: (EFH2)
DA = 1.6 SQ MILES
Q2 = 48 CFS
Q100 = 833 CFS

EXISTING CULVERT AREA = 18.3 SQ FT
Q (CMP) = 281 CFS

PROPOSED CULVERT AREA = 68 SQ FT
Q (CONCRETE BOX CULVERT) = 971 CFS

WATER DEPTHS AND VELOCITIES ARE COMPARABLE TO THOSE FOUND WITHIN THE EXISTING STREAM CHANNEL

*ADDITIONAL GEOTECHNICAL, WETLANDS DELINETION AND HH ANALYSIS REQUIRED FOR DEVELOPMENT OF FINAL PLANS

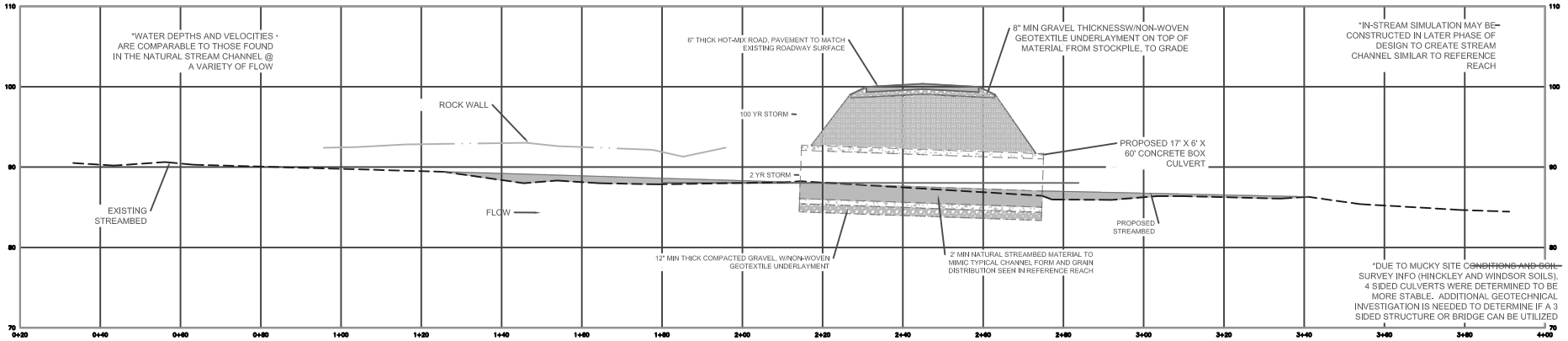
SCALE: 1" = 20'

TROUT UNLIMITED
IPSWICH RIVER ASSOCIATION
AOP RESTORATION PROJECT
TOPSFIELD, MA

GEORGETOWN ROAD
PROPOSED CONDITIONS PLAN

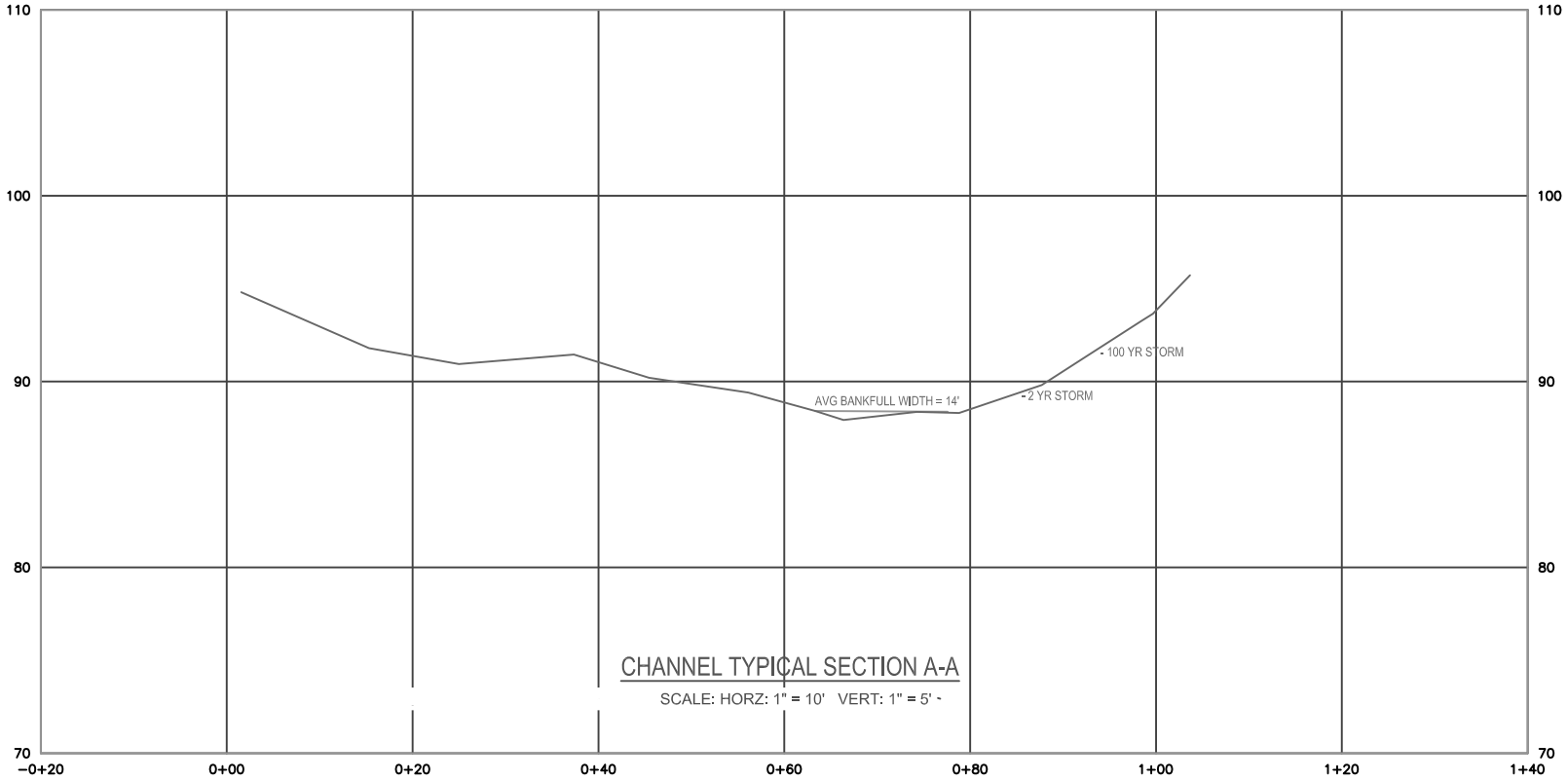
NO.	REVISION	DATE

DATE: JULY 2020
PROJECT #:
DESIGNED BY: JDT
DRAWN BY: JDT



GEORGETOWN RD PROPOSED CULVERT AND STREAM CHANNEL PROFILE

SCALE: HORZ: 1" = 20' VERT: 1" = 10'



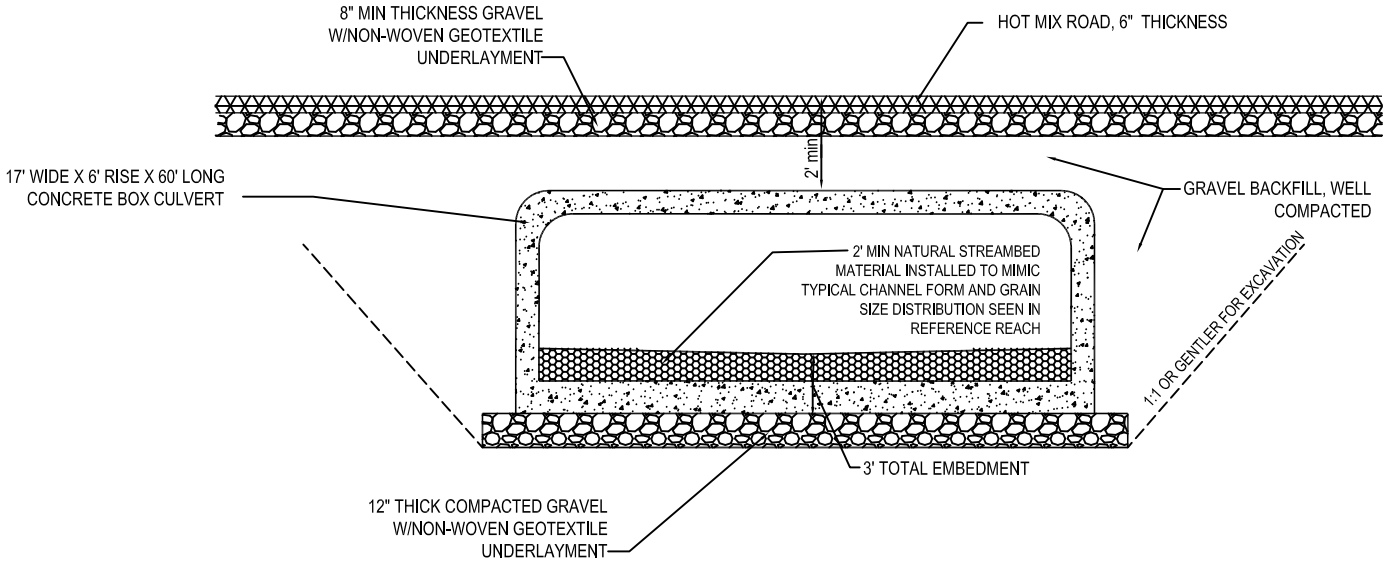
CHANNEL TYPICAL SECTION A-A

SCALE: HORZ: 1" = 10' VERT: 1" = 5'

TROUT UNLIMITED
IPSWICH RIVER ASSOCIATION
AOP RESTORATION PROJECT
TOPSFIELD, MA
GEORGETOWN ROAD
LONGITUDINAL PROFILE

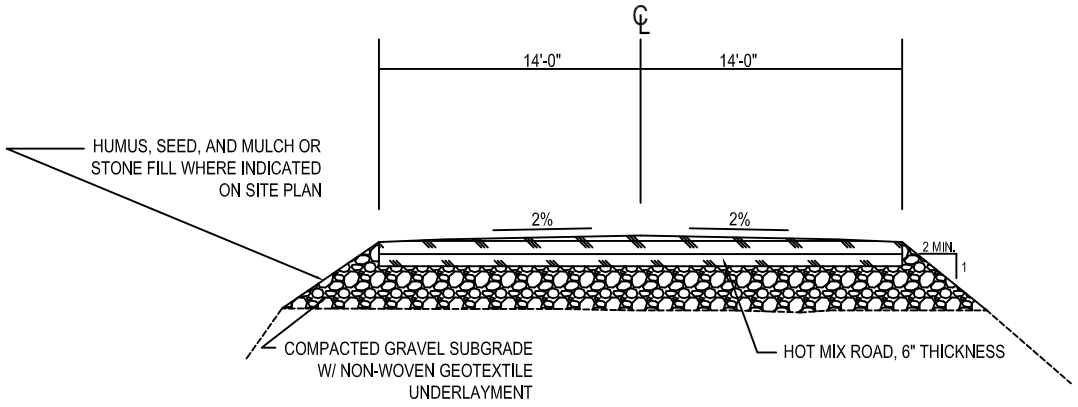
NO.	REVISION	DATE

DATE: JULY 2020
PROJECT #:
DESIGNED BY: JDT
DRAWN BY: JDT



TYPICAL CULVERT SECTION

NO SCALE



TYPICAL ROAD SECTION

NOT TO SCALE

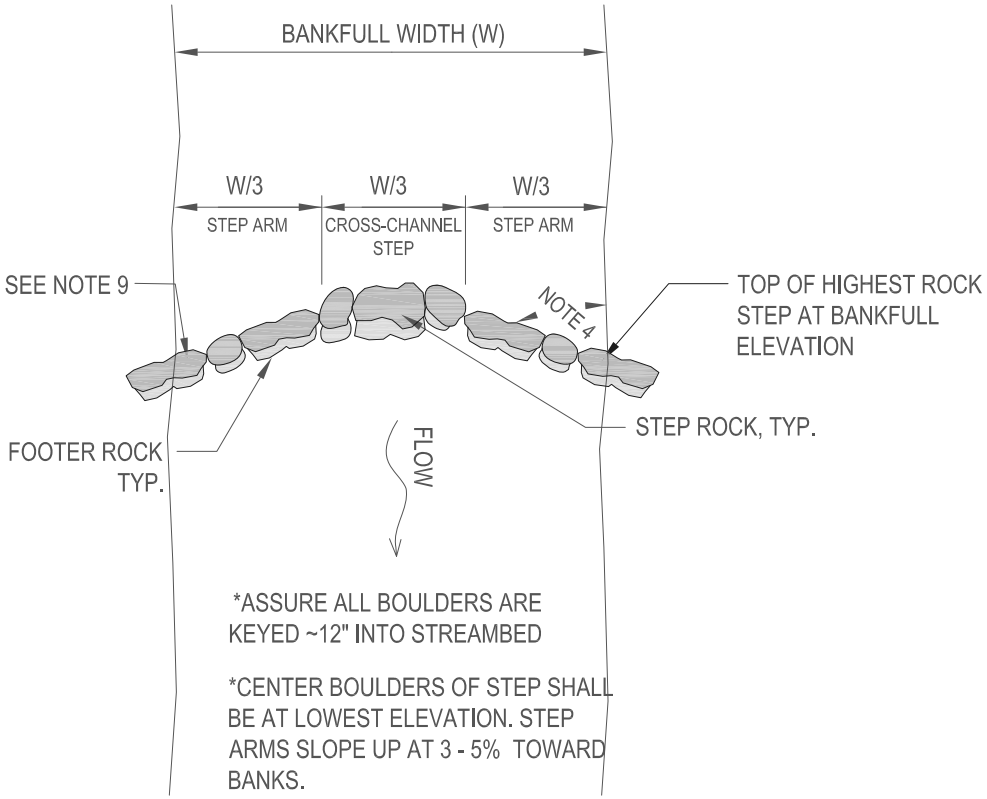
*PROPOSED ROAD TO MATCH
EXISTING ROAD ELEVATIONS

ROADSIDE BARRIERS TO BE
CONSIDERED IN FUTURE PHASE OF
DESIGN, IF NEEDED

TROUT UNLIMITED
IPSWICH RIVER ASSOCIATION
AOP RESTORATION PROJECT
TOPSFIELD, MA
GEORGETOWN RD
CULVERT CROSS SECTION

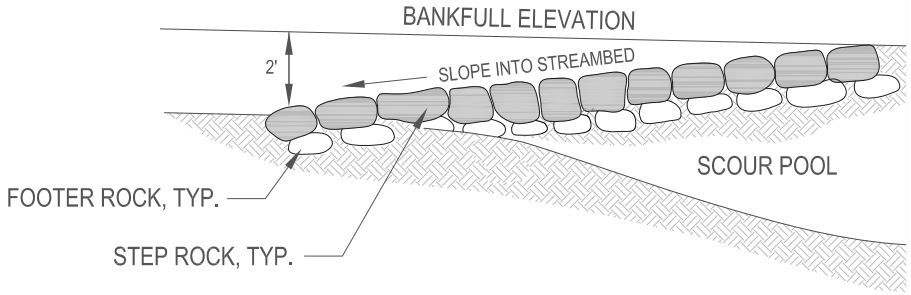
NO.	REVISION	DATE

DATE: JULY 2020
PROJECT #:
DESIGNED BY: JDT
DRAWN BY: JDT



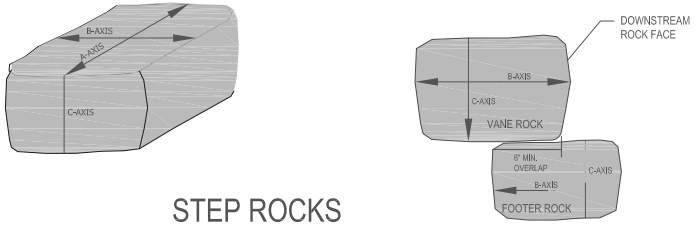
ROCK STEP PLAN VIEW

NOT TO SCALE



PROFILE VIEW

NOT TO SCALE



STEP ROCKS

	A-AXIS	B-AXIS	C-AXIS
MINIMUM	TO BE DETERMINED IN LATER DESIGN PHASE		

FOOTER ROCKS

	A-AXIS	B-AXIS	C-AXIS
MINIMUM	TO BE DETERMINED IN LATER DESIGN PHASE		

TROUT UNLIMITED
IPSWICH RIVER WATERSHED
AOP RESTORATION PROJECT
TOPSFIELD, MA

GEORGETOWN RD
ROCK STEP DETAILS

NO.	REVISION	DATE

DATE: JULY 2020
PROJECT #:
DESIGNED BY: JDT
DRAWN BY: JDT

Hydrology & Hydraulic Analysis

Attribute	Value	Units	Definition
Drainage Area	1.60	sq. miles	Area that drains to crossing
Wetlands	22.25	percent	Percentage of NWI storage
Elevation	141	feet	Mean basin elevation
Precipitation	47	inches	Mean annual precipitation
Aquifer	65.7	percent	Percentage of land underlain by sand & gravel aquifers
X-Coordinate	241125	meters	Basin centroid E/W location
Y-Coordinate	936575	meters	Basin centroid N/S location

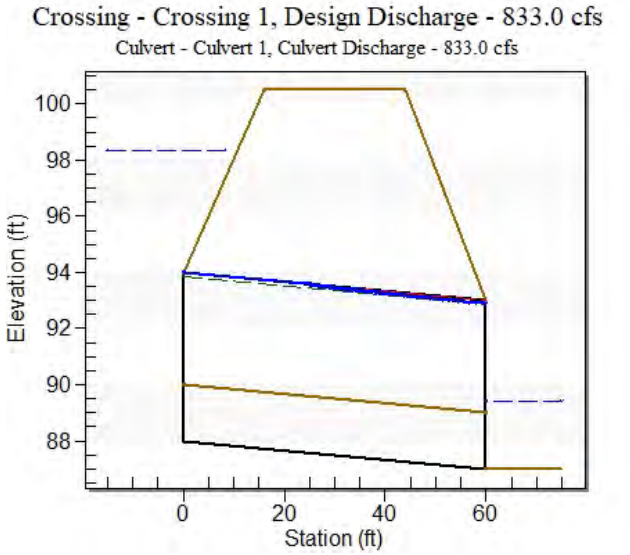
Return T (yr)	Peak Q_T (ft^3/s)[1]
2	48
5	126.5
10	205
25	440.5
50	597.5
100	833

References:

[1] USDA NRCS EFH2 – EFH2 uses procedures defined in the Natural Resources Conservation Service National Engineering Handbook, Part 650, (NEH 650), *Engineering Field Handbook* (EFH); Chapter 2, *Estimating Runoff and Peak Discharge* (NEH 650.02) and the National Engineering Handbook, Part 630, *Hydrology* (NEH 630).

USGS StreamStats was used to delineate drainage area, obtain basin characteristics. NOAA Atlas 14 was used for precipitation frequency estimates.

HY-8 Hydraulic Analysis Program of the U.S. Federal Highway Administration provides results for the above peak flow estimates for the proposed crossing design and indicates that the crossing as proposed will successfully pass the expected 100-year storm event.



Discharge Name	Total Discharge (cfs)	Headwater Elevation (ft)	Flow Type	Outlet Control Depth (ft)	Outlet Depth (ft)	Outlet Velocity (ft/s)
2	48	91.06	2-M2c	1.06	0.63	4.50
5	126.5	92.03	2-M2c	2.03	1.20	6.21
10	205	92.52	1-S2n	0.98	1.63	7.41
25	440.5	94.31	5-S2n	3.22	2.60	9.98
50	597.5	95.65	5-S2n	5.34	3.14	11.19
100	833	98.35	5-S2n	8.05	3.87	12.65

Note that prediction errors are quite large when using regression equations to estimate flows and bankfull widths based on drainage area. It is best to account for potentially larger flows at these return intervals.

Computed Project Costs

GEORGETOWN RD	AOP - Concrete Box Culvert	Prog:		Date:	7/1/2020
By: JDT	Checked By:			Check Date:	
Practice Name	**Component Name**	**Unit**	**Price**	**Qty**	**Cost**
Obstruction Removal	Concrete pipe, >36" dia	LF	$70.15	60	$4,209.00
	Tree Removal, disposal	EA	$250.00	7	$1,750.00
	Asphalt Removal	SY	$11.28	312	$3,519.36
	Rock Headwalls	Tons	$97.20	36	$3,499.20
	Guardrail Removal	LF	$19.91	140	$2,787.40
					$15,764.96
Seed/Mulch	Hydroseeding (Small application, ≤2,000 SF)	SF	$0.20	4356	$871.20
	Straw mulch, by power mulcher	SY	$0.21	484	$101.64
					$972.84
Asphalt Road	Hot Bituminous Pavement (Asphalt) 6" thick	SF	$10.04	2800	$28,112.00
	Crushed Gravel, compacted in place yardage	CY	$30.29	80	$2,423.20
	Nonwoven Geotextile- NRCS Class I - Level installation	SY	$2.00	411	$822.00
					$31,357.20
Stream Simulation	Excavation for structures	CY	$12.00	56	$672.00
	Rock step/footer placement imported material	CY	$68.00	28	$1,904.00
	Nonwoven Geotextile- NRCS Class I - Level installation	SY	$2.00	133	$266.00
	Cluster boulders, 12" to 18" dia	ton	$90.00	23	$2,070.00
	Haul common earth, 12 CY Truck, 0.5 mile cycle	CY	$11.00	56	$616.00
					$5,528.00
AOP - Concrete Box Culvert	Common earth, excavated, loaded	CY	$10.00	2331	$23,310.00
	On-site material, walk-behind plate, lifts, compacted in place yardage	CY	$12.02	1951	$23,451.02
	Haul common earth, 12 CY Truck, 0.5 mile cycle	CY	$11.00	380	$4,180.00
	Channel substrate placement from on site	CY	$30.02	74	$2,221.48
	Concrete Box Culvert, 14' x 7' x 44' deivered, w/ wingwalls/headers	LF	$2,383.33	60	$142,999.80
	Concrete box install	LS	$52,433.26	1	$71,499.90
	Crushed Gravel, compacted in place yardage	CY	$30.29	82	$2,483.78
	Common gradations ≥ 9"	CY	$45.00	68	$3,060.00
	MSG longspan, guardrail, 120' total	LF	$43.55	140	$6,097.00
	Beam Guardrail, terminal type EAGRT, TL2	EA	$2,700.00	4	$10,800.00
	Nonwoven Geotextile- NRCS Class I - Sloped installation (4:1 or steeper)	SY	$2.75	825	$2,268.75
	Traffic Control	Ea.	$5,000.00	1	$5,000.00
	Per piece of equipment, mob. and demob. total	Ea.	$840.00	4	$3,360.00
	Silt Fence, installation and removal	LF	$3.44	200	$688.00
	Turbidity Curtain	LF	$34.50	100	$3,450.00
	Dewatering Sediment Bag 10'x15', leveled, w disposal, no subgrade	Ea.	$369.00	1	$369.00
	Cofferdam, sand bags, 20' wide, 3' high, installation and removal	Ea.	$2,172.00	2	$4,344.00
	Sump pump, 4" diaphragm pump 8 hrs. a day, includes suction and discharge hoses	Day	$268.80	16	$4,300.80
	Temp Access, gravel, geo,exc, and removal	LS	$2,121.00	1	$2,121.00
					$316,004.63
			Project Subtotal		**$369,627.63**
			Total Project Cost with Contingency (20%)		**$443,553.16**

*Cost estimate references: RS Means, Mass DOT, NH DOT, NRCS, Local Sources

IPSWICH RIVER WATERSHED ASSOCIATION
The Voice of the River

Funding & Technical Resources for Barrier (Culvert, Dam, Bridge) Mitigation Projects

FUNDER	GRANT PROGRAM*	NON-TIDAL	TIDAL	DAM	BRIDGE
DFG Division of Ecological Restoration (DER)	Culvert Replacement Municipal Assistance (CRMA)	X			
DFG Division of Ecological Restoration (DER)	Restoration and Revitalization Priority Projects	X	X	X	X
MassDOT	Small Bridge Program	X	X		X
National Atmospheric and Oceanic Administration (NOAA), National Marine Fisheries Service (NMFS)	Habitat Restoration Grants, Coastal Resilience Grants	X	X	X	X
EEA Municipal Vulnerability Preparedness (MVP)	Action Grants	X	X	X	X
EEA Office of Coastal Zone Management	Coastal Resilience Grant Program		X	X	X
EEA	The Dam and Seawall Repair or Removal Program			X	
Department of Fish and Game (DFG)	In-Lieu Fee (ILF) Program	X	X	X	X
United States Fish and Wildlife Service (USFWS)	National Fish Passage Program	X	X	X	X
National Fish and Wildlife Foundation (NFWF)	Forest and Rivers Fund	X	X	X	X
FEMA, administered by MEMA	Hazard mitigation, pre-disaster mitigation, flood mitigation	X	X	X	X
EOHED	MassWorks Infrastructure Program	X	X	X	X
Division of Local Services	Community Compact Best Practices Program	X	X	X	X
Private & Corporate Foundations	Regional Foundations	X	X	X	X

*Refer to most current RFR for types of project funded.

Adapted from 10/30/19 DER Massachusetts Culvert Replacement Resources document

IPSWICH RIVER WATERSHED ASSOCIATION
The Voice of the River

Funding & Technical Resources for Barrier (Culvert, Dam, Bridge) Mitigation Projects

TECHNICAL SUPPORT	DESCRIPTION	WEBSITE
DFG- Division of Ecological Restoration	Technical Assistance with culvert, dam & salt marsh restoration projects	https://www.mass.gov/orgs/division-of-ecological-restoration Stream Crossing Handbook
DFG- Division of Marine Fisheries	Technical Assistance with diadromous fish passage projects	https://www.mass.gov/orgs/division-of-marine-fisheries
DFG- Office of Fishing and Boat Access	The Office of Fishing and Boating Access provides access to waterways.	https://www.mass.gov/fishing-and-boating-access
DFW- MassWildlife	Conservation of freshwater fish and wildlife, including endangered plants and animals.	https://www.mass.gov/orgs/division-of-fisheries-and-wildlife
US Fish and Wildlife Service	Endangered Species Act Technical Guidance	https://www.fws.gov/newengland/endangeredspecies/index.html
NOAA	Estuarine, coastal and river habitat restoration technical assistance	https://www.fisheries.noaa.gov/topic/habitat-conservation#how-we-restore
MVP Regional Coordinators	Work with city and town officials to support communities through the MVP process.	https://www.mass.gov/municipal-vulnerability-preparedness-mvp-program
Massachusetts Emergency Management Agency (MEMA)	FEMA grants are administered by MEMA	https://www.mass.gov/service-details/pdm-fma-grants
DEP Circuit Rider	Technical, administrative, and regulatory assistance on numerous wetland topics	https://www.mass.gov/orgs/eea-office-of-grants-and-technical-assistance
EEA Office of Grants and Technical Assistance	Conservation of natural resources and outdoor recreational programs	https://www.mass.gov/orgs/eea-office-of-grants-and-technical-assistance
Community Grant Finder	Mass.gov resource for finding grant opportunities	https://www.mass.gov/lists/community-grant-finder
MassDOT	Stream Crossing Handbook	https://www.mass.gov/massdot-environmental-services
Local Conservation Agents	Assistance on local wetland topics	Located on Town or City Conservation Commission Website Page

Adapted from 10/30/19 DER Massachusetts Culvert Replacement Resources document