MASSACHUSETTS watershed·based plans

WATERSHED-BASED PLAN

Fort River Watershed within the Towns of Amherst, Belchertown, Hadley, Pelham, and Shutesbury

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Prepared For:

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

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Contents

Executive Summary

Introduction: The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present it in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (USEPA's) recommended format for "nine-element" watershed plans. This WBP was developed by Geosyntec Consultants (Geosyntec) under the direction of the Town of Amherst and the University of Massachusetts, Amherst (UMass) with funding, input, and collaboration from the Massachusetts Department of Environmental Protection (MassDEP).

The Fort River (MA34-27) is a tributary to the Connecticut River (segment MA34-04) and includes several tributaries, ponds, and reservoirs located in the Towns of Amherst, Belchertown, Hadley, Pelham, and Shutesbury. This WBP was prepared for waterbodies located within the Fort River Watershed (MA34-27). These waterbodies include Fort River (MA34-27), Adams Brook, Amethyst Brook (MA34-35), Baker Brook, Buffam Brook, Dean Brook, Dunlop Brook, Gates Brook, Harris Brook, Harts Brook, Hearthstone Brook, Hop Brook, Nurse Brook, Plum Brook, Scarboro Brook, and Fearing Brook.

Impairments and Pollution Sources: The Fort River is listed on the Massachusetts List of Integrated Waters (303(d) list) as a category 5 waterbody for impairments related to elevated levels of *Escherichia coli* (*E. coli*) bacteria. The cause of *E. coli* impairment for the Fort River is listed as unknown, but the impaired section is located within the Towns of Amherst and Hadley. The major pollution sources that have been identified within the Fort River watershed include the urbanized Fearing Brook subwatershed and dairy and equine agricultural land uses. Sampling conducted in the Fearing Brook subwatershed in 2015—2016 identified that dry and wet weather *E. coli* levels measured in different sections of Fearing Brook were Too Numerous to Count (TNTC). Elevated levels of total phosphorus (TP) (above .05 milligrams per liter [mg/L]) were also identified. Finally, microbial source tracking conducted in the Fearing Brook subwatershed indicated that the brook had fecal contamination from mammals (pets or rodents), human, and gull sources (New England Environmental, Inc., 2015).

UMass has identified several agricultural operations, including an equine farm in Belchertown (Moonlit Farm) as potential sources of pollution in the watershed. The farm is bisected by an unnamed tributary to Hop Brook, which ultimately discharges to the impaired segment of Fort River. Issues identified include animals directly accessing the unnamed tributary and improved manure management is needed. Additional farms that have been identified as potential pollution sources are located in Hadley and Amherst. Sampling conducted in 2003 and 2008 in the Fort River at Route 47 (near the confluence of the Fort River with the Connecticut River) indicated elevated *E. coli* and TP levels (above Massachusetts Surface Water Quality Standards [314 CMR 4.00, 2013] and Quality Criteria for Water [USEPA, 1986], respectively) (MassDEP, 2008 and 2013a). Additionally, recent data from July 2020 conducted by the Connecticut River Conservancy identified high levels of *E. coli* in Amethyst Brook (2,420 colony forming units [cfu]/100 milliliters [ml]) and in the Fort River at Groff Park in Amherst (1,986 cfu/100 ml) (https://connecticutriver.us/node/480 and https://connecticutriver.us/node/479).

Goals, Management Measures, and Funding: Water quality goals for this WBP are focused on addressing the listed *E. coli* impairment and observed elevated concentrations of *E. coli* and TP from ambient monitoring data. The goals are to reduce *E. coli* and TP loading to the Fort River, improving water quality within the watershed and leading to delisting of the Fort River from the 303(d) list.

It is expected that continued progress towards meeting these goals will be accomplished through implementation of agricultural best management practices (BMPs), applying structural BMPs on new and existing development, implementation of non-structural BMPs (e.g., street sweeping, catch basin cleaning), floodplain restoration projects, and watershed education and outreach.

BMPs will first be implemented at the confluence of Fearing Brook in Amherst and at Moonlit Farm in Belchertown per Fiscal Year 2020 Section 319 grants (Project Numbers: 20-02, 20-07). Stakeholder engagement, desktop analysis, and field investigation were conducted during the summer of 2020 to identify and prioritize future BMP opportunity sites. Future structural BMPs are currently focused within the Fearing Brook subwatershed due to its high urbanization and associated impervious cover, documented poor water quality, and its role as a significant source of pollution to the Fort River mainstem. BMP implementation opportunities at the Hickory Ridge Golf Course and agricultural properties within Hadley and Amherst, potentially major sources of bacteria and nutrients, may be targeted in the future. Additional planning and implementation is expected to be performed in subsequent years, focusing on each waterbody in the study area.

It is expected that funding for management measures will be obtained from a variety of sources, including Section 319 Grant Funding, Town capital funds, volunteer efforts, and other sources.

Public Education and Outreach: Public education and outreach goals include promoting watershed stewardship and providing information about proposed stormwater improvements and their anticipated benefits.

For its ongoing flood restoration project at Fearing Brook, the Town of Amherst aims to engage students and watershed residents through signage, use of the proposed project as a "living classroom," tours and programming centered on the proposed project, and promotion of the proposed project and related events on the Town's social media. The project is located on Town conservation land, which includes community gardens and a public walking trail. In addition to residents visiting the conservation area, the Town of Amherst plans to engage Fort River Elementary School, Amherst College, and the Hitchcock Center for the Environment by bringing students and tour groups to the proposed project site. It is expected that public outreach and education will be evaluated by tracking residents, tour groups, and classroom visits to the conservation area, and activity associated with the Town's social media posting relevant to the project or watershed stewardship.

UMass as part of its ongoing project at Moonlit Farm in Belchertown aims to engage the equine industry and community horse owners by hosting an annual field day at the project. Work will include the generation of educational materials and identification and subsequent follow up discussion and engagement with interested attendees. This outreach program will be evaluated by tracking field day attendance. UMass plans to distribute fact sheets and newsletters to an email list serve of over 800 relevant parties and post news of the project on the "Crops, Dairy, Livestock and Equine" UMass Extension webpage. It is expected that this effort will be evaluated by tracking the number of emails and the size of the list serve receiving the emails in addition to visitors to the UMass Extension webpage.

Implementation Schedule and Evaluation Criteria: Project activities will be implemented as outlined in the following elements of this WBP. It is expected that a water quality monitoring program will enable direct evaluation of improvements over time. Other indirect evaluation metrics are also recommended, including quantification of potential pollutant load reductions from nonstructural BMPs (e.g., street sweeping). The

long-term goal of this WBP is to de-list the all waterbodies within the study area from the 303(d) list by 2035. The WBP will be reevaluated and adjusted, as needed, once every three years.

Introduction

What is a Watershed-Based Plan?

Purpose & Need

The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present it in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (USEPA's) recommended format for "nine-element" watershed plans, as described below.

All states are required to develop WBPs, but not all states have taken the same approach. Most states develop watershed-based plans only for selected watersheds. MassDEP's approach has been to develop a tool to support statewide development of WBPs, so **that good projects in all areas of the state may be eligible for federal watershed implementation grant funds** under Section 319 of the Clean Water Act.

USEPA guidelines promote the use of Section 319 funding for developing and implementing WBPs. WBPs are required for all projects implemented with Section 319 funds and are recommended for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both.

Watershed-Based Plan Outline

This WBP for Fort River Watershed includes nine elements (a through i) in accordance with USEPA Guidelines:

a. An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBP (and to achieve any other watershed goals identified in the watershed-based plan), as discussed in item (b) immediately below.

b. An **estimate of the load reductions** expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time).

c. A **description of the nonpoint source management measures** needed to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this WBP), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, United States Department of Agriculture (USDA)'s Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant federal, state, local and private funds that may be available to assist in implementing this plan.

e. An **information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

f. A **schedule for implementing the nonpoint source management measures** identified in this plan that is reasonably expeditious.

g. A description of **interim, measurable milestones** for determining whether nonpoint source management measures or other control actions are being implemented.

h. A set of **criteria to determine if loading reductions are being achieved** over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a nonpoint Total Maximum Daily Load (TMDL) has been established, whether the TMDL needs to be revised.

i. A **monitoring component** to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Project Partners and Stakeholder Input

This WBP was developed by Geosyntec under the direction of the Town of Amherst and UMass with funding, input, and collaboration from MassDEP. This WBP was developed using funds from the Section 319 program to assist grantees in developing technically robust WBPs using MassDEP's Watershed-Based Planning Tool. The Town of Amherst and UMass were recipients of Section 319 funding in Fiscal Year 2020 to implement BMPs in the Fort River Watershed.

Core project stakeholders include:

- David Ziomek, Assistant Manager – Town of Amherst
- Elizabeth Willson – Town of Amherst
- Jim Brassord – Amherst College
- Cindy Delpapa – MA Division of Ecological Restoration (DER)
- Julie Johnson – Hitchcock Center for the Environment
- John Presnosil, Owner – Moonlit Farm
- Masoud Hashemi – UMass Extension (Crops, Dairy, Livestock, and Equine), UMass Stockbridge School of Agriculture
- Timothy Randhir – Department of Environmental Conservation, UMass
- Cassandra Urrichio – UMass Extension (Crops, Dairy, Livestock, and Equine), UMass Stockbridge School of Agriculture
- Robert Eastman – Student, The Conway School
- Brian Yellen – Department of Geosciences, UMass
- Janice Stone – Hadley Conservation Commission
- Matthew Reardon – MassDEP

This WBP was developed as part of an iterative process. The Geosyntec project team collected and reviewed existing data from the Town of Amherst and UMass. This information was then used to develop a preliminary WBP for review by core project stakeholders. Two stakeholder conference calls were held to solicit input and gain consensus on elements included in the plan (e.g., water quality goals, future BMP implementation priority locations, public outreach activities). The first version of the WBP was finalized in December 2019,

and the first revision was completed in November 2020 once stakeholder consensus was obtained for all elements.

Data Sources

This WBP was developed using the framework and data sources provided by MassDEP's Watershed-Based Plan Tool and supplemented by data from additional studies and a field watershed investigation. Supplemental data sources were reviewed and are included in subsequent sections of this WBP, if relevant.

For the two ongoing Section 319 grant-funded projects, information from the following two Section 319 Nonpoint Source Pollution Grant Program applications was also referenced:

- "Fearing Brook Floodplain Creation Project" (Town of Amherst, 2019)
- "Implementation, Remediation, and Education of Selected Best Management Practices to Minimize the Environmental Impact of Two Equine Operations" (UMass, 2019)

Summary of Past and Ongoing Work

The Town of Amherst and UMass have a history of successfully planning for watershed improvements. The stakeholders from UMass (see Project Partners and Stakeholder Input) have implemented 6 Section 319 grants in the past 19 years (UMass, 2019), although none of the previous projects were located in the Fort River watershed. The Town of Amherst has been able to coordinate on multiple watershed studies within the Fort River watershed as summarized by the below project descriptions (Town of Amherst, 2019). The Town of Amherst has also had successful implementation of their Stormwater Management Program (SWMP), which impacts a large portion of the Fort River watershed. A summary of recent accomplishments of the SWMP is also included in the sections below.

Town of Amherst Year 1 Annual Report

This 2019 report included the results of the Town of Amherst's first year of SWMP implementation. The Town of Amherst had multiple achievements, including 270 miles of street sweeping, 160 catch basins cleaned, 20–30 construction plans reviewed, 100–150 construction sites inspected, and organization of a town-wide cleanup day on May 4, 2019, that engaged watershed residents. The Town of Amherst continued to maintain its dedicated Stormwater Management webpage. Future plans for the next year of implementation were also outlined in the report, including public education efforts, catch basin stenciling, updating the wetlands bylaws, performing another annual town cleanup day, organizing a "Source to Sea" cleanup for the Fort River, and working on additional new stormwater bylaws.

Preliminary Assessment of the Fearing Brook Corridor

This February 2018 report was the result of the Massachusetts Division of Ecological Restoration engaging the technical expertise of the firm Milone and MacBroom, Inc. (MMI). The project assessed the conditions of Fearing Brook, identified degraded or impaired reaches, identified factors within the channel and watershed causing degraded conditions and assessed the channel and watershed for potential restoration projects. The report noted that an exposed sewer pipe was located in the stream. The report identified seven projects on Fearing Brook, including a floodplain connectivity project that was ultimately selected and is further described in this plan.

Hydrologic Effects of Land Use in the Fearing Brook Watershed

This May 2017 report was the result of a Master's Thesis by Anthony Damiano for UMass. The report provided a geographic information system (GIS) analysis of the Fearing Brook watershed. The study highlighted critical areas in the watershed to address concerns in flow regime and water quality. The Amherst College campus was identified as a potential location for green infrastructure projects.

Monitoring, Assessing, and Restoring Urban Streams: Fearing Brook Restoration Project

This report was the result of a study led by Rebecca Szal in partial fulfillment of her Bachelor's degree at the Hampshire College School of Natural Science in April 2016. The report was prepared to provide the Town of Amherst an analysis of the current condition of Fearing Brook and the stressors on Fearing Brook, including potential pollutant sources and hydrologic and hydraulic conditions. Analytical measurements in the study included substrate composition, discharge, temperature, dissolved oxygen (DO), conductivity, salinity, turbidity, nitrates, nitrites, phosphates, pH, and total dissolved solids. The biotic community was also assessed. Restoration concepts, including rain gardens, bank plantings, and integrated wetlands, were discussed along with potential implementation locations.

Identifying Sources of Fecal Contamination in the Fearing Brook Watershed

This report was submitted to New England Environmental Inc. in February 2016 by Dr. Stephen Jones and Derek Rothenheber at the University of New Hampshire's Jackson Estuarine Laboratory. The report's goal was to identify the sources of fecal contamination in the Fearing Brook watershed. The report found that the Fearing Brook watershed is consistently impacted by fecal pollution. Results found that human contamination was present at the downstream end of the study area and gull contamination was present throughout the watershed (New England Environmental, Inc., 2015).

Fearing Brook Watershed Plan Study Report and Remedial Recommendations

This report was prepared for the Town of Amherst by New England Environmental Inc. in May of 2015. The report developed a surface water monitoring protocol for the Fearing Brook watershed to start developing a data record for locations along the brook over time. Nine sampling locations were established, and analytical data was collected, including temperature, pH, DO, turbidity, EV potential, nutrient levels, metals, hydrocarbons, and overall bacteria levels. Microbial source tracking found that the brook had fecal contamination from mammal (pets or rodents), human, and gull sources. Ruminant (cows, sheep) markers were not detected at any of the sample sites. The human markers were observed in the lower reaches of the watershed but not at the upstream end (New England Environmental, Inc., 2015).

East Hadley Road Multi-use Path East End

East Hadley Road, which is adjacent to the Fort River in Amherst, was recently improved (summer of 2020) with a multi-use path. Structural BMPs included as part of the improvement were hydrodynamic separators and vegetated swales.

Element A: Identify Causes of Impairment & Pollution Sources

Element A: Identify the causes and sources or groups of similar sources that need to be controlled to achieve the necessary pollutant load reductions estimated in the watershed based plan (WBP).

General Watershed Information

This WBP was prepared for waterbodies located within the Fort River Watershed located in the towns of Amherst, Belchertown, Hadley, Pelham, and Shutesbury. These waterbodies include the Fort River (MA34-27), Adams Brook, Amethyst Brook (MA34-35), Baker Brook, Buffam Brook, Dean Brook, Dunlop Brook, Gates Brook, Harris Brook, Harts Brook, Hearthstone Brook, Hop Brook (MA34-61), Nurse Brook, Plum Brook, and Scarboro Brook. Acadia Lake and Lake Holland are also included in the watershed. The Fort River is the longest free-flowing tributary to the Connecticut River and has a drainage area of approximately 36,000 acres (approximately 56 square miles). In addition, the Fort River watershed has high freshwater mussel diversity, with 10 different species recorded (Carmignani, 2020).

Table A-1 presents the general watershed information for the applicable Fort River watershed[1] and **Figure A-1** includes a map of the watershed boundary.

Table A-1: General Subwatershed Information

Fort River Watershed Information	
Watershed Name (Assessment Unit ID):	Adams Brook, Amethyst Brook (MA34-35), Baker Brook, Buffam Brook, Dean Brook, Dunlop Brook, Fort River (MA34-27), Gates Brook, Harris Brook, Harts Brook, Hearthstone Brook, Hop Brook (MA34-61), Nurse Brook, Plum Brook, Scarboro Brook, Fearing Brook
Major Basin:	Connecticut River
Watershed Area (within MA):	35,730 acres

[1] Watersheds are defined by the WBP-tool by utilizing MassGIS drainage sub-basins.

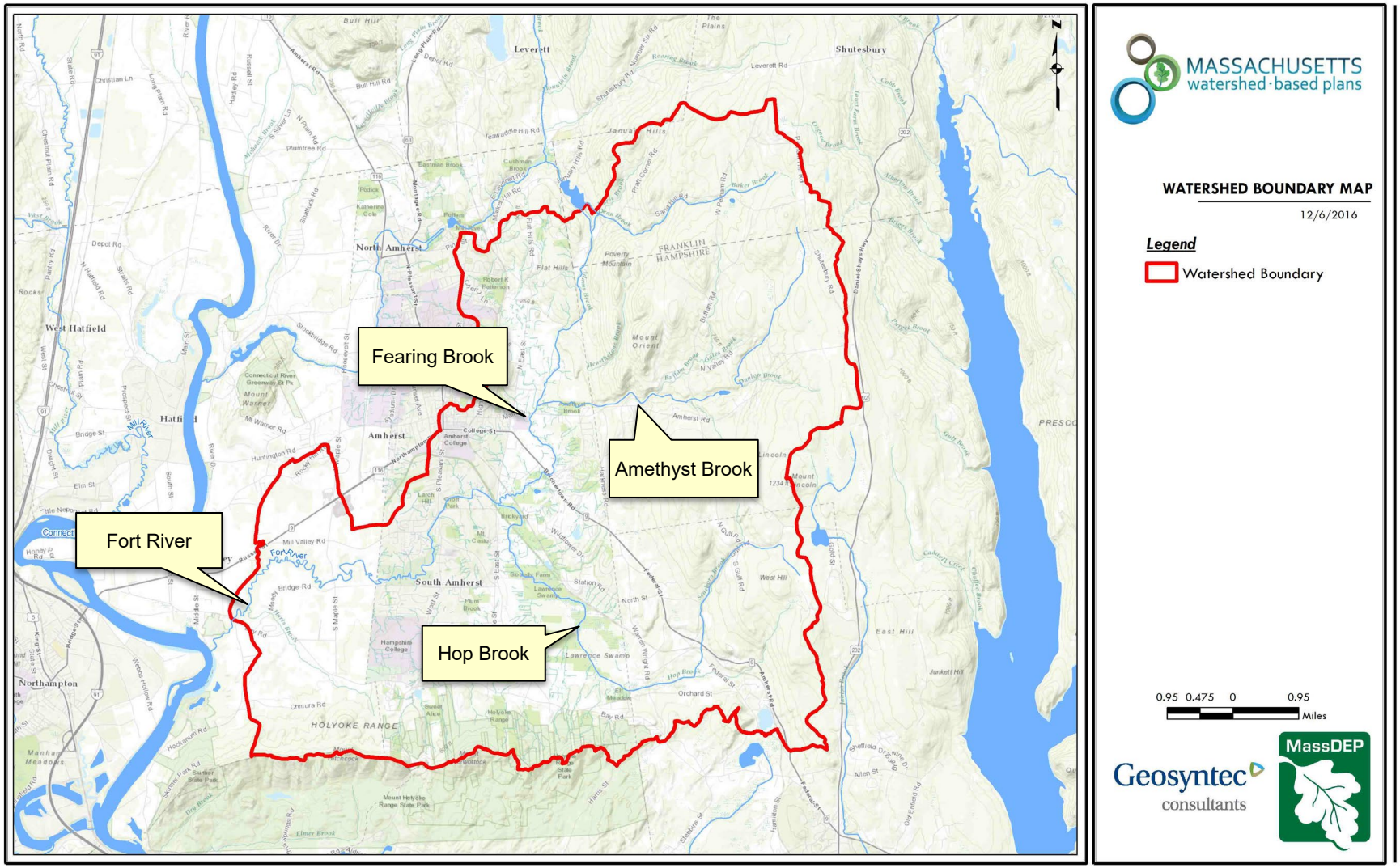

Figure A-1: Watershed Boundary Map

(MassGIS, 2007; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

MassDEP Water Quality Assessment Report and TMDL Review

The following reports are available:

- Connecticut River Watershed 2003 Water Quality Assessment Report
- Connecticut River Watershed 2008 DWM Water Quality Monitoring Data (MassDEP 2013a)
- Connecticut River Watershed 2008 Benthic Macroinvertebrate Bioassessment (MassDEP 2013b)

Select excerpts from these documents relating to the water quality in the Fort River watershed is included below (note: relevant information is included directly from these documents for informational purposes and has not been modified).

Connecticut River Watershed 2003 Water Quality Assessment Report (MA34-27 - Fort River)

Aquatic Life Use

Biology

MA DFG collected fish community data at the Fort River at Site 948 upstream from South Maple Street in Hadley in 2003 (Richards 2006). Only four fish species, and five total fish were collected. However, sampling efficiency was rated at 50% and comments indicated that the current was very swift and that section should be sampled with a barge instead of backpack electroshocking equipment. Two rock bass, 1 longnose dace, 1 fallfish, and 1 chain pickerel were collected.

Toxicity – Effluent

Whole effluent toxicity tests were conducted on the Coal Storage and Handling Facility treated effluent. Between August 2000 and April 2005, 16 valid tests were conducted using both *C. dubia* and *P. promelas*. The LC50s were all >100% effluent (n=16).

Water Chemistry

DWM conducted water quality sampling at Route 47 in Hadley, Station 27B, on this segment of the Fort River between April and October 2003. Most measurements were indicative of good water quality conditions. Total phosphorus concentrations were elevated and ranged from 0.029 to 0.160 mg/L (half of the measurements exceeded 0.05 mg/L). It should be noted that on 6 August, a wet weather sampling date, TSS was 46 mg/L and turbidity was 8.9 NTU.

The Fort River is assessed as support for the Aquatic Life Use based on the good water quality data. Total phosphorus concentrations were frequently elevated and are of concern, and result in an Alert Status for this use.

Primary and Secondary Contact Recreation and Aesthetics Uses

DWM collected *E. coli* samples from the Fort River at Route 47 in Hadley (Station 27B) between April and November 2003 (Appendix B). The geometric mean of these samples was 254 cfu/100ml.

DWM personnel made field observations at Station 27B during surveys conducted between April and October 2003. No objectionable deposits or water odors were recorded. White foam was recorded on one occasion and water clarity was recorded as highly turbid on three occasions (MassDEP 2003).

The Primary Contact Recreational Use is assessed as impaired because of elevated *E. coli* bacteria counts. The Secondary Contact Recreation and Aesthetics uses are assessed as support based upon bacteria counts that are acceptable for secondary contact and the general lack of objectionable conditions. These uses are identified with an Alert Status due to high TSS concentrations and high turbidity documented during wet weather sampling.

Report Recommendations:

Investigate the origin and pattern of highly turbid conditions noted on several occasions.

Consider this segment for bacteria source tracking work to investigate sources of elevated bacteria counts.

Connecticut River Watershed 2008 DWM Water Quality Monitoring Data (MA34-27 - Fort River)

Water Quality Monitoring Data

Table 1. MassDEP, DWM 2008 Connecticut River Watershed sampling station descriptions, sampling parameters and frequency.

Station ID	Unique ID	Waterbody	Description	Latitude	Longitude	Nutrients/ Solids/Color	*E.Coli*	Attended Multiprobe	Deployed MultiProbe	Temperature Logger
FORT1	W1804	Fort River	bike path bridge ~50 feet east of Route 116, Amherst	42.35565	-72.52065	5	6	5		
FORT2	W1051	Fort River	Route 47, Hadley	42.33279	-72.57858	5	6	6	3	

Table 5. 2008 Field observations from MassDEP DWM Connecticut River Watershed river surveys

S=sparse (0-25%, M=moderate (25-50%), D=dense (50-75%), VD=very dense (75-100%), N=none, U=unobservable, NA=not recorded, NP=not applicable – probe deploy field sheet)

Station ID	Unique ID	Date	Odor	Water Clarity	Color	Aquatic Plants	Filamentous Algae	Film Algae	Loose Floc	Moss	Floating Scum	Floating Scum Comments	Objectionable Deposits	Objectionable Deposit Comments
FORT1	W1804	05/06/08	N	Clear	Clear	N	N	N	N	N	No		No	
FORT1	W1804	06/03/08	N	Clear	Yellow/ Tan	N	N	N	N	N	Yes	Foam, natural	No	
FORT1	W1804	07/01/08	N	Slightly Turbid	Yellow/ Tan	S	N	N	N	N	No		No	
FORT1	W1804	07/29/08	N	Clear	Yellow/ Tan	S	NR	S	NR	NR	Yes	Foam, natural	No	
FORT1	W1804	09/03/08	Musty	Clear	Clear	S	NR	M	NR	NR	Yes	Foam	No	
FORT1	W1804	09/09/08	Musty	Clear	Yellow/ Tan	N	N	N	N	N	No		No	
FORT2	W1051	05/06/08	N	Clear	Clear	N	N	N	N	N	No		No	
FORT2	W1051	05/30/08	N	Clear	Clear	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
FORT2	W1051	06/03/08	N	Clear	Yellow/ Tan	N	N	N	N	N	Yes	Foam, natural	No	
FORT2	W1051	06/27/08	N	Slightly Turbid	Yellow/ Tan	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
FORT2	W1051	07/01/08	Musty	Mod. Turbid	Yellow/ Tan	N	U	U	U	U	Yes	Foam	No	
FORT2	W1051	07/25/08	U	Highly Turbid	U	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
FORT2	W1051	07/29/08	N	Clear	Yellow/ Tan	U	U	U	U	U	Yes	Foam, natural	No	
FORT2	W1051	09/03/08	Sulfide	Clear	Yellow/ Tan	N	M	NR	NR	S	Yes	Foam, natural	No	
FORT2	W1051	09/09/08	Musty	Mod. Turbid	Yellow/ Tan	N	N	N	N	N	No		No	

Connecticut River Watershed 2008 DWM Water Quality Monitoring Data (MA34-27 - Fort River)

Table 6. 2008 MassDEP, DWM Connecticut River Watershed water quality data

NOTE: Result Qualifier definitions appear in Appendix 1.

Station ID	Unique ID	OWMID	Date	Time	Analyte	Units	Result	Result Qualifiers
FORT1	W1804	34-0588	05/06/08	11:53	Ammonia-N	mg/L	<0.02	
FORT1	W1804	34-0690	06/03/08	12:15	Ammonia-N	mg/L	0.04	
FORT1	W1804	34-0792	07/01/08	11:53	Ammonia-N	mg/L	0.03	
FORT1	W1804	34-0924	07/29/08	11:59	Ammonia-N	mg/L	<0.02	
FORT1	W1804	34-1035	09/09/08	11:25	Ammonia-N	mg/L	0.03	
FORT1	W1804	34-0588	05/06/08	11:53	*E. coli*	CFU/100mL	24	
FORT1	W1804	34-0690	06/03/08	12:15	*E. coli*	CFU/100mL	60	
FORT1	W1804	34-0792	07/01/08	11:53	*E. coli*	CFU/100mL	100	
FORT1	W1804	34-0924	07/29/08	11:59	*E. coli*	CFU/100mL	30	
FORT1	W1804	34-0981	09/03/08	11:18	*E. coli*	CFU/100mL	140	
FORT1	W1804	34-1035	09/09/08	11:25	*E. coli*	CFU/100mL	460	
FORT1	W1804	34-0588	05/06/08	11:53	Suspended Solids	mg/L	1.4	
FORT1	W1804	34-0690	06/03/08	12:15	Suspended Solids	mg/L	2.3	
FORT1	W1804	34-0792	07/01/08	11:53	Suspended Solids	mg/L	2.2	
FORT1	W1804	34-0924	07/29/08	11:59	Suspended Solids	mg/L	2.4	
FORT1	W1804	34-1035	09/09/08	11:25	Suspended Solids	mg/L	4.6	
FORT1	W1804	34-0588	05/06/08	11:53	Total Nitrogen	mg/L	0.25	
FORT1	W1804	34-0690	06/03/08	12:15	Total Nitrogen	mg/L	0.45	
FORT1	W1804	34-0792	07/01/08	11:53	Total Nitrogen	mg/L	0.40	
FORT1	W1804	34-0924	07/29/08	11:59	Total Nitrogen	mg/L	0.42	h
FORT1	W1804	34-1035	09/09/08	11:25	Total Nitrogen	mg/L	0.45	
FORT1	W1804	34-0588	05/06/08	11:53	Total Phosphorus	mg/L	0.011	
FORT1	W1804	34-0690	06/03/08	12:15	Total Phosphorus	mg/L	0.031	
FORT1	W1804	34-0792	07/01/08	11:53	Total Phosphorus	mg/L	0.024	
FORT1	W1804	34-0924	07/29/08	11:59	Total Phosphorus	mg/L	0.029	h
FORT1	W1804	34-1035	09/09/08	11:25	Total Phosphorus	mg/L	0.036	
FORT1	W1804	34-0588	05/06/08	11:53	True Color	PCU	17	
FORT1	W1804	34-0690	06/03/08	12:15	True Color	PCU	39	
FORT1	W1804	34-0792	07/01/08	11:53	True Color	PCU	47	
FORT1	W1804	34-0924	07/29/08	11:59	True Color	PCU	53	
FORT1	W1804	34-1035	09/09/08	11:25	True Color	PCU	60	
FORT1	W1804	34-0588	05/06/08	11:53	Turbidity	NTU	1.3	b
FORT1	W1804	34-0690	06/03/08	12:15	Turbidity	NTU	3.5	b
FORT1	W1804	34-0792	07/01/08	11:53	Turbidity	NTU	3.2	
FORT1	W1804	34-0924	07/29/08	11:59	Turbidity	NTU	3.3	
FORT1	W1804	34-1035	09/09/08	11:25	Turbidity	NTU	4.7	
FORT2	W1051	34-0589	05/06/08	12:23	Ammonia-N	mg/L	<0.02	
FORT2	W1051	34-0691	06/03/08	13:18	Ammonia-N	mg/L	0.04	
FORT2	W1051	34-0793	07/01/08	12:14	Ammonia-N	mg/L	0.04	
FORT2	W1051	34-0925	07/29/08	12:48	Ammonia-N	mg/L	0.03	
FORT2	W1051	34-1036	09/09/08	11:44	Ammonia-N	mg/L	0.03	
FORT2	W1051	34-0589	05/06/08	12:23	E. coli	CFU/100mL	52	
FORT2	W1051	34-0691	06/03/08	13:18	*E. coli*	CFU/100mL	208	
FORT2	W1051	34-0793	07/01/08	12:14	*E. coli*	CFU/100mL	240	
FORT2	W1051	34-0925	07/29/08	12:48	*E. coli*	CFU/100mL	210	
FORT2	W1051	34-0982	09/03/08	11:39	*E. coli*	CFU/100mL	240	
FORT2	W1051	34-1036	09/09/08	11:44	*E. coli*	CFU/100mL	1500	
FORT2	W1051	34-0589	05/06/08	12:23	Suspended Solids	mg/L	12	
FORT2	W1051	34-0691	06/03/08	13:18	Suspended Solids	mg/L	3.5	

Connecticut River Watershed 2008 DWM Water Quality Monitoring Data (MA34-27 - Fort River)

Station ID	Unique ID	OWMID	Date	Time	Analyte	Units	Result	Result Qualifiers
FORT2	W1051	34-0793	07/01/08	12:14	Suspended Solids	mg/L	10	
FORT2	W1051	34-0925	07/29/08	12:48	Suspended Solids	mg/L	18	
FORT2	W1051	34-1036	09/09/08	11:44	Suspended Solids	mg/L	25	
FORT2	W1051	34-0589	05/06/08	12:23	Total Nitrogen	mg/L	0.36	
FORT2	W1051	34-0691	06/03/08	13:18	Total Nitrogen	mg/L	0.54	
FORT2	W1051	34-0793	07/01/08	12:14	Total Nitrogen	mg/L	0.52	
FORT2	W1051	34-0925	07/29/08	12:48	Total Nitrogen	mg/L	0.52	h
FORT2	W1051	34-1036	09/09/08	11:44	Total Nitrogen	mg/L	0.54	
FORT2	W1051	34-0589	05/06/08	12:23	Total Phosphorus	mg/L	0.022	
FORT2	W1051	34-0691	06/03/08	13:18	Total Phosphorus	mg/L	0.033	
FORT2	W1051	34-0793	07/01/08	12:14	Total Phosphorus	mg/L	0.038	
FORT2	W1051	34-0925	07/29/08	12:48	Total Phosphorus	mg/L	0.053	h
FORT2	W1051	34-1036	09/09/08	11:44	Total Phosphorus	mg/L	0.070	
FORT2	W1051	34-0589	05/06/08	12:23	True Color	PCU	16	
FORT2	W1051	34-0691	06/03/08	13:18	True Color	PCU	32	
FORT2	W1051	34-0793	07/01/08	12:14	True Color	PCU	39	
FORT2	W1051	34-0925	07/29/08	12:48	True Color	PCU	47	
FORT2	W1051	34-1036	09/09/08	11:44	True Color	PCU	45	
FORT2	W1051	34-0589	05/06/08	12:23	Turbidity	NTU	3.9	b
FORT2	W1051	34-0691	06/03/08	13:18	Turbidity	NTU	3.9	b
FORT2	W1051	34-0793	07/01/08	12:14	Turbidity	NTU	6.0	
FORT2	W1051	34-0925	07/29/08	12:48	Turbidity	NTU	12.5	
FORT2	W1051	34-1036	09/09/08	11:44	Turbidity	NTU	13.5	

Table 7. Geometric mean* of the 2008 *E. coli* results for each DWM Connecticut River sampling station

*The detection limit or the upper quantification limit was used in the geometric mean calculation if the result was either below the detection limit or above the upper quantification limit. Results from duplicate samples were removed before completing the geometric mean calculation. Stations that had *E. coli* results that were below the detection limit are marked with [1]. Stations that had *E. Coli* results above the upper quantification are marked with a [2]. Please see Table 6 for a complete listing of *E. coli* results.

Station ID	Unique ID	Sample Count	Geometric Mean (CFU/100 ml)
FORT1	W1804	6	80.8
FORT2	W1051	6	241.1

Connecticut River Watershed 2008 DWM Water Quality Monitoring Data (MA34-27 - Fort River)

Table 8. 2008 MassDEP, DWM Connecticut River Watershed Attended Multiprobe Data

Note: Descriptions of data qualifiers may be found in Appendix 1.

Station ID	Unique ID	OWMID	Date	Time	Sample Depth (m)	Depth Qualifiers	Temperature °C	Temperature Qualifiers	pH (SU)	pH Qualifiers	Specific Conductivity (µS/cm)	Specific Conductivity Qualifiers	Total Dissolved Solids (mg/l)	Total Dissolved Solids Qualifiers	Dissolved Oxygen (mg/l)	Dissolved Oxygen Qualifiers	Dissolved Oxygen Saturation (%)	Dissolved Oxygen Saturation Qualifiers
FORT1	W1804	34-0617	05/06/08	12:02	0.5		12.8		6.6		91		58		10.4		99	
FORT1	W1804	34-0719	06/03/08	12:22	0.3		18.4		6.9		124	i	80	i	8.7		94	
FORT1	W1804	34-0821	07/01/08	11:58	0.3		21.5		7		122		80		8.8		99	
FORT1	W1804	34-0953	07/29/08	12:06	--		20.4		6.3		77		49		7		79	
FORT1	W1804	34-1064	09/09/08	11:29	--		17.7		6.2		81		52		7.3		77	
FORT2	W1051	34-0638	05/30/08	12:38	0.3		16.5		6.8		149	i	95	i	8.8		91	
FORT2	W1051	34-0639	06/04/08	12:21	0.4		17.2		6.8	i	146	i	93	i	8		85	
FORT2	W1051	34-0740	06/27/08	13:30	0.2		18.1		6.8		116		74		8.7		93	
FORT2	W1051	34-0741	07/02/08	12:31	0.1		21.1		6.8		144		92		7.8		89	
FORT2	W1051	34-0872	07/25/08	12:32	--		19.7		6.2		60		38		6.9		77	
FORT2	W1051	34-0873	07/30/08	12:39	0.3		21.2		6.7		101		65		7.5		86	

Table 9. 2008 MassDEP, DWM Connecticut River Watershed Deployed Multiprobe Data

Note: Descriptions of data qualifiers may be found in Appendix 1.

Station ID	Unique ID	OWMID	Start Date	Deployment Duration (Hours)	Minimum Dissolved Oxygen (mg/l)	Average Dissolved Oxygen (mg/L)	Amount of Time < 5.0 mg/L (Hours)	Percentage of Time < 5.0 mg/L (%)	Amount of Time < 6.0 mg/L (Hours)	Percentage of Time < 6.0 mg/L (%)	Minimum Saturation (%)	Average Saturation (%)	Maximum Saturation (%)
FORT2	W1051	34-0637	05/30/08	119.0	7.4	8.0	0	0	0	0	78.6	84.1	93.7
FORT2	W1051	34-0739	06/27/08	118.5	7.0	7.5	0	0	0	0	81.2	84.6	89.8
FORT2	W1051	34-0871	07/25/08	119.5	6.2	7.1	0	0	0	0	70.4	79.7	85.8

Connecticut River Watershed 2008 DWM Water Quality Monitoring Data (MA34-27 - Fort River)

Table 10. 2008 MassDEP, DWM Connecticut River Watershed Temperature Data

Note: Data qualifier descriptions appear in Appendix1. Temperature data sourced from both deployed multiprobes and deployed temperature loggers.

Station ID	Unique ID	OWMID	Start Date	Deployment Duration (hours)	Mean Temperature °C	Maximum Temperature °C	Mean of the Daily Maximum Temperature °C	Amount of time temperature greater than 20 °C (Hours)	Percent of time temperature greater than 20 °C (%)	Amount of time temperature greater than 28.3 °C (Hours)
FORT2	W1051	34-0637	05/30/08	119	17.4	19.3	18.5	0.0	0.0	0
FORT2	W1051	34-0739	06/27/08	118.5	20.4	22.4	21.7	80.4	67.9	0
FORT2	W1051	34-0871	07/25/08	119.5	20.5	21.4	21.0	98.5	82.4	0

Additional Water Quality Data

In addition to the Fort River sampling stations detailed above (FORT1 and FORT2), sampling was also conducted by MassDEP in 2008 at two other locations in the Fort River watershed. The four locations sampled in 2008 included:

- Fort River mainstem at the bike path bridge 50 feet east of Route 116 in Amherst (FORT1);
- Fort River mainstem at Route 47 in Hadley (FORT2);
- Hop Brook at Station Road in Amherst (HOP1); and
- Amethyst Brook at Allen Mill Road, Amherst (AM01).

The results indicated elevated levels (above the criteria presented in **Table A-5**) of TP at FORT2 and of *E. coli* at all four locations (MassDEP, 2013a). The results for the macroinvertebrate surveys conducted in 2008 are not detailed here but can be found in MassDEP 2013b.

Sampling conducted in the Fearing Brook subwatershed in 2015—2016 identified that dry and wet weather *E. coli* levels measured in different sections of Fearing Brook were TNTC. Elevated levels of TP (above the criteria presented in **Table A-5**) were also identified. Microbial source tracking conducted in the Fearing Brook subwatershed indicated that the brook had fecal contamination from mammals (pets or rodents), human, and gull sources (New England Environmental, Inc., 2015).

Additionally, recent data from July 2020 conducted by the Connecticut River Conservancy identified high wet weather levels of *E.coli* in Amethyst Brook (2,420 cfu/100 ml) and in the Fort River at Groff Park in Amherst (1,986 cfu/100 ml) (https://connecticutriver.us/node/480 and https://connecticutriver.us/node/479).

Water Quality Impairments

Impairment categories from the Integrated List are included in **Table A-2**. Known water quality impairments as documented in the MassDEP 2016 Massachusetts Integrated List of Waters are listed below in **Table A-3**.

Table A-2: 2016 MA Integrated List of Waters Categories

Integrated List Category	Description
1	Unimpaired and not threatened for all designated uses.
2	Unimpaired for some uses and not assessed for others.
3	Insufficient information to make assessments for any uses.
4	Impaired or threatened for one or more uses, but not requiring calculation of a Total Maximum Daily Load (TMDL), including: 4a: TMDL is completed 4b: Impairment controlled by alternative pollution control requirements 4c: Impairment not caused by a pollutant - TMDL not required
5	Impaired or threatened for one or more uses and requiring preparation of a TMDL.

Table A-3: Water Quality Impairments

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Impairment Source
MA34-27	**Fort River**	**5**	Primary Contact Recreation	Escherichia coli	Source Unknown

Water Quality Goals

Water quality goals may be established for a variety of purposes, including the following:

a. For **waterbodies with known impairments**, a Total Maximum Daily Load (TMDL) is established by MassDEP and USEPA as the maximum amount of the target pollutant that the waterbody can receive and still safely meet water quality standards. If the waterbody has a TMDL for TP or total nitrogen (TN), or total suspended solids (TSS), that information is provided below and included as a water quality goal.

b. For **waterbodies without a TMDL for TP**, a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (USEPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 micrograms per liter (µg/L) in any stream at the point where it enters any lake or reservoir, nor 25 µg/L within a lake or reservoir. For the purposes of developing WBPs, MassDEP has adopted 50 µg/L as the TP target for all streams at their downstream discharge point, regardless of which type of waterbody the stream discharges to.

c. Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. **Table A-4** lists the Class for each Assessment Unit ID within the Amherst subwatersheds that contribute to the Fort River. The water quality goal(s) for bacteria are based on the Massachusetts Surface Water Quality Standards.

Table A-4: Surface Water Quality Classification by Assessment Unit ID

Assessment Unit ID	Waterbody	Class
MA34-27	Fort River	B

d. **Other water quality goals set by the community** (e.g., protection of high-quality waters, in-lake TP concentration goal to reduce recurrence of cyanobacteria blooms).

Refer to **Table A-5** for a list of water quality goals. There are known impairments for Fort River; however, because there are no existing TMDLs for Fort River or its receiving waterbody, the Connecticut River, water quality goals are focused on reducing common nonpoint source pollutants as well as *E. coli*.

It is expected that efforts to reduce loads of these pollutants will also result in improvements to other nonpoint source pollutants for waterbodies within the Fort River watershed (e.g., nutrients, turbidity). **Element C** of this WBP includes proposed BMPs to address these pollutants, including BMPs that provided increases in infiltration. Infiltration is a commonly used method to reduce phosphorus and bacteria loads in stormwater runoff, and it can also help with peak runoff rate attenuation, reduced thermal impacts to receiving waters, and enhanced base flow to receiving waters (USEPA, 2014).

Table A-5: Water Quality Goals

Pollutant	Waterbody Name (Assessment Unit ID(s))	Goal	Source
Total Phosphorus (TP)	Fort River (MA34-27)	Total phosphorus should not exceed: --50 ug/L in any stream --25 ug/L within any lake or reservoir	Quality Criteria for Water (USEPA, 1986)
Bacteria	Fort River (MA34-27)	**Class B Standards** • Public Bathing Beaches: For *E. coli*, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml; • Other Waters and Non-bathing Season at Bathing Beaches: For *E. coli*, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml.	Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013)

Land Use Information

Land use information and impervious cover is presented by the tables and figures below. Land use source data is from 2005 and was obtained from MassGIS (MassGIS, 2009b).

Watershed Land Uses

As summarized by **Table A-6**, land use in the Fort River watershed is mostly forested (approximately 72.8 percent); approximately 12.5 percent is agricultural; approximately 9.9 percent of the watershed is residential; approximately 2.4 percent of the watershed is open land or water; approximately 1.8 percent of the watershed is commercial; approximately 0.4 percent of the watershed is industrial; and approximately 0.1 percent is devoted to highways.

Table A-6: Watershed Land Uses

Land Use	Area (acres)	% of Watershed
Forest	26,024.17	72.8
Agriculture	4,481.27	12.5
Low Density Residential	2,276.53	6.4
Medium Density Residential	774.98	2.2
Commercial	658.3	1.8
Open Land	640.39	1.8
High Density Residential	455	1.3
Water	211.71	0.6
Industrial	157.16	0.4
Highway	50.8	0.1
TOTAL:	35,730.31	100

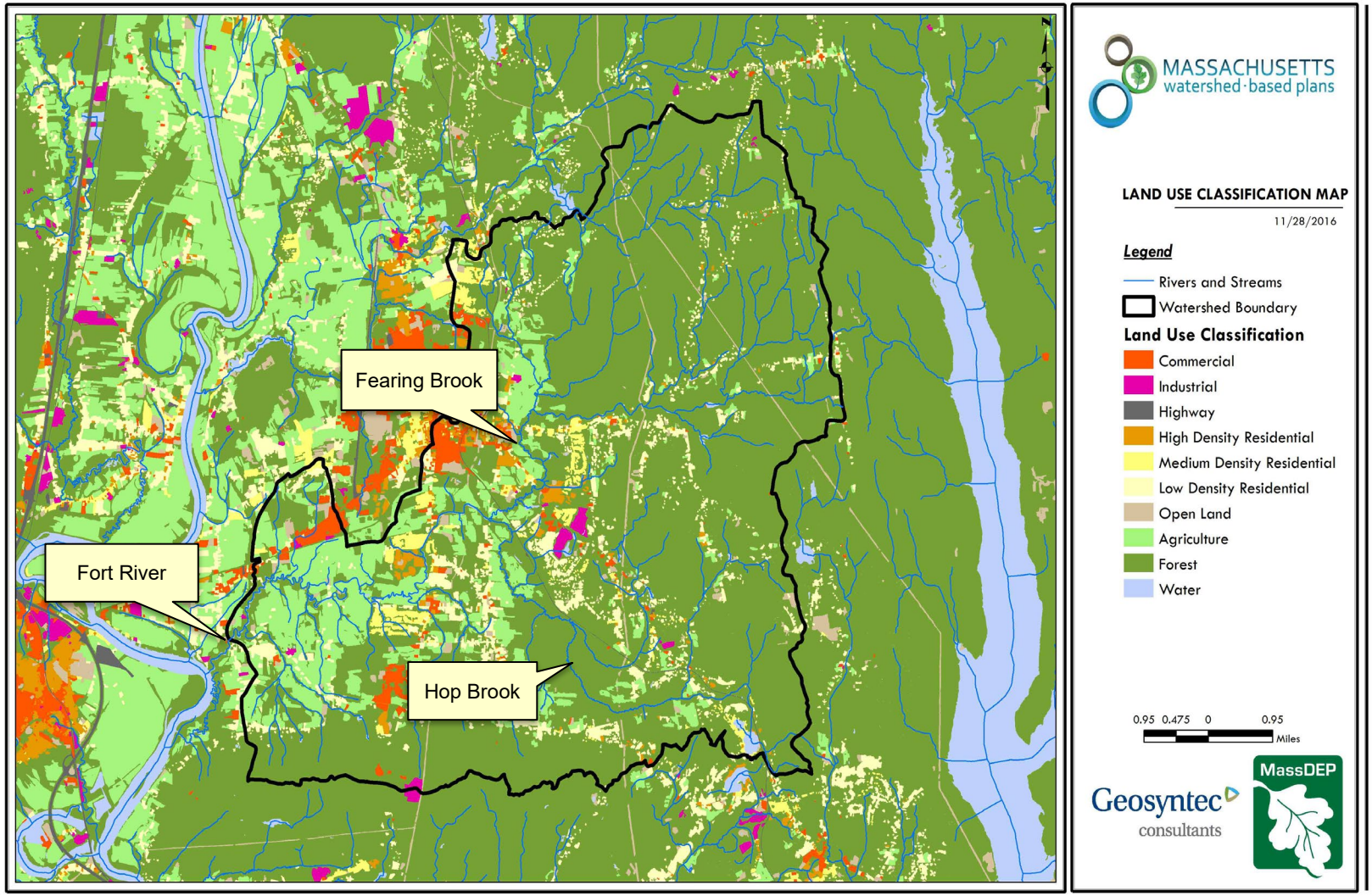

Figure A-2: Subwatershed Land Use Map

(MassGIS, 2007; MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc. Impervious area within the watershed of the Fort River is concentrated in western and central portion of the watershed as illustrated in **Figure A-8** below.

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land. Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent pervious surfaces.

An estimate of DCIA for the subwatershed area was calculated based on the Sutherland equations. USEPA provides guidance (USEPA, 2010) on the use of the Sutherland equations to predict relative levels of connection and disconnection based on the type of stormwater infrastructure within the total impervious area (TIA) of a watershed. Within the subwatershed, the total area of each land use was summed and used to calculate the percent TIA (**Table A-7**).

Table A-7: TIA and DCIA values for the Watershed

Watershed	Estimated TIA (%)	Estimated DCIA (%)
Fort River	5.2	3.8

The relationship between TIA and water quality can generally be categorized as listed by **Table A-8** (Schueler et al., 2009). The TIA value for the entire watershed is 5.2 percent, which generally indicates good to excellent water quality. However, the most concentrated impervious area within the Fort River watershed is within the Fearing Brook subwatershed. The TIA within the Fearing Brook subwatershed is estimated at 35 to 40 percent (Damiano, 2017; MMI, 2018), but the Fearing Brook subwatershed area only comprises approximately 1.3 percent of the total Fort River watershed area. Therefore, approximately 10 percent of the Fort River watershed TIA is within the Fearing Brook subwatershed. Due to its high percentage of TIA (as well as supporting data indicating poor water quality), the Fearing Brook tributary is considered a significant point source into the Fort River.

Table A-8: Relationship between Total Impervious Area (TIA) and water quality (Schueler et al. 2009)

% Watershed Impervious Cover	Stream Water Quality
0-10%	Typically high quality, and typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects.
11-25%	These streams show clear signs of degradation. Elevated storm flows begin to alter stream geometry, with evident erosion and channel widening. Streams banks become unstable, and physical stream habitat is degraded. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.
26-60%	These streams typically no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Biological quality is typically poor, dominated by pollution tolerant insects and fish. Water quality is consistently rated as fair to poor, and water recreation is often no longer possible due to the presence of high bacteria levels.
>60%	These streams are typical of “urban drainage”, with most ecological functions greatly impaired or absent, and the stream channel primarily functioning as a conveyance for stormwater flows.

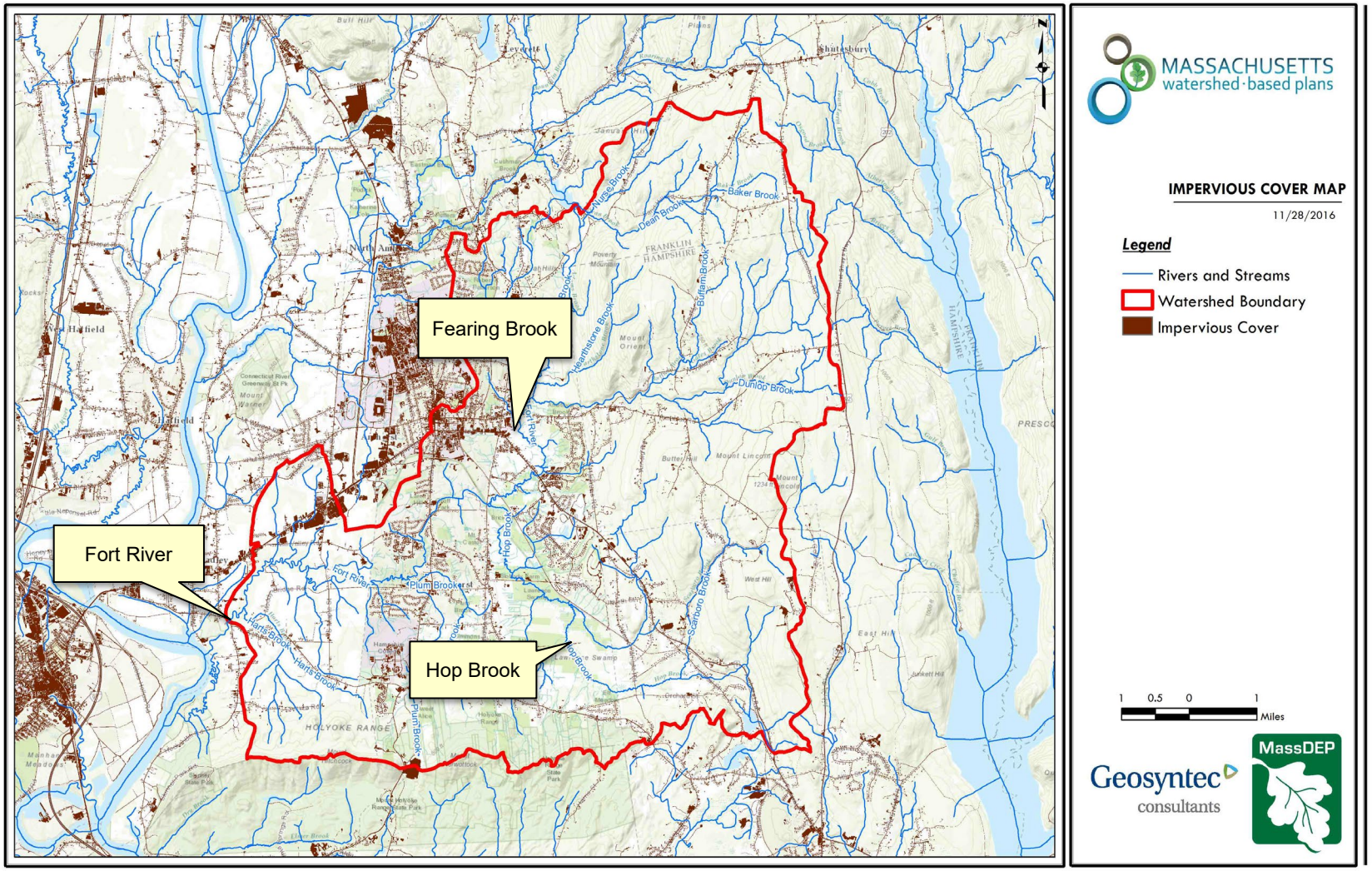

Figure A-3: Watershed Impervious Surface Map

(MassGIS, 2007; MassGIS 2009a; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Pollutant Loading

The land use data (MassGIS, 2009b) was intersected with impervious cover data (MassGIS, 2009a) and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils data (USDA NRCS and MassGIS, 2012) to create a combined land use/land cover grid. The grid was used to sum the total area of each unique land use/land cover type.

The amount of DCIA was estimated using the Sutherland equations as described above and any reduction in impervious area due to disconnection (i.e., the area difference between TIA and DCIA) was assigned to the pervious D soil category for that land use to simulate that some infiltration will likely occur after runoff from disconnected impervious surfaces passes over pervious surfaces.

Pollutant loading for key nonpoint source pollutants in the subwatershed area was estimated by multiplying each land use/cover type area by its pollutant load export rate (PLER). The PLERs are an estimate of the annual total pollutant load exported via stormwater from a given unit area of a particular land cover type. The PLER values for TN, TP, and TSS were obtained from USEPA (Voorhees, 2016b) (see documentation provided in Appendix C) as follows:

$$L_n = A_n * P_n$$

Where L_n = Loading of land use/cover type n (lb/yr); A_n = area of land use/cover type n (acres); P_n = PLER rate of land use/cover type n (lb/acre/yr)

The estimated land use-based phosphorus to receiving waters within the watershed areas is 7,827 pounds per year, as presented by **Table A-9**. The largest contributor of the land use-based phosphorus and nitrogen load originates from areas designated as forested (45 percent of the TP load and 36 percent of the TN load). Phosphorus generated from forested areas is a result of natural processes such as decomposition of leaf litter and other organic material; the forested portions of the watershed therefore are unlikely to provide opportunities for nutrient load reductions through BMPs. The second largest contributors of the land use-based phosphorus and nitrogen load in the watershed are agricultural areas. Agricultural areas provide excellent opportunities for nutrient load reductions through agricultural BMPs.

Table A-9: Estimated Pollutant Loading for Key Nonpoint Source Pollutants within Fort River

Land Use Type	Pollutant Loading[1]		
	Total Phosphorus (TP) (lb/yr)	Total Nitrogen (TN) (lb/yr)	Total Suspended Solids (TSS) (tons/yr)
Forest	3,529	17,864	595.14
Agriculture	2,168	12,976	143.41
Commercial	614	5,333	66.71
Low Density Residential	582	5,799	80.17
High Density Residential	355	2,429	35.92
Medium Density Residential	263	2,268	31.64
Open Land	180	1,743	35.54
Industrial	101	918	11.47
Highway	36	287	17.38
TOTAL	7,827	49,618	1,017.38

[1]These estimates do not consider loads from point sources or septic systems.

Element B: Determine Pollutant Load Reductions Needed to Achieve Water Quality Goals

Element B of your WBP should:

Determine the pollutant load reductions needed to achieve the water quality goals established in Element A. The water quality goals should incorporate Total Maximum Daily Load (TMDL) goals, when applicable. For impaired water bodies, a TMDL establishes pollutant loading limits as needed to attain water quality standards.

Estimated Pollutant Loads

Estimated pollutant loads for TP (7,827 lb/yr), TN (49,618 lb/yr), and TSS (1,017 tons/yr) were previously presented in Table A-9 of this WBP. Bacteria cannot be presented as a load; however, the measured geomean concentration of *E. coli* at the downstream section of the Fort River at Route 47 (FORT2) was measured at 254 cfu/100ml in 2003 (MassDEP, 2008) and 241 cfu/100 ml in 2008 (MassDEP, 2013a).

Water Quality Goals

There are many methods that can be used to set pollutant load reduction goals for a WBP. Goals can be based on water quality criteria, surface water standards, existing monitoring data, existing TMDL criteria, or other data. As discussed by the Water Quality Goals section of **Element A**, the water quality goals for this WBP are focused on addressing *E. coli* for Fort River. A description of criteria for TP and bacteria is described by **Table B-1**.

Table B-1: Pollutant Load Reductions Needed

Pollutant	Existing Estimated Total Load	Water Quality Goal	Planned Load Reduction
Total Phosphorus	7,827 lb/yr	6,653 lb/yr	1,174 lb/yr
Total Nitrogen	49,618 lb/yr		
Total Suspended Solids	1,017 ton/yr		
Bacteria	*MSWQS for bacteria are concentration standards (e.g., colonies of fecal coliform bacteria per 100 ml), which are difficult to predict based on estimated annual loading. E. coli samples collected between April—November 2003 from the Fort River at Route 47 in Hadley (Station 27B) had a geometric mean of 254 colonies/100 ml*	Class B. **Class B Standards** • Public Bathing Beaches: For *E. coli*, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For *enterococci*, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml; • Other Waters and Non-bathing Season at Bathing Beaches: For *E. coli*, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml.	*50% – Concentration Based*

Recommended Load Reduction

Past water quality monitoring data summarized in **Element A** indicates that the geometric mean of *E. coli* samples collected in the Fort River (241 and 254 cfu/100ml in 2003 and 2008, respectively) exceeds the benchmark for streams (geometric mean of samples greater than 126 colonies/100 ml and no single sample greater than 235 colonies/100 ml) (Massachusetts Surface Water Quality Standards 2013). Data from 2015 for Fearing Brook indicated dry and wet weather Fecal Coliform Units (FCUs) in Fearing Brook at different sections of Fearing Brook were TNTC as well as some elevated levels (above the criteria in Table A-5) of TP. MassDEP Water Quality Assessment Report TP monitoring data included in **Element A** indicates that total TP concentrations were elevated and ranged from 29 to 160 µg/L, with half of the measurements above 50 µg/L, the benchmark for streams (USEPA, 1986). Fort River was given an "Alert Status" in the Connecticut River Watershed 2003 Water Quality Assessment Report for designated uses based on phosphorus.

The method used in the WBP tool for calculating a water quality goal for TP produces a water quality goal of 9,728 lb/yr, which is greater than the estimated TP load of 7,827 lb/yr. Given the iterative and adaptive nature of this plan, the monitoring portion of this WBP (**Element I**) recommends that monitoring be performed to

close this data gap, which may help establish a specific TP related water quality goal with the next update of the WBP (expected in 2023). In the interim, the current external phosphorus load is estimated to be 7,827 pounds per year per WBP tool estimates. A long-term 15 percent reduction in external loading to 6,653 lb/yr is proposed to improve the water quality within the Fort River.

The proposed projects described in this plan are expected to reduce both *E. coli* and TP loads to Fort River, however, additional load reductions will be required to meet the water quality benchmark.

The following adaptive sequence is recommended to sequentially track and meet these load reduction goals:

1. Given current water quality conditions, establish an **interim goal** to reduce land use-based phosphorus by 15 percent (1,174 pounds) over the next 5 years (by 2024). Considering known pollutant loads for existing and proposed BMPs (please refer to the Introduction or **Element C** for more details on existing and proposed BMPs), it is anticipated that land-use-based phosphorus loading will be reduced by approximately 12 percent (945 pounds) at completion of the BMPs proposed by the Town of Amherst and the UMass (by 2020).

2. Given current water quality conditions, establish an **interim goal** to reduce the geometric mean concentration of *E. coli* by 50 percent over the next 10 years (by 2029). Considering known pollutant loads for existing and proposed BMPs (please refer to the Introduction or **Element C for** more details on existing and proposed BMPs), it is anticipated that land-use-based *E. coli* loading will be reduced by $3.53x10^{12}$ colonies/year from Moonlit Farm BMPs (UMass, 2019) in addition to the unquantified, but anticipated reductions through the Fearing Brook floodplain creation (Town of Amherst, 2019).

3. Establish a baseline water quality monitoring program in accordance with **Element I**. Results from the monitoring program should advise if **Element C** management measures have been effective at addressing listed water quality impairments or water quality goals for other indicator parameters established by **Table A-5** of this WBP (e.g., Total phosphorus and *E. coli*). Results can further be used to periodically inform or adjust load reduction goals.

4. Establish a **long-term reduction goal** to reduce land-use-based phosphorus and *E. coli* over the next 15 years. Based on monitoring data, establish additional **long-term reduction goal(s)**, if needed, to lead to delisting of all assessment units within the study watershed from the 303(d) list.

Element C: Describe Management Measures that Will Be Implemented to Achieve Water Quality Goals

Element C: A description of the nonpoint source management measures needed to achieve the pollutant load reductions presented in Element B, and a description of the critical areas where those measures will be needed to implement this plan.

Current and Ongoing Management Measures

The Town of Amherst was awarded funding through the Fiscal Year 2020 Section 319 Nonpoint Source Pollution Grant Program to install the proposed structural BMPs listed in **Tables C-1 (Town of Amherst)** and **C-2 (UMass)** within the Fort River watershed. The planning level cost estimates and pollutant load reduction estimates were based off information obtained from the "Fearing Brook Floodplain Creation Project" Section 319 Nonpoint Source Pollution Grant Program application (Town of Amherst, 2019) and the "Implementation, Remediation, and Education of Selected Best Management Practices to Minimize the Environmental Impact of Two Equine Operations" Section 319 Nonpoint Source Pollution Grant Program application (UMass, 2019). It is anticipated that these BMPs will result in a combined load reduction of approximately 945 lb of TP and at least $3.53x10^{12}$ organisms/year of *E. coli*. Details of these BMP designs are included in **Appendix A (Town of Amherst, 2019) and Appendix B (UMass, 2019)**.

Table C-1: Fearing Brook Floodplain Restoration Project - Estimated Pollutant Load Reductions and Costs

Town of Amherst BMPs		
BMP Type	Floodplain Restoration	
BMP Location	Fearing Brook	
Estimated Pollutant Load Reduction	Biochemical Oxygen Demand (BOD)	48.6% Removal
	Nitrogen	38.0% Removal
	Phosphorus	42.5% Removal
	Total Suspend Solids (TSS)	68.3% Removal
	E. coli	Unquantified
Estimated Cost ($)	$464,834	

The floodplain restoration project is proposed at the downstream end of Fearing Brook before the confluence with the Fort River. The project will include the following:

- Stabilization of the bank and channel to reduce erosion (TSS load)
- Reconnecting Fearing Brook to its historic floodplain to allow for attenuated flows
- Reducing stormwater volume through infiltration

- Treating nutrients and *E. coli*, and TSS capture
- Providing in-stream and floodplain habitat improvements to improve aquatic life and reduce thermal load

Table C-2: UMass Proposed Management Measures, Estimated Pollutant Load Reductions and Costs

Moonlit Farm BMPs		
BMP Type	Equine Farm Improvements	
BMP Location	Moonlit Farm (Unnamed Tributary to Hop Brook)	
Estimated Pollutant Load Reduction	Biochemical Oxygen Demand (BOD)	Unquantified
	Nitrogen	2,847 lb-N/year
	Phosphorus	899 lb-P/year
	Total Suspend Solids	Unquantified
	E. coli	$3.53x10^{12}$ organisms/year
Estimated Cost ($)	$239,033	

The equine farm improvements at Moonlit Farm in Belchertown will include the following:

- A solar-powered, 3-pile static aerated composting system
- Three sacrifice lots with at least 2,400 square feet
- Gutters and downspout to reduce runoff into unnamed tributary to Hop Brook
- Fencing to inhibit horses from directly accessing the unnamed tributary and wetlands
- Cleanup and repair of the forested area near the unnamed tributary where manure was historically dumped

Future Management Measures

As discussed by the Recommended Load Reduction section in **Element B**, it is recommended that future planning initially focus on water quality goals related to *E. coli* and TP in the Fort River Watershed. It is expected that efforts to reduce TP loading will also result in improvements to *E. coli.* Geosyntec performed a field investigation on September 2, 2020, to identify locations where additional structural BMPs could potentially be implemented to reduce pollutant loads to the Fort River. Prior to the field investigation, the following opportunity areas were identified through a desktop analysis as well as input from the Fort River stakeholders:

- Hickory Ridge Golf Club
- Agricultural properties in Hadley and Amherst
- Various locations within the Fearing Brook subwatershed

- Groff Park (bank erosion along Fort River)

Locations within the Fearing Brook subwatershed, Groff Park, and Hickory Ridge Golf Club were visited during the field investigation. While the Hickory Ridge Golf Club and agricultural properties present opportunities to implement BMPs to improve water quality, these locations could not be thoroughly evaluated under this current investigation phase and were therefore not visited during this field investigation. During field reconnaissance, Geosyntec assessed identified locations for space constraints, potential accessibility issues, presence of mature vegetation that may cause conflicts (e.g., roots), potential utility conflicts, site-specific drainage patterns, and other factors that may cause issues during design, construction, or long-term maintenance. Six locations were ultimately identified for future structural BMP implementation (five of which are in the Fearing Brook subwatershed and one of which is located along Mill Lane adjacent to Groff Park). **Figure C-1** identifies the locations of the six BMP concepts, and **Appendix C** presents the proposed BMP concepts for each of the six locations. Each BMP concept sheet includes the following:

- A site summary that describes current conditions and stormwater drainage patterns
- A description of proposed improvements, anticipated operations and maintenance, and anticipated permitting requirements
- BMP sizing parameters, including drainage area, design storm depth for which the BMP is sized,[2] and the percent impervious area within the drainage area of the proposed BMP
- Estimated costs that represent installed contractor construction costs (i.e., capital costs)
- Estimated TP, TN, and TSS pollutant load reduction for the proposed BMP

Geosyntec also performed a ranking analysis to identify a prioritized list of BMPs for future implementation. The site-specific prioritization criteria included cost, expected TP pollutant load reductions, implementation complexity, potential outreach opportunities and visibility to public, and expected operation and maintenance/accessibility effort. Results of the prioritization are presented in **Table C-3.** The proposed BMP at the Fort River Elementary School scored the highest. The total estimated pollutant load reduction and capital construction cost for all six BMPs is 22.8 lb/year and $500,000, respectively. The total estimated pollutant load reduction and capital construction cost for the five BMPs located within the Fearing Brook subwatershed is 20 lb/year and $410,000, respectively. While the Hickory Ridge Golf Club and additional agricultural BMP opportunities could not be evaluated and included in this prioritization, the opportunities are described below without specific quantification. Due to providing opportunities to target elevated nutrient sources (agricultural properties) and the large amount of land available (Hickory Ridge Golf Club), these opportunities are expected to result in significant water quality improvement and therefore are listed as “high” priority even though their prioritized rank could not be quantified at this time.

The Hickory Ridge Golf Club and potential locations where agricultural BMPs may be implemented at various farms in Hadley and Amherst are identified in **Figure C-2**. These opportunities are described further below.

[2] Proposed BMPs should be designed (at a minimum) to treat the water quality volume to the maximum extent practicable. The water quality volume is defined in the Massachusetts Stormwater Handbook as the volume equal to 0.5 inches of runoff times the total impervious area that drains to the BMP. However, each proposed BMP should be designed to achieve the most treatment that is practical given the size and logistical constraints of the site.

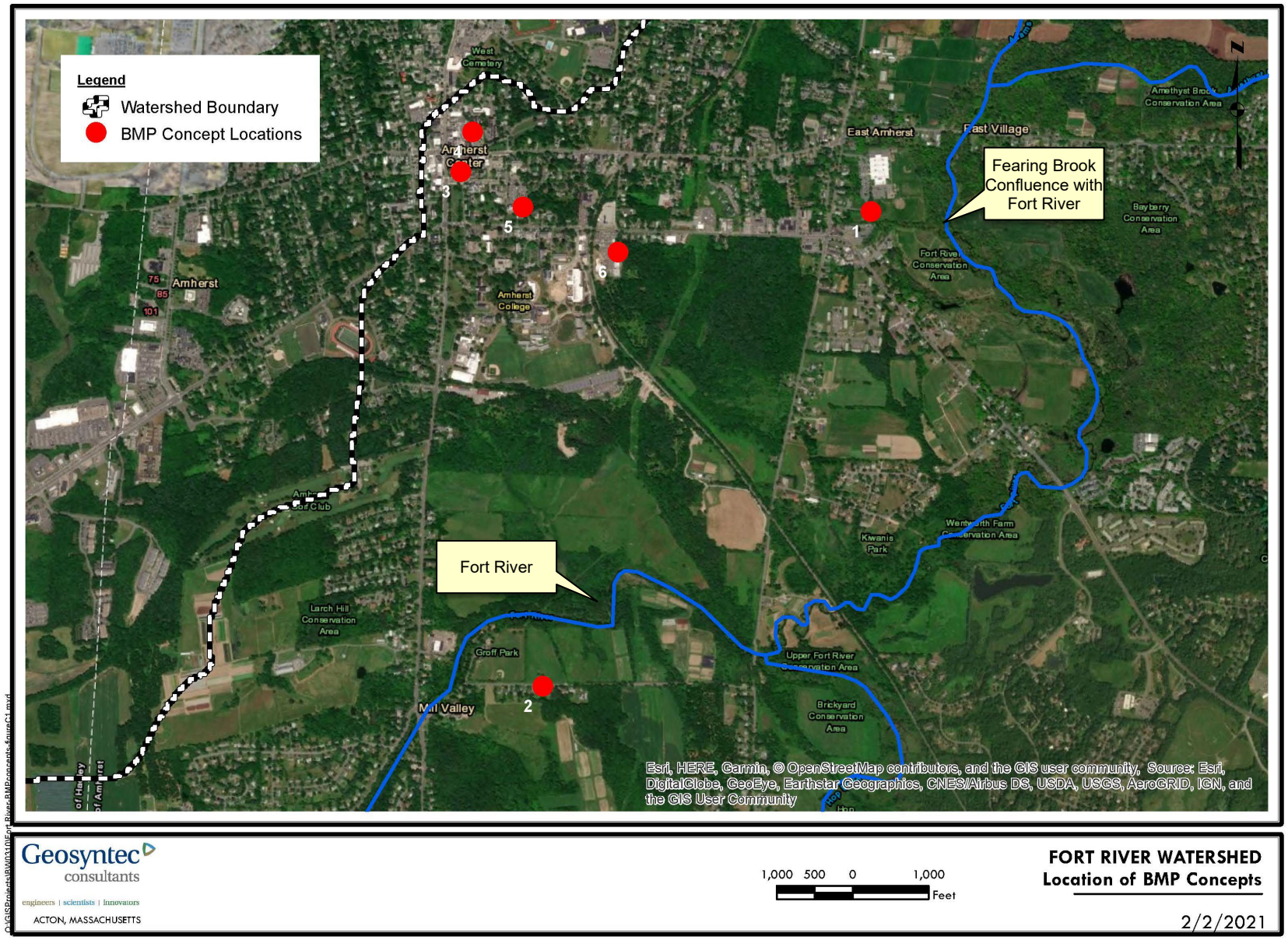

Figure C-1: Location of BMP Concepts in the Fort River Watershed (see Appendix C)

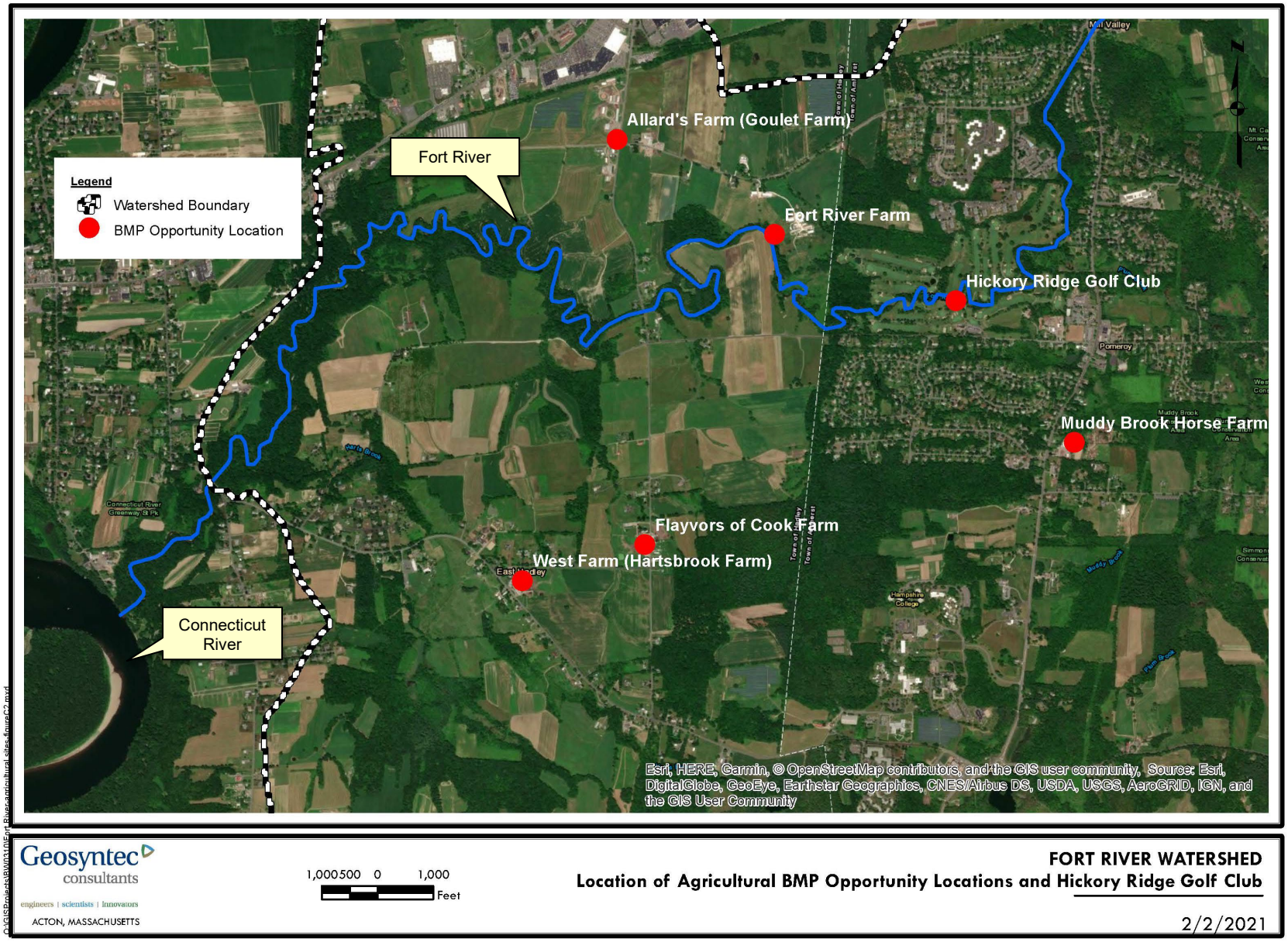

Figure C-2: Location of Agricultural BMP Opportunity Locations and Hickory Ridge Golf Club in the Fort River Watershed

Table C-3: Priority Ranking of Fort River Structural BMP Concepts (see Appendix C for Concepts)

BMP ID	BMP Location	BMP Type(s)	Planning Level (Construction Only) Capital Cost		TP Pollutant Load Reduction		Implementation Complexity	Visibility to Public/Outreach Potential	Operation and Maintenance/ Accessibility Effort	TOTAL	PRIORITY
			$	Rank	lb/year	Rank	Rank	Rank	Rank		
1	Fort River Elementary School	Infiltration Basin with Sediment Forebay	120,000	4	12.3	1	1	1	1	8	**1**
5	Alumni Parking Lot	Infiltration Basin with Sediment Forebay	30,000	1	2.3	4	4	5	3	17	**2**
3	Main Street and Spring Street Parking Lots	Rain Gardens	30,000	1	1	6	2	3	5	17	**2**
4	Boltwood Parking Lot	Rain Gardens	40,000	2	1.3	5	5	2	4	18	**3**
6	Hills Parking Lot	Constructed Wetland	190,000	5	3.5	2	3	6	2	18	**3**
2	Mill Lane at Groff Park	Rain Gardens	90,000	3	2.4	3	6	4	6	22	**4**
NA	Hickory Ridge Golf Club	Floodplain Restoration	TBD	NA	TBD	NA	NA	NA	NA	NA	**HIGH**
NA	Agricultural Properties	Agricultural BMPs	TBD	NA	TBD	NA	NA	NA	NA	NA	**HIGH**

TBD- To Be Determined, NA- Not Applicable

Hickory Ridge Golf Club

The Town of Amherst is currently in the process of purchasing the 149-acre Hickory Ridge Golf Club property, which includes a large (1.4-mile) section of the Fort River. Once the purchase is completed, master planning will be conducted for the property. Major goals for the future use of the property include protecting valuable habitat along the river, restoring floodplain, improving water quality, providing open space for residents, and creating other potential uses such as land for a new senior center.

Figure C-3: View of the Fort River at Hickory Ridge Golf Club

Agricultural Properties in Hadley and Amherst

A watershed-wide initiative to implement farm conservation practices and agricultural BMPs is recommended to reduce the pollutant loading from agricultural land uses within the Fort River watershed. Agricultural properties identified as potential significant sources for TP and *E. coli* pollutant loads to the Fort River are listed in **Table C-4**.

Table C-4: Agricultural BMP Opportunity Locations in the Fort River Watershed

Farm Name	Address	Approximate Area (acres)	Type of Farm
Muddy Brook Farm	646 West Street, Amherst	30	Equine
Flayvors of Cook Farm	129 S Maple St, Hadley	50	Dairy
West (Hartsbrook) Farm	Bay Rd, Hadley, MA	80	Dairy
Allard's (Goulet) Farm	41 South Maple Street, Hadley	130	Dairy
Fort River Farm	100 Mill Valley Road, Hadley	95	Beef

Implementation of such an initiative will require a regional coordinator to work with the various farmers to develop and implement comprehensive farm conservation plans that outline a full suite of BMPs necessary to prevent or remediate nonpoint source pollution generated by farm activities. Engagement with the farms should be coordinated with UMass and the Natural Resources Conservation Service (NRCS) both of whom have already developed relationships with some of the farm owners. Element D also provides more

information on grant opportunities through NRCS. Examples of agricultural BMPs that could be implemented include (but are not limited to) the following:

- Livestock exclusion fencing
- Nutrient management systems
- Erosion control
- Buffer systems
- Heavy use area protection
- Roof drains/barnyard runoff control
- Waste storage facilities
- Soil health (conservation tillage, cover crops on agricultural lands)
- Prescribed grazing
- Implementation of vegetative buffer
- Critical area planting
- Integrated pest management system

For one list of potential agricultural BMPs with information on effectiveness, impacts to surface waters, advantages for farms, cost and operation and maintenance considerations, estimated system lifespan, and NRCS Standards that could be used see https://www.dec.ny.gov/docs/water_pdf/agriculturebmp.pdf.

Element D: Identify Technical and Financial Assistance Needed to Implement Plan

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

Current and Ongoing Management Measures

The funding needed to implement the proposed management measures presented in this watershed plan is based on estimates from the "Fearing Brook Floodplain Creation Project" Section 319 Nonpoint Source Pollution Grant Program application (Town of Amherst, 2019) and the "Implementation, Remediation, and Education of Selected Best Management Practices to Minimize the Environmental Impact of Two Equine Operations" Section 319 Nonpoint Source Pollution Grant Program application (UMass, 2019). The total costs for structural and nonstructural BMPs, O&M activities, information/education measures, and monitoring/evaluation activities is estimated at approximately $703,867, as detailed by **Tables D-1 (Town of Amherst)** and **D-2 (UMass)**. Additionally, annual operation and maintenance costs were estimated, based on best professional judgment, to be 2 percent of the BMP supplies cost (i.e., approximately $2,900/year); this estimate will be reevaluated when the projects are implemented and exact O&M activities, along with O&M agreements, are established.

Table D-1: Summary of Proposed BMPs Costs (Fearing Brook Floodplain Creation Project, Town of Amherst)

Expense Item	s.319 Amount	Non-Federal Match and Source	Total Amount
Salary - By Title and Hourly Range			
Town Environmental Scientist ($40/hr)	$0	$10,000	$10,000
DER Program Manager ($65/hr)	$0	$6,700	$6,700
Subcontractual Service			
Town Environmental Scientist ($40/hr)	$150,955	$46,000 – in kind services, Town hauls & disposes of soil	$196,995
DER Program Manager ($65/hr)	$20,000	0	$20,000
Materials and Supplies			
Erosion control & construction fencing	$7,360	$0	$7,360
Boulders, steps, coir logs	$28,750	$0	$28,750
New topsoil	$30,475	$0	$30,475
Plantings, seed & mulch for restoration	$38,969	$36,500 – Town cash	$75,469
Other			
Preparation of preliminary 60% design	$0	$49,085	$49,085
Preparation Final design & bid package	$0	$40,000	$40,000
Totals	**$276,549**	**$188,285**	**$464,834**

Table D-2: Summary of Proposed BMPs Costs (Moonlit Farm BMPs, UMass)

Expense Item	s.319 Amount	Non-Federal Match and Source	Total Amount
Salary and Wages			
University staff (salary and 38.5% fringe)	$0	$43,190	$43,190
Technical Extension staff (salary and 2.03 fringe)	$38,858	$0	$38,858
Students Assistance (part time and 1.73 fringe)	$3,882	$0	$3,882
Supplies			
Publications (posters, signage, worksheets)	$250	$0	$250
BMP supplies and contracts	$68,200	$0	$68,200
Travel	$750	$0	$750
Indirect Costs			
26% indirect	$20,807	$0	$20,807
59.5% vs 26% waived indirect on Fed share	$0	$52,508	$52,508
Totals	**$143,335**	**$95,698**	**$239,033**

Future Management Measures

Table D-1 presents the anticipated funding needed to implement the proposed BMPs presented in Element C and Appendix C of this WBP. The table includes planning level capital construction costs for structural BMPs, technical assistance (i.e., engineering) and O&M activities. The table also includes summary statistics of proposed BMPs, including potential pollutant load reductions. Costs for the Hickory Ridge Golf Club and agricultural BMPs are to be determined.

Table D-3: Summary of Proposed BMPs and Estimated Funding Needed Implement

Site	BMP Identification / Location	Drainage Area (ac)	Imp. Area (%)	Est. Load Reduction (lb/yr)			Cost Estimates ($)			
				TN	TP	TSS	Capital[1]	Engineering[2]	O&M Materials[3]	Total
1	Fort River Elementary School	10.3	53	80.9	12.3	2539	$ 120,000	$ 48,000	$ 2,400	$ 168,000
2	Mill Lane at Groff Park	2.7	48	14.8	2.4	604	$ 90,000	$ 36,000	$ 1,800	$ 126,000
3	Main Street and Spring Street Parking Lots	0.73	99	8.1	1	270	$ 30,000	$ 12,000	$ 600	$ 42,000
4	Boltwood Parking Lot	0.95	100	10.7	1.3	355	$ 40,000	$ 16,000	$ 800	$ 56,000
5	Alumni Parking Lot	2	66	20.5	2.3	524	$ 30,000	$ 12,000	$ 600	$ 42,000
6	Hills Parking Lot	6.6	63	34.7	3.5	1358	$ 190,000	$ 76,000	$ 3,800	$ 266,000
TOTALS				169.7	22.8	5650	$ 500,000	$ 200,000	$ 10,000	$ 700,000

General Notes

1. Planning level capital costs for BMPs obtained from WBP Element C and/or professional judgement from past projects.

2. Engineering (i.e. design, survey, permitting, construction quality assurance) estimated based on 40 percent of capital costs.

3. Annual operation and maintenance estimated as 2 percent of capital costs. Actual costs may vary widely based on which entity performs maintenance.

Funding for future BMP installations to further reduce loads within the watershed may be provided by a variety of sources, such as the Section 319 Nonpoint Source Pollution Grant Program, Town capital funds, state grant funding through the Massachusetts Municipal Vulnerability Preparedness (MVP) program or Massachusetts Department of Ecological Restoration (DER), and other grant programs, such as hazard mitigation funding. Section 604b watershed planning grants are also available to support BMP design work and water quality sampling and assessment.

Funding for future agricultural BMPs may also be provided through the Natural Resources Conservation Service (NRCS), which offers financial and technical assistance to farmers, ranchers, and forest landowners interested in improving water quality and aquatic habitats. NRCS helps producers implement conservation and management practices through a systems approach to control and trap nutrient and manure runoff. Qualified producers receive assistance for installing conservation practices such as cover crops, filter strips, and terraces. NRCS conservation professionals provide technical assistance and planning tools to farm-owners to determine which conservation actions will provide the best results to improve water quality. Nutrient management systems, erosion control, conservation tillage, pest management, and buffers systems are just some of the practices NRCS can support. To help install these conservation practices, financial assistance to share in the cost of these conservation practices is available through the Environmental Quality Incentives Program (EQIP). Additional funding sources include the NRCS Agricultural Management Assistance (AMA) program, the Massachusetts Agricultural Environmental Enhancement Program (AEEP), and the Agricultural Produce Safety Improvement Program (APSIP).

The Town of Amherst and UMass have previously been successful with and will continue to pursue securing additional funding through various sources. Guidance is available to provide additional information on potential funding sources for nonpoint source pollution reduction efforts.[3]

[3] Guidance on funding sources to address nonpoint source pollution: http://prj.geosyntec.com/prjMADEPWBP_Files/Guide/Element%20D%20-%20Funds%20and%20Resources%20Guide.pdf

Element E: Public Information and Education

Element E: Information and Education (I/E) component of the watershed plan used to:

1. Enhance public understanding of the project; and
2. Encourage early and continued public participation in selecting, designing, and implementing the NPS management measures that will be implemented.

Step 1: Goals and Objectives

The goals and objectives for the watershed information and education program.

1. Provide information about proposed stormwater improvements and their anticipated water quality benefits.
2. Provide information to promote watershed stewardship.

Step 2: Target Audience

Target audiences that need to be reached to meet the goals and objectives identified above.

1. All watershed residents
2. Businesses within the watershed
3. Farmers within the watershed (targeted through UMass Extension)
4. Schools within the watershed, including Amherst College and Fort River Elementary School
5. Watershed organizations and other user groups, including Hitchcock Center for the Environment
6. Horse owners and related groups (such as riding clubs).

Step 3: Outreach Products and Distribution

The outreach product(s) and distribution form(s) that will be used for each.

1. Develop and post informational signs at proposed BMP locations (Fearing Brook Floodplain Creation, and Moonlit Farm Improvements).
2. Allow for the use of the Fearing Brook Floodplain as a "living classroom" for Amherst College and Fort River Elementary and develop programming centered on the proposed project.
3. Encourage tours and community engagement of the Fearing Brook Floodplain Project through use of the Fort River Farm Conservation Area and the Hitchcock Center for the Environment.
4. Promote the Fearing Brook Floodplain on the Town of Amherst's social media pages.
5. Conducting one annual field day at Moonlit Farm, which will include an educational workshop for equine farm owners and its users on the BMPs.
6. Developing a minimum of five new and/or revised factsheets related to the various aspects of manure management, composting, protecting wetlands, sacrifice lots, pasture management, mud management, and controlling runoff will be generated and posted online ("Crops, Dairy, Livestock

and Equine" UMass Extension website) and emailed to an equine list serve (800 members and counting).

Step 4: Evaluate Information/Education Program

Information and education efforts and how they will be evaluated.

1. Track the number of classes or number of students who utilize the Fearing Brook Floodplain as a "living classroom," participate in tours or programming, or study the Fearing Brook for their studies.
2. Track the number and size of tours of the Fearing Brook Floodplain Project through the Fort River Farm Conservation Area.
3. Track the number of posts and associated activity (likes/shares) related to posts of the Fearing Brook Floodplain Project on the Town of Amherst's social media pages.
4. Track field day and workshop attendance at Moonlit Farm.
5. Track the number of fact sheet emails and the size of the list serve receiving the emails in addition to visitors to the UMass Extension webpage.

Elements F & G: Implementation Schedule and Measurable Milestones

Element F: Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

Element G: A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

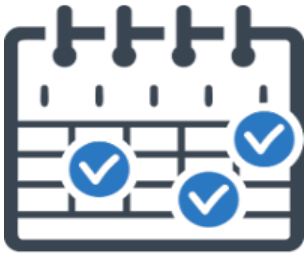

Table FG-1 provides a preliminary schedule for implementation of recommendations provided by this WBP. It is expected that the WBP will be reevaluated and updated in 2023, or as needed, based on ongoing monitoring results and other ongoing efforts. New projects for further implementation of the WBP will be identified through future data analysis and stakeholder engagement and will be included in updates to the implementation schedule.

Table FG-1: Implementation Schedule and Interim Measurable Milestones for Fearing Brook Floodplain Creation Project

Category	Action	Estimated Cost	Year(s)
Monitoring /Evaluation	Write Quality Assurance Project Plan (QAPP) for sampling and establish water quality monitoring program	TBD	2020
	Perform annual water quality sampling per Element H&I monitoring guidance	TBD	Annual
	Upon completion of the Fearing Brook Floodplain Creation Project, the Town of Amherst will inspect the area following rain events to ascertain if the stream is fully and easily accessing the recreated floodplain. It will be assumed if the floodplain reconnection is experiencing frequent inundation during rain events/snow melt that the predicted pollutant removals are being achieved	$11,500	Periodically (after rain events)
	The implemented BMPs at Moonlit Farm will be evaluated through a) continuous oversight with recommendation from technical guidance committee b) photos and videos taken before and after each specific task implementation, and c) Quantities of N, P, pathogens will be estimated for each implemented BMPs, using NRCS guidance.	$20,000	On-going
Structural BMPs	Document estimated pollutant removals from existing BMPs in the watershed		2020
	Complete installation of proposed BMPs associated with the Fearing Brook Floodplain Creation Project	$418,834	2020
	Complete installation of proposed BMPs at Moonlit Farm	$189,033	2021--2022
	Obtain funding and implement 2-3 additional BMPs within the Fort River watershed (see Appendix C for proposed concepts and Element C for priority ranking of concepts)	$200,000	2024
	Obtain funding and implement 2-3 additional BMPs within the Fort River watershed	$200,000	2026
Nonstructural BMPs	Document potential pollutant removals from ongoing non-structural BMP practices (i.e., street sweeping, catch basin cleaning)	TBD	2020
	Evaluate ongoing nonstructural BMP practices and determine if modifications can be made to optimize pollutant removals (e.g., increase frequency).	TBD	2021
	Routinely implement optimized nonstructural BMP practices	TBD	Annual
Public Education and Outreach *(See Element E)*	Implement signage at the Fort River Conservation Area that will explain the Fearing Brook Floodplain Creation Project and its benefits	$11,500	2020
	Tours of the Fearing Brook Floodplain Creation Project will be hosted by the Town of Amherst for Fort River Elementary and Amherst College staff so that the area can be used as a living classroom for their students.	$11,500	On-going
	The Town of Amherst and/or the Massachusetts Division of Ecological Restoration (DER) will organize walks at the Fort River Farm Conservation Area, which will focus on the river and restoration efforts	$11,500	On-going
	One annual field day will be held at Moonlit Farm to discuss the rational and demonstrate the implemented BMPs.	$15,000	Annual
	A minimum of five new and/or revised factsheets related to the various aspects of manure management, composting, protecting wetlands, sacrifice lots, pasture management, mud management, and controlling runoff will be generated and posted online. Copies of and revised factsheets and the calendar developed for this task will be submitted in a suitable format for reproduction and web posting.	$15,000	2020--2021
Adaptive Management and Plan Updates	Establish working group comprised of stakeholders and other interested parties to implement recommendations and track progress. Meet at least twice per year.	--	2020
	Re-evaluate Watershed Based Plan at least once every three (3) years and adjust, as needed, based on ongoing efforts (e.g., based on monitoring results, 319 funding, etc.). – Next update, December 2022	--	2023
	Reach interim goal to reduce land-based phosphorus by 15% (1,174 lb/yr)	--	**2024**
	Reach interim goal to reduce the geometric mean concentration of *E. coli* by 50 percent	--	**2029**
	Establish additional long-term reduction goal(s) from baseline monitoring results, if needed	--	**2024**
	Reach long-term phosphorus and *E. coli* load reduction goals	--	**2034**

Elements H & I: Progress Evaluation Criteria and Monitoring

Element H: A set of criteria used to determine (1) if loading reductions are being achieved over time and (2) if progress is being made toward attaining water quality goals. Element H asks "**how will you know if you are making progress towards water quality goals?**" The criteria established to track progress can be direct measurements (e.g., E. coli bacteria concentrations) or indirect indicators of load reduction (e.g., number of beach closings related to bacteria).

Element I: A monitoring component to evaluate the effectiveness of implementation efforts over time, as measured against the Element H criteria. Element I asks "**how, when, and where will you conduct monitoring?**"

The water quality target concentration(s) is presented under **Element A** of this plan. To achieve this target concentration, the annual loading must be reduced to the amount described in **Element B**. **Element C** of this plan describes the various management measures that will be implemented to achieve this targeted load reduction. The evaluation criteria and monitoring program described will be used to measure the effectiveness of the proposed management measures (described in **Element C**) in improving the water quality of the Fort River.

Indirect Indicators of Load Reduction

Nonstructural BMPs

Potential load reductions from nonstructural BMPs (i.e., street sweeping and catch basin cleaning) can be estimated from indirect indicators, such as the number of miles of streets swept or the number of catch basins cleaned. Appendix F of the 2016 Massachusetts Small MS4 General Permit provides specific guidance for calculating phosphorus removal from these practices. As indicated by **Element C**, it is recommended that potential phosphorus removal from these ongoing actives be estimated. Next, it is recommended that ongoing activities be evaluated to see if potential improvements can be implemented to achieve higher pollutant load reductions such as increased frequency or improved technology.

The Town of Amherst currently performs street sweeping and catch basin cleaning, in addition to other nonstructural BMPs. The Town organized a town-wide clean-up day, which engaged watershed residents. The Town discontinued the use of sand for icy road conditions, which decreased TSS in street catch basins. The Town of Amherst is developing multiple programs to address water quality, including erosion and sediment control standards for construction projects, and post-construction water quality requirements.

Phosphorus load reductions can be estimated in accordance with Appendix F of the 2016 Massachusetts Small MS4 General Permit as summarized by **Figure HI-1 and HI-2**.

$$\text{Credit}_{\text{sweeping}} = \text{IA}_{\text{swept}} \times \text{PLE}_{\text{IC-land use}} \times \text{PRF}_{\text{sweeping}} \times \text{AF} \qquad \textbf{(Equation 2-1)}$$

Where:

$\text{Credit}_{\text{sweeping}}$	=	Amount of phosphorus load removed by enhanced sweeping program (lb/year)
IA_{swept}	=	Area of impervious surface that is swept under the enhanced sweeping program (acres)
$\text{PLE}_{\text{IC-land use}}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
$\text{PRF}_{\text{sweeping}}$	=	Phosphorus Reduction Factor for sweeping based on sweeper type and frequency (see Table 2-3).
AF	=	Annual Frequency of sweeping. For example, if sweeping does not occur in Dec/Jan/Feb, the AF would be 9 mo./12 mo. = 0.75. For year-round sweeping, AF=1.0[1]

As an alternative, the permittee may apply a credible sweeping model of the Watershed and perform continuous simulations reflecting build-up and wash-off of phosphorus using long-term local rainfall data.

Table 2-3: Phosphorus reduction efficiency factors ($\text{PRF}_{\text{sweeping}}$) for sweeping impervious areas

Frequency[1]	Sweeper Technology	$\text{PRF}_{\text{sweeping}}$
2/year (spring and fall)[2]	Mechanical Broom	0.01
2/year (spring and fall)[2]	Vacuum Assisted	0.02
2/year (spring and fall)[2]	High-Efficiency Regenerative Air-Vacuum	0.02
Monthly	Mechanical Broom	0.03
Monthly	Vacuum Assisted	0.04
Monthly	High Efficiency Regenerative Air-Vacuum	0.08
Weekly	Mechanical Broom	0.05
Weekly	Vacuum Assisted	0.08
Weekly	High Efficiency Regenerative Air-Vacuum	0.10

Figure HI-1. Street Sweeping Calculation Method

$$\text{Credit}_{\text{CB}} = \text{IA}_{\text{CB}} \times \text{PLE}_{\text{IC-land use}} \times \text{PRF}_{\text{CB}} \qquad \textbf{(Equation 2-2)}$$

Where:

$\text{Credit}_{\text{CB}}$	=	Amount of phosphorus load removed by catch basin cleaning (lb/year)
IA_{CB}	=	Impervious drainage area to catch basins (acres)
$\text{PLE}_{\text{IC-and use}}$	=	Phosphorus Load Export Rate for impervious cover and specified land use (lb/acre/yr) (see Table 2-1)
PRF_{CB}	=	Phosphorus Reduction Factor for catch basin cleaning (see Table 2-4)

Table 2-4: Phosphorus reduction efficiency factor (PRF_{CB}) for semi-annual catch basin cleaning

Frequency	Practice	PRF_{CB}
Semi-annual	Catch Basin Cleaning	0.02

Figure HI-2. Catch Basin Cleaning Calculation Method

Project-Specific Indicators

Moonlit Farm

The implemented BMPs at Moonlit Farm will be evaluated through a) continuous oversight with recommendation from technical guidance committee b) photos and videos taken before and after each specific task implementation, and c) quantities of N, P, pathogens will be estimated for each implemented BMPs, using NRCS guidance.

Fearing Brook Floodplain Creation Project

Upon completion of the Fearing Brook Floodplain Creation Project, the Town of Amherst will inspect the area following rain events to ascertain if the stream is fully and easily accessing the recreated floodplain. It will be assumed if the floodplain reconnection is experiencing frequent inundation during rain events/snow melt that the predicted pollutant removals are being achieved.

Town of Amherst Stormwater Management Plan (SWMP) Implementation:

Ongoing efforts by the Town of Amherst during implementation of their SWMP will be tracked in annual reports that are posted on the Town's dedicated Stormwater Management webpage. The Town of Amherst is currently developing additional stormwater ordinances for new developments, which will require the use of green infrastructure. As part of the SWMP, the Town of Amherst will identify new or retrofit opportunities for green infrastructure and will install at least one BMP as a demonstration project to remove nitrogen.

TMDL Criteria

Fort River (MA34-27) will be included in the upcoming "Massachusetts Statewide TMDL for Pathogen-Impaired Inland Freshwater Rivers," which is currently being drafted.

Direct Measurements

Direct measurements are generally expected to be performed as described below. Prior to implementing a direct measurement program, an abbreviated quality assurance project plan (QAPP) and/or standard operating procedures (SOPs) will be established to flesh out details of the program and establish best practices for sample collection and analysis. Water quality monitoring may be performed through a volunteer training program to save on costs in accordance with established practices for MassDEP's environmental monitoring for volunteers.

River Sampling

Sampling is recommended approximately once per month from May through October to understand the water quality in Fort River Watershed, including determining sources for pollution and tracking achievements toward water quality goals, including analysis of *E. coli,* TP, TN, and TSS. Additional parameters such as chlorophyll-a, DO, temperature, conductivity, pH, and flow rate could provide additional data for consideration. If possible, obtain sampling of Fearing Brook and the unnamed tributary to Hop Brook (downstream of Moonlit Farm) to determine the impact of proposed BMPs within the watershed. Additional monitoring locations may be selected following installation of stormwater BMPs based on accessibility and representativeness and shall be appropriate to quantify water quality improvements in the watershed.[4]

In-Lake Phosphorus and Water Quality Monitoring

Sampling programs specific for the contributing ponds (Arcadia Lake and Lake Holland) within the watershed could be established to more closely track the progress of water quality improvements toward water quality

[4] Additional guidance is provided at: https://www.epa.gov/sites/production/files/2015-06/documents/stream.pdf and https://www.mass.gov/guides/water-quality-monitoring-for-volunteers#2

goals. Monitoring locations should at minimum include the outlet of the pond, tributaries, and the deepest "in-lake" location.[5] It is recommended that sampling programs include analysis of *E. coli*, secchi disk transparency, phosphorus, chlorophyll-a, turbidity, temperature/oxygen profiles, and aquatic vegetation. These parameters will also enable tracking relative to Carlson's state trophic index to evaluate improvements over time.

Adaptive Management

As discussed by Recommended Load Reduction section of **Element B**, the baseline monitoring program will be used to establish a long-term (i.e., 15-year) *E. coli* and TP load reduction goal (or other parameters depending on results). Long-term goals will be reevaluated at least **once every three years** and adaptively adjusted based on additional monitoring results and other indirect indicators. If monitoring results and indirect indicators do not show improvement to the *E. coli* and TP concentrations and other indicators (e.g., chlorophyll-a) measured within the watershed, the management measures and loading reduction analysis (**Elements A through D**) will be revisited and modified accordingly.

[5] Additional guidance is provided at: https://www.epa.gov/sites/production/files/2015-06/documents/lakevolman.pdf

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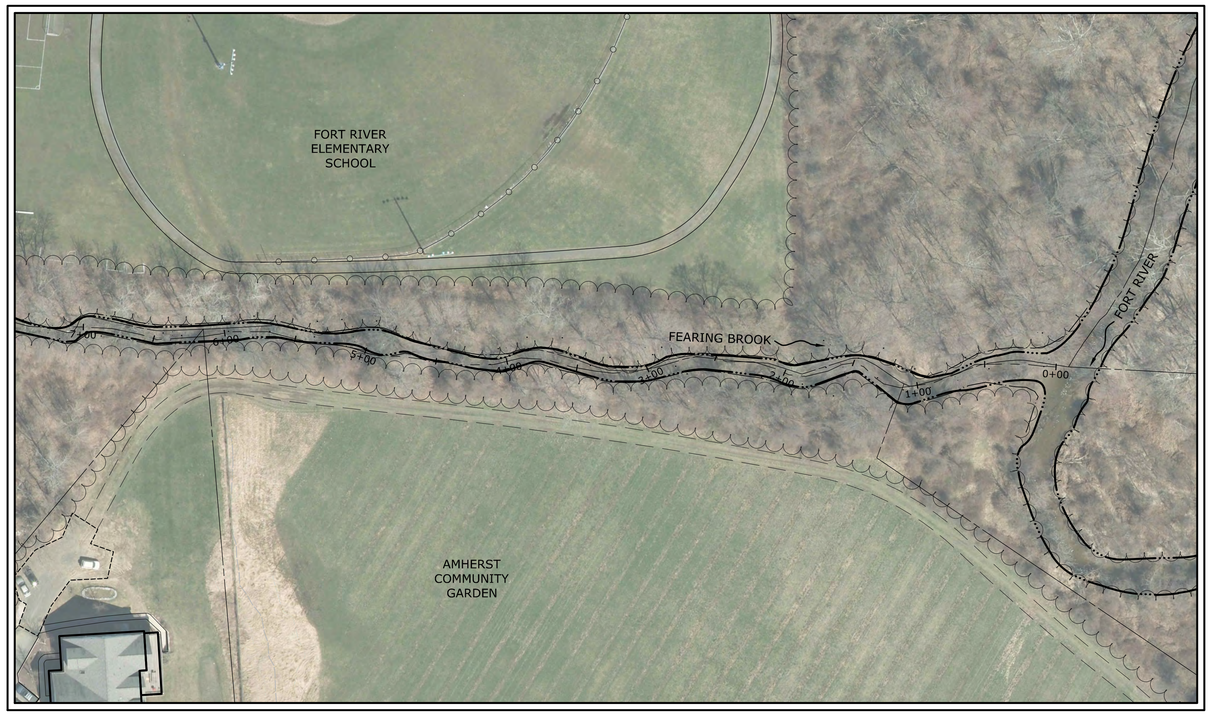
Appendices

Appendix A – Fort River Elementary School - Proposed BMP Design Drawings (Town of Amherst, 2019)

FEARING BROOK
FLOODPLAIN CREATION PROJECT

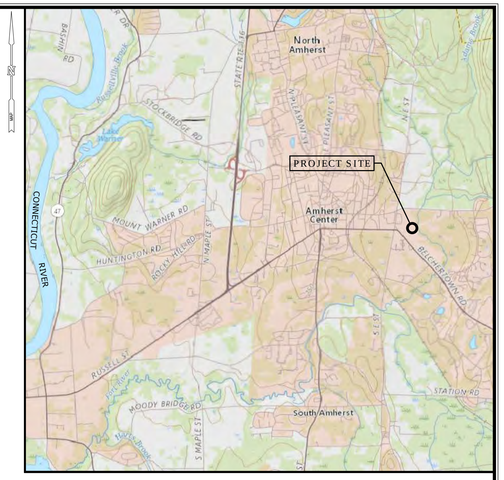
AMHERST, MASSACHUSETTS

ADVANCED DESIGN
MAY 14, 2019



PROJECT SITE VICINITY MAP:

0' 50' 100'
0 1/2" 1"
SCALE 1" = 50'



LOCATION MAP:

0' 2500' 5000'
0 1/2" 1"
SCALE 1" =5000'

PREPARED FOR:

MASSACHUSETTS DEPARTMENT OF FISH AND GAME
DIVISION OF ECOLOGICAL RESTORATION
251 CAUSEWAY STREET, SUITE 400
BOSTON, MA 02114

LIST OF DRAWINGS

Sheet Number	Sheet Description	Sheet Title
01	--	Title
02	IN-1	Index
03	SP-1	Site Plan - Existing Conditions
05	SP-3	Site Plan - Layout and Grading
04	SP-2	Site Plan - Erosion Controls and Site Preparation
06	SP-4	Site Plan - Landscaping and Restoration
07	RR-1	Regulated Resources Areas
08	CS-1	Cross Sections
09	CS-2	Cross Sections
10	CP-1	Construction Plan - Traffic and Pedestrian Control
11	SE-1	Details - Sediment and Erosion Control
12	DE-1	Details

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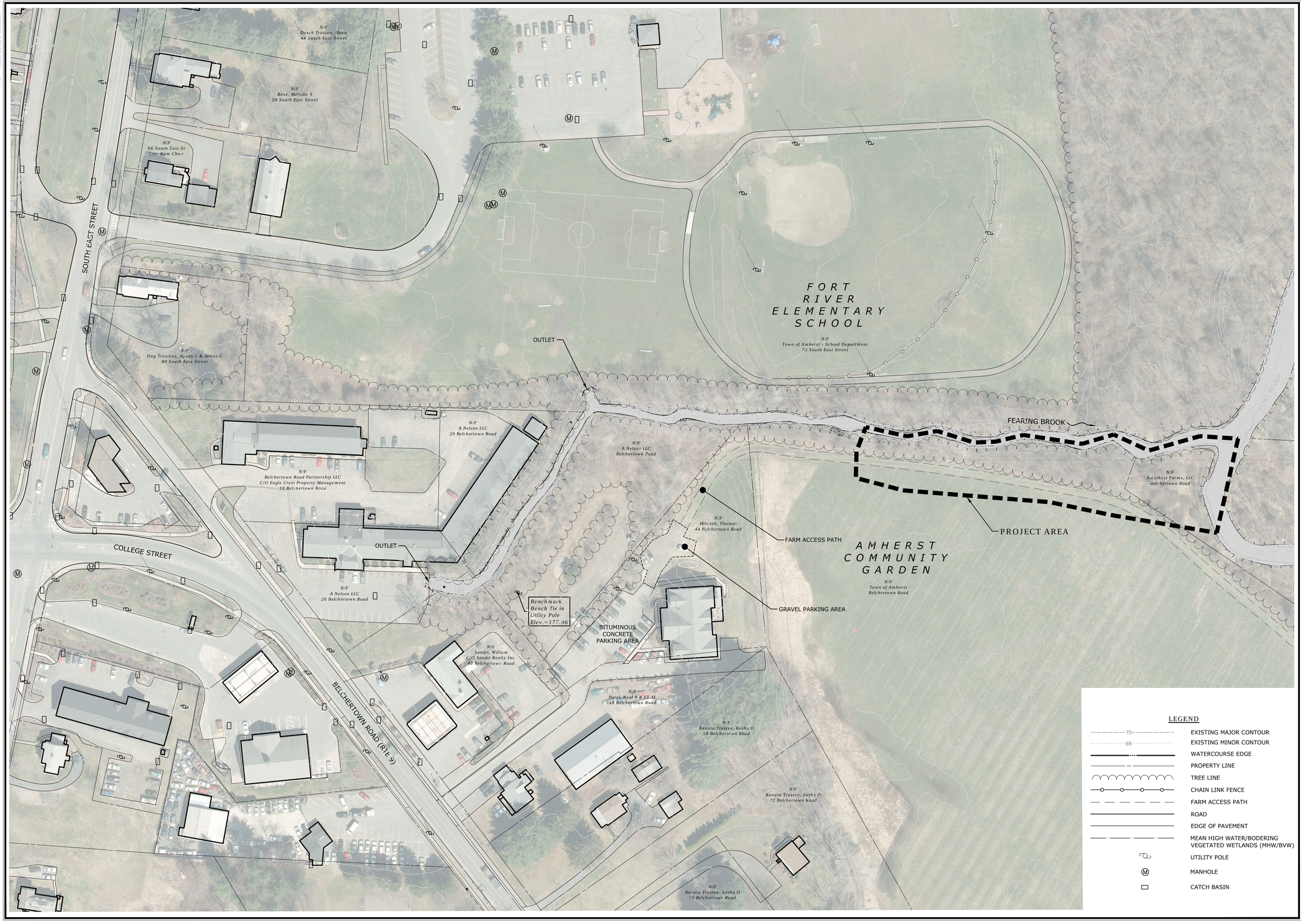

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INDEX

FEARING BROOK
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AMHERST, MASSACHUSETTS

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DESIGNED	DRAWN	CHECKED

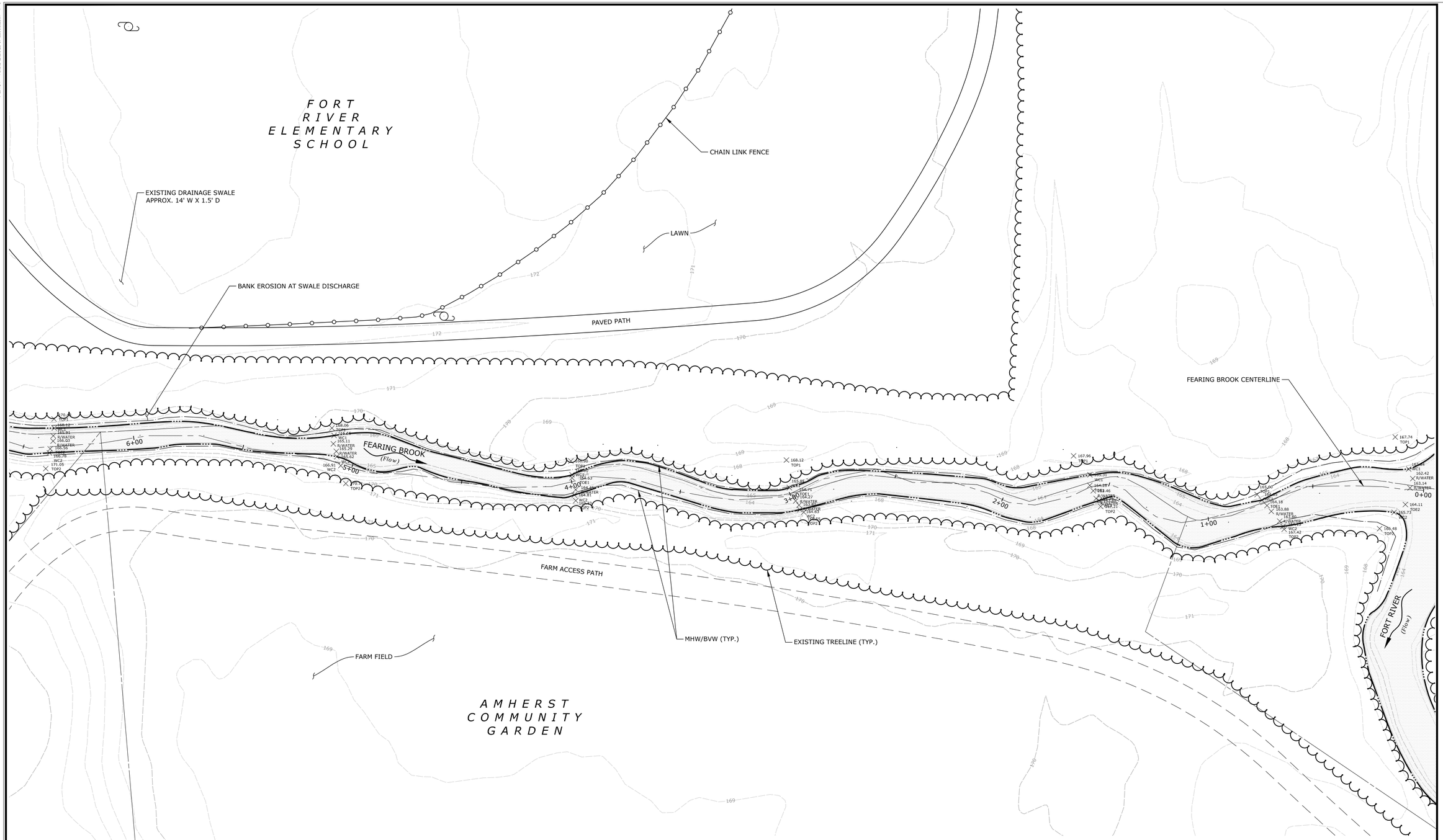
SCALE: 1"=50'

DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 02 OF 12

SHEET NAME: IN-1



GENERAL NOTES

1. TOPOGRAPHIC INFORMATION IS BASED UPON GROUND AND BATHYMETRIC SURVEY PERFORMED BY MILONE & MACBROOM INC., ON MAY 17, 2018. LIDAR ELEVATION DATA WAS OBTAINED FROM THE TOWN OF AMHERST MA GIS 2009 LIDAR DATA, DATED SPRING 2009.
2. HORIZONTAL MAPPING IS REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), MASSACHUSETTS MAINLAND ZONE. ELEVATION DATA IS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88). ALL CONTOURS ARE PRESENTED IN FEET.
3. MILONE & MACBROOM, INC. DID NOT PERFORM PROPERTY BOUNDARY SURVEY. PROPERTY LINE INFORMATION AND OTHER R.O.W. INFORMATION ARE DERIVED FROM THE TOWN OF AMHERST GIS DATABASE.
4. CHANNEL EDGES AS SHOWN INDICATE EDGES OF WATER AT TIME OF SURVEY.
5. ALL DIMENSIONS AND ELEVATIONS SHALL BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR DETERMINATION.
6. MILONE & MACBROOM, INC. ACCEPTS NO RESPONSIBILITY FOR THE ACCURACY OF MAPS AND DATA WHICH HAVE BEEN SUPPLIED BY OTHERS.
7. INFORMATION REGARDING THE LOCATION OF EXISTING UTILITIES HAS BEEN BASED UPON AVAILABLE INFORMATION AND MAY BE INCOMPLETE, AND WHERE SHOWN SHOULD BE CONSIDERED APPROXIMATE. THE LOCATION OF ALL EXISTING UTILITIES SHOULD BE CONFIRMED PRIOR TO BEGINNING CONSTRUCTION. CALL "CALL BEFORE YOU DIG", 1-800-922-4455. ALL UTILITY LOCATIONS THAT DO NOT MATCH THE VERTICAL OR HORIZONTAL CONTROL SHOWN ON THE PLANS SHALL IMMEDIATELY BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR RESOLUTION.
8. THE PROJECT SITE (FEARING BROOK) IS SUBJECT TO FLOODING. INFORMATION DEPICTED HEREIN IS SHOWN AS A REPRESENTATION OF THE PROJECT SITE AT THE TIME IT WAS SURVEYED, AND IS SUBJECT TO CHANGE BASED UPON HIGH FLOWS, FLOOD, EROSION, AND/OR CHANGING SITE CONDITIONS.
9. ALL DISTURBED AREAS SHALL RECEIVE A MINIMUM OF 6" TOPSOIL, AND BE SEEDED WITH GRASS, AS SHOWN ON THE PLANS, UNLESS OTHERWISE SPECIFIED BY THE ENGINEER.
10. ALL PROPOSED CONTOURS AND SPOT ELEVATIONS INDICATE FINISHED GRADE.
11. COMPLIANCE WITH ALL REGULATORY PERMIT APPROVALS AND SPECIAL CONDITIONS IS THE RESPONSIBILITY OF BOTH THE CONTRACTOR AND THE PERMITTEE.
12. THE CONTRACTOR MUST MAINTAIN (REPAIR/REPLACE WHEN NECESSARY) THE SILTATION CONTROL MEASURES UNTIL ALL DEVELOPMENT ACTIVITY IS COMPLETED AND ALL DISTURBED AREAS ARE PERMANENTLY STABILIZED.
13. ALL CONTRACTORS ARE ADVISED TO VISIT THE SITE TO CONFIRM CURRENT CONDITIONS PRIOR TO SUBMITTING BIDS.

LEGEND

- 70 — EXISTING MAJOR CONTOUR
- 68 — EXISTING MINOR CONTOUR
- WATERCOURSE EDGE
- PROPERTY LINE
- TREE LINE
- CHAIN LINK FENCE
- FARM ACCESS PATH
- PAVED PATH
- MEAN HIGH WATER/BODERING VEGETATED WETLANDS (MHW/BVW)
- 168.12 TOP1 — SURVEY POINT

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SITE PLAN - EXISTING CONDITIONS

FEARING BROOK
FLOODPLAIN CREATION PROJECT

AMHERST, MASSACHUSETTS

ADVANCED DESIGN

DESIGNED	DRAWN	CHECKED
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SCALE: 1"=20'

DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 03 OF 12

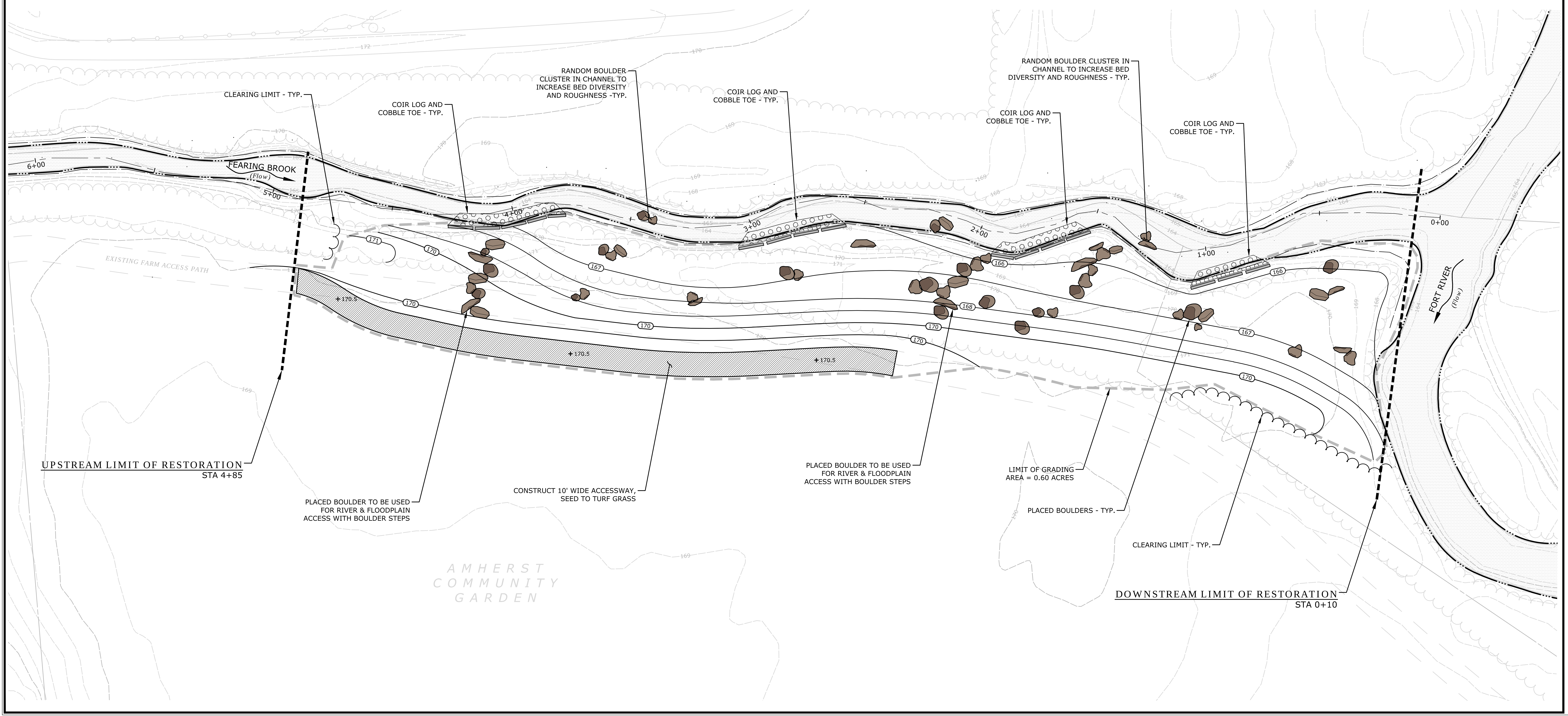
SHEET NAME: SP-1

CONSTRUCTION NOTES

1. THE CONTRACTOR SHALL CALL DIGSAFE AT 1-888-344-7233 AT LEAST 72 HOURS, SATURDAYS, SUNDAYS, AND HOLIDAYS EXCLUDED, PRIOR TO EXCAVATING AT ANY LOCATION. A COPY OF THE DIGSAFE PROJECT REFERENCE NUMBER(S) SHALL BE GIVEN TO THE OWNER PRIOR TO EXCAVATION.
2. LOCATIONS OF EXISTING PIPES, CONDUITS, UTILITIES, FOUNDATIONS AND OTHER UNDERGROUND OBJECTS ARE NOT WARRANTED TO BE CORRECT AND THE CONTRACTOR SHALL HAVE NO CLAIM ON THAT ACCOUNT SHOULD THEY BE OTHER THAN SHOWN.
3. ALL PAVEMENT DISTURBED BY THE CONTRACTOR BEYOND PAYMENT LIMITS SHALL BE RESTORED AT NO ADDITIONAL COST TO THE OWNER.
4. THE CONTRACTOR SHALL NOT STORE ANY APPARATUS, MATERIALS, SUPPLIES, OR EQUIPMENT ON DRAINAGE STRUCTURES OR WITHIN 100 FEET OF WETLANDS.
5. THE CONTRACTOR SHALL COMPLETE ALL LAYOUTS, SURVEYS, ETC. REQUIRED FOR CONSTRUCTION OF THE PROJECT AS SHOWN AND AS SPECIFIED.
6. THE PROJECT VERTICAL DATUM IS NAVD 1988.
7. THE PROJECT HORIZONTAL DATUM IS MASSACHUSETTS MAINLAND ZONE NAD83.
8. AT THE PRE-CONSTRUCTION MEETING, THE CONTRACTOR SHALL DESIGNATE A CONTACT PERSON TO RESPOND TO EMERGENCIES THAT OCCUR ON NIGHTS, WEEKENDS, AND HOLIDAYS. THIS DESIGNATED CONTACT SHALL HAVE A CREW AT THEIR DISPOSAL TO EFFECTIVELY RESPOND TO ALL EMERGENCIES.
9. THE CONTRACTOR SHALL CHECK THE WEATHER FORECAST PRIOR TO EACH DAY'S CONSTRUCTION AND SHALL BE RESPONSIBLE FOR SAFE HANDLING OF ANY EXISTING OR FORECAST FLOWS.
10. WEEKLY MEETINGS SHALL BE HELD BETWEEN THE CONTRACTOR, THE TOWN, AND THE ENGINEER TO DISCUSS WEATHER FORECASTS AND THEIR ANTICIPATED IMPACT ON SCHEDULED WORK.
11. CONTRACTOR IS RESPONSIBLE TO HANDLE FORECAST FLOWS AND STABILIZE THE CONSTRUCTION AREA TO PREVENT THE LOSS OF MATERIAL AND EROSION FROM THE SITE AND REPAIR SEDIMENTATION AND EROSION CONTROL MEASURES AS NECESSARY.

LEGEND

- 170 — EXISTING MAJOR CONTOUR
- 168 — EXISTING MINOR CONTOUR
- 170 — PROPOSED MAJOR CONTOUR
- 168 — PROPOSED MINOR CONTOUR
- + 170.5 — PROPOSED SPOT GRADE
- LIMIT OF TREE CLEARING
- LIMIT OF GRADING
- COIR LOG WITH COBBLE TOE
- 10' WIDE ACCESSWAY
- PLACED BOULDERS



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SITE PLAN - LAYOUT AND GRADING

FEARING BROOK
FLOODPLAIN CREATION PRO□ECT

AMHERST, MASSACHUSETTS

DESIGNED	DRAWN	CHECKED
□CM	CME	---

SCALE: 1"=20'

DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 05 OF 12

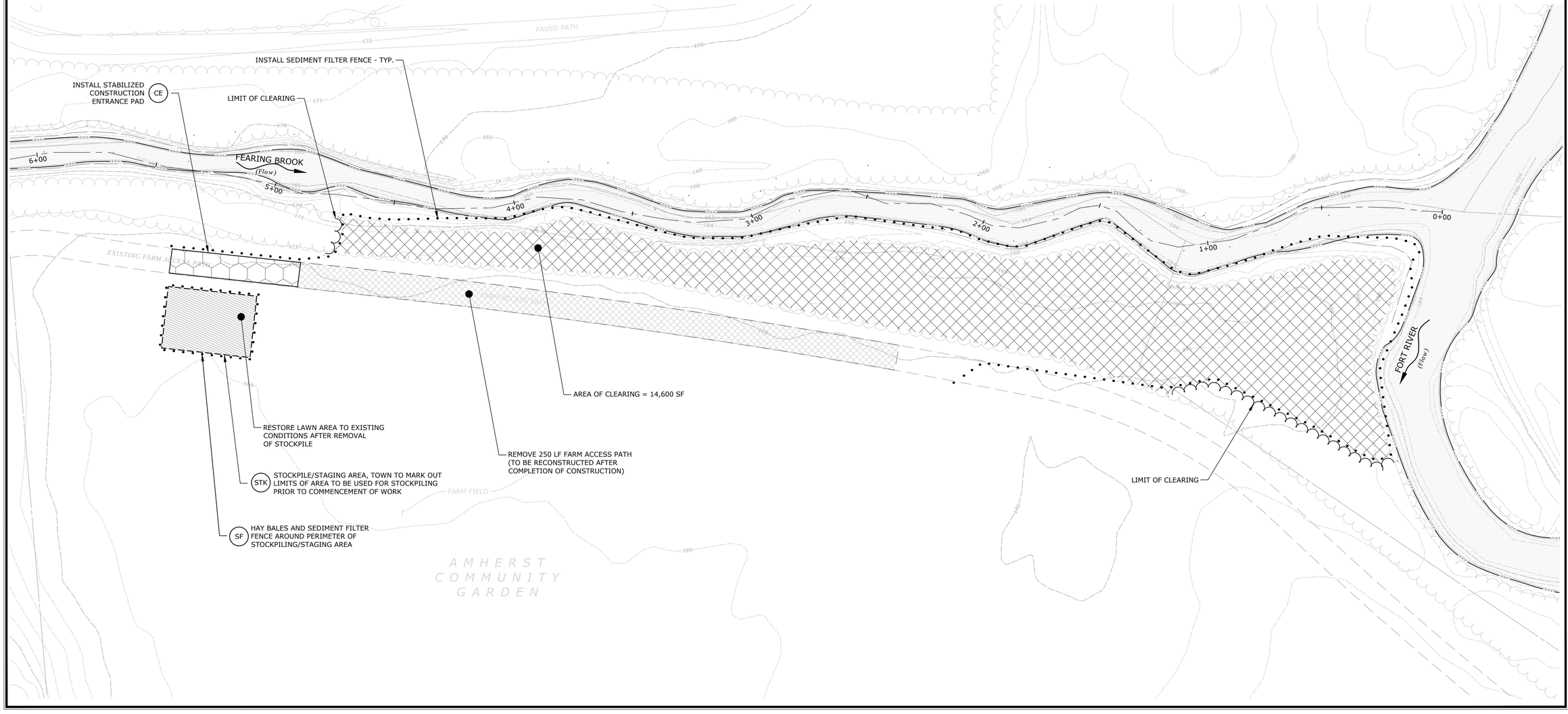
SHEET NAME: SP-3

EROSION CONTROL NOTES

1. ACCESS ROADS TO BE GRADED, WIDENED AND STABILIZED AS NEEDED BY CONTRACTOR WITH APPROVAL OF ENGINEER.
2. TOWN OF AMHERST WILL MARK OUT THE AREA TO BE USED FOR STOCKPILE PRIOR TO COMMENCEMENT OF CONSTRUCTION. ACCESS ROAD AND STOCKPILE AREAS SHALL BE BORDERED WITH SEDIMENT AND EROSION CONTROL FENCES. SEE DETAILS.
3. THE CONTRACTOR SHALL MAINTAIN ALL STREETS, SIDEWALKS, AND WALKWAYS IN THE AREA FREE OF SOIL, MUD AND CONSTRUCTION DEBRIS. CONSTRUCTION ENTRANCES MUST BE MAINTAINED. SEE PLANS AND DETAILS.
4. ALL VEGETATIVE AND STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE CONSTRUCTED ACCORDING TO THE STANDARDS AND SPECIFICATIONS IN THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES.
5. A COPY OF THE APPROVED EROSION AND SEDIMENT CONTROL PLAN SHALL BE MAINTAINED ON THE SITE AT ALL TIMES.
6. TEMPORARY EROSION CONTROL BLANKET SHALL BE PLACED OVER ANY DISTURBED AREAS TO PREVENT EROSION DURING PREDICTED LARGE STORMS.
7. THE CONTRACTOR IS RESPONSIBLE FOR THE MAINTENANCE OF ALL SOIL EROSION AND SEDIMENT CONTROL MEASURES. THE CONSTRUCTION INSPECTOR WILL VERIFY THE MAINTENANCE WEEKLY AND AFTER RAIN EVENTS.
8. TEMPORARY STOCKPILE AND STAGING AREAS TO BE FLAGGED BY CONTRACTOR PRIOR TO CONSTRUCTION AND APPROVED BY TOWN, LANDOWNERS AND PROJECT ENGINEER.
9. NO CONSTRUCTION VEHICLES SHALL BE STORED, SERVICED, WASHED OR FLUSHED IN A LOCATION WHERE LEAKS, SPILLAGE, WASTE MATERIALS, CLEANERS, OR WATERS WILL BE INTRODUCED OR FLOW INTO WETLANDS OR WATERCOURSES. AN EMERGENCY MANAGEMENT PLAN AND SPILL KIT WILL BE MAINTAINED ON SITE AT ALL TIMES. IN THE EVENT OF AN ACCIDENTAL RELEASE, IMMEDIATELY STOP CONSTRUCTION WORK, CONTAIN THE SPILL, AND NOTIFY THE TOWN, APPROPRIATE AUTHORITIES AND PROJECT ENGINEER.
10. THE PROJECT SITE IS SUBJECT TO FLOODING. THE CONTRACTOR SHALL MONITOR WEATHER FORECASTS AND STABILIZE THE CONSTRUCTION SITE AND REMOVE EQUIPMENT FROM FLOOD PRONE AREAS IN THE EVENT OF FLOOD WARNINGS. WORK SHOULD BE PERFORMED DURING LOW WATER AS POSSIBLE. EQUIPMENT AND MATERIALS MUST BE AVAILABLE TO ALLOW A RAPID RESPONSE TO STABILIZE OPEN CONSTRUCTION AREAS, EVACUATE WORKERS, EQUIPMENT, AND ANY STOCKPILED MATERIALS FROM POTENTIALLY IMPACTED AREAS, IF NEEDED.
11. ALL STORAGE AND ACCESS ROUTES, PEDESTRIAN FENCES/BARRIERS, WORKING HOURS, AND LIMITS OF CLEARING SHALL BE APPROVED BY THE TOWN OF AMHERST AND THE PROJECT ENGINEER.
12. ALL WETLANDS SHALL BE AVOIDED AND PROTECTED FROM CONSTRUCTION ACTIVITIES WITH SEDIMENT CONTROL MEASURES WHERE NECESSARY AS DETERMINED BY THE PROJECT ENGINEER.
13. CLEARING OF NATIVE VEGETATION OUTSIDE OF THE AREAS SPECIFIED IN THIS PLAN IS UNAUTHORIZED WITHOUT PRIOR DISCUSSION AND APPROVAL WITH THE TOWN OF AMHERST AND THE ENGINEER.
14. STOCKPILE AREA TO BE SURROUNDED WITH STRAW BALES AND SILT FENCE. LOCATION OF STOCKPILE AREA TO BE APPROVED BY THE ENGINEER AT THE PRE-CONSTRUCTION MEETING.
15. ALL SEDIMENTATION AND EROSION CONTROL DEVICES AROUND STOCKPILED MATERIAL SHALL BE INSPECTED DURING CONSTRUCTION AS REQUIRED BY THE ENGINEER AND FOLLOWING ALL STORMS. THE CONTRACTOR SHALL MAINTAIN AND MAKE REPAIRS TO THE SEDIMENTATION AND EROSION CONTROL DEVICES AS NECESSARY.
16. BOULDER CLUSTERS SHALL BE CONSTRUCTED "IN THE WET" USING MACHINERY LOCATED ON THE BANKS OF THE BROOK. AS SUCH, CARE SHALL BE TAKEN TO MINIMIZE DISTURBANCE OF THE STREAM BED AND BANK. ALL AREAS SHALL BE PROTECTED FROM SEDIMENTATION DURING AND AFTER CONSTRUCTION TO THE MAXIMUM EXTENT PRACTICABLE.
17. FOLLOWING COMPLETION OF CONSTRUCTION, THE CONTRACTOR SHALL REPAIR ALL ERODED AREAS AND ENSURE A GOOD STAND OF TURF OR APPROPRIATE VEGETATION IS ESTABLISHED THROUGHOUT.

LEGEND

- SF — SEDIMENT FILTER FENCE
- LIMIT OF CLEARING
- STK — TEMPORARY SOIL STOCKPILE AREA SURROUNDED WITH SILT FENCE AND HAYBALES
- AREA OF CLEARING
- REMOVE FARM ACCESS PATH
- CE — STABILIZED CONSTRUCTION



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SITE PLAN - EROSION CONTROLS AND SITE PREPARATION

FEARING BROOK
FLOODPLAIN CREATION PROJECT

AMHERST, MASSACHUSETTS

ADVANCED DESIGN

DESIGNED	DRAWN	CHECKED
CM	CME	WAG

SCALE: 1"=20'

DATE: MAY 14, 2019

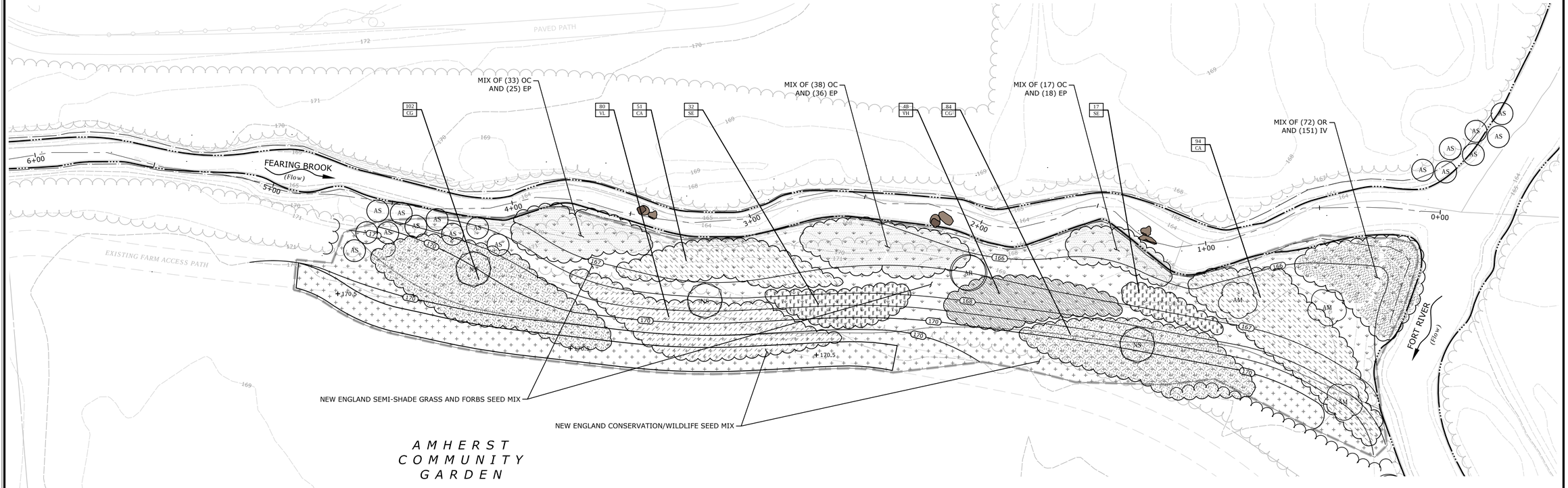
PROJECT NO.: 26□□-43

SHEET NO.: 04 OF 12

SHEET NAME: SP-2

PLANTING NOTES

1. EROSION CONTROLS SHALL BE INSTALLED, REPAIRED AND MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD OF THE FLOOD SHELF CREATION AREA OR UNTIL THE SITE IS FULLY STABILIZED BY VEGETATION (SEED MIX). EROSION CONTROLS SHALL THEN BE REMOVED FROM THE SITE.
2. WETLAND SCIENTIST SHALL BE ON SITE TO MONITOR PLANTING AND GRADING OF THE FLOOD SHELF CREATION AREA TO ENSURE COMPLIANCE WITH THE APPROVED PLANS.
3. GRADING LINES DEPICTED ON THE PLAN ARE DRAWN SMOOTHLY, ACTUAL SURFACE GRADES ACROSS FLOOD BASIN 'FLOOR' SHALL REFLECT HUMMOCK AND HOLLOW TOPOGRAPHY OF NATURAL WETLANDS.
4. 6 INCHES OF SUPER ENRICHED TOPSOIL (MUST CONTAIN MINIMUM 6% AND MAXIMUM 20% ORGANIC CARBON BY WEIGHT) SHALL BE INSTALLED OVER THE ROUGH SUB GRADE.
5. THE SURFACE AND GROUNDWATER LEVELS SHALL BE MONITORED PRIOR TO PERMANENT PLANTING. AS A RESULT OF ACTUAL WATER LEVELS, THE CORRESPONDING PLANTINGS MAY NEED TO BE ADJUSTED IN THE FIELD.
6. ALL PLANTINGS ARE TO BE PLANTED ONLY AFTER STABILIZATION OF CONTRIBUTING DRAINAGE AREAS.
7. WETLAND PLANTINGS SHALL BE LIMITED TO THE PERIODS OF APRIL 15 - JUNE 30, OR SEPTEMBER 15 - OCTOBER 15. ONLY QUALITY NATIVE PLANTS FROM A NORTHERN NURSERY SHALL BE USED.
8. ALL WOODY PLANT MATERIAL SHALL BE PROVIDED IN CONTAINERS THAT ARE APPROPRIATELY SIZED FOR THE SPECIFIED PLANT. HERBACEOUS PLANT MATERIAL SHALL BE PLUGS AND CONTAINERIZED. WETLAND PLANTS SHALL HAVE BEEN GROWN IN A LOCAL/REGIONAL NURSERY.
9. SUPPLEMENTAL HERBACEOUS PLANTINGS SHALL BE CONCENTRATED IN GROUPINGS, TO BE DETERMINED. HERBACEOUS PLANTINGS TO BE PLUGS TWO FOOT ON CENTER. SHRUB PLANTINGS TO BE 36" O.C. (DEPENDENT UPON SPECIES), OR AS DIRECTED BY THE SUPERVISING WETLAND SCIENTIST.
10. ALL TUBERS AND ROOT STOCK SHALL BE PUSHED ONE TO TWO INCHES DEEP INTO THE ORGANIC SOIL & SPACED AS SPECIFIED. PLANTS WITH GROWING STEMS SHALL BE PLANTED SUCH THAT THE GROWING STEM EXTENDS ABOVE THE SOIL SURFACE. WEIGHTING OF TUBERS & ROOT STOCK WITH FENCE STAPLES AND/OR EIGHT PENNY NAILS MAY BE REQUIRED IF DISLODGING & FLOATING IS A PROBLEM.
11. THE SOILS IN THE FLOOD SHELF CREATION AREA SHALL BE SEEDED WITH DESIGNATED FLOOD SHELF AND FLOOD SHELF EMBANKMENT SEED MIXES AS NOTED IN PLANT LIST. ALL PLUGS & SEED. MIXES SPECIFIED BY NEW ENGLAND WETLAND PLANTS INC. 800 MAIN ST. AMHERST, MA 01002 (413) 256-1752 OR APPROVED EQUIVALENT.
12. ALL PLANT MATERIALS SHALL CARRY A FULL GUARANTEE FOR A PERIOD OF ONE YEAR FROM THE DATE OF ACCEPTANCE BY THE CITY AND SUPERVISING WETLAND SCIENTIST, TO INCLUDE PROMPT TREATMENT OR REMOVAL AND REPLACEMENT OF ANY PLANTS FOUND TO BE IN AN UNHEALTHY CONDITION BY THE WETLAND SCIENTIST. ALL REPLACEMENTS SHALL BE OF THE SAME KIND AND SIZE OF PLANTS SPECIFIED IN THE PLANT LIST.
13. MAINTENANCE SHALL BEGIN IMMEDIATELY AFTER PLANTING AND SHALL CONTINUE UNTIL ACCEPTANCE BY THE WETLAND SCIENTIST. MAINTENANCE SHALL INCLUDE WATERING, MULCHING, TIGHTENING & REPLACING OF GUYS, REPLACEMENT OF SICK OR DEAD PLANTS, RESETTING PLANTS TO PROPER GRADE OR UPRIGHT (PLUMB) POSITION, RESTORATION OF SAUCERS, AND ALL OTHER CARE NEEDED FOR PROPER GROWTH OF THE PLANTS.
14. ALL TREES AND SHRUBS PLANTED ABOVE ELEVATION 169.0 SHALL BE MULCHED WITH NON-DYE CEDAR MULCH TO A DEPTH OF 4 INCHES. TREES AND SHRUBS SHALL HAVE A MINIMUM 4 FOOT DIAMETER MULCH BED AROUND EACH SHRUB AND/OR TREE.



PLANT SCHEDULE

TREES	QTY	BOTANICAL NAME	COMMON NAME	CONT
AR	2	Acer rubrum	Red Maple	2"-2.5" Cal.
AM	3	Amelanchier canadensis	Shadblow Serviceberry Multitrunk	6'-7' Ht.
NS	3	Nyssa sylvatica	Sour Gum	2"-2.5" Cal.

SHRUBS	QTY	BOTANICAL NAME	COMMON NAME	CONT	SPACING
AS	17	Alnus serulata	Hazel Alder	#2	
CA	145	Cornus amomum	Silky Dogwood	#3	5' o.c.
CG	186	Cornus racemosa	Gray Dogwood	#3	5' o.c.
EP	79	Eupatorium perfoliatum	Common Boneset	#1	4' o.c.
IV	151	Iris versicolor	Blue Flag	#1	2' o.c.
OC	88	Osmunda cinnamomea	Cinnamon Fern	#1	4' o.c.
OR	72	Osmunda regalis	Royal Fern	#1	3' o.c.
SE	49	Sambucus canadensis	Elderberry	#3	5' o.c.
VH	48	Vaccinium corymbosum	Highbush Blueberry	#3	5' o.c.
VL	80	Viburnum lentago	Nannyberry	#3	5' o.c.

TOPSOIL & HYDROSEED

NEW ENGLAND CONSERVATION/WILDLIFE SEED MIX = ±8030 SF.

SPECIES: Virginia Wild Rye (Elymus virginicus), Little Bluestem (Schizachyrium scoparium), Big Bluestem (Andropogon gerardii), Red Fescue (Festuca rubra), Switch Grass (Panicum virgatum), Partridge Pea (Chamaecrista fasciculata), Paniciedleaf Tick Trefoil (Desmodium paniculatum), Indian Grass (Sorghastrum nutans), Blue Vervain (Verbena hastata), Butterfly Milkweed (Asclepias tuberosa), Black Eyed Susan (Rudbeckia hirta), Common Sneezeweed (Helenium autunale), Heath Aster (Asterpilosus/Symphyotrichum pilosum), Early Goldenrod (Solidago juncea), Upland Bentgrass (Agrostis perennans). APPLICATION RATE: 25lbs/acre | 1750 sq ft/lb

NEW ENGLAND SEMI-SHADE GRASS AND FORBS SEED MIX = ±17,900 SF.

SPECIES: Virginia Wildrye (Elymus virginicus), Canada Wild Rye (Elymus canadensis), Partridge Pea, (Chamaecrista fasciculata), Red Fescue, (Festuca rubra), Spiked Gayfeather/Marsh Blazing Star (Liatris spicata), Sensitive Fern (Onoclea sensibilis), Zigzag Aster (Aster prenanthoides/Symphyotrichum prenanthoide), Hollow-Stem Joe Pye Weed (Eupatorium fistulosum/Eutrochium fistulosum), White Avens, (Geum canadense), Eastern Columbine (Aquilegia canadensis), Path Rush (Juncus tenuis). APPLICATION RATE: 30 lbs/acre | 1450 sq ft/lb

MILONE & MACBROOM
99 REALTY DRIVE
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DESCRIPTION	DATE	BY

ADVANCED DESIGN

SITE PLAN - LANDSCAPING AND RESTORATION

FEARING BROOK
FLOODPLAIN CREATION PRO ECT

AMHERST, MASSACHUSETTS

MBR	SRS	WAG
DESIGNED	DRAWN	CHECKED

1"=20'
SCALE

MAY 14, 2019
DATE

26□□-43
PROJECT NO.

06 OF 12
SHEET NO.

SP-4
SHEET NAME

REGULATED RESOURCES LEGEND

- EXISTING LAND UNDER WATER
- NATURAL HERITAGE & ENDANGERED SPECIES PROGRAM (NHESP) MAPPED AREA
- BANKFULL/MEAN ANNUAL HIGH WATER (MAHW)
- 200' RIVERFRONT AREA (± 200' FROM MAHW)
- PROJECT AREA LIMIT
- 100-YEAR FLOOD EXTENTS

N
W E
S

0' 25' 50'
0 1/2" 1"

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REGULATED RESOURCES AREAS

FEARING BROOK
FLOODPLAIN CREATION PRO_ECT

AMHERST, MASSACHUSETTS

ADVANCED DESIGN

--	CME	MBR
DESIGNED	DRAWN	CHECKED

SCALE: 1"=50'

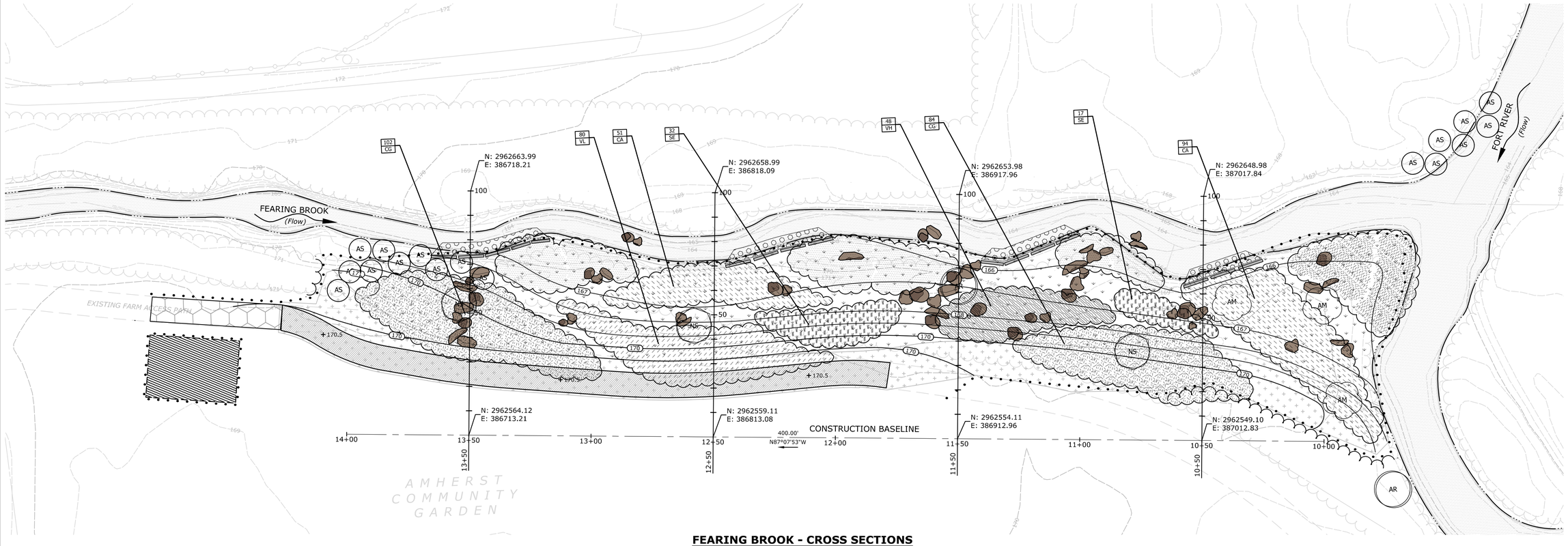
DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 07 OF 12

RR-1

SHEET NAME



FEARING BROOK - CROSS SECTIONS

SCALE: 1"=20'

COORDINATES TABLE		
STA	START COORDINATES	END COORDINATES
10+50	N 2962549.10 E 387012.83	N 2962648.98 E 387017.84
11+50	N 2962554.11 E 386912.96	N 2962653.98 E 386917.96
12+50	N 2962559.11 E 386813.08	N 2962658.99 E 3868181.09
13+50	N 2962564.12 E 386713.21	N 2962663.99 E 386718.21

CONSTRUCTION NOTE

CONTRACTOR MAY PROPOSE ALTERNATIVES TO THIS CONSTRUCTION SEQUENCE THAT OTHERWISE CONFORM TO ALL PERMITTING CONDITIONS, PROJECT PLANS, AND SPECIFICATIONS. REVISED ALTERNATIVES MUST BE DEVELOPED AND SUBMITTED TO THE ENGINEER FOR APPROVAL PRIOR TO IMPLEMENTATION.

CONSTRUCTION SEQUENCE

1. PERFORM NECESSARY SITE CLEARING, ESTABLISH CONSTRUCTION ENTRANCE AT GRAVEL PARKING LOT, OFF OF BELCHERTOWN ROAD.
2. INSTALL TRAFFIC CONTROL SIGNAGE ON ALL EGRESS POINTS FROM THE SITE, AS SHOWN ON THE CONSTRUCTION PLAN - TRAFFIC AND PEDESTRIAN CONTROL (SHEET CP-1) OR APPROVED BY THE ENGINEER.
3. INSTALL TEMPORARY STABILIZED CONSTRUCTION ENTRANCE PAD, SEDIMENT FILTER FENCE, STOCKPILE AND STAGING AREA.
4. EXCAVATE AND PERFORM ROUGH GRADE OF PROPOSED BANK AND FLOODPLAIN.
5. INSTALL FEATURES IN CHANNEL (PROPOSED BOULDER CLUSTERS) AS SHOWN ON THE SITE PLAN IN THE PROPOSED CHANNEL LOCATIONS. INSTALL FEATURES IN BANK AND FLOODPLAIN (BOULDERS, BOULDER STEPPING STONES, 10' WIDE ACCESSWAY).
6. FINALIZE CHANNEL AND BANK WORK. RESTORE AND VEGETATE.
7. REMOVE ALL TEMPORARY ACCESS ROADS AND WATER CONTROL, AND RESTORE ALL DISTURBED AREAS TO EXISTING CONDITIONS, TOPSOIL AND SEED, AND INSTALL POTTED SHRUBS AND TREES.

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DESCRIPTION	DATE	BY

ADVANCED DESIGN

CROSS SECTIONS

FEARING BROOK
FLOODPLAIN CREATION PROJECT

AMHERST, MASSACHUSETTS

CME	CME	WAG
DESIGNED	DRAWN	CHECKED

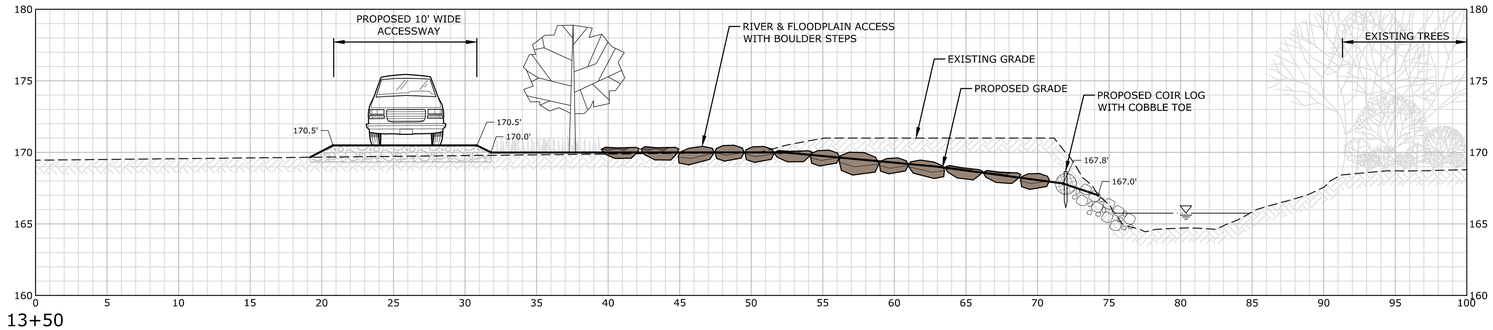
SCALE: 1"=20'

DATE: MAY 14, 2019

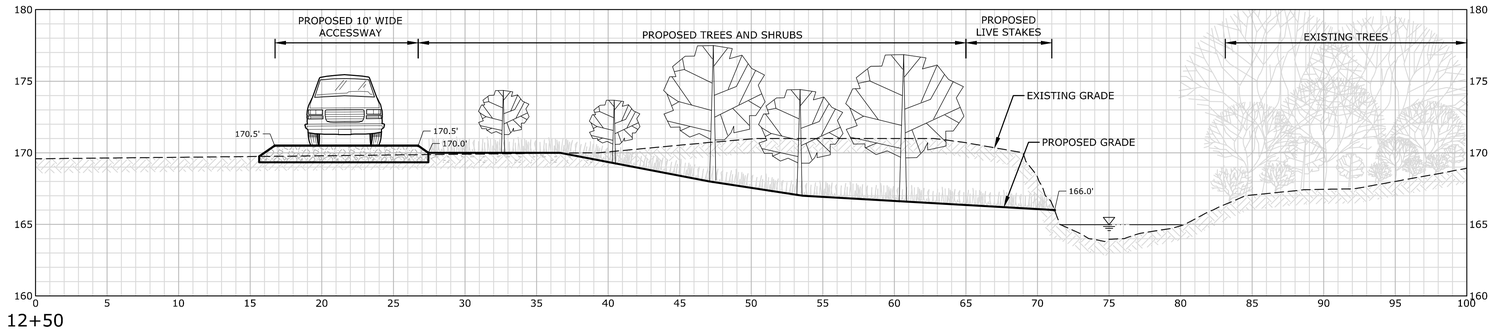
PROJECT NO.: 26□□-43

SHEET NO.: 0□ OF 12

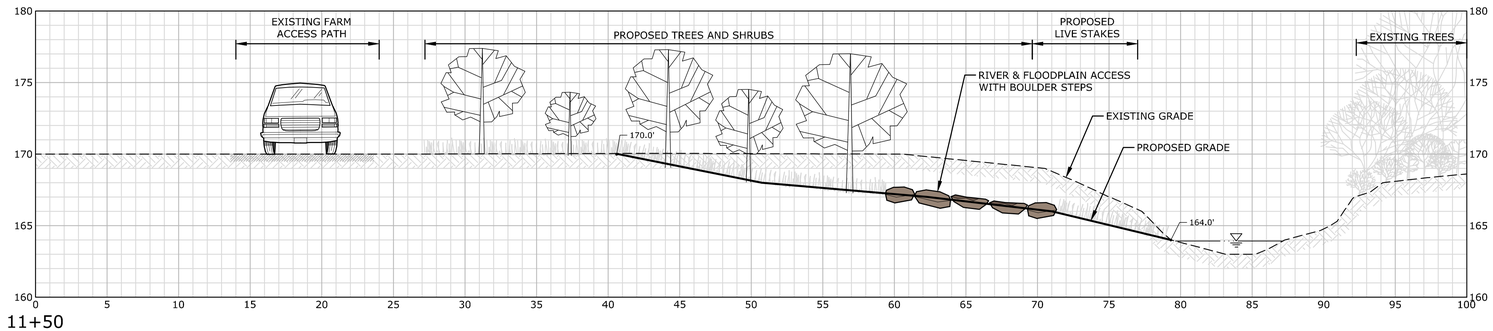
SHEET NAME: CS-1



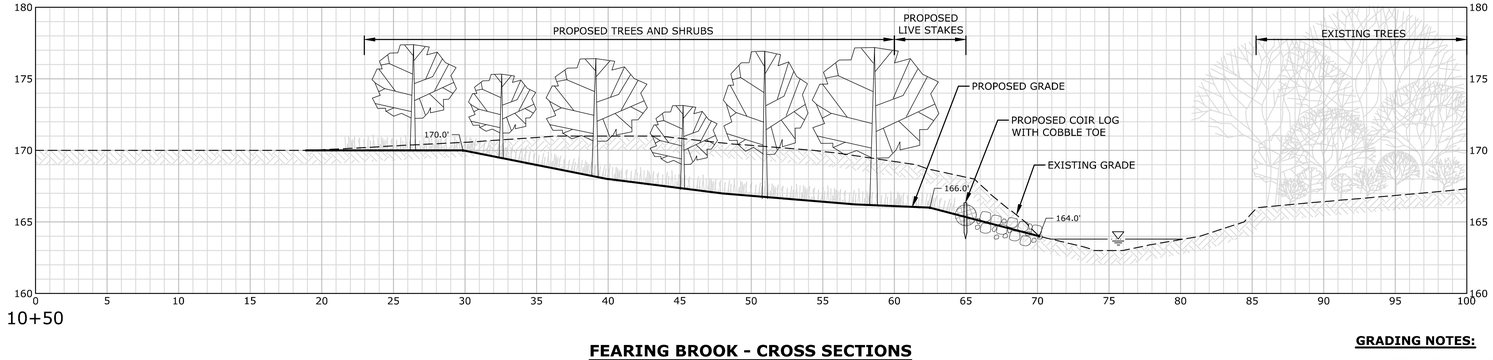
13+50



12+50



11+50



10+50

FEARING BROOK - CROSS SECTIONS

CENTERLINE ALIGNMENT, LOOKING UPSTREAM
SCALE: 1"=5' (H) ; 1"=5' (V)

LEGEND

EXISTING CHANNEL GRADE

PROPOSED CHANNEL GRADE

GRADING NOTES:

1. CROSS SECTIONS LOOK UPSTREAM.
2. PROPOSED GRADE AS PRESENTED ON THIS PLAN INDICATE FINAL GRADE AFTER TOPSOIL, ROCKS, AND OTHER PROPOSED STRUCTURES AND FINISH TREATMENTS ARE COMPLETED.

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DESCRIPTION	DATE	BY

ADVANCED DESIGN

CROSS SECTIONS

FEARING BROOK
FLOODPLAIN CREATION PROJECT

AMHERST, MASSACHUSETTS

CME	CME	WAG
DESIGNED	DRAWN	CHECKED

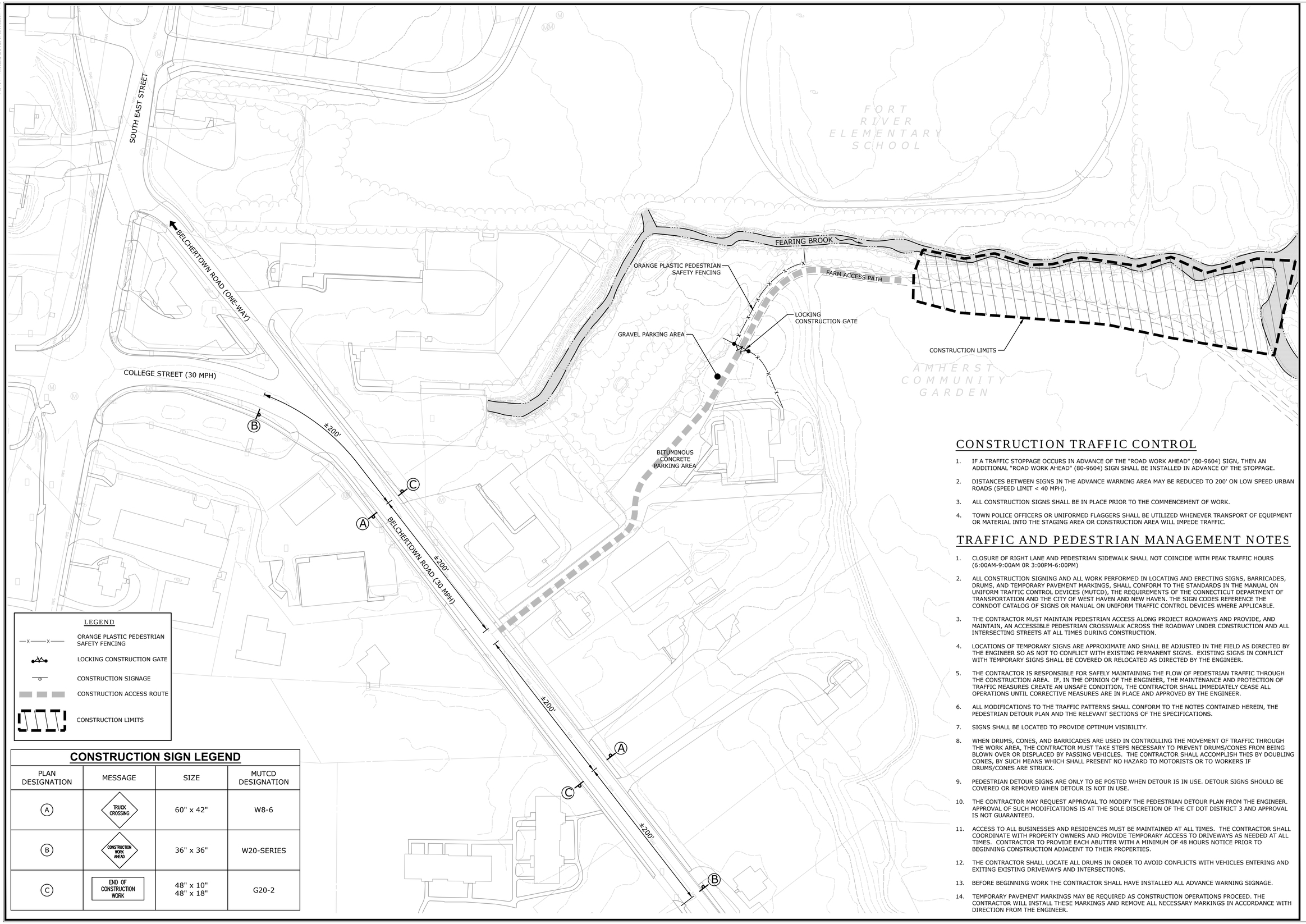
SCALE: 1"=5'

DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 09 OF 12

SHEET NAME: CS-2



LEGEND

- ORANGE PLASTIC PEDESTRIAN SAFETY FENCING
- LOCKING CONSTRUCTION GATE
- CONSTRUCTION SIGNAGE
- CONSTRUCTION ACCESS ROUTE
- CONSTRUCTION LIMITS

CONSTRUCTION SIGN LEGEND

PLAN DESIGNATION	MESSAGE	SIZE	MUTCD DESIGNATION
A	TRUCK CROSSING	60" x 42"	W8-6
B	CONSTRUCTION WORK AHEAD	36" x 36"	W20-SERIES
C	END OF CONSTRUCTION WORK	48" x 10" 48" x 18"	G20-2

CONSTRUCTION TRAFFIC CONTROL

1. IF A TRAFFIC STOPPAGE OCCURS IN ADVANCE OF THE "ROAD WORK AHEAD" (80-9604) SIGN, THEN AN ADDITIONAL "ROAD WORK AHEAD" (80-9604) SIGN SHALL BE INSTALLED IN ADVANCE OF THE STOPPAGE.
2. DISTANCES BETWEEN SIGNS IN THE ADVANCE WARNING AREA MAY BE REDUCED TO 200' ON LOW SPEED URBAN ROADS (SPEED LIMIT < 40 MPH).
3. ALL CONSTRUCTION SIGNS SHALL BE IN PLACE PRIOR TO THE COMMENCEMENT OF WORK.
4. TOWN POLICE OFFICERS OR UNIFORMED FLAGGERS SHALL BE UTILIZED WHENEVER TRANSPORT OF EQUIPMENT OR MATERIAL INTO THE STAGING AREA OR CONSTRUCTION AREA WILL IMPEDE TRAFFIC.

TRAFFIC AND PEDESTRIAN MANAGEMENT NOTES

1. CLOSURE OF RIGHT LANE AND PEDESTRIAN SIDEWALK SHALL NOT COINCIDE WITH PEAK TRAFFIC HOURS (6:00AM-9:00AM OR 3:00PM-6:00PM)
2. ALL CONSTRUCTION SIGNING AND ALL WORK PERFORMED IN LOCATING AND ERECTING SIGNS, BARRICADES, DRUMS, AND TEMPORARY PAVEMENT MARKINGS, SHALL CONFORM TO THE STANDARDS IN THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD), THE REQUIREMENTS OF THE CONNECTICUT DEPARTMENT OF TRANSPORTATION AND THE CITY OF WEST HAVEN AND NEW HAVEN. THE SIGN CODES REFERENCE THE CONNDOT CATALOG OF SIGNS OR MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES WHERE APPLICABLE.
3. THE CONTRACTOR MUST MAINTAIN PEDESTRIAN ACCESS ALONG PROJECT ROADWAYS AND PROVIDE, AND MAINTAIN, AN ACCESSIBLE PEDESTRIAN CROSSWALK ACROSS THE ROADWAY UNDER CONSTRUCTION AND ALL INTERSECTING STREETS AT ALL TIMES DURING CONSTRUCTION.
4. LOCATIONS OF TEMPORARY SIGNS ARE APPROXIMATE AND SHALL BE ADJUSTED IN THE FIELD AS DIRECTED BY THE ENGINEER SO AS NOT TO CONFLICT WITH EXISTING PERMANENT SIGNS. EXISTING SIGNS IN CONFLICT WITH TEMPORARY SIGNS SHALL BE COVERED OR RELOCATED AS DIRECTED BY THE ENGINEER.
5. THE CONTRACTOR IS RESPONSIBLE FOR SAFELY MAINTAINING THE FLOW OF PEDESTRIAN TRAFFIC THROUGH THE CONSTRUCTION AREA. IF, IN THE OPINION OF THE ENGINEER, THE MAINTENANCE AND PROTECTION OF TRAFFIC MEASURES CREATE AN UNSAFE CONDITION, THE CONTRACTOR SHALL IMMEDIATELY CEASE ALL OPERATIONS UNTIL CORRECTIVE MEASURES ARE IN PLACE AND APPROVED BY THE ENGINEER.
6. ALL MODIFICATIONS TO THE TRAFFIC PATTERNS SHALL CONFORM TO THE NOTES CONTAINED HEREIN, THE PEDESTRIAN DETOUR PLAN AND THE RELEVANT SECTIONS OF THE SPECIFICATIONS.
7. SIGNS SHALL BE LOCATED TO PROVIDE OPTIMUM VISIBILITY.
8. WHEN DRUMS, CONES, AND BARRICADES ARE USED IN CONTROLLING THE MOVEMENT OF TRAFFIC THROUGH THE WORK AREA, THE CONTRACTOR MUST TAKE STEPS NECESSARY TO PREVENT DRUMS/CONES FROM BEING BLOWN OVER OR DISPLACED BY PASSING VEHICLES. THE CONTRACTOR SHALL ACCOMPLISH THIS BY DOUBLING CONES, BY SUCH MEANS WHICH SHALL PRESENT NO HAZARD TO MOTORISTS OR TO WORKERS IF DRUMS/CONES ARE STRUCK.
9. PEDESTRIAN DETOUR SIGNS ARE ONLY TO BE POSTED WHEN DETOUR IS IN USE. DETOUR SIGNS SHOULD BE COVERED OR REMOVED WHEN DETOUR IS NOT IN USE.
10. THE CONTRACTOR MAY REQUEST APPROVAL TO MODIFY THE PEDESTRIAN DETOUR PLAN FROM THE ENGINEER. APPROVAL OF SUCH MODIFICATIONS IS AT THE SOLE DISCRETION OF THE CT DOT DISTRICT 3 AND APPROVAL IS NOT GUARANTEED.
11. ACCESS TO ALL BUSINESSES AND RESIDENCES MUST BE MAINTAINED AT ALL TIMES. THE CONTRACTOR SHALL COORDINATE WITH PROPERTY OWNERS AND PROVIDE TEMPORARY ACCESS TO DRIVEWAYS AS NEEDED AT ALL TIMES. CONTRACTOR TO PROVIDE EACH ABUTTER WITH A MINIMUM OF 48 HOURS NOTICE PRIOR TO BEGINNING CONSTRUCTION ADJACENT TO THEIR PROPERTIES.
12. THE CONTRACTOR SHALL LOCATE ALL DRUMS IN ORDER TO AVOID CONFLICTS WITH VEHICLES ENTERING AND EXITING EXISTING DRIVEWAYS AND INTERSECTIONS.
13. BEFORE BEGINNING WORK THE CONTRACTOR SHALL HAVE INSTALLED ALL ADVANCE WARNING SIGNAGE.
14. TEMPORARY PAVEMENT MARKINGS MAY BE REQUIRED AS CONSTRUCTION OPERATIONS PROCEED. THE CONTRACTOR WILL INSTALL THESE MARKINGS AND REMOVE ALL NECESSARY MARKINGS IN ACCORDANCE WITH DIRECTION FROM THE ENGINEER.

N
W E
S
0' 25' 50'
0 1/2" 1"

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DESCRIPTION	DATE	BY

CONSTRUCTION PLAN - TRAFFIC AND PEDESTRIAN CONTROL

FEARING BROOK
FLOODPLAIN CREATION PROJECT

AMHERST, MASSACHUSETTS

ADVANCED DESIGN

CM	CME	WAG
DESIGNED	DRAWN	CHECKED

SCALE: 1"=50'

DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 10 OF 12

SHEET NAME: CP-1

PROJECT DESCRIPTION

THE MASSACHUSETTS DIVISION OF ECOLOGICAL RESTORATION (MADER) RETAINED MILONE & MACBROOM, INC. (MMI) TO DEVELOP ECOLOGICAL RESTORATION ALONG A PORTION OF THE FEARING BROOK, LOCATED NEAR THE FORT RIVER ELEMENTARY SCHOOL PROPERTY IN AMHERST, MASSACHUSETTS. THE GOAL IS TO IMPROVE THE HABITAT, WATER QUALITY, AND NATURALIZED FUNCTIONS OF FEARING BROOK.

SITE DESCRIPTION

THE PROJECT SITE IS A PORTION OF FEARING BROOK LOCATED NEAR THE FORT RIVER ELEMENTARY SCHOOL, UPSTREAM OF THE CONFLUENCE OF FEARING BROOK AND THE FORT RIVER. A 500-FOOT-LONG SEGMENT OF FEARING BROOK FLOWS BETWEEN THE SCHOOL ALONG THE NORTHERN BANK AND A TOWN-OWNED PIECE OF LAND ALONG THE SOUTHERN BANK.

THE PROJECT REACH HAS A MODEST RIPARIAN CORRIDOR WITH MATURE WOODY VEGETATION ON BOTH BANKS, EVIDENCE OF CHANNEL MANIPULATION SUCH AS STRAIGHTENING, DREDGING, AND SIDECAST BERMS EXISTS. THE MANIPULATION HAS CAUSED THE BROOK IN THIS REACH TO BE OVERLY ENTRENCHED WITH HIGH, STEEP BANKS THAT CONCENTRATE FLOOD FLOWS INTO THE CHANNEL AND CAUSE INSTABILITY OF THE BED AND BANKS.

FEARING BROOK IS AN APPROXIMATELY ONE MILE LONG EASTWARD-FLOWING TRIBUTARY OF THE FORT RIVER. IT DRAINS A WATERSHED OF APPROXIMATELY 0.7 SQUARE MILES, EXTENDING NORTH AND WEST TO INCLUDE THE AMHERST COLLEGE CAMPUS, AS WELL AS THE TOWN GREEN IN THE CENTER OF AMHERST. APPROXIMATELY TEN PERCENT OF THE WATERSHED IS WOODED, UNDEVELOPED LAND. THE REMAINDER OF THE WATERSHED IS WELL DEVELOPED HAVING A MIX OF INSTITUTIONAL, COMMERCIAL AND RESIDENTIAL LAND USES. THE HEADWATERS OF THE BROOK ARE FORMED BY THE DISCHARGES OF MULTIPLE DRAINAGE SYSTEMS, AS WELL AS GROUNDWATER DISCHARGE.

PROPOSED IMPROVEMENTS

GIVEN THE CHANNEL MANIPULATION THROUGHOUT THE FEARING BROOK CORRIDOR, THE FOLLOWING GOALS WERE CONSIDERED FOR THE SUBJECT RESTORATION:

- STABILIZE ERODING BANKS THROUGH USE OF NATURAL CHANNEL DESIGN AND BIOENGINEERING APPROACHES, AS STREAM MECHANICS ALLOW
- ENCOURAGE HEALTHY FLOODPLAIN CONNECTIVITY AND SEDIMENT TRANSPORT THROUGH THE PROJECT AREA

SOILS

ONE SEDIMENT SAMPLE WAS COLLECTED ON A POINT BAR AND BROUGHT TO A TESTING LAB FOR GRADATION ANALYSIS. THE SAMPLE CONSISTED OF A MIXTURE OF SANDY GRAVEL.

THE BANKS OF THE BROOK WERE GENERALLY FOUR TO SIX FEET HIGH AND NEARLY VERTICAL, CONSISTING OF SANDY SILTY MATERIALS WITH HIGH COHESION, WITHER HIGHER WATER CONTENT NEAR THE BASE OF THE BANK AND GENERALLY DRIER NEAR THE TOP OF THE BANK.

CONSTRUCTION SEQUENCE

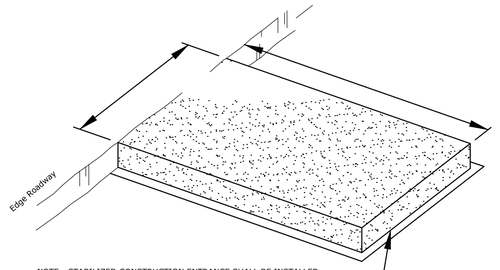
(SEE SHEET CS-1)

EROSION CONTROL NOTES

(SEE SHEET SP-2)

EROSION CONTROL MAINTENANCE INTERVALS

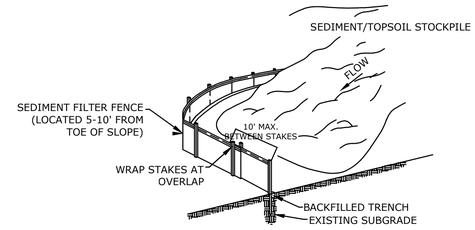
EROSION CONTROL MEASURE	CONTROL OBJECTIVE	INSPECTION/MAINTENANCE	FAILURE INDICATORS	REMOVAL
SILT FENCE	- INTERCEPT, AND REDIRECT/DETAIN SMALL AMOUNTS OF SEDIMENT FROM SMALL DISTURBED AREAS - DECREASE VELOCITY OF SHEET FLOW - PROTECT SENSITIVE SLOPES OR SOILS FROM EXCESSIVE WATER FLOW	INSPECT AT LEAST ONCE A WEEK AND WITHIN 24 HOURS OF THE END OF A STORM WITH A RAINFALL OF 0.5 INCHES OR MORE. ACCUMULATED SEDIMENT MUST BE REMOVED ONCE ITS DEPTH IS EQUAL TO ½ THE TRENCH HEIGHT. INSPECT FREQUENTLY DURING PUMPING OPERATIONS IF USED FOR DEWATERING OPERATIONS.	- PHYSICAL DAMAGE OR DECOMPOSITION - EVIDENCE OF OVERTOPPED OR UNDERCUT FENCE - EVIDENCE OF SIGNIFICANT FLOWS EVADING CAPTURE - REPETITIVE FAILURE	SILT FENCE MAY BE REMOVED AFTER UPHILL AND SENSITIVE AREAS HAVE BEEN PERMANENTLY STABILIZED.
STABILIZED CONSTRUCTION ENTRANCE	- REDUCE THE TRACKING OF SEDIMENT OFF-SITE ONTO PAVED SURFACES	INSPECT AT THE END OF EACH WORK DAY AND IMMEDIATELY REPAIR DAMAGES. PERIODIC ADDITION OF STONE, OR LENGTHENING OF ENTRANCE MAY BE REQUIRED AS CONDITIONS DEMAND. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO PAVED SURFACES AS A RESULT OF INEFFICIENCY OF CONSTRUCTION ENTRANCE SHALL BE IMMEDIATELY REMOVED.	- SEDIMENT IN ROADWAY ADJACENT TO SITE	CONSTRUCTION ENTRANCE MAY BE REMOVED ONCE THE SITE HAS BEEN PERMANENTLY STABILIZED, AND ALL OTHER SECTIONS OF ROADWAY HAVE BEEN PERMANENTLY PAVED.



NOTE: STABILIZED CONSTRUCTION ENTRANCE SHALL BE INSTALLED AND MAINTAINED DURING OPERATIONS WHICH PROMOTE VEHICULAR TRACKING OF MUD

CONSTRUCTION ENTRANCE PAD

NOT TO SCALE



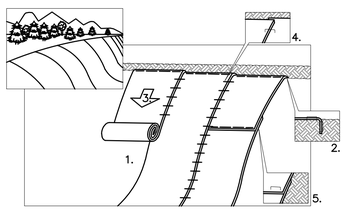
STOCKPILE AREA

NOT TO SCALE

NOTES:
1. CRUSHED STONE #3 TO BE REMOVED UPON COMPLETION OF CONSTRUCTION AND TO BE RESTORED TO EXISTING OR BETTER CONDITION.
2. ACCESS ROAD FILTER CLOTH AND CRUSHED STONE TO BE PLACED ON GRADE, NO EXCAVATION NECESSARY.

CONSTRUCTION ACCESS ROAD

NOT TO SCALE

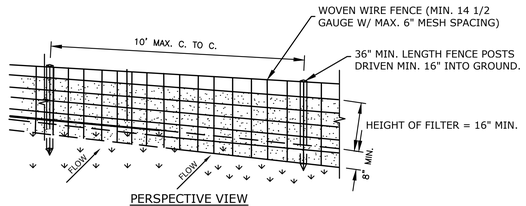


1. PREPARE SOIL BEFORE INSTALLING BLANKETS, INCLUDING APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING S150, DO NOT SEED PREPARED AREA. S150 MUST BE INSTALLED WITH PAPER SIDE DOWN.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE BLANKET IN A 6" DEEP BY 6" WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
3. ROLL THE BLANKETS DOWN THE SLOPE IN THE DIRECTION OF THE WATER FLOW.
4. THE EDGES OF PARALLEL BLANKETS MUST BE STAPLED WITH APPROXIMATELY 2" OVERLAP.
5. WHEN BLANKETS MUST BE SPLICED DOWN THE SLOPE, PLACE BLANKETS END OVER END (SHINGLE STYLE) WITH APPROXIMATELY 6" OVERLAP. STAPLE THROUGH OVERLAP AREA, APPROXIMATELY 12" APART.

REFER TO GENERAL STAPLE PATTERN GUIDE IN NORTH AMERICAN GREEN CATALOG FOR CORRECT STAPLE RECOMMENDATIONS FOR SLOPE INSTALLATIONS.

APPLICATION OF EROSION CONTROL BLANKET ON TEMPORARY DISTURBANCE AREAS

NOT TO SCALE



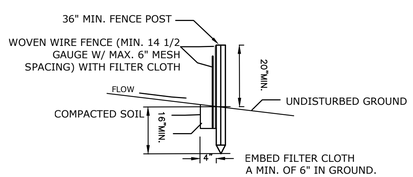
PERSPECTIVE VIEW

CONSTRUCTION SPECIFICATIONS

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POSTS WITH WIRE TIES OR STAPLES. POSTS SHALL BE STEEL EITHER "T" OR "U" TYPE OR HARDWOOD.
2. FILTER CLOTH TO BE TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MID SECTION. FENCE SHALL BE WOVEN WIRE, 12 1/2 GAUGE, 6" MAXIMUM MESH OPENING.
3. WHEN TWO SECTIONS OF FILTER CLOTH ADJOIN EACH OTHER THEY SHALL BE OVER-LAPPED BY SIX INCHES AND FOLDED. FILTER CLOTH SHALL BE EITHER FILTER X, MIRAFI 100X, STABILINKA T140N, OR APPROVED EQUIVALENT.
4. PREFABRICATED UNITS SHALL BE GEOFAB, ENVIROFENCE, OR APPROVED EQUIVALENT.
5. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE.

SILT FENCE

NOT TO SCALE



SECTION VIEW

MILONE & MACBROOM
99 REALTY DRIVE
CHESHIRE, CT 06410
203.271.1773
WWW.MMINC.COM

DESCRIPTION	DATE	BY

DETAILS - SEDIMENT AND EROSION CONTROL
FEARING BROOK
FLOODPLAIN CREATION PRO ECT
AMHERST, MASSACHUSETTS
ADVANCED DESIGN

--	CME	WAG
DESIGNED	DRAWN	CHECKED

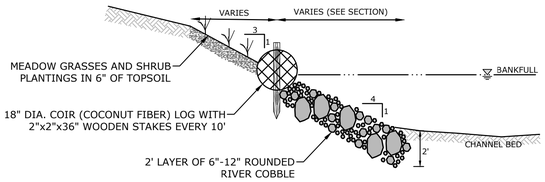
NTS
SCALE

MAY 14, 2019
DATE

26□□-43
PROJECT NO.

11 OF 12
SHEET NO.

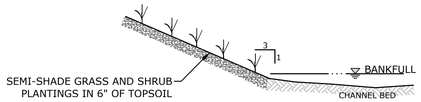
SE-1
SHEET NAME



COIR LOG WITH COBBLE TOE

(NOT TO SCALE)

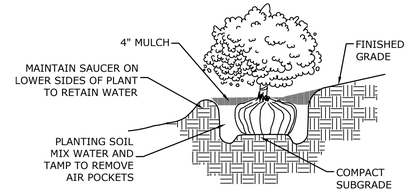
NOTES:
1. 6"-12" RIVER COBBLES SHALL EXTEND UP TO BANKFULL FLOOD ELEVATION. COIR (COCONUT FIBER) LOGS SHALL BE PLACED AT THE BANKFULL FLOOD ELEVATION. ABOVE BANKFULL FLOOD ELEVATION TO THE 5-YEAR FLOOD ELEVATION SHALL BE MEADOW GRASSES AND SHRUB PLANTINGS.
2. 6" OF TOPSOIL IS TO BE PLACED ABOVE COIR LOGS UP TO THE 5-YEAR FLOOD ELEVATION.
3. COIR LOGS ARE TO BE BURIED TO 1/2 OF LOG DIAMETER.
4. DRIVE STAKES DOWN ALONG THE CENTER OF THE LOG. DRIVE STAKES FLUSH WITH THE TOP OF THE COIR LOG.
5. WEAVE COIR OR NYLON TWINE BETWEEN AND AROUND THE STAKES.
6. DRIVE STAKED IN FIRMLY, SECURING THE LOG TO THE STREAMBANK.



SEMI-SHADE GRASS AND SHRUB PLANTINGS

NOT TO SCALE

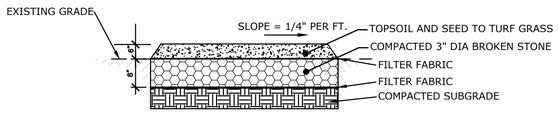
NOTES:
1. NEW ENGLAND SEMI-SHADE GRASS AND FORBS SEED MIX AND SHRUB PLANTINGS SHALL BE PLACES IN 6" LAYER OF TOPSOIL.



NOTE:
UNLESS OTHERWISE DIRECTED SHREDDED MULCH SHALL BE PLACED TO A LIMIT OF ONE FOOT BEYOND THE CENTER OF THE OUTERMOST SHRUBS IN PLANTING BED. SPECIES SHALL BE EQUALLY DISTRIBUTED THROUGHOUT THE SITE.

SHRUB PLANTING

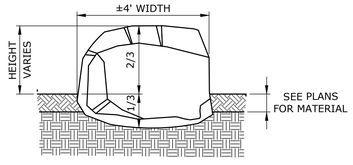
NOT TO SCALE



NOTES:
1. WESTERN ACCESS ROAD TO REMAIN AT THE CONCLUSION OF CONSTRUCTION TO PROVIDE ACCESS TO THE RIVER

10-FOOT WIDE ACCESS ROAD

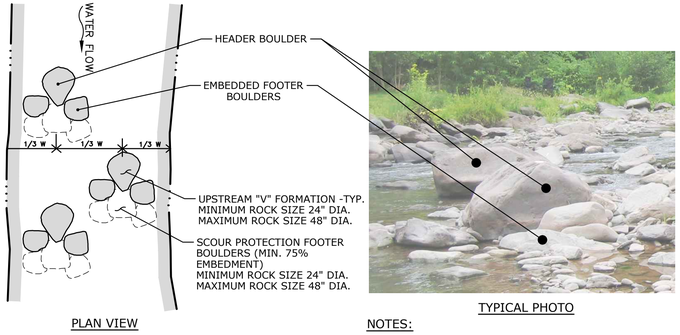
NOT TO SCALE



NOTES:
1. ALL LOCATIONS AND ELEVATIONS TO BE APPROVED BY THE ENGINEER OR LANDSCAPE ARCHITECT.

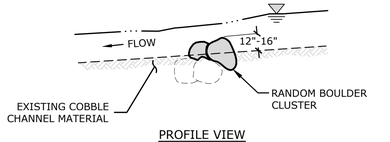
PLACED BOULDER

NOT TO SCALE



PLAN VIEW

TYPICAL PHOTO

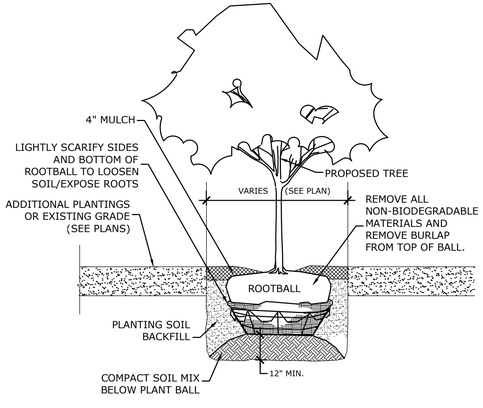


PROFILE VIEW

NOTES:
1. 3 BOULDERS PER RANDOM BOULDER CLUSTER, PLUS 3 SCOUR PROTECTION FOOTER BOULDERS.
2. PLACE BOULDERS IN THE MIDDLE THIRD OF THE STREAM WITHIN DEEPEST PORTION OF CHANNEL.
3. POSITION BOULDER GROUPS IN A UPSTREAM "V" FORMATION.
4. INDIVIDUAL BOULDERS PLACED IN THE STREAM SHOULD BE 24" TO 48" IN DIAMETER.
5. POSITION BOULDERS WITH THEIR LONG AXIS PARALLEL TO THE STREAM FLOW.
6. INSTALL FOOTER BOULDER TO WEDGE HEADER BOULDER IN PLACE FROM DOWNSTREAM.
7. INSTALL HEADER BOULDERS AT A LOW PROFILE SUCH THAT THEY ARE PARTIALLY SUBMERGED DURING NORMAL LOW FLOW. INSTALL SUCH THAT ⅓ OF ROCK DIAMETER IS BURIED IN STREAM CHANNEL.
8. FINISHED ELEVATION OF THE BOULDERS WILL BE DETERMINED IN THE FIELD.

RANDOM BOULDER CLUSTER

NOT TO SCALE



TREE PLANTING

NOT TO SCALE

MILONE & MACBROOM
99 REALTY DRIVE
CHESHIRE, CT 06410
203.271.1773
WWW.MMINC.COM

DESCRIPTION	DATE	BY

ADVANCED DESIGN

DETAILS

FEARING BROOK FLOODPLAIN CREATION PROJECT

AMHERST, MASSACHUSETTS

--	--	WAG
DESIGNED	DRAWN	CHECKED

SCALE: NTS

DATE: MAY 14, 2019

PROJECT NO.: 26□□-43

SHEET NO.: 12 OF 12

SHEET NAME: DE-1

Appendix B – Moonlit Farm - Proposed BMP Design Concept (UMass, 2019)

Appendix C – BMP Concepts

Site 1: Fort River Elementary School[1]

BMP Type: Infiltration Basin with Sediment Forebay

Priority: 1

Site Summary: Stormwater runoff from the parking lot, school roof, and surrounding area currently enters a storm drainage network via catch basins in the parking lot and discharges untreated to the downstream portion of the Fearing Brook via two 28x44" elliptical pipes[2] (approximately 800 feet upstream of the confluence with the Fort River). Photo 1-1 depicts the parking lot south-adjacent to the school.

Proposed Improvement: The proposed concept includes daylighting the existing 28x44" pipes to convey stormwater into a sediment forebay and infiltration basin (pending soil investigations)[3] at the location where the drainage network converges. Photo 1-2 illustrates the approximate footprint of the proposed infiltration basin and sediment forebay and Photo 1-3 provides an example cross-section of the proposed BMP. Native species should be planted within the ponding area of the infiltration basin to improve resiliency, stormwater treatment, biodiversity and aesthetics (Photo 1-3). Nutrient-sensitive vegetative support materials (e.g., low-nutrient compost, coconut coir, etc.) should be implemented to limit export of nutrients.

Expected Operation and Maintenance (O&M):

- Inspect and clean sediment forebay regularly.
- Inspect for erosion and re-mulch void areas as necessary.
- Remove and replace dead vegetation in Spring and Fall.
- Remove invasive species.
- Clean flow control structures at least once annually, or as indicated by inspection.
- Do not store snow in the infiltration basin.
- Periodically observe function under wet weather conditions.

Wetland Permitting: None expected

Parcel Ownership: Town of Amherst

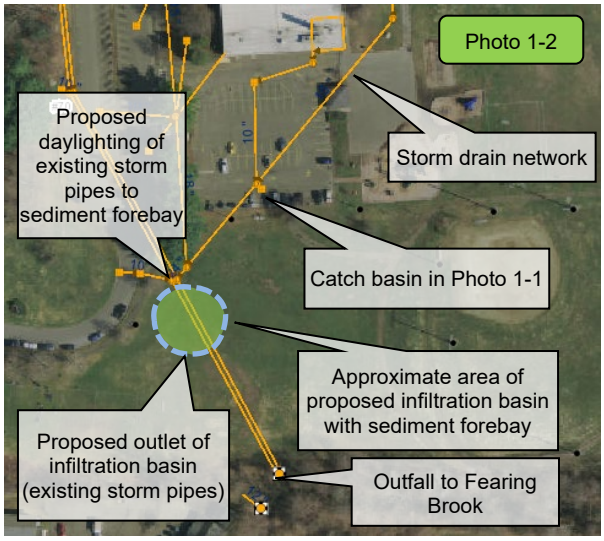
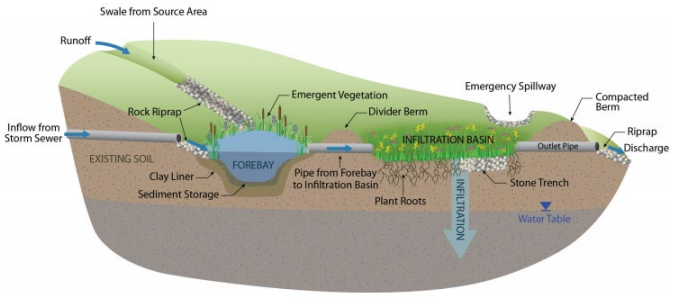


Photo 1-3



Sizing Characteristics	
BMP Drainage Area (acres)	10.3
BMP Size (storm depth; inches)	1.0
Impervious Area (%)	53
Estimated Pollutant Load Reduction[1]	
TP (lbs./yr.)	12.3
TN (lbs./yr.)	80.9
TSS (lbs./yr.)	2,539
Estimated Cost	
Planning-level Capital (Construction Only) Cost	$120,000
Engineering (estimated 40 % of Capital Cost)	$48,000
O & M (estimated 2 % of Capital Cost, annually)	$2,400/yr.

[1] There is potentiality of a new school or major renovations to Fort River Elementary school within the next 5—10 years. It is therefore currently unknown if this property will remain a school or if it will have another use in the future.

[2] The existing pipe dimensions are based on amherstma.gov/maps data and should be field confirmed prior to advancing the design.

[3] Based on the USDA NRCS Web Soil Survey, the soil within the area of the proposed infiltration basin is "Amostown-Windsor silty substratum-Urban land complex, 0 to 3 percent slopes" and "Limerick silt loam, 0 to 3 percent slopes", which includes Hydrologic Soil Groups (HSG) A, B, and B/D. Soil tests should be conducted in the areas of the proposed infiltration basin to confirm the HSG and to determine depth to groundwater. HSG and depth to groundwater should be considered when advancing the design.

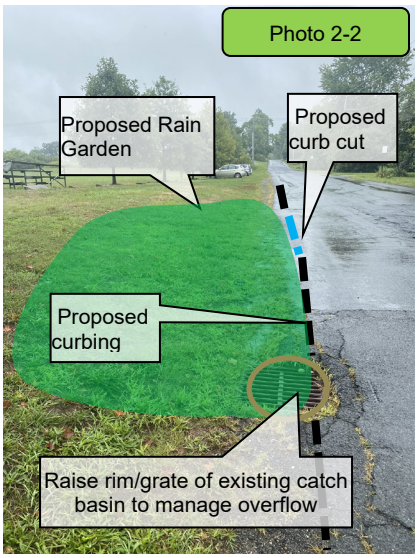
Site 2: Mill Lane at Groff Park

BMP Type: Series of Rain Gardens

Priority: 4

Site Summary: A stormwater drainage network of nine catch basins located along Mill Lane (six on the northern side and three on the southern side) collects stormwater from Mill Lane and adjacent residences and flows untreated into the Fort River via a 15" corrugated metal pipe. Photo 2-1 depicts the location of the nine catch basins and the associated outfall to the Fort River.

Proposed Improvement: Install an approximately 350 square foot rain garden in the location of each of the catch basins so that stormwater runoff routes to the rain garden (total of 9 rain gardens) prior to flowing into the catch basin[4]. The existing catch basins will be used for overflows. The rain gardens will include a 6-inch gravel bed layer and a 2.5-4 feet thick bioretention cell soil media layer to increase biological treatment of the stormwater infiltrating through the rain garden. Also, 2-3 inches of hardwood mulch should be added and a minimum of 6-inch ponding depth should be included. Finally, native species should be planted within the ponding area of the rain garden to improve resiliency, stormwater treatment, biodiversity and aesthetics (Photo 2-3). Nutrient-sensitive vegetative support materials (e.g., low-nutrient compost, coconut coir, etc.) should be implemented to limit export of nutrients.



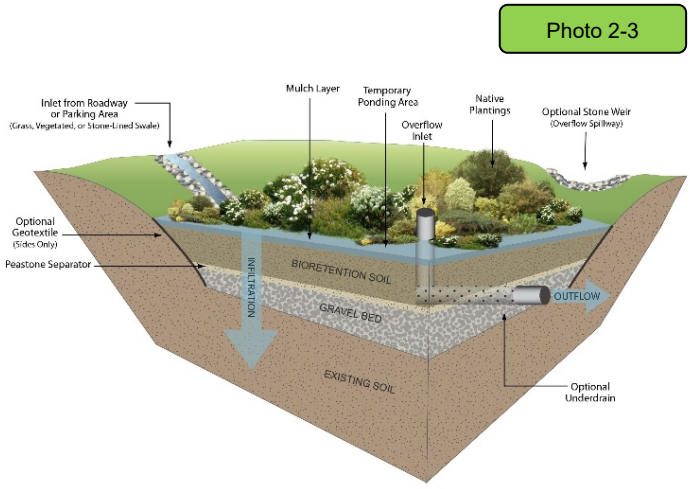
Expected Operation and Maintenance (O&M):

- Inspect rain gardens regularly for sediment build-up, structural damage and standing water.
- Inspect for erosion and re-mulch void areas as necessary.
- Remove and replace dead vegetation in Spring and Fall.
- Remove invasive species.
- Do not store snow rain gardens.
- Periodically observe function under wet weather conditions.

Wetland Permitting: Not expected

Parcel Ownership: Town of Amherst

Sizing Characteristics	
BMP Drainage Area (acres)	2.7
BMP Size (storm depth; inches)	1.0
Impervious Area (%)	48
Estimated Pollutant Load Reduction	
TP (lbs./yr.)	2.4
TN (lbs./yr.)	14.8
TSS (lbs./yr.)	604
Estimated Cost	
Planning-level Capital (Construction Only) Cost	$90,000
Engineering (estimated 40 % of Capital Cost)	$36,000
O & M (estimated 2 % of Capital Cost, annually)	$1,800/yr.



[4] Based on the USDA NRCS Web Soil Survey, the soil within the proposed BMP footprint is "Boxford silt loam, 3 to 8 percent slopes", which includes soils with HSG D. Soil tests should be conducted in the areas of the proposed rain gardens to confirm the HSG and to determine depth to groundwater. HSG and depth to groundwater should be considered when advancing the design.

Site 3: Main Street and Spring Street Parking Lots

BMP Type: Rain Garden

Priority: 2

Site Summary: Runoff from each parking lot flows to a catch basin at the southeast corner of the lot. This runoff enters the storm drainage network that eventually discharges into the Fearing Brook (Photo 3-1).

Proposed Improvement: Install a rain garden in the location of each of the catch basins identified in Photo 3-1, Photo 3-2 (Main Street lot), and Photo 3-3 (Spring Street lot). The proposed BMP footprints are approximately 630 square feet and 750 square feet or the Main Street lot and Spring Street lot, respectively[5]. The existing catch basins will be used for overflows. The cross-sections of the rain gardens will be like those proposed under Site 2 (Mill Lane). Native species should be planted within the rain garden to improve resiliency, stormwater treatment, biodiversity and aesthetics. Nutrient-sensitive vegetative support materials (e.g., low-nutrient compost, coconut coir, etc.) should be implemented to limit export of nutrients.

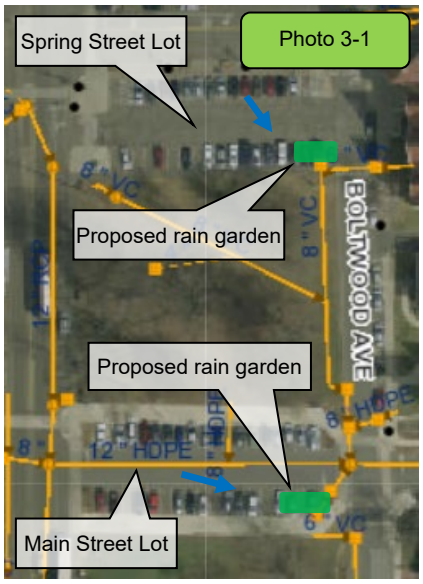
Expected Operation and Maintenance (O&M):

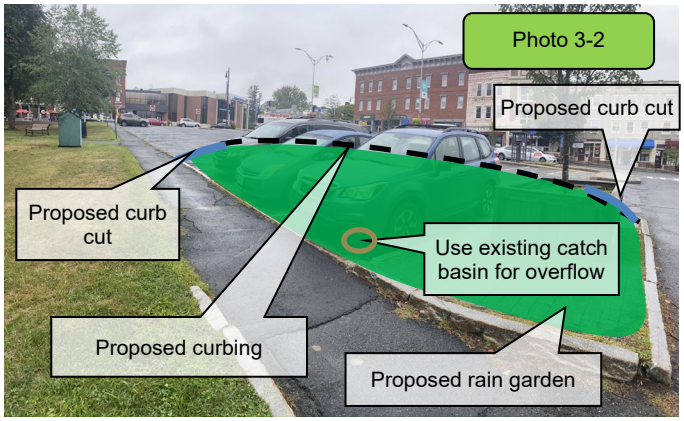
- Inspect rain gardens regularly for sediment build-up, debris, structural damage and standing water.
- Inspect for erosion and re-mulch void areas as necessary.
- Remove and replace dead vegetation in Spring and Fall.
- Remove invasive species.
- Do not store snow in rain gardens.
- Periodically observe function under wet weather conditions.

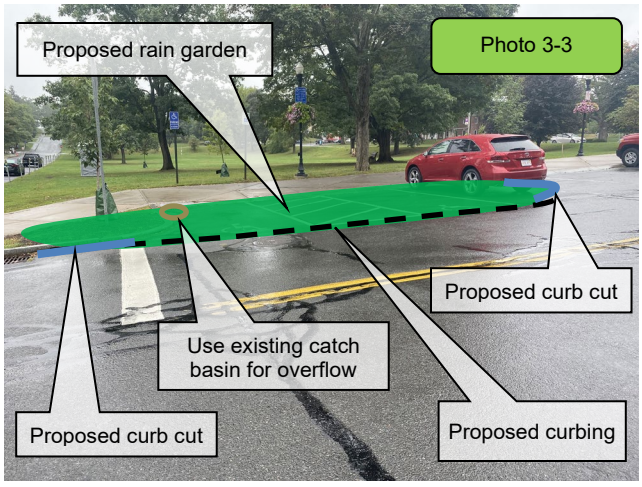
Wetland Permitting: Not expected

Parcel Ownership: Town of Amherst

Sizing Characteristics		
BMP Drainage Area (acres)	0.40 (Spring St. Lot)	0.33 (Main St. Lot)
BMP Size (storm depth; inches)	1	
Impervious Area (%)	99	
Estimated Pollutant Load Reduction		
TP (lbs./yr.)	1.0	
TN (lbs./yr.)	8.1	
TSS (lbs./yr.)	270	
Estimated Cost		
Planning-level Capital (Construction Only) Cost	$30,000	
Engineering (estimated 40 % of Capital Cost)	$12,000	
O & M (estimated 2 % of Capital Cost, annually)	$600/yr.	







[5] Based on the USDA NRCS Web Soil Survey, the soil within the proposed BMP footprint is "Paxton-Charlton-Urban land complex, 3 to 15 percent slopes", which includes soils with HSG B and C. Soil tests should be conducted in the areas of the proposed rain gardens to confirm the HSG and to determine depth to groundwater. HSG and depth to groundwater should be considered when advancing the design.

Site 4: Boltwood Parking Lot

BMP Type: Rain Gardens

Priority: 3

Site Summary: Stormwater runoff enters a catch basin at the northwest corner of the eastern section of the parking lot. Stormwater runoff also enters two catch basins at the northern edge of the western portion of the parking lot (Photo 4-1). The stormwater flows through the drainage network until it discharges untreated into Fearing Brook from the outfall east adjacent to the Alumni Parking Lot (Site 5).

Proposed Improvement: Install rain gardens in the two locations identified in Photo 4-1[6]. The proposed BMP footprints are approximately 460 square feet and 1,160 square feet for the eastern portion (Photo 4-2) and western portion (Photo 4-3) of the lot, respectively. The rims and grates of the existing catch basins will be raised and used to manage overflows. The proposed cross-sections of the rain gardens are like those proposed under Site 2 (Mill Lane). Native species should be planted within the rain garden to improve resiliency, stormwater treatment, biodiversity and aesthetics. Nutrient-sensitive vegetative support materials (e.g., low-nutrient compost, coconut coir, etc.) should be implemented to limit export of nutrients.

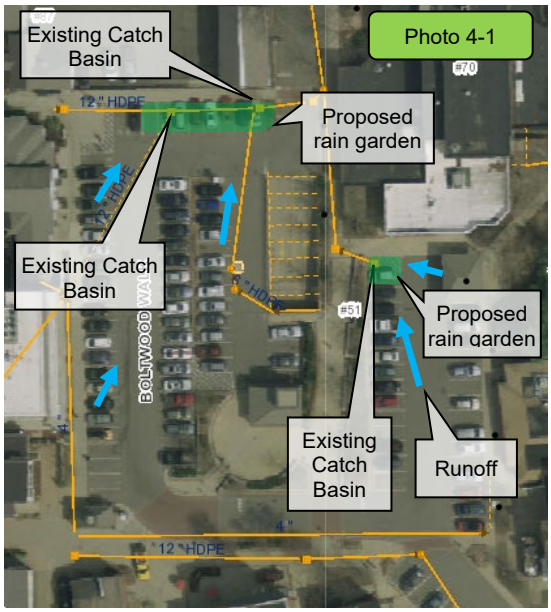
Expected Operation and Maintenance (O&M):

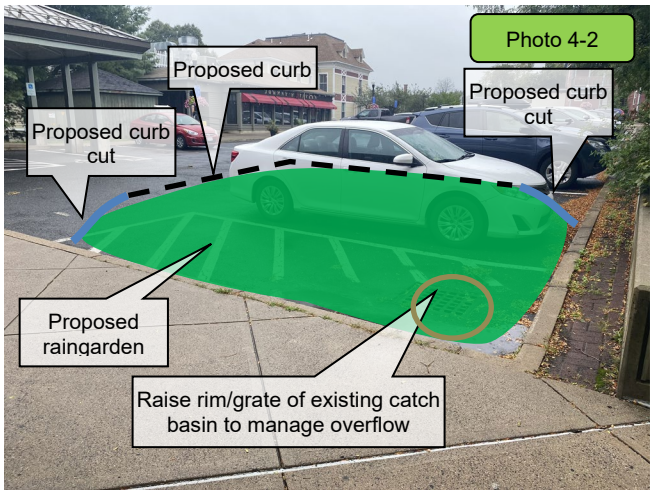
- Inspect rain gardens regularly for sediment build-up, debris, structural damage and standing water.
- Inspect for erosion and re-mulch void areas as necessary.
- Remove and replace dead vegetation in Spring and Fall.
- Remove invasive species to prevent from spreading within the rain garden.
- Do not store snow in rain gardens.
- Periodically observe function under wet weather conditions.

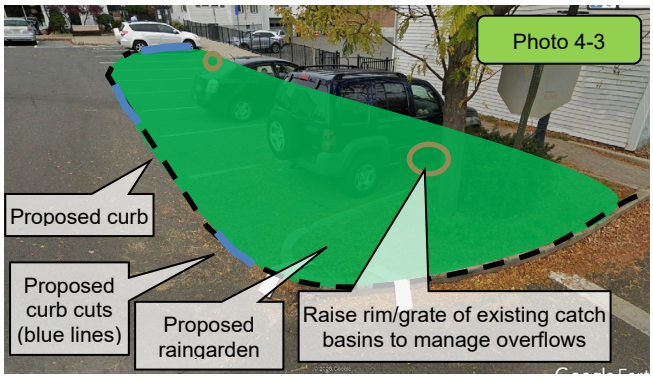
Wetland Permitting: Not expected

Parcel Ownership: Town of Amherst

Sizing Characteristics	
BMP Drainage Area (acres)	0.95
BMP Size (storm depth; inches)	1.0
Impervious Area (%)	100
Estimated Pollutant Load Reduction	
TP (lbs./yr.)	1.3
TN (lbs./yr.)	10.7
TSS (lbs./yr.)	355
Estimated Cost	
Planning-level Capital (Construction Only) Cost	$40,000
Engineering (estimated 40 % of Capital Cost)	$16,000
O & M (estimated 2 % of Capital Cost, annually)	$800/yr.







[6] Based on the USDA NRCS Web Soil Survey, the soil within the proposed BMP footprint is "Paxton-Charlton-Urban land complex, 3 to 15 percent slopes", which includes soils with HSG B and C. Soil tests should be conducted in the areas of the proposed rain gardens to confirm the HSG and to determine depth to groundwater. HSG and depth to groundwater should be considered when advancing the design.

Site 5: Alumni Parking Lot

BMP Type: Infiltration Basin with Sediment Forebay

Priority: 2

Summary: Stormwater runoff from the approximately 1-acre parking lot and surrounding area enters one of four catch basins located in the Alumni Parking Lot. The catch basins route to the storm drain network and outfall where the Fearing Brook daylights east adjacent to the parking lot and Seelye Street. Based on Amherst MA GIS data, additional stormwater runoff from a portion of the south-adjacent parking lot and roof area also enters existing drainage and discharges to Fearing Brook (Photo 5-1).

Proposed Improvement: Install an infiltration basin[7] in the existing depression area south-adjacent to the Alumni Parking Lot, block the two catch basins located in the center of the parking lot, and install piping to route the runoff entering the catch basins at the southern edge of the lot to the proposed infiltration basin (Photos 5-1, 5-2, 5-3). Install an overflow outlet pipe that routes to the existing manhole and discharges into Fearing Brook. The cross-section of the infiltration basin is like that proposed under Site 1 (Fort River Elementary School). Native species should be planted within the ponding area of the infiltration basin. Nutrient-sensitive vegetative support materials (e.g., low-nutrient compost, coconut coir, etc.) should be implemented to limit export of nutrients.

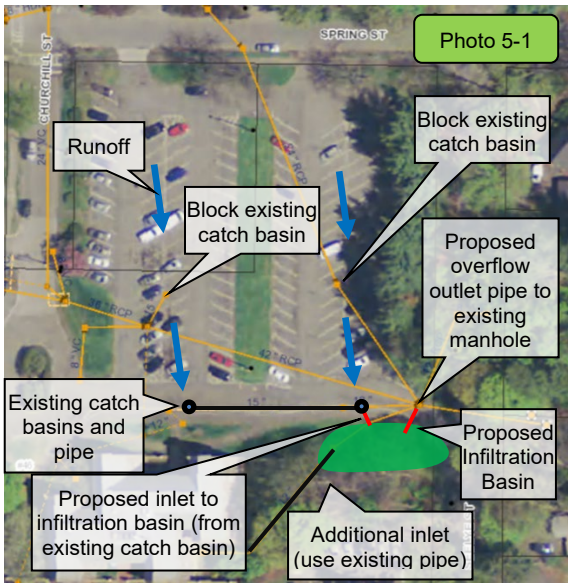
Expected Operation and Maintenance (O&M):

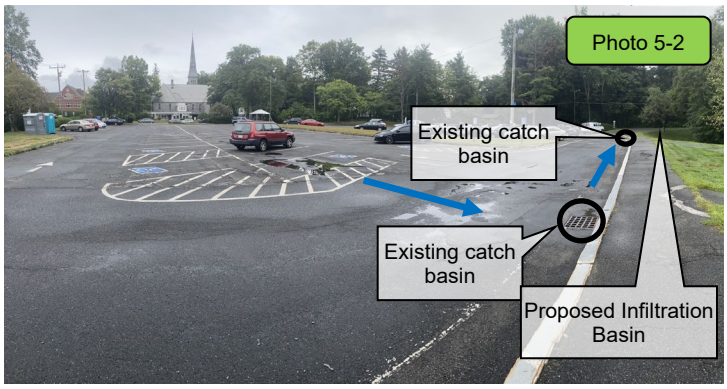
- Inspect and clean sediment forebay regularly.
- Inspect for erosion and re-mulch void areas as necessary.
- Remove and replace dead vegetation in Spring and Fall.
- Remove invasive species.
- Clean flow control structures at least once annually, or as indicated by inspection.
- Do not store snow in the infiltration basin.
- Periodically observe function under wet weather conditions.

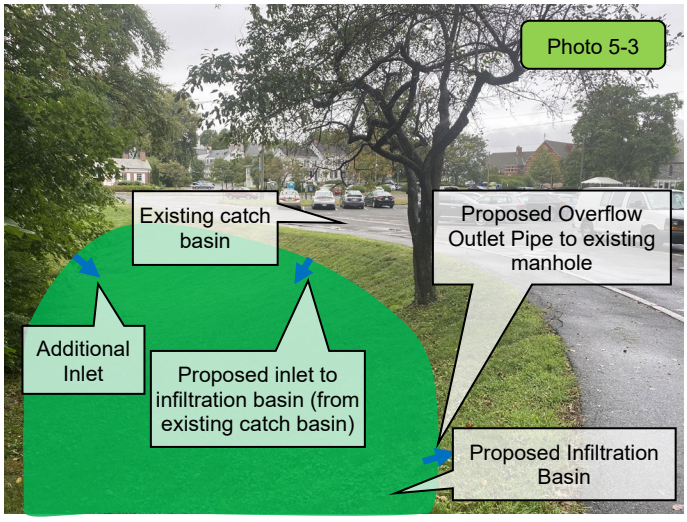
Wetland Permitting: Not expected

Parcel Ownership: Amherst College

Sizing Characteristics	
BMP Drainage Area (acres)	2.0
BMP Size (storm depth; inches)	1.0
Impervious Area (%)	66
Estimated Pollutant Load Reduction	
TP (lbs./yr.)	2.3
TN (lbs./yr.)	20.5
TSS (lbs./yr.)	524
Estimated Cost	
Planning-level Capital (Construction Only) Cost	$30,000
Engineering (estimated 40 % of Capital Cost)	$12,000
O & M (estimated 2 % of Capital Cost, annually)	$600/yr.







[7] Based on the USDA NRCS Web Soil Survey, the soil within the proposed BMP footprint is "Paxton-Charlton-Urban land complex, 3 to 15 percent slopes", which includes soils with HSG B and C. Soil tests should be conducted in the area of the proposed infiltration basin to confirm the HSG and to determine depth to groundwater. HSG and depth to groundwater should be considered when advancing the design.

Site 6: Hills Parking Lot

BMP Type: Constructed Wetland

Priority: 3

Site Summary: A 54" pipe discharges east-adjacent to the parking lot where Fearing Brook daylights; this pipe conveys runoff from the upstream storm drain network including upstream parking lots in Amherst Center and Amherst College (including drainage from Sites 3, 4, and 5). A 4-inch pipe and a 15-inch pipe (adjacent to the 54" pipe) also discharge here, but it is unclear where these pipes originate from. A 12 - inch pipe also discharges here and conveys stormwater runoff from the Amherst College drainage network. A low point with a catch basin exists in the area directly above the 54" outfall, and there is significant deterioration of the pavement/trench above the 54" outfall. There is an existing detention basin that collects runoff from the southern portion of the parking lot (including the buildings) (Photos 6-1, 6-2, 6-3).

Proposed Improvement: Horsley-Witten Group developed 30 percent conceptual design drawings (see Appendix E), which propose converting the existing detention basin into a constructed wetland with a sediment forebay and installing underground chambers. Infrastructure (i.e., manhole and piping) are proposed along the existing 12" drain line to intercept the flow from the Amherst College campus and direct it to the constructed wetland. The drawings indicate that the existing catch basin at the low point of the parking lot routes to the existing detention basin, but the Amherst GIS data indicates that this catch basin routes to the 54" outfall. If this catch basin does currently route to the 54" outfall, it is recommended that the drainage to this catch basin also be diverted to the proposed constructed wetland.

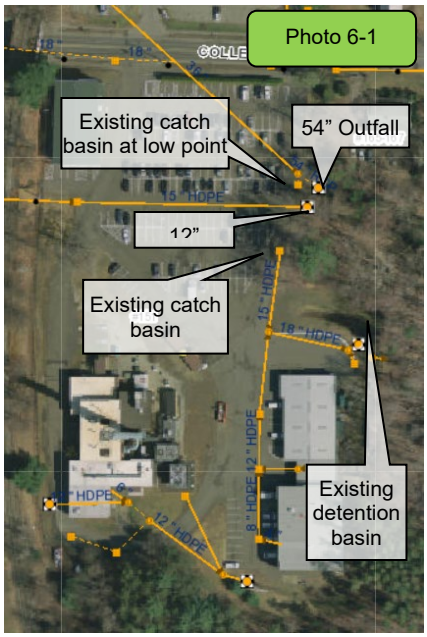
Expected Operation and Maintenance (O&M):

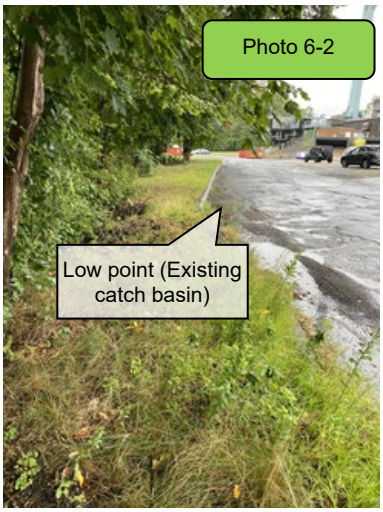
- Inspect and clean the catch basins in the parking lot regularly.
- Inspect constructed wetland at least twice a year.
- Remove and replace dead vegetation as needed and remove invasive species.
- Clean out forebay at least once a year, and clean sediment out of constructed wetland at least once every ten years.
- Annually inspect the underground chambers and remove sediment buildup as required.

Wetland Permitting: Not expected

Parcel Ownership: Town of Amherst

Sizing Characteristics	
BMP Drainage Area (acres)	6.6
BMP Size (storm depth; inches)	0.5
Impervious Area (%)	63%
Estimated Pollutant Load Reduction	
TP (lbs./yr.)	3.5
TN (lbs./yr.)	34.7
TSS (lbs./yr.)	1,358
Estimated Cost	
Planning-level Capital (Construction Only) Cost	$190,000
Engineering (estimated 40 % of Capital Cost)	$76,000
O & M (estimated 2 % of Capital Cost, annually)	$3,800/yr.





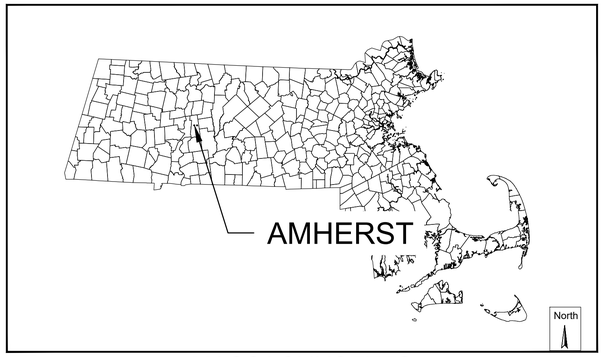
Appendix D – Pollutant Load Export Rates (PLERs)

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
AGRICULTURE, HSG A	0.45	7.14	2.59
AGRICULTURE, HSG B	0.45	29.4	2.59
AGRICULTURE, HSG C	0.45	59.8	2.59
AGRICULTURE, HSG D	0.45	91.0	2.59
AGRICULTURE, IMPERVIOUS	1.52	650	11.3
COMMERCIAL, HSG A	0.03	7.14	0.27
COMMERCIAL, HSG B	0.12	29.4	1.16
COMMERCIAL, HSG C	0.21	59.8	2.41
COMMERCIAL, HSG D	0.37	91.0	3.66
COMMERCIAL, IMPERVIOUS	1.78	377	15.1
FOREST, HSG A	0.12	7.14	0.54
FOREST, HSG B	0.12	29.4	0.54
FOREST, HSG C	0.12	59.8	0.54
FOREST, HSG D	0.12	91.0	0.54
FOREST, HSG IMPERVIOUS	1.52	650	11.3
HIGH DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
HIGH DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
HIGH DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
HIGH DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
HIGH DENSITY RESIDENTIAL, IMPERVIOUS	2.32	439	14.1
HIGHWAY, HSG A	0.03	7.14	0.27
HIGHWAY, HSG B	0.12	29.4	1.16
HIGHWAY, HSG C	0.21	59.8	2.41
HIGHWAY, HSG D	0.37	91.0	3.66
HIGHWAY, IMPERVIOUS	1.34	1,480	10.2
INDUSTRIAL, HSG A	0.03	7.14	0.27
INDUSTRIAL, HSG B	0.12	29.4	1.16
INDUSTRIAL, HSG C	0.21	59.8	2.41
INDUSTRIAL, HSG D	0.37	91.0	3.66

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
INDUSTRIAL, IMPERVIOUS	1.78	377	15.1
LOW DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
LOW DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
LOW DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
LOW DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
LOW DENSITY RESIDENTIAL, IMPERVIOUS	1.52	439	14.1
MEDIUM DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
MEDIUM DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
MEDIUM DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
MEDIUM DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
MEDIUM DENSITY RESIDENTIAL, IMPERVIOUS	1.96	439	14.1
OPEN LAND, HSG A	0.12	7.14	0.27
OPEN LAND, HSG B	0.12	29.4	1.16
OPEN LAND, HSG C	0.12	59.8	2.41
OPEN LAND, HSG D	0.12	91.0	3.66
OPEN LAND, IMPERVIOUS	1.52	650	11.3
[1]HSG = Hydrologic Soil Group			

Appendix E – Hills Parking Lot 30 Percent Design Drawings (Horsley-Witten, 2018)

FEARING BROOK STREAM RESTORATION
AMHERST, MASSACHUSETTS
30% CONCEPTUAL DESIGN
JUNE 2018

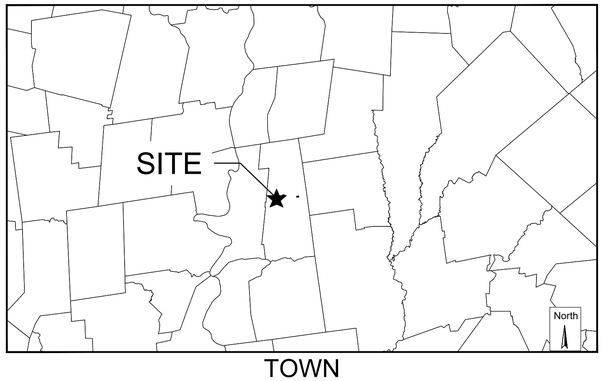


MASSACHUSETTS

Graphic Scale

0 150000

SCALE IN FEET
1:150000



TOWN

Graphic Scale

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SCALE IN FEET
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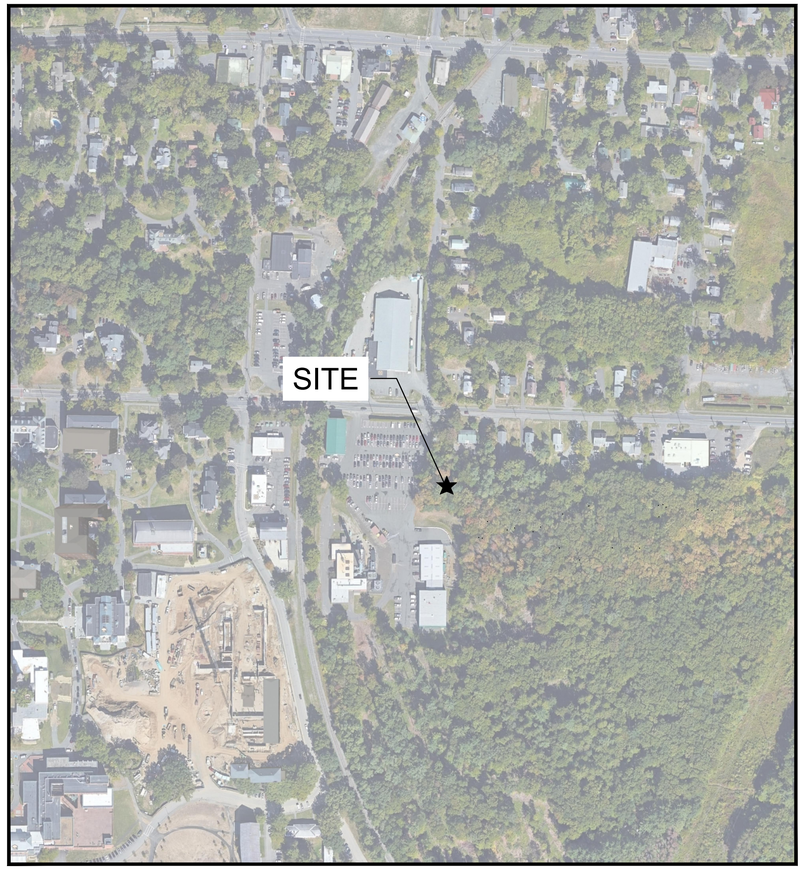

VICINITY MAP

Graphic Scale
1-inch = 200-feet

Sheet List Table	
Sheet Number	Sheet Title
1	COVER SHEET
2	EXISTING CONDITIONS
3	EXISTING STREAM TRANSECTS & PROFILE
4	SITE & GRADING PLAN
5	PROPOSED STREAM TRANSECTS & PROFILE
6	TYPICAL DETAILS

Plan Set:
FEARING BROOK STREAM RESTORATION
AMHERST, MASSACHUSETTS
30% CONCEPTUAL DESIGN

Prepared For:
Division of Ecological Restoration
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Registration:
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Revisions

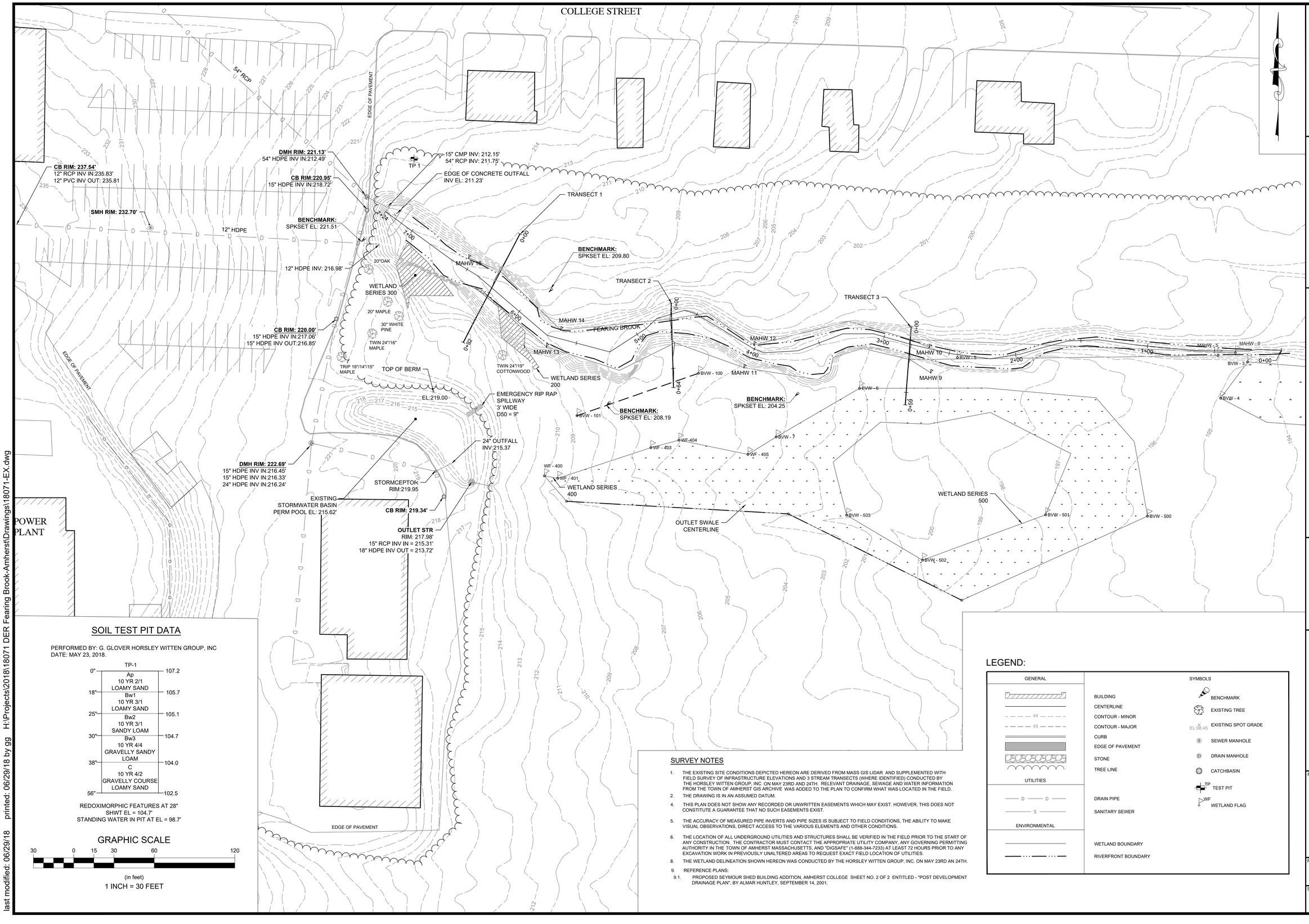
Rev.	Date	By	Appr.	Description
1				
2				
3				
4				
5				
6				
7				

Project Number: 18071

Sheet Number: 1 of 6

Drawing Number: C - 1

last modified: 06/29/18 printed: 06/29/18 by gg H:\Projects\2018\18071 DER Fearing Brook-Amherst\Drawings\18071-CV.dwg



SOIL TEST PIT DATA

PERFORMED BY: G. GLOVER HORSLEY WITTEN GROUP, INC
DATE: MAY 23, 2018.

TP-1

0"	Ap 10 YR 2/1 LOAMY SAND	107.2
18"	Bw1 10 YR 3/1 LOAMY SAND	105.7
25"	Bw2 10 YR 3/1 SANDY LOAM	105.1
30"	Bw3 10 YR 4/4 GRAVELLY SANDY LOAM	104.7
38"	C 10 YR 4/2 GRAVELLY COURSE LOAMY SAND	104.0
56"		102.5

REDOXIMORPHIC FEATURES AT 28"
SHWT EL = 104.7'
STANDING WATER IN PIT AT EL = 98.7'

GRAPHIC SCALE

30 0 15 30 60 120

(in feet)

1 INCH = 30 FEET

SURVEY NOTES

1. THE EXISTING SITE CONDITIONS DEPICTED HEREON ARE DERIVED FROM MASS GIS LIDAR AND SUPPLEMENTED WITH FIELD SURVEY OF INFRASTRUCTURE ELEVATIONS AND 3 STREAM TRANSECTS (WHERE IDENTIFIED) CONDUCTED BY THE HORSLEY WITTEN GROUP, INC ON MAY 23RD AND 24TH. RELEVANT DRAINAGE, SEWAGE AND WATER INFORMATION FROM THE TOWN OF AMHERST GIS ARCHIVE WAS ADDED TO THE PLAN TO CONFIRM WHAT WAS LOCATED IN THE FIELD.
2. THE DRAWING IS IN AN ASSUMED DATUM.
4. THIS PLAN DOES NOT SHOW ANY RECORDED OR UNWRITTEN EASEMENTS WHICH MAY EXIST. HOWEVER, THIS DOES NOT CONSTITUTE A GUARANTEE THAT NO SUCH EASEMENTS EXIST.
5. THE ACCURACY OF MEASURED PIPE INVERTS AND PIPE SIZES IS SUBJECT TO FIELD CONDITIONS, THE ABILITY TO MAKE VISUAL OBSERVATIONS, DIRECT ACCESS TO THE VARIOUS ELEMENTS AND OTHER CONDITIONS.
6. THE LOCATION OF ALL UNDERGROUND UTILITIES AND STRUCTURES SHALL BE VERIFIED IN THE FIELD PRIOR TO THE START OF ANY CONSTRUCTION. THE CONTRACTOR MUST CONTACT THE APPROPRIATE UTILITY COMPANY, ANY GOVERNING PERMITTING AUTHORITY IN THE TOWN OF AMHERST MASSACHUSETTS, AND "DIGSAFE" (1-888-344-7233) AT LEAST 72 HOURS PRIOR TO ANY EXCAVATION WORK IN PREVIOUSLY UNALTERED AREAS TO REQUEST EXACT FIELD LOCATION OF UTILITIES.
8. THE WETLAND DELINEATION SHOWN HEREON WAS CONDUCTED BY THE HORSLEY WITTEN GROUP, INC. ON MAY 23RD AN 24TH.
9. REFERENCE PLANS:
   9.1. PROPOSED SEYMOUR SHED BUILDING ADDITION, AMHERST COLLEGE SHEET NO. 2 OF 2 ENTITLED - "POST DEVELOPMENT DRAINAGE PLAN", BY ALMAR HUNTLEY, SEPTEMBER 14, 2001.

LEGEND:

GENERAL		SYMBOLS	
	BUILDING		BENCHMARK
	CENTERLINE		EXISTING TREE
44	CONTOUR - MINOR	45.45	EXISTING SPOT GRADE
45	CONTOUR - MAJOR	S	SEWER MANHOLE
	CURB	D	DRAIN MANHOLE
	EDGE OF PAVEMENT		CATCHBASIN
	STONE	TP	TEST PIT
	TREE LINE	WF	WETLAND FLAG
UTILITIES			
D D	DRAIN PIPE		
S	SANITARY SEWER		
ENVIRONMENTAL			
	WETLAND BOUNDARY		
	RIVERFRONT BOUNDARY		

Revisions

Rev.	Date	By	Appr.	Description
1	---	---	---	---
2	---	---	---	---
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Checked By: RAC
Drawn By: GKS
Designed By: RAC/GKS
Date: JUNE 2018

Plan Set: FEARING BROOK STREAM RESTORATION
AMHERST, MASSACHUSETTS
30% CONCEPTUAL DESIGN

Plan Title: EXISTING CONDITIONS

Prepared For:
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Dated: MAY 2018

Registration:

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Project Number: 18071
Sheet : 2 of 6

Sheet Number: C - 2

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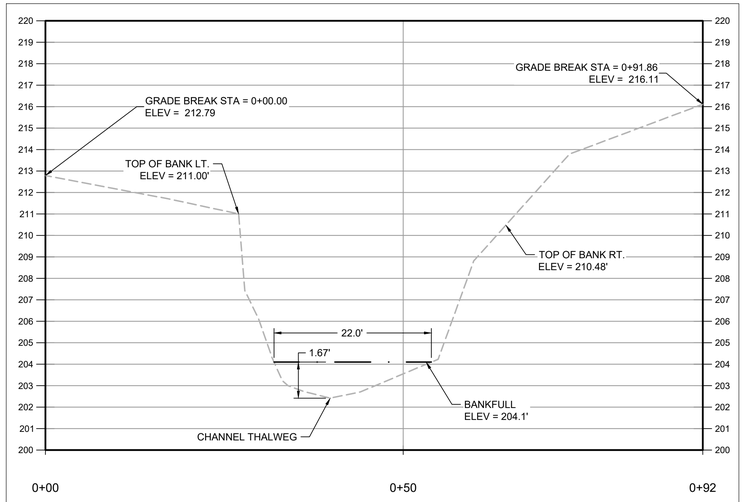

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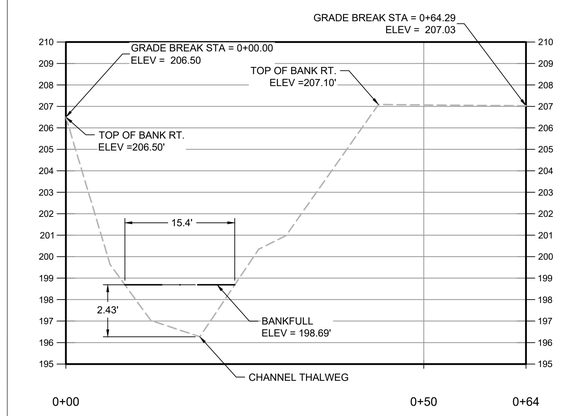
VERTICAL SCALE: 1" = 3'



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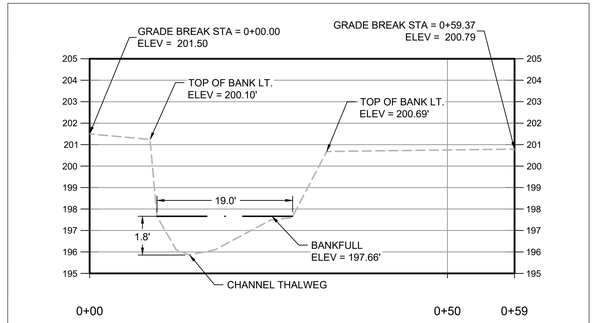

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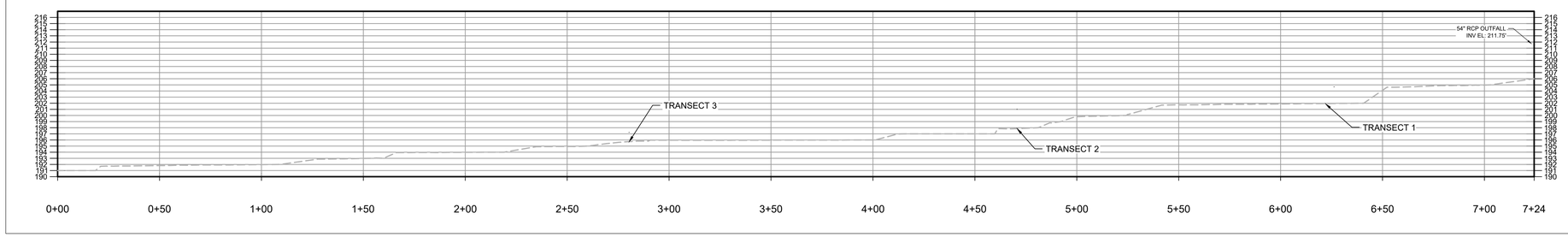

EXISTING FEARING BROOK PROFILE
HORIZONTAL SCALE : 1" = 30'
VERTICAL SCALE : NTS

Revisions

Rev.	Date	By	Appr.	Description
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2	---	---	---	---
3	---	---	---	---
4	---	---	---	---
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8	---	---	---	---

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Drawn By: GS3
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Plan Set:
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AMHERST, MASSACHUSETTS
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EXISTING STREAM TRANSECTS & PROFILE

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Project Number: 18071
Sheet : 3 of 6

Sheet Number:
C - 3

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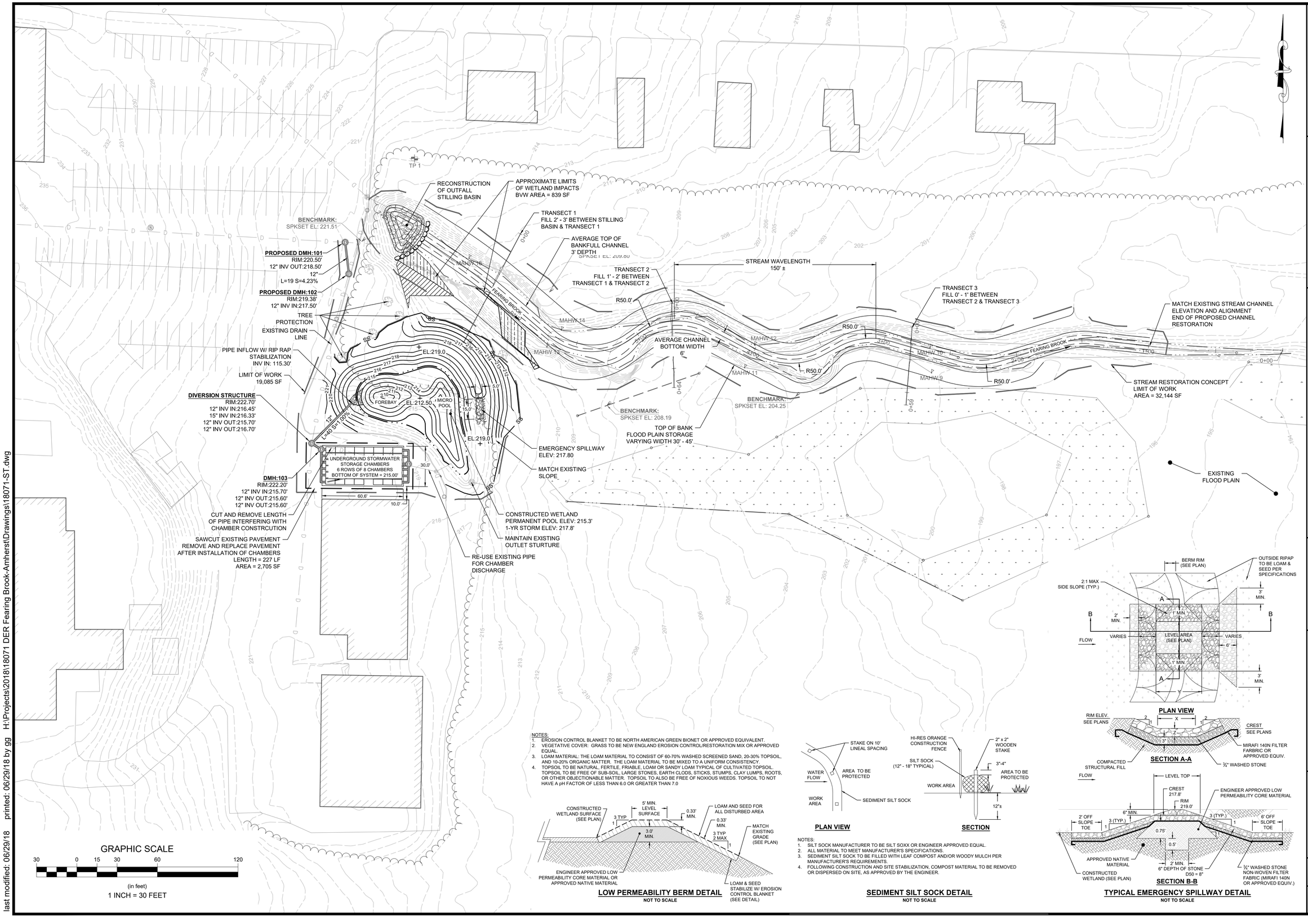

NOTES:
1. EROSION CONTROL BLANKET TO BE NORTH AMERICAN GREEN BIONET OR APPROVED EQUIVALENT.
2. VEGETATIVE COVER: GRASS TO BE NEW ENGLAND EROSION CONTROL/RESTORATION MIX OR APPROVED EQUAL.
3. LOAM MATERIAL: THE LOAM MATERIAL TO CONSIST OF 60-70% WASHED SCREENED SAND, 20-30% TOPSOIL, AND 10-20% ORGANIC MATTER. THE LOAM MATERIAL TO BE MIXED TO A UNIFORM CONSISTENCY.
4. TOPSOIL TO BE NATURAL, FERTILE, FRIABLE LOAM OR SANDY LOAM TYPICAL OF CULTIVATED TOPSOIL. TOPSOIL TO BE FREE OF SUB-SOIL, LARGE STONES, EARTH CLODS, STICKS, STUMPS, CLAY LUMPS, ROOTS, OR OTHER OBJECTIONABLE MATTER. TOPSOIL TO ALSO BE FREE OF NOXIOUS WEEDS. TOPSOIL TO NOT HAVE A pH FACTOR OF LESS THAN 6.0 OR GREATER THAN 7.0

LOW PERMEABILITY BERM DETAIL
NOT TO SCALE

PLAN VIEW SECTION

NOTES:
1. SILT SOCK MANUFACTURER TO BE SILT SOXX OR ENGINEER APPROVED EQUAL.
2. ALL MATERIAL TO MEET MANUFACTURER'S SPECIFICATIONS.
3. SEDIMENT SILT SOCK TO BE FILLED WITH LEAF COMPOST AND/OR WOODY MULCH PER MANUFACTURER'S REQUIREMENTS.
4. FOLLOWING CONSTRUCTION AND SITE STABILIZATION, COMPOST MATERIAL TO BE REMOVED OR DISPERSED ON SITE, AS APPROVED BY THE ENGINEER.

SEDIMENT SILT SOCK DETAIL
NOT TO SCALE

PLAN VIEW

SECTION A-A

SECTION B-B

TYPICAL EMERGENCY SPILLWAY DETAIL
NOT TO SCALE

Revisions

Rev.	Date	By	Appr.	Description

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Designed By: DAC/GES
Date: JUNE 2018

FEARING BROOK STREAM RESTORATION
AMHERST, MASSACHUSETTS
30% CONCEPTUAL DESIGN

SITE & GRADING PLAN

Prepared For:
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Dated: MAY 2018

Registration:

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Project Number: 18071
Sheet : 4 of 6
Sheet Number: C - 4

Plan Set:
Plan Title:

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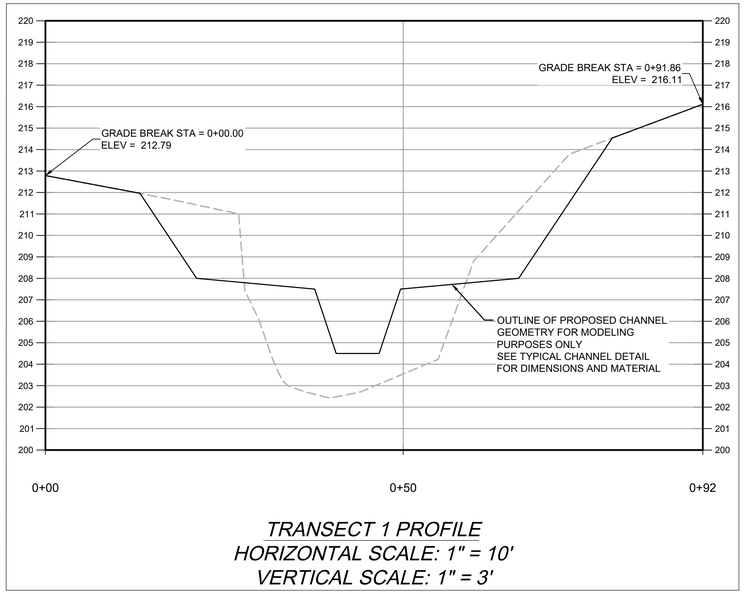

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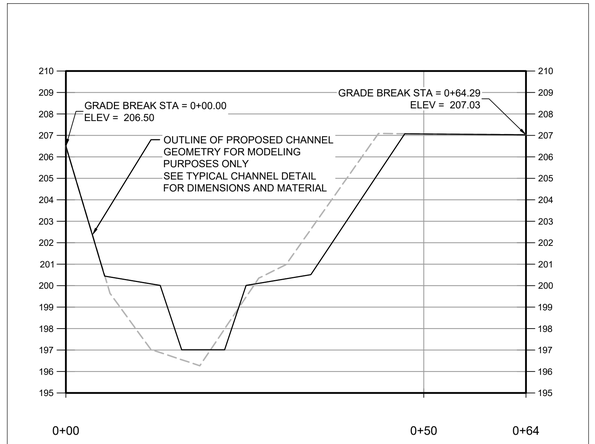
VERTICAL SCALE: 1" = 3'



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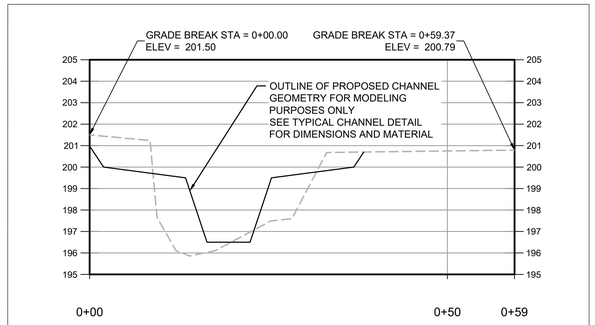

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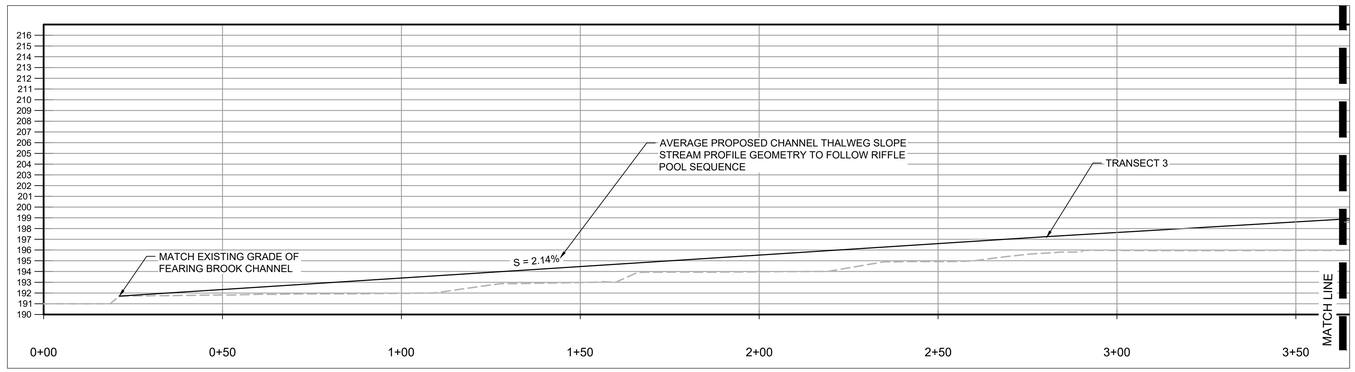

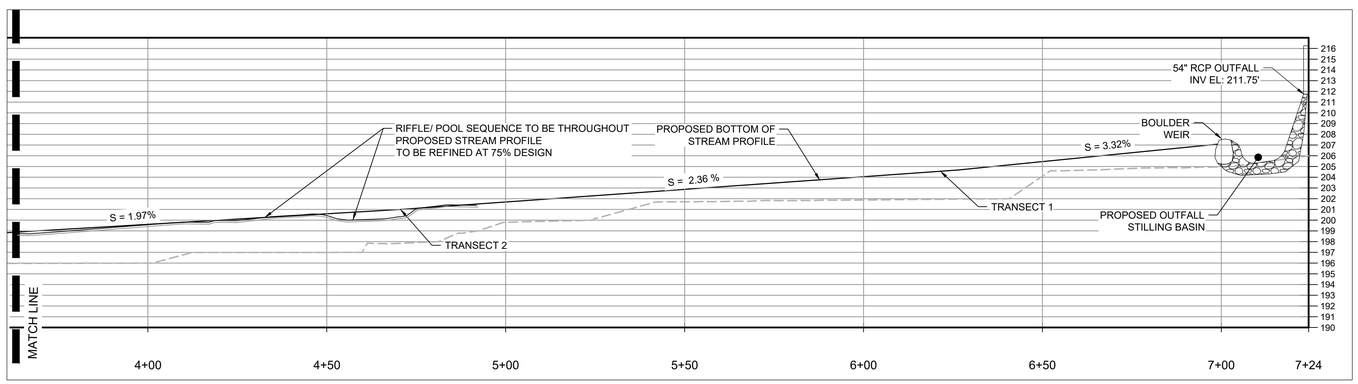

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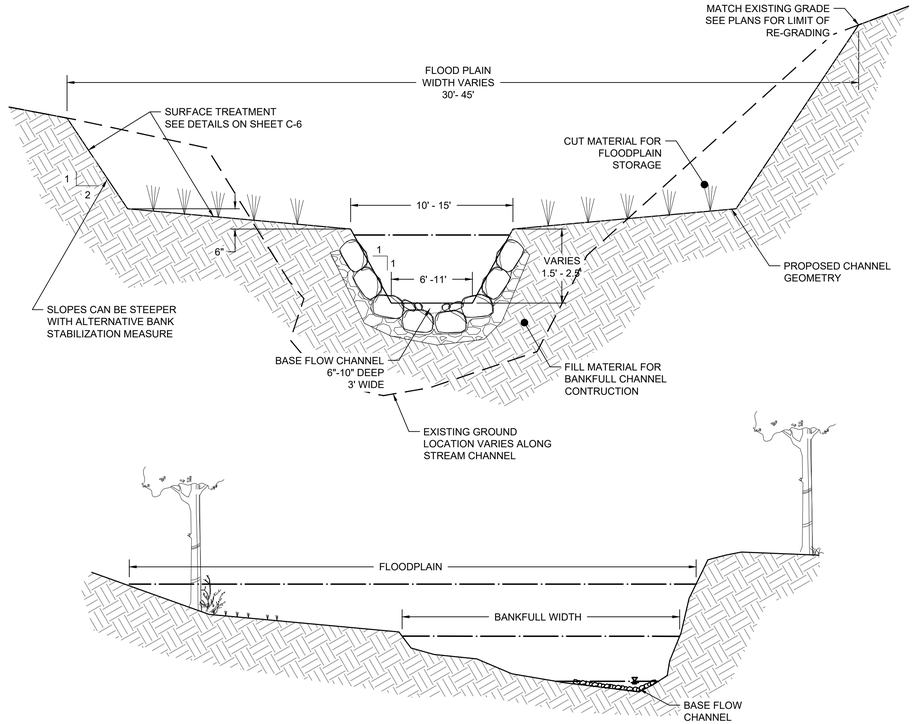

NOTES
1. CHANNEL AND BANK STABILIZATION MATERIALS AND METHODS VARY ALONG REACH. HARD ARMORING TO BIO ENGINEERED METHODS (TO BE REFINED PRIOR TO 75% DESIGN STAGE).
2. LOCATION OF BASE FLOW CHANNEL VARIES ALONG STREAM PROFILE.
3. DIMENSIONS WILL VARY W/ POSITION ALONG PROFILE PER STREAM CHANNEL SCHEMATIC

TYPICAL FEARING BROOK CHANNEL RECONSTRUCTION DETAIL
NOT TO SCALE

last modified: 06/29/18 printed: 06/29/18 by gg H:\Projects\2018\18071 DER Fearing Brook-Amherst\Drawings\18071-EX.dwg

Revisions

Rev.	Date	By	Appr.	Description
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Checked By: RAD
Drawn By: GSS
Designed By: RAD/GSS
Date: JUNE 2018

Plan Set: FEARING BROOK STREAM RESTORATION
AMHERST, MASSACHUSETTS
30% CONCEPTUAL DESIGN

Plan Title: PROPOSED STREAM TRANSECTS & PROFILE

Prepared For:
Division of Ecological Restoration
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Westfield, MA
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Dated: MAY 2018

Registration:

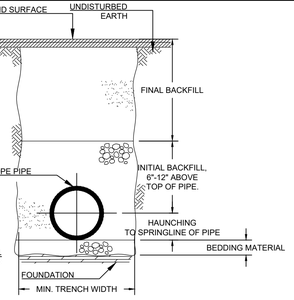
DRAFT
NOT FOR CONSTRUCTION

Project Number: 18071
Sheet : 5 of 6

Sheet Number: C - 5

NOTES:

1. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE, THE CONTRACTOR TO EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH A FOUNDATION OF CLASS I OR II MATERIAL AS DEFINED IN ASTM D2321, "STANDARD PRACTICE FOR INSTALLATION OF THERMOPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY-FLOW APPLICATIONS," LATEST EDITION; AS AN ALTERNATIVE AND AT THE DISCRETION OF THE ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A WOVEN GEOTEXTILE FABRIC.



2. BEDDING, HAUNCHING AND INITIAL BACKFILL: SUITABLE MATERIAL TO CONSIST OF CLEAN, HARD, PARTICLES OF GRAVEL MEETING THE FOLLOWING:
   SIEVE SIZE% PASSING
   3/8" 85-95
   NO. 4 5-15
   NO. 8 0-2
   MATERIAL TO BE INSTALLED AS REQUIRED IN ASTM D2321, LATEST EDITION.

   MINIMUM BEDDING THICKNESS TO BE 4" (100mm) FOR 4"-24" (100-600mm) AND 42"-48"(1050-1200mm) CORRUGATED POLYETHYLENE PIPE (CPEP); 6" (150mm) FOR 30"-36" (750-900mm) CPEP.

3. MINIMUM TRENCH WIDTHS TO BE AS FOLLOWS:

NOMINAL Ø in (mm)	MIN. RECOMMENDED TRENCH WIDTH, in (mm)
8 (200) 10	25 (630)
(250) 12	28 (710)
(300) 15	31 (790)
(375) 18	34 (860)
(450)	39 (990)

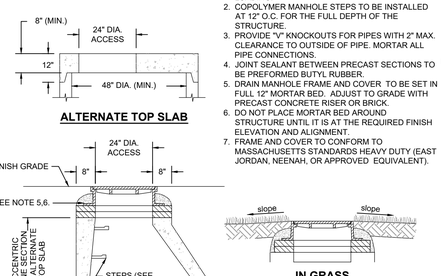
DETAIL PROVIDED BY ADVANCED DRAINAGE SYSTEMS, INC.

4. MINIMUM COVER: MINIMUM RECOMMENDED DEPTHS OF COVER FOR VARIOUS LIVE LOADING CONDITIONS ARE SUMMARIZED IN THE FOLLOWING TABLE. UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE TAKEN FROM THE TOP OF PIPE TO THE GROUND SURFACE.

SURFACE LIVE LOADING CONDITION	MINIMUM RECOMMENDED * COVER, in (mm)
H25 (FLEXIBLE PAVEMENT)	12 (300)
H25 (RIGID PAVEMENT) E80	12 (300)
RAILWAY HEAVY	24 (610)
CONSTRUCTION	48 (1220)

* TOP OF PIPE TO BOTTOM OF BITUMINOUS PAVEMENT THE MINIMUM COVER FOR A HDPE PIPE IS 1'-0" FOR H-20 TRAFFIC LOADS IF INSTALLED IN ACCORDANCE WITH AASHTO SECTION 30. THIS IS BASED ON EMPIRICAL CALCULATION OF LOAD RESPONSE, MANUFACTURER'S TESTING AND FIELD EXPERIENCE WITH THE PIPE. AASHTO SPECIFICATIONS SECTION 18.4.1.5 DEFINES THE MINIMUM COVER AS "ID/8 BUT NOT LESS THAN 12 INCHES". THIS COVER IS MEASURED FROM THE PIPE OD TO THE TOP OF A RIGID (CONCRETE) PAVEMENT OR THE BOTTOM OF A FLEXIBLE (BITUMINOUS) PAVEMENT. BOTH AASHTO AND ASTM, AS WELL AS MOST MANUFACTURERS, REQUIRE ADDITIONAL (TEMPORARY COVER, MOUNDED OVER THE PIPE AND REMOVED FOR FINAL GRADING AND PAVING, IS SUFFICIENT FOR LARGE CONSTRUCTION VEHICLE LOADS.

TYPICAL DRAINAGE PIPE TRENCH DETAIL
NOT TO SCALE

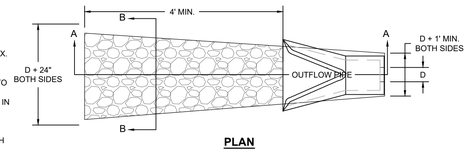


ALTERNATE TOP SLAB

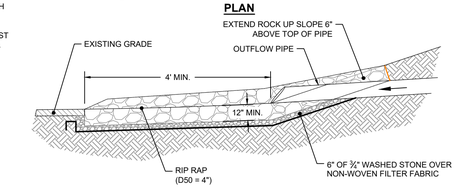
NOTES:
1. ALL SECTIONS TO BE DESIGNED FOR H-20 LOADING.
2. COPOLYMER MANHOLE STEPS TO BE INSTALLED AT 12" O.C. FOR THE FULL DEPTH OF THE STRUCTURE.
3. PROVIDE "V" KNOCKOUTS FOR PIPES WITH 2" MAX. CLEARANCE TO OUTSIDE OF PIPE. MORTAR ALL PIPE CONNECTIONS.
4. JOINT SEALANT BETWEEN PRECAST SECTIONS TO BE PREFORMED BUTYL RUBBER.
5. DRAIN MANHOLE FRAME AND COVER TO BE SET IN FULL 12" MORTAR BED. ADJUST TO GRADE WITH PRECAST CONCRETE RISER OR BRICK.
6. DO NOT PLACE MORTAR BED AROUND STRUCTURE UNTIL IT IS AT THE REQUIRED FINISH ELEVATION AND ALIGNMENT.
7. FRAME AND COVER TO CONFORM TO MASSACHUSETTS STANDARDS HEAVY DUTY (EAST JORDAN, NEENAH, OR APPROVED EQUIVALENT).

IN GRASS

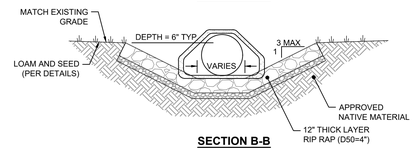
PRECAST DRAIN MANHOLE (DMH)
NOT TO SCALE



PLAN



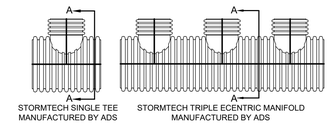
SECTION A-A



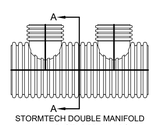
SECTION B-B

NOTES:
1. RIP RAP TO SURROUND THE OUTFLOW PIPE PER THE DIMENSIONS SHOWN.
2. BACKFILL TO COMPLETELY COVER FILTER FABRIC.
3. FILTER FABRIC TO BE TOED INTO THE END OF THE OUTFALL (3" MIN.).

PIPE OUTFLOW DETAIL
NOT TO SCALE



SECTION VIEW A-A



STUB SIZE	HEADER PIPE SIZES										
	48"	42"	36"	30"	24"	18"	15"	12"	10"	8"	6"
12"	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	-	-	-
10"	-	-	-	-	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	-	-
8"	-	-	-	-	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	-
6"	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL	AVAIL

AVAIL - STANDARD HEADERS AVAILABLE

MANIFOLDS ARE DESIGNED TO BE COUPLED TO STORMTECH PREFABRICATED END CAPS. WHEN USING STANDARD END CAPS, CORRUGATE DPIPE UP TO 10 INCHES CAN BE INSERTED DIRECTLY INTO THE END CAP. FOR 12" INLET PIPES, A CORRUGATED TO SMOOTH PIPE ADAPTER IS REQUIRED.

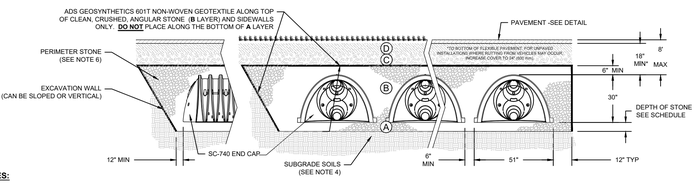
ADS MANIFOLD DETAIL
NOT TO SCALE

FOR INFORMATION CALL 1-888-892-2694

ACCEPTABLE FILL MATERIALS: STORMTECH SC-740 CHAMBER SYSTEMS

	MATERIAL LOCATION	DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 18" (450 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145* A-1, A-2-4, A-3 OR AASHTO M43* 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 12" (300 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 6" (150 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. ROLLER GROSS VEHICLE WEIGHT NOT TO EXCEED 12,000 lbs (53 kN). DYNAMIC FORCE NOT TO EXCEED 20,000 lbs (89 kN).
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43* 3, 357, 4, 467, 5, 56, 57	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43* 3, 357, 4, 467, 5, 56, 57	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE.^^

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 6" (150 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:
1. SC-740 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS", OR ASTM F2922 "STANDARD SPECIFICATION FOR POLYETHYLENE (PE) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"
2. SC-740 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. THE INSTALLED CHAMBER SYSTEM TO PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCE.
4. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
5. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
6. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
7. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.
8. FOR INFORMATION, CONTACT STORMTECH AT 1-888-892-2694.

STORMTECH SC-740 CHAMBER TYPICAL CROSS SECTION
NOT TO SCALE

NOMINAL CHAMBER SPECIFICATIONS

SIZE (W x H x INSTALLED LENGTH)	51.0" x 30.0" x 85.4"
CHAMBER STORAGE	45.9 CUBIC FEET
MINIMUM INSTALLED STORAGE	74.9 CUBIC FEET
WEIGHT	75 lbs.

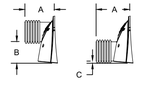
STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"

PART#	STUB	A	B	C
SC740EPE06T	6"(150 mm)	10.90" (277 mm)	18.50" (470 mm)	N/A
SC740EPE06B	6"(150 mm)	10.90" (277 mm)	N/A	0.50" (13 mm)
SC740EPE08T	8"(200 mm)	12.20" (310 mm)	16.50" (419 mm)	N/A
SC740EPE08B	8"(200 mm)	12.20" (310 mm)	N/A	0.60" (15 mm)
SC740EPE10T	10"(250 mm)	13.40" (340 mm)	14.50" (368 mm)	N/A
SC740EPE10B	10"(250 mm)	13.40" (340 mm)	N/A	0.70" (18 mm)
SC740EPE12T	12"(300 mm)	14.70" (373 mm)	12.50" (318 mm)	N/A
SC740EPE12B	12"(300 mm)	14.70" (373 mm)	N/A	1.20" (30 mm)
SC740EPE15T	15"(375 mm)	18.40" (467 mm)	9.00" (229 mm)	N/A
SC740EPE15B	15"(375 mm)	18.40" (467 mm)	N/A	1.30" (33 mm)
SC740EPE18T	18"(450 mm)	19.70" (500 mm)	5.00" (127 mm)	N/A
SC740EPE18B	18"(450 mm)	19.70" (500 mm)	N/A	1.60" (41 mm)
SC740EPE24B	24"(600 mm)	18.50" (470 mm)	N/A	0.10" (3 mm)

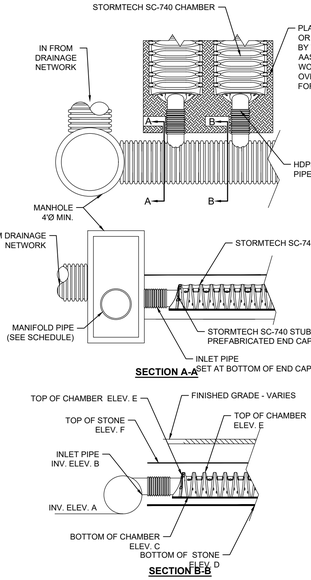
NOTE: ALL DIMENSIONS ARE NOMINAL

ALL STUBS, EXCEPT FOR THE SC740EPE24B ARE PLACED AT BOTTOM OF END CAP SUCH THAT THE OUTSIDE DIAMETER OF THE STUB IS FLUSH WITH THE BOTTOM OF THE END CAP. FOR ADDITIONAL INFORMATION CONTACT STORMTECH AT 1-888-892-2694.

*FOR THE SC740EPE24B THE 24" STUB LIES BELOW THE BOTTOM OF THE END CAP APPROXIMATELY 1.75". BACKFILL MATERIAL SHOULD BE REMOVED FROM BELOW THE N-12 STUB SO THAT THE FITTING SITS LEVEL.



STORMTECH TECHNICAL DETAILS
NOT TO SCALE



STORMTECH SYSTEM DETAIL
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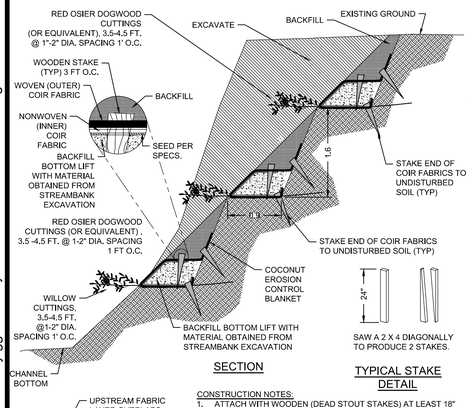

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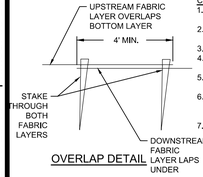
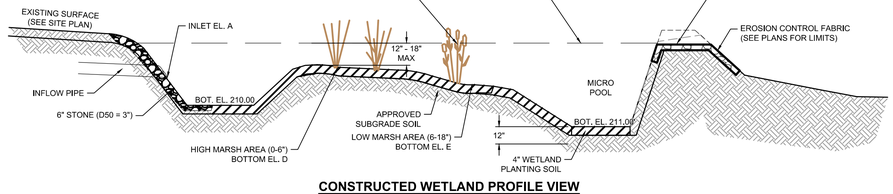


OVERLAP DETAIL

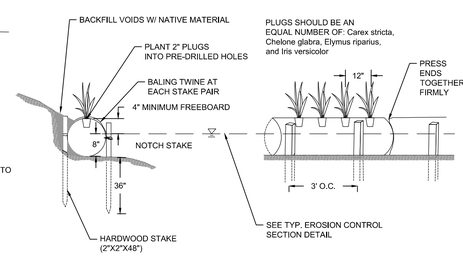
TYPICAL STAKE DETAIL

CONSTRUCTION NOTES:
1. ATTACH WITH WOODEN (DEAD STOUT STAKES) AT LEAST 18" IN LENGTH (2X4 CUT AT AN ANGLE) OR METAL PINS.
2. POSITION STAKES APPROXIMATELY 3' APART (3 PER SQ. YARD OF FABRIC), DOMINO PATTERN.
3. OVERLAP FABRIC AT LEAST 18" IN WATER FLOW DIRECTION.
4. OVERLAP EDGES AT LEAST 8", STAKING BOTH EDGES SECURELY.
5. CHECK SLOTS WITH FABRIC BURIED AT LEAST 6" DEEP SHOULD BE USED EVERY 25' IN WATERWAYS OR DITCHES.
6. THE FABRIC SHOULD BE BURIED IN ANCHOR TRENCHES AT LEAST 10" DEEP AT THE TOP AND BOTTOM ENDS OF AN INSTALLATION TO PREVENT UNDERCUTTING OF THE FABRIC.
7. COCONUT EROSION CONTROL BLANKET SHALL BE 'GEOCOIR 700' OR APPROVED EQUAL, ABLE TO WITHSTAND 10 FPS WATER VELOCITIES AND 4.46 PSF SHEAR STRESS. FABRIC EMBEDMENT 3.0 FT MIN.

LIVE STAKING FOR BANK STABILIZATION DETAIL
NOT TO SCALE



CONSTRUCTED WETLAND PROFILE VIEW
NOT TO SCALE



COIR FIBER LOG DETAIL
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Revisions

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Checked By: RAC
Drawn By: GES
Designed By: DAC/GES
Date: JUNE 2018

Plan Set:
FEARING BROOK STREAM RESTORATION
AMHERST, MASSACHUSETTS
30% CONCEPTUAL DESIGN

Plan Title:
TYPICAL DETAILS

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Dated: MAY 2018

Registration:

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Sheet: 6 of 6
Sheet Number: C - 6

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